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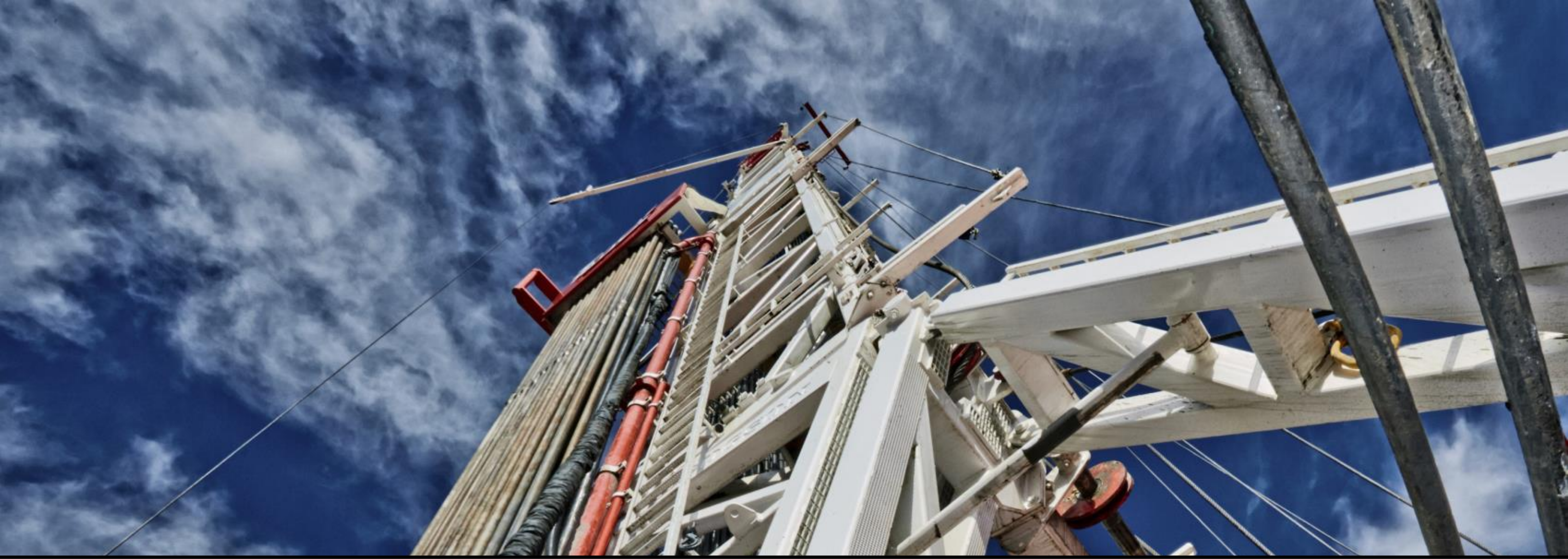

AMERICA'S UNCONVENTIONAL ENERGY OPPORTUNITY

A WIN-WIN PLAN FOR THE ECONOMY, THE ENVIRONMENT, AND A LOWER-CARBON, CLEANER-ENERGY FUTURE

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EXECUTIVE SUMMARY

Unconventional gas and oil resources* are perhaps the single largest opportunity to improve the trajectory of the U.S. economy, at a time when the prospects for the average American are weaker than we have experienced in generations. America's new energy abundance can not only help restore U.S. competitiveness but can also create geopolitical advantages for America. These benefits can be achieved while substantially mitigating local environmental impact and speeding up the transition to a cleaner-energy future that is both practical and affordable.

However, America is currently caught in an unproductive, divisive, and often misinformed debate about our energy strategy, which threatens our nation's economic and environmental goals. There is an urgent need for the U.S. to get on a new path. We set forth an overall strategy for unconventional energy development that meets the most important goals of industry, environmental stakeholders, and governments, and allows the U.S. to responsibly achieve the full benefits of this unique and vital opportunity.

THE U.S. COMPETITIVENESS CHALLENGE

The ability of the U.S. economy to improve the standard of living of the average citizen is weaker than it has been in generations. The deterioration began well before the Great Recession and is reflected by slow job growth and stagnating wages, especially for middle- and lower-middle-class Americans. While U.S.-based multinational businesses have outperformed those in other advanced economies, small businesses in the U.S. are registering eroding performance, and business failures have outnumbered new startups from 2009 through 2012—the last year of available data—for the first time since at least the 1970s. U.S. growth has exceeded that of Europe and Japan in recent years, but our growth is still the slowest in many decades.

America's poor economic performance is not cyclical but structural, and it reflects an erosion of the nation's fundamental competitiveness. As documented by the U.S. Competitiveness Project at Harvard Business School (HBS), the overall quality of America's business environment has declined in key areas, including skills, infrastructure, costs of doing business, and corporate tax structure. While the U.S. retains core strengths, partisan political gridlock has meant that little progress has been made on reducing any of America's emerging weaknesses. This project is motivated by that gridlock, which is also threatening one of America's emerging strengths: unconventional energy development.

AMERICA'S UNCONVENTIONAL ENERGY ADVANTAGE

America's abundant and low-cost unconventional gas and oil resources are a once-in-a-generation opportunity to change the nation's economic and energy trajectory. The U.S. now has a global energy advantage, with wholesale natural gas prices averaging about one-third of those in most other industrial countries, and industrial electricity prices 30–50% lower than in other major export nations. That means major benefits for industry, households, governments, and communities, while reducing America's trade deficit and geopolitical risks. The U.S. has had a 10- to 15-year head start in commercializing unconventional resources versus other countries. Though the recent decline in world oil prices has affected the short-term prospects of U.S. unconventionals, low prices are unlikely to significantly impact the fundamental U.S. competitive advantage over the next several decades.

THE ENERGY OPPORTUNITY AT RISK

Despite these major benefits, however, public support for unconventional energy development, and especially hydraulic fracturing, is decidedly mixed and seems to be declining. Further development is increasingly threatened. Opposition reflects both legitimate concerns over local environmental and climate impacts, and widespread confusion over the facts.

In today's status quo, no stakeholder is achieving its most essential goals. The ability to change America's economic trajectory is being eroded, industry is facing stiff opposition, local environmental performance is not improving as

*We define unconventional gas and oil resources as shale gas and oil resources as well as tight gas and oil resources. These resources are accessed and extracted through the process of hydraulic fracturing. Unconventionals do not include other forms of oil and gas resources, such as oil sands, extra heavy oil, coal-to-gas conversion, or coal bed methane.

rapidly as it can and should, and large-scale progress toward a cleaner-energy and a lower-carbon future remains fiercely contested. There is now a real risk that America will fail to capitalize on this historic opportunity, much less build on it.

CREATING A WIN-WIN STRATEGY

The HBS–Boston Consulting Group (BCG) project was established to develop a shared fact base, engage the key stakeholders, and advance a shared agenda for developing America's unconventional gas and oil resources in a way that addresses the key objectives of all the stakeholders. This win-win pathway involves 11 action steps across three pillars:

A. Capitalizing on America's new energy advantage to enhance **U.S. competitiveness** and the prosperity of the average citizen;

B. Minimizing the **local environmental**, health, and community impacts of developing the new energy resources at competitive cost;

C. Utilizing unconventionals to accelerate a practical and cost-efficient transition to a **lower-carbon, cleaner-energy** future.

A. Enhancing the economic opportunity

Unconventionals have already created major economic benefits for the U.S., adding more than $430 billion to annual GDP and supporting more than 2.7 million American jobs that pay, on average, two times the median U.S. salary. Fully 50% of the unconventionals production jobs are middle-skills jobs, accessible to the average citizen. The U.S. is still in the early stages of capitalizing on this economic opportunity, and current activity is concentrated in the upstream energy-production sector. With proper policies and actions by the industry and other stakeholders, this economic opportunity can further spread into downstream industries, such as petrochemicals and energy-intensive industries, and more broadly throughout the economy.

To realize that potential, however, the U.S. must address a number of key challenges:

1. **Continuing the timely development of efficient energy infrastructure.** Additional pipelines, gathering, and processing infrastructure are needed to safely and efficiently move unconventional gas and oil from producing regions to users across America.
2. **Delivering a skilled workforce.** The U.S. will need many more trained workers with the right skills across a wide variety of occupations to fill the well-paying middle-skills jobs.
3. **Eliminating outdated restrictions on gas and oil exports.** With abundant resources, restrictions on exports created in response to the 1970s' energy crises are no longer needed, and exports would boost U.S. economic and job growth while benefitting friendly nations.

B. Minimizing local environmental impacts

The development of unconventional energy resources creates significant environmental risks to water, air, land, and communities, which must be clearly acknowledged. Our research reveals that real progress is being made in managing these environmental risks at a cost that does not threaten competitiveness. In addition, mitigation technology is rapidly improving. Significant progress has also been made in improving regulatory standards in most energy-producing states, and continuous-improvement bodies have been formed to diffuse leading practices among regulators and industry stakeholders.

There is no inherent trade-off between environmental protection and company profitability. With sound regulation and strong compliance, the cost of good environmental performance is modest and gives companies a level playing field on which to compete. However, poor and uneven compliance by some operators and uneven diffusion of leading practices continue to create significant problems. Improvement is needed in four key areas:

4. **Developing transparent and consistent environmental performance data.** Transparent environmental performance data creates the foundation for monitoring compliance and stimulating innovation. State governments, industry, and NGOs all have roles to play.
5. **Setting robust regulatory standards.** Better standards are needed to fill gaps, speed adoption of industry-leading practices, and encourage further innovation.
6. **Achieving universal regulatory compliance.** Both industry and regulators need to strengthen regulatory enforcement and producer compliance.

7. **Strengthening bodies driving continuous environmental improvement.** Continuous-improvement organizations such as STRONGER and CSSD* have played an important role, but steps are needed to improve collaboration and better disseminate recommendations.

C. Speeding the transition to a cleaner-energy, lower-carbon future

Over the last decade, the U.S. has begun a major transition toward a more-efficient, cleaner, and lower-carbon energy system led by the power sector. Our research finds that that transition will not only continue, but could accelerate over the next 20–30 years and will lead to major economic and environmental benefits.

While many stakeholders still believe that unconventional energy development and America's energy transition are antithetical, they are actually complementary. Natural gas is the only fuel that can cost-effectively deliver large-scale carbon emissions reductions over the next 20 years while also providing a bridge to achieving even lower low-carbon solutions over the long term.

Our analysis shows that developing unconventional resources today is unlikely to delay the rollout of renewables. Instead, it can actually enable their scale-up. We also find that the use of natural gas today will not lock in greenhouse gas emissions for the indefinite future, and that low-cost natural gas-fired power plants will provide the essential standby power needed to scale up renewables.

However, to achieve this successful transition to a lower-carbon future, the U.S. must address a number of key challenges:

8. **Containing methane leakage.** Uncontrolled methane leakage can offset the climate benefits of natural gas. Cost-effective methods to contain leakage are available and need to be deployed throughout the natural gas value chain.
9. **Setting policies that encourage cost-effective emissions reductions.** Climate policies and regulations should be market-based to encourage cost-effective carbon reductions, rather than specifying particular technologies.
10. **Fostering clean-energy technologies.** The U.S. needs to encourage ongoing private- and public-sector research investments in cost-effective, low-carbon energy technologies and applications, including potentially broader uses of unconventional natural gas.
11. **Building out a smart, efficient energy grid.** The long-term (by around 2050) transition to a low-carbon energy system will require a robust power grid infrastructure capable of addressing the intermittent nature of renewable power sources. The U.S. and states must invest now in these grid improvements to enable renewables to scale over the long run.

MOVING TO ACTION

These 11 action steps are a practical, achievable strategic agenda for America to make the most of its energy advantage while delivering on the nation's most important economic, environmental, and climate objectives.

To move these steps to action, we need to change the discussion, move beyond ideology, and break the gridlock. Industry, NGOs, governments, and academics must transcend their traditional positions, let go of the exaggerated rhetoric, and start overcoming historic skepticism and distrust that have led to the current, zero-sum mindsets and halting progress. Every stakeholder will be most effective in meeting its essential goals if it can recognize the benefits of working toward a good overall outcome for America, not just maximizing its narrowly defined historical self-interests.

The U.S. needs to achieve a "rational middle" ground to capitalize on this historic opportunity. The stakes are too high to fail. Long-entrenched opposition and antagonism will not dissipate overnight. But we must get started.

*STRONGER is the State Review of Oil and Natural Gas Environmental Regulations, and CSSD is the Center for Sustainable Shale Development

The win-win plan for unconventional energy development

Strategic Agenda	Immediate Action Steps
Enhance the Economic Opportunity	
Continue the timely development of efficient energy infrastructure	• Set and enforce existing federal and state timetables for infrastructure permitting processes. • Designate a lead state agency for coordinating infrastructure permit reviews at the state level.
Deliver a skilled workforce	• Business across the sector should identify the middle-skills and high-skills gaps that are hardest to fill, and proactively invest in developing a pipeline of talent for their industry or region. • Industry should partner with educators to continually shape the curriculum that delivers the qualifications and credentials employers need, and support schools with equipment, internships, instructors, and hiring commitments.
Eliminate outdated restrictions on gas and oil exports	• Lift the ban on crude oil exports to all WTO members. • Remove restrictions to Department of Energy permitting of LNG export projects.
Minimize Local Environmental Impacts	
Develop transparent and consistent environmental performance data	• Develop consistent data standards for measuring environmental impacts of unconventionals, led by states working with industry and NGOs. • Ensure that the data are made accessible and publicly available, and are consistent and comparable across states.
Set robust regulatory standards	• Set robust state regulatory standards that are performance-based to better address gaps in areas such as water management, seismicity, and truck traffic. • Design standards that are performance-based and encourage further innovation.
Achieve universal regulatory compliance	• Bolster enforcement by adequately staffing state agencies, modernizing data management systems, prioritizing inspections based on past behavior, and sharing best practices among state regulators. • Establish an industry-led self-enforcement process to supplement regulatory enforcement, considering models such as Responsible Care (chemicals) or the Center for Offshore Safety (offshore oil and gas).
Strengthen bodies driving continuous environmental improvement	• Expand collaboration among existing continuous improvement bodies on overlapping areas of focus (e.g., IOGCC and STRONGER collaborating on regulatory best-practice sharing). • Speed the dissemination of best practices in operator performance, regulations, and enforcement through more proactive stakeholder outreach by continuous-improvement bodies.
Speed the Transition to a Cleaner-Energy, Lower-Carbon Future	
Contain methane leakage	• Finalize the Obama Administration's plan to reduce methane leakage in the oil and gas sector by 40-45% through flexible federal methane leakage standards for new oil & gas installations together with an enhanced voluntary Gas STAR improvement program for existing installations. • Develop a strong industry-led program to ensure that the voluntary component for existing installations achieves its targets, through existing bodies like America's Natural Gas Alliance (ANGA) and American Petroleum Institute (API), or through new coalitions such as One Future.
Set policies that encourage cost-effective emissions reductions	• Ensure that all federal climate policies and regulations set clear, long-term targets for greenhouse gas emissions. • Utilize market mechanisms to encourage cost-effective emissions reductions using the most competitive technologies.
Foster clean-energy technologies	• Continue both industry and federal research and development in renewables as well as other potentially competitive, cleaner-energy technologies. • Encourage low-carbon innovation outside the power sector, including in transportation and heavy manufacturing.
Build out a smart, efficient energy grid	• Modernize and expand the electricity grid (transmission and distribution) in all U.S. regions to enable utilization and management of large-scale renewable generation. • Streamline rules and planning processes across regions to facilitate crucial interregional connections and efficiencies.

Chapter 1:

INTRODUCTION

THE U.S. ENERGY OPPORTUNITY

Today, the U.S. economy is doing only half of its job. Starting well before the Great Recession and subsequent slow recovery, U.S. economic performance has eroded. While highly skilled individuals, large international companies, and some high-tech startups are doing well, middle- and lower-middle-class Americans have seen slow job growth and stagnating wages. Small businesses are generating fewer jobs, and more are closing than are opening. Although the U.S. is doing relatively better recently than other advanced nations, such as in Western Europe and Japan, U.S. economic performance by many indicators is worse than we have experienced in generations.

This poor performance is not cyclical but structural. It reflects an erosion of the nation's fundamental competitiveness. Over the last five years of research, the U.S. Competitiveness Project at Harvard Business School (HBS) has sought to understand why. We have found that, while the U.S. retains core strengths that provide advantages relative to other countries, the overall quality of America's business environment has eroded in key areas, including skills, infrastructure, costs of doing business, and corporate tax structure.[1]

HBS has put forward a consensus plan to address key U.S. weaknesses, as have others. However, political gridlock has meant that little progress has been made on any of America's fundamental weaknesses in a decade.

Despite these challenges, however, an unprecedented opportunity has emerged for the U.S. Vast new reserves of unconventional domestic oil and gas have been opened up over the last five years, using recent advances in hydraulic fracturing and horizontal drilling. These new resources are both abundant and low-cost. U.S. production of natural gas has increased by 35% since 2005,[2] eliminating the need for gas imports. Oil production has increased by 45% since 2010,[3] restoring the U.S. as the second-largest oil producer in the world for the first time since 1991.[4]

Unconventional energy is perhaps the largest single opportunity to change America's competitiveness and economic trajectory, as well as our geopolitical standing.

This energy revolution has created a major energy advantage for the U.S., especially in natural gas. In the U.S., wholesale gas prices average about one-third of those in most other industrial countries.[5] Low gas costs are also driving advantages in electricity costs, where U.S. industrial electricity prices are 30-50% lower than those of other major exporters. The American energy advantage is likely to persist for the foreseeable future. The U.S. has a 10- to 15-year head start in commercializing unconventional resources versus other countries, and efficiency innovations driven by the recent oil price decline may extend the U.S. lead even further.[6]

Unconventionals generate enormous benefits

Unconventionals are already driving major benefits in economic growth, job generation, consumer savings, and government revenue. (See Figure 1.) We estimate that unconventional energy development contributes more than $430 billion to annual U.S. GDP, nearly equal to the GDP of the entire state of Ohio. Unconventionals also supported more than 2.7 million American jobs, ranging from those in exploration and production to supporting industries and local services. To put that in perspective, since 2005 the U.S. economy has only added a total of 4.9 million new jobs.[8]

The types of jobs being created are desperately needed. More than 50% of jobs in unconventional energy development require middle-skills, and the average job generated from the production of unconventionals pays nearly two times the median U.S. salary.[9] As BCG's *Made in America, Again* series shows, the energy advantage is not only creating new U.S. jobs but is shifting thousands of jobs back to the U.S. from overseas.

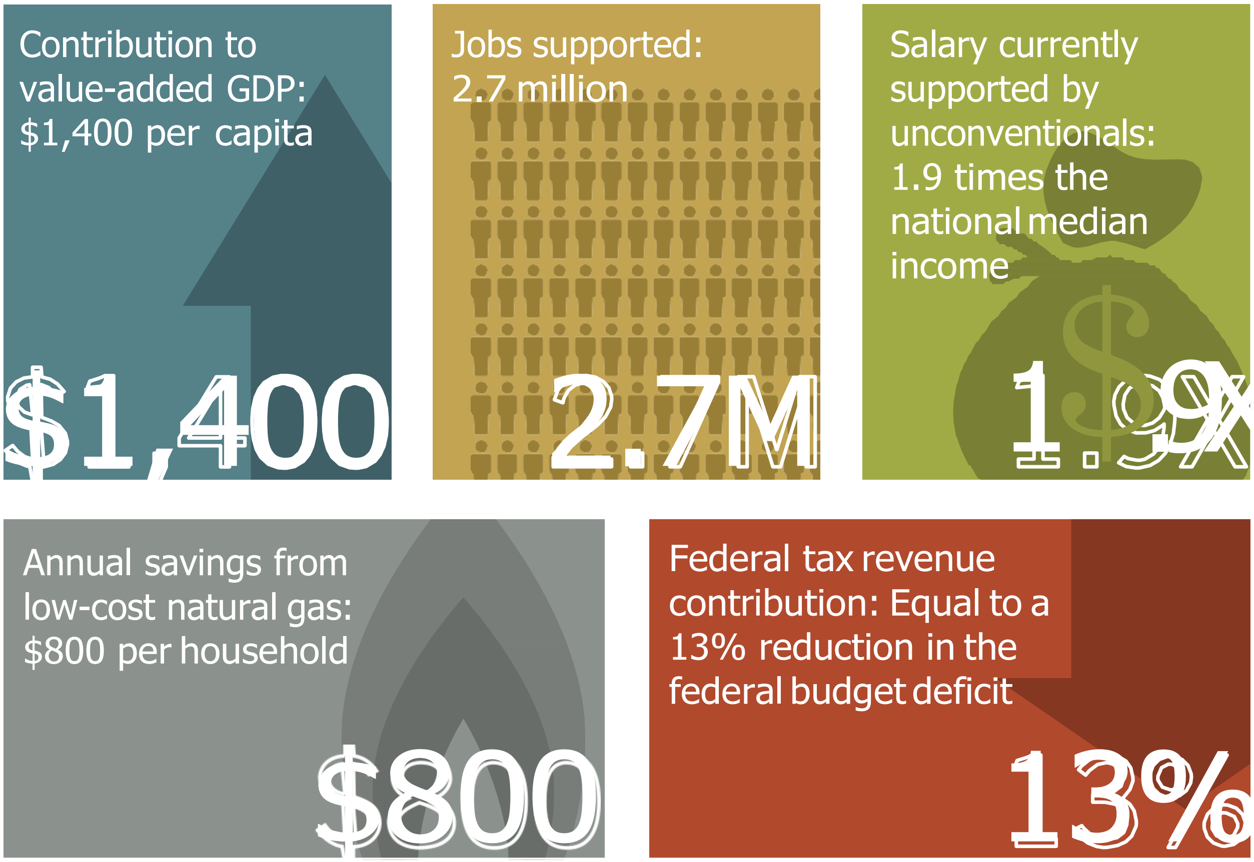
Current oil prices and their long-term implications

Worldwide crude oil prices have experienced a more than 50% decline since mid-2014, driven by an expanding oil supply and weaker demand.

Near-term prices will have impacts on oil and gas production, but are unlikely to significantly impact the fundamental U.S. competitive advantage over the next several decades. In fact, price pressure has led to increased innovation in unconventionals technology and lower production cost in the U.S., while deterring efforts in other countries to develop this resource.

The U.S. energy advantage is likely to persist for the foreseeable future. The urgent priority is for the nation to take advantage of this opportunity.

Figure 1: **The economic impacts of U.S. unconventionals, 2014**



Note: Estimates include all direct extraction, transport, and refining of unconventional oil & gas, as well as activities that support this production, such as oil field services and local services. Value-added GDP figure expressed in 2012 dollars. Annual energy savings expressed in 2014 dollars. Federal budget deficit estimate for 2013.

Sources: BCG and HBS Competitive Impacts Model; please refer to Appendix I for detailed methodology; "Measure of Central Tendency For Wage Data," Official Social Security Website, Office of the Chief Actuary, http://www.ssa.gov/oact/cola/central.html, accessed May 2015.

Unconventionals are not just regional phenomena. They are directly benefiting every consumer and small business, lowering power costs and improving income. In 2014 alone, American households were estimated to enjoy about $800 in annual savings from lower energy costs attributable to unconventional natural gas, and to reap additional savings from lower oil prices.[10]

Unconventionals have also helped turn struggling regions of the U.S., including North Dakota, Western Pennsylvania and Eastern Ohio, Oklahoma, and West Texas, into newly thriving communities. Energy growth has spread to support industries, real estate, local services, and community needs such as schools. While some of this growth has slowed with the recent fall in world oil prices, many communities are still far more prosperous today than they were in the mid-2000s.

Finally, unconventionals are reshaping America's geopolitical position, reducing the trade deficit, improving energy security and our exposure to unstable regions, and opening up new avenues for trade and diplomacy abroad. The U.S. is now self-sufficient in natural gas production, and oil imports have decreased by 28% over the last decade.[11] Furthermore, the growing U.S. oil supply has limited the power of the OPEC oil cartel and helped bring down oil prices globally. Our energy resources have given the U.S. important new diplomatic tools that can aid allies and counteract the ability of unfriendly countries to use oil and gas access to achieve political aims.

The benefits are just beginning

America's energy advantage is in the early stages of spreading into downstream industries and throughout the economy. For example, low-cost natural gas feedstocks have made the U.S. competitive in petrochemicals, plastics, and inorganic chemicals, where $138 billion in new U.S.-based investments has been announced.[12] In energy-intensive industries, lower cost electricity and lower natural gas fuel costs are beginning to drive investments such as new iron and steel plants and plastics processing.[13] Moreover, lower prices have catalyzed a renewed interest in the use of natural gas in transportation such as CNG vehicles, fleets, and trucks, which significantly lowers costs, improves emissions, and reduces dependence on oil. Finally, abundant domestic supplies open the opportunity for the U.S. to export both gas and oil, with legislative changes, for the first time in decades.

Coupled with rising wages in emerging markets, low energy costs and abundant supplies promise to stimulate U.S. growth and investment across a wide range of industries. BCG's *Made in America, Again* project found that the estimated average manufacturing cost structure for the U.S. in 2015 is within 5% of China's and 10-20% lower than major European economies'.[14]

AMERICA RUNS THE RISK OF NOT CAPITALIZING ON THIS OPPORTUNITY

Despite these major benefits, however, unconventional energy has become highly controversial in the U.S. Public support for hydraulic fracturing is decidedly mixed and seems to be declining. Expanding development is increasingly threatened. Today, more Americans oppose expanded hydraulic fracturing than support it.[15] This opposition has grown both out of legitimate concerns over local environmental impacts and how unconventionals affect climate change and out of widespread confusion over the facts.

The development of unconventionals has created real local environmental, public health, and community risks. Production of unconventionals uses a heavy industrial process, a combination of horizontal drilling and hydraulic fracturing to extract oil and gas from rock formations. This process, along with the growing scale of production, creates significant issues related to freshwater use and wastewater disposal, ground water contamination, air pollution, land degradation, seismic events, and community disturbances such as noise and heavy road use. Though energy producers and U.S. state and federal regulators have made considerable progress in addressing many of these risks and impacts, there is still need for improvement.

Unconventionals also elicit concerns that their use is incompatible with responding to climate change. While natural gas emits 50% less carbon dioxide when burned than coal[16] and while the increased use of natural gas power plants contributed significantly to a 15% reduction in carbon emissions in the power sector between 2005 and 2013,[17] gas is not carbon-free. Climate stakeholders worry that developing unconventional resources will delay the scale-up of renewables and other lower-carbon energy sources, and will lock in high levels of greenhouse gas emissions for the indefinite future. There are also concerns that the leakage of methane in the production and processing of natural gas will offset the relative benefits of natural gas versus coal, since methane is itself a potent greenhouse gas.

In addition to these legitimate concerns, much of the debate over unconventionals is driven by polarizing arguments, which are uninformed and reflect the absence of a shared fact base. The "facts" advanced by all sides are sometimes incomplete or taken out of context, and situations are often purposefully distorted. (See below for a recent example.) Some industry actors, for example, push the economic arguments while downplaying or ignoring the negative environmental and other impacts. Some environmental and climate advocates use single, non-representative environmental incidents to generalize about the performance of the whole industry, without putting incidents in context. As a result, there is a lack of trust all around, and the general public is both misled and confused.

Federal hydraulic fracturing rules emblematic of unproductive debate

In late March 2015, the Interior Department announced new regulations for hydraulic fracturing on federal lands. Only a small minority of unconventionals operations occur on federal lands and are largely catching up to rules that states already have in place. However, stakeholder reactions showed just how divisive the unconventionals debate has become:[18]

- The federal government positioned the rules as a new blueprint for states to follow, when in reality most states are already leading: "There are a number of states where these may be the only regulations they have." – *Sally Jewel, Interior Secretary*
- The Independent Petroleum Association of America (IPAA) filed suit against the regulations, despite the low estimated compliance costs: "These new federal mandates will add burdensome new costs on our independent producers." – *Barry Russell, CEO of IPAA*
- Some environmental groups opposed the regulations for using the FracFocus chemical disclosure database as pro-industry, despite it already being mandated in 16 states. "We remain disappointed with some provisions, like continued reliance on the industry-run website FracFocus for disclosure of toxic chemicals." – *Madeline Foote, legislative representative for the League of Conservation Voters*

No one is winning

In today's status quo, no stakeholder is achieving its most essential goals. Instead of having a constructive dialogue about how to capture the clear economic benefits while minimizing the impacts and risks, the debate has devolved into an "either/or" battle where no one is really winning.

While the oil and gas industry has so far achieved significant unconventionals production levels, continued development and expansion are under threat. State and local bans on hydraulic fracturing, such as the December 2014 decision by New York State, are the most prominent blocks to further development. (See right for more detail.) But there are also other costs. Opposition to critical infrastructure projects has led to protracted delays in the development of efficient pipeline infrastructure. This increases truck traffic, more risky rail shipments, and higher transport costs. The industry's lack of community support and legitimacy also increases the risk of policy uncertainty, diminished access to public services, and investment delays, especially downstream. Finally, antiquated policies on oil and gas exports, developed during periods of scarcity, remain in place, limiting the total market for U.S. producers.

At the same time, local environmental stakeholders are not yet succeeding in addressing many of the environmental risks. Poor operators cause unnecessary spills, contamination, leaks, and community disruptions. Gaps in regulatory standards across states persist. Intense industry lobbying weakens the regulatory agenda and politicizes environmental protection. Uneven compliance and enforcement lead to more accidents and faulty practices. Furthermore, pipeline infrastructure delays are actually making some environmental and community problems worse.

Climate stakeholders, meanwhile, are far short of where they would like to be in making large-scale progress. While some states have taken limited action, there is no accepted federal or global plan in place to limit carbon dioxide and other greenhouse gas emissions. Absolutist approaches to mitigation at all costs have run into fierce opposition from public, business, and political stakeholders who are wary of high costs and perpetual subsidies. Even worse, climate stakeholders must still spend much of their effort debating the science of climate change itself, instead of building feasible approaches to mitigation.

New York state ban shows dangers for future unconventionals development

In late March 2015, the New York Department of Health recommended a ban on hydraulic fracturing[19] because of unknown total risk and potential public health effects:[20]

- Air/climate impacts (methane and volatile organic compounds)
- Water management impacts
- Earthquakes
- Community impacts (noise, odors, overburdened resources)

A ban was recommended until "the science provides sufficient information to determine the level of risk to public health from high-volume hydraulic fracturing to all New Yorkers and whether the risks can be adequately managed."

However, the report also notes that "absolute scientific certainty is unlikely to ever be attained," making it unclear what evidence will be sufficient to determine the level of risk.

Other issues with the ban:

- The New York report could not find conclusive evidence that hydraulic fracturing causes excessive health and environmental risks.
- Trajectory of progress on public-health risk-mitigation improvements was not taken into account.
- An assessment of the economic costs of banning hydraulic fracturing was not conducted.

DEVELOPING A CONSTRUCTIVE PATH FORWARD

The joint HBS-BCG project on America's energy opportunity arose from our recognition that unconventional energy resources represented one of America's biggest economic opportunites today and our concern about the unproductive public and political discourse about the nation's future energy strategy. Given the lack of shared progress on key challenges, we became concerned that there is now a real risk that American citizens, communities, and companies will fail to capitalize and expand on the historic opportunity that unconventional energy resources represent.

The lack of trust and productive solutions-based dialogue among stakeholders has created gridlock and put America on a path that is not in anyone's interests. We see many stakeholders talking past each other and too few efforts to synthesize and find common ground. That has created unnecessary risks for our energy development, future U.S. competitiveness, and the trajectory of the overall U.S. economy. The HBS-BCG project was established to create a better way forward. Its purpose is to develop a shared fact base, shift the discourse, and advance a shared policy agenda on unconventionals development.

Creating the fact base

The team synthesized the large body of existing but sometimes conflicting or misleading research in the field on the nature of the current and future economic opportunity for the U.S., including economic growth, jobs, wages, and benefits for consumers, government revenues, and strengthening America's position internationally. The project also examined the evidence on the environmental risks of unconventionals and examined the steps and costs required to minimize them. Finally, we examined the energy transition underway toward cleaner energy, the progress on mitigating climate change, and the benefits and issues of using unconventionals to achieve short-term and long-term U.S. carbon emissions reductions. The project involved reviewing hundreds of existing studies, as well as developing primary research and analysis on key areas such as the economic impact of unconventionals, understanding the costs of improving environmental performance, and detailed modeling of the degree to which current investments in natural gas power and infrastructure would impede the development of renewables, among others.

Steering Committee Members

Anadarko: R.A. Walker, *Chairman, President and Chief Executive Officer*

BASF Corporation: Hans Engel, *Chairman and Chief Executive Officer*

CB&I (Chicago Bridge & Iron Company): Philip K. Asherman, *President and Chief Executive Officer*

Center for Strategic and International Studies (CSIS): Robin West, *Senior Adviser, Energy and National Security Program*

Entergy: Leo Denault, *Chairman and Chief Executive Officer*

Environmental Defense Fund: Fred Krupp, *President*

Environment Defense Fund: Mark Brownstein, *Associate Vice President*

Harvard Business School: Rebecca Henderson, *John and Natty McArthur University Professor*

Harvard Business School: Forest Reinhardt, *John D. Black Professor*

Harvard Business School: Jan W. Rivkin, *Bruce V. Rauner Professor of Business Administration*

Siemens Corporation: Eric A. Spiegel, *President and Chief Executive Officer*

The Whitman Strategy Group: The Honorable Christine Todd Whitman, *President*

Engaging the key stakeholders

We interviewed numerous experts and leaders across all stakeholders to gather data about on-the-ground performance, understand their thinking, and test assumptions. A smaller steering committee of senior leaders was convened to solicit deeper guidance and stress-test our analyses and recommendations. (See lower left.) Participants in the Steering Committee were not asked to endorse any of the analysis or recommendations, but provided extremely helpful feedback and suggestions.

Developing an overall strategy

Our research and interviews provided the foundation for drafting a practical, constructive, and feasible win-win pathway for capturing the U.S. unconventional energy opportunity. Instead of the hard trade-offs commonly portrayed, the facts reveal an ample middle ground where all stakeholders can benefit from unconventionals development. This plan sets forth the set of steps necessary to move America forward in a way that increases U.S. competitiveness and economic growth while achieving the major goals of industry, government, environment, and climate change stakeholders.

Convening energy leaders at hbs

More than 80 leaders from industry, the environmental community, suppliers, think tanks, state and federal government, and academia convened at HBS in March 2015 for an intensive discussion of the fact base and proposed win-win pathway. The gathering brought together a breadth of leaders who rarely, if ever, are in the same room. It also provided a setting in which active, constructive discussions occurred. The discussions were remarkable.

THE REPORT

This report is a summary of our findings, the win-win pathway, and how America might go about achieving it in practice. The report is structured as follows:

Chapter 2 – Outlines the U.S. economic and competitiveness context

Chapter 3 – Analyzes the economic impact of unconventionals

Chapter 4 – Addresses the local environmental impact

Chapter 5 – Discusses the climate impact

Chapter 6 – Outlines the win-win path forward

Chapter 7 – Sets forth actions needed to realize the opportunity

Appendices – Summarize the methodologies used for key analyses

For additional information on this topic and our process, please see the U.S. Competitiveness Project website at: http://www.hbs.edu/competitiveness/research/Pages/unconventional-energy.aspx

As we assembled the facts and sought input from a wide range of stakeholders, we have become more and more convinced that the U.S. can move unconventionals and America's energy transformation forward in a way that greatly enhances American competitiveness and drives economic growth while substantially improving environmental performance and accelerating a clean energy future. The key objectives of the stakeholders currently locked in opposition to one another can all be advanced.

The U.S. can enhance its competitiveness based on America's new energy advantage. The U.S. can minimize local environmental, health, and community impacts at competitive cost. And unconventionals, together with a holistic approach to the issues, can enable a practical and cost-efficient transition to a lower-carbon, cleaner-energy future that will make America a leader and innovator in the energy system of the future.

Chapter 2:

THE U.S. ECONOMIC AND COMPETITIVENESS CONTEXT

A WEAKENED U.S. ECONOMIC TRAJECTORY

Assessing the significance of low-cost unconventional energy resources requires understanding the broader trajectory of the U.S. economy. The U.S. economy's ability to improve the nation's standard of living is weaker than it has been in generations, a deterioration that began well before the Great Recession. Between 1950 and 2000, the U.S. economy grew at an average of 3.7% per year. Between 2000 and 2014, growth has averaged just 1.9% per year.[21]

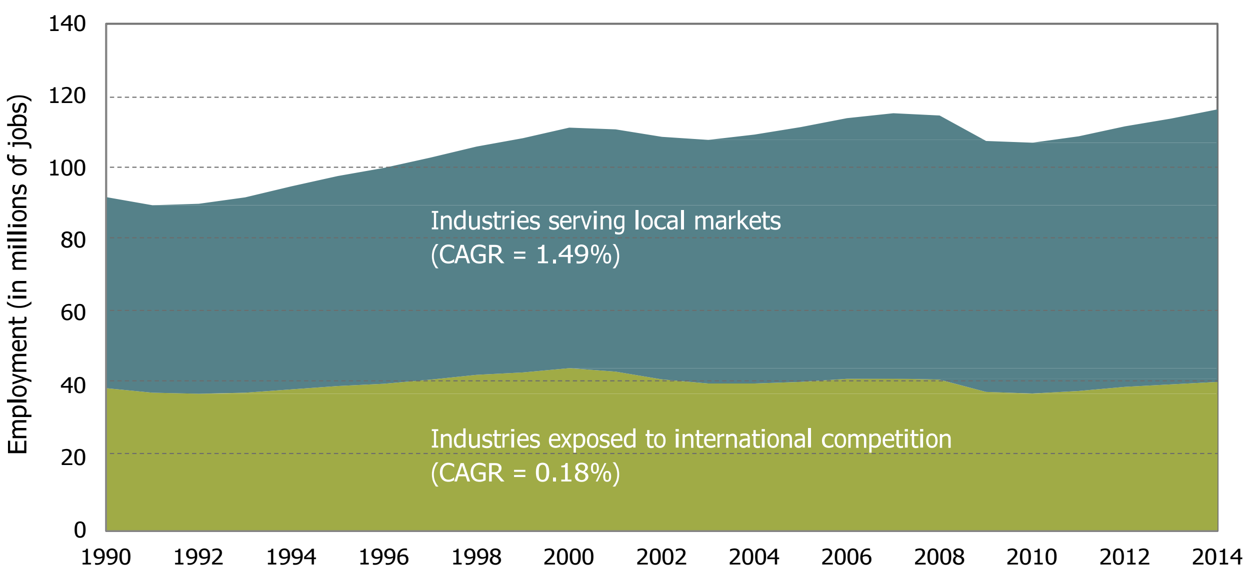
Job growth has also declined markedly. Since the 1970s, the U.S. economy created jobs at roughly a 2% annual rate. Starting around 2001, job growth rates began declining and averaged only approximately 1% annually from 2001 to 2010.[22] As jobs became scarce, the U.S. labor force participation rate, which had climbed for five decades from 1947 to 1997, started falling in 2001. Today it is at levels not seen since the early 1980s.[23]

The composition of new jobs has also been changing. Between 1990 and 2014, the U.S. economy generated 22.5 million net jobs in local industries, such as retailing, construction, and government, paying an average wage of just $37,000 per annum as of 2014.[24] Just 1.7 million new jobs were created in industries exposed to international competition, paying $69,000 in 2014.[25] (See Figure 2.)

Slowing economic and job growth has contributed to stagnant incomes, especially in America's middle- and lower-income households. Between 1999 and 2013, median household earnings actually declined by about 9% in real terms.[26] Income growth has been slowest for lower-income households and those without advanced education. However, even those in the upper half of the income distribution have seen slow income growth, with the only exception being those at the very top. Not only have wages stagnated for working Americans, but the number of Americans who are long-term unemployed (those jobless for 27 weeks or more) was 2.6 million in March 2015,[27] compared with fewer than 1 million in January 2000.[28]

The recent trajectory of the U.S. economy reflects a growing divergence.[29] Highly skilled individuals are doing

Figure 2: **U.S. private employment, by type of industry, 1990-2014**



Note: The compound annual growth rate (CAGR) is for the period June 1990 through June 2014.

Source: Mercedes Delgado, Michael E. Porter, and Scott Stern, "Defining Clusters of Related Industries," The National Bureau of Economic Research, August 2014, http://www.nber.org/papers/w20375.pdf, accessed May 2015.

well, while the average American is struggling. The same divergence applies to businesses. Large multinationals are recording record profits and continuing to grow. Since the largest companies dominate overall corporate profitability in the economy, U.S. corporate profits have risen as a percentage of GDP. Except for a relatively small number of high-tech startups, however, small businesses are languishing. The proportion of jobs created by smaller businesses (with 10–99 employees), which historically, have been the nation's job-creation engine, has been falling since 1997.[30] And in 2008, for the first time since 1978, the number of businesses that failed in the U.S. exceeded the number of new businesses created.[31] Based on the data available at the time of writing this report, this trend has not yet reversed itself, despite the last few years of overall economic growth.

THE U.S. COMPETITIVENESS CHALLENGE

What is causing this poor and diverging performance? While many point to the Great Recession, all of these trends began well before 2008.[32] Based on our research conducted by the U.S. Competitiveness Project at HBS, the underlying problem is a structural decline in U.S. competitiveness that has been building for decades.

What do we mean by competitiveness? A nation such as the United States is competitive if firms operating there are able to compete successfully in the global economy while maintaining or improving wages and living standards for the average American. Competitiveness requires that firms and workers succeed simultaneously. If American companies are doing well, but succeeding only through cutting jobs and squeezing wages, that reflects a lack of competitiveness. Conversely, if American workers are earning rising wages but American companies are unable to compete, that is not a sign of competitiveness either.

The only way that both companies and workers can prosper is for an economy to be highly productive. Only if there is a business environment in which workers can produce high-quality products and services with increasing efficiency can companies prosper while supporting rising wages for citizens.

Productivity and productivity growth, then, underlie competitiveness and are the fundamental causes of long-term growth in GDP, jobs, and wages. In the United States, solid labor productivity growth, which had traditionally supported rising wages, has declined since 2000. The annual average rate of labor productivity growth held steady at around 2% from 1986 to 2000,[33] but averaged just 1.4% for the period 2000 to 2014.[34]

Growing weaknesses in the business environment have changed the trajectory of U.S. performance. That reflects both challenges in the U.S., and also the rising globalization of the economy, putting the U.S. in competition with many other nations who have growing capabilities.

A nation such as the United States is competitive if firms operating there are able to compete successfully in the global economy while maintaining or improving wages and living standards for the average American.

DRIVERS OF COMPETITIVENESS

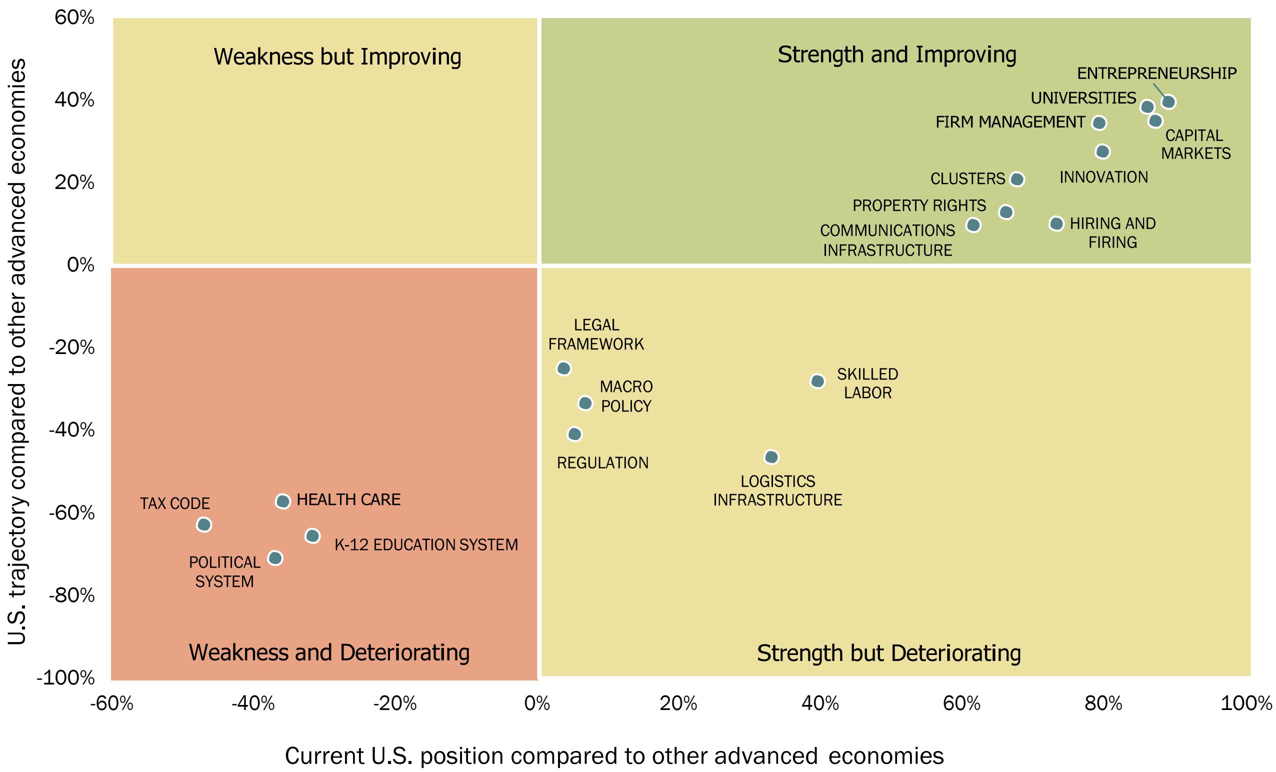
The HBS U.S. Competitiveness Project, as well as BCG's *Made in America, Again* series, set out to understand the drivers of the American competitiveness challenge and the actions required to overcome it. Based on surveys of HBS alumni[35] and supported by broader research, Figure 3 on page 14 assesses the position of the U.S. on a series of factors most important to competitiveness.

The U.S. retains some core strengths, shown in the upper right quadrant, in areas like university education, entrepreneurship, quality of management, clusters, innovation, capital markets, and property rights. Those areas are not just strong but even improving.

However, in other crucial areas for competitiveness, the U.S. has allowed its once-strong positions to deteriorate. American workers, who prided themselves on high productivity and formed the backbone of America's middle class, have seen a decline in skills relative to workers in many other countries. U.S.-based firms face skills shortages, which means that positions are going unfilled even as U.S. workers struggle to find jobs. American airports, ports, roads, and energy infrastructure are inadequate and in need of maintenance and upgrades. The U.S. PK–12 education system has lagged behind improving education systems in other countries. A complicated tax code, a high-cost legal system, growing regulatory complexity, and an unsustainable budget are some of the other key areas in which America's business environment has been eroding.

That pattern of strengths and weaknesses helps explain diverging U.S. performance. Larger international firms and Americans with advanced education are doing well because they leverage America's greatest strengths, such as: sophisticated management, access to capital, world-class universities, and a climate for entrepreneurship. But the average worker and most small businesses are captives of America's biggest weaknesses: declining elementary education, eroding skills, the burdensome tax code and regulatory environment, and the high cost of health care. Larger companies can neutralize these weaknesses through offshoring and global operations.

Figure 3: **State of the U.S. business environment in 2013–2014**



Source: Michael E. Porter and Jan W. Rivkin, "An Economy Doing Half of Its Job: Findings of Harvard Business School's 2013-14 Survey on U.S. Competitiveness," September 2014, p. 9, http://www.hbs.edu/competitiveness/Documents/an-economy-doing-half-its-job.pdf, accessed May 2015.

CHANGING THE TRAJECTORY

The U.S. faces a multifaceted strategic challenge to change the trajectory of U.S. competitiveness. Some of this hard work can and should take place in businesses and at the local or regional levels. However, solutions to many of the key weaknesses shown in Figure 3 rest in Washington, D.C. HBS's U.S. Competitiveness Project identified an agenda for Washington to restore U.S. competitiveness,[36] shown on page 15. Seven of the eight points in the figure focus on addressing major weaknesses, many of which are most strongly influenced by federal policy. Unfortunately, the U.S. has made little significant progress across the first seven points of the plan. Political gridlock has left nothing accomplished in Washington. Efforts at tax reform, immigration policy, and long-term budget plans have all fallen flat, even when pragmatic solutions with bipartisan support exist. The zero-sum battles in Congress and at the White House have scored nothing more than political points, while the American economy struggles to get moving.

CAPITALIZING ON AMERICA'S ENERGY ADVANTAGE

While there are many weaknesses to address, America has a once-in-a-generation opportunity to build on a crucial new strength: unconventional gas and oil resources.

We believe that the single-largest source of competitive advantage and economic opportunity for the United States over the next decade or two is likely to be energy. Rising unconventional energy production over the last 5–10 years is already driving much of the limited growth that the U.S. economy has achieved. BCG's *Made in America, Again* project highlights low-cost energy as the most significant emerging advantage for U.S. manufacturing competitiveness. America's energy advantage is likely to persist over time and will spread to more and more industries. Low energy costs benefit both large and small businesses and will lead to a large number of middle-skills jobs that pay attractive wages. Unconventional energy production also creates major geopolitical benefits for the U.S., such as a lower trade deficit, as well as reduced dependence on unstable regions.

Despite the high stakes, however, America lacks a strategy to fully capitalize on this crucial opportunity. Instead, the development of unconventional energy resources is politically charged and highly controversial. We run the risk of the same political gridlock here that has paralyzed U.S. progress in so many other crucial economic policy priorities at a time when the need to change the trajectory of divergence is urgent.

The industry, NGOs, the federal and state governments, and local communities must develop a plan to responsibly extract and utilize our energy resources in a way that strengthens overall U.S. competitiveness while mitigating environmental risk and furthering the transition to a cleaner-energy, lower-carbon future. We think such a win-win pathway is not only possible, but within reach.

The strategic agenda for Washington

1. Simplify the corporate tax code with lower statutory rates and no loopholes
2. Tax overseas profits earned by American multinational companies only where they are earned
3. Ease the immigration of highly skilled individuals
4. Aggressively address distortions and abuses in the international trading system
5. Improve logistics, communications, and energy infrastructure
6. Simplify and streamline regulation
7. Create a sustainable federal budget, including reform of entitlements
8. **Responsibly develop America's unconventional gas and oil reserves**

Source: Michael E. Porter and Jan W. Rivkin, "What Washington Must Do Now: An Eight-Point Plan to Restore American Competitiveness," *The Economist*, November 21, 2012.

Chapter 3:

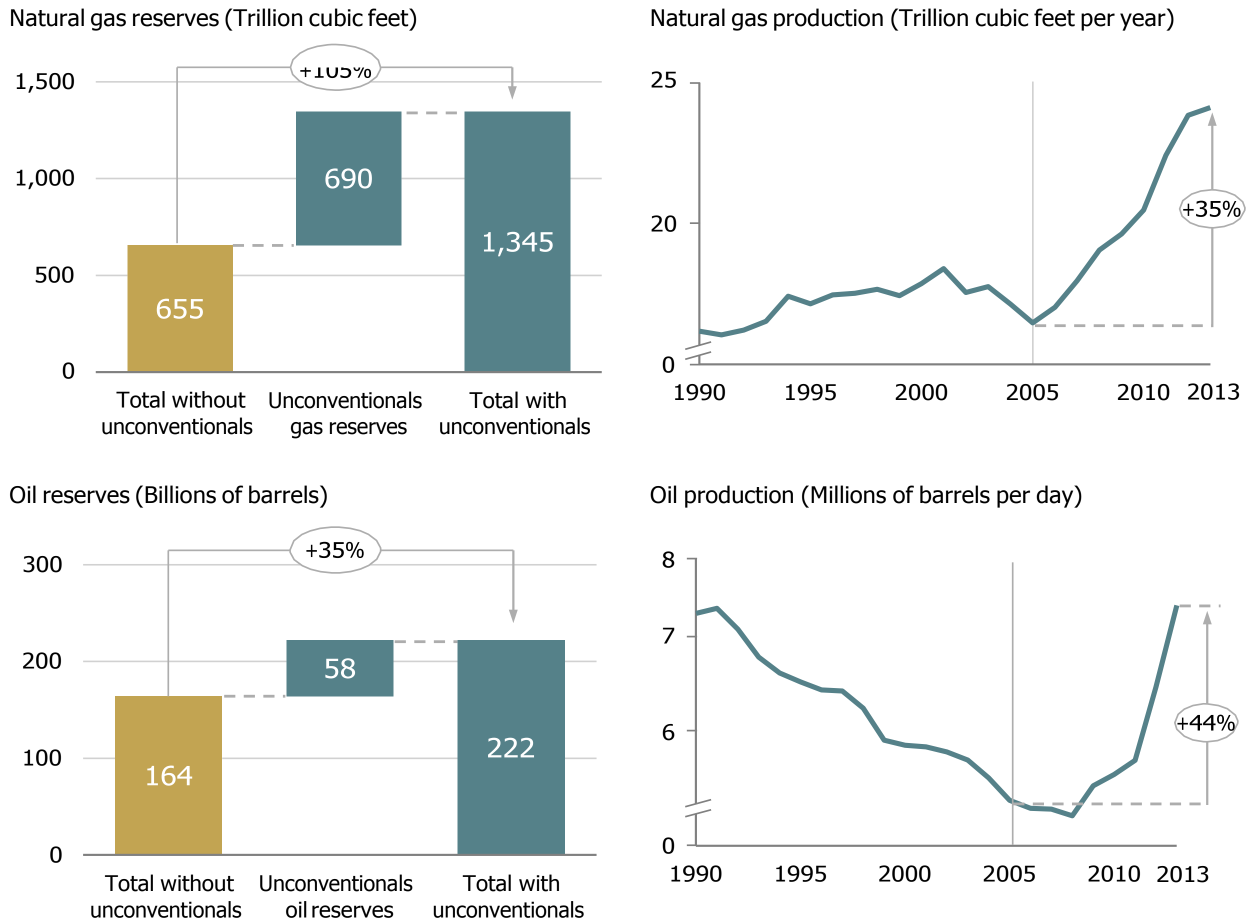
THE IMPACT OF UNCONVENTIONALS ON THE U.S. ECONOMY

THE U.S. ENERGY ADVANTAGE

Unconventionals have unlocked major low-cost oil and gas reserves and production in the U.S. over the last decade. Between 2005 and 2013, reserves of natural gas increased by 105%[37] and oil reserves by 35%.[38] After a 6% decline in U.S. natural gas production and an 11% decline in U.S. oil production from 2000–2005, U.S. production has boomed: natural gas production has increased by 35% since 2005,[39] while oil production has increased by 44%.[40] (See Figure 4.) Low-cost resources are substantial and are likely to support growing production through the next decade or longer.[41]

For natural gas, unconventionals have dramatically lowered domestic prices versus the rest of the world and have created a major U.S. advantage. U.S. natural gas prices (Henry Hub) have fallen by more than 60% between December 2005 and May 2015.[42] The U.S. now has among the lowest industrial natural gas prices in the world, with gas prices two-thirds less than those of China and Germany.[43] (See Figure 5.)

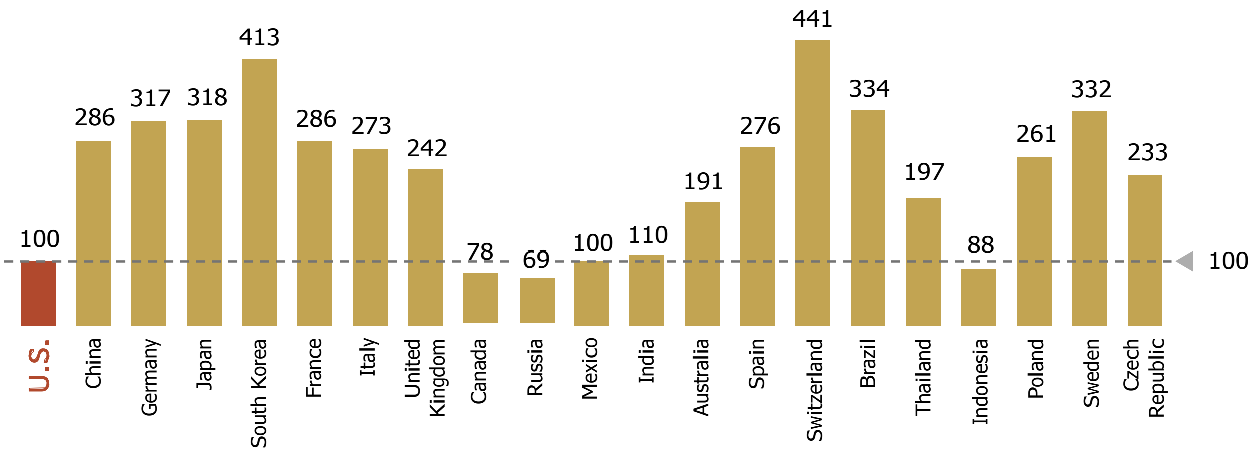
Figure 4: **Change in U.S. natural gas and oil reserves and production, 2005–2013**



Notes: Unconventional gas reserves include shale and tight gas. Resources include proved and unproved.

Source: Rystad Ucube, http://www.rystadenergy.com/Databases/UCube, accessed August 2014; "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States," Energy Information Administration website, June 13, 2014, http://www.eia.gov/analysis/studies/ worldshalegas/, accessed April 2015; February 2013 Monthly Energy Review: Table 1.2 Primary Energy Production by Source, Energy Information Administration website, http://www.eia.gov/totalenergy/data/monthly/archive/00351502.pdf, p. 5, accessed April 2015.

Figure 5: **Indexed average industrial natural gas prices (2013) for top manufactured goods exporters (U.S.=100)**



Source: Harold L. Sirkin, Michael Zinser, and Justin Rose, "The U.S. as One of the Developed World's Lowest-Cost Manufacturers: Behind the American Export Surge," The Boston Consulting Group, August 20, 2013, p. 6, https://www.bcgperspectives.com/content/articles/lean_manufacturing_sourcing_procurement_behind_american_export_surge, accessed May 2015.

Since the U.S. currently has no operational gas export terminals (although several are under construction), the U.S. supply boom has not affected world gas markets. Even when those export terminals are completed over the next few years, however, high natural gas shipping costs will maintain the favorable spread between U.S. and world prices.[44]

Oil, unlike gas, trades largely as a global commodity, with similar prices around the world, since crude oil, gasoline, and other refined products can be efficiently transported by tanker. Booming U.S. unconventional oil production, particularly in 2014, was one of several factors that contributed to a global oversupply of oil, which has driven down global oil prices substantially since mid-2014. That has benefited all oil users, including Americans. However, the U.S. oil users have not gained a relative competitive advantage, since all countries have experienced similar price declines. For producers, on the other hand, the U.S. crude oil market has been distorted by the ban on oil exports dating back to the 1970s, which we will discuss further in following sections.

THE U.S. LEAD

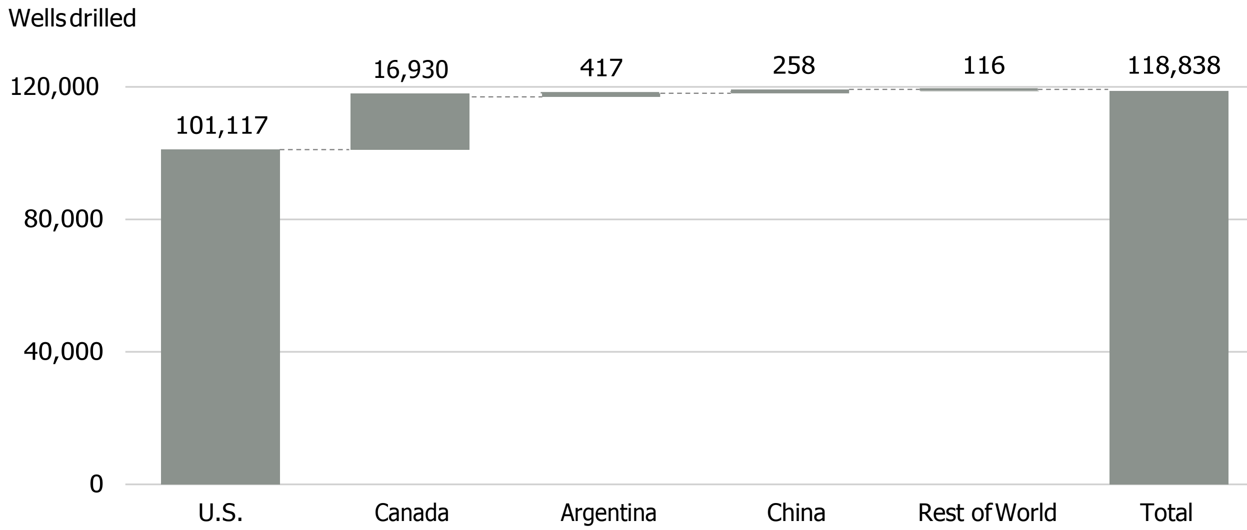
In addition to large reserves, the U.S. has a significant head start in unconventionals technology and production versus other countries. That has resulted from a combination of factors: attractive geology, world-leading technology, well-developed infrastructure, talent, strong private-property rights, intense competition, and access to financing. The U.S. advantage is likely to persist for the foreseeable future, and the recent price declines have likely reinforced that advantage by reducing incentives for investment in countries where production is still nascent. To date, Argentina, Canada, and China are the only other countries that have even begun commercial unconventionals production, but at far smaller levels. (See Figure 6 on page 18.) Some countries other than the U.S. also have significant levels of unconventional gas and oil resources and are investing in their development,[45] but they often lack critical U.S. strengths. China, for example, has more difficult geology than the U.S., little natural-gas infrastructure, reserves that are distant from major markets, and limited water supplies required for large-scale production. China produced just 1.2 billion cubic meters (bcm) of unconventional natural gas in 2014, less than 20% of what was targeted in its original development plan created in 2012.[46]

THE ECONOMIC BENEFITS

Oil and gas have a broad and multifaceted impact on the U.S. economy. (See Figure 7 on page 18.) The production and processing of oil and gas involves multiple industries, including producers, oil field service contractors, transportation companies, and refiners. Oil and gas can then be exported or converted into feedstocks, fuel, or power for use in downstream industries. In 2014, 32% of natural gas went to industrial uses, 31% to power generation, 18% to residential heating and cooking, 12% to heating commercial buildings, 3% to petrochemicals, and 3% to transportation.[47] Many of those uses will grow substantially as natural gas continues to be more competitive than its alternatives.

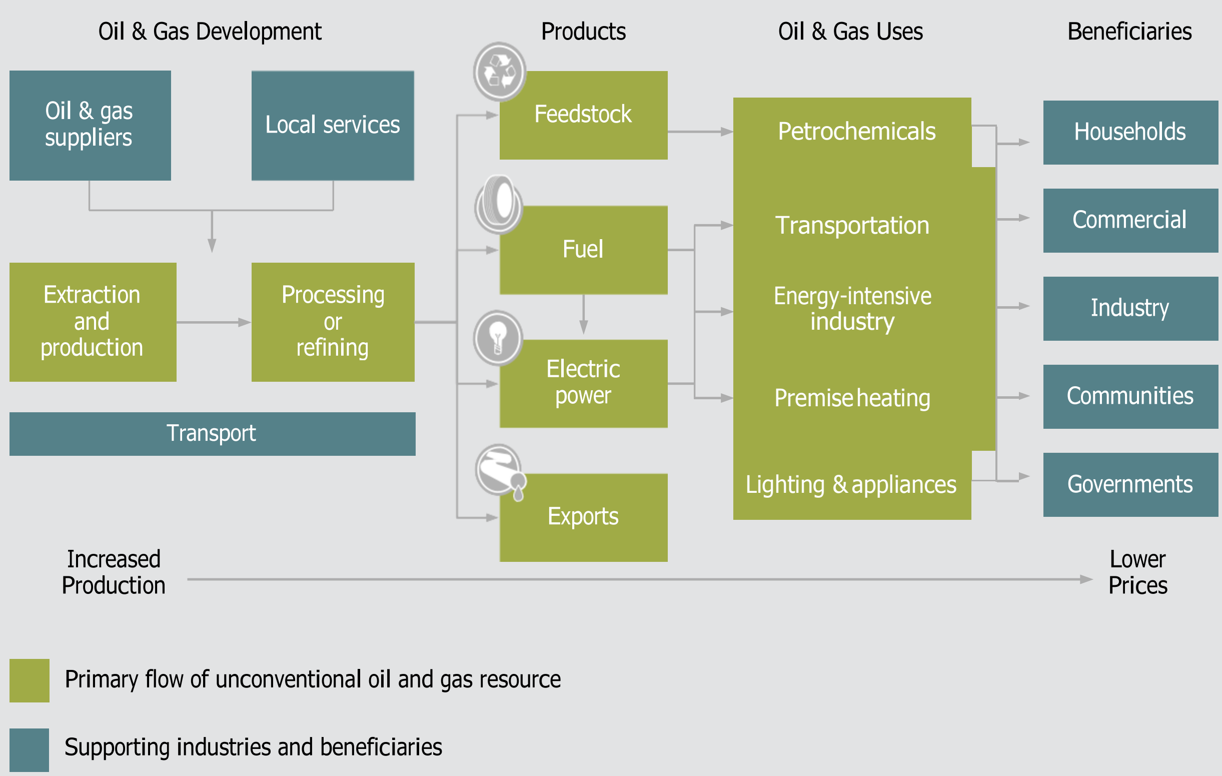
Oil's use is far more concentrated: 70% is used for transportation, 24% for industrial purposes, and 6% for residential and commercial purposes, mainly heating and cooking.[48]

Figure 6: **Unconventional gas and oil wells drilled globally, January 2005 – January 2015**



Source: "Shale Gas Prospects Outside North America: Boston Consulting Group's Quarterly Analysis," The Boston Consulting Group, January 2015; "Shale Gas Exploration Status in Poland as of April 2015," http://infolupki.pgi.gov.pl/en/exploration-status/news/shale-gas-exploration-status-poland-april-2015, accessed May 2015.

Figure 7: **Unconventional energy's economic impacts**



Source: HBS and BCG analysis.

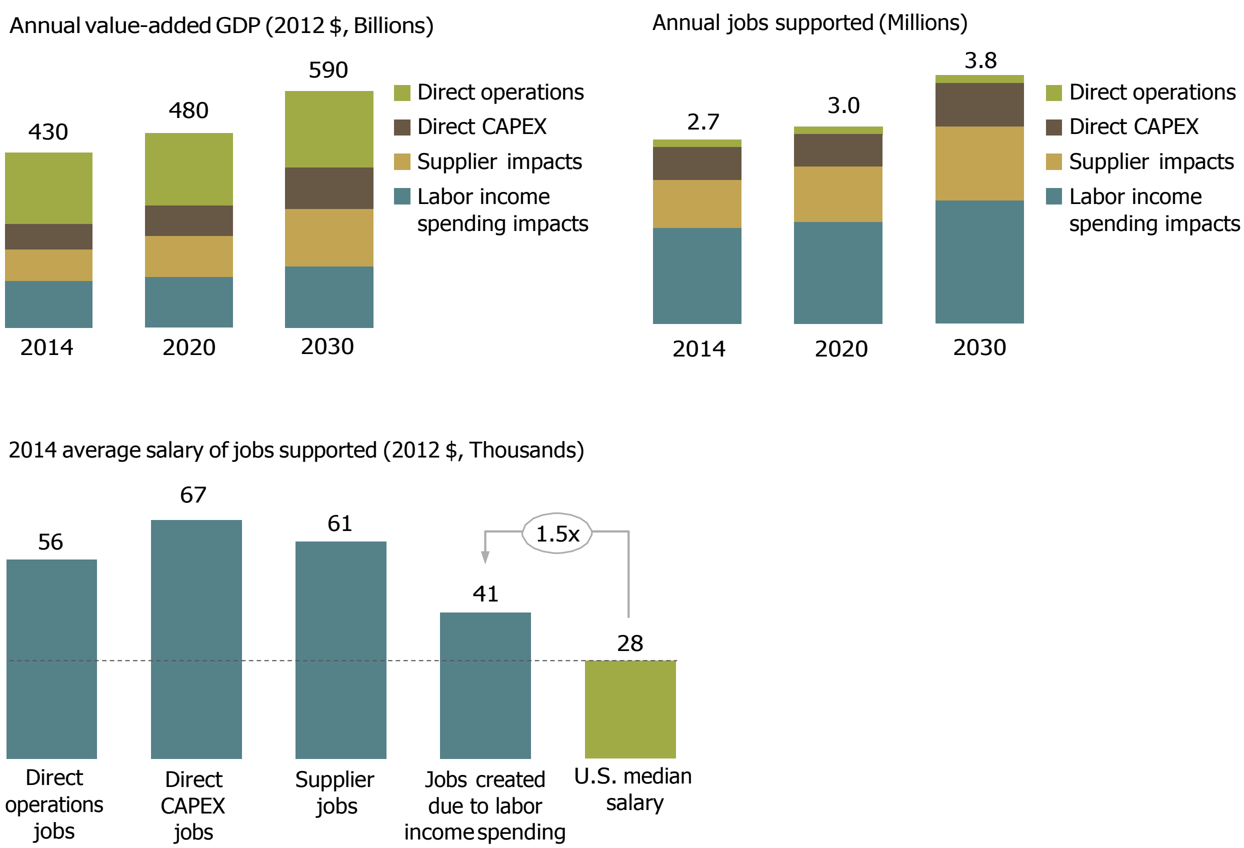
Production and supply impacts

Unconventional gas and oil production and supply, defined to include exploration and production, gathering and processing, transportation, refining, suppliers, supporting industries, and local services, have been the primary driver thus far of economic growth and jobs. (See Figure 8.) Our analysis estimates that the development of unconventionals contributed $430 billion to U.S. GDP in 2014, equating to roughly $1,400 for every American.[49] We estimate that this contribution can grow to about $590 billion by 2030, not including impacts downstream from low-cost gas and energy, but including the incremental impacts from the export of oil and liquefied natural gas (LNG).[50] (For a detailed explanation of the methodology for calculating the economic impacts of unconventionals development, please turn to Appendix I on Page 53).

Unconventionals production and supply supported about 2.7 million jobs in 2014, with the potential to grow to 3.8 million jobs by 2030.[51] Oil and gas development requires not only production workers but oil field services, engineers and contractors, transportation and logistics services, and supporting industries, including water, chemicals, and equipment. Unconventionals jobs also represent a significant reshoring of energy jobs that had previously been lost overseas when the U.S. became a major oil importer.

Moreover, the average unconventionals production job pays nearly twice the national average salary and offers a significant opportunity for middle-skilled workers.[52] A recent analysis of available job postings in unconventionals by labor market analytics firm Burning Glass found that approximately 50% of the available jobs required only middle-level skills, not advanced

Figure 8: **Impacts of unconventional oil and gas development on GDP, jobs, and salaries**



Note: CAPEX stands for capital expenditures. Figures include incremental impacts from reversing the ban on crude oil exports, as well as incremental impacts from liquefied natural gas (LNG) exports. Salary figures represent the total payroll cost of the employee for the employer, including wage and salary, benefits (e.g. health, retirement), and payroll taxes. Figures are rough estimates used for illustration.

Sources: BCG and HBS Competitive Impacts Model; please refer to Appendix I for detailed methodology; "Measure of Central Tendency For Wage Data," Official Social Security Website, Office of the Chief Actuary, http://www.ssa.gov/oact/cola/central.html, accessed May 2015.

education and training.[53] As discussed in Chapter 2, the lack of enough middle-skills jobs paying a good wage and supporting a middle-class income has been a critical weakness in the U.S. Energy jobs, then, are vital for reversing the decline in middle-class opportunity. (For a detailed explanation of the methodology used to analyze the unconventionals job market, please turn to Appendix II on Page 56).

Upstream unconventionals development is also an important catalyst for broader community development, including local services such as restaurants, financial services, housing, and entertainment. Each direct production job supports about two other jobs in the rest of the economy.[54]

Investments are especially transforming the Gulf Coast, where many new plants from the initial wave will be located. For example, Sasol broke ground on an $8.1 billion world-scale ethane cracker facility at Lake Charles, Louisiana, in March 2015.

User impacts

Unconventionals also create significant energy-cost and input-cost advantages for many users of oil and gas products. Those benefits are particularly large in petrochemicals and energy-intensive industries, though these low-energy cost benefits also flow to virtually all industries at some level. Such downstream advantages created by unconventionals are only just beginning to be realized.

Petrochemicals. Oil and gas are the main feedstocks for the petrochemical industry, an $80 billion sector in the U.S.[55] and $560 billion globally.[56] Petrochemical companies convert gas and oil into the base chemicals used in plastics, fertilizers, and a wide array of other products. Low-cost natural gas is a major competitive advantage for U.S. petrochemical producers, especially in producing natural gas-derived ethylene. BCG's *Made in America, Again* research estimates that low-cost gas reduces total manufacturing costs for U.S. chemicals players by 8%, relative to their costs prior to unconventionals.[57]

Prior to the development of unconventionals, investment in the U.S. petrochemical industry had virtually dried up.[58] Over the last five years, however, more than 220 new petrochemicals, chemicals, and plastics plants, as well as plants for other derivative products, have been announced in the U.S., representing approximately $138 billion in planned investment.[59] Of that, estimates show that planned investment in petrochemicals and chemicals accounts for more than $40 billion.[60] Those investments are especially transforming the Gulf Coast, where many new plants from the initial wave will be located.[61] For example, Sasol broke ground on an $8.1 billion world-scale ethane cracker facility at Lake Charles, Louisiana, in March 2015.[62] Over time, growth in petrochemicals will likely also extend to Pennsylvania and other sites near the Marcellus Shale in the Appalachian Basin.[63] While the recent drop in oil prices has slowed some of that growth, we believe that the huge U.S. cost advantage will drive significant petrochemicals expansion over the coming decade.

Plastics. Low feedstock costs are making the U.S. a far more attractive location for plastics producers. Since 2010, the American Chemistry Council estimates that nearly $47 billion will be invested in resin, compounding and ancillary chemicals (such as additives and colorants), and products over the next decade.[64]

Power. Natural gas now makes up more than 27% of U.S. power generation, up from 19% in 2005.[65] Natural gas-fired power has substituted for coal-fired power, driven primarily by favorable economics, and has created a significant electricity cost advantage versus other industrialized nations.

Energy-intensive industries. Low-cost gas and gas-fired power, particularly, benefit energy-intensive industries, which use gas and high levels of electricity to fuel foundries, paper mills, and other heavy industrial processes. BCG's *Made in America, Again* series estimated the cost savings from unconventional natural gas to be 4% or more of total manufacturing costs in a variety of industries, including minerals, metals, paper, and textiles.[66] (See Figure 9.)

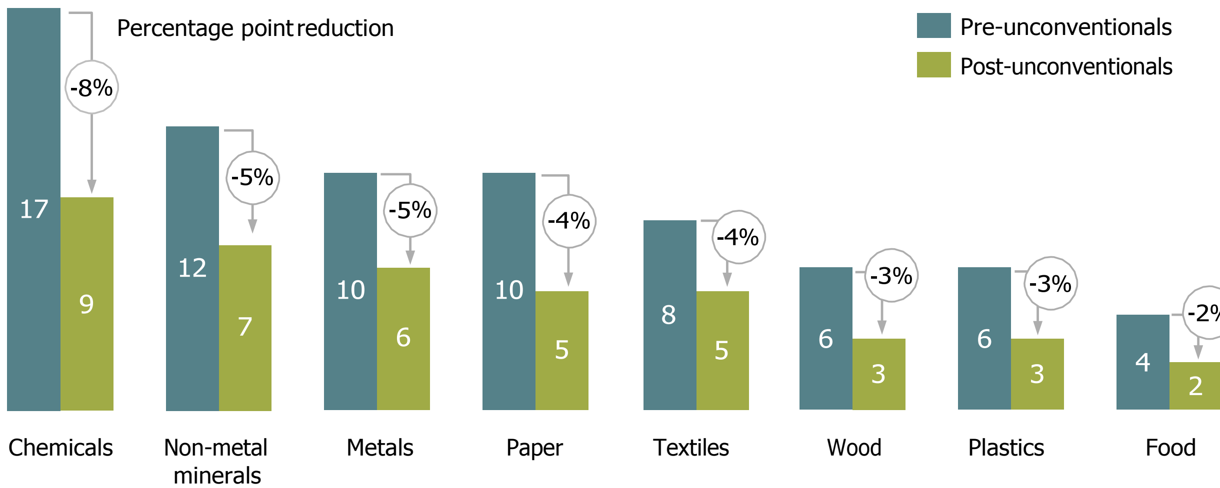
Some investments in these fields are underway or announced. For example, Big River Steel broke ground in September 2014 on a new $1.3 billion steel mill and recycling facility in Osceola, Arkansas, taking advantage of lower energy costs.[67] But this impact is still in its infancy. We see a significant potential upside that will expand the economic impacts of unconventionals beyond current forecasts. However, such large long-term investments require confidence that the cost advantage from unconventionals will be long-lasting. The highly divisive debate over unconventionals development can only delay such investments.

Fuel. Oil is the primary fuel used for transportation, and natural gas is the primary fuel used for heating. Unconventionals have lowered the costs of both inputs and created cost savings for businesses and households alike. For example, in 2014, residential, commercial, and industrial users saved about $90 billion in natural gas and natural gas liquids (ethane, propane, and butane) fuel costs.

Exports. Large U.S. reserves of gas and oil create new opportunities for exports, as well as greater energy trade

Figure 9: **Downstream cost advantages from unconventionals in selected industries**

Natural gas and electricity costs as a % of total pre-unconventionals manufacturing costs



Note: Manufacturing costs include all raw materials through all production processes with overhead included.

Source: Harold L. Sirkin, Michael Zinser, and Justin Rose, "The U.S. as One of the Developed World's Lowest-Cost Manufacturers: Behind the American Export Surge," The Boston Consulting Group, August 20, 2013, https://www.bcgperspectives.com/content/articles/lean_manufacturing_sourcing_procurement_behind_american_export_surge, accessed May 2015.

among states. U.S. exports of crude oil and liquefied natural gas currently are very limited due to out-of-date policies but represent a major new opportunity for economic growth.

Natural Gas Exports: For the first time in decades, the U.S. produces more low-cost natural gas than it can consume and also enjoys large reserves for future production. That has created the opportunity for LNG exports to European and Asian markets. Such exports will require multibillion-dollar investments in export terminals, as the U.S. currently only has LNG import terminals and a slate of U.S. LNG export terminals are currently being planned or under construction in 2015. Cheniere Energy's LNG export terminal in Louisiana is the first one, and is nearing completion. Sempra Energy has a terminal under construction in Louisiana as well. Eighteen companies have filed LNG export proposals with the Federal Energy Regulatory Commission (FERC), while 40 companies have applied for Department of Energy (DOE) export permits, both of which are required steps for any export activity.[68]

The potential size of the LNG export market is uncertain, but we estimate that in a favorable price environment, it could reach 3.1 trillion cubic feet (Tcf) by 2030, or 14% of total U.S. production, and contribute an additional $18 billion in GDP.[69] That potential may be dampened somewhat if low world oil prices persist. While U.S. export contracts are priced based on U.S. domestic prices (Henry Hub), most LNG export contracts outside the U.S. peg their pricing to world oil pricing.

Low current oil prices have, therefore, made U.S. LNG exports relatively less economical in the short term.[70]

Oil Exports: There is a sizable market abroad for the light-grade crude oil produced in U.S. unconventional basins. Today, the U.S. has a domestic mismatch in the types of crude produced from U.S. basins and the crude types required by U.S. refiners. Unconventionals skew U.S. supply toward light grades, but U.S. refineries have been built to operate with a mix of light and heavy crude oils. Currently, however, exports of crude oil are restricted by federal law, which forces U.S. refineries to adjust away from their optimal mix of crude grades in order to accommodate the overabundance of U.S. light-grade oil. That has created an artificial discount for light grades that reduces U.S. income.

Opening up exports would allow a better U.S. balance in crude grades and would bring domestic oil prices in line with world market prices, which would increase the value of oil produced in the U.S. Exports will also create an incentive for increased U.S. production, which will be especially important if low oil prices persist. There are also opportunities to better trade oil among U.S. states if ocean shipping costs, now artificially inflated, are reduced. We will discuss the legal and regulatory barriers to LNG and crude oil exports in a later section.

Other beneficiaries

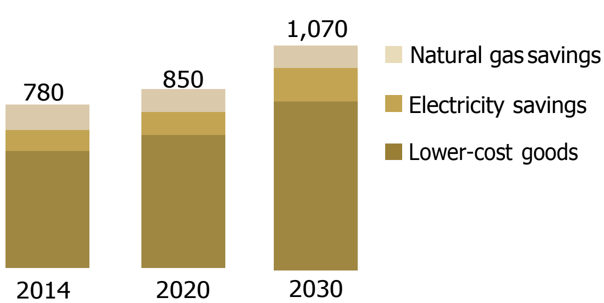
Unconventionals also benefit households, local governments, the federal government, and communities due to lower costs, increased tax revenues, and spillover benefits to other local businesses.

Households. Consumers across America are major beneficiaries of unconventionals, extending well beyond just the regions where significant production or conversion of gas and oil is occurring. BCG'S *Made in America, Again* series estimated that the average U.S. residential household has enjoyed nearly $800 in annual savings from the availability of low-priced unconventional natural gas. (See Figure 10.) That includes direct savings on household utility bills for electricity and heating, as well as savings from lower-cost goods and transport. Those estimates do not factor in the recent decline in oil prices that are also due in part to U.S. unconventional oil production. The DOE estimates that the fall in oil prices will save the average household an additional $750 in gasoline bills in 2015, compared with 2014.[71]

Governments. Both state and federal governments have been major financial beneficiaries of unconventionals production and resulting economic growth. Governments collect revenues from unconventionals development in several ways: royalties and taxes on land leases from production, corporate taxes on businesses, and personal income taxes due to new jobs, wages, and royalty income. We estimated that new government revenues in the U.S. from unconventionals development, excluding downstream industries, totaled approximately $110 billion in 2014, split between the federal- and state-level governments. That number could reach $160 billion by 2030. (See Figure 11.) To put it in perspective, the absence of the federal portion of these revenues would have added approximately 13% to the total 2014 federal budget deficit.[72]

Figure 10: **Annual household savings from low-cost energy**

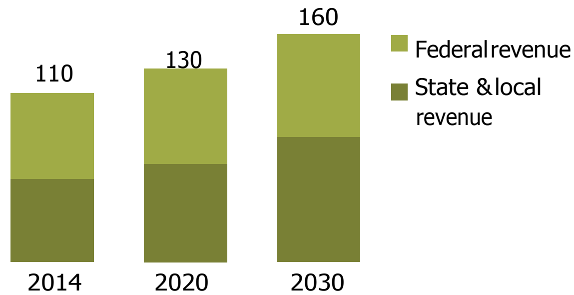
(2014 $)



Source: BCG and HBS Competitive Impacts Model; please refer to Appendix I for detailed methodology.

Figure 11: **Annual incremental government revenue from unconventionals**

(2012 $, Billion)



Note: Figures include incremental impacts from reversing the ban on crude oil exports, as well as incremental impacts from liquefied natural gas (LNG) exports. Both personal and corporate taxes are included in government revenues. State and local taxes also include severance and ad valorem taxes. Revenues also include income generated from federal royalties, as well as lease payments to private landowners. Figures are rough estimates used for illustration.

Source: BCG and HBS Competitive Impacts Model; please refer to Appendix I for detailed methodology.

IMPROVING AMERICA'S GEOPOLITICAL POSITION

Unconventionals also create major trade and geopolitical benefits for the U.S. The balance of trade has improved substantially, with oil imports down 28% between 2005 and 2014,[73] representing $103 billion at 2014 prices.[74] Unconventionals have also dramatically improved energy security. With natural gas reserves that can meet U.S. needs many times over, our economy is more resilient and less vulnerable to energy shocks from abroad. There is also less vulnerability to unstable producing countries and regions and less need to secure energy supplies abroad.

The new energy advantage has also increased U.S. economic strength and creates important new ways that the U.S. can support allies. Asia and Europe are both dependent on imported energy, which the U.S. could supply if export policies were updated. In particular, U.S. energy can help offset Europe's dependence on Russia. Finally, the greenhouse gas reductions already achieved through coal-to-gas switching in the power sector have given the U.S. new credibility in the international community.

EXPANDING THE ECONOMIC BENEFITS

Unconventionals are already playing a major role in lifting the U.S. economy and improving competitiveness across geographies. (See Figure 12.) However, there is real potential to expand the economic benefits even further. To do so, we must address a number of key challenges.

Upgrading oil and gas transportation infrastructure

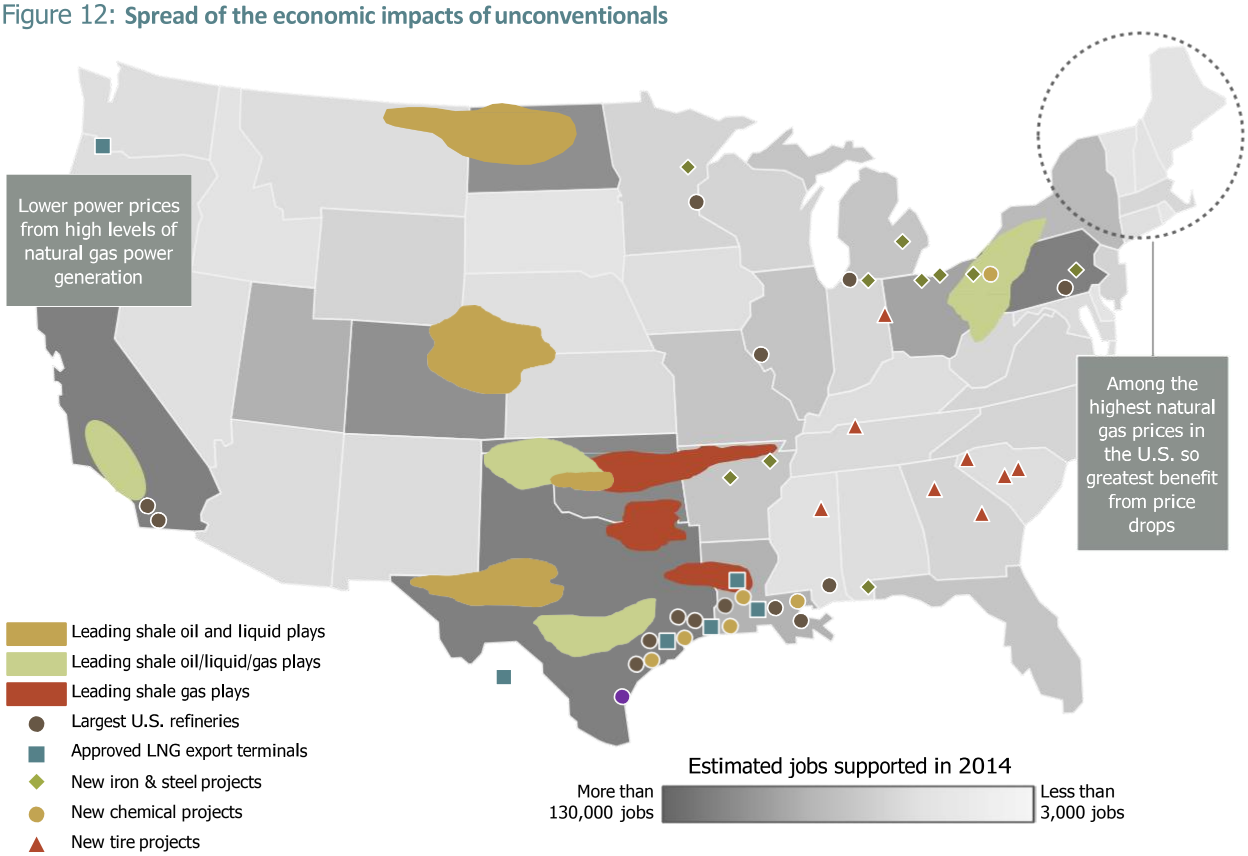
To support the continued growth of unconventionals, the U.S. must significantly upgrade its energy transportation infrastructure. By 2025, the oil and gas industry will need to invest approximately $200 billion in oil and gas transportation infrastructure, including new interstate pipelines, storage facilities, and rail and marine transport upgrades. Considering all the gathering and processing infrastructure, LNG export terminals, and road upgrades, the new investment requirement reaches nearly $900 billion.[75] Such infrastructure is essential to efficiently develop and utilize unconventionals both domestically and internationally.

However, oil and gas infrastructure projects have become a proxy battleground for larger climate and environmental debates, leading to delays that are hurting the U.S. both economically and environmentally. More than 4,600 miles of interstate pipeline projects in North America have been postponed by more than six months.[76] (See Figure 13 on page 24.) The absence of pipelines raises transportation costs and lowers the value of the gas and oil extracted. For example, natural gas in the Marcellus Shale has been trading at a significant discount to the Henry Hub benchmark, mostly because production has outpaced local pipeline takeaway capacity.

The lack of pipeline infrastructure has also shifted more crude oil transport to railroads. That has caused environmental, safety, and public health risks. The U.S. government estimates that an oil or ethanol train will derail an average of 10 times per year over the next two decades and cause more than $4 billion in damage, with pipelines being much safer.[77]

Long, inefficient, and highly political permitting processes are the major driver of infrastructure delays. The inter- and intrastate pipeline approval process is highly complex. The FERC process for interstate pipelines, for example, includes overlapping assessments and involves more than 10 stakeholders, from federal agencies—Bureau of Land Management, National Forest Service, and the Army Corps of Engineers—to regional consortia, state regulators, and local ordinances.[78]

Figure 12: **Spread of the economic impacts of unconventionals**



Note: Job forecast includes direct, indirect, and induced employment. Projects shown on map are examples, not an exhaustive list. Oregon's LNG export terminal is under DOE review.

Source: BCG and HBS Competitive Impacts Model; please refer to Appendix I for detailed methodology.

Figure 13: **Interstate pipeline projects in North America delayed more than six months**

Delayed Projects	Miles	Investment
Keystone XL	1,169	$10 billion
Northern Gateway	710	$6.5 billion
Trans Mountain	618	$4.8 billion
Sandpiper	612	$2.6 billion
Constitution	124	$693 million
Line 9B	397	$355 million
Alberta Clipper	999	$160 million

Source: Amy Harder, "Protests Slow Pipeline Projects Across US, Canada," The Wall Street Journal, December 2014, http://www.wsj.com/articles/protests-slow-pipeline-projects-across-u-s-canada-1418173235, accessed May 2015.

For intrastate pipelines, many states have not clearly delegated the authority for infrastructure reviews to a lead agency. As a result, the time it takes to permit and complete a project is rising. The number of infrastructure projects delayed more than 90 days is up 28% between 2005 and 2012, and the number of projects delayed more than 180 days is up 20%.[79] While FERC has more authority to set and enforce permitting timelines, and new proposals have been made in Congress to address those challenges, no real progress has occurred.

Developing a skilled workforce

There is a pressing need for skilled workers in both upstream and downstream industries. Unconventionals development is creating growing demand for a diverse set of well-paying jobs. An analysis of Burning Glass's data on occupations related to unconventionals development shows that many states registered a three-digit spike in job postings between 2011 and 2014,[80] including North Dakota (286%), West Virginia (212%), Montana (198%), Minnesota (193%), Arkansas (163%), Washington (120%), and North Carolina (100%), and with states like Ohio (95%) and New Mexico (93%) just behind. That growth has been somewhat offset by cyclical layoffs due to the recent decline in oil prices, but we expect the need for skilled workers to resume over the medium and longer term as oil prices recover.

In production and supply, new jobs are created for petroleum engineers, roustabouts, extraction helpers, drill operators, and derrick operators.[81] (See Figure 14.) Further downstream, hundreds of thousands of new machinists, welders, industrial machinery mechanics, and industrial engineers will be needed by 2020.[82] In addition to skilled blue-collar jobs, there is high demand for engineers, sales and marketing personnel, geologists, finance professionals, and IT professionals.[83]

However, skills gaps in the U.S. labor force make it more difficult for employers to hire qualified workers. An aging workforce exacerbates the skill gaps—nearly 25% of extraction and production workers are over the age of 55,[84] and will need to be replaced in addition to meeting the growing demand. There is a pressing need for programs and initiatives to fill the workforce gap, or the economic potential of unconventionals will be constrained.

Opening up gas and oil exports

The oil export ban is outdated and based on circumstances in the 1970s that since have been reversed. Today, the ban on crude exports to almost all countries is reducing market opportunities for producers and reducing U.S. growth, with no clear offsetting

Figure 14: **Occupations with the largest number of job postings in the unconventionals industry (12-month period ending October 2014)**

	Occupation	Job Postings
1	Tractor-Trailer Truck Driver	3,198
2	Reservoir / Petroleum Engineer	1,195
3	Production Worker	627
4	Geologist	542
5	Automotive Service Technician / Mechanic	311
6	Laborer / Material Handler	217
7	Machinist	203
8	Industrial Engineer	198
9	Office / Administrative Assistant	193
10	Civil Engineer	191

Note: Data based on a sample size of 13,136 job postings listed on major online job websites for the 12-month period ended October 2014. Job postings are related to unconventional energy extraction using keyword and skills filters.

Source: Burning Glass analysis; please refer to Appendix II for detailed methodology.

benefits for America or Americans. By 2030, oil and gas exports could create an additional $23 billion in GDP and around 125,000 new U.S. jobs.[85] (See Figure 15.)

Crude oil exports increase the competitiveness of domestic oil production without affecting U.S. consumers. The U.S. price for gasoline and other refined products is closely tied to global market prices for these products, because the U.S. places no restrictions on their import or export. However, the existing ban on crude oil exports hurts domestic producers while benefitting domestic refiners, because U.S. producers must sell their crude at a discount to U.S. refiners. Therefore, exports will not cause an increase in prices at the pump, and few, if any, other U.S. industries would be affected. Crude oil is the source of less than 1% of the fuel for power generation,[86] and U.S. petrochemical companies are already using natural gas and related natural gas liquid products, rather than crude oil, as their primary feedstock. Instead of raising domestic prices, then, the overall effect of lifting the oil export ban could actually reduce global prices for gasoline by increasing the global availability of crude oil.

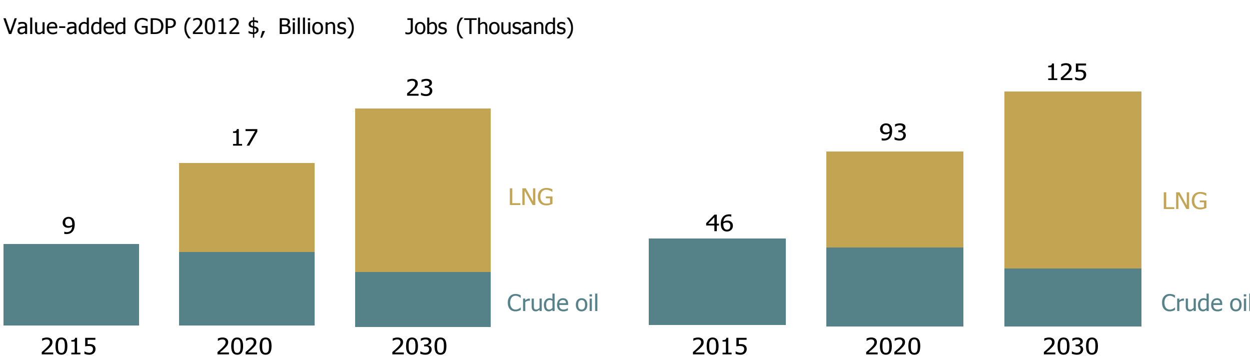
Export bans are also inconsistent with longstanding U.S. trade policy and undermine U.S. efforts in opening markets generally, which benefits U.S. producers and consumers across all industries.

Current permitting processes are also restraining the export of natural gas through LNG. Natural gas exports would create new markets for U.S. production without affecting the U.S. cost advantage or raising U.S. prices. The high transport costs of LNG (about 50% of the landed price) (see Figure 16 on page 26) mean that U.S. natural gas prices will remain well below global LNG prices and that U.S. downstream companies will continue to enjoy large cost advantages.[87] U.S. prices are also unlikely to rise substantially with LNG exports because of the abundance of low-cost U.S. natural gas.[88] Moreover, they will need to remain near current levels for U.S. LNG exports to be competitively priced in key foreign markets. Forecasted 2020 LNG prices for major global markets range from $8/MMBtu to $11/MMBtu. With expected transport costs from the U.S. ranging from $5–7/MMBtu, domestic prices must be in the $3–5/MMBtu range to be competitive, representing little or no increase compared with current prices.[89]

Exporting LNG is also unlikely to affect long-term U.S. supply security because domestic reserves of natural gas greatly exceed expected total domestic and foreign demand. Even in a scenario with high-demand for exports, our analysis suggests that LNG exports will account for just 10–15% of total U.S. natural-gas production and make little impact on U.S. overall reserves.[90]

As large as the existing and future economics of unconventionals are, however, the U.S. runs the risk of not taking advantage of them due to strong opposition from other stakeholders. That opposition reflects the belief that there are trade-offs between the economic benefits of unconventionals and the environmental impact, which includes reducing climate risks. In the U.S., those beliefs are reflected in declining public support for hydraulic fracturing. Prior battles waged over nuclear power and hydroelectric power show how such opposition can all but stop technologies with major potential. We discuss the facts about the local environmental and climate impacts of unconventionals in Chapters 4 and 5. The trade-offs prove to be false ones that can be avoided.

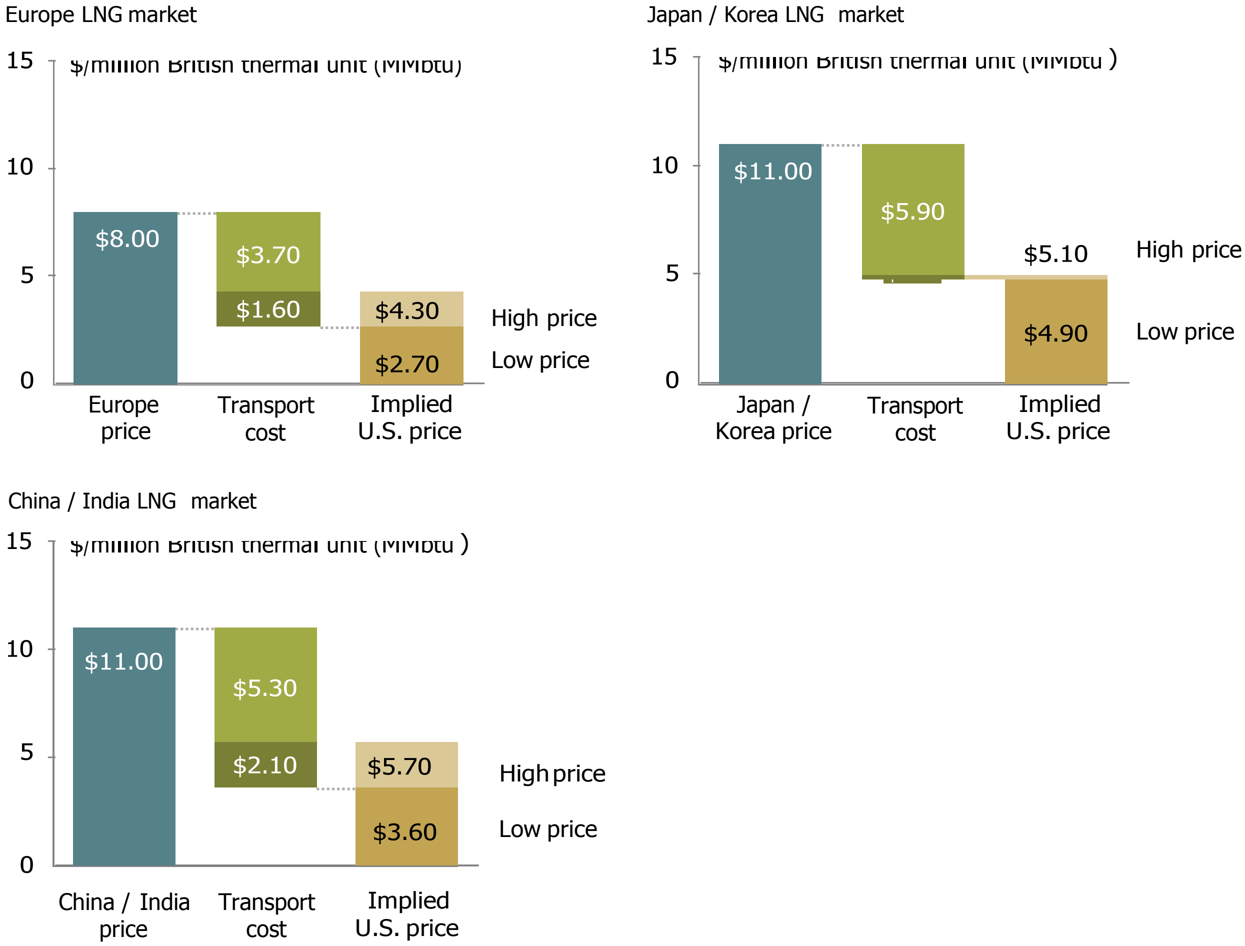
Figure 15: **Estimated GDP and jobs generated by oil and gas exports without export restrictions (2015 – 2030)**



Note: GDP and job impacts include multiplier effects on suppliers and local services and include offset from lower margins for U.S. refiners.

Source: BCG and HBS Competitive Impacts Model; please refer to Appendix I for detailed methodology.

Figure 16: **Forecasted 2020 LNG market prices and implied U.S. prices required to meet forecasted LNG market prices**



Note: Netback includes costs of liquefaction, shipping, and regasification. U.S. netback estimates are primarily from Gulf Coast region.

Sources: "US Manufacturing and LNG Exports: Economic Contributions to the US Economy and Impacts on US Natural Gas Prices," Charles River Associates, prepared for The Dow Chemical Company, February 25, 2013, http://www.crai.com/sites/default/files/publications/CRA_LNG_Study.pdf, accessed May 2015; W. David Montgomery et al, "Macroeconomic Impacts of LNG Exports from the United States," NERA Economic Consulting, April 2013, p. 2, http://energy.gov/sites/prod/files/2013/04/f0/nera_lng_report.pdf, accessed May 2015; BCG Global Natural Gas Market Model.

Chapter 4:

MINIMIZING LOCAL ENVIRONMENTAL IMPACTS IN A COST-COMPETITIVE WAY

Despite its major positive economic impacts for business, government, consumers, and America's geopolitical position, the development of unconventionals faces determined opposition. Recent polling shows a 7% decline (from 48% to 41%) in the percentage of Americans favoring "fracking" from March 2014 to November 2014, while those opposing it increased by 9% (from 38% to 47%). That 16-point swing has coincided with public action to curtail extraction of unconventionals: In Colorado, Governor John Hickenlooper brokered an agreement to remove a November 2014 ballot initiative on hydraulic fracturing, at least temporarily;[92] voters in Denton, Texas, approved a ban on hydraulic fracturing in November 2014;[93] New York Governor Andrew Cuomo banned fracking throughout the State of New York in December 2014;[94] and the Maryland legislature voted to place a 30-month statewide ban on hydraulic fracturing in April 2015.

Such opposition is due in large part to the environmental, health, and community impacts of unconventionals development (there are also concerns driven by climate change, which will be discussed in Chapter 5). These community concerns are justified and are especially present in areas with no history of oil and gas industry development. Unconventionals do raise significant risks in multiple areas, and industry performance in addressing these risks has been highly uneven.

SIGNIFICANT ENVIRONMENTAL IMPACTS

The development of unconventionals creates significant risks in a variety of areas:

- *Water issues:* Well construction, chemical injections, freshwater use, and wastewater disposal create risks of freshwater depletion, groundwater contamination, radioactive contamination, and surface water pollution.
- *Air pollution:* Onsite diesel engines, truck traffic, wastewater storage vessels, and gas flaring create potential emissions of volatile organic chemicals (VOCs), sulfur dioxide, nitrogen oxides, and other local air pollutants.
- *Seismic:* Wastewater disposal wells have been associated with increased seismic events in some regions, such as Oklahoma[95] and Texas.[96] Disposal wells sited near fault lines create the greatest earthquake risks.
- *Land and community impacts:* The rapid expansion of drilling operations and well sites can create despoiled landscapes, significant truck traffic, and visual and noise pollution in sensitive areas and near populated areas.

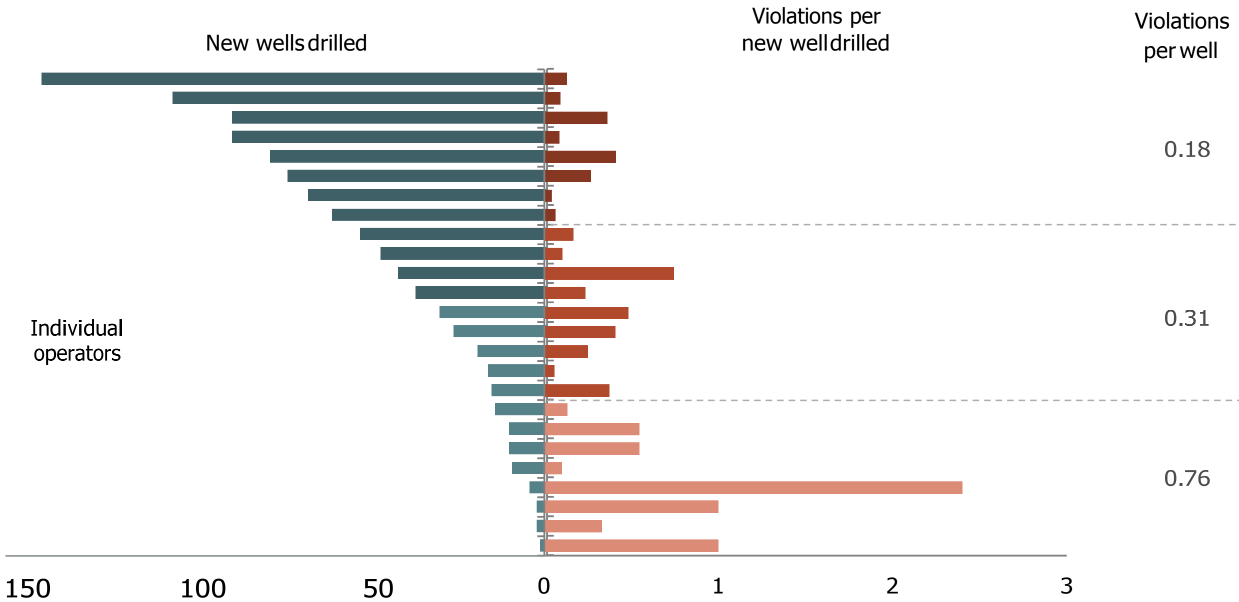
The risks of unconventionals development are exacerbated by uneven industry regulatory compliance and uneven regulatory enforcement. Many of the environmental incidents most associated with unconventionals, like drinking water contamination and chemical spills, are the result of operator noncompliance, rather than insufficient regulations.

These environmental, public health, and community impacts vary significantly by region. Geologic conditions, the degree of water stress,* and population density, among other things, affect the techniques with which unconventionals are produced, as well as the nature and severity of the environmental and health risks. For example, the Marcellus Shale in Pennsylvania has ample availability of fresh water,[97] but wastewater disposal is difficult. In contrast, the Permian Basin in Texas is located in a water-stressed region[98] but has more readily available sites for water disposal.[99] Best practices to address local environmental risk are not one-size-fits-all and must be tailored to circumstances. That increases the complexity of regulation and compliance, which means that states must play the leading role in regulation and enforcement.

Furthermore, the risks of unconventionals development are exacerbated by uneven industry regulatory compliance and uneven regulatory enforcement. Many of the environmental incidents most associated with unconventionals, like drinking water contamination and chemical spills, are the result of operator noncompliance, rather than insufficient regulations.

*Water stress measures total annual withdrawals (municipal, industrial, and agricultural) expressed as a percentage of water available. (Ceres, Hydraulic Fracturing & Water Stress: Water Demand By The Numbers, p.15, February 2014.)

Figure 17: **Violations data (2013) in Pennsylvania for new unconventional wells drilled**



Note: Violations per well represent the average for the top, middle, and bottom third of violations per new well drilled. Duplicate violations and administrative violations were removed from original data.

Sources: Data from "Oil and Gas Reports, Oil and Gas Compliance Report," Pennsylvania Department of Environmental Protection, http://www.portal.state.pa.us/portal/server.pt/community/oil_and_gas_reports/20297, accessed May 2015; BCG-HBS calculations.

There are thousands of producers and contractors involved in unconventional development, ranging from global energy giants to single-family operations. Operational capability and training vary widely. 2013 data from Pennsylvania on well violations illustrate the variation in performance across producers. In this example, producers in the bottom third of new wells drilled have more than four times the rate of violations as firms in the top third of new wells drilled. (See Figure 17.)

Regulatory enforcement capacity is also lagging in a number of areas. Though many states have expanded the size of their regulatory staffs, they are still playing catch-up. In North Dakota, for example, limited staff means that regulators are often reactive, primarily issuing warnings, while collecting only 10% of the fines and penalties assessed.[100] States are also competing with producers for workers with the appropriate skills to competently carry out inspections and enforcements. Finally, many states also have antiquated data and IT systems that limit the transparency and usability of enforcement data, and their ability to prioritize and target enforcement activities.

UNMISTAKABLE PROGRESS

While these risks are real, significant progress has already been made in improving leading practices for mitigating impacts. Producers, NGOs, and regulators have all achieved a better understanding of how to address local environmental and public health risks. Some leading practices, such as proper well construction, have been widely implemented by producers and regulated by states for many decades (for example, well casing). In other areas, like chemicals disclosure and water management, substantial improvement has occurred since unconventionals development has grown.

There is already a large body of high-quality research that lays the foundation for successfully managing environmental impacts. Groups as diverse as the Environmental Defense Fund (EDF), the International Energy Agency (IEA), the National Petroleum Council (NPC), and the American Petroleum Institute (API) are codifying effective approaches. Our research reveals that it is truly possible to successfully and economically manage the environmental risks of unconventionals.

Industry innovation

The API standards process, accredited by the American National Standards Institute (ANSI), is the definitive process for developing technical standards for the oil and gas industry. Since 2009, API has added six hydraulic-fracturing standards: in well construction, water management, mitigating surface impacts, environmental protection, isolating flow zones, and community engagement.[101] These standards are disseminated across the industry and serve as a benchmark for improving performance.

The more sophisticated producers have already adopted these and other leading practices, and the state of the art is rapidly advancing. Leaders have pioneered and adopted many of the cutting-edge environmental mitigation techniques and see it as good business in order to reduce costs, capture lost production, and build productive relationships in the communities in which they operate. In response to concerns in Colorado about the community impacts of unconventionals development, for example, Noble Energy and Anadarko are rolling out remote well pad servicing. Anadarko estimates that its efforts alone have reduced well pad sizes by 40% and eliminated approximately 300,000 truck-trips annually.[102] Water recycling has also become a big point of emphasis for operators to improve environmental performance while reducing costs. Range Resources, for example, pioneered flowback water recycling in 2009 and by 2013 used recycled water for most of its well completions, accounting for 30–40% of its water usage in Pennsylvania.[103]

Improving regulation

Regulators are also learning rapidly and taking steps to address many of the risks of unconventionals development. They have significantly improved rules since 2010. Prior to 2010, regulators in many states, especially those without a history of conventional oil and gas activities, were not prepared to deal with the rapid growth of drilling and hydraulic fracturing activity for unconventionals. Over the last five years, however, most states have put better regulatory frameworks in place. Even states with little to no prior drilling activity have enacted broad regulatory oversight that addresses water issues, well location requirements, and other drilling aspects (for example Ohio, West Virginia, and Pennsylvania).[104] Established oil states have also improved the regulatory framework for hydraulic fracturing (for example., Texas, Colorado, Arkansas, and Montana).[105] Now, 27 states have rules in place to regulate the use and disclosure of hydraulic fracturing chemicals. Ten of the 12 states catalogued by LawAtlas' Policy Surveillance Portal have air quality regulations governing well site setbacks from other activity and rules mandating leak detection and repair (LDAR) programs.[106]

A successful example of producers and regulators working together to improve water recycling rates is in the Eagle Ford Shale, Texas, basin, a water-scarce region. Water recycling rates in the region have increased from less than 1% five years ago to 30% today and are expected to reach 50% or more in the next five years. The increase is attributable to new approaches and technologies by producers, as well as changes to regulations by the Texas Railroad Commission, to make it easier to recycle.[107]

Leading states have even made progress in addressing emerging risks like induced seismicity. For example, the Texas Railroad Commission introduced new regulations in October 2014 that require applicants for injection well permits to determine the seismic history within 100 square miles of the proposed well and to disclose water disposal volumes.[108] Ohio regulators tightened permitting rules for drilling near fault lines or in areas with a history of seismic activity.[109]

Continuous improvement efforts

A number of organizations dedicated to continuous improvement in practices and regulation have been formed or strengthened to support innovation in unconventionals. Those include longstanding industry bodies, such as the API, which updates its industry technical standards on a regular basis through a process that includes both industry participants and other individuals or organizations that have a direct and material interest in the development of oil and gas resources, including government, academia, and NGOs. The Interstate Oil and Gas Compact Commission (IOGCC), led by the governors of 30 member states, and the State Review of Oil and Natural Gas Environmental Regulations (STRONGER), consisting of government, industry, and NGO representatives, are bodies designed to share best practices and review and compare regulations across jurisdictions.[110]

FracFocus, a national hydraulic fracturing chemical registry managed by the Ground Water Protection Council (GWPC) and the IOGCC, was created to encourage the disclosure of the chemicals used in hydraulic fracturing. That effort has achieved remarkable success, with 18 states now mandating the use of the FracFocus database and more than 94,000 wells listed on the site.[111] The Center for Sustainable Shale Development (CSSD) is dedicated to setting performance standards for the Appalachian Basin, primarily in Pennsylvania, West Virginia, and Ohio, and now has accredited its first three operators—Chevron, Shell, and CONSOL Energy—for meeting its standards.[112] The Colorado Oil & Gas Task Force, formed by the Governor and consisting of 19 local government, industry, agriculture, NGO, and community representatives, formulates recommendations to balance Colorado land-use issues in ways that minimize conflicts, allow access to private mineral rights, and protect communities.[113]

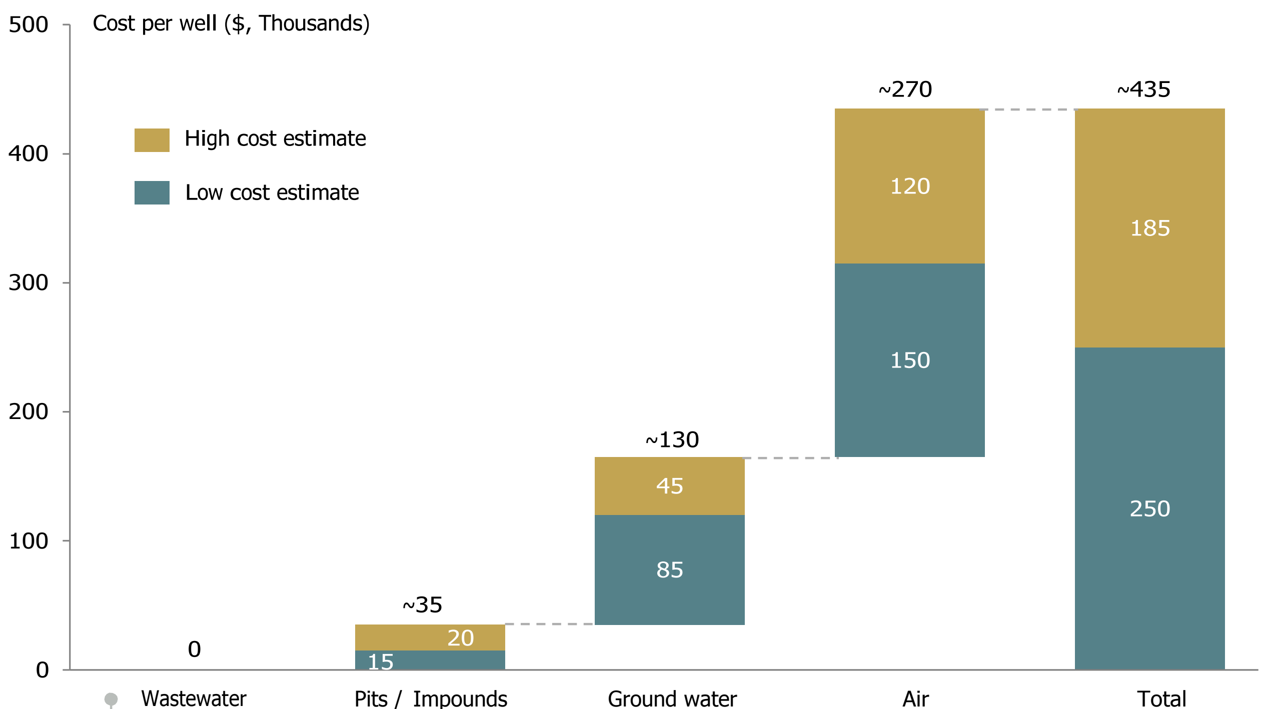
ENVIRONMENTAL PROTECTION WHILE PRESERVING COMPETITIVENESS

Despite the progress made, there is a common perception that environmental protection can only be achieved at high and potentially prohibitive costs to producers. As a consequence, there has been strong resistance in the industry to regulation, with opponents arguing that such standards are too costly and will make U.S. unconventionals uncompetitive.

Our research reveals that, in fact, there is not an inherent trade-off between environmental protection and profitability. We find that some techniques to mitigate the environmental impacts of unconventionals are actually cost saving. That is because they reduce producers' use of costly inputs (for example, water recycling) or allow producers to capture more gas or oil (for example, reduced flaring). In other areas, environmental standards do involve cost, especially in the short run. However, our research shows that the net costs are a small portion of the lifetime revenues and costs of operating a well.

To understand the cost of robust environmental protection, we examined Pennsylvania's Marcellus Shale as a case study. We analyzed the environmental performance standards developed by the Center for Sustainable Shale Development (CSSD), which consist of 15 standards designed to be clear, consensus-driven, and performance-based.[114] The standards were developed in a joint effort by industry members, the NGO community, and policy makers in the Appalachian Basin, and they cover wastewater, pits and impounds, ground water, and air pollution. The CSSD's standards go beyond current Pennsylvania laws and are meant to be leading-edge performance benchmarks for robust environmental protection.

Figure 18: **Estimated incremental costs to meet CSSD standards**



No incremental cost due to reduction in transportation & disposal costs from water recycling/re-use (unique to Marcellus Basin, which has very few water disposal wells)

Total well lifetime production (median)*	~8,000,000 MMbtu
Additional cost of CSSD per lifetime MMbtu*	~$0.05
Additional cost as % of expected lifetime revenue**	1-2%

*Assumes a well expected ultimate recovery (EUR) of 7,938,451,950 MMbtu, cost of meeting standards at $435k. Well EUR is a median value of a Marcellus operator and is variable; 25th to 75th percentile EURs range from 6,200,000 MMbtu to 9,700,000 MMbtu.

**Assumes a Henry Hub spot price of $3.78/MMbtu as of October 2014. Though some areas of the Marcellus Shale are experiencing prices discounted from Henry Hub due to infrastructure constraints, this discount should ease as the constraints are addressed.

Source: BCG and HBS analysis; please refer to Appendix III for detailed methodology.

To test the effect of meeting these standards on economic competitiveness, we used the best available public sources to estimate the costs of meeting each standard, drawing on BCG's Unconventionals Operations Database, as well as BCG's Energy Practice's upstream operations experts. We developed a conservative estimate by assuming that producers were not currently meeting any of the 15 standards and reviewed this with industry experts. (See Appendix III on page 56 for more detail.) Our analysis probably overstates the actual costs for the average midsize producer, however, as many producers are already meeting multiple CSSD standards in their current operations.

We found that CSSD standards can be met without materially affecting a producer's drilling economics. Compliance costs range from $250,000 to $435,000 per well, representing less than 2% of the expected lifetime revenues from the well.[115] (See Figure 18.) While that is a meaningful cost, particularly in the current low-price environment, it will not have a material impact on the competitive advantage of U.S. unconventionals versus other locations, or on the U.S. cost advantage in power generation and other downstream industries. In fact, the cost of meeting these standards is less than the daily fluctuations of the Henry Hub price of natural gas, which has averaged 2.2% over the last five years.[116] With a level playing field of sound regulation and strong enforcement of compliance, individual producers are unlikely to face a significant competitive disadvantage from complying unless they are inefficient in their deployment of proven mitigation techniques.

ACCELERATING LOCAL ENVIRONMENTAL IMPROVEMENT

The U.S. can substantially reduce virtually all the major impacts of unconventionals at a modest cost. In order to do so, we need to make improvements in four main areas. First, there is a lack of sufficient environmental performance data by area. Second, there are gaps in current regulatory standards that need to be filled. Third, steps are needed to improve enforcement and achieve universal compliance, to level the playing field across producers. Finally, more coordination is needed among continuous-improvement bodies to accelerate learning and innovation.

Developing transparent and rigorous performance data

There is a lack of high-quality systematic data measuring actual environmental performance by region on the key risk areas. Without a common and transparent fact base, compliance improvement and innovation is set back. Over the course of this study, we found it difficult to establish an environmental performance fact base and had to rely on case studies. Very few companies publish clear data on their environmental impact, leaving it to state regulators.[117] However, an April 2015 report by the Natural Resources Defense Council (NRDC) and the FracTracker Alliance (FTA) found that only three of the 36 states with significant oil and gas development have publicly accessible databases on violations and spills.[118] In other states, regulatory IT systems are outdated, and data sets are often unreliable.

These data gaps make it easy for both industry and environmental stakeholders to dispute and distort actual performance, rather than progress from a common starting point. NGOs and media outlets produce some data and investigative reports in an attempt to fill the gaps, but they are often focused on advocacy of a particular group or risk and lack appropriate context. Moreover, many advocacy articles use the data quite selectively.

Closing regulatory gaps

While regulations have substantially improved, gaps remain in the current regulatory framework across states. Many local and state governments can further improve some standards, especially for water life cycle management, road use and maintenance, and VOCs. Regulations also need to keep pace with new mitigation techniques and approaches.

In water management, for example, the proper treatment and disposal of wastewater continues to be an issue requiring attention. One currently debated impact is the potential for earthquakes caused by wastewater disposal wells. While some states like Texas and Ohio have taken early steps to address that issue, most states are only starting to set concrete rules and regulations. Oklahoma, the state most affected by induced seismicity, has only recently even recognized that there is a link between the wastewater injection wells and the state's dramatic uptick in earthquakes since the early 2000s.[119]

An emerging issue in water management is the disposal of naturally occurring radioactive materials (NORM), primarily radium-226 and radium-228, which can be drawn up to the surface by the drilling and fracturing process.[120] The Groundwater Protection Council reports that state regulations are only in the early stages of managing this potential public health risk, especially in the Appalachian Basin.[121] These issues and others need to be fully understood and appropriately incorporated into the regulatory framework, reflecting the true level of risk posed.

It is also important that regulatory standards be based on performance outcomes wherever possible. Producers should have the flexibility to tailor solutions to their particular geologic and environmental circumstances, to utilize new technologies, and to be motivated to deliver continuous improvement. The best broad example of such environmental regulations is the SO_2 and NOx trading systems introduced by the Clean Air Act Amendments of 1990. Within oil and gas, regulators have also improved the use of performance-based standards, such as the EPA's 2012 New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants. These standards reduce VOCs from oil and gas drilling by setting key technology performance requirements.[122] Such performance-based methodologies must be used to address water management and other issues.

Moving to universal compliance

Today's uneven compliance by producers and uneven enforcement by regulators means that too many adverse environmental impacts result from operator violations. The steps required for regulators to achieve stronger enforcement and universal compliance vary by state. In some cases, inadequate staffing is the problem. Though many states have expanded the size of their regulatory staffs, they are still playing catch-up.

In other cases, regulators can use new technologies to make inspections more effective. For example, the Texas Commission on Environmental Quality (TCEQ) has started using aerial infrared cameras in the Eagle Ford Shale to detect major methane leaks and to prioritize where to send field inspection personnel.[123]

Modern data analytics are also a powerful tool to target the most likely violators. Colorado has taken the lead here, using a risk-based inspection strategy to prioritize inspections of equipment types with the highest spill rates versus inspecting all equipment with the same frequency.[124] That allows state regulators to address the most common causes of spills with fewer resources.

The industry can also expand its role in self-enforcement. Today, compliance with API standards is voluntary, and API has no mechanism to enforce adoption. However, precedents inside and outside the oil and gas industry provide instructive examples for how producers can take a more proactive role. In chemicals, Responsible Care is a global voluntary initiative formed by the chemical industry to improve occupational health and safety, plant safety, product stewardship and logistics, environmental performance, and dialogue with neighbors and the public. From 1988–2012, Responsible Care companies have reduced Hazardous Air Pollutants (HAPs) by more than 77%.[125] In oil and gas, the Center for Offshore Safety (COS) was initiated by the API after the Deepwater Horizon oil spill in the Gulf of Mexico.[126] It is an industry-wide body whose activities include sharing best practices, providing a forum to discuss methods for continuous improvement, and overseeing third-party audits of drilling facilities. During the first full year of reporting (2013), not a single COS member suffered a fatality or loss of well control during more than 42 million work hours.[127] Such efforts not only spread strong compliance but also build industry legitimacy and help ensure that industry retains the license to operate.

Strengthening continuous improvement

There is a diverse set of continuous improvement bodies that are playing an important role in advancing environmental performance, as practices and technologies rapidly evolve in this still-new sector. However, coordination among them is uneven, which limits their effectiveness.

IOGCC and STRONGER are each multi-state, multi-stakeholder groups focused on regulatory and legislative best practices. IOGCC "tracks, evaluates, and disseminates information on state innovations and best practices."[128] STRONGER, now a non-profit organization, was originally initiated by the IOGCC and EPA in the late 1980s to "review state oil and gas waste management programs against a set of guidelines developed and agreed to by all the participating parties."[129] However, the IOGCC no longer works with STRONGER, because it was unable to reach an agreement to continue sponsoring STRONGER in the late 1990s.[130] This political disagreement is counterproductive to the common mission of state regulatory improvement and creates overlapping mandates.

Such a lack of coordination also occurs at the state and local level, where there are organizations focused on important regional topics (like the CSSD and the Colorado Oil and Gas Task Force). Their role with state agencies and regulations is not always clear. For example, the CSSD has set out its 15 performance standards for unconventionals development, but there is no clear plan for how these higher standards will eventually link up with state laws in Pennsylvania, Ohio, and West Virginia. Such gaps in coordination and political associations leave the average American confused as to whether progress is truly being made on key environmental topics.

With progress in these four areas, unconventionals development can win the support of the public, and the process of innovation and improvement in environmental performance will accelerate.

Chapter 5:

THE TRANSITION TO A LOWER-CARBON, CLEANER-ENERGY FUTURE

Over the last decade, the U.S. has begun a major transition toward a more efficient, cleaner, and lower-carbon energy system, particularly in the power sector. Energy efficiency has significantly improved since 2005,[131] as energy consumed per unit of GDP has decreased by 23%.[132] Pollution has fallen, as sulfur dioxide has declined by more than 55%[133] and nitrous oxide and particulate matter (PM10) levels have each fallen by more than 15%.[134] And, importantly, carbon dioxide emissions have decreased by 10%.[135] Unconventionals, especially natural gas, have played a significant role in this transition, and will continue to play a major role going forward.

DRIVERS OF THE ENERGY TRANSITION

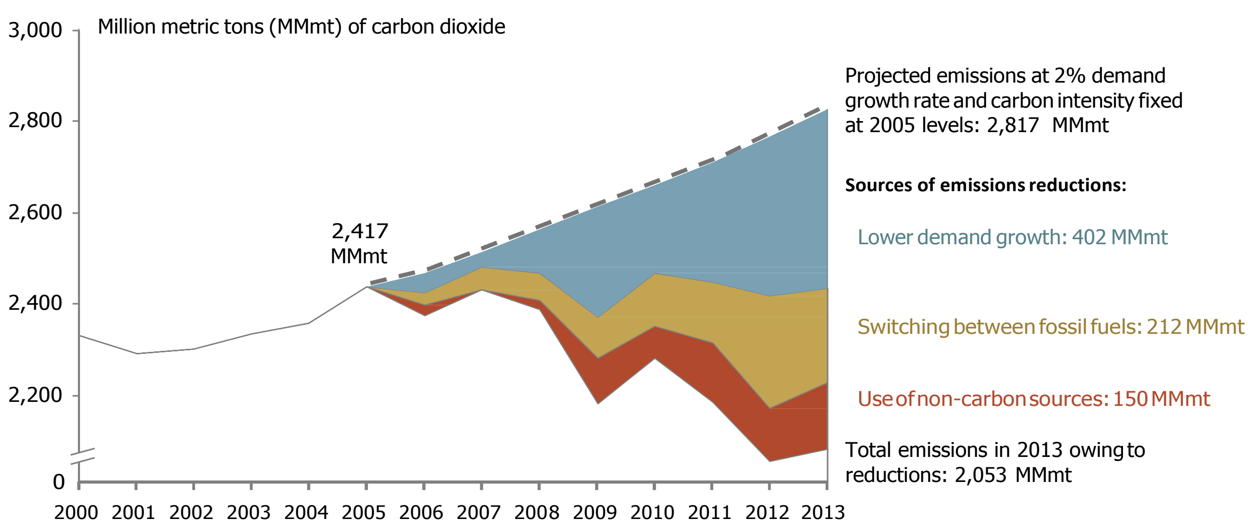
The transition to a cleaner, lower-carbon energy system is the result of a series of major and likely irreversible drivers.

Energy efficiency

Energy demand growth has historically been tightly tied to overall economic growth, but they have decoupled over the last decade due to rising energy efficiency and demand response efforts. Overall energy demand has grown by just 0.24% annually since 2010 and is expected to grow at 0.4% annually to 2040.[136] By contrast, annual energy demand growth averaged approximately 1.8% between 1950 and 2010.[137] The compound annual growth rate (CAGR) for electricity demand was 1.6% from 1990 to 2010 but actually declined by approximately 0.2% between 2011 and 2014.[138]

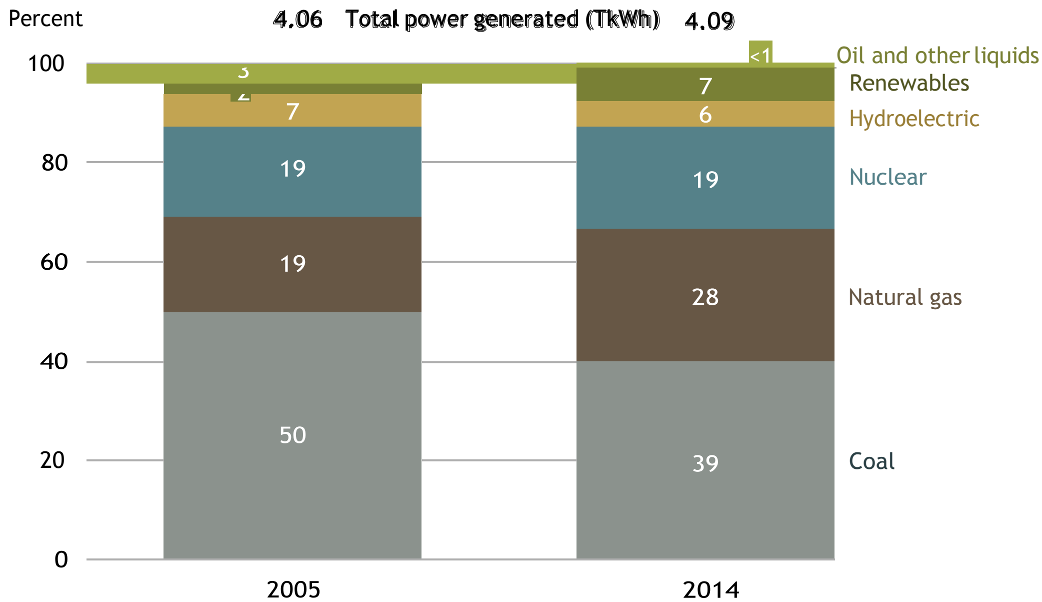
State and federal policies have stimulated efficiency improvements. State-level electric efficiency programs have mandated increasingly efficient buildings, lighting, and appliances. Federal standards have increased vehicle efficiencies and have reduced fuel costs for businesses and consumers.[139] Greater efficiency in energy use has also been a major factor slowing carbon dioxide emissions. The EIA estimates that more than 50% of the carbon reductions in the power sector since 2005 can be attributed to lower demand growth.[140] (See Figure 19.)

Figure 19: **U.S. electric power carbon dioxide emissions (2000–2013)**



Source: "Lower Electricity-Related CO2 Emissions Reflect Lower Carbon Intensity and Electricity Use," Energy Information Administration website, October 23, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=18511, accessed May 2015.

Figure 20: **Percentage of U.S. power generation by type**



Note: Total power generated is in trillion kilowatt hours (TkWh).

Source: "Electric Power Monthly," Energy Information Administration website, http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_1, accessed May 2015.

Coal to gas

A major shift from coal to natural gas in power generation has led to economic, environmental, and climate benefits. Since 2005, coal has declined, from 50% of the fuel mix in the U.S. power sector to less than 40% in 2014, and natural gas has grown, from 19% to over 28%.[141] (See Figure 20.) Low natural gas prices have made gas more cost-competitive than coal, especially relative to older, lower-capacity coal plants.

Gas-fired power is also far less polluting than coal (in SO_2, NOx, particulate matter, and mercury).

Finally, gas fired plants have about half the carbon[142] emissions of coal. That means that the major shift in power supply from coal to gas reduces U.S. carbon emissions substantially as well. In fact, the EIA estimates that coal-to-gas switching has contributed more than 25% of power-sector carbon emission reductions since 2005.[143] (See Figure 19 on page 33.)

Growth of renewables

Renewables, excluding conventional hydroelectric power, have increased from 2% of the energy mix in 2005 to 7% in 2014.[144] Renewables made up approximately 52% of the total new generation capacity installed in the U.S. in 2012.[145] In states with attractive wind and sun conditions, renewables have become an even larger part of the power mix. Iowa generated more than 27% of its electricity from wind in 2013,[146] for example, while California became the first state to generate 5% of its electricity from large-scale solar in 2014.[147]

Supportive government policies have played a role in renewables growth. State-level Renewable Portfolio Standards (RPS) in 29 states mandate minimum targets for renewables in the power sector. Collectively, states mandated a total of 150 GW[148] in renewables for 2012, and their impact will continue over the next decade. Nine other states also have renewable portfolio goals to encourage renewable generation. Federal investment tax credits and production tax credits have lowered the costs of solar and wind installations, with some states enacting additional incentive policies.

However, perhaps the major driver of renewables growth is the dramatic improvement in wind and solar technologies. Between 2009 and 2014, the levelized cost of electricity (LCOE)* for solar installations has fallen by more than 75% and for wind power by over 50%.[149] Improvements are the result of better technology, more-efficient project developers, and larger-scale installations. Solar and wind projects are already cost-competitive in the most attractive locations.[150]

*Levelized Cost of Electricity (LCOE), as defined by the EIA, is "the per-kilowatt-hour cost (in real dollars) of building and operating a generating plant over an assumed financial life and duty cycle."

Major solar power project more competitive than coal or gas in Texas

In May 2014, Austin Energy signed a 20-year power purchase agreement (PPA) for 150 MW of solar power, priced at less than $50/MWh.[151] The agreement is the lowest-priced solar PPA in the U.S. and the first to be priced under $50/MWh. At this price, solar power is more economically competitive in Texas than gas and coal.

The low price is a harbinger of the future. Texas has some of the most favorable wind and solar resources in the U.S., and the state already generates nearly 10% of its power from wind. Texas has also improved its grid infrastructure to support renewables, completing the Competitive Renewable Energy Zone (CREZ) project to bolster transmission lines to West Texas.

FUTURE TRAJECTORY

The transition to cleaner energy will continue, and potentially accelerate, over the next 20–30 years. Economics, public support, and policy actions will all play a role in driving these changes.

Renewables are becoming increasingly competitive

The cost of renewables, particularly solar, is likely to continue to fall dramatically over the next 10–15 years. Our estimates show that the average utility-scale solar installation is likely to reach cost-parity with natural gas-fired power within 10–30 years, varying by state circumstances.[152] And these averaged figures understate the future competitiveness of renewables in some cases. (See Figure 21 on page 36.) (For a detailed explanation of the methodology for estimating LCOE for onshore wind and solar energy, please turn to the Appendix IV on page 58.)

Renewables, then, are likely to become both the cleanest and the most cost-competitive power generation source by 2050, even without legislation that limits carbon emissions.

Other technological trends will improve the economic viability of renewables even further. Distributed energy resources, like rooftop solar, are already economic for some homeowners and businesses. That opens up a direct consumer market for renewables. Smart homes allow homeowners and businesses to better manage their electricity use and operate appliances in sync with renewables generation. Cost-effective energy storage technologies will combine with renewables and other emergent technologies to create microgrids and off-grid solutions. Finally, the penetration of electric vehicles is expected to grow and create a natural storage place for solar and wind power, especially in peak daylight hours. As companies and households begin to generate, store, and manage their own power, this will further reduce the demand for traditional power sources.

Taking renewables to scale will also face some challenges. Renewables are intermittent and only provide power to the grid when the wind is blowing or the sun is shining. On average, wind turbines generate only 30–35% of their potential installed capacity, while solar panels achieve just 20–25%.[153] Therefore, storage capacity or a backup power source is required to meet the peaks and valleys of renewables generation. At large scale, renewables also require a more sophisticated electric grid than the one in place today. Whereas today's grid is built to send power in one direction from a small number of centralized generation sources to a large number of distributed users, the future grid must be able to manage large volumes of intermittent and distributed flows of supply as well as demand.

Coal will continue to lose ground

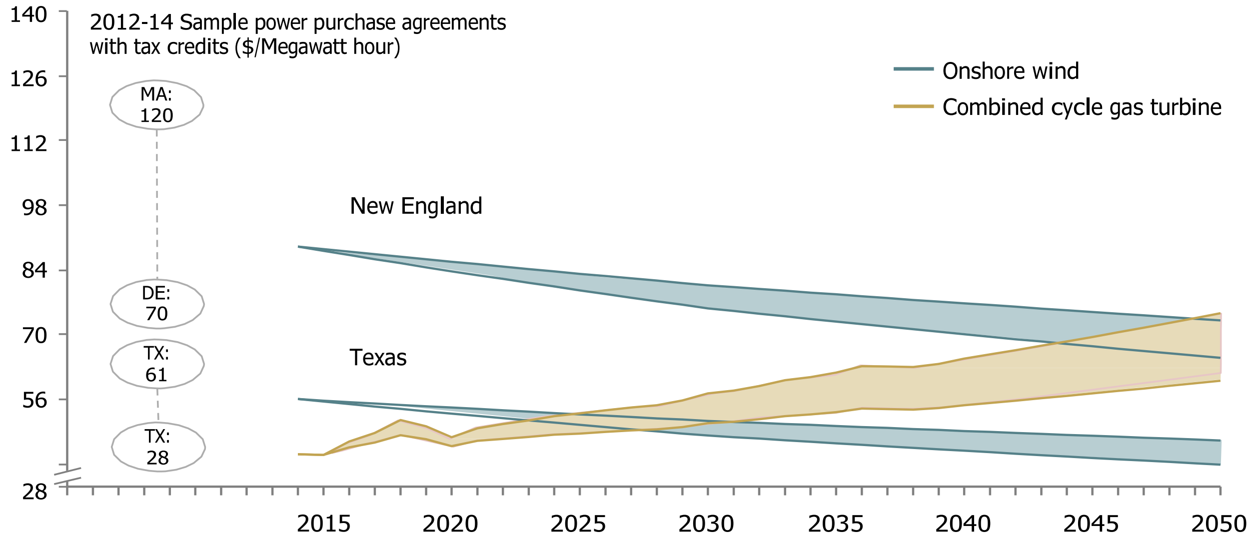
Coal generation is expected to decline further over the next several decades. Coal is becoming more and more uncompetitive, even without any further carbon emissions restrictions or incentives. While many coal plants are still marginally viable versus natural gas today, our modeling shows that most will lose economic viability when the next major capital project is required to deal with obsolescence and already existing pollution regulations. We expect approximately half of the current coal generating capacity to be retired by 2022, across a range of potential gas price and policy scenarios.[154] Only the largest, most efficient, multi-generating-unit coal plants with existing back-end pollution controls are likely to survive.

Further declines in coal-fired generation in the near term are already occurring. According to the EIA, 81% of electricity-generation capacity retirements in 2015 will be coal (12.9 GW), and coal will account for no new capacity additions. Wind (9.8 GW), natural gas-fired (6.3 GW) and solar power (2.2 GW) are expected to account for 91% of the new additions, with the remainder made up by nuclear (1.1 GW) and other renewables (0.5 GW).[155]

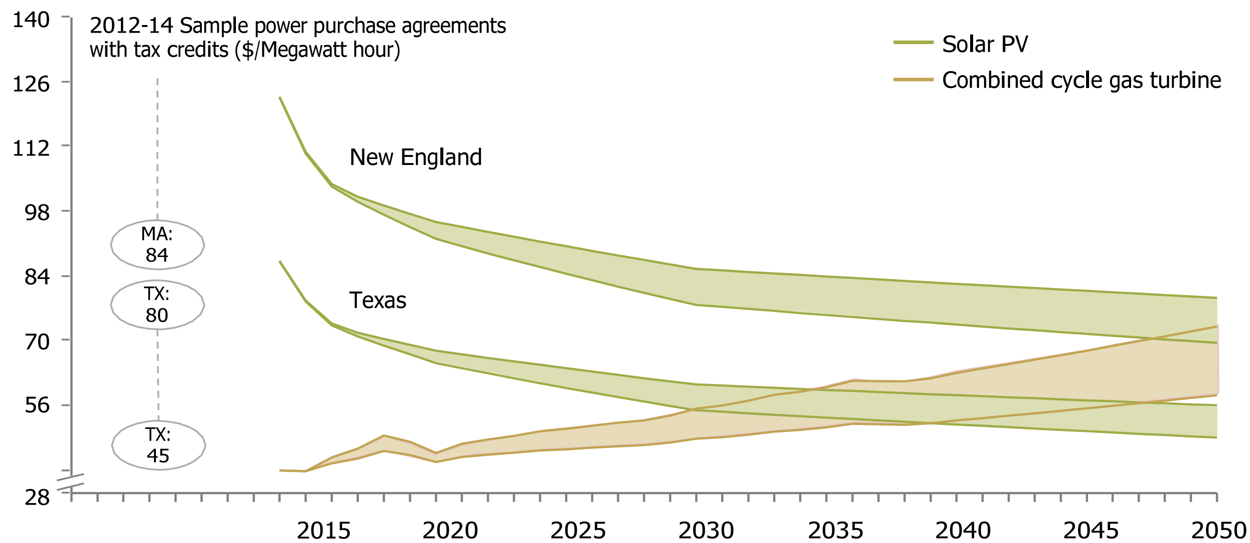
Continuing with coal is no longer just an environmental problem. Increasingly, gas is more economical than coal.

Figure 21: **Estimated levelized cost of electricity (LCOE) for onshore wind and solar photovoltaics (PV), 2015–2050**

Average unsubsidized onshore wind LCOE ($/Megawatt hour)



Average unsubsidized solar PV LCOE ($/Megawatt hour)



Note: Levelized cost of electricity (LCOE) is a utility industry metric for calculating the total cost of electricity produced by a generator.

Assumptions: Capacity factors of 34% and 20% for Texas wind and solar, 24% and 17% for New England wind and solar, and 6% WACC. Learning rates of 13% for solar modules, 12% for inverters, 7.5% for labor/balance of system, and 7% for onshore wind technology assumed.

Combined cycle gas turbine (CCGT) curves reflect +/- 25% of forecasted Henry Hub prices.

Source: BCG and HBS analysis; please refer to Appendix IV for detailed methodology.

American public supports carbon reductions

While political and business communities remain fiercely split on the need to take steps to address climate change, the broader American public strongly supports actions to curb greenhouse gas emissions. Multiple surveys reveal that a large majority of Americans are worried about climate change and believe that the U.S. should take action. Support for change has held steady or increased over time. A January 2015 poll conducted by Resources for the Future and Stanford University,[156] for example, found that 83% of Americans believed that global warming will be somewhat of or a very serious problem if nothing is done to reduce greenhouse gas emissions, and 74% believed that the federal government should be doing a substantial amount to combat climate change. These poll results cut across party affiliation. Concerning coal, a 2014 Yale study found that 63% of Americans support setting strict carbon dioxide limits on existing coal plants, with majority public support even in states with large coal industries. The study also found that 77% of the public supports research and development on renewables.[157]

While some in the energy industry continue to lobby for the status quo on carbon reductions, this stance is increasingly at odds with American public opinion.

Public policies will continue to push carbon reductions

Policies at both the state and federal level will continue to encourage lower-carbon energy solutions. State Renewable Portfolio Standards will cumulatively require a minimum of 60 GW of new renewable generation by 2030, 40% higher than is mandated today.[158] In addition, 13 states have introduced greenhouse gas emissions limits that will require further shifts to lower-carbon power.[159] Federal standards will also ensure that vehicles and appliances continue to improve their energy efficiency.

There are also a growing number of other proposals that would encourage carbon reductions over the next 10–15 years and longer. The Obama Administration, for example, has recently introduced the proposed Clean Power Plan (CPP)[160] that covers carbon reductions in the power sector, signed a greenhouse gas emissions accord with China,[161] and made U.S. greenhouse gas reduction pledges to the Paris round of international climate negotiations.[162] Each proposal targets a 25–30% reduction in carbon emissions by 2030 compared with 2005 levels. These proposals face stiff political and legal challenges, but the reality is that numerous factors are likely to encourage additional reductions, particularly as the economics increasingly favor cleaner energy.

Addressing climate change is not just a U.S. trend, but increasingly a global one. (See Figure 22 on page 38.) The European Union, long a leader in climate action, has extended emissions reductions targets to 2050.[163] Mexico has announced an unconditional 25% emissions reduction from its business-as-usual scenario by 2030, which would increase to 40% with a global climate deal.[164] Even China, a traditional opponent to any restrictions on its carbon emissions, has agreed to carbon targets for the first time, pledging to begin reducing emissions by 2030 in its recent accord with the U.S.[165] Political debates over climate change will continue, as in Australia, which enacted carbon limits and then repealed them.[166] Some countries have also missed their Kyoto Protocol commitments.[167] However, while the right targets and the best policies are still being debated, the general trend and current momentum for carbon reductions are greater than at any time over the last 15 years.

NATURAL GAS AND THE U.S. ENERGY TRANSITION

The U.S. position in natural gas is a crucial asset in making America's energy transition both feasible and at a competitive cost across a range of carbon reduction scenarios, at least through 2030. Natural gas can replace up to 50% of the existing coal capacity by 2022 at lower cost,[168] providing significant economic and carbon benefits, regardless of other climate policies.

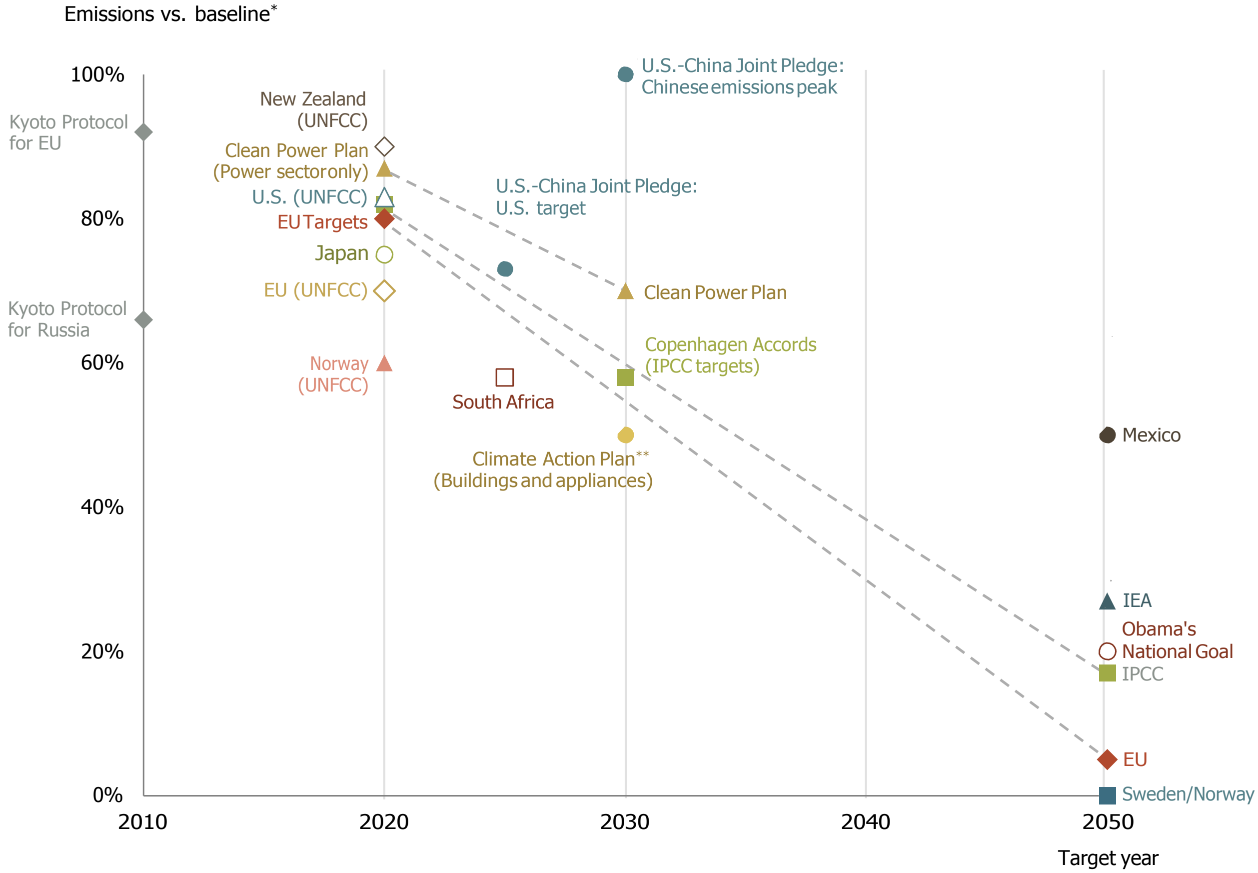
EPA Administrator Gina McCarthy put it well in April 2015 when she said, "[Fracking] has changed the game for me in terms of how the energy system is working. The inexpensive gas that's being produced has allowed us to make leaps and bounds in progress on the air pollution side and, frankly, to make the Clean Power Plan."[169]

Natural gas essential for near-term carbon reductions

Natural gas is the only fuel that can cost-effectively deliver large-scale carbon emissions reductions in the near term, including the 30% carbon emissions reduction targeted by the proposed Clean Power Plan. A 2014 CSIS/Rhodium Group study[170] shows that increasing natural gas's share of power generation from 28% today[171] to 43% by 2030 allows the U.S. to meet the 30% reduction target of the Clean Power Plan without significantly increasing the cost of electricity in the U.S.[172] The study estimates that power rates would rise by around 4%, while overall energy expenditures would remain nearly flat, assuming that states coordinate their implementation.[173] (See Figure 23 on page 39.)

Unconventional natural gas also gives the U.S. a competitive advantage in moving to a low-carbon energy system over other countries that lack abundant natural gas resources. Without a supply of low-cost gas, Germany, for example, set aggressive renewables goals and then spent $400 billion in direct government subsidies to support renewable growth.[174] The price of

Figure 22: **Selection of U.S. and international greenhouse gas emissions reductions targets**



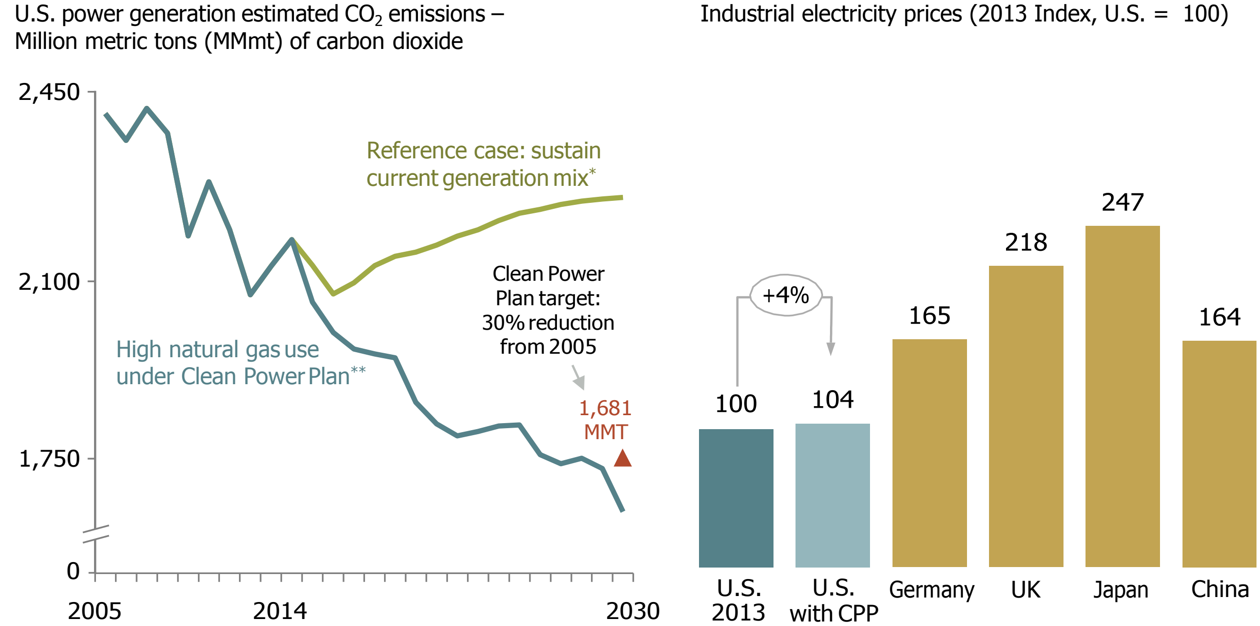
*Relative to 2005 levels for U.S. goals; relative to 1990 levels for European goals. Other baselines specific to each country.

**Relative to 2000 levels.

Note: Abbreviations are United Nations Framework Convention on Climate Change (UNFCC), Intergovernmental Panel on Climate Change (IPCC), European Union (EU).

Sources: "Roadmap for Moving to a Low-Carbon Economy in 2050," European Commission website, http://ec.europa.eu/clima/policies/roadmap/index_en.htm, accessed May 2015; "Intended Nationally Determined Contribution," Republic of Mexico website, http://www.semarnat.gob.mx/sites/default/files/documentos/mexico_indc.pdf, p. 2, accessed May 2015; "Paris 2015: Tracking country climate pledges," The Carbon Brief (blog), March 31, 2015, http://www.carbonbrief.org/blog/2015/03/paris-2015-tracking-country-climate-pledges/, accessed May 2015; "Climate Change and International Policies Under Development," The Boston Consulting Group, October 2012; "FACT SHEET: U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation," The White House, November 11, 2014, https://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c, accessed May 2015; "The Obama-Biden Plan," Change.gov The Office of the President-Elect, http://change.gov/agenda/energy_and_environment_agenda/, accessed May 2015; "Kyoto Protocol, Targets for the first commitment period," United Nations Framework Convention on Climate Change, http://unfccc.int/kyoto_protocol/items/3145.php, accessed May 2015; "Clean Power Plan: Reducing Carbon Pollution From Existing Power Plants, Proposal," United States Department of Environmental Protection, http://111d.naseo.org/Data/Sites/5/media/clean-power-plan-overview.pdf, accessed May 2015; "The President's Climate Action Plan," Executive Office of the President, June 2013, https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf, accessed May 2015.

Figure 23: **Estimated impacts of using natural gas to meet proposed clean power plan (CPP)**



*EIA Reference Case, AEO 2014.

**Center for Strategic and International Studies, "Remaking American Power." National compliance scenario without energy efficiency.

Sources: John Larsen et al., "Remaking American Power: Potential Energy Market Impacts of EPA's Proposed GHG Emission Performance Standards for Existing Electric Power Plants," Rhodium Group and the Center For Strategic & International Studies, November 2014, http://rhg.com/wp-content/uploads/2014/11/RemakingAmericanPower.pdf, accessed May 2015; John Larsen et al., "Remaking American Power: Preliminary Results," Rhodium Group and Center for Strategic and International Studies: Energy & National Security Program, July 24, 2014, p.20, http://csis.org/files/attachments/140724_RemakingAmericanPower.pdf, accessed May 2015; Harold L. Sirkin, Michael Zinser, and Justin Rose, "The U.S. as One of the Developed World's Lowest-Cost Manufacturers: Behind the American Export Surge," The Boston Consulting Group, August 20, 2013, https://www.bcgperspectives.com/content/articles/lean_manufacturing_sourcing_procurement_behind_american_export_surge, accessed May 2015.

electricity for residential customers increased by 70% between 2004 and 2014.[175] The share of renewables has increased to about 25%,[176] but the share of coal-fired power has actually increased as well.[177] Greenhouse gas emissions have only fallen approximately 10% since 2000.[178]

An all-renewables approach not feasible

Switching the U.S. to all-renewable power in the near term is neither technically nor economically viable. A faster transition to renewables would require significant increases in electricity rates immediately. While renewable energy is becoming more cost-effective with each passing year, the current average unsubsidized, cost differential with natural gas is 20–100% higher for wind and 90–175% for solar, depending on the state.[179] As the German example shows, major subsidies or much higher electricity bills would be required to meet the Clean Power Plan, or similar reduction goals, using renewables alone.

In addition to the higher cost of generation, the transition to a high renewable share will require an estimated $750 billion in grid improvements in the U.S. to handle large volumes of intermittent renewables and the more sophisticated forms of energy management and efficiency needed.[180] Transmission and distribution lines will require additional capacity and two-way flows to manage widening sources of intermittent renewables. Smart grid metering and control systems need to become more sophisticated and widespread to allow grid operators to harmonize the new, complex flows of power supply and demand. Practically, this process will require a 20- to 30-year period.[181]

Natural gas needed for standby power

Natural gas power plants are a necessary complement to the scale-up of renewables. As renewables gain share, backup capacity will need to grow significantly to ensure that a large volume of on-demand power can come online over extremely short periods to compensate for absences of wind or sun. (See Figure 24.) The particular levels of backup capacity required will depend on the percentage and distribution of intermittent renewables, as well as the ability of the grid to utilize demand response and storage, but they will amount to a significant portion of the total installed renewables capacity.

Natural gas power plants are by far the most efficient source of backup power, at least over the medium term. Natural gas plants can be brought online in under an hour, in some cases as rapidly as 15 minutes,[182] compared with eight to 48 hours to start up a coal-fired plant.[183] Natural gas plants can also operate more efficiently across a variety of load factors, allowing them to meet varying needs throughout the day. While energy storage solutions, such as large-scale batteries, may eventually become economic to provide backup power, they are years away from being competitive with gas-fired plants.[184]

Gas drives carbon reductions in other sectors

Natural gas is also beginning to contribute cost-competitive carbon reductions outside the power sector. Natural-gas-powered vehicles, trains, ships, and other transportation modes are one prime opportunity, where current battery technology limits the feasibility of electric-powered alternatives. For trucking, marine transport, rail, and aviation, natural-gas–based fuels are 10–20% less carbon-intensive and 30–50% less expensive than petroleum-based counterparts on average. (See Figure 25.) Though the near-term expansion of natural gas transport will be greatest in trucking, natural gas should spread to other segments over time.

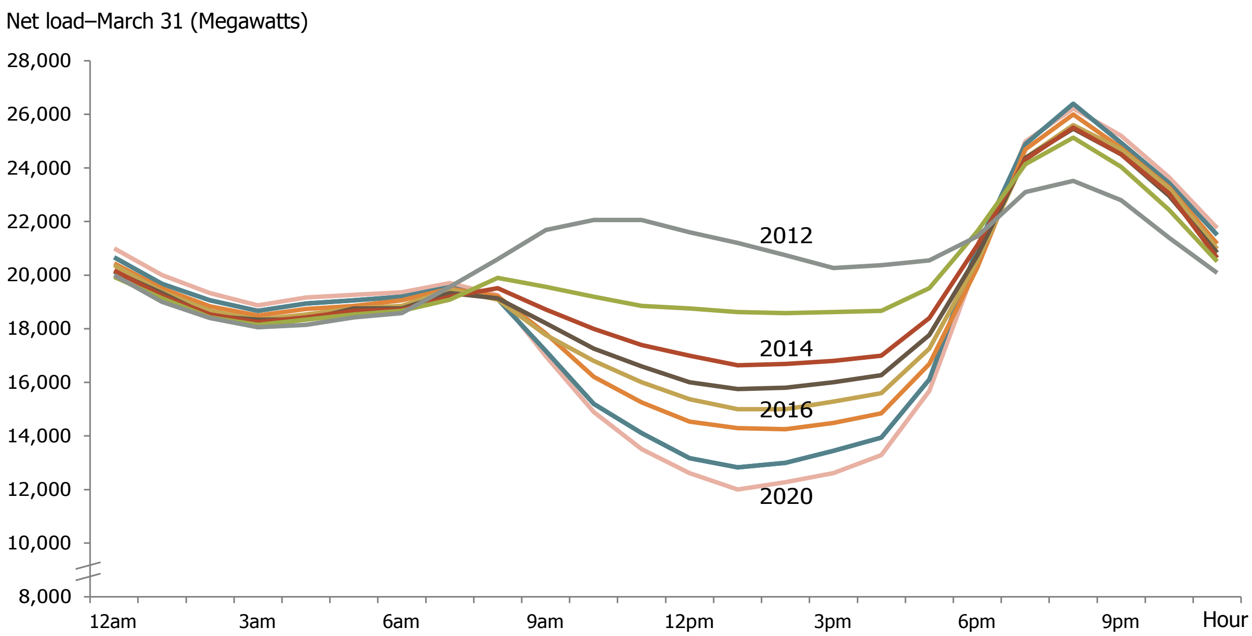
REALIZING AMERICA'S ENERGY TRANSITION ADVANTAGE

There are three primary issues raised that stand in the way of the U.S. taking advantage of the opportunity to more competitively bridge the transition to a cleaner, low-carbon energy system by utilizing natural gas: methane leakage, fears that natural gas will slow renewable development, and concerns that investment in natural gas will "lock in" the use of fossil fuels in the longer term.

Containing methane leakage

Methane is a potent greenhouse gas, and it has a more powerful warming effect than CO_2 when released directly into the atmosphere. According to the IPCC's 2013 report on climate change,[185] one pound of methane (CH_4) released into the atmosphere has the same effect

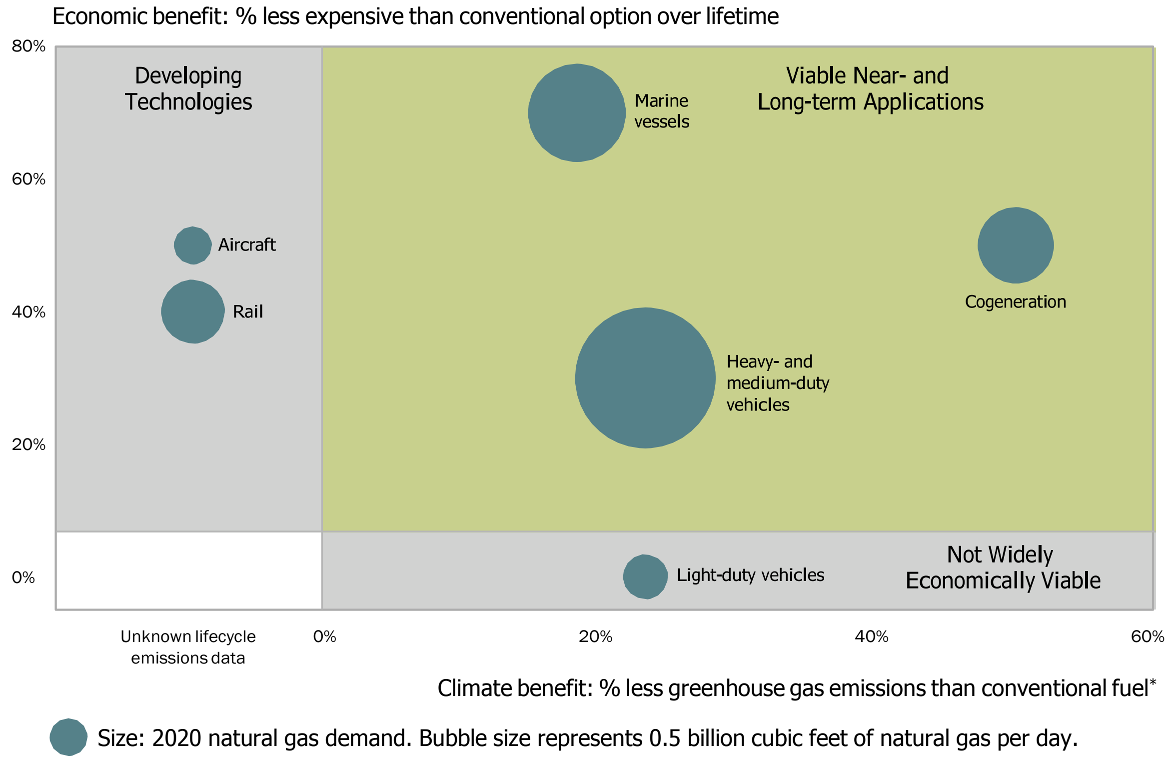
Figure 24: **California ISO estimated electric load, net of renewables through 2020**



Note: The California ISO (independent system operator) provides open and non-discriminatory access to the bulk of the state's wholesale transmission grid, supported by a competitive energy market and comprehensive infrastructure planning efforts.

Source: "Fast Facts, What the duck curve tells us about managing a green grid," California ISO, http://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf, accessed May 2015.

Figure 25: **Economic and climate benefits of potential natural gas applications**



*Environmental benefit is contingent on low methane leakage rate throughout lifecycle.

Sources: "Energy 2020: Truck, Trains and Automobiles," Citi Research, June 2014, http://www.usaee.org/usaee2014/submissions/presentations/IAEE_Transportation_presentation_201406_v01.pdf, accessed May 2015; "Annual Energy Outlook 2014 with Projections to 2040," Energy Information Administration, April 2014, p. A-6, http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf, accessed May 2015; "Natural Gas as a Transportation Fuel," Morgan Stanley, April 16, 2013, http://www.ngvitaly.com/wp-content/uploads/2014/03/Natural_Gas_as_a_Transportation_Fuel-Energy.pdf, accessed May 2015; "Natural Gas for Marine Vessels: U.S. Market Opportunities," American Clean Skies Foundation, April 2012, http://www.cleanskies.org/wp-content/uploads/2012/04/Marine_Vessels_Final_forweb.pdf, accessed May 2015; "Environmental Benefits," Environmental Protection Agency, http://www.epa.gov/chp/basic/environmental.html, accessed May 2015; BCG-HBS analysis.

as 34 pounds of carbon dioxide (CO_2) over a 100-year time horizon, and the same effect as 86 pounds of CO_2 over a 20-year time horizon.[186] Since methane is the primary gas molecule contained in natural gas, leaks in producing, transporting, and utilizing natural gas will release methane into the atmosphere and offset some of natural gas's carbon benefits. In order for coal-to-natural-gas conversions in the power sector to yield a net greenhouse gas benefit, for example, methane leakage rates across the entire production, gathering, and transmission chain must remain below 3.2%.[187] A feasible leakage level of 1% or less is needed to ensure a significant greenhouse gas benefit from natural gas.[188]

Our research shows that methane leakage can be effectively and economically contained. While current rates of methane leakage are still not well-measured, the most recent (2013) EPA study estimated the methane leakage rate from end-to-end natural gas activities is 1.5%.[189] However, there are well-established approaches to achieve low rates of methane leakage across the gas value chain. They include regular well-pad and distribution facility surveys, using newer methods to maintain older equipment, and capturing or controlling gas vented during hydraulic fracturing.[190] A recent EDF/ICF study showed that many reductions can actually be cost-effective and reduce leakage rates by up to 50%.[191] Such reductions allow producers to capture and sell more gas if sufficient off-take infrastructure is in place. While the exact costs to reduce leaks will vary by source, it is clear that significant containment can be achieved economically.

Continuing renewables development

Climate-oriented activists and NGOs worry that the large-scale adoption of low-cost natural gas in the power sector will crowd out or delay the development of renewable technologies. Since natural gas has a distinct cost advantage over renewables in most U.S. markets today, renewables proponents fear that gas will constrain the market for renewables and lower the incentive for research and development in renewables. That would then delay the cost and efficiency improvements in renewables, making it harder for renewables to compete over the long term.

Our analysis suggests that natural gas is highly unlikely to retard the development of renewables or slow the rapid improvement in their economic viability. Both policy and economics continue to create incentives for the development of renewable technologies. At a minimum, existing renewable portfolio standards will ensure that the mandated generation capacity of renewables increases by at least 40% by 2030.[192] More importantly, competitive improvements will continue to encourage renewables growth, which is well underway. Demand for renewables in other countries will further drive new renewables technology. Just as many natural gas plants begin to reach retirement age in the 2020s and 2030s, renewably sourced energy should be more competitive with natural gas-derived energy—even in regions with less favorable conditions for wind and solar.

Avoiding carbon emissions lock-in

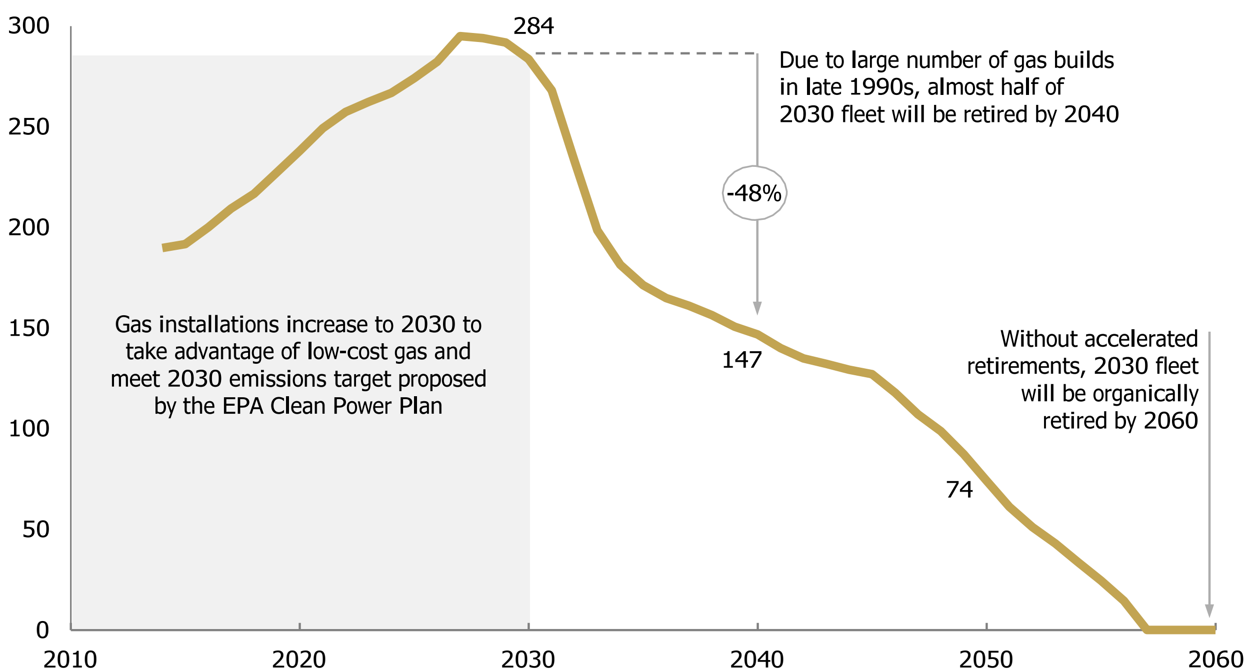
Despite the near-term climate benefits of natural gas in the power sector, climate stakeholders are concerned that natural gas will "lock in" carbon emissions over the long-term because natural gas plants and infrastructure will continue to be used and emit greenhouse gases. While natural gas can drive 30% greenhouse gas emissions reductions to 2030, even lower-carbon solutions will be necessary by 2050 to significantly mitigate the risk of rises in global temperatures above 2 degrees Celsius, according to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report.[193] Some believe that new natural gas infrastructure will stand in the way of making these additional reductions.

Our analysis shows that long-term carbon emissions lock-in from gas power plants and pipeline infrastructure is highly unlikely. Natural gas power plants have a useful life of 30 years, after which retrofitting and maintenance of obsolete turbines becomes more costly than building new, efficient plants. (See Appendix V: Estimating

Figure 26: **Estimated gas turbine power generation capacity over the 2014 – 2060 period, assuming no new gas turbines are built after 2030**

Assumes gas capacity without previously announced retirements will be retired after 30 years (EIA technical lifetime).

Gigawatts of U.S. gas capacity



Gas turbine capacity to 2030 based on CSIS report November 2014 "Remaking American Power." National compliance scenario without energy efficiency.

Source: BCG and HBS analysis; please refer to Appendix V for detailed methodology.

natural gas power plant retirements, 2014-2060.) While new natural gas power plants will be required to meet the 30% reductions in the power sector by 2030, the vast majority of gas plants needed in 2030 are already in operation today. A large portion of them were built in the early 2000s, and our analysis shows that half of the natural-gas capacity in use in 2030 would be naturally retired by 2040, and 100% would be retired by 2060.[194] (See Figure 26.) Thus, the U.S. will actually have substantial flexibility post-2030 to utilize the most competitive power investments then available and achieve ambitious climate goals by 2050.

Moreover, there will be substantial long-term requirements for natural gas in sectors outside of power, including residential and commercial uses, as well as petrochemical feedstocks and fuel. By 2040, the EIA projects that nearly 60% of U.S. natural gas demand will originate outside the power sector.[195] Even if there is a decline in natural gas use for power generation after 2030, to meet further carbon emissions reduction targets significant demand for natural gas will remain, and pipeline and distribution infrastructure are highly unlikely to become stranded assets.[196]

While many stakeholders on both sides of the debate see unconventionals and mitigating climate change as antithetical, they are actually complementary. The industry benefits from progress on climate change because it will enlarge demand for natural gas and reduce opposition to critical infrastructure and expanded development. Climate advocates benefit from unconventionals because they enable cost-effective progress on climate change in the near term and support investments critical to lower-carbon solutions over the longer term.

Chapter 6:

THE WIN-WIN PATH FORWARD

Our research makes it clear that America can take advantage of the huge economic opportunity created by unconventionals while minimizing environmental impact and supporting the transition to a lower-carbon energy system. We call this the win-win pathway. It is a strategy for the U.S. where all the key stakeholders can benefit.

Here, we outline eleven key steps along the win-win pathway. These, taken together, can deliver substantial environmental, climate, and economic benefits. Getting on this path will require a different dialogue and interaction. It requires actions from policy makers, industry leaders, and NGOs alike, both independently and collaboratively, to ensure America fully capitalizes on the unconventionals opportunity.

Here, we outline eleven key steps along the win-win pathway. These, taken together, can deliver substantial environmental, climate, and economic benefits. Getting on this path will require a different dialogue and interaction.

ENHANCING THE ECONOMIC OPPORTUNITY

While there have already been major economic benefits, the advantages of unconventionals can be amplified and spread more broadly throughout the economy. They will flow to every state, even states that are not involved in production.

Continue the timely development of efficient energy infrastructure

Pipeline, gathering, and processing infrastructure forms the backbone of safe and efficient unconventional resource development. But we need to ensure the timely development of these key assets, which are being slowed down by delays and politics in the permitting process. These delays cause increases in oil and gas prices for consumers and decreases in prices for producers (for example, customer gas prices in some places increased more than three times during the 2014 "Polar Vortex" due primarily to infrastructure gaps[197]), and they create supply uncertainty for downstream industries, slowing down investment in other industries that are advantaged.

At the federal level, FERC and DOE should reestablish and enforce their existing authority as the lead federal agencies to set deadlines on the interstate pipeline permitting process.[198] At the state level, each state should establish a lead agency to coordinate the permitting process both statewide and locally. On both the federal and state levels, collaboration between agencies, such as FERC, the Bureau of Land Management, the Army Corps of Engineers, state environmental protection agencies (EPAs), and state transportation agencies, should be enhanced to reduce redundant assessments. The permitting process should be made transparent with clear steps. It should incorporate public review and comment, but be structured to address infrastructure, rather than be abused for ideological battles over larger environmental and climate issues (for example, the Northeast Energy Direct[199] and Constitution interstate natural gas pipelines in the Northeast U.S.[200]).

Immediate actions:

- Set and enforce existing federal and state timetables for infrastructure-permitting processes.
- Designate a lead state agency for coordinating infrastructure permit reviews at the state level.

Deliver a skilled workforce

In order to support the growth of unconventionals and the next wave of downstream development, the U.S. has a critical need to qualify more workers with the right skills across a variety of occupations. An analysis of Burning Glass's data on occupations related to unconventionals shows that, while approximately 12% of unconventionals jobs relate directly to manufacturing and production, more than 50% of the new job growth related to unconventionals was in occupations such as transportation, logistics and distribution, maintenance, repair and installation, construction, and sales and marketing.[201]

While the recent oil price decline has led to layoffs over the last six months, that is likely a cyclical phenomenon. When prices rise again to reinvestment levels, the need for skilled workers will reemerge. That is particularly true for "middle skills" jobs—those that require more education and training than a high-school diploma but less than a four-year college degree. Job postings between November 2013 and October 2014 show that a majority of unconventionals jobs, 52%, required middle skills, including tractor-trailer truck drivers, production workers, automotive service technicians, mechanics, material handlers, and machinists.

It is important for business, education, and policy leaders to work together to invest in developing skills and trained worker pipelines that can support the growth of unconventionals over time. Business can and must play a key role in leading such collaborations across regions, and many already are.[202] For example, Southwestern Energy has invested heavily in skill development in Arkansas, where it partnered with the University of Arkansas Community College at Morrilton (UACCM) to establish the state's first two-year petroleum technology program in 2006, and to endow a scholarship fund for the program.[203] More recently, workforce development efforts have also been extended to training regulators, as both states and industry players have realized the need for qualified, capable inspectors and policy makers. In 2012, GE and ExxonMobil partnered with three universities, Colorado School of Mines, Penn State University, and The University of Texas at Austin, to develop programs aimed at giving regulators and policy makers training on the latest unconventionals technologies, as well as operational and enforcement best practices.[204]

Immediate actions:

- Business across the sector should identify the middle-skills and high-skills gaps that are hardest to fill, and proactively invest in developing a pipeline of talent for their industry or region.
- Industry should partner with educators to continually shape the curriculum that delivers the qualifications and credentials employers need, and support schools with equipment, internships, instructors, and hiring commitments.

Eliminate outdated restrictions on gas and oil exports

Natural-gas and crude-oil exports leverage America's strengths, increase economic growth, and benefit partner nations, without compromising our competitiveness, environmental standards, or domestic prices. Current U.S. restrictions on natural gas and oil exports are antiquated and based on historical circumstances that no longer apply. The Natural Gas Act of 1938 was created to curb the monopolistic tendencies of pipeline owners in the early 20th century, a concern no longer relevant. Oil exports were restricted by the Energy Policy and Conservation Act of 1975, passed in response to the oil scarcity caused by the 1973–1974 international oil embargo. Restrictions were later expanded in the 1979 Export Administration Act. Today, ample new domestic resources mean that removing these antiquated restrictions will both reduce the U.S. trade deficit and bolster the value of unconventionals to the U.S. economy, while having little if any impact on consumer prices. (See Chapter 3 for more details.)

Congress should pass legislation that amends the Energy Policy and Conservation Act and the Export Administration Act, allowing for the export of unrefined crude to all WTO members, not just to Canada. Likewise, Congress should amend the Natural Gas Act to formally allow exports of natural gas to all WTO member countries, without the need for the current project-by-project approval from the Department of Energy.

Immediate actions:

- Lift the ban on crude oil exports to all WTO members.
- Remove restrictions to Department of Energy permitting of LNG export projects.

MINIMIZING LOCAL ENVIRONMENTAL IMPACTS

As we discussed earlier, local environmental risks can be effectively mitigated without nullifying economic competitiveness. Technology and best practices are rapidly improving, and the cost of meeting high standards is modest and can be profitable. Achieving this improvement will be made possible from a number of steps.

Develop transparent and consistent environmental performance data

Measuring and providing disclosure on key environmental performance data creates the foundation for improving environmental performance and compliance. It is also one critical step to building public understanding and trust for unconventionals technology and operators. The current lack of consistent data leaves too many gaps that can be exploited counterproductively by all sides (for example, selectively using data to support one side of the debate). That only exacerbates the current unproductive dialogue and introduces unnecessary uncertainty that retards improvement and slows investment.

State governments, industry, and NGOs all need to play important roles in building better data sources. States should create clear, structured databases for various types of performance data that include not only the quantity of violations but also information on severity and causes. They must also make data easily accessible and digestible. To do so, many states will also need to upgrade their current antiquated user interfaces and IT systems.

Industry participants should work together, and with states, to establish consistent measures, thresholds, and methods for reporting data and to proactively report their performance. Environmental and community stakeholders must ensure that useful and accurate data are being reported, but they must also hold each other accountable that the data are being used properly and fairly.

Immediate actions:

- Develop consistent data standards for measuring environmental impacts of unconventionals, led by states working with industry and NGOs.
- Ensure that the data are made accessible and publicly available, and are consistent and comparable across states.

Set robust regulatory standards

States require a full set of regulatory standards that address the local environmental risks of unconventionals development. Standards should be designed to be cost-effective, encourage adoption of industry-leading practices, and encourage further innovation.

Sound state standards are essential to underpinning strong local environmental and public health performance. Given regional variations (for example, plentiful water in the Marcellus Shale, an arid climate in the Permian Basin), regulatory standards need to be mostly state-driven. While many states have made significant progress over the last five years to create appropriate regulations, standards need to continue to improve to address emerging issues like wastewater management, induced seismicity, air pollution from VOCs, and community impacts from truck traffic. Different states have started to put needed regulations in place—Pennsylvania on water use and recycling, Texas and Ohio on seismicity, Colorado on truck traffic—but all states must ensure their standards appropriately mitigate environmental and public health risks.

Regulators must also create standards that ensure that regulations are cost-effective and do not unnecessarily undermine competitiveness. Where possible, states should mandate performance levels versus requiring specific technologies. For example, rules on water recycling and flaring should set standards for the outcomes—the percentage of water recycled or gas flared—rather than prescribing specific techniques or technologies. Industry and NGOs can also play a proactive role, using forums like API to help codify and disseminate leading practices (for example, API's July 2014 "Community Engagement Guidelines"[205]).

Immediate actions:

- Set robust state regulatory standards that are performance-based to better address gaps in areas such as water management, seismicity, and truck traffic.
- Design standards that are performance-based and encourage further innovation.

Achieve universal regulatory compliance

Uneven compliance is unnecessarily lowering environmental performance and slowing down the adoption of leading practices. Both industry and regulators have a stake in strengthening regulatory enforcement, complemented by stronger industry self-enforcement efforts.

Regulators must improve enforcement efforts. As production grows in a state, leaders must ensure that regulatory agencies are sufficiently funded and resourced with adequate talent. Furthermore, states should make inspections more effective by using better inspection technologies, such as infrared cameras to detect leaks, and by prioritizing inspection approaches, such as Colorado's data-based reviews focused on the least reliable equipment.[206]

Industry must also take a leading role in encouraging compliance across producers and contractors. Unconventionals players can draw on the experiences of the chemicals industry or even the offshore oil sector to develop a pragmatic and proactive approach to self-enforcement. That not only benefits the American public, but also benefits the many producers who already have strong environmental compliance records.

Immediate actions:

- Bolster enforcement by adequately staffing state agencies, modernizing data management systems, prioritizing inspections based on past behavior, and sharing best practices among state regulators.
- Establish an industry-led self-enforcement process to supplement regulatory enforcement, considering models such as Responsible Care (chemicals) or the Center for Offshore Safety (offshore oil and gas).

Strengthen bodies driving continuous environmental improvement

Collaborative organizations are a powerful tool to raise the bar on environmental performance on an ongoing basis. As technologies and approaches to hydraulic fracturing and unconventionals development continue to progress, regulations and compliance practices need to keep pace. As outlined in Chapter 4, a group of continuous improvement bodies already exists to address operational, regulatory, and community topics (for example, IOGCC, STRONGER, CSSD, and API).

Such bodies can do much more to collaborate and ensure that their recommendations are widely adopted and understood by their constituents and the general public. They can proactively work with one another to achieve meaningful changes and then create communication forums to reach affected communities and raise general public awareness. One highly successful example of such collaborative continuous improvement has been the work by FracFocus to encourage chemical disclosures. The Groundwater Protection Council (GWPC) and IOGCC joined together to launch FracFocus.org in 2011, supported with funding from oil and gas trade groups and the U.S. DOE. The GWPC then worked with industry and regulators to spread the use of the database and widen the disclosure of chemicals. As of May 2015, 29 states have chemical disclosure rules in place, and 23 states use the FracFocus database.[207] The database is well-known to the public and provides assurance to communities that producers are accountable for the chemicals they use. By working together, the GWPC, IOGCC, government agencies, and industry players were much more effective in mitigating chemicals risks than they would have been independently.

Immediate actions:

- Expand collaboration among existing continuous improvement bodies on overlapping areas of focus (e.g., IOGCC and STRONGER collaborating on regulatory best-practice sharing).
- Speed the dissemination of best practices in operator performance, regulations, and enforcement through more proactive stakeholder outreach by continuous-improvement bodies.

SPEEDING THE TRANSITION TO A CLEAN-ENERGY, LOWER-CARBON FUTURE

Unconventional natural gas is a powerful mechanism to achieve substantial, low-cost carbon reductions while enabling a long-term, cleaner-energy, and lower-carbon transition. To achieve that, a series of steps is needed.

Contain methane leakage

Containing methane leaks throughout the natural gas production and transportation process secures the climate benefits of natural gas. The current extent of methane leakage is becoming better understood, and there are economical methods available today to contain leakage throughout the natural gas value chain. The EPA, the oil and gas industry, and NGOs must work together to develop both regulatory standards and best practices to ensure that all operators sufficiently mitigate leakage risks. While voluntary efforts and economic incentives have already led many producers to reduce methane emissions, sufficient regulations are also needed to curtail the emissions of outliers.

The Obama Administration's recently proposed fugitive methane emissions reductions goals provide a constructive blueprint for balancing methane emission regulations with industry-led voluntary efforts.* The plan calls for a 40–45% reduction in fugitive methane emissions from oil and gas activity by 2025. For new oil and gas assets, including wells, gathering stations, processing plants, and transmission compressor stations, the EPA will establish rules to regulate methane emissions. For existing assets, the EPA will encourage voluntary reductions, utilizing the existing EPA Natural Gas STAR program, which encourages oil and gas companies to adopt cost-effective methods of methane containment. If the Administration's plan is implemented through performance-based regulations and active industry leadership, it can move the U.S. forward by developing some regulations to encourage higher performance, while also giving industry players the opportunity to proactively reduce methane in their current operations.

Immediate actions:

- Finalize the Obama Administration's plan to reduce methane leakage in the oil and gas sector by 40–45% through flexible federal methane leakage standards for new oil and gas installations together with an enhanced voluntary Gas STAR improvement program for existing installations.
- Develop a strong industry-led program to ensure that the voluntary component for existing installations achieves its targets through existing bodies like America's Natural Gas Alliance (ANGA) and American Petroleum Institute (API), or through new coalitions such as One Future.

Set policies that encourage cost-effective emissions reductions

Natural gas is an essential tool for making cost-competitive carbon reductions in the power sector through 2030. Natural gas is the only fuel that is low-carbon, economically competitive, and highly scalable in the near term. And natural gas expansion does not lock in gas-fired power over the long term, as discussed in Chapter 5.

To speed up natural gas-based carbon reductions through 2030, climate policies and regulations should be market-based, so that cost-effective reductions are encouraged independent of specific technologies. Market-based policies, such as a carbon charge or cap-and-trade, are the most economically efficient ways of achieving emissions-reduction goals. They provide policy certainty for companies, reward the lowest-cost reductions, and encourage businesses to innovate and choose the most-effective emissions reduction options.

For example, if the proposed Clean Power Plan (CPP) or a similar policy is implemented, it should employ well-structured market mechanisms to achieve the most cost-effective reductions. Our estimates suggest that natural gas will be relied on heavily to implement

*The Administration's plan to reduce methane emissions from the oil and gas sector, announced January 14, 2015, is separate from the EPA's proposed Clean Power Plan. The methane emissions plan is focused on the oil and gas sector, whereas the Clean Power Plan is focused on the power sector.

a market-based carbon policy and that natural gas will drive large-scale reductions competitively.

Immediate actions:

- Ensure that all federal climate policies and regulations set clear, long-term targets for greenhouse gas emissions.
- Utilize market mechanisms to encourage cost-effective emissions reductions using the most competitive technologies.

Foster clean-energy technologies

While the transition to lower-carbon energy is already underway, the U.S. needs to make ongoing research investments in low-carbon energy technologies and applications, including potential future uses of unconventional natural gas. Since more than 60% of current carbon emissions come from sources outside of the power sector,[208] low-carbon innovation will be needed in transportation and broader industry as well.

To get there, continued investment in research and development by both the private sector and government is needed. Venture capitalists and energy companies are already investing heavily in a range of low-carbon technologies, not only for energy production but also for how products can conserve energy. The U.S. must continue to lead the world in those areas. Private investments in energy research and development topped nearly $115 billion in 2009.[209] Industry-funded non-profit research efforts, like the Electric Power Research Institute (EPRI), also contribute to technology development.

The U.S. government spends approximately $2 billion annually on energy R&D across all fuel types and technologies.[210] By comparison, however, the U.S. spends more than $30 billion annually on health R&D and nearly $70 billion on R&D for national defense.[211] Federal policy must provide for competitively sourced and broad-based energy R&D that explores a wide range of technologies, including renewables, carbon capture and storage, and natural gas for transportation.

Immediate actions:

- Continue both industry and federal research and development in renewables as well as other potentially competitive, cleaner-energy technologies.
- Encourage low-carbon innovation outside the power sector, including in transportation and heavy manufacturing.

Build out a smart, efficient energy grid

Beyond near-term carbon reduction from natural gas, a long-term (by approximately 2050) transition to an even lower lower-carbon energy system requires a robust, dynamic power-grid infrastructure for both transmission and distribution. That grid will need to manage intermittent and distributed renewables generation and distributed generation, provide storage capacity, and process and react to real-time data to balance the electricity load. The U.S. and states must invest in improvements to grid infrastructure and smart, efficient-energy management systems that are essential to enabling lower-carbon technologies.

Building out the grid is estimated to require more than $750 billion in investment and several decades.[212] In the near term (the next 10–15 years), low-cost natural gas can enable these investments. Natural gas plants will hold down power-generation costs, while large capital spending on the grid is required and will provide standby power to enable the greater introduction of more intermittent renewable sources.

States and regional electricity reliability councils must both take the lead to ensure that these needed grid improvements occur as quickly as possible. Today, the development of a smart, efficient grid across state lines is often slow and costly, due to inconsistent state and regional planning processes and rules. Several U.S. regions, including the Western Electricity Coordinating Council (WECC)[213] and the Electricity Reliability Council of Texas (ERCOT),[214] have ambitious plans and are making grid improvements to accommodate high levels of intermittent renewables (for instance, Texas' ambitious CREZ system[215]). Other regions however, such as the Southeast Regional Transmission Planning (SERTP) process, still have no concrete plans in place for grids that can manage large-scale renewables. All states and regions need plans and must speed up the necessary investments to ensure that the future transmission and distribution grids are in place to economically and efficiently handle low-carbon sources.

Immediate actions:

- Modernize and expand the electricity grid (transmission and distribution) in all U.S. regions to enable utilization and management of large-scale renewable generation.
- Streamline rules and planning processes across regions to facilitate crucial interregional connections and efficiencies.

These eleven steps represent a viable, practical strategy for the U.S. They will be most effective if acted on collaboratively, with stakeholders supporting the combination of measures needed to minimize trade-offs and achieve the best overall outcome.

In the final chapter, we discuss how each stakeholder group can contribute to ending the current cycle of distrust and gridlock and begin to take actions that will put America on this win-win path.

Chapter 7:

MAKING PROGRESS

We believe that unconventional energy is one of the single-largest opportunities to change the trajectory of the U.S. economy and the prospects for the average American in the coming decades at a time when it is urgently needed. We also believe that America's new energy advantage is key to reversing the faltering influence of the U.S. in the world and to making the transition to a cleaner-energy future practical and achievable. Only a thoughtful, coordinated approach by industry, environmental stakeholders, and governments can put the U.S. on the path to responsibly achieving the full benefits.

The win-win pathway allows the U.S. to take full advantage of the unconventionals opportunity, while delivering on the most important economic, environmental, and climate objectives. To put these steps into action, however, industry, NGOs, governments, and academics will need to move beyond their traditional postures and begin to break down the historic rivalries and distrust that have led to the current discord, zero-sum mindsets, and slow progress. Stakeholders, who doubt the motives of other actors, wait on others to move first. A lack of common understanding of the facts compounds the problem, especially when stakeholders continue to echo established ideology, rather than engaging in constructive dialogue based on up-to-date understanding of the opportunity, risks, and choices at hand.

Amid the rancor, however, there are signs of change. Leading companies are working with communities to minimize local environmental impact. Efforts like FracFocus and CSSD have begun to bring industry, NGOs, and policy makers together on particular regulatory issues, or in particular geographies. NGOs, producers, and academic institutions have collaborated to study methane leakage intensively. Upstream and downstream industries, together with local governments, are developing worker training programs to make sure key skill gaps are addressed.

We need to achieve a "rational" middle ground that allows us to meet our collective goals. Long-entrenched opposition and antagonism will not dissipate overnight. But we must get started.

THE WAY FORWARD

The starting point in making real progress is to acknowledge that achieving our economic, environmental, and climate goals is important to all stakeholders, including the American public. We must increase economic growth, competitiveness, and prosperity. We

A lack of common understanding of the facts compounds the problem, especially when stakeholders continue to echo established ideology, rather than engaging in constructive dialogue based on an up-to-date understanding of the opportunity, risks, and choices at hand.

must protect the environment and health of our local communities and open spaces. And we must move to preserve the planet for future generations by taking pragmatic steps to mitigate the risks of climate change.

While acknowledging the legitimate concerns of stakeholders committed to each of these objectives, America must transition to a solutions mindset. Our work has amply demonstrated that there are barriers to the successful development of unconventionals, but also practical solutions. If we can approach this opportunity from the perspective of the national interest, all the work needed to be done becomes possible.

Gain a shared understanding of the facts

The first step toward changing the current rancor and debate is to establish common ground on the major economic, environmental, and climate facts about unconventionals. Time and again, our work has highlighted the reality that each stakeholder group is often operating from different versions of the truth. Stakeholders often choose to make arguments based on a siloed perspective or an unrealistic starting point, without consideration for the larger objectives and realities. And we are not alone in this view.

Even a recent U.S. Congress hearing highlighted the negative effects of biased research on hydraulic fracturing. (See page 50.) This lack of common understanding stymies nearly any discussion before it starts. By achieving common understanding, stakeholders can begin to debate real trade-offs and start to take positive actions that advance their own real interests.

Distorted Data Undermine the Legislative Process

On April 23, 2015, The House of Representatives Committee on Science, Space, and Technology held a hearing that highlighted its concern that biased research was driving state and local decision-making on hydraulic fracturing. Representatives from both sides of the aisle lamented the misuse of data to support specific agendas.[216]

"We get so much diverse information disseminated … it's hard to tell who is telling the truth and who might not be telling the whole truth and nothing but the truth." *– Rep. Bill Posey, R-Florida*

The array of conflicting information "not only does a disservice to members of this committee [but also] does nothing to increase the trust of the fracking industry in … communities." *– Rep. Eddie Bernice Johnson, D-Texas*

Highlight the distortions of obstructionists

Bad actors, who oppose making things better, not only hurt the chances of achieving a win-win pathway but also undermine the interests of all constructive companies and organizations across the stakeholder groups. For example, non-compliant producers make it harder for compliant producers to operate. Misinformation from one environmental NGO makes the legitimate research of other NGOs less credible. And hard-line obstructionist climate advocates close political doors for other climate groups that are trying to enact balanced agreements. The leaders in each stakeholder group must have the courage to highlight counterproductive behavior and draw distinctions between themselves and those who are not truly interested in progress.

Moderate rhetoric and inflammatory behavior

In addition to highlighting the distortions of the most extreme actors, it is important that companies and other organizations take steps to change their tone, moderate rhetoric, and temper disrespectful and combative behaviors. Industry leaders should use forums like the API, ANGA, and IPAA to encourage others within the industry to support the fundamental elements of a win-win path, and to move beyond the stance of constant opposition that many in the industry take. Environmental and climate groups should work within their coalitions to promote constructive views and actions built on making actual environmental and climate progress, rather than holding out for unrealistic ideals and absolutist solutions. Even governments and politicians need to moderate their stances, by proactively depoliticizing energy and climate battles.

By showing a willingness to seek solutions, and to put the American public and its broad interests first, stakeholders will lay the foundation for collaboration and progress.

Expand cross-stakeholder groups and forums

Finally, all the stakeholders need to start working together in earnest. That starts with building on already successful collaborations, and by talking regularly with one another. Cross-stakeholder forums on key topics pull together the legitimate interests and best thinking from each sector, which is where practical actions and solutions come from. The API technical standards process, STRONGER, CSSD, and the Colorado Oil and Gas Task Force are all good examples of what productive collaboration looks like.

In these, as well as in new partnerships, stakeholders need to focus on concrete actions to further the win-win pathway. For example, a coordinated cross-stakeholder advocacy campaign could help expedite elements of the action plan, especially those requiring political actions, such as export laws and climate legislation. Collaborative groups could even draft specific legislative and regulatory proposals, such as how to improve regulator IT systems and databases, or how to streamline infrastructure permitting. Collaborative efforts could also develop and put forward implementation plans for meeting specific regulations, like the EPA's proposed methane rules.

GETTING STARTED

Each stakeholder group needs to get started. In Table 1 we have laid out concrete steps for industry, NGOs, and government stakeholders to begin moving forward. These steps are all actions that stakeholders can take on their own, even before the need to work across groups. They will lay the foundation for broader progress.

Industry

The first crucial step for industry stakeholders is to recognize the legitimate interests of environmental and climate stakeholders. While the economic benefits of unconventionals development are important, industry rhetoric can too often come across as focusing on economics at the expense of all other interests. Industry can also stop its often intense lobbying campaigns against any environmental or climate objectives. In doing so, industry would demonstrate that it is committed to a productive dialogue and not a zero-sum battle. Finally, industry stakeholders, especially producers, can start taking actions to recognize the risks and be more transparent. Examples include disclosing environmental performance data and working within the industry to proactively improve environmental compliance.

Environmental and climate NGOs

For NGOs, their actions in many ways should mirror those of industry. They can start by recognizing the value and urgent need for economic growth and its fundamental role in driving American prosperity. While minimizing environmental impacts, protecting health, and mitigating climate change are crucial, NGOs must also be realistic that economic opportunity and an improving standard of living will inevitably require some impacts on the natural world. NGOs also need to make sure to portray the facts around hydraulic fracturing and unconventionals fairly and in full context, rather than using isolated incidents or biased studies to oppose development. In doing so, NGOs will show they are serious about making real environmental progress and provide incentives for industry players to come to the table. Finally, NGOs can work within their communities to reign in some of the most radical and least constructive actors. While difficult, this also shows commitment to achieving progress and building positive momentum.

Policy makers and governments

While policy makers and regulators are obligated to balance the various stakeholder interests and put the American public first, they need to do more to make this a reality. First, across both sides of the aisle, they need to recognize that, to truly achieve American prosperity and serve the community, economic, environmental, and climate objectives are all important. Policies and regulations need to reflect that balance. Next, government actors need to reduce the partisanship associated with every aspect of unconventionals development. Unconventionals development should not just be a Republican platform plank, nor should environmental and climate protection just be a Democratic platform plank.

Finally, policy makers can start to take constructive and needed actions as well, such as enforcing infrastructure permitting timelines, bolstering environmental enforcement capacity, and finalizing methane leakage rules.

Table 1: **Immediate steps stakeholders can take on their own to move toward a win-win path**

Industry	Local environmental groups and climate change advocates	Policy makers and governments
Recognize that battling with the communities in which industry does business is not good strategy Acknowledge the importance of acting on environmental protection and climate change	Acknowledge the economic and competitiveness benefits of unconventionals, and their importance to communities across America	Acknowledge the legitimate interests of the economic, environmental, and climate stakeholders
Publicly recognize the legitimate environmental risks created by unconventionals development	Publicly recognize the progress made by industry and governments in reducing environmental impacts and risks	Publicly support the need for better policies and regulations to support responsible development, rather than posturing for unrealistic ideals
Recognize and acknowledge the long-term energy transition that is well underway. Stop aggressive lobbying against all environmental and climate regulations	Stop aggressive protests and legal battles towards all unconventionals production or infrastructure	Stop the partisan gridlock that prevents progress on even no-regret moves and harms both parties core constituencies
Disclose environmental performance data	Support and actively participate in continuous improvement efforts such as API standards, STRONGER, and local efforts	Enforce existing policies including regulatory compliance and permitting timelines
Take proactive steps to improve environmental practices across all industry participants	Take proactive steps to bring more combative groups into the collaborative discussion	Take proactive steps to establish public roadmaps for resolving key economic, environmental, and climate topics at the federal and state levels

OUR COMMITMENT

As stakeholders in the future of the U.S. and authors of this work, the HBS-BCG team is committed to determining and sharing the facts on unconventionals, working across stakeholder groups to further productive actions going forward, and playing other roles in turning the win-win pathway into reality. In particular, we commit to taking the following steps:

- We will pursue a public education campaign on America's energy opportunity, the facts, and the path forward
- We will convene more cross-stakeholder forums to discuss solutions and tangible action steps
- We will respond to and cooperate with thoughtful efforts to improve the fact base, analysis and policy steps needed
- We will call out groups and individuals who distort the truth, and take self-serving actions that are not in the interest of the U.S. or the public.
- We will publicize what's working and share best practices across all stakeholders

Appendix I:

ESTIMATING ECONOMIC IMPACTS OF UNCONVENTIONAL ENERGY DEVELOPMENT

GDP CONTRIBUTION, JOBS SUPPORTED, SALARIES, AND GOVERNMENT REVENUES

Summary of the approach

To estimate the GDP, jobs, salary, and government revenue impacts of unconventional oil and gas resource extraction in the U.S. economy, The Boston Consulting Group and Harvard Business School utilized software from the IMPLAN Group LLC.[217] The IMPLAN software uses a set of linear multipliers derived from an input-output analysis to estimate the value-added output, employment, employee compensation (also referred to as salary), and government tax revenue effects of an increase in final demand in an industry. Specifically, final demand, the value of goods and services sold to final users, is estimated for an industry. This final demand figure is then multiplied by a set of GDP, employment, and labor income multipliers to estimate the direct, supplier, and labor income spending impacts of that industry. Definitions of direct impacts, supplier impacts, and labor income spending impacts are provided below:

- **Direct impacts** – The economic impacts generated from the industries engaged directly in unconventionals operations and capital expenditure (CAPEX) activities (for example, oil and gas extraction, oil field services).
- **Supplier impacts** – The additional economic impacts generated from other industries expanding in order to supply those industries engaged directly in unconventionals operations and CAPEX activities.
- **Labor income spending impacts** – The additional economic impacts generated by labor income spending from households who work in or are suppliers for industries engaged in unconventionals operations and CAPEX activities. Labor income includes employee compensation (wages and benefits) and proprietor income. Employee compensation is defined as the total payroll cost of the employee for the employer, including wage and salary, all benefits (such as health or retirement) and payroll taxes (both sides of social security, unemployment taxes).

BCG and HBS utilized the 2013 IMPLAN parameters and multipliers for this study, which are available for purchase online from the IMPLAN Group (http://www.implan.com).

For a detailed explanation of the IMPLAN methodology and software, please refer to the IMPLAN guide "Principles of Impact Analysis and IMPLAN Application."[218]

Inputs used in the IMPLAN software

In the BCG and HBS model, the economic impact estimates of unconventional oil and gas resource extraction are based on the level of industry demand for two categories of activities related to unconventional resource extraction. The first category of demand is CAPEX activities, which is the demand generated from initial investments in property, plants, and equipment required to enable production of the unconventional oil and gas and downstream processes. CAPEX spending is measured for oil, gas, and natural gas liquids (NGLs) extraction, transportation and storage logistics, LNG export facilities, petroleum refining, and petrochemical manufacturing. The second category of demand results from operational activities (in other words, production) along the unconventional oil and gas value chain. Production final demand is measured for oil, gas and NGLs extraction, petroleum refining, and petrochemical manufacturing.

Final demand figures are estimated for all of the activities in each category. For example, final demand figures for unconventional oil extraction was obtained by multiplying estimates of resource production level and prices. Forecasts of resource production levels were obtained from the Energy Information Administration (EIA).[219] Forecasts of CAPEX spending were obtained from IHS.[220] Refining final demand is calculated as a percentage of unconventional oil production. Forecasts of petrochemical production from unconventionals were obtained from the American Chemistry Council.[221]

After final demand figures for each industry are estimated, they are provided as an input to the software, which multiplies them with the set of GDP, employment, and labor income multipliers for each industry to arrive at the direct, supplier, and labor income spending impacts to value-added output, employment, employee compensation, and government tax revenues for all industries in the economy.

Other calculations

Employment: The IMPLAN estimates of employment in oil and gas extraction include proprietors—individuals who do not receive a wage or salary but receive income from an oil or gas extraction business (such as revenues from an ownership stake in a well). Because these individuals are not involved in day-to-day operations related to oil and gas extraction, BCG and HBS subtracted these individuals from the IMPLAN estimates of direct employment from unconventional oil and gas extraction. The proportion of proprietors in oil and gas extraction employment figures provided by the Bureau of Economic Analysis[222] was used to estimate the percentage of proprietors in the IMPLAN figures.

Salaries: Salaries are estimated by dividing the employee compensation estimates by the estimates of employment, net of proprietors.

Federal, state, and local revenues: The IMPLAN software provides an estimate of the federal, and state, and local taxes generated by the final demand input using another set of multipliers. However, these figures do not include other sources of revenue specific to oil and gas resource development, such as royalty and bonus payments. To the IMPLAN software output, BCG and HBS added estimates of federal royalty and bonus payments, severance taxes, ad valorem taxes, and state bonus and royalty payments from oil and gas production. These estimates were obtained from IHS.[223]

Impacts from oil and gas exports: To estimate the potential impacts of lifting the ban on U.S. crude oil exports and the potential effects of LNG exports, BCG and HBS first estimated alternative price and production figures for unconventional oil and gas resources in a scenario where oil exports were permitted and a domestic LNG export market was developed.

If the ban on U.S. crude oil exports were lifted, BCG and HBS estimates that spot crude oil prices received by oil extraction companies would experience a moderate increase as domestic prices converged with international spot prices, while production would remain unchanged (a conservative assumption). In addition, as a result of higher crude oil prices, refiners would enjoy smaller margins,[224] impacting the value of final demand generated by the industry, and therefore the economic impacts predicted by the IMPLAN approach.

BCG and HBS also modeled the impact of the development of an LNG export market, projecting that this market would develop by 2020 and would lead to up to 3.07 TCF of additional unconventional natural gas production by 2030. BCG and HBS estimated that spot prices would rise moderately.[225]

The price and production estimates in the oil and gas export scenarios were then used to calculate an alternative set of GDP, employment, employee compensation, and government revenue impacts. The difference in the value of the impacts between the export scenarios and the scenario without exports were used to estimate the incremental contribution of exports to the economic impacts of unconventional resource development.

SAVINGS FOR HOUSEHOLDS FROM LOW-COST NATURAL GAS AND NATURAL GAS LIQUIDS (NGLS)

Forecasts of household savings from cheaper lower-cost natural gas and NGLs as a result of unconventionals extraction were obtained for three categories: 1) natural gas bill savings; 2) electric-bill savings; and 3) lower-cost goods and services. The forecasts were derived by first estimating the prices of natural gas and NGLs (ethane, propane, and butane) in the absence of unconventional resource extraction. Future natural gas prices were estimated to remain at the 2005 level.[226] Historical ratios of NGL prices to crude oil prices were used to estimate future NGL prices.[227] These prices were then multiplied by BCG and HBS forecasts of consumption. The difference between the expenditures in the absence of and presence of unconventional resource extraction yielded the aggregate annual savings for the U.S. economy. To apportion these savings to households, BCG and HBS followed the methodology set out in BCG's *Made in America, Again* series publication on household energy savings.[228]

Table 2: **Summary table of the economic impacts from unconventional gas and oil development**

	2014	2020	2030
Value-added (2012 $, millions)	$433,613	$482,433	$586,345
Direct	238,929	255,175	291,370
Operation activities	177,015	179,171	189,248
Capital investment activities (CAPEX)	61,913	76,004	102,122
Supplier impacts	78,909	101,459	143,185
Labor income spending impacts	115,776	125,798	151,791
Jobs supported	2,697,541	3,014,920	3,787,877
Direct	627,645	668,057	833,509
Operation activities	116,892	117,895	124,712
Capital investment activities (CAPEX)	510,753	550,163	708,797
Supplier impacts	667,644	823,421	1,116,510
Labor income spending impacts	1,402,252	1,523,442	1,837,859
Average compensation per employee (2012 $)	$51,672	$52,156	$52,795
Direct	61,928	63,335	65,313
Operation activities	55,850	56,155	57,393
Capital investment activities (CAPEX)	66,584	68,322	69,637
Supplier impacts	61,067	60,826	60,491
Labor income spending impacts	40,539	40,541	40,544
Government revenues (2012 $, millions)	$111,371	$127,921	$159,090
Federal taxes and other revenues	56,524	63,045	76,395
State and local taxes and other revenues	54,847	64,875	82,695
Household savings from low-cost energy (2014 $)	$776	$848	$1,067
Natural gas bill savings	120	109	106
Electric bill savings	102	109	159
Cheaper goods & services	554	630	802

Note: CAPEX stands for capital expenditures. Figures include incremental impacts from reversing the ban on crude oil exports, as well as incremental impacts from liquefied natural gas (LNG) exports. Salary figures represent the total payroll cost of the employee for the employer, including wage and salary, benefits (e.g. health, retirement), and payroll taxes. Figures are rough estimates used for illustration.

Appendix II:

ANALYSIS OF UNCONVENTIONALS JOB POSTINGS BY BURNING GLASS

All job posting data in this report are drawn from Burning Glass's database of online job postings, which includes nearly 100 million worldwide postings collected since 2007. Burning Glass collects these job postings from more than 38,000 online job boards and sites, and uses advanced text analytics to extract more than 70 data fields from each posting, such as job title, occupation, employer, industry, required skills, and credentials and salary. Postings are then edited for duplications and placed in a database for further analysis.

The jobs in this analysis are for the period of October 2013 to November 2014.

For the purposes of this analysis, unconventional energy jobs were defined as those supporting the extraction, distribution, and refinement of oil and gas resources obtained through hydraulic fracturing-related technologies. Unconventional energy job postings were identified using a combination of skills, keywords, and industries mentioned in postings. Keywords were broken into three categories: technological terms associated with fracking (such as "hydraulic fracturing"), terms associated with fracking geology ("shale"), and names of prominent shale plays (geographic areas) that featured in postings (for example, "Marcellus").

Appendix III:

CALCULATING COSTS OF CSSD STANDARDS COMPLIANCE

To estimate the costs of complying with CSSD standards for new wells drilled in the Marcellus Shale, BCG and HBS calculated the incremental costs required to meet each of the 15 CSSD performance standards. Though many operators are already complying with a number, and some with all, of the CSSD's performance standards, we estimated the average cost for an operator in the Marcellus Shale who is not currently complying with any of the performance standards.

To estimate the additional cost of meeting each standard, we utilized primarily public sources. (See Table 3.) Where public sources were unavailable, we utilized BCG's Unconventionals Operational Database, as well as BCG's Energy Practice upstream operations experts, and we cross-referenced estimates with industry operators and environmental groups. We discovered that a range of additional costs can be expected, depending on the existing operational setup, regional geography and geology, and compliance methodologies utilized. The costs of meeting the overall standards were compiled by adding up the individual estimates. The overall low-cost estimate is the sum of the low-cost estimates for each individual standard (where a range was estimated). The overall high-cost estimate is the sum of the high-cost estimate for each individual standard.

Table 3: **Estimated costs to comply with CSSD performance standards**

CSSD category	CSSD performance standard		Additional cost to implement for a standard well	Source for cost data
Wastewater	1	Zero wastewater discharge	$0 (can generate net savings at scale)[A]	Tom Lewis III, "Frac Water Disposal / Recycling Processes for Unconventional Shale Gas Waste Water," Lewis Environmental, p. 56, http://www.gwpc.org/sites/default/files/event-sessions/19r_Lewis_Tom.pdf, accessed May 2015.
	2	Recycle produced water	$0 (can generate net savings at scale)[A]	James Slutz et al., "Key Shale Gas Water Management Strategies: An Economic Assessment Tool," Australian Petroleum Production & Exploration Association Limited and SPE International, p. 13, http://www.oilandgasbmps.org/docs/GEN187-spe157532watermanagement.pdf, accessed May 2015.
Pits/ impounds	3	Closed loop containment	$0 (saves on pit construction)[B]	"Waste Minimization in Drilling Operations," Railroad Commission of Texas, http://www.rrc.state.tx.us/oil-gas/publications-and-notices/publications/waste-minimization-program/operation-specific-documents/waste-minimization-in-drilling-operations/, accessed May 2015.
	4	Hydrocarbon removal	~$15K–$35K	"Reduced Emissions Completions for Hydraulically Fractured Natural Gas Wells," Environmental Protection Agency, p. 6, http://www.epa.gov/gasstar/documents/reduced_emissions_completions.pdf, accessed May 2015.
Ground-water	5	Drilling area of review	$0 (already being done)[C]	BCG-HBS analysis.
	6	Water monitoring	~$2K–$8K[D]	"Testing Drinking Water Supplies Near Gas Drilling Activity," Penn State Extension College Agricultural Sciences, http://extension.psu.edu/natural-resources/water/marcellus-shale/drinking-water/testing-drinking-water-supplies-near-gas-drilling-activity, accessed May 2015.
	7-a 7-b 7-c	Casing and cementing No diesel fuel use Disclosure of chemicals and move toward neutral additives	~$40K–$60K	My-Linh Ngo, "A 'Golden Age' of Shale … or Just a Pipe Dream?," Schroders, April 2014, p. 13 http://www.schroders.com/staticfiles/Schroders/Sites/global/pdf/RI-Shale-Energy-Report-April-2014.pdf, accessed May 2015.
	8	Well pad design to minimize spills	~$40K–$60K	My-Linh Ngo, "A 'Golden Age' of Shale … or Just a Pipe Dream?," Schroders, April 2014, p. 13, http://www.schroders.com/staticfiles/Schroders/Sites/global/pdf/RI-Shale-Energy-Report-April-2014.pdf, accessed May 2015.
Air	9 10	Minimize and disclose flaring	~$20K–$40K	"Air Pollution Control Technology Fact Sheet," Environmental Protection Agency, p. 2, http://www.epa.gov/ttncatc1/dir1/fflare.pdf, accessed May 2015.
	11	Minimize on-site diesel engines, move to electric or NG	~$25K (capital, difficult to quantify/well)[E]	Potential savings from reduced fuel and maintenance costs; Terry Wade, "GE pushes gas power for drill rigs, Caterpillar's diesel turf," November 12, 2013, http://www.reuters.com/article/2013/11/12/oil-rigs-engines-idUSL1N0II1DA20131112, accessed May 2015.
	12 14	Minimize VOCs and other air pollutants	~$75K–$175K[F]	"Oil and Natural Gas Sector Compressors," U.S. EPA Office of Air Quality Planning and Standards (OAQPS), April 2014, p. 32, 35, 28, 40, 41, http://www.epa.gov/airquality/oilandgas/2014papers/20140415compressors.pdf, accessed May 2015. "Reducing Methane Emissions From Compressor Rod Packing Systems," Environmental Protection Agency, p. 4, http://www.epa.gov/gasstar/documents/ll_rodpack.pdf, accessed May 2015.
	13	Reduce VOC emissions from storage vessels	~$25–35K (existing requirement)	BCG-HBS analysis.
	15	Minimize truck emissions	~$5K (EPA standard, capital cost)[G]	"Regulations & Standards: Heavy-Duty," Environmental Protection Agency, http://www.epa.gov/otaq/climate/regs-heavy-duty.htm, accessed May 2015.

[A]Depends on well location, valuation of water, transportation, and recycling costs.

[B]Operation costs on water tank storage or immediate haul away instead of pit construction.

[C]Will add costs if data not available from the state or operator.

[D]Pre-drill sampling already required, post-drill sampling additional cost.

[E]Rough estimate of capital cost per well, savings in maintenance and fuel savings from using field gas instead of delivered diesel fuel.

[F]Cost variance depends on number of wells that feed to a central tank battery.

[G]Rough estimate.

Appendix IV:

ESTIMATING THE LEVELIZED COST OF ELECTRICITY (LCOE), 2015–2050

To model solar power's levelized cost per unit of energy output through 2050, we adapted average industry costs for the module,[229] inverter,[230] and other labor/balance of system costs.[231] We then applied different learning curves to each component to model the change in cost over time using rates established by BCG[232] and Heliotronics.[233] A learning curve rate is the proportion by which unit costs fall for each doubling of volume produced. We also assumed that the growth in solar would slowly diminish over time using projections from ACORE,[234] such that the year-over-year rate of decline in costs would also slow. Our aggressive cost estimate assumes full learning curve rates; our conservative estimate assumes halved learning curve rates. In addition, the aggressive curve assumes an average capacity factor characteristic of Texas; the conservative curve assumes a factor characteristic of New England.[235]

As wind power is a more mature technology than solar, we estimated its costs using a single learning curve rate (established by IEA Wind[236] and Bloomberg[237]) that we applied to its overall 2014 levelized cost as analyzed by the DOE.[238] The model also assumes that the growth of the wind industry steadily slows, according to projections from the American Wind Energy Association,[239] such that the rate of cost decline also slows over time. Our aggressive cost estimate assumes full learning curve rates; our conservative estimate assumes halved learning curve rates. Like the solar curves, the aggressive curve reflects a capacity factor characteristic of Texas, while the conservative curve assumes a capacity factor characteristic of New England.[240]

We modeled the cost of energy output for a combined cycle gas turbine (CCGT) by examining the projected lifetime costs of a plant, factoring in a plant's declining heat rate (volume of energy delivered per kilowatt-hour) and the projected cost of natural gas fuel. Installation, operating, and maintenance costs were adapted from EIA.[241] The base heat rate and rate of heat rate decline for an aging plant were adapted from historical EIA data,[242] and a 30-year lifetime was assumed.[243] Aggressive cost estimates were developed by decreasing forecasted Henry Hub natural gas prices by 25%, and conservative cost estimates were developed by increasing forecasted Henry Hub natural gas prices by 25%.[244]

Appendix V:

ESTIMATING NATURAL GAS POWER PLANT RETIREMENTS, 2014–2060

We estimated the evolution of U.S. natural gas power plant capacity from 2014 through 2060 for the following scenario: Natural gas power plant capacity follows the capacities needed to achieve the proposed Clean Power Plan at lowest cost by 2030, but then no new natural gas power plant capacity is installed past 2030. As a starting point to model capacity growth from 2014 through 2030, we used natural gas capacity projections from EIA's 2014 AEO Reference Case. However, these projections do not factor in the impacts of the EPA's Clean Power Plan, so we modified the AEO Reference Case projections using capacity projections developed in the report "Remaking American Power" by CSIS and Rhodium Group.[245]

To model retirements of natural gas plants beginning in 2014, we assumed that every year, power plants installed 30 years prior would be retired. This assumption is widely employed in natural gas power plant life-cycle analysis by industry, as well as organizations such as the NREL[246] and IEA.[247] Although gas plants can be utilized for more than 30 years with significant refurbishments, as a plant's efficiency declines and the efficiency of newer models improves, investing in continued refurbishments for a 30-year-old plant will yield lesser returns than investing in a new plant altogether. Therefore, the 30-year assumed lifetime is an accurate reflection of the expected economic lifetime for an average gas power plant.

Historical installation data from the Energy Velocity[248] database was used to project the number of gigawatts retired from 2014 through 2044. Beyond 2044 and through 2060, we used our own growth projections of capacity additions from 2014 to 2030 to model the remainder of the retirements.

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RENDERING VITAL ASSISTANCE:

ALLOWING OIL SHIPMENTS TO U.S. ALLIES

PREPARED FOR SEN. LISA MURKOWSKI

U.S. SENATE COMMITTEE ON ENERGY & NATURAL RESOURCES

JUNE 9, 2015

Rendering Vital Assistance:
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Prepared by Majority Staff for Chairman Lisa Murkowski
U.S. Senate Committee on Energy & Natural Resources
June 9, 2015

Summary

During the 1970s, the United States enacted a series of laws that, taken together as a practical matter, ban the export of domestic crude oil. The Unites States is the only advanced nation that maintains such a general prohibition.[1] Efforts are currently underway to repeal those laws, such as S. 1312, *The Energy Supply and Distribution Act of 2015*.[2] The President also retains the authority to approve oil exports immediately, without any further action from Congress.[3] American allies could formally request an exemption from the general prohibition and President Obama is fully empowered to grant such a request under existing laws.

Legislative Framework

The centerpiece of the oil export regime is the Energy Policy and Conservation Act (EPCA) of 1975. Section 103 of the Act provides the President authority to restrict exports of oil by rule. It also provides explicitly for exemptions and grants the President broad discretion to apply them. For example, in providing for exemptions, it also states:

> "Exemptions from any rule prohibiting crude oil . . . exports . . . may be based on the purpose for export, class of seller or purchaser, country of destination, or any other reasonable classification or basis as the President determines to be appropriate and consistent with the national interest and the purposes of this chapter."[4]

It is noteworthy that even EPCA, enacted at a time of severe oil shortages, from the outset clearly provided the President with very broad discretion to exempt oil exports from the general restrictions it empowered him to impose and contemplated that he would use it. The implementing regulations also show the scope of the President's authority to allow oil exports. Other export-restrictive laws also allow oil exports – subject to a presidential finding – including the Mineral Leasing Act, the Outer Continental Shelf Lands Act, and the Naval Petroleum Production Reserves Act.[5]

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[1] See *A Ban for One: The Outdated Prohibition on U.S. Oil Exports in Global Context* (June 26, 2014): http://1.usa.gov/1iNfofu.
[2] The bill's status is available here: https://www.congress.gov/bill/114th-congress/senate-bill/1312.
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Regulatory Framework

Oil exports are regulated by the Bureau of Industry and Security (BIS) at the Department of Commerce. The rules governing these exports are enshrined in the Short Supply Controls, Part 754 of the Export Administration Regulations. Originally conceived during an era of scarcity and Cold War tension, the list of items still in "short supply" now includes only western red cedar (a type of tree), horses for export by sea (intended for slaughter), and crude oil (but not petroleum products).

The BIS regulations provide detail about an array of exceptions to the general prohibition on crude oil exports. Crude oil may be exported from Alaska and California under certain conditions, for example, and crude oil may also be exported to Canada for consumption in Canada. Exports are authorized for testing purposes and from the Strategic Petroleum Reserve in certain cases. The BIS may also approve swaps or exchanges.

Most significantly, the regulations state:

> "BIS will review other applications to export crude oil on a case-by-case basis and... generally will approve such applications if BIS determines that the proposed export is consistent with the national interest and the purposes of the Energy Policy and Conservation Act (EPCA)."

This "case-by-case" authority is the regulatory expression of the legislative framework discussed above. Under existing regulations, any company may submit an application to export crude oil from the United States and the Department of Commerce retains the explicit authority to approve or deny such an application. The only question is whether the administration determines that exports are in the national interest.

National Exemptions

The existing legal structure allows for exemptions for virtually any reason. The administration could determine that all exports of condensate or light crude oil are in the national interest or that a mismatch between high production levels of light crude oil and low capacity levels at refineries capable of processing that type of oil warrants a new class of exception to the general prohibition.[6] The administration could authorize all exports from unconventional shale plays or from certain regions that lacked access to infrastructure. Perhaps most easily, however, the administration could exempt certain countries of destination from the export ban.

President Reagan authorized all crude oil exports to Canada for consumption Canada in 1985, establishing an exemption for that country. (See Appendix A.) This decision has

[6] See *License to Trade: The Commerce Department's Authority to Allow Condensate Exports* (April 2, 2014): http://1.usa.gov/1HwAiWk. See also *Terms of Trade: Condensate as an Exportable Commodity* (July 9, 2014): http://1.usa.gov/VYuJQE.

proved to be far-sighted. In 2005, the United States exported only 30,000 barrels per day of crude oil to Canada. In February of 2015, that number stood at 409,000 barrels per day. This national interest determination followed the conclusion of a cross-border swap program initiated in 1976 by President Ford and continued by President Carter.[7]

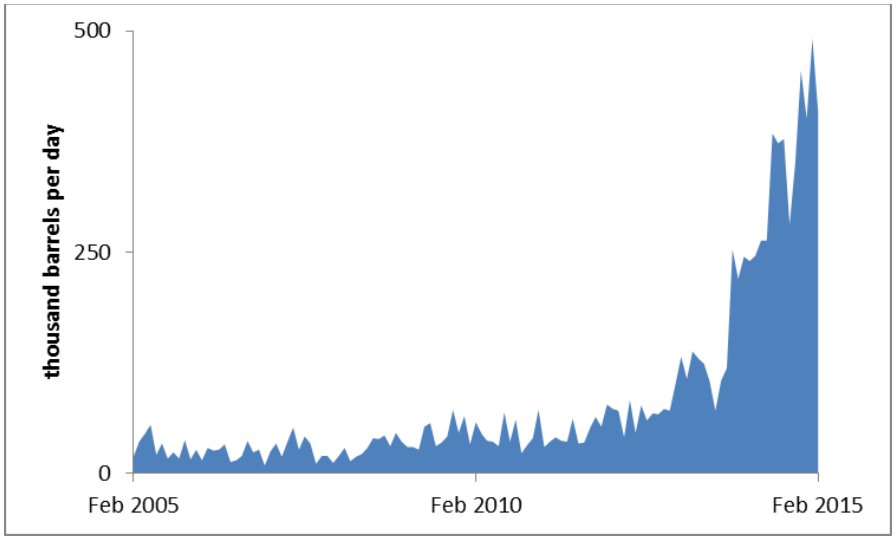

Figure 1. U.S. Crude Oil Exports to Canada (Source: EIA)

In March 2015, a bipartisan group of twenty-one senators led by Senators Murkowski (R-AK) and Heidi Heitkamp (D-ND) sent a letter to the Department of Commerce encouraging the administration to grant an exemption for Mexico on the same basis as the one granted for Canada in 1985. (See Appendix B.) This letter was followed by a bipartisan companion letter sent from the House of Representatives in April 2015.

The United States is also permitted to export crude oil to Israel in the event of a national emergency. This agreement was first signed in 1975 by the Ford administration and formalized in 1979 by the Carter administration. It was subsequently reauthorized by the Clinton administration in 1994 and by the Bush administration in 2004. It expired in November 2014, but the Obama administration renewed the agreement following a bipartisan letter led by Senators Lisa Murkowski and Mark Warner (D-VA) sent in April 2015, encouraging the Department of State to expedite its renewal. (See Appendix C.)

Nothing at all prevents another government from requesting an exemption from the general prohibition on U.S. oil exports. There is no standard protocol for submitting such a request. It could be transmitted by a letter or during a meeting at the ministerial or ambassadorial level, for example. Further, companies could also submit a detailed proposal for transactions directly to the Department of Commerce.

Any nation could make a request. To demonstrate the breadth of the opportunity, consider a series of examples:

[7] See *Crude Pro Quo: The Use of Oil Exchanges to Increase Efficiency* (May 22, 2014): http://1.usa.gov/1nUEA1K.

Poland

In 2012, Poland produced approximately 20,000 barrels per day of crude oil and imported another 500,000 barrels per day.[8] This equation renders it virtually entirely dependent on oil imports, 96 percent of which come from Russia. There are four operational refineries in the country. Despite its import dependence, Poland exports small amounts of crude oil and significant volumes of refined products, occasionally even to the United States.

Ties between Poland and the U.S. date back to the American Revolution, when figures such as Tadeusz Kościuszko and Casimir Pulaski fought alongside the colonists. More recently, Poland deployed troops to both Iraq and Afghanistan as a vital coalition partner.

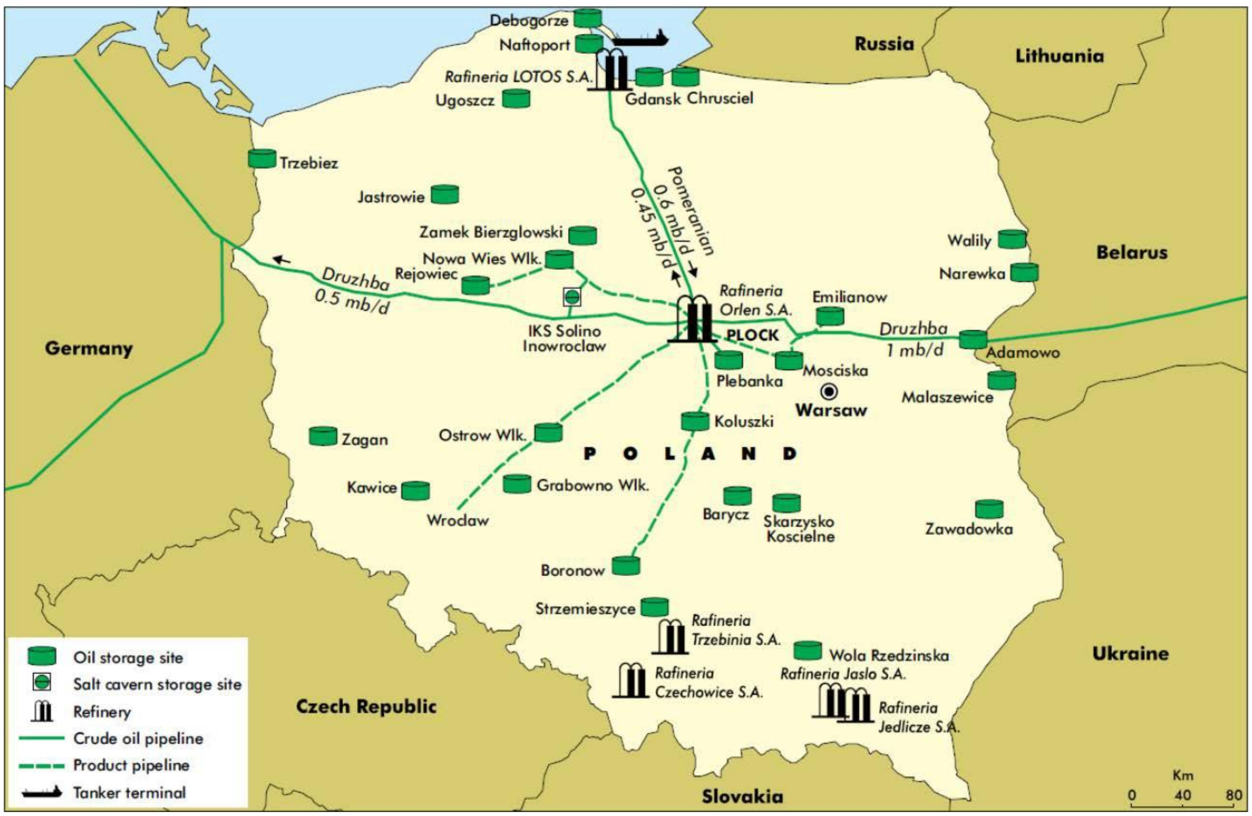

Figure 2. Poland's Oil Infrastructure (IEA)

8 International Energy Agency, *Energy Supply Security: The Emergency Response of IEA Countries* (2014): https://www.iea.org/media/freepublications/security/EnergySupplySecurity2014_Poland.pdf.

Belgium

In 2012, Belgium produced no crude oil. It imported over 300,000 barrels per day, with 37 percent of that total coming from Russia and another 23 percent from Saudi Arabia.[9] Despite this complete dependence on imported crude oil, Belgium maintains a significant presence in the downstream sector, boasting four refineries and the major port of Antwerp. The United States is among its customers, importing some 60,000 barrels per day of mostly unfinished oils in 2014. The North Atlantic Treaty Organization (NATO) is headquartered in Brussels. Belgium has also deployed troops to Afghanistan as part of the coalition.

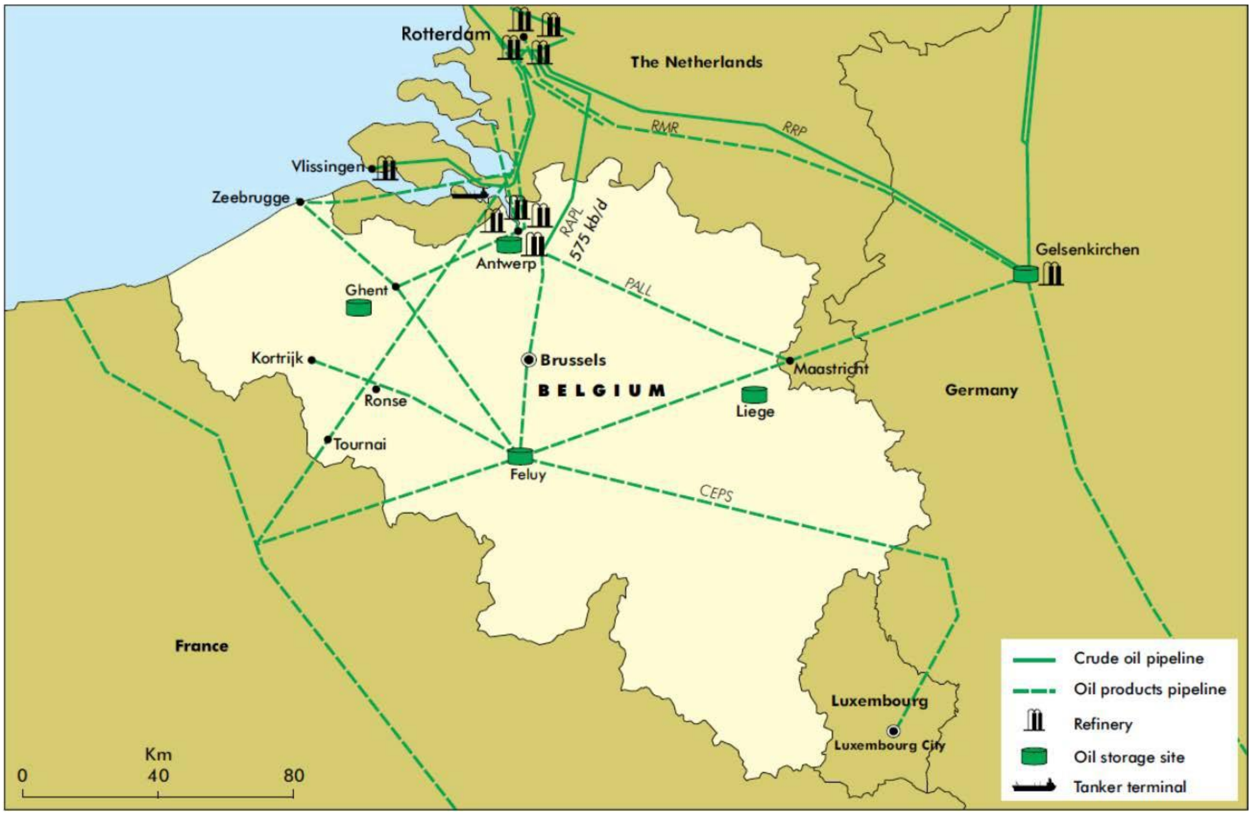

Figure 3. Belgium's Oil Infrastructure (IEA)

9 IEA, *Energy Supply Security*: https://www.iea.org/media/freepublications/security/EnergySupplySecurity2014_Belgium.pdf.

The Netherlands

In 2012, the Netherlands produced approximately 52,000 barrels per day of crude oil, but consumed over 1 million barrels per day.[10] It is approximately 95 percent dependent on imported crude oil. About 31 percent of these barrels come from Russia. The country is a major hub in the broader European energy system. The International Energy Agency describes the Netherlands as "a key link in European oil supply flows, with the total volumes of oil transiting over four times larger than Dutch oil demand." The country's five refineries export petroleum products, including some 84,000 barrels per day to the United States. The two nations have maintained diplomatic relations since 1782. Dutch and American military forces have served together in numerous engagements across the globe.

Figure 4. The Netherlands' Oil Infrastructure (IEA)

[10] IEA, *Energy Supply Security*: https://www.iea.org/media/freepublications/security/EnergySupplySecurity2014_TheNetherlands.pdf.

India

In 2012, India produced just over 800,000 barrels per day of crude oil but imported more than three times that amount.[11] The country is approximately 76 percent dependent on crude oil imports, the vast majority (69 percent) from the Middle East – including 279,000 barrels per day from Iran in 2014, according to the International Energy Agency. There were 22 refineries in India in 2012 with approximately 4.4 million barrels per day in refining capacity. In 2014, the U.S. imported over 90,000 barrels per day of refined products – mostly motor gasoline blending components – from India. The two nations are strategic partners with growing bilateral economic and security ties.

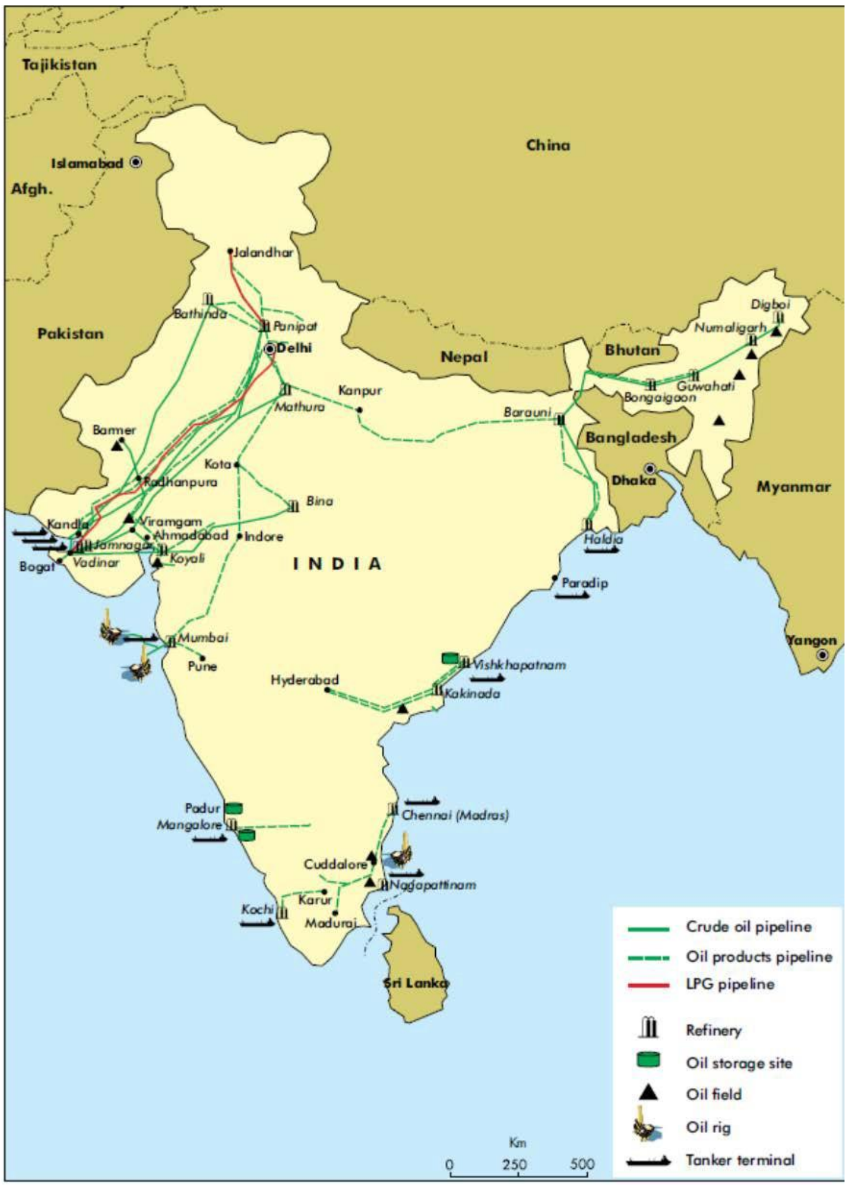

Figure 5. India's Oil Infrastructure (IEA)

[11] IEA, *Energy Supply Security*: https://www.iea.org/media/freepublications/security/EnergySupplySecurity2014_India.pdf.

Japan

In 2012, Japan produced approximately 17,000 barrels per day of crude oil but imported approximately 4.7 million barrels per day.[12] The island nation is 99.7 percent dependent on oil imports. It receives approximately 33 percent of its crude oil from Saudi Arabia, 23 percent from the United Arab Emirates, 8 percent from Kuwait, 6 percent from Qatar, and 5 percent from Russia. Nonetheless, it is home to one of the largest downstream centers in the world with 27 refineries and nearly 5 million barrels per day in capacity. Japan has historically imported liquefied natural gas, as well as crude oil, from Alaska, and even exports approximately 14,000 barrels per day of refined products to the United States. The two nations signed a bilateral defense treaty in 1951 and have cooperated in security operations ever since.

Figure 6. Japan's Oil Infrastructure (IEA)

[12] IEA, *Energy Supply Security*: https://www.iea.org/media/freepublications/security/EnergySupplySecurity2014_Japan.pdf.

South Korea

In 2012, South Korea produced approximately 21,300 barrels of crude oil but imported more than ten times that amount.[13] It is 99.1 percent dependent on crude oil imports, the vast majority of which originate from the Middle East: 33 percent from Saudi Arabia, 15 percent from Kuwait, 11 percent from Qatar, 10 percent from Iraq, and 9 percent from the United Arab Emirates. It has five refineries with approximately 3 million barrels per day in capacity and exports approximately 61,000 barrels per day in refined products to the United States. The two nations signed a bilateral defense treaty in 1953.

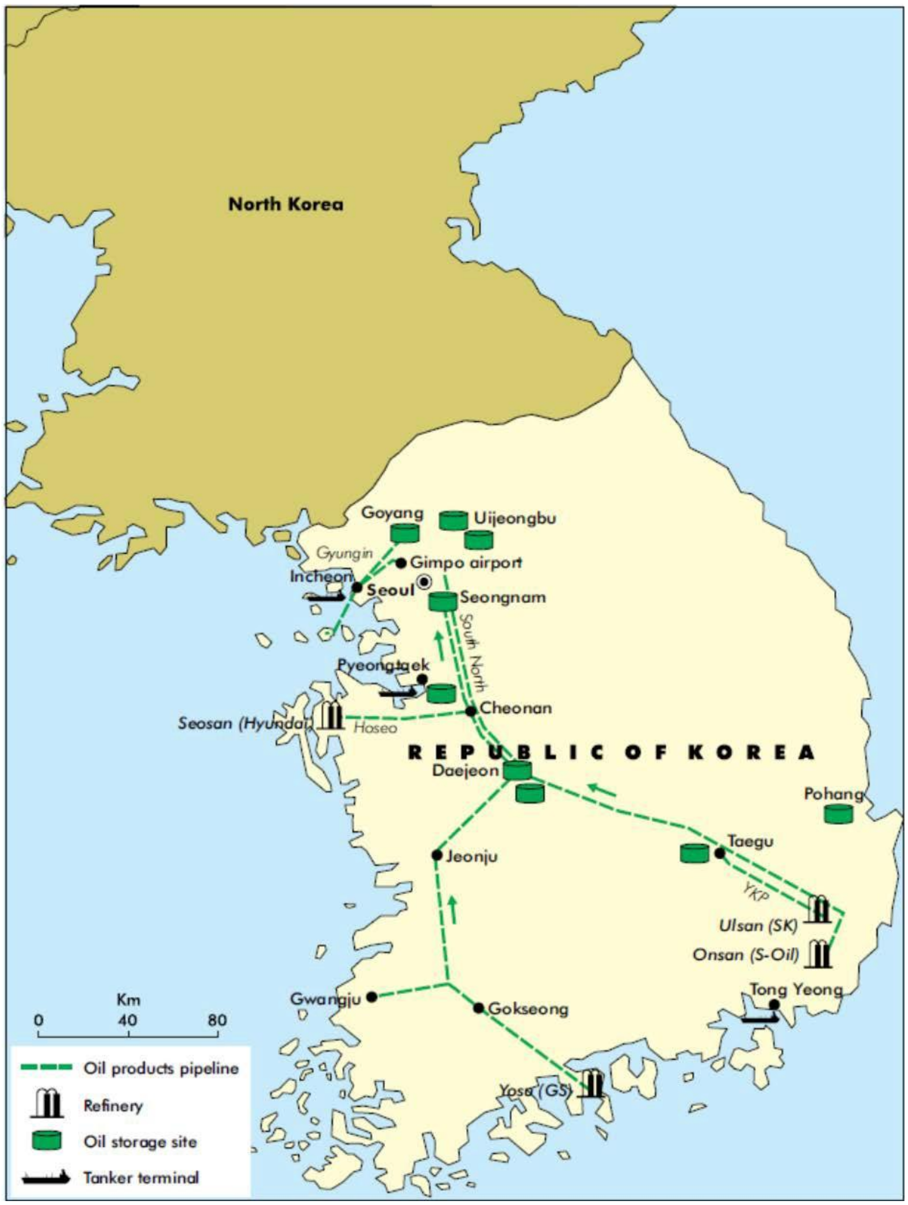

Figure 7. South Korea's Oil Infrastructure (IEA)

[13] IEA, *Energy Supply Security*: https://www.iea.org/media/freepublications/security/EnergySupplySecurity2014_TheRepublicofKorea.pdf.

Conclusion

While legislative efforts aimed at full repeal of crude oil export restrictions progress in Congress, the administration retains broad authority to allow greater exports to U.S. allies that request exemptions from those restrictions. This authority is enshrined in both law and regulation and was explicitly delegated to the executive branch by Congress. Substantial precedent exists for such exemptions to be granted, particularly to U.S. allies. A national interest finding by the President could be implemented immediately by the Department of Commerce and exports could set sail as soon as the commercial and logistical arrangements were made.

Many U.S. allies and trading partners are interested in purchasing American oil to diversify away from Russia, Iran, and other problematic sources. Allowing such shipments would send a powerful signal of support and reliability at a time of heightened geopolitical tensions in much of the world.[14] The mere option to purchase U.S. oil would enhance the energy security of countries such as Poland, Belgium, the Netherlands, India, Japan, and South Korea, even if physical shipments did not occur. The administration, in fact, makes this same argument in its authorizations to export liquefied natural gas (LNG):

> "An efficient, transparent international market for natural gas with diverse sources of supply provides both economic and strategic benefits to the United States and our allies. Indeed, increased production of domestic natural gas has significantly reduced the need for the United States to import LNG. In global trade, LNG shipments that would have been destined to U.S. markets have been redirected to Europe and Asia, improving energy security for many of our key trading partners. To the extent U.S. exports can diversify global LNG supplies, and increase the volumes of LNG available globally, it will improve energy security for many U.S. allies and trading partners."[15]

Exempting certain countries on a case-by-case basis, as the statutes and regulations currently allow, would be a partial and helpful step toward the modernization of U.S. energy policy. Nonetheless, full statutory repeal of U.S. oil export restrictions remains the most effective way of allowing domestic producers to access global markets.

Acknowledgments

Staff wish to thank the Congressional Research Service for its assistance with this report. The cover image is of the oiler USNS Big Horn replenishing the aircraft carrier USS Dwight D. Eisenhower in the Mediterranean Sea.[16]

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[14] Arthur Herman, "Crude Story," *The American Interest* (May 26, 2015): http://www.hudson.org/research/11324-crude-story.

[15] See, for example: http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/ord3638.pdf, p. 191.

[16] Marc D. Schron, US Navy (March 14, 2009): http://www.defense.gov/HomePagePhotos/LeadPhotoImage.aspx?id=13529.

APPENDIX A:
President Reagan's Finding for Canada

F11deral Register
Vol. 50, No. 117
Tuesday, June 18, 1985

Presidential Documents

Title 3–

The President

Presidential Findings of June 14, 1985

United States-Canadian Crude Oil Transfers

On March 18, 1985, at the Quebec Summit, I joined Prime Minister Mulroney in endorsing a Trade Declaration with the objective of liberalizing energy trade, including crude oil, between the United States and Canada. Both Governments recognized the substantial benefits that would ensue from broadened crude oil transfers and exchanges between these two historic trading partners and allies. These benefits would include the increased availability of reliable energy sources, economic efficiencies, and material enhancements to the energy security of both countries. Following this Declaration, Canada declared that it would permit Canadian crude oil to be freely exported to the United States effective June 1, 1985.

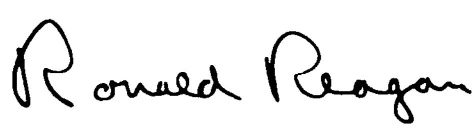
Before crude oil exports to Canada can be authorized, I must make certain findings and determinations under statutes that restrict exports of crude oil. I have decided to make the necessary findings and determinations under the following statutes: Section 103 of the Energy Policy and- Conservation Act (42 U.S.C. 6212); section 28 of the Mineral Lands Leasing Act of 1920, as amended by the Trans-Alaska Pipeline Authorization Act of 1973 (30 U.S.C. 185); and section 28 of the Outer Continental Shelf Lands Act (43 U.S.C. 1354) (crude oil transported over the Trans-Alaska Pipeline or derived from the Naval Petroleum Reserves is excluded).

I hereby find and determine that exports of crude oil under these statutes are in the U.S national interest, and I further find and determine that such U.S. crude oil exports to Canada–

- will not diminish the total quantity or quality of petroleum available to the United States;
- will not increase reliance on imported oil;
- are in accord with provisions of the Export Administration Act of 1979; and
- are consistent with the purposes of the Energy Policy and Conservation Act.

Therefore, such domestic crude oil may be exported to Canada for consumption or use therein.

These findings and determinations shall be published in the Federal Register. I direct the Secretary of Commerce to take all other necessary and proper action to expeditiously implement this decision.



THE WHITE HOUSE,
June 14, 1985.

[FR Doc. 85-14782
Filed l}-17-85; 9:35 am]
Billing code 3195--01-M

Rules and Regulations

Federal Register
Vol. 50, No. 122
Tuesday, -June 25, 1985

This section of the FEDERAL REGISTER contains regulatory documents having general applicability and legal effect, most of which are keyed to and codified in the Code of Federal Regulations, which is published under 50 titles pursuant to 44 U.S.C. 1510.
The Code of Federal Regulations is sold by the Superintendent of Documents. Prices of new books are listed in the first FEDERAL REGISTER issue of each week.

DEPARTMENT OF COMMERCE

International Trade Administration

15 CFR Part 377

[Docket No. 50698-5098]

Exports of Crude 011 to Canada for Consumption or Use Therein

AGENCY: International Trade Administration, Commerce.

ACTION: Final rule.

SUMMARY: On June 14, 1985, President Reagan determined that crude oil exports to Canada are in the national interest and made the necessary findings under the Energy Policy and Conservation Act, the Mineral Lands Leasing Act, and the Outer Continental Shelf Lands Act to permit exports to Canada of crude oil subject to those statutory restrictions (50 FR 25189, June 18, 1985). To implement this determination, Part 377 of the Export Administration Regulations is being revised to permit crude oil exports to Canada for consumption or use therein, provided that it was not transported via the Trans-Alaska Pipeline and was not produced from Naval Petroleum Reserves.

EFFECTIVE DATE: June 25, 1985.

FOR FURTHER INFORMATION CONTACT: Rodney A. Joseph, Acting Manager, Short Supply Program, Room 3876, Office of Industrial Resource Administration, U.S. Department of Commerce, Washington, DC 20230, Telephone: 202/377-3984.

SUPPLEMENTARY INFORMATION:

Rulemaking Requirements

1. Since this rule pertains to a foreign affairs function of the United States, the proposed rulemaking procedures and the delay in effective date required under the Administrative Procedures Act are inapplicable.

2. This rule contains a collection of information requirement subject to the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 *et seq.* The collection of this information has been approved by the Office of Management and Budget (OMB control number 0625--0001).

3. This rule_ is not subject to the requirements of the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.* because a notice of proposed rulemaking is not required to be published. Accordingly, no initial or final Regulatory Flexibility Analysis has or will be prepared.

4. Since this rule pertains to a foreign affairs function, it is not a rule within the meaning of section 1(a) of Executive Order 12291 (46 FR 13193, February 19, 1981), "Federal Regulation."

Therefore, this regulation is issued in final form. Although there is no formal comment period, public comments on this regulation are welcome on a continuing basis.

List of Subjects in 15 CFR Part 377

Exports.

PART 377-SHORT SUPPLY CONTROLS AND MONITORING

1. The authority citation for Part 377 is revised to read as follows:

Authority: Secs. 203, 206, Pub. L. 95-223, as amended (50 U.S.C. 1702, 1704); E.O. 12470 of March 30, 1984 (49 FR 13099, April 3, 1984); Presidential Notice of March 28, 1985 (50 FR 12513, March 29, 1985); Sec. 103, Pub. L. 94-163, as amended, (42 U.S.C. 6212); Sec. 28, Pub. L .93-153, (30 U.S.C. 185); Sec. 28, Pub. L. 95-372, (43 U.S.C. 1354); E.O. 11912 of April 3, 1976 (41 FR 15825, as amended); and Presidential Findings (50 FR 25189, June 18, 1985)

2. Accordingly, the Export Administration Regulations (15 CFR Part 368-399) are amended by adding § 377.6(d)(1)(viii) as follows:

§ 377.6 Petroleum and petroleum products.

(d) * * *
(1) * * *
(viii) *Exports to Canada for consumption or use therein.* The Group A commodity was not produced from the Naval Petroleum Reserves and was not and will not be transported by pipeline over rights-of-way granted pursuant to Sec. 203 of the Trans-Alaska Pipeline Authorization Act and is being exported to Canada for consumption or use therein.

Issued: June 20, 1985.
William T. Archey,
Acting Assistant Secretary for Trade Administration.
[FR Doc. 85-15284 Filed 6-24-85; 8:45 am]
BILLING CODE 3510-25-M

SECURITIES AND EXCHANGE COMMISSION

17 CFR Parts 230, 239, 270, and 274

[Release Nos. 3H588; IC-14575; File No. 57-1007] .

Registration Forms for Insurance Company Separate Accounts That Offer Variable Annuity Contracts

AGENCY: Securities and Exchange Commission.

ACTION: Adoption of forms, rule amendments, and publication of guidelines.

SUMMARY: The Commission is adopting: (1) Form N-3, a new registration form for certain separate accounts registered under the Investment Company Act of 1940 as management investment companies, and certain other separate accounts; (2) Form N-4, a registration form for certain separate accounts registered under the Investment Company Act of 1940 as unit investment trusts, and certain other separate accounts; and (3) related rule amendments. The Commission is also publishing staff guidelines for the preparation of Forms N-3 and N-4. The Commission is adopting the foregoing to integrate and codify disclosure requirements for insurance company separate- accounts that offer variable annuity contracts and to shQrten and simplify the prospectus provided to investors, while making more extensive information available for those who request it. Separate accounts will be permitted to use existing registration forms during a transition period of approximately one year.

DATE: The amended rules will be effective July 25, 1985. The new forms and guidelines will be available for registration of separate accounts and for

APPENDIX B:

Letter to Secretary Pritzker on Mexico Oil Exports ilnittd taus matt

WASHINGTON, OC 20515 10

February 18, 2015

The Honorable Penny Pritzker
Secretary
U.S. Department of Commerce
1401 Constitution Ave., NW
Washington, D.C. 20230

Dear Secretary Pritzker:

We are writing to express our support for increasing our nation's energy ties with Mexico. As you know, energy resources often overlie international boundaries, as we have clearly seen in deepwater exploration in the Gulf of Mexico and the Eagle Ford shale along our southern border. Natural gas is traded between our two nations tlu·ough more than twenty existing pipelines, and many others are under consideration. Additionally, increasing commerciaJ activity in petroleum products, natural gas liquids, and other types of energy is further expanding the U.S.-Mexico energy relationship.

Recent news reports indicate that PEMEX has applied for a swap transaction that would involve imports of heavy Mexican oil in exchange for exports of light U.S. oil. We encourage the Department of Commerce to approve any such applications it has received or may receive from c1djacent foreign states, such as Mexico. The Energy Policy and Conservation Act and other relevant statutes clearly authorize swaps and exchanges and in our view, deserve bipartisan support. Presidents Gerald Ford, Jimmy Carter, and Ronald Reagan all supported such a program with Canada from 1976 to 1985, with the intention of relieving a supply and quality mismatch comparable to the present North American situation. These potential transactions are in the national interest and, if applied for, should be authorized without delay.

Jn fact, we believe it would be appropriate to further liberaJize energy trading with Mexico. President Reagan issued a national interest fincting in 1985 stating that oil exports to Canada (for consumption in that country) were in accord with existing statutes and would not threaten U.S. supply. This limited but clear authority to expand exports was given to the executive branch through Jaws (such as the Energy Policy and Conservation Act of 1975) passed by Congress and is particularly relevant as our nation's energy mix evolves with the rise of domestic production. As a result of the expressed interest from Mexico in obtaining U.S. crude oil, we encourage the current administration to follow President Reagan's example by issuing a similar finding that United States oil exports to Mexico, for consumption in Mexico, are in the national interest.

Sincerely,

Lisa Murkowski
United States Senator

United States Senator

John Cornyn
United States Senator

Lamar Alexander
United States Senator

James Inhofe
United States Senator

[redacted]
United States Senator

Jeff Flake
United States Senator

James Lankford
United States Senator

David Perdue
United States Senator

John Barrasso
United States Senator

Marco Rubio
United States Senator

Jo Hoeven
[redacted]
United States Senator

Ted Cruz
United States Senator

Tim Scott
U[redacted]

Tom Cotto
[redacted]
United States Senator

[redacted]
Cory Gardner
United States Senator

Dan Sullivan
United States Senator

[redacted]
United States Senator

[redacted]
United States Senator

Ron Senator
[redacted]

Mike Lee
United States Senator

APPENDIX C:
Letter to Secretary Kerry on Israel Oil Supply Agreement

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WASHINGTON, DC 20510

March 12, 2015

The Honorable John Kerry
Secretary of State
United States Department of State
220 I C Street, NW
Washington, DC 20520

Dear Secretary Keny:

The President's National Security Advisor recently said that our nation's relationship with Israel should be "unquestionably strong, immutable, regardless of political seasons in either country and regardless of which party is in control in either country." We could not agree more.

The United States has long worked with Israel on issues related to energy and the environment. The Energy Independence and Security Act of 2007, which provided for such cooperation, passed the Senate in an overwhelming bipartisan vote. An American company is helping explore and develop hydrocarbon resources in the Eastern Mediterranean. Most recently, the United States-Israel Strategic Partnership Act of 2014 passed both chambers of Congress unanimously and President Obama signed i1 into law last December.

We are writing to express our support for the renewal of a historic agreement that expired on November 25, 2014. Under its terms, our nation guarantees the delivery of oil to IsraeJ in the event that Israel ever loses access to global markets, as may occur during a crisis. The first iteration of this agreement was signed under President Ford in 1975. President Carter's Secretary of State formalized the agreement in 1979. It bas been renewed under Presidents Clinton in 1994 and Bush in 2004. Ithas never been invoked. We appreciate that your Department is working closely with the Government oflsrael to assure its energy security. We urge you to expedite the renewal of this important agreement as a meaningful gesture of suppo1t to our friend and ally at this challenging time.

Sincerely,

Lisa Murkowski
United States Senator

(Mv.1. K' 4)
Mark Warner
Uni ed States Senator

James Risch
United States Senator

Heidi Heitkamp
United States Senator

John Barrasso
United States Senator

Joe Manchin
United States Senator

The Economic Case for

Lifting the Crude Oil Exports Ban

JUNE 2015

Margo Thorning, Ph.D, *Senior Vice President and Chief Economist, American Council for Capital Formation*

William Shughart, Ph.D, *Research Director, Independent Institute and J. Fish Smith Professor in Public Choice, Huntsman School of Business, Utah State University, and Strata Fellow*

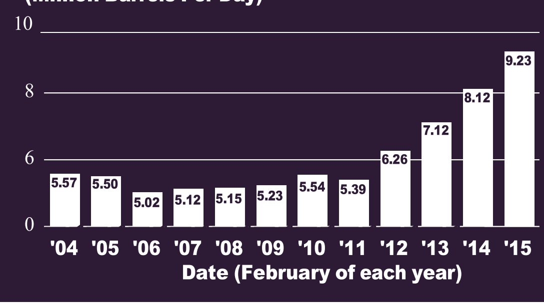
UNLOCK CRUDE EXPORTS

STRATA

INTRODUCTION

Oil and natural gas development in the United States is expanding at record levels. In the last week of February 2015, the U.S. produced more than 9.2 million barrels of oil per day (bpd), up 14% from a year ago *(Figure 1.)*.[1] U.S. natural gas production was almost 31.9 trillion cubic feet in 2014, an increase of 29% since 2007. Consider these facts and figures in the context of the events of the 1970s when the ban was established: today, the United States is an energy powerhouse poised to become a key influencer in global markets.

(*Figure 1)* U.S. Field Production of Crude Oil
(Million Barrels Per Day)



In Washington, a debate around our country's ban on crude oil exports – a policy dating back to the energy crises of 1973-1979 –has emerged around this new energy landscape. The Administration has recently taken steps to modify the ban by permitting energy companies to ship slightly refined crude oil condensate abroad. In December, the Commerce Department granted export licenses to a select few companies (easing the backlog of condensate export requests) and issued a document outlining what types of crude oil could be legally shipped abroad, clearing the way for the export of up to one million barrels per day of ultra-light U.S. crude.[3]

Political momentum to overturn the decades-long federal ban on crude oil exports has gained signifigant traction over the last year with numerous members calling for a clear change in policy. A chorus of voices including Senate Energy and Natural Resources Committee Chairman Lisa Murkowski and House Majority Whip Steve Scalise, have expressed firm support for removing the ban. Most recently, Colorado Gov. John Hickenlooper became the first Democratic governor to encourage the Commerce Department to eliminate the ban.

An examination of expert reports released over the last year illustrates the economic benefits inherent in eliminating the ban and exporting American crude overseas.

While many groups have opined, five macroeconomic studies explain how lifting the ban on U.S. crude oil exports will have multiple positive effects on our economy (See Appendix A).

Lifting The Ban On U.S. Crude Oil Exports Would:

- **Create Good Paying U.S. Jobs**
- **Boost U.S. Investment and GDP**
- **Put Downward Pressure on Fuel Prices**
- **Strengthen Geopolitical Ties**

In this report we examine studies by the Brookings Institution (Brookings), Resources for the Future (RFF), ICF International, The Aspen Institute, and IHS. We highlight the unanimous conclusion of these reports that lifting the crude oil exports ban will provide measurable economic advantages, namely;

- Job creation
- A boost in investment at home and increased Gross Domestic Product (GDP)
- The narrowing of our international trade deficit, and
- Downward pressure on fuel prices.

In addition, government reports by the U.S. Department of Energy's Energy Information Administration (EIA) and the General Accountability Office (GAO) conclude that allowing crude oil exports from the U.S. will tend to reduce domestic fuel prices.

Finally, along with the accompanying economic benefits discussed, lifting the crude oil exports will also strengthen ties with our trading partners and uphold the principles of free trade, the very foundation that is the basis of our country's economic philosophy.

INCREASING AMERICA'S GROSS DOMESTIC PRODUCT

GDP is the most commonly used indicator to assess America's economic health. The investment, ingenuity and output of the hard working Americans are what keep our economic engines running. It is therefore significant to note that each independent report predicts that unlocking crude oil exports will substantially increase GDP. Four of the expert reports quantify this positive impact. Brookings, The Aspen Institute, ICF International and IHS predict GDP increases ranging from:

- Brookings – the present discounted value of increases in GDP over the 2015–2039 period range from $550 billion to $1.8 trillion;[4]
- The Aspen Institute – annual increase in GDP of $105 billion in 2017 under the low export case to as much as $165 billion in 2021 under the high export case;[5]
- ICF International – the annual increase in GDP over the 2015 to 2035 period averages between $10.1 billion and $14.8 billion in the low differential scenario, and between $18.6 billion and $27.1 billion in the high differential scenario;[6]
- IHS – annual increase in GDP over the 2016 -2030 period averages $86 billion under the base case and $170 billion under the high production case.[7]

"Therefore, by removing this outdated policy we will incentivize production for years to come and ensure these economic predictions are fulfilled."

As Brookings notes, "there are very few actions that the U.S. government can take that as a long-term instrument of economic policy would make as measurable a difference in the economy."[8] Yet it is important to note that these numbers are a direct result of increased U.S. crude oil production and depend on our nation's energy renaissance to continue into the near future. Analysis by Columbia University shows that lifting current crude export restrictions could increase U.S. crude production by up to 1.2 million barrels per day between now and 2025.[9] Therefore, by removing this outdated policy we will incentivize production for years to come and ensure these economic predictions are fulfilled.

Some opposed to lifting the ban argue that we should keep U.S. crude for domestic processing into heating oil, gasoline and other energy products. Yet the analysis by academics, think tanks and economic modeling firms predict that exporting U.S. crude will provide substantial economic benefits to American consumers; the increases in consumer welfare will trump potential harm industry stakeholders may suffer in having to pay world oil prices rather than the current artificially low, trade-protected domestic prices. In fact, a recent study by Rice University highlights the stability that adding U.S. crude oil to the market will generate, stating, "The research shows that removing the [export] ban yields positive impacts by providing a more stable and secure source of oil to the world. That greater stability would lessen price volatility that U.S. consumers face and thus improve U.S. energy security."[10]

DRIVING JOB CREATION

Based on the consensus view in the series of studies released last year, lifting the crude oil export ban would promote job growth. The predicted employment gains occur in a variety of sectors, from the traditional jobs that are directly related to extraction, construction and manufacturing sectors to indirect gains in professional services and consumer-related industries.

Four of the reports examined forecast significant job growth if the crude oil export ban were lifted. Brookings, The Aspen Institute, ICF International, and IHS quantify their predictions for employment gains as follows:

- Brookings – unemployment will fall by an annual average of 200,000 - 400,000 jobs between 2015 and 2020;[11]
- Aspen Institute – between 495,000 and 630,000 more jobs in 2019 in the high exports scenario;[12]
- ICF – increase of as many as 300,000 new jobs in 2020;[13]
- IHS – create between 394,000 and 859,000 new jobs every year nationwide.[14]

Beyond the thousands of Americans directly employed by oil and natural gas companies, the energy boom has yielded job creation and stimulated the growth of businesses across the economy. The Aspen Institute, focused on the employment benefits in these non-traditional industries as a result of lifting the ban. Looking at various sectors and timeframes, the Aspen Institute forecasts that new construction will result in 216,000 new jobs by 2017; the manufacturing sector will gain an average of 37,000 jobs per year through 2025; and, finally professional services related to the oil and fuels sector will increase by an average of 148,000 jobs per year through 2025.[15]

Opponents argue that the "added value" of refining crude oil here at home will be transferred abroad if we allow companies to export crude oil. This notion fails to take into account that exporting crude oil will increase domestic production and in turn produce more jobs, adding significant value to the American economy. According to a study by the Small Business Entrepreneurship Council, the domestic oil and gas sector is overwhelmingly comprised of small and medium sized businesses – meaning that the benefits of new jobs and good wages resulting from smarter trade policy will extend well beyond the large companies typically associated with the industry.[16]

"Beyond the thousands of Americans directly employed by oil and natural gas companies, the energy boom has yielded job creation and stimulated the growth of businesses across the economy."

DOWNWARD PRESSURE ON FUEL PRICES

The price of fuel is a key factor in determining economic growth rates. Any policy effort that has the potential to reduce fuel prices are worthy of careful examination. Basic economic principles would dictate that if we diversify supply and increase the amount of crude oil flowing into global markets, assuming international demand remains constant given the integration of efficient technologies, the world price of crude would fall. When that price falls, U.S. gasoline prices are predicted to decline because U.S. gasoline prices are tied primarily to the global market for crude oil. While this is not a simple black and white scenario as a result of constantly changing demand forces, the principle used in the econometric models of these reports suggest allowing crude oil exports will benefit consumers at the pump.

The five reports we examined in this paper predict that removing the crude oil exports ban will reduce consumer fuel prices, including heating oil, gasoline and diesel. When looking at gasoline, the savings per gallon differ based on the conditions each expert group used to create their forecasting model. What remains constant is that all five reports reach the same conclusion of consumer benefits, lending credence to the argument that lifting the ban will lower prices under certain market conditions.

> **"Basic economic principles would dictate that if we diversify supply and increase the amount of crude oil flowing into global markets, assuming international demand remains constant given the integration of efficient technologies, the world price of crude would fall."**

Brookings, RFF, ICF International and IHS go so far as to quantify their conclusions, predicting that removing the crude oil exports ban will lower gasoline prices by the following amounts:

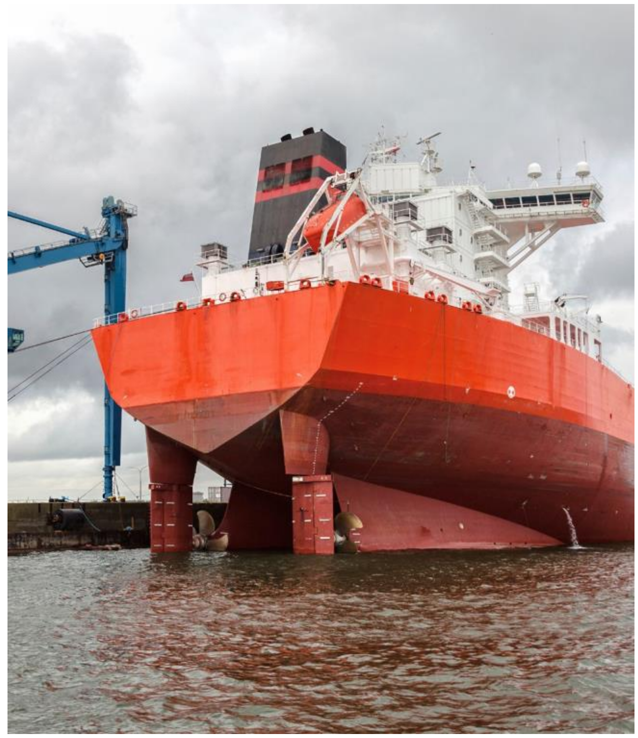
- Brookings – $0.09 to $0.12 per gallon by 2015;[17]
- RFF – $0.02 to $0.05 per gallon;[18]
- ICF International – $0.023 to $0.038 per gallon by 2017 (including heating oil and diesel);[19]
- IHS – average of $0.08 per gallon between 2016-2030.[20]

The primary factor driving this downward price trend, according to the studies' conclusions, is the result of gasoline prices being linked to the international market. Brookings asserts that gasoline prices "decline when the ban is lifted because they are set in the international market,"[21] a point that the GAO[22] and the Congressional Budget Office (CBO)[23] both confirmed in two separate reports last year. Similarly, the Aspen Institute says that because "petroleum products like gasoline are more closely linked to the world price of oil, the price of imported and domestically refined gasoline is expected to fall slightly" if export restrictions are relaxed or eliminated.

The IHS report notes that since "U.S. gasoline is priced off global gasoline prices, not domestic crude prices, the reduction will flow back into lower prices at the pump"[24] and predicts motorists will save "$265 billion over the 2016-2030 period" as a result of lifting the crude oil exports ban. *The Wall Street Journal* recently explained this point, saying "the oil market is global. What matters for prices are global supply and demand. To the extent more U.S. crude makes it to the global market, prices will be lower, other things being equal."[25] Finally, since all fuel pricing – not just gasoline – is determined on an international scale, the report by ICF predicts American consumers will save up to $5.8 billion per year, on average, from 2015 to 2035 as a result of lowered prices on all petroleum products, like heating oil.[26]

GEOPOLITICAL IMPACTS

Columbia University's analysis suggests that there could be significant political and diplomatic benefits for the United States if the ban on exports is lifted. The report notes that "[o]il importing countries, from the United States to Japan, have long attached special importance to their bilateral relationship with crude trading partners. The importing country is often seen as the subjugate in such relationships, though, ironically, Chinese oil imports are generally seen by the West as providing Beijing with geopolitical leverage. Yet like all freely entered commercial engagements, the benefits of trade are mutual. Beyond the direct economic gains, trade generally improves bilateral relations more broadly, opens new lines of communication and reduces the odds of conflict. Lifting crude export restrictions extends U.S. geopolitical influence by maintaining current trade relationships on the import side and generating new ones through exports."[27]



UPHOLDING U.S. PRINCIPLES OF FREE TRADE

One of the most well-established principles in the United States is our commitment to free trade. Therefore, in addition to the economic benefits and pricing implications that lifting the crude oil exports ban will have, exporting is mandated by our country's founding principles. The United States, traditionally seen as one of the foremost promoters of free trade, stands to violate its own policies and international trade regulations if it continues to restrict exports of crude oil. Crude oil should be treated no differently from the billions of dollars' worth of products Americans buy and sell every day through free and open exchanges in the global economy. It makes no more sense to restrict a product like crude oil than it does to forbid the export of wheat or automobiles for fear that their prices will rise. The United States must live up to its word and reputation as a champion of free trade by lifting the ban. To do otherwise would diminish American influence and credibility in key regions of the world and leave certain strategic allies exposed to market volatility.

"The United States, traditionally seen as one of the foremost promoters of free trade, stands to violate its own policies and international trade regulations if it continues to restrict exports of crude oil."

CONCLUSION

The outdated ban on crude oil exports fails to serve our national interest and only threatens to undercut economic gains dependent on efficient energy markets. Policies simply must be updated or changed to align with current events and advances in technology. American ingenuity has brought us the abundant resources of oil and gas that we have today – unthinkable in the 1970s, particularly when coupled with dire predictions of "peak oil." Technology constantly evolves, and production methods are becoming more efficient and economic over time; energy policy should evolve in tandem. While some slightly positive developments have materialized, experts predict that half-measures, such as allowing only condensate exports, will reduce the benefits for small businesses and American consumers by 60 percent versus completely lifting the ban on crude oil exports altogether.[28] The economic data presented by the reports we reviewed provides a compelling case for an evolution in policy which takes the present and future into account.

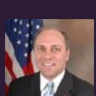
It is now well-established that lifting the crude oil export ban will grow our economy, provide jobs, enhance U.S. national security, and expand our influence in global energy markets. Economists and policymakers alike are calling for a policy change that embrace our new paradigm of energy abundance. (Figure 2.)

The President and members of Congress have an opportunity to respond to constituent interests and do what is right for the American people. The numbers don't lie. It is time the U.S. tells the world that we are ready to do business by repealing existing restrictions on crude oil exports altogether. ■

(Figure 2.) Bipartisan Voices Support Lifting the Ban on Crude Oil Exports

Senator Lisa Murkowski (R-AK): "America has entered an era of energy abundance… The United States has a general prohibition – a 'ban' – on exports of domestic crude oil. To me, this equates to a sanctions regime against ourselves. It hurts American producers, who have to sell oil at a significant discount to Brent, and it hurts American consumers, whose prices at the pump are higher than they would otherwise be." (***Senate ENR Press Release***, 4/04/15)

Governor John Hickenlooper (D-CO): "…We believe that continuing to build upon the [Bureau of Industry and Security] decision by ending the outdated and counterproductive ban on crude oil exports is the next logical step to ensuring that domestic producers continue to invest and the energy consumer benefit." (***Official Letter to Department of Commerce***, 4/30/15)



Representative Steve Scalise (R-LA): The crude oil export ban is "a relic of the 1970s whose time has come to pass." (***Dallas Morning News***, 4/30/15)

Senator Heidi Heitkamp (D-ND): "We now live in a global world and it's past time that we end an outdated policy from a bygone era by lifting the ban on exporting American crude oil… we need to be able to step up, compete on a level playing field, and get the best price on the world market… We have a real opportunity to make a needed change that supports our country, our economy, and our security." (***Official Press Release***, 4/1/15)

Representative Michael McCaul (R-TX): "Lifting the outdated ban on crude oil exports will result in more production, create new jobs at home and boost America's energy security while giving us a powerful new foreign policy tool. Ending self-imposed energy trade restrictions should be a top priority of the new Congress." (***Official Press Release***, 1/8/15)

Representative Henry Cuellar (D-TX): "It's time the crude oil ban is lifted, allowing the U.S. to compete in the global marketplace and reap the benefits of doing so, including hundreds of thousands of jobs—many of which right at home in Texas…Free trade and free markets are the goal--that is what is best for America and for Texas." (***Official Press Release***, 4/20/15)

APPENDIX: EXPERT STUDIES' SUMMARY

Below is a charted summary of the recurring themes discussed in the various crude oil export studies and the specific findings reached by each report:

Themes	Study	Analysis
Increase Oil Production	IHS	Production increase averages 1.2 million barrels per day in the base production case and 2.3 million barrels per day in the potential production case
	Brookings	By 1.1 million barrels per day; in a "high oil and gas resource case" by 1.5 million barrels per day
	ICF International	By 500,000 barrels per day by 2020
	GAO	By 8 million barrels per day in April 2014
Increase Investment	IHS	$750 billion
	ICF International	$15.2 – 70.2 billion in additional investment between 2015 and 2020
Increase Oil Exports	Brookings	In a "high oil and gas resource case" exports could increase as much as 2.5 mbd in 2015, rising to 5.2 mbd in 2035
Cut U.S. Import Bill	IHS	By an average of $67 billion/year, a 30% reduction from the 2013 level
Create Jobs in America	Brookings	200,000 on average from 2015-2020 and in the "high oil and gas resource case" by 400,000 on average between 2015-2020
	IHS	On average, creation of 394,000 jobs in the "base production case" and 859,000 jobs in the "potential production case" over the 2016-2030 period Add 964,000 jobs at peak production in 2018 in the "base production case" and 1.537 million jobs in 2018 in the "potential production case" An increase of almost 124,000 supply chain jobs, on average in the "base production case" and 240,000 jobs in the "potential production case" during 2016-2030
	ICF International	Up to 300,000 potential job gains in 2020
	Aspen Institute	630,000 jobs added at the peak in 2019, including: • Jobs in mining (including oil and gas) up by average 43,000 per year through 2025 • New construction jobs peak at 216,000 in 2017 • All manufacturing jobs see average gain of 37,000 per year through 2025 • Related professional services jobs increase by average 148,000 per year through 2025

Themes	Study	Analysis
Increase Incomes for Americans	IHS	Disposable income averages $238.00 per household in the "base production case" and $466.00 per household in the "potential production case" On a per household basis, the net benefit of a U.S. free trade policy for crude oil translates to an average gain of $158 in labor income per year in the Base Production Case and $285 in the Potential Production Case in 2016-2030
	Aspen Institute	$2,000 to $3,000 higher per household in 2025, an increase of 2.2%, and reaches a peak of 2.5% on a per household basis in 2019
Increase U.S. GDP	ICF International	$38.1 billion in 2020
	Aspen Institute	$165 billion in 2019-2021 or a increase of 0.93% and levels off at approximately 0.74% higher, or about $141 billion in 2025
	Brookings	$600 billion and in a "high oil and gas resource case" it could exceed $1.8 trillion through 2039
	IHS	GDP increases annually by an average $86 billion under the "base-production case" and $170 billion under the potential production case over the 2016–2030 period
Gains for U.S. Industrial Sector	Aspen Institute	Various industrial sectors will see gains from exports including: • Production of durable goods and materials gains 1.4 percent ($8 billion) by 2017 • Machinery production gains 3.3 percent ($12.4 billion) in 2017 • Agriculture, Mining, and Construction Equipment gains 6 percent ($6.1 billion) in 2017 • Capital Investment for Machinery—exploration and development—up by $7 billion in 2020 and for construction and mining machinery by $3.6 billion
Lower Gasoline Prices	IHS	Annual savings of 8 cents per gallon, saving motorists $265 billion from 2016-2030
	Brookings	Savings of 9 cents per gallon in 2015; in a "high oil and gas resource case" savings could reach 12 cents per gallon, sustained until 2035
	ICF International	Annual savings of 2.3 cents per gallon on petroleum products, including gasoline, heating oil, and diesel with the greatest potential annual decline is up to 3.8 cents per gallon in 2017
	RFF	Decrease by $0.02 to $0.05 per gallon depending on how quickly additional oil is produced in the U.S. and how quickly industry is able to shift its crude oil supplies between refineries

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MAY 2015

CRUDE OIL EXPORT & U.S. NATIONAL SECURITY

By Elizabeth Rosenberg, David Gordon,
and Ellie Maruyama

Center for a New American Security

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A dramatic increase in the production of domestic crude oil over the last several years is creating a new era of energy abundance in the United States.[1] In addition to a major economic boost, this provides the United States with important national security benefits. By making the global oil market more stable and better able to adjust to shocks, U.S. producers are reducing the ability of other countries to use energy supply or price decisions to coerce or harm the United States, our allies, and others. The energy boom also provides U.S. policymakers with the abil- ity to impose powerful energy sanctions and gain important leverage in trade negotiations.

Continuing to collect and expand the dividends of American energy resources for our economic strength and international security requires the United States to adapt its energy policy to new market conditions. Promoting the export of U.S. oil, which is currently under nearly complete prohibi- tion, would help to sustain the benefits of the U.S. oil boom.[2] Low oil prices are slowing energy invest- ments and the contribution of the energy boom to U.S. domestic economic growth is diminishing, but the logic of adopting new policies to promote oil export remains squarely within the national interest. Even if it does not lead to more oil production while prices are low, the market will inevitably rebound. Opening up the export market would help make U.S. energy producers more nimble and the economy more resilient, while at the same time strengthen- ing Washington's influence and leverage around the world.

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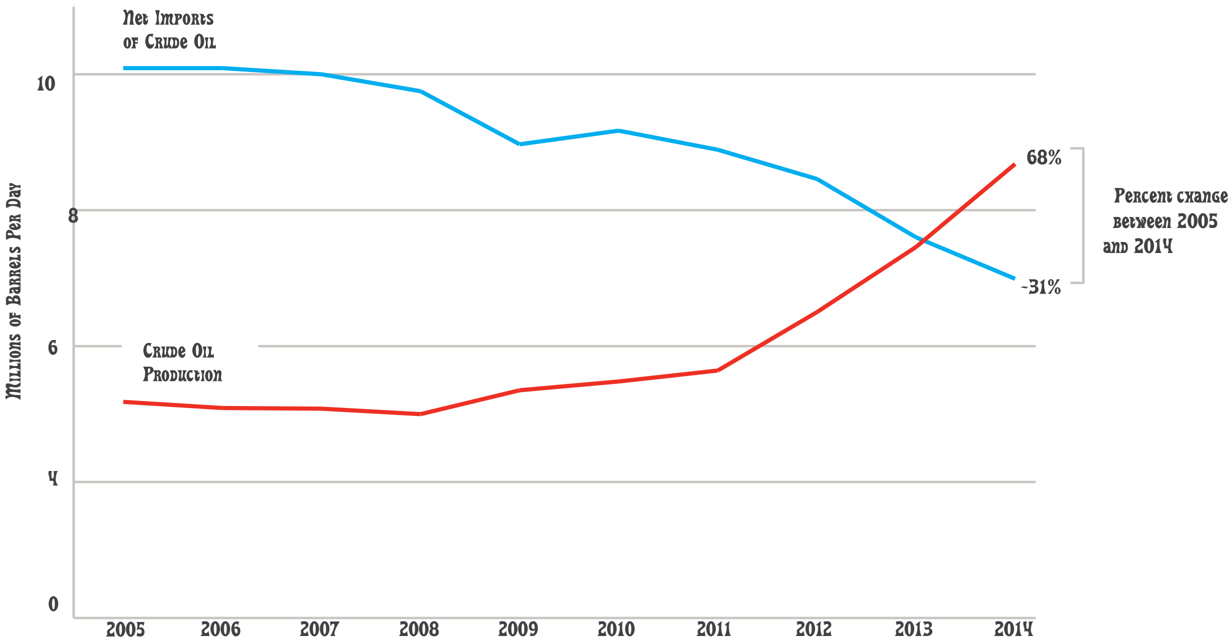
Lifting the oil ban requires policy innovation and a plan for managing the environmental impacts of producing more oil. It also requires a major effort to educate policymakers and the public about how such a policy change would benefit consumers by contrib- uting to lower gasoline prices. If policymakers fail to chart this course, they would undercut dynamic American potential and miss an important opportu- nity to contribute to U.S. prosperity and security.

The core argument for promoting more U.S. oil export is the economic stimulus and resilience it would provide to the United States and its allies. This economic benefit is also an important national security argument for greater oil export because of the fundamental importance of economic strength to national security. A strong and growing econ- omy supports job creation, investment capital for commercial growth, defense and social spending, and foreign aid, all of which elevate U.S. stature and the ability of U.S. policymakers and entrepre-neurs to lead on security and economic matters globally.

There are additional security benefits that have been largely overlooked in the public debate about U.S. oil export. Changing oil market circumstances and grave international security challenges create new opportunities for the United States to lever- age its abundant energy; these changes demand a sharper look at the national security arguments for greater energy export.

With a specific emphasis on national security implications, this policy brief describes the recent U.S. energy production expansion and the his- tory of crude export prohibitions. It also discusses the impact on U.S. economic and foreign policy interests of promoting oil export. Specifically, it explores the expanded international influence the United States could achieve in the areas of sanc- tions, security alliance politics, strategic trading and technology export, and promotion of energy security. Finally, the brief provides recommenda- tions for pragmatic policy to expand U.S. crude oil export to enhance American energy security and global leadership.

U.S. Oil Production Grows and Net Imports Decline



U.S. Rules for Oil Export Do Not Fit the Times

In today's conditions of abundant oil supply, shrinking U.S. oil demand and imports, and a large, global, and integrated oil market, current U.S. crude oil export rules undermine economic growth and security. Congress passed oil export restrictions in 1975 to prevent domestic produc- ers from circumventing the oil price controls and supply allocations that were designed to man- age the domestic oil market.[3] In the wake of the 1973 Organization of Arab Petroleum Exporting Countries (OAPEC) oil embargo, the export ban aimed to promote energy supply security by keep- ing oil at home. Price controls and limits on the export of refined petroleum products were unsuc- cessful in delivering oil price stability or balanced economic growth, and were removed in the early 1980s.[4] However, crude oil export restrictions remained, and were largely unnoticed given the rising trend in crude oil imports, until the present energy revolution.

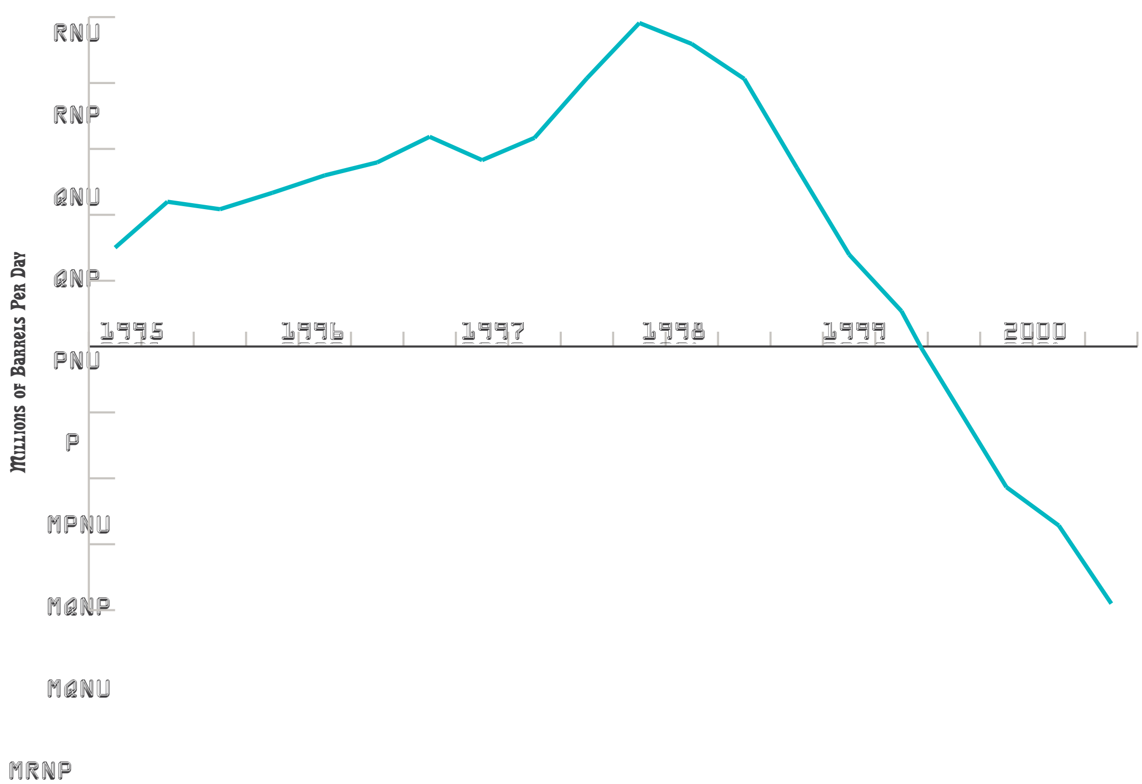
Promoting U.S. crude oil export today would encourage efficient and open markets, diver- sify the global oil supply pool, and contribute to domestic economic growth and the U.S. balance of trade.[5] It would ease the mis-match between the abundance of light quality domestic oil and of refineries oriented mainly to heavy oil by giving U.S. producers more access to markets abroad. Critically, this would stimulate domestic production growth when global prices are stronger than those in the domestic market and would offer a variety of strategic benefits.

There is logic to lifting the ban even though the magnitude of the economic and security benefits to be gained will vary with fluctuations in the oil price and be more limited in a low oil price cycle. This logic holds even if the dividends are not as great as those that the shale revolution has delivered to the United States over the last several years.

Supporters of maintaining crude oil export restric- tions include the subset of U.S. manufacturers who benefit from the market distortions, specifically the lower domestic prices of crude relative to interna- tional benchmark prices. Some domestic refineries would see shrinking margins and possibly even have to fold or significantly change their business model if the export ban were lifted, resulting in some domestic oil producers finding greater value in sending crude abroad rather than refining it domestically. However, there is no public policy justification for privileging

... there is no public policy justification for privileging a subset of U.S. refiners over the rest of the energy industry, including other refiners and oil drilling and producing companies, particularly given the broad market and security advantages of lifting the ban.

Net Imports of Refined Products



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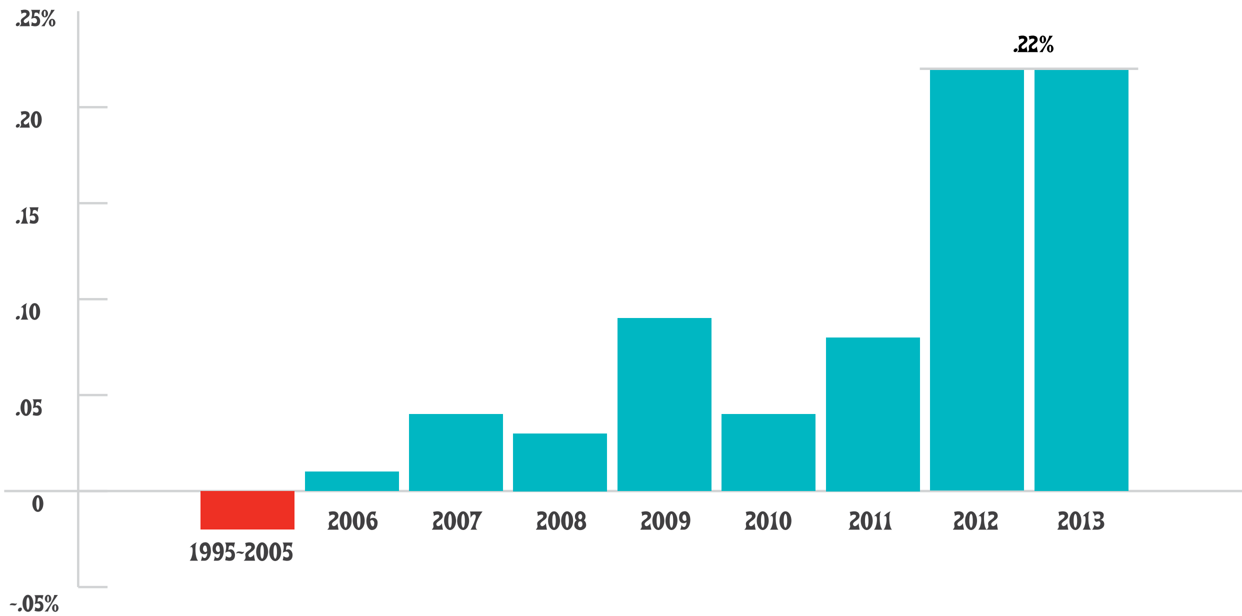
Contributions of Energy Production to U.S. GDP Growth



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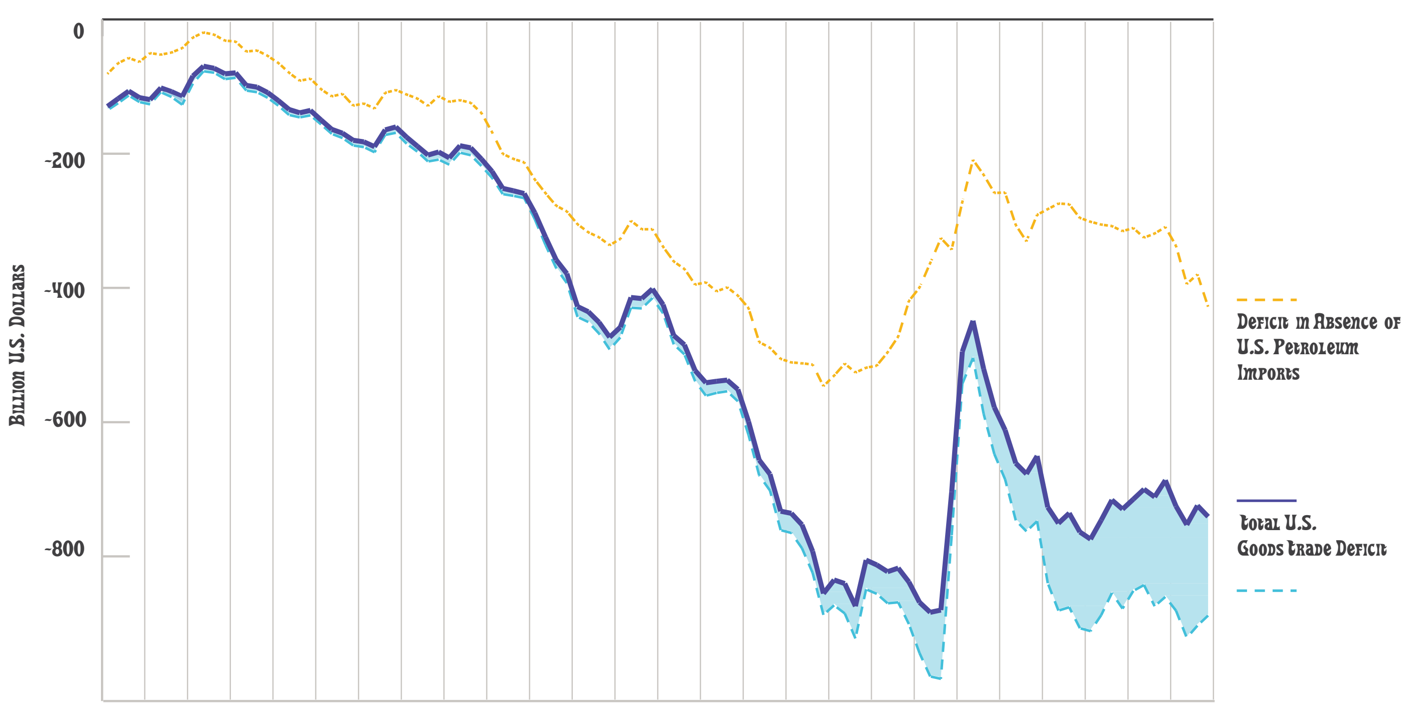
Improvements in Petroleum Trade Balance Reduce U.S. Trade Deficit



Deficit in Absence of U.S. Petroleum Export

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a subset of U.S. refiners over the rest of the energy industry, including other refiners and oil drilling and producing companies, particularly given the broad market and security advantages of lifting the ban.

Some policymakers support a status-quo protectionist oil trade policy, citing the risk that constituents might blame them if gasoline prices were to rise after a liberalization of export measures, even if a price increase were unrelated to the policy change. The damaging political consequences of being accused of causing an increase in gasoline price – which can be a major household expenditure for working Americans – leads politicians to shy away from any energy policy change. This is particularly true in an election year and is a significant reason that policymakers have shied away from major energy policy reform in recent years. However this concern demands public education and leadership, rather than tepid maintenance of the status quo.

An additional argument for the current policy is environmental. Supporters say that the increased oil production from lifting the ban would contribute to greater carbon emissions. While the consumption of non-renewable hydrocarbon energy and climate change are very serious issues worthy of urgent policy attention, the most effective strategies for promoting clean, renewable energy and limiting emissions are those that tackle these challenges head-on. Trying to limit emissions through oil export policy is indirect and inefficient.
U.S. leaders would be better able to model strong global leadership on climate change if they were to sustain and expand a direct policy focus on the most serious transport and power-sector emitters through direct policy initiatives, as the last several administrations have done.

National Security Implications of a New Oil Export Policy

To seize the opportunities presented by the current domestic oil boom, including greater market efficiency and increased trade and political leverage, policymakers should promote greater oil export.
Among a variety of national security benefits associated with lifting the U.S. crude oil export restrictions, the economic benefits may be most significant.

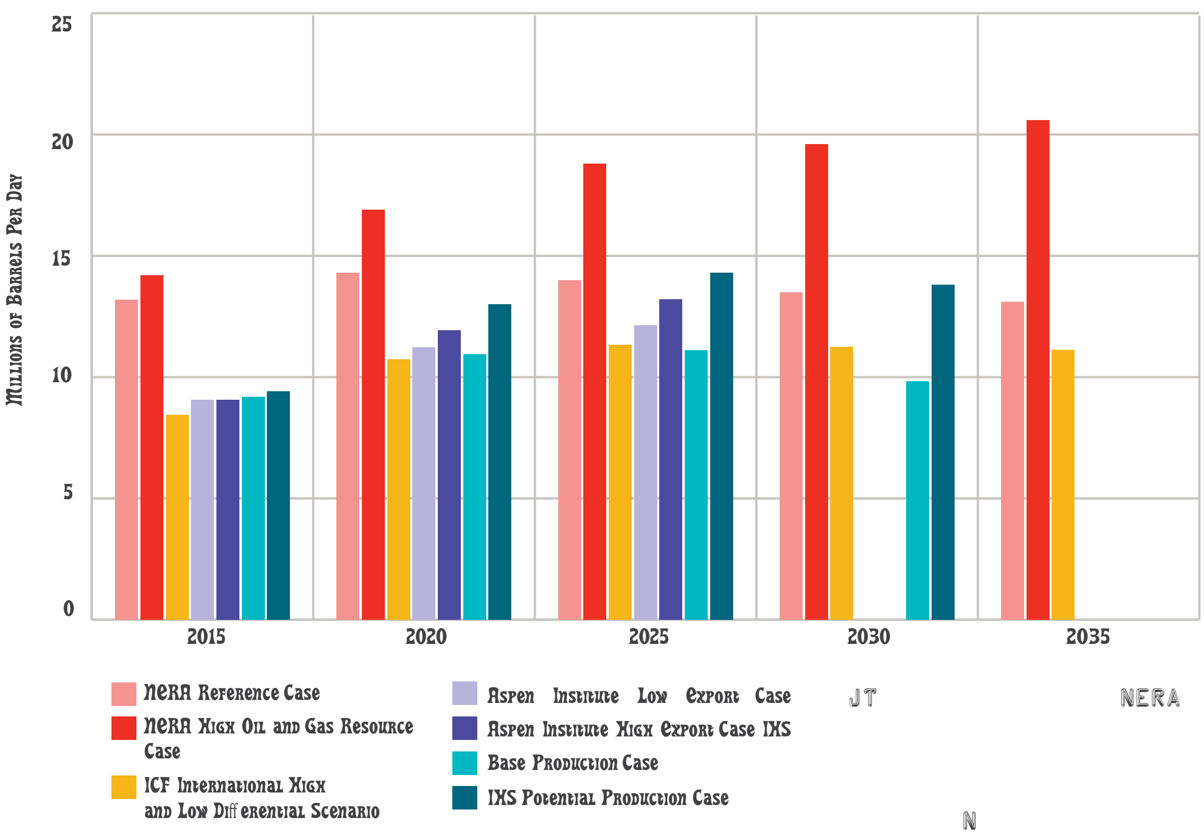
Strengthen the U.S. Economy

A fundamental underpinning of national security is a vibrant economy. Promoting more energy export by lifting the oil export ban would increase U.S.
oil production, decrease domestic refined product prices, and grow GDP.[6] Key to these effects is the signal to investors and producers that expanded U.S. oil output would be able to access global, not simply domestic, markets.

Expanding U.S. oil supply would contribute more oil to the global market, with estimates ranging from 110,000 to 2.8 million barrels per day by 2020 depending on various factors, including oil price.[7] In a more competitive supply environment, additional supplies would contribute to decreasing global benchmark oil prices.[8] This would reduce U.S. gasoline prices too, given the dependence of U.S. gasoline prices on global benchmark oil prices.[9] This effect is counterintuitive and surprising to those not closely following oil market movements, but nevertheless one on which analysts broadly agree. Recent studies estimate that lifting the export ban alone would reduce U.S. gasoline prices by 1.4–12 cents per gallon.[10] While the level of gasoline price decrease would be tempered in a low oil price environment, consumers would see relief at the pump if the United States were to embrace oil export.

Stimulating U.S. oil production through encouraging export would, broadly speaking, grow GDP because oil production harnesses an enormous amount of capital and labor,[11] thus keeping more oil rents, and taxes, at home. Consultancy IHS estimated in March

Lifting the Crude Export Ban Will Yield Greater Domestic Oil Production



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2015 that the U.S. energy revolution has contributed nearly 1 percent to GDP growth annually over the last six years and accounted for about 40 percent of overall GDP growth in that time.[12] According to the same study, lifting the ban on crude oil export would add $86 billion to $170 billion to U.S. GDP annually on average between 2016 and 2030.[13] A NERA study prepared for the Brookings Institution estimated GDP gains from lifting the ban to be $66–94.5 billion in 2015 and $39.2–82.5 billion in 2020.[14]

Growth in domestic oil production and export of refined products in the past few years has steadily improved the U.S. trade balance and provided support for the dollar as net oil imports declined sharply.[15] This reinforces the U.S. posi- tion as the world's financial center and safe haven, both of which contribute significantly to U.S. power abroad and national security at home. With more tax revenue available for defense and social spending and for foreign assistance, and with a country less indebted – and less beholden – in its foreign trading positions, the United States is able to exercise more influence among allies and against adversaries in multilateral security and economic commitments.

However, absent policy changes initiated through Congressional legislation or administrative rulemak- ing, executive order, or waiver, there is a risk that positive effects would diminish over the next few years, whereas promoting crude export would con- tribute to their persistence.

Promote Open Markets

Increasing oil export would make the United States a more important trading partner for more energy consumers abroad, which would expand its role and leverage in international strategic relationships. Additionally, this increase is in the interest of our foreign trade partners. A U.S. energy export policy that allowed the free flow of all energy commodities would expand the scope for the United States and its trade partners to optimize consumption of energy commodities, particularly in response to seasonal and regional demands. By deepening the diversity of energy commodity trading relationships, this would achieve greater market efficiencies, lower costs for consumers, and strengthen economic resil- iency in times of shock.

Exporting more U.S. oil would also support global supply security. When more of the sup- ply pool comes from producers, such as those in the United States, that do not suffer threats from political instability or imminent danger to critical energy infrastructure or supply lanes, the overall market is more stable. Additionally, U.S. crude shipped to consumers overseas can avoid maritime hot spots and choke points such as the Strait of Hormuz. Major consumers in East Asia, for example, are highly vulnerable to supply dis- ruptions from conflict in the Middle East, from where they import most of their oil. Roughly 83 percent of Japan's crude oil imports and 52 per- cent of China's crude oil imports in 2013 came from the Middle East.[16] U.S. crude may not be a direct substitute for the kinds of crude cut off from the global market by conflict or sanctions, including Libyan, Iranian, or Iraqi supplies. However, the capacity of sophisticated refineries or long-haul shippers to match available crude to consumer demand means that, broadly speaking, increased U.S. oil production and export would contribute to a more flexible market that could better adapt to supply disruptions.

Greater U.S. oil export would allow the United States to strengthen the credibility of an anti-protectionist trade policy, given that many U.S. trading partners have put liberalizing energy export at the top of their national security agendas with Washington. The American commitment to free trade has allowed it to pressure other countries to open their own markets to American goods and services. Making a clear commitment to free trade in energy now would afford Washington leverage on key commodity trade issues under negotiation with foreign partners. European negotiators in the Transatlantic Trade and Investment Partnership (TTIP) talks, for example, have called for an energy title in the agreement, and may be willing to make concessions to achieve this.[17]

Asian nations, including South Korea, Japan, and China, are also seeking more liberal U.S. energy trade terms.[18] They may similarly be willing to offer concessions that would assure greater market open- ness and a more level playing field for U.S. firms. At a dynamic moment in the evolution of Asia-Pacific economic and commercial relations, the United States has an opportunity to send a strong signal of continuing, indeed growing, relevance to Asia's economic future. This would provide some negoti- ating leverage and a powerful signal of continuing U.S. engagement in the region. Furthermore, open energy trade would be indispensable for winning potential disputes over natural resource trading that may arise with other countries, like the trade dispute with China brought to the World Trade Organization in 2012 after China cut its quota of export of rare earth minerals to international markets.[19] More open global energy trade would also position developing energy consumers, such as China and India, to join the economies of the Organisation for Economic Co-operation and Development as responsible stakeholders in collec- tive energy crisis management.

Cultivate Sanctions Leverage

One of the most important security benefits of lifting the crude export ban is the additional flex- ibility and leverage it would give to the United States to sustain and expand energy sanctions.

Diplomatic experience from the Iran sanctions case indicates that the effectiveness of powerful energy sanctions is underpinned by the ability of the United States to facilitate oil production growth.[20] As U.S. producers added more oil to the global marketplace, they effectively created alter- natives for buyers who pulled back from Iranian supplies due to sanctions. The United States will be in a stronger position to impose future energy sanctions, if necessary, if it promotes free trade in energy. In so doing, policymakers would make it possible for U.S. producers to expand produc- tion more easily to substitute for global supplies unavailable due to sanctions.

The United States has increasingly used energy sanctions over the last several years as a policy instrument to isolate and coerce adversaries. Economic sanctions have removed roughly 1.4 million barrels per day of Iranian oil from the market since 2012, [21] which played an impor- tant part in bringing Iran to the negotiating table regarding its nuclear enrichment program. Without substantial increases in alternative oil supplies, the international community would not have been willing to sustain these sanctions, nor to cope with the oil price increases they would have caused, particularly in light of historically high oil supply disruptions of 2–3 million barrels per day globally during this time.[22] The United States has added about 1 million barrels per day annually over the last several years, and Saudi Arabia also turned up its production to bal- ance the market.[23] In addition to targeting Iran's energy sector, the United States and the European Union have also imposed sanctions on Russia to handicap its energy sector as part of the broader Ukraine policy strategy.

The achievement of a framework for a nuclear deal with Iran in April 2015 offers reason for optimism that the parties will reach a final deal by their deadline in June and begin a process of removing sanctions. Nevertheless, if only as a contingency, policymakers in Washington need to retain their ability to impose tough additional energy sanctions on Iran. A grim outlook for relations with Russia, and the attractiveness of energy sanctions as a tool to address other potential security problems, means that policymakers have a stake in cultivat- ing the U.S. ability to deploy this tool in the future without causing spikes in oil prices.

The United States will be in a stronger position to impose future energy sanctions, if necessary, if it promotes free trade in energy. In so doing, policymakers would make it possible for U.S. producers to expand production more easily to substitute for global supplies unavailable due to sanctions.

Promoting U.S. oil export would give Washington more flexibility to impose new oil sanctions, whether an agreement with Iran on the nuclear question is achieved or not. It would also make the United States a more formidable market competitor which, in the case of Iran, would mean a limiting effect on Tehran's market power and attempts to influence market balances. The United States and

Iran are two major producers of condensate;[24] their competition can be exploited to the benefit of the United States if the United States promotes more export, thereby competing more aggressively with Iran in this niche market.

Lifting the ban and actively promoting alterna- tive oil supply would also bolster the ability of U.S. policymakers to convince international allies to support further energy sanctions. Putting more U.S. oil on the market would increase the leverage of the United States as it seeks to build the multilateral coalitions that are necessary for effective energy sanctions. Most of the closest security partners of the United States, like those in Europe and Northeast Asia, are net-consuming, importing nations who are highly sensitive to the negative economic effects of energy supply disrup- tions. Their collaboration with the United States on energy sanctions would be more forthcoming if alternative energy supplies were available and if the United States, as the leader on sanctions, were actively promoting this objective.

Support Allies

Greater U.S. oil export would be strategically significant for our allies, offering price and market access and stability benefits, and representing an important show of support. This would be true for Canada and Mexico, which are among the most significant U.S. trading partners, as well as allies overseas. For our European allies, the presence of more U.S. oil in the market could, over time, help reduce their reliance on Russian oil. Accessing more U.S. oil means European consumers would have more supply options and could therefore shrink their roughly 30 percent oil dependency on Russia,[25] which has recently stepped up its use of energy leverage as a coercive foreign policy tool.

While Europe's energy vulnerability to Russia is more of a concern when it comes to natural gas than oil, due to the greater difficulty in access- ing alternative supplies in the natural gas market, Europeans are eager to distance themselves from Russia as an energy supply source wherever feasible. Europe's ability to look elsewhere for oil supplies would make Russia compete harder, diminishing its oil revenue from sales to Europe.

A fundamental pillar in the current U.S. response to Russia's destabilizing role in Ukraine involves transatlantic collaboration to degrade Moscow's ability to compete in global energy markets. However, there is an asymmetry involved, given that Europe pays a much more substantial eco- nomic cost than the United States for this effort at economic coercion. Liberalizing U.S. oil export policy would, over time, reinforce the pressure on Russia's energy sector and would be seen as impor- tant strategic support for allies in Europe. When our closest allies are stronger, the United States is more secure and better able to bolster and lead multilateral security initiatives to counter Russian behavior.

For East Asian allies, more U.S. oil supply in the market would be a strong signal of U.S. economic engagement with the region. It would also present them with an opportunity to diversify away from Gulf and Russian oil, and would support lower prices. This market stabilization would benefit all East Asian nations, including our treaty allies Japan and Korea, as well as China. Policies that confer mutual benefit on the United States and East Asian nations, particularly in an area of significant trade, enhance regional security and should be pri- orities for the United States. Over the longer term, they might also help to weaken strategic regional competition by increasing the shared incentives for stable, efficient market activity. An active U.S. role in using energy to enhance stability in this neigh- borhood reinforces the credibility of our policy of rebalance to Asia. It would benefit our country and all others that see their own future tied to stability in this burgeoning region.

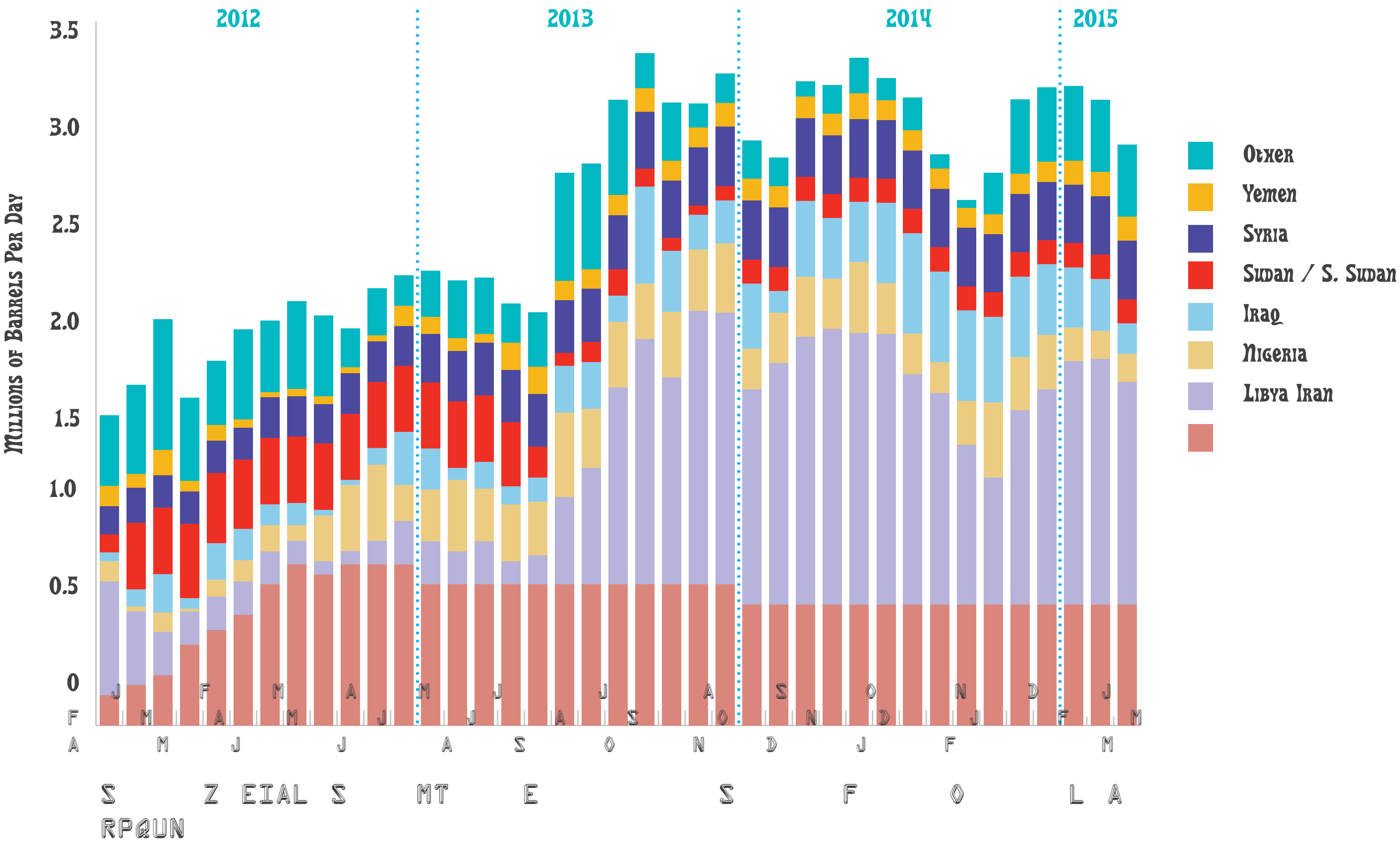
Oil Will Flow to More Key U.S. Allies if the Export Ban is Lifted

Weaken OPEC's Leverage

Expanding oil export would contribute to mak- ing the United States and its allies less vulnerable to market supply or price spikes. This is due to its contribution to reducing Saudi Arabia's role as the sole significant market balancer. After adding roughly 4 million barrels per day of production over the last several years, U.S. producers have become a leading oil market supply constitu- ency. Promoting U.S. oil export would support the growth of U.S. oil supply and would therefore contribute to diversity and flexibility in the global oil market system. As a result, U.S. producers
would be even more important to global oil market stability and more able to play a role in balancing a volatile market. While U.S. oil companies cannot make supply changes instantaneously – only Saudi Arabia, with the vast majority of global spare sup- ply capacity, is able to move the market substantially within days or weeks[26] – they are relatively agile and resilient. Some North American oil companies can bring on new production, from investment to com- mercial production, in a period of just months; many conventional oil producers elsewhere, in places such as Brazil, West Africa, Canada, the Gulf of Mexico, and the Arctic, require years to do so.[27]

Having two major supplier nations capable of signifi- cantly influencing marginal production, even if they move at different paces and have different amounts of clout, is better for global oil market stability and economic growth. In a large, widely traded, and interconnected global oil market, the ability to make relatively quick moves on the supply side in response to prices represents an important ability to influence markets. This means that U.S. producers, in addition

Unplanned Supply Outages



to OPEC's leader Saudi Arabia, would share greater responsibility for keeping prices stable, a heavy but important burden in low-price periods when producers are forced to cut back production.

Over time, U.S. relations with Saudi Arabia could become more balanced by the elevated role for U.S. producers in shaping the market. Additionally, the ability of U.S. producers to raise output quickly and flexibly may eventually also influence the decision-making of other producers, such as Russia, if it attempts to use oil as a strategic weapon. Coupled with the leverage of the potential release of Strategic Petroleum Reserve stocks, this U.S. ability to move nimbly to raise output might even deter Russia from attempting energy coercion in the first place.

Expanding oil export would contribute to making the United States and its allies less vulnerable to market supply or price spikes.

Expand America's High-tech Advantage

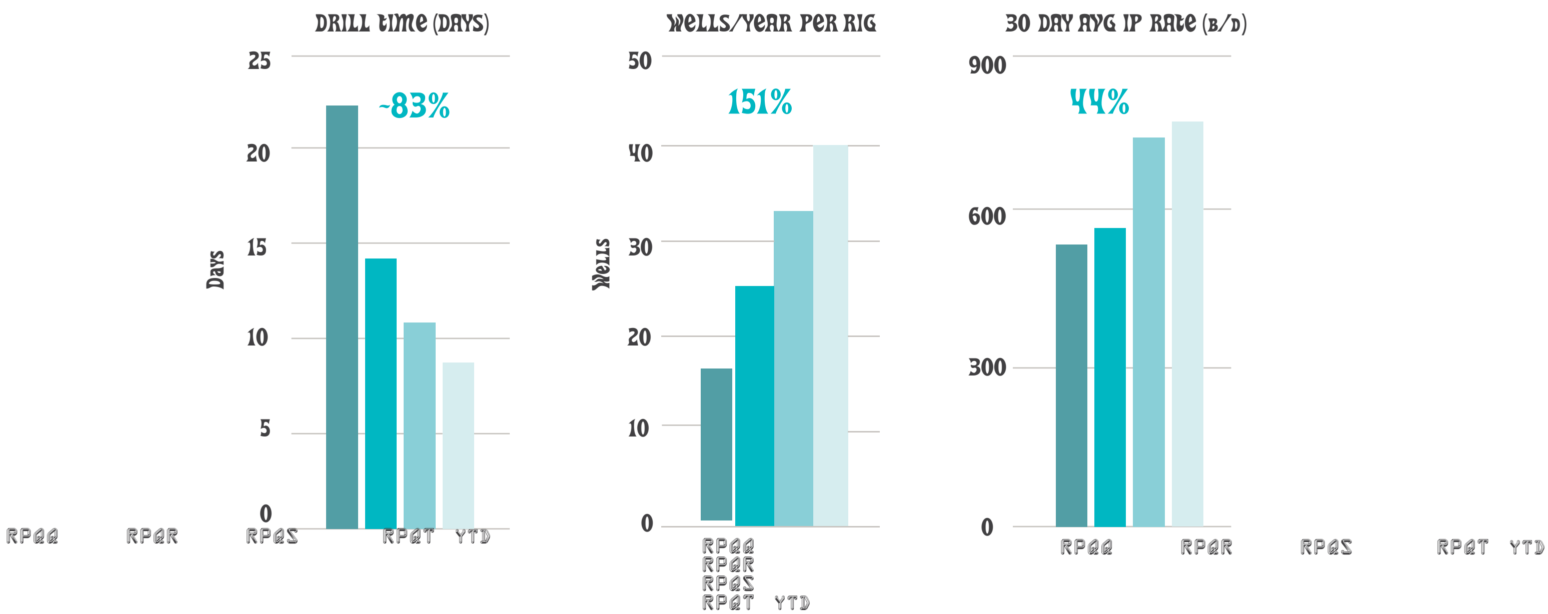
Increased U.S. oil export would also ensure that U.S. producers continue their aggressive approach to technological development and to maintaining superiority wherever leading energy technology is deployed globally. The sophisticated unconventional technology that brought about the energy revolution is a significant American asset. Over the last decade, the U.S. oil patch has been the most productive laboratory for the development of unconventional energy production technology. This innovation is the envy of competing producers, particularly in China, where growing energy import dependence and difficulties in unlocking domestic uncon-ventional energy resources foster a keen sense of vulnerability.[28]

Official estimates from the U.S. Energy Information Administration (EIA) suggest that the shale and tight rock formations feeding the current U.S. oil bonanza will see peak production in the early 2020s.[29] Historical experience suggests that this may be a modest estimate. Whenever this production begins to plateau and decline – whether due to geol- ogy, price, or public sentiment – the U.S. technology know-how that pioneered this energy revolution will continue to represent an important strategic and economic asset.

Removing U.S. oil export restrictions is an invest- ment in the "laboratory" that the U.S. oil patch provides for energy technology development. It would stimulate capital expenditures and research and development to improve well productivity and oil recoverability. Actively positioning U.S. technology firms as the developers and drivers of unconventional energy development, wherever it occurs in the world, would bring numerous strategic and economic benefits. Licensing or selling highly sought-after technology for a critical economic sector is lucrative, and can link the most important energy producers of tomorrow to U.S. firms for energy and economic success. It would also establish a firm precedent on protection of intellectual property and a commitment to free trade terms and environmentally responsible energy extraction practices as high-tech energy development spreads globally.

U.S. Oil Producers Increase Productivity

Data from EOG Resources production in the Eagle Ford Shale



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Policy Recommendations

Facilitating new opportunities for U.S. oil export would not be a panacea for sustaining the U.S. energy revolution, nor would it, by itself, assure U.S. energy or economic security. However, it would make important practical contributions to these ends. Additionally, it would send a powerful signal to partners abroad that the United States is commit- ted to open markets and to its investment in its own energy market power. Lifting export restrictions would establish law, practice, and expectations that make sense for present market conditions, and that support the U.S. goal of expanding its economic vitality and national security.

What is the best way to begin a phased, incremen- tal lifting of U.S. crude oil export restrictions to support more efficient markets and greater energy security? Both the administration and Congress are able to modify existing law to promote more crude export; although the administration can do this more easily, Congress must act to make permanent change. Policy change requires, first and foremost, broad education for stakeholders, policymak-
ers, and the public on the role – and the strategic advantages – of the United States as a major energy player. It must also feature a bipartisan process to lift export rules in order to facilitate credible, stable, and lasting policy change. While it should begin with administration signaling and policy leader- ship, it must feature coordination between the administration and Congress, and action by both to affirm and enact legal change that permits the lift- ing of crude export restrictions.

A first step is the adoption of a policy framework reflecting high-level support for lifting crude oil export restrictions. Next is the implementation of new export rules that allow condensate to be freely exported from the United States and that allow more crude oil export in the near term via presi- dential authority. Oil export policy reform should become a priority for the National Security Council directorate responsible for macroeconomic affairs. U.S. olicy must acknowledge and address public concerns regarding perceived negative effects on gasoline prices of exporting oil. Advanced U.S. technology, specifically unconventional drilling technology and expertise, should be promoted and exported. International energy coordination must be enhanced, particularly North American energy cooperation on crude oil trade and the transatlan- tic dialogue on energy.

ADOPT A POLICY FRAMEWORK

Establish high-level policy support for lifting crude oil export restrictions. Senior officials at the White House, the National Security Council, and the Department of Commerce – the agency responsible for directly administering the restric- tions – should clearly and publicly articulate support for greater export of domestically pro- duced crude oil. This would signal to market participants and international partners that the administration embraces a more open energy trade policy and will work toward formal rules to imple- ment this policy.

DEVELOP AND IMPLEMENT NEW EXPORT RULES

Allow condensate to be freely exported from the United States. It is already permissible to export "stabilized" condensate; White House and Commerce Department officials should build upon this to develop a mechanism – whether by license, regulatory guidance, or executive determination – to allow all U.S. condensate to be freely exported from the United States. They should embrace a clear definition of condensate (such as 50 degrees API – measured at the terminal or at the port),[30] and offer formal written guidance to clarify the new regulatory framework for market partici- pants, forecasters, and economic planners. Such a measure would expand and standardize export opportunities for all U.S. condensate.

Allow more crude oil export via presidential determination in the near term. The White House should initiate a policy process for allowing the export of additional increments of crude oil from the United States in the near term. Building on the limited exceptions already in U.S. law that allow for some export of crude, this process should lay out additional limited classes of crude oil export (such as light-quality crude oil, or crude oil sold to free-trade or Caribbean partners) that can be exported in the near term, in line with the areas of greatest benefit to the national interest.

Prioritize oil export policy reform in the portfo- lio of the National Security Council directorate responsible for macroeconomic affairs. NSC officials responsible for macroeconomic affairs should lead an interagency process that brings together representatives from relevant agencies of the executive branch to craft and coordinate a multi-step process to culminate in a full lift- ing of oil export prohibitions. This effort should include close coordination and consultation with members of Congress and independent non-gov- ernmental experts. It should include the drafting of recommendations that could aid lawmakers in formulating legislation to update the Energy Policy and Conservation Act. In turn, Congress should continue its legislative efforts on this topic, with the goal of passing new legislation to roll back oil export prohibitions. NSC economic officials should also lead a process to draft principles for new administration policy to lift the export ban, which could, similarly, form the basis of an execu- tive order to complement statutory action and accomplish this goal. In setting a new oil export policy, limited prohibitions on export should be the exception, reserved only for extraordinary circumstances.

ADDRESS PUBLIC CONCERNS

Acknowledge and address public concerns regarding perceived negative effects on gasoline prices of exporting oil. Beyond the reports and statements released by the EIA on how gasoline prices are formed and how exporting oil would affect the formation of gasoline prices, the EIA should report to Congress regularly and publicly on the effects of crude export policy reform on retail gasoline prices.

PROMOTE ADVANCED U.S. TECHNOLOGY

Advance the export of unconventional drilling technology and expertise. As part of a broader set of efforts to stimulate responsible U.S. oil production and the unencumbered export of this commodity, the Departments of Energy and Commerce and the U.S. Trade Representative should promote the export of unconventional drilling technology through foreign techni- cal assistance programs and export promotion platforms. These officials should underscore the imperative that unconventional drilling activity must occur in an environmentally sound manner to put the development of this resource on a stable and responsible footing.

ENHANCE INTERNATIONAL ENERGY COORDINATION

Strengthen North American energy cooperation on crude oil trade. The administration should take steps to expand official communication and cooperation among Canada, the United States, and Mexico on regional oil production, transport, and trade, with the goal of enhancing the ease of oil trade between Mexico and the rest of North America. While there is already a free flow of energy between Canada and the United States, and from Mexico to the United States, this coopera- tion should aim to ease the flow of oil from the United States to Mexico and should develop shared principles on the regional trade of oil and the deployment of unconventional drilling technology. Additionally, administration policymakers should aim to revise regulations in these arenas. This must proceed in step with broader U.S. executive-branch activities to liberalize the export of crude oil.

Elevate the transatlantic dialogue on energy. The United States must enhance diplomatic, security, and trade discussions on the role of energy in transatlantic relations; specifically, it should pro- pose the inclusion of an energy title that deals with transatlantic oil trade in the Transatlantic Trade and Investment Partnership talks. This would more broadly support a coherent and integrated treatment of trade in the negotiations, especially important for this key commodity, and would give the United States valuable negotiating leverage with counterparts. Additionally, such a dialogue would help U.S. national security policymakers better appreciate the energy and economic vul- nerabilities that European allies face, and how transatlantic partners can best collaborate to mitigate them.

Conclusion

Promoting the export of crude oil from the United States is an important step toward sustaining and expanding the benefits of U.S. energy abundance. It would also send a powerful strategic signal, indi- cating to international counterparts and economic planners that the United States plans to lead in the energy arena in the years to come. As proliferat- ing global security challenges make oil market volatility more and more likely, and as many world economies struggle with tepid growth, adopting pragmatic polices, such as the promotion of U.S. crude oil export, is an important investment in the strength and resiliency of the U.S. economy and the U.S. ability to lead internationally.

The focus on responsible natural resource steward- ship will only grow in the years ahead, a reality that makes conservation, efficiency, and climate change mitigation necessary complements to any conventional energy policy. Conventional energy policy is central, nevertheless, to economic and security strategy. Achieving the strongest position for the United States on these fronts in the years ahead demands smart energy policy, including

the prioritization of free trade in energy, critically including unencumbered export of U.S. crude. This will offer benefits in the future as the United States maintains a powerful role in this strategic and important energy commodity market.

endnotes

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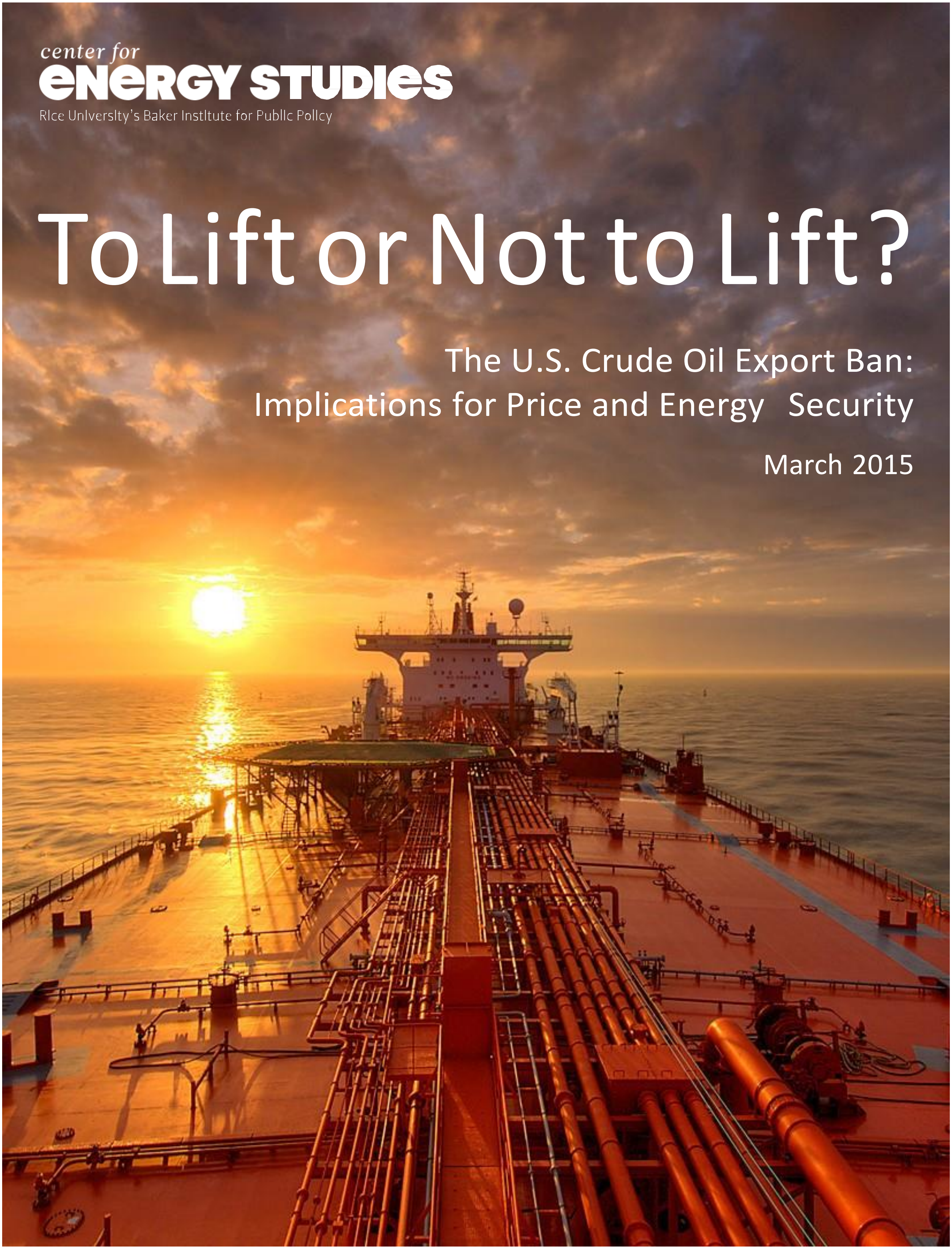

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To Lift or Not to Lift?

The U.S. Crude Oil Export Ban: Implications for Price and Energy Security

March 2015

James A. Baker III Institute for Public Policy
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To Lift or Not to Lift?
The U.S. Crude Oil Export Ban: Implications for Price and Energy Security

by

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March 2015

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Medlock is currently the vice president for conferences for the United States Association for Energy Economics (USAEE), and previously served as vice president for academic affairs. In 2001, he won (joint with Ron Soligo) the International Association for Energy Economics Award for Best Paper of the Year in the *Energy Journal*. In 2011, he was given the USAEE's Senior Fellow Award, and in 2013 he accepted on behalf of the Center for Energy Studies the USAEE's Adelman-Frankel Award. In 2012, Medlock received the prestigious Haydn Williams Fellowship at Curtin University in Perth, Australia. He is also an active member of the American Economic Association, and is an academic member of the National Petroleum Council (NPC). Medlock has served as an advisor to the US Department of Energy and the California Energy Commission in their respective energy modeling efforts. He was the lead modeler of the Modeling Subgroup of the 2003 NPC study of long-term natural gas markets in North America, and was a contributing author to the recent NPC study "North American Resource Development."

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Extended Abstract

In the past few years, innovative techniques involving the use of horizontal drilling and hydraulic fracturing have triggered unprecedented increases in production of crude oil from shale in the United States. This domestic production surge has reduced US crude oil imports and led some to call for an end to the 40-year-old ban on crude oil exports. In this paper, we lay out a framework for discussing the issues germane to this debate and apply empirical tools to evaluate these matters.

We find evidence that the export ban already presents a binding constraint on the domestic market. We develop an approach based on a hedonic pricing method to evaluate the discounts being realized on West Texas Intermediate (WTI) and other domestic crude oil prices over a wide range of global crude oil price environments, ranging from $30 to $150 per barrel. The results indicate that even in a low international crude oil price environment, the importance of addressing the export ban is very high, with discounts attributable to the trade barrier erected by current policy reaching as high as $8 per barrel in a $50 world, depending on the quality of the crude oil that is being produced and marketed.

The US refining sector has already backed out imports of light crude oil and is now backing out imported crude oils that are heavier than WTI and light oils from shale. This is where the discount arises – the domestic crudes, regardless of quality, must compete with lower quality crude oils, as the only market outlet for domestic crude oil is domestic refiners, regardless of quality. As more imported oil is displaced, the competitive margin for domestic production will increasingly be established by a heavier crude oil, which will drive steeper discounts until a new arbitrage mechanism is introduced, through either new refinery capacity or a lift of the export ban. We find that lifting the ban on exports could benefit upstream producers as well as attract capital investment into midstream infrastructure development.

We also find support for the conjecture that lifting the ban on crude oil exports would not raise gasoline prices in the US. Since refined products, such as gasoline, can be freely traded in the international market, the prices of refined products sold in the US are at parity with *international* prices for refined products. Thus, the discounted prices of oil produced in the US are not

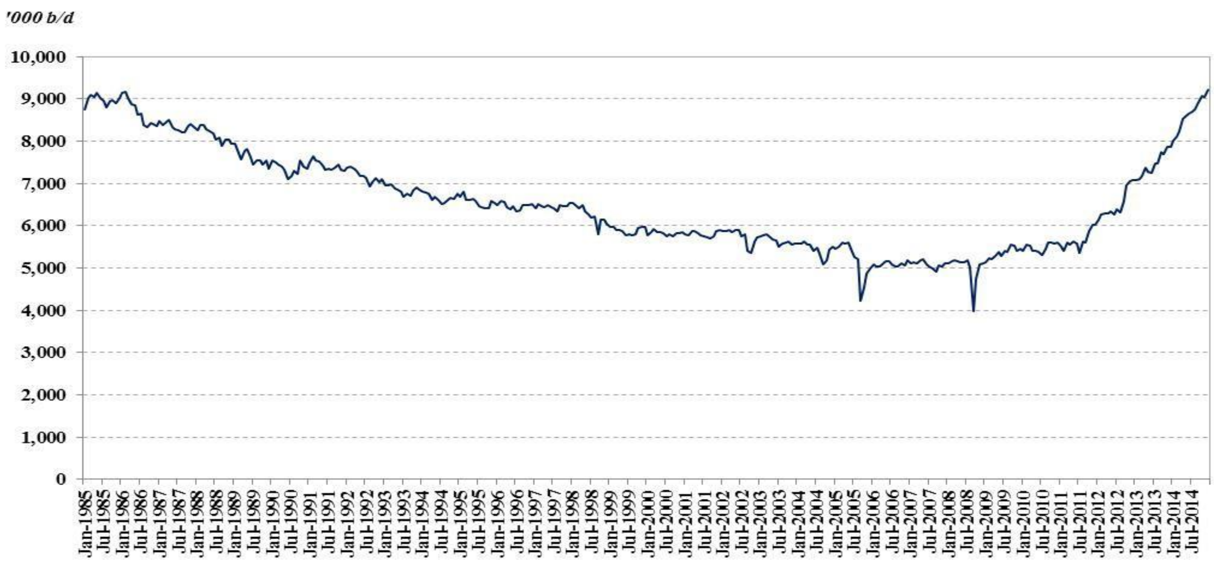
reflected in US gasoline and refined product prices. This is an important point when considering the implications of lifting the export ban for US consumers, and more generally, energy security.

Finally, we provide an in-depth analysis of the implications of lifting the crude oil export ban for US energy security. It is well-documented that heightened oil price volatility is associated with macroeconomic malaise, and the drivers of oil price volatility are *unexpected* shocks to *global* demand and/or supply. Removing the export ban generates distinct energy security benefits by providing a more stable and secure source of crude oil to a growing global market. Therefore, to the extent that US crude oil exports increase fungibility and dampen global oil price volatility, it will transmit an energy security benefit to US consumers. Indeed, we argue that in the longer term, the US can lead a transformation of the global oil market that could see North American and Western Hemisphere production capture a larger portion of the growing international market. This would carry tremendous benefits for US foreign policy endeavors in dealing with hostile oil-producing nations. It would also provide stability to the global oil market and convey benefits more broadly to the US and its allies.

I. Introduction

During the past decade in the United States, innovative techniques involving the use of horizontal drilling and hydraulic fracturing have triggered unprecedented increases in production of natural gas, crude oil, and natural gas liquids from shale. This development, the so-called "shale revolution," has already transformed the North American gas market and, perhaps of greater significance, set the stage for a paradigm shift in the *global* gas market.

Figure 1 – US Crude Oil Production (Jan 1985-Dec 2014)



Source: US Energy Information Administration

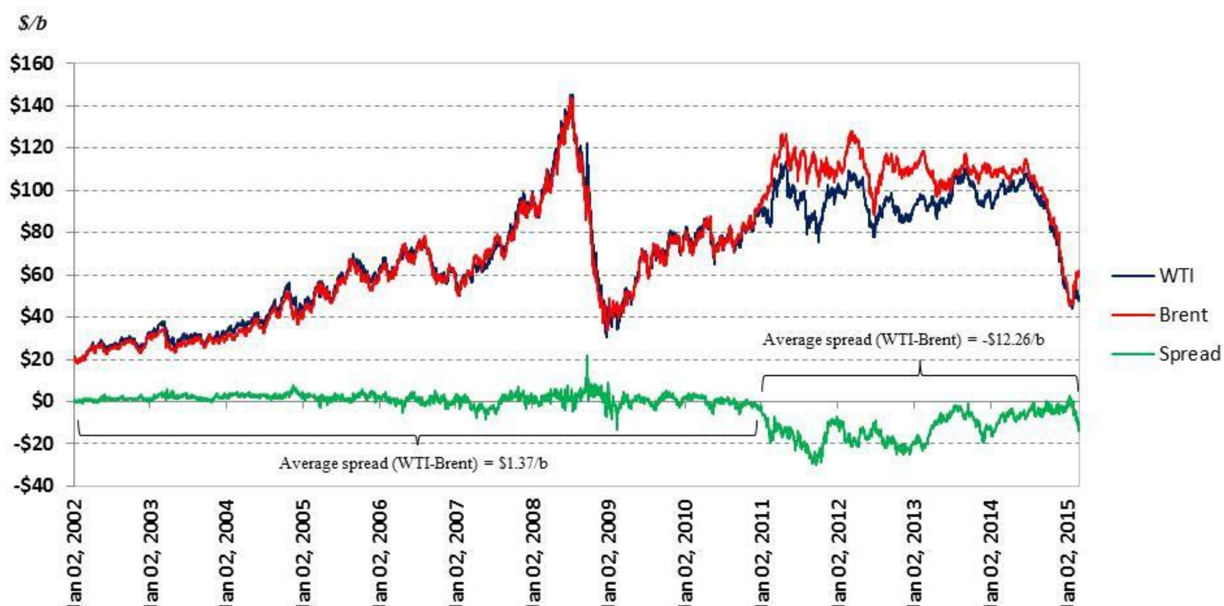
Shale resource development has also significantly impacted the US domestic crude oil market. Rapid growth in production (see Figure 1) has dramatically reversed a decades-long decline[1] and turned the US from an ever-expanding sink for global crude oil into a viable global supply province in only a few years. Of course, the global crude oil production anthology is still being written, but we have seen real supply-side responses to high prices in the last decade in the form of deep water and unconventional sources of oil. In fact, US production growth in the last five years, due in large part to new production from unconventional resources, has been the highest

[1] Note, US oil production peaked in 1970 but experienced a slight recovery in the early 1980s with rising global oil prices. Post-1985, however, the decline in US oil production was steady for over two decades until the onset of rapid increases in production of light tight oil (LTO) from shale.

seen in many decades. To date, growth in domestic production has been driven by shale oil (also known as or light tight oil (LTO)) developments in the Bakken and Eagle Ford shale plays, while other opportunities – such as in the Permian basin – have been receiving increasing attention.

Rapid growth in domestic crude oil production has also transformed regional crude oil pricing. In particular, the relatively recent discount of the benchmark US domestic crude oil price – West Texas Intermediate (WTI) – to a global benchmark for crudes – such as Brent – has occurred concomitantly with US domestic production growth (see Figure 2). While it is generally recognized that the WTI discount arose largely due to constraints on the ability to move crude oil away from Cushing, Oklahoma, it triggered concerns that broader discounts of US crude oil prices would become the norm as US domestic production continues to increase.

Figure 2 – The Evolution of WTI and Brent (Daily, 1/2/02-2/27/15)



Source: US Energy Information Administration

This begs the question, "Why would further increases in US domestic crude oil production drive discounts in domestic crude oil prices?" Moreover, and perhaps more importantly, "What bearing does this have on US petroleum product prices and energy security?" A number of studies have already attempted to address these issues. For the most part, each study to date has framed the analysis by identifying the recently emerged discount between WTI and Brent crude oil price and attributing it to transportation bottlenecks, the existing ban on crude oil exports, and the mismatch between LTO being produced domestically and the configuration of US refineries. While there have been serious attempts to address domestic transportation bottlenecks, and refineries have been receiving more LTO, thus displacing imports, little has been done regarding the decades-old ban on US oil exports. As such, studies have attempted to model the potential impacts of an end to the ban on oil exports, with an emphasis on US crude oil production, imports and exports, the implications for domestic gasoline prices, and the broader impacts on US employment, investment, and trade balance. Most studies underscore a positive economic impact of lifting the ban, while those that state opposition generally base their arguments on environmental concerns. Table 1 summarizes the principle findings of previous studies.

Regardless of the policy stance, all studies generally recognize that lifting the restriction would result in increased domestic crude oil production, as US oil producers could access international markets and the prices therein. The studies differ significantly, however, in their assessment of how large the increase in production would be. Projections range from a meager 100,000 barrels per day according to the consulting firm ICF (see Vidas et al. (2014)) to as much as 2.3 million barrels per day according to the consulting firm IHS (see Rosenfield et al. (2014)). The wide range of estimated production increases follows from different assumptions about market conditions, resource cost and abundance, and pace of productivity improvements. Bordoff and Houser (2015) attempt to understand the differences in supply responsiveness across studies, ultimately settling on an average across studies as a basis for forming expectations.

All studies, regardless of the supply responsiveness, point to a similar mechanism through which higher domestic production would be realized. Specifically, as the ban is lifted, the discount on the US crude oil prices dissipates. Hence, more plays become commercially attractive. Interestingly, the studies tend to focus on WTI, going so far as to estimate the impact of lifting the ban on WTI price and thus the WTI-Brent differential. But, as will be expounded below, that may not be the appropriate price to consider.

Table 1 – Previous Studies of the Oil Export Ban

Study Title	The Impacts of US Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs	US Crude Oil Export Decision: Assessing the Impact of the Export Ban and Free Trade on the US Economy	Economic Benefits of Lifting the Crude Oil Export Ban	Lifting the Crude Oil Export Ban: The Impact on U.S. Manufacturing
Authors	Harry Vidas, Martin Tallett, Tom O'Connor, David Freyman, William Pepper, Briana Adams, Thu Nguyen, Robert Hugman, Alanna Bock	Jamey Rosenfield, Kurt Barrow, Hames Falllon, Jeff Marn	Robert Baron, Paul Bernstein, W. David Montgomery, Reshma Patel, Sugandha D. Tuladhar	Thomas J. Duesterberg, Donald A. Norman, and Jeffrey F. Werling
Publisher/Agency	ICF International and EnSYS Energy	IHS Energy	NERA Economic Consulting	The Aspen Institute and MAPI foundation
Publication Date	Mar-14	Mar-14	Sep-14	Oct-14
Approach	EnSYS world refining and logistics model projecting international pricing across markets based on an assumed world oil price. The model employs freight costs between markets to model global pricing and arbitrage to forecast refinery operations. This is coupled with ICF's proprietary models to estimate North American crude oil production and its impact on the world crude oil production, world oil prices, and the consumption of petroleum products.	Employs refinery models to estimate profitability of processing crude oils in different refinery capacities and configurations to calculate a domestic LTO discount.	Uses the partial equilibrium Global Petroleum Model (GPM) to assess the impact on lifting the export ban on energy markets in the US and abroad, along with the NewERA model, which is a computable general equilibrium model of the US economy, to understand how changes in the global market will ripple through the US economy. The GPM and NewEra models are linked in order to provide a consistent picture of the US crude oil and refined petroleum product markets.	Uses the Long-term Interindustry Forecasting Tool (LIFT), which is a dynamic equilibrium model that combines an interindustry input-output model with regression analysis to create a bottom-up approach to macroeconomic modeling.
Cases/Scenarios	Two scenarios: (I) Low WTI-Brent Price Differential Market Scenario in which there is rapid accommodation of light crudes and condensate in the US (by 2015) leading to a narrowing of the WTI-Brent spread, and (II) High WTI-Brent Price Differential Market Scenario in which there is slow adjustment to a new domestic crudes with the WTI-Brent spread remaining wide for several years. Two policy cases were considered in each scenario - (1) no exports and (2) export allowed	Two scenarios: (I) Base Production IHS forecast with a conservative view based on defined plays assuming limited industry improvement, and (II) Potential Production scenario that includes additional resources in less well-defined areas of existing plays with moderate improvement in industry drilling productivity and technology. For each scenario there are two trade policy variations: (1) restricted trade allowoing for then current condensate treatment as crude, and (2) free trade allowed	Considered 18 cases based on US crude oil production potential from EIA's Annual Energy Outlook 2014 reference case and high oil and gas resource case, with additional options for modifying/lifting the ban, including allowing condensate exports, lifting ban entirely in 2015, or delaying lifting the ban until 2020. The analysis also considers Asian demand response and OPEC's market response.	Considered three basic frames: (1) A baseline projection that follows EIA's Annual Energy Outlook 2014 with only trivial exports (0.13 to 0.15 million b/d) through 2025; (2) a low export case where crude exports increase by 1.3 million b/d by 2020 then levelign at 1.2 million b/d by 2025; and (3) a high export case that sees crude oil exports increase to 2.35 million b/d by 2020 and 3.12 million b/d by 2025.
Period Covered	2015-2035	2016-2030	2015-2035	2015-2025
Crude oil production	Allowing crude exports leads to an increase in US oil production of 110,000 to 500,000 b/d by 2020, with LTO production growing to 6.5 million b/d by 2020 and averaging 6.3 million b/d over 2015-2035 (representing about 59% of US oil production). Global liquids production rises to a 2015-2035 average of 103.5 million b/d if exports are allowed, but 103.4 million b/d if exports are not allowed, representing a relatively minimal impact on the global supply-demand balance.	Allowing exports sees an increase of 1.2 million b/d in the low case and 2.3 million b/d in the high case (11 to 13.3 million b/d). Due to limitations of the refining sector, domestic LTO production peaks in the Base case at 6.1 million b/d in 2024, while total US output is expected to rise from 7.4 to 11.2 million b/d by 2022. In the Potential case, domestic LTO production peaks at 9.2 million b/d in 2028, with total US crude production rising to 14.3 million b/d. If the export ban remains in place, there is a loss of between 1 and 2 million b/d, depending on the case.	If the export ban is lifted in 2015, domestic production rises by 1.5 to 2 million b/d in 2015, depending on the case, with the greatest increase seen in PADD 3 followed by PADD 2. The increase in crude oil supplies is attributable almost entirely to greater production of light tight crude oil and condensate.	In the Baseline scenario, domestic production reaches 9.8 million b/d in 2019, peaking at 9.96 million b/d in 2024-25. In the Low Exports scenario, domestic production increases to 10.96 million b/d by 2020 and 12.13 million b/d by 2025. In the High Exports case, production reaches 11.53 million b/d and 13.21 million b/d in 2020 and 2025, respectively.

Table 1 (cont.) – Previous Studies of the Oil Export Ban

Study Title	The Impacts of US Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs	US Crude Oil Export Decision: Assessing the Impact of the Export Ban and Free Trade on the US Economy	Economic Benefits of Lifting the Crude Oil Export Ban	Lifting the Crude Oil Export Ban: The Impact on U.S. Manufacturing
Refinery details	If exports are not allowed, refineries will struggle to digest light crudes and condensates. If exports are allowed, refinery margins are projected to average $12.75 per barrel over 2015-2035, which represents a $1.50 to $2.85 per barrel discount relative to when exports are not allowed under different scenarios.	With the export ban in place, refinery margins are higher despite a suboptimal yield on capacity. The higher margins owe to the discount that applies to LTO, which can rise to a $10 to $25 discount per barrel when sour crude refining capacity (Tier 4) is required to absorb domestic LTO. If the ban is lifted margins are lower, but domestic refiners still do well due to low cost natural gas and favorable transport differentials for domestic crude oil.	Recognizes the difficulty in predicting constraints on domestic refining capabilities due to uncertainty about how fast US production will grow, noting that EIA's projections consistently underestimate oil production growth as technology outpaces expectations. If the ban remains in place, a persistent and growing discount of up to $27/b for domestic crude oil when oil and gas production remains robust. If the export ban lifted, there will be an increase in the average cost of crude to some US refiners, domestic demand increases and exports decrease.	Argues that since refiners have already made investments ($85 billion over last 25 years) to process heavy crudes, although new investment will be needed, it will take years to fully accommodate. They see a slight reduction of refining margins if the ban is lifted. Moreover, since world crude oil prices decrease given higher global supply with exports, gasoline prices to fall.
US refined product trade	Refined product exports increase with or without the crude oil export ban in place, but are 13,000 bpd lower when the crude oil export ban is lifted.	See a significant reduction in overall crude oil and petroleum product trade deficit with or without a ban on crude oil exports, but lifting the ban bears greater benefits. For example, in the potential production case, free trade renders a surplus of $55 billion from 2016 through 2030, which represents a $93 billion improvement over a restricted trade scenario.	Lifting the ban results in a decline of refined product exports as the competitive advantage for domestic refineries is diminished, with total refinery throughput declining from 0-100,000 b/d in 2015 and 0-300,000 b/d in 2030 (representing a less than 1% and 2% decline, respectively).	Total refinery throughput grows and so do exports.
Crude oil prices and spreads	WTI prices increase by $2.25 to $4.00/b on average over 2015-2035 when exports are allowed. This is against a backdrop of near $100 per barrel global prices. Brent price declines when US exports are allowed. Even with exports, WTI remains discounted to Brent by almost $5/b, but in the case without exports the discount is closer to $10/b.	Given a Brent price of $100 per barrel, if exports are allowed WTI will converge toward Brent. Without exports, however, the discount of WTI to Brent could approach $15 per barrel. This discount would be deeper for oil plays located inland given the cost of transporting crude oil to refining centers, with Bakken crude oil being discounted up to $25.	If the crude oil export ban is lifted in 2015, the price of US crude oil rises between $2/b and $9/b depending on the scenario and year. By contrast, the international average crude oil price declines between a negligible amount up to $7/b, also depending on the scenario. Accordingly, the spread betweeen domestic and international crude decreases when the ban is lifted, but remains strong if the ban persists.	If exports are allowed, the near term domestic crude oil price increase relative to a case when exports are not allowed approaches $25/b in 2016 declining to nearer $5/b in 2025. This reflects a large near term spread if the ban remains in place that declines over time.
Other highlights	Addresses US crude oil export volumes, production impacts and implications for royalty and tax receipts, GDP impacts, employment impacts and balance of trade implications. All variable outcomes are viewed as positive for the US economy as a whole.	Addresses US crude oil export volumes and direction of traded volumes. Also details positive outcomes for investment flows, GDP, employment and the balance of trade.	Addresses US crude oil export volumes and direction of traded volumes. Also details implications for carbon emissions and, using the EPA estimates for the social cost of carbon, estimates the cost of the export ban far exceeds the environmental benefit. Outlines and discusses OPEC response.	Addresses the trade balance implications, the price of gasoline and the sector-specific impacts of lifting the ban on exports. Outlines and discusses the importance of OPEC market response, arguing the revenue concerns will ultimately drive instability in cartel cohesion.

Table 1 (cont.) – Previous Studies of the Oil Export Ban

Study Title	**Navigating the Oil Export Debate**	**Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States**	**Changing Crude Oil Markets: Allowing Exports Could Reduce Consumer Fuel Prices, and the Size of Strategic Reserves Should be Reexamined**
Authors	Jason Bordoff and Trevor Houser	Stephen Brown, Charles Mason, Alan Krupnick, and Jan Mares	Frank Rusco with key contributions from Christine Kehr (Assistant Director), Philip Farah, Quindi Franco, Cindy Gilbert, Taylor Kauffman, Celia Rosario Mendive, Alison O'Neill, and Barbara Timmerman
Publisher/Agency	Columbia Center on Global Energy Policy	Resources for the Future	U.S. Government Accountability Office
Publication Date	Jan-15	Mar-14	Sep-14
Approach	Used EIA's NEMS Model to run simulations using oil market assumptions from the High Oil and Gas Resource case by EIA 2014. Also assesses the output of other studies to come to an average finding across the space of analyses considered.	Used monthly panel data in a hedonic pricing approach to explain differences between regional refiner acquisition costs and average monthly spot price of crude at Brent allowing for idiosyncratic effects in PADD 4 and PADD from Jan 2004 to Oct 20132. A static simulation model (developed by Brown and Kennelly, 2013) then explicitly links the world crude market to a global refined product market via refinery operations as the demand for crude oil is derived from demand for refined products.	Reviews studies (RFF, ICF, IHS, NERA) and conducts interviews with various stakeholders on crude exports.
Cases/Scenarios	Overview and critique of scenarios from previously published studies (ICF, IHS, NERA and MAPI).	Consider the impacts on gasoline prices specifically when the export ban is lifted	N/A
Period Covered	2015-2025	long run	dependent on study reviewed by the report
Crude oil production	Lower oil prices will impact US production, but the authors are skeptical of the high supply elasticities used by NERA and IHS, with the study positing that US producers more resilient. If the export ban is lifted, domestic production rises between 0 and 1.2 million b/d, with no increase if domestic market saturation never occurs (as under EIA's Reference case) and 1.2 million b/d if global crude prices return to $100 per barrel. The report finds that the magnitude of lifting export restrictions is modest but beneficial, all else equal.	With higher crude prices in the Midwest in the wake of the export ban being lifted, production in the region and in Canada increases by an estimated 84,000 b/d. Elsewhere in the world, higher oil prices boost production by 54,000 b/d for a global total of 138,000 b/d.	Cites EIA in projecting domestic production will increase and could reach 9.6 million b/d by 2019. Removing the export ban would increase domestic production but there is a large spread in projections across the studies that were reviewed. The report cites a stakeholder that believes a rise in production will happen primarily due to higher international demand, mostly from Asia. The report also cites another stakeholder who argues that domestic production could be negatively affected if the ban remains.

Table 1 (cont.) – Previous Studies of the Oil Export Ban

Study Title	Navigating the Oil Export Debate	Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States	Changing Crude Oil Markets: Allowing Exports Could Reduce Consumer Fuel Prices, and the Size of Strategic Reserves Should be Reexamined
Refinery details	Authors requested Turner Mason to assess the cost and scale of additional capacity necessary for (1) EIA Reference and High Oil&Gas Resource scenarios, (2) an Upper Bound Scenario (IHS Potential Production Case). In the High O&Gcase, 3 to 4 condensate stabilizers and 13 to 15 hydro skimmers are required at a cost between $13-16 billion. In the Upper Bound Scenario, 30-35 stabilizers and/or hydro skimmers are requried costing $26 - $31 billion, which would be recouped if crude oil price is discounted at a level of $5 - $6.50 per barrel.	Assumes reduction in the cost of global refining operations of 0.5%. Perform sensitivity analyses with 0.0% cost reduction and 1.0% cost reduction.	Cites other studies as well as stakeholders who raised three key uncertainties about (1) the extent of future domestic production growth, (2) the extent to which the increase can be absorbed, and (3) whether export restrictions will change, which is a key uncertainty that limits new investment needed to relieve contracts associated with refining lighter crudes at refineries configured to process heavier grades. Somestakeholders noted that refinery margins could be reduced if the ban is lifted, leading to refinery closures in some regions, while other stakeholders disagree with this claim given low prices of natural gas that US refineries use as a feedstock.
US refined product trade	N/A	N/A	The report cites a stakeholder that believes that, if ban is lifted, increased transportation and crude costs would negatively affect the ability of US refiners to compete internationally. Another stakeholder, however, believes that this should not be the case given significant cost advantage in terms of feedstock (access to cheap natural gas). No definitive estimate is given.
Crude oil prices and spreads	Sees an increase in domestic crude prices if the crude oil export ban is eliminated. The prices of global crude oil could decline slightly with US exports. Accordingly, they agree with a discount of $5-$6.50 (per estimates provided by Turner Mason and IHS). They see the NERA study as overly pessimistic on the ability of US refiners to respond with capacity investments, especially if the discount approaches the $20 range.	As of 1Q 2014, crude oil in the Midwest was $6.34/b below the price of a comparable crude oil. The increase in oil price due to lifting the ban in the Midwest would be $6.49/b. The manner in which this matriculates into the global market and hence the price of petroleum products is contingent on OPEC response and the elasticities of supply and demand for oil and petroleum products.	Cites study projections agreeing that lifting the ban would lead to increase in domestic crude prices.
Other highlights	Reviews and notes broad agreement of other studies regarding the positive macroeconomic benefits of liftiing the ban on crude oil exports. Comments on potential role OPEC may play in understading the dynamic international response of lifting the ban.	Mentions positive gains from trade as well as the implications for US carbon dioxide emissions. Also addresses the importance of OPEC in understanding market response.	Cites result of previous studies and stakeholder views on a variety of macroeconomic and investment flow data.

In general, the increase in domestic crude oil price is the primary factor, the studies conclude, that will contribute to change in the spread between US and international crude prices. A secondary but important factor is the increased supply of crude into international markets, which has the potential to lower world oil prices. While an attempt to quantify the impact on international crude oil price that follows from lifting the ban on US exports is a laudable goal, it is fraught with uncertainty. In particular, the supply and demand responsiveness of global market participants – both OPEC and non-OPEC – are uncertain at best, meaning a precise estimate of the price impact is meaningless unless those factors are explicitly taken into account.

The various studies also report a range of estimates with regard to what will happen to the domestic crude oil price discount should the ban on exports remain in place or be lifted. For example, if global prices remain in the $100 per barrel range, the IHS study projects a WTI price discount relative to Brent of $12–15 per barrel, and an even deeper discount for crude oils extracted further inland – up to a $25 discount, for instance, to Bakken crude oils – given the cost of transportation to refining centers. If exports are allowed, however, the IHS study predicts that the differential would disappear. Importantly, the results are contingent on the international crude oil price staying in the $100 range. This is generally the case for all the studies that have been conducted over the last couple of years. At the higher end of the spectrum, Baron et al. (2014), consultants at NERA, estimate that the spread between the US and international crude prices could grow to $34 per barrel if the export ban remains in place.

The studies also examine changes in US trade patterns if the ban is lifted, noting that exported crude oils would go to Asia, Latin America, or Europe, depending on the study in question. All studies agree that even with increasing US crude oil production, the US will remain a net importer of crude. The ICF and NERA studies each indicate the largest change will come through a shift in the composition of imported crudes, as virtually all imports of light crude oil will be eliminated, while the US continues to import heavier crudes in line with the configuration of most US refineries. The extent of the impact on the overall trade balance differs across studies, but the general results are similar.

Studies also attempt to assess the impact of the ban, lifted or not, on the US refining sector. A number of outcomes are noted. In the event of the ban remaining in place, the steep discounts of domestic crude oil prices would stimulate investments in the refining sector, in particular since there are no barriers to exporting refined products. However, there are differences across studies as to the manner in which this arbitrage mechanism is employed. In the case where the ban on exports is lifted, the incentive to add refining capacity to process light crudes is dissipated, and refineries remain focused on processing heavier imported crudes that are effectively "swapped" with lighter exported crudes.

All the studies underscore that lifting the export ban will not translate into higher gasoline prices. In fact, the studies generally project that gasoline prices in the US will fall once the ban is lifted, all else equal. There are a number of anticipated declines in the price of gasoline, but the analyses generally miss an important caveat, namely, the possible response to US exports by OPEC and other producing nations. Only the NERA study gives consideration to the OPEC response, but it does so through addressing a series of possible options rather than a distinct modeling framework aimed at explicitly assessing OPEC behavior.

In sum, most studies agree that allowing exports will increase US crude oil production, provide a boost to domestic crude oil prices, lower international crude oil prices, and drive a reduction in gasoline prices. The studies also generally agree that allowing exports will provide substantial benefits to the US economy through increased employment and energy sector investment, higher local and federal tax revenues, and positive impacts on the trade balance.

Considering the above, the economic benefits of lifting the crude oil export ban are quite well documented and widely acknowledged, with the largest differences lying in various assumptions that studies hold about domestic supply responsiveness and future demand. However, the non-market impacts of lifting the ban on US crude exports are much more controversial. In fact, it is the non-market impacts – such as environmental and national/energy security concerns – that are the most common basis for opposition to allowing US crude exports.

Those who support the ban on oil exports often argue that allowing exports, thereby raising production, will negatively impact the climate and lead to local environmental damage to US land, water, and air resources (see Stockmeane (2013)). The studies by RFF and NERA recognize that allowing exports will increase carbon dioxide emissions. However, they do not advocate using trade policy to affect environmental goals. Indeed, other policy options that limit environmental damage seem to be more viable, including but not limited to those pointed out in the Columbia/SIPA study, such as performance standards for existing power plants, methane regulations, or heavy vehicle fuel standards.

Another point of disagreement across studies relates to the effect the end of the ban would have on energy security and national security. Senators Edward Markey and Robert Menendez, for example, have argued that export restrictions are vital for US national security, which should not be swapped for economic benefits. However, others argue, for example in the Columbia/SIPA report, that permitting exports has the potential to mitigate disruptions in international supply of crude and prevent oil price shocks, a result that follows from greater oil market fungibility. In general, the crude oil export ban is more and more frequently seen as distortionary, resulting in a misallocation of capital and having generally negative macroeconomic impacts.

In order to bring a new perspective to the discussion, this paper is organized as follows. First, we discuss the relevance of referencing WTI prices when considering the effects of the export ban and develop a framework utilizing a hedonic pricing method to understand the impact of trade restrictions on crude oil prices. Next, we characterize the current policy using options theory and motivate a discussion of gasoline prices. Then we turn to a discussion of energy security and how existing trade restrictions may, counterintuitive to some, compromise energy security, particularly in a world where global market balance is increasingly dependent on new and emerging supplies from non-traditional locations. We wrap up with some concluding thoughts on policy direction and areas for future research.

II. Trade Restrictions and Domestic Crude Oil Price

Much of the existing literature on the crude oil export ban has focused on the spread between WTI and Brent, largely because these are two commonly quoted benchmark prices. Indeed, the last few years have witnessed a shift in the relationship between WTI and Brent, as indicated in Figure 2 above. Strong domestic production growth coupled with a physical constraint on moving crude oil away from Cushing resulted in a discount in WTI relative to Brent. In fact, the discount has averaged over $10 per barrel since the end of 2010, which is especially remarkable given WTI priced at a *premium* of $1.37 (average) the decade prior. This provides evidence of an emerging, binding constraint on the ability to trade WTI. This is further supported by the fact that the standard deviation of the spread between Brent and WTI is 4.5 times higher after 2010. This is exactly what one should expect in the face of a binding constraint to trade – shifts in both the *average value* and *volatility* of the price difference across the trade pathway.

Over the past few years, concerns have mounted that the observed discount at WTI will spread to be more broadly representative of all US crude oil prices. This concern owes to the fact that current US policy explicitly prohibits exports of crude oil, thereby limiting arbitrage of growing domestic supply into the global market. The commercial implications are that lower domestic crude oil prices could trigger a stronger profit opportunity for refineries in the near term, and may even encourage investment in the downstream in the longer term, should the discount persist. But a persistent discount may also negatively impact US production, which has implications for the economic activity associated with upstream production and, of course, the impact that US shale will ultimately have on the global oil market. So, there are trade-offs that must be evaluated in the context of current law versus lifting the ban on crude oil exports.

Given the shift in the pricing relationship of Brent and WTI, it is useful to understand what the price of WTI and other domestic crude oil would be if no barrier to trade exists. Thus, we enter into the analysis recognizing that the history of price data for Bakken and Eagle Ford crude oils, for example, is not sufficiently long so as to predate the shift in WTI price after 2010. Therefore, the market has not revealed the prices of these domestic crude oils in an unconstrained environment. This is perhaps the reason studies focus only on WTI when discussing domestic crude oil prices. However, the crude oil being produced in the Bakken and Eagle Ford shales is lighter and sweeter than WTI, so it is important to understand how crude oils of similar quality price in the international market if we wish to fully assess the impact of the export ban. Therefore, we can more generally evaluate the effect of crude oil characteristics on the relative prices of different crude oils that are traded without constraint in the international market to inform an assessment of how domestic crude oils would price if trade were unimpeded.

To begin, no two crude oils are the same, and crude oil prices vary depending on quality. This suggests that a hedonic pricing method can be employed to evaluate how differences in crude oil characteristics drive differences in prices across different crude oils. Hedonic pricing is often employed in evaluating things such as environmental attributes and/or housing values because it stipulates that particular combinations of characteristics unique to a good or asset influence its demand and hence pricing. Crude oil assays contain important information about the physical and chemical characteristics of a crude oil, and these characteristics establish a crude oil's relative value. Thus, information in a crude assay can be used to evaluate the influences of various crude oil characteristics on pricing differences. This then allows, in principle, a revealed preference treatment for the value of each characteristic. Previous literature has identified various crude characteristics – such as API number, sulfur content, and total acid number – as being important in determining differences in prices across various crudes (see, for example, Bacon and Tordo (2005)).

We evaluate daily price data for 30 different crudes with sufficiently long time-series so that a wide range of market prices can inform the analysis. Table 2 indicates the crude oils included in the analysis along with selected characteristics of each crude oil. Next, we estimate a panel that allows the crude oil's characteristics to determine its price relative to Brent, an internationally accepted benchmark. More specifically, we estimate

$$\ln P_{i,t} = \alpha_{0,i} + \alpha_1 \ln P_{Brent,t} + \alpha_2 API_i + \alpha_3 Sulfur_i + \alpha_4 TAN_i \qquad (1)$$

where $P_{i,t}$ is the price of crude oil *i* at time *t*, $P_{Brent,t}$ is the price of Brent crude oil at time *t*, and API_i, $Sulfur_i$ and TAN_i are the API number, sulfur content, and total acid number of crude oil *i*, respectively. The term $\alpha_{0,i}$ is an effect specific to crude oil *i* that can be treated as fixed or random.[2] We use daily data spanning from January 2, 2002, through the end of 2014.

Table 2 – Crude Oils and Characteristics in the Analysis

Crude Oil	API	Sulfur	Total Acid Number
Brent	37.5	0.400	0.010
WTI	40.8	0.340	0.100
Urals	31.3	1.250	0.080
Syrian Light	38.0	0.680	0.050
Syrian Heavy	23.1	4.200	0.280
Siberian Light	37.8	0.420	0.652
Saharan Blend	45.3	0.120	0.060
Kumkol	42.5	0.070	0.041
Kirkuk	34.3	2.280	0.090
Escravos	33.5	0.170	0.500
Brass River	37.4	0.110	0.230
Bow River Hardisty	20.3	2.960	0.690
Azeri Light	34.8	0.150	0.260
CPC Blend	45.3	0.560	0.060
Zarzatine	42.6	0.080	0.100
Forcados	30.4	0.280	0.400
Iranian Heavy	30.1	1.780	0.130
Iranian Light	33.1	1.330	0.090
Suez Blend	31.3	1.410	0.060
Es Sider	36.7	0.370	0.100
Flotta	36.2	0.980	0.150
Ekofisk	38.5	0.190	0.104
Forties	38.7	0.790	0.093
Oseberg	37.8	0.274	0.260
Cabinda	37.0	0.170	0.030
Bonny Light	35.3	0.150	0.200
Qua Iboe	36.0	0.130	0.370
Oriente	24.0	1.590	0.040
Escalante	24.1	0.190	0.560
US Poseidon	29.7	1.650	0.410
Sample Max	45.3	4.200	0.690
Sample Min	20.3	0.070	0.010
Sample Average	34.8	0.836	0.207

Source: Oil & Gas Journal and various industry websites

[2] The estimated coefficient on the price relationship is unchanged when a fixed effect specification is estimated, suggesting the crude quality variables adequately capture the differences across crudes in the sample. The Breusch-Pagan Lagrange multiplier test for random effects reveals $\chi^2(1) = 1.2 \times 10^7$ indicating with very high confidence the random effects specification is appropriate. Similarly, a Hausman specification test of the null that there is not a systematic difference in the estimated coefficients for the fixed and random effects specifications reveals $\chi^2(5) = 0.2864$, meaning we cannot reject the null hypothesis that the random effects treatment is appropriate.

The specification in equation (1) implies

$$P_{i,t} = \gamma_i P_{Brent,t}^{\alpha_1}$$

where $\gamma_i = e^{\alpha_{0,i} + \alpha_2 API_i + \alpha_3 Sulfur_i + \alpha_4 TAN_i}$. The appendix contains a graphical depiction of the above functional relationship for each of the crude oils considered in this analysis. The relationship holds very well for all but two of the crude oils in the sample – WTI and Bow River Hardisty – each North American crude oils. Indeed, there is evidence of structural breaks in the price series indicative of binding constraints on the ability to move the crudes (see Figure A1 in the appendix for more). As such, a dummy variable, denoted as D_i, is included in equation (1) and takes a value of one in periods where the breaks are identified to occur and zero otherwise.

Estimation of equation (1) reveals

$$\ln P_{i,t} = \underset{(0.0449)}{-0.2678} + \underset{(0.0003)}{1.0249} \ln P_{Brent,t} + \underset{(0.0012)}{0.0046} API_i - \underset{(0.0074)}{0.0294} Sulfur_i + \sum_j \alpha_j D_{ij} \qquad (2)$$

with overall $R^2 = 0.9904$. The coefficients α_j are detailed in the appendix. Equation (2) indicates a higher API number tends to raise the price of crude oil relative to Brent, while higher sulfur content tends to lower the price of crude oil relative to Brent. The coefficient on total acid number, α_4, was negative but not significantly different from zero, so it was dropped.

Table 3 highlights the implications of equation (2). Specifically, we note that based on its qualities, WTI should price at a premium to Brent, which is consistent with the period prior to 2011. Thus, the hedonic pricing method provides additional evidence of a constraint on the ability to arbitrage WTI relative to Brent, which is consistent with observed pricing behavior after 2010 when constraints emerged on moving crude oil away from Cushing. Table 3 also indicates how the other crudes in the sample would price according to their characteristics. The only crude—aside from WTI—that deviates dramatically is the other North American crude in the sample, the Canadian crude oil Bow River Hardisty. Importantly, this crude should price below WTI and Brent, given its characteristics, but the degree of discount observed over the last 13 years has at times been far in excess of what is implied by equation (2).

Table 3 – Within-Sample Crude Oil Prices Implied by Equation (2)

Crude Oil	API	Sulfur	Price												
Brent	**37.5**	**0.40**	**$ 30.00**	**$ 40.00**	**$ 50.00**	**$ 60.00**	**$ 70.00**	**$ 80.00**	**$ 90.00**	**$ 100.00**	**$ 110.00**	**$ 120.00**	**$ 130.00**	**$ 140.00**	**$ 150.00**
WTI	40.8	0.34	$ 30.50	$ 40.68	$ 50.85	$ 61.03	$ 71.20	$ 81.38	$ 91.56	$ 101.73	$ 111.91	$ 122.09	$ 132.27	$ 142.45	$ 152.63
Urals	31.3	1.25	$ 28.47	$ 37.94	$ 47.41	$ 56.88	$ 66.34	$ 75.81	$ 85.27	$ 94.73	$ 104.19	$ 113.65	$ 123.10	$ 132.56	$ 142.01
Syrian Light	38.0	0.68	$ 29.83	$ 39.77	$ 49.71	$ 59.65	$ 69.59	$ 79.53	$ 89.46	$ 99.40	$ 109.34	$ 119.28	$ 129.22	$ 139.16	$ 149.10
Syrian Heavy	23.1	4.20	$ 25.20	$ 33.56	$ 41.90	$ 50.24	$ 58.56	$ 66.89	$ 75.21	$ 83.52	$ 91.83	$ 100.13	$ 108.43	$ 116.73	$ 125.03
Siberian Light	37.8	0.42	$ 30.02	$ 40.03	$ 50.04	$ 60.05	$ 70.06	$ 80.06	$ 90.07	$ 100.08	$ 110.09	$ 120.10	$ 130.11	$ 140.11	$ 150.12
Saharan Blend	45.3	0.12	$ 31.33	$ 41.79	$ 52.25	$ 62.71	$ 73.17	$ 83.64	$ 94.10	$ 104.57	$ 115.04	$ 125.51	$ 135.98	$ 146.45	$ 156.93
Kumkol	42.5	0.07	$ 30.98	$ 41.32	$ 51.66	$ 62.00	$ 72.34	$ 82.68	$ 93.02	$ 103.37	$ 113.71	$ 124.06	$ 134.41	$ 144.76	$ 155.10
Kirkuk	34.3	2.28	$ 28.01	$ 37.33	$ 46.64	$ 55.95	$ 65.26	$ 74.56	$ 83.87	$ 93.17	$ 102.46	$ 111.76	$ 121.06	$ 130.35	$ 139.65
Escravos	33.5	0.17	$ 29.66	$ 39.54	$ 49.42	$ 59.31	$ 69.19	$ 79.07	$ 88.95	$ 98.83	$ 108.71	$ 118.59	$ 128.47	$ 138.35	$ 148.22
Brass River	37.4	0.11	$ 30.24	$ 40.32	$ 50.40	$ 60.48	$ 70.57	$ 80.65	$ 90.73	$ 100.82	$ 110.90	$ 120.99	$ 131.07	$ 141.15	$ 151.24
Bow River Hardisty	20.3	2.96	$ 25.79	$ 34.34	$ 42.89	$ 51.43	$ 59.96	$ 68.48	$ 77.01	$ 85.53	$ 94.04	$ 102.55	$ 111.06	$ 119.57	$ 128.07
Azeri Light	34.8	0.15	$ 29.85	$ 39.80	$ 49.75	$ 59.69	$ 69.64	$ 79.59	$ 89.54	$ 99.48	$ 109.43	$ 119.38	$ 129.32	$ 139.27	$ 149.22
CPC Blend	45.3	0.56	$ 30.94	$ 41.26	$ 51.58	$ 61.90	$ 72.23	$ 82.56	$ 92.89	$ 103.21	$ 113.54	$ 123.88	$ 134.21	$ 144.54	$ 154.87
Zarzatine	42.6	0.08	$ 30.99	$ 41.32	$ 51.66	$ 62.01	$ 72.35	$ 82.69	$ 93.04	$ 103.39	$ 113.73	$ 124.08	$ 134.43	$ 144.78	$ 155.13
Forcados	30.4	0.28	$ 29.15	$ 38.86	$ 48.57	$ 58.28	$ 67.98	$ 77.69	$ 87.39	$ 97.10	$ 106.80	$ 116.50	$ 126.20	$ 135.90	$ 145.60
Iranian Heavy	30.1	1.78	$ 27.88	$ 37.16	$ 46.42	$ 55.69	$ 64.95	$ 74.21	$ 83.47	$ 92.72	$ 101.98	$ 111.23	$ 120.48	$ 129.73	$ 138.98
Iranian Light	33.1	1.33	$ 28.63	$ 38.16	$ 47.69	$ 57.21	$ 66.73	$ 76.26	$ 85.78	$ 95.29	$ 104.81	$ 114.33	$ 123.84	$ 133.36	$ 142.87
Suez Blend	31.3	1.41	$ 28.33	$ 37.76	$ 47.19	$ 56.61	$ 66.03	$ 75.45	$ 84.86	$ 94.28	$ 103.69	$ 113.10	$ 122.51	$ 131.92	$ 141.33
Es Sider	36.7	0.37	$ 29.92	$ 39.89	$ 49.86	$ 59.83	$ 69.81	$ 79.78	$ 89.75	$ 99.72	$ 109.69	$ 119.66	$ 129.63	$ 139.61	$ 149.58
Flotta	36.2	0.98	$ 29.33	$ 39.10	$ 48.87	$ 58.64	$ 68.40	$ 78.17	$ 87.93	$ 97.70	$ 107.46	$ 117.22	$ 126.99	$ 136.75	$ 146.51
Ekofisk	38.5	0.19	$ 30.32	$ 40.43	$ 50.54	$ 60.65	$ 70.76	$ 80.87	$ 90.98	$ 101.10	$ 111.21	$ 121.32	$ 131.43	$ 141.55	$ 151.66
Forties	38.7	0.79	$ 29.83	$ 39.77	$ 49.71	$ 59.65	$ 69.59	$ 79.53	$ 89.46	$ 99.40	$ 109.34	$ 119.28	$ 129.22	$ 139.16	$ 149.10
Oseberg	37.8	0.27	$ 30.15	$ 40.20	$ 50.25	$ 60.31	$ 70.36	$ 80.41	$ 90.46	$ 100.52	$ 110.57	$ 120.62	$ 130.67	$ 140.73	$ 150.78
Cabinda	37.0	0.17	$ 30.13	$ 40.18	$ 50.22	$ 60.27	$ 70.31	$ 80.36	$ 90.40	$ 100.45	$ 110.50	$ 120.54	$ 130.59	$ 140.64	$ 150.68
Bonny Light	35.3	0.15	$ 29.92	$ 39.89	$ 49.86	$ 59.83	$ 69.80	$ 79.77	$ 89.75	$ 99.72	$ 109.69	$ 119.66	$ 129.63	$ 139.60	$ 149.57
Qua Iboe	36.0	0.13	$ 30.03	$ 40.04	$ 50.05	$ 60.06	$ 70.07	$ 80.08	$ 90.09	$ 100.10	$ 110.11	$ 120.12	$ 130.13	$ 140.14	$ 150.15
Oriente	24.0	1.59	$ 27.27	$ 36.34	$ 45.40	$ 54.45	$ 63.50	$ 72.55	$ 81.59	$ 90.63	$ 99.67	$ 108.71	$ 117.74	$ 126.77	$ 135.80
Escalante	24.1	0.19	$ 28.41	$ 37.86	$ 47.31	$ 56.76	$ 66.20	$ 75.64	$ 85.09	$ 94.52	$ 103.96	$ 113.40	$ 122.84	$ 132.27	$ 141.70
US Poseidon	29.7	1.65	$ 27.94	$ 37.23	$ 46.52	$ 55.80	$ 65.08	$ 74.36	$ 83.64	$ 92.91	$ 102.18	$ 111.45	$ 120.72	$ 129.99	$ 139.26

Table 4 – Out-of-Sample Crude Prices Implied by Equation (2)

Crude Oil	API	Sulfur	Price												
Brent	**37.5**	**0.40**	**$ 30.00**	**$ 40.00**	**$ 50.00**	**$ 60.00**	**$ 70.00**	**$ 80.00**	**$ 90.00**	**$ 100.00**	**$ 110.00**	**$ 120.00**	**$ 130.00**	**$ 140.00**	**$ 150.00**
WTI	40.8	0.34	$ 30.50	$ 40.68	$ 50.85	$ 61.03	$ 71.20	$ 81.38	$ 91.56	$ 101.73	$ 111.91	$ 122.09	$ 132.27	$ 142.45	$ 152.63
LLS	38.0	0.40	$ 30.07	$ 40.09	$ 50.11	$ 60.14	$ 70.16	$ 80.19	$ 90.21	$ 100.23	$ 110.26	$ 120.28	$ 130.31	$ 140.33	$ 150.35
Eagle Ford Crude I	47.7	0.10	$ 31.69	$ 42.27	$ 52.85	$ 63.44	$ 74.03	$ 84.62	$ 95.21	$ 105.81	$ 116.40	$ 127.00	$ 137.60	$ 148.20	$ 158.80
Eagle Ford Crude II	58.8	0.04	$ 33.39	$ 44.55	$ 55.71	$ 66.89	$ 78.07	$ 89.25	$ 100.44	$ 111.63	$ 122.82	$ 134.02	$ 145.22	$ 156.42	$ 167.62
Bakken I	36.7	0.10	$ 30.15	$ 40.20	$ 50.26	$ 60.31	$ 70.36	$ 80.41	$ 90.47	$ 100.52	$ 110.57	$ 120.63	$ 130.68	$ 140.73	$ 150.79
Bakken II	46.3	0.06	$ 31.53	$ 42.05	$ 52.58	$ 63.11	$ 73.64	$ 84.18	$ 94.71	$ 105.25	$ 115.79	$ 126.33	$ 136.87	$ 147.41	$ 157.95

Indeed, Table 3 indicates the Canadian crude oil should price at a discount to Brent of $12 to $15 per barrel at prices between $90 and $110, but the actual discount was as deep as $60 per barrel in early 2013, when Brent was pricing at about $110, and had an average discount of around $40 from late 2012 through early 2014. Again, this signals a constraint on the ability to arbitrage Canadian crude oil that would under different circumstances incentivize pipeline infrastructure development. Rather, the inability to build pipeline capacity coupled with the steep discounts observed has incentivized other, more costly arbitrage mechanisms, such as transport by rail.

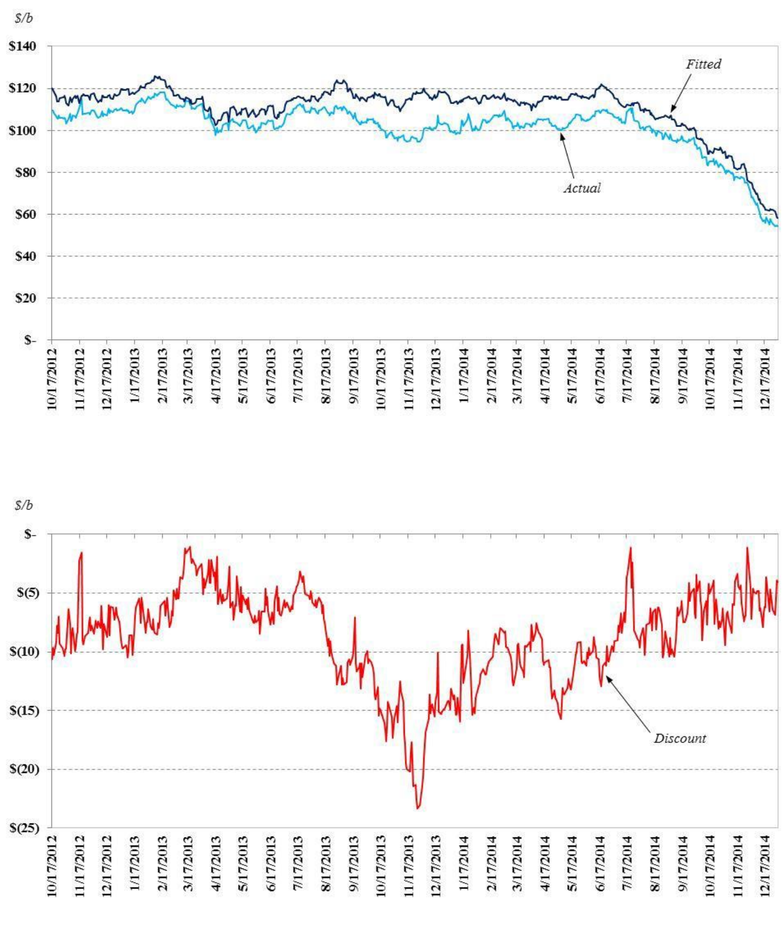
We can also use equation (2) to simulate prices for crude oil that are not included in the estimated sample. This provides an indication as to what the price of a crude oil should be given its characteristics as priced on the open water. Of course, the price differentials between any two crude oils will also reflect transportation costs. In equation (2), the crude-specific constant term provides flexibility to capture any persistent differences in the different crude oil prices relative to Brent, but these values are not known for out-of-sample crude oil prices. As noted above, estimation of equation (2) revealed the crude-specific effects are not correlated with crude oil prices, as a random effects estimator proved appropriate, so there do not appear to be any systematic crude-specific differences in the estimated sample that are not captured by the crude oil qualities and the estimated constant term. Nevertheless, it is important to recognize that there are transportation costs for inland crude oils to arrive at a port of loading, meaning the current price quote for crude oils in the Bakken or Eagle Ford shales should be below the FOB price of similar crude oils. In a market where exports are allowed the price difference would be the cost of transport.[3] However, if a binding constraint is present, the difference will generally be greater.

Assessing the prices of various crude oils out-of-sample is an important step in determining the effect of the export ban, or any constraint for that matter, on domestic crude oil price because for several of these domestic crude oils for which there is a quoted price, the crude oils are relatively new to the market, so their historical price data does not exist in an unconstrained environment. Thus, we can use the hedonic pricing method, or more specifically equation (2), to infer the prices of these crude oils in an unconstrained global market. Table 4 reveals the prices of

[3] This issue is being explored in separate CES research. Namely, the existence of an export ban discourages the construction of pipelines to the coast for export because the economies of scale cannot be captured absent access to the larger international market. Hence, transportation capacity is added in smaller increments, such as through rail capacity, resulting in a higher per unit cost of transportation.

selected domestic crude oils – WTI, two Eagle Ford crudes, two Bakken crudes, and Louisiana Light Sweet (LLS) – according to their qualities. Importantly, the price implied by equation (2) should be interpreted as the price fetched in the international crude oil market for a specific quality of crude oil. Notably, none of these crudes actually priced at these levels, which indicates an additional factor that acts to discount price. Figure 3 depicts the actual daily price, the price implied by equation (2), and the implied discount for Eagle Ford crude (API 47.7, Sulfur 0.101) from October 2012 through the end of 2014. The price indicated as "Fitted" in Figure 3 should be interpreted as the price of an Eagle Ford quality crude oil on the open water. As noted above, even in an unconstrained market the wellhead price would be lower than the price of the same quality crude on the open water by the cost of transport to a port of loading.

Figure 3 – Eagle Ford Crude Oil Price and Implied Discount



Source: Platts and Author's Calculations

The results in Table 4 and Figure 3 signal a significant incentive for infrastructure development to move crude oil from inland locations to the coasts, even at prices as low as $30 per barrel. Of course, this incentive hinges on the ability to sell the crude oil into the international market. Absent that capability, the incentive for infrastructure investment is stymied and the arbitrage will not occur. The exact amount of infrastructure investment that would occur is subject to more than just the price differential between the inland location and the point of sale; it also depends on the transport costs from wellhead to port of loading, the anticipated return to investment, the longevity of the resource play, and a host of other factors, some of which are specific to individual industry participants. Hence, a point estimate of how much investment would be forthcoming if the export ban were lifted is not prudent and is out of scope herein. However, the incentive to capture the arbitrage value that is present already exists, particularly given the price discounts implied by the analysis herein.

Next, we turn our attention to the fundamental drivers of a discount and compare selected domestic crude oils in this context to shed light on the impacts – both existing and potential – of the crude oil export ban.

Why Does a Discount Emerge in the US?

Much of the analysis that has recently been done regarding the ban on US crude oil exports has attempted to highlight the domestic price impacts of a ban on crude oil exports. In general, the arguments are couched in a discussion of the impact of trade restrictions. Figure 4 provides a graphical representation of "why" domestic crude oil prices become discounted and, more importantly, the mechanism through which such a discount operates. To begin, note that the figure represents only three different crude qualities. In practice, there are many more than this, but for the sake of exposition we keep it simple. More generally, this is an abstract, simplified, and stylized representation designed to highlight a market reality, which we will return to below.

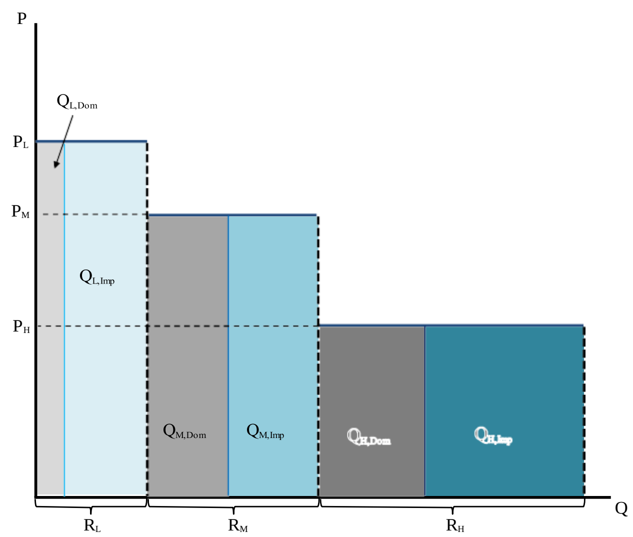
The fundamental question we must ask here is, "Since no crude is the same, how might arbitrage constraints be manifested through price?" To answer this, we must first recognize that any discount will be reflective of the competitive margin that is realized in the presence of a policy constraint. In other words, the inability to export growing light crude oil production will force an alternative arbitrage mechanism. This will be at the competitive margin that is realized by displacement of heavier, lower value crude oils. So, as the competitive margin shifts to heavier crudes, the discount on domestic light crude oil will increase, all else equal, with the countervailing force being a new arbitrage capability introduced through investment in domestic crude oil processing capacity. In general, this latter arbitrage pathway will be encouraged as the domestic price discount grows.

As established above, crude oil is priced differently in the international market according to quality. In Figure 4, we indicate three broadly defined qualities as P_L, P_M, and P_H, denoting the prices of light crude, medium crude, and heavy crude, respectively. There is also an existing set of refinery configurations associated with existing refinery capacities that are predisposed to processing different crude oils, where R_L, R_M, and R_H denote domestic crude oil refining capacity for light, medium, and heavy crude oils, respectively. A portion of the crude oil inputs come from domestic producers – denoted as $Q_{L,Dom}$, $Q_{M,Dom}$, and $Q_{H,Dom}$ for domestic light, medium, and heavy crude oil production, respectively – and a portion comes from imported sources – denoted as $Q_{L,Imp}$, $Q_{M,Imp}$, and $Q_{H,Imp}$ for imported light, medium, and heavy crude oil, respectively.

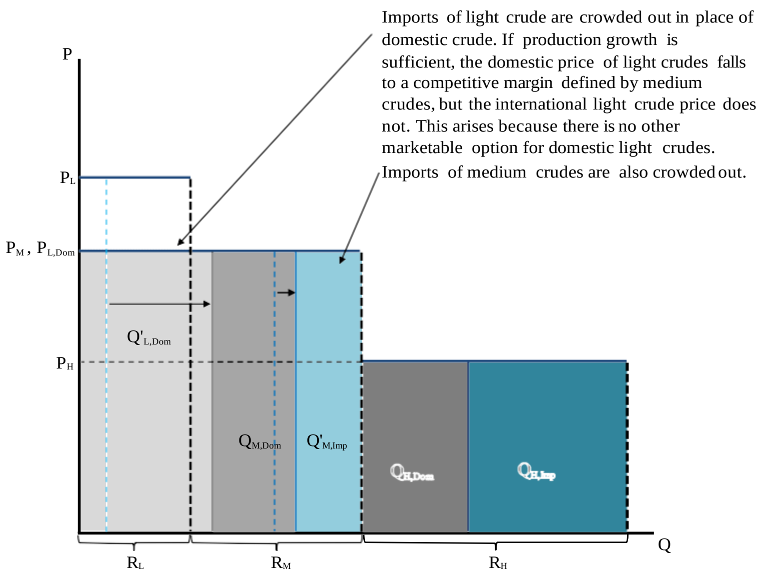
The first graphic in Figure 4 indicates the market in equilibrium prior to a rapid, unexpected growth of domestic production of light crude oil. The second graphic indicates the situation immediately after domestic production growth has occurred. As pictured, growth in domestic production outstrips available refining capacity tuned specifically to handle light crudes. Imports of light crude oils decline, as they are crowded out by domestic production. But, as domestic production continues to grow and exports are not allowed, the only available market is to refiners of medium crudes. These refiners have the option of buying domestically produced light crude oil or imported medium crude oil. Having already made investments to handle the medium crude oils, they choose to optimize their existing configurations and purchase the lower cost medium crude in the international market. However, since domestic producers of light crude oil have no other market outlet, they can either discount the price to be competitive at the margin defined by the medium crudes or shut in production. In either case, revenues are constrained, but producers will choose to sell at a discount so long as the cost of production is covered. In turn, as $P_{L,Dom} < P_L$ imports of medium crudes are crowded out.

Figure 4 – Why Does a Trade Restriction Lead to a Domestic Crude Oil Price Discount?

Initial equilibrium: domestic market harmonized with international market



After domestic LTO production growth: domestic market discounted to international market



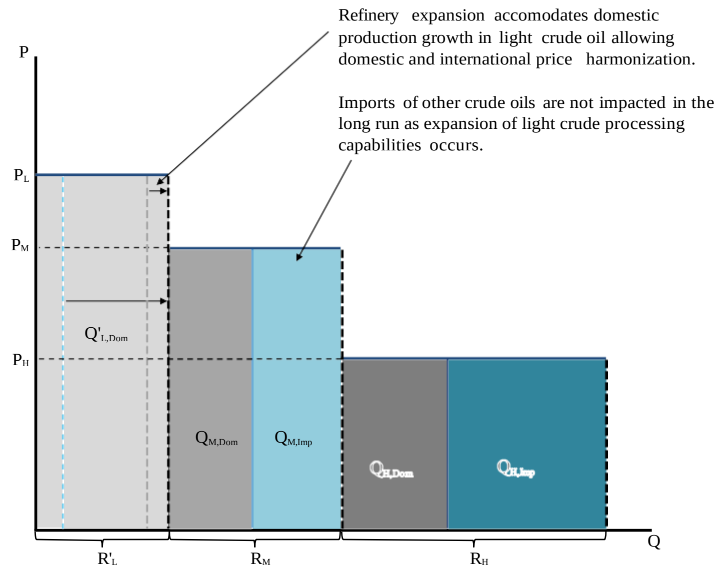
If domestic production of light crude oil continues to increase, eventually all imports of medium crudes will be displaced and the new competitive margin will be heavy crude oils. In turn, this would result in an even steeper discount of domestic crude oil. Importantly, this can only occur in the relatively short run, because should such a steep discount emerge, it would signal investment opportunities in new refining capability. As pictured in Figure 5, this would result in a reemergence of imports of medium crudes to the refineries that are tuned to process those crudes, and the total quantity of imports that are ultimately displaced is only the light crudes. Of course, this outcome depends on sufficient investment, which may be a difficult proposition given the historical uncertainty of refining margins that are needed to provide a return to such investments. The unclear future of crude oil export policy only adds to this uncertainty.

If, however, the ban on crude oil exports was lifted, then no domestic price discount would exist, and no additional refining investments would be needed (nor perhaps even incentivized); rather, as indicated in Figure 5, the excess light crude oil would be exported. Again, imports of medium and heavy crudes are not affected. In the end, each outcome – export ban remains in place versus export ban is lifted – is characterized by imports of medium and heavy crude oils. However, the case in which exports are allowed does not require investment in the domestic refining sector and it is not laden with the same degree of uncertainty.

In one sense, the conjecture in Figure 5 indicates that, in the long run, the export ban does not matter. However, there is a fallacy in such an argument. In particular, the current policy does not result in an optimal allocation of capital. Moreover, it establishes a "no-cost call option" for domestic refiners at the margin. We return to this below in more detail, but, briefly, refiners have the ability to either buy imported crude oil or domestic crude oil. If the price of domestic crude becomes discounted relative to the international market, then the refiner can opt to purchase the high quality domestic crude, thus exercising the option to buy domestically. Importantly, not all refiners benefit in such a manner. Namely, refiners that normally process light crude oil earn tremendous rents when the domestic light crude price is discounted, while refiners of heavy crudes would see little to no tangible benefit from the current policy. Thus, while the current policy secures rents for a segment of the refining industry, it does not do so for the entire industry. Moreover, it does so at the cost of domestic producers and inhibits midstream infrastructure investment by blocking an arbitrage pathway that would otherwise attract capital.

Figure 5 – Long-Run Implications for Crude Oil Imports

Markets harmonized after expansion of light crude oil processing capability



Markets harmonized as domestically produced light crude oil is exported

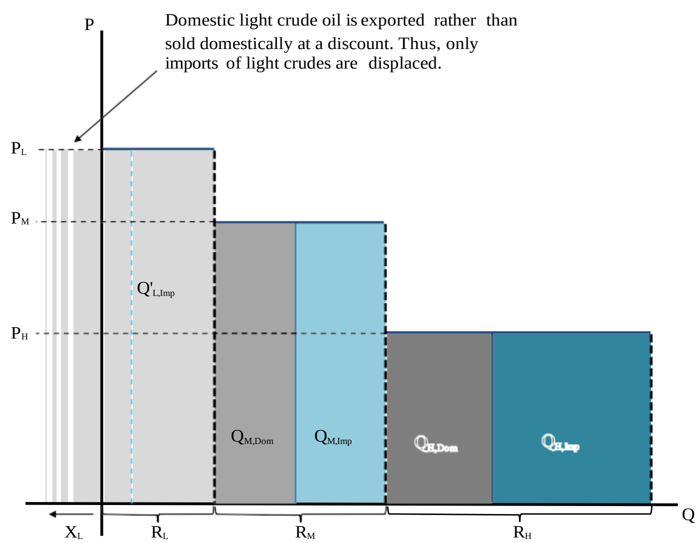
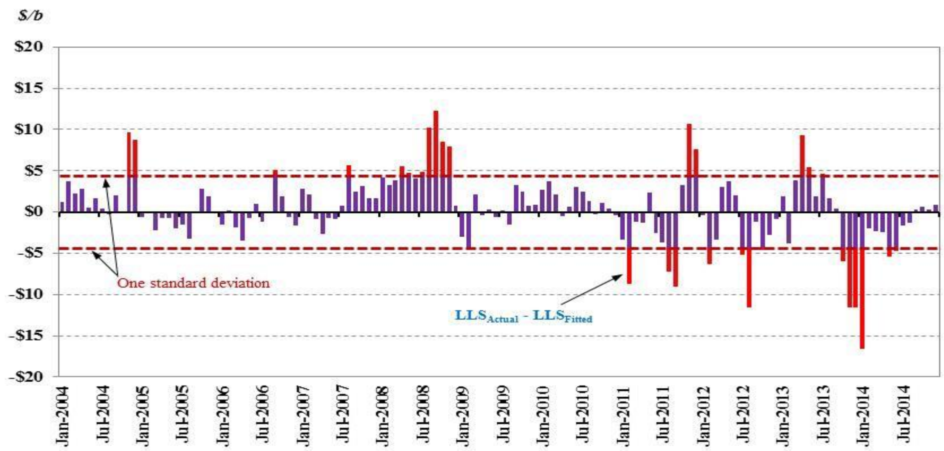


Figure 6 – LLS Actual versus LLS "Fitted"



Source: US Energy Information Administration and author calculations

As indicated in Figure 4, the price discount is not uniform across all crudes, and a discount is only realized at the margin that is binding. To this end, identifying the competitive margin is useful is we wish to understand the discounts that may already be present. As such, we can examine LLS. In particular, if we simulate daily LLS according to equation (2), then aggregate to monthly price for comparison to publicly available LLS pricing data from EIA, we see in Figure 6 that the actual and "fitted" LLS prices match very well. However, we also see in Figure 6 that an interesting pattern is revealed in the difference between the actual and fitted LLS prices. In the last 11 years, 14 of the 15 negative differences between actual and fitted LLS prices in excess of one standard deviation have occurred since January 2011.[4] Moreover, the fact that the LLS discounts are intermittent suggests the competitive margin for domestic crudes has been hovering around the price for LLS.

It is important to underscore that refiners of heavy crude oils do not benefit from the domestic price discount as they will continue to import heavy crude oils anyway. If LLS is indeed currently at the margin, then refiners of crude oils heavier than LLS are currently unaffected by the export ban. Moreover, domestic crude oils that are heavier than the crude oil at the margin will not see a discount. Even if domestic crude oil production grows to the point that heavy crude oil imports are crowded out, meaning a rather steep discount for domestic crude oil must emerge, the refiners of heavy crude oils will not earn rents. Rather, the refiners of lighter crude oils do. Thus, not all refiners benefit uniformly from discounted domestic crude oil prices. Only those refiners who are inframarginal see a benefit because they are able to purchase crude oil at a price lower than they would pay for imported crudes. This effectively establishes a paradigm where current policy dictates a no-cost call option for inframarginal domestic refiners. We return to this in more detail below.

How Deep Is the Implied Discount Given the Export Ban?

The framework presented above provides a theoretical argument for how price discounts might emerge when trade restrictions are present. But does evidence support theory? Figure 6 reveals monthly crude oil imports to the United States by API spanning January 2002 through December 2014. As seen in Figure 7, imports of light crude oils have been declining, with imports of the lightest crude oil imports virtually eliminated. This has been occurring lockstep with increased domestic production of light crude oils from the Bakken, Eagle Ford, Permian, and other shale formations. As argued above, in order for refiners to substitute domestic for imported crude oils, the domestic crude oils must be priced competitively. So, as the competitive margin for domestically produced crude oil is set by lower API crude oils, the discount for those light crude oils will grow. Figure 7 suggests that the competitive margin is shifting into the crudes with API in the 35-40 range. Notably, LLS is squarely in the middle of this range.

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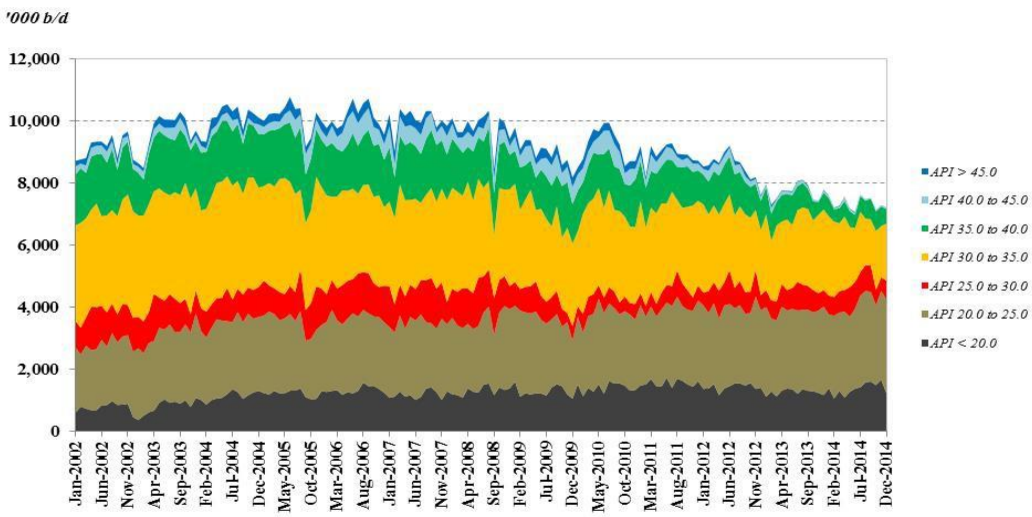
[4] Note that the positive differences are largely prior to January 2011, which indicates LLS was more likely to price significantly above its “equilibrium” value, as measured by equation (2), prior to January 2011 than after. Importantly, the significant discount observed for WTI relative Brent emerged around this time.

Figure 7 – US Crude Oil Imports by API (Monthly, Jan 2002-Dec 2014)



Source: US Energy Information Administration

Given the results from the hedonic pricing model estimated above, we can determine for particular sulfur contents what the domestic crude oil price at the competitive margin in the US will be. Then we can determine the implied discount for select domestic crude oils. Table 5 details these results. Specifically, we see the price at the competitive margin for different "representative" refineries where the designations are consistent with those in Figure 7. The sulfur contents across APIs are consistent with the US average for data on imports by API.

We see in the case where the competitive margin is established by Refinery #1 there is no implied discount for LLS, WTI and Bakken (Type I), but there is for the other crude oils. Interestingly, this reveals that even in the case where the US is still importing light crudes at API of 45, the lighter, sweeter crude produced in Eagle Ford and Bakken would still fetch a higher price internationally. Hence, there is incentive to export those crude oils even if the US is importing light crude oils. Perhaps this sheds some light on why there has been such a strong push to export condensates, which are more similar to Eagle Ford (Type II) crude oil in Table 5. In Table 5, the price reported for each crude oil is consistent with its own characteristics and a Brent price of $40, $80, and $120 per barrel, as defined by equation (2) above.

Table 5 – Implied Discounts for US Crude Oils

				Unconstrained Domestic Crude Oil Prices at Coast if Brent = $40					
				WTI	LLS	Eagle Ford I	Eagle Ford II	Bakken I	Bakken II
Representative Refinery	API	Sulfur	Competitive Margin	$ 40.68	$ 40.09	$ 42.27	$ 44.55	$ 40.20	$ 42.05
				Implied Discount					
#1	45.0	0.15	$ 41.70	$ -	$ -	$ 0.57	$ 2.85	$ -	$ 0.35
#2	40.0	0.39	$ 40.48	$ 0.20	$ -	$ 1.80	$ 4.07	$ -	$ 1.58
#3	35.0	0.98	$ 38.89	$ 1.79	$ 1.20	$ 3.38	$ 5.66	$ 1.31	$ 3.16
#4	30.0	1.15	$ 37.82	$ 2.86	$ 2.27	$ 4.45	$ 6.72	$ 2.38	$ 4.23
#5	25.0	1.54	$ 36.55	$ 4.13	$ 3.54	$ 5.72	$ 7.99	$ 3.65	$ 5.50
#6	20.0	2.02	$ 35.24	$ 5.43	$ 4.85	$ 7.03	$ 9.30	$ 4.96	$ 6.81

				Unconstrained Domestic Crude Oil Prices at Coast if Brent = $80					
				WTI	LLS	Eagle Ford I	Eagle Ford II	Bakken I	Bakken II
Representative Refinery	API	Sulfur	Competitive Margin	$ 81.38	$ 80.19	$ 84.62	$ 89.25	$ 80.41	$ 84.18
				Implied Discount					
#1	45.0	0.15	$ 83.45	$ -	$ -	$ 1.17	$ 5.80	$ -	$ 0.72
#2	40.0	0.39	$ 80.97	$ 0.41	$ -	$ 3.65	$ 8.28	$ -	$ 3.21
#3	35.0	0.98	$ 77.74	$ 3.64	$ 2.44	$ 6.88	$ 11.51	$ 2.67	$ 6.43
#4	30.0	1.15	$ 75.57	$ 5.81	$ 4.62	$ 9.05	$ 13.68	$ 4.84	$ 8.61
#5	25.0	1.54	$ 72.98	$ 8.39	$ 7.20	$ 11.64	$ 16.27	$ 7.43	$ 11.19
#6	20.0	2.02	$ 70.32	$ 11.06	$ 9.86	$ 14.30	$ 18.93	$ 10.09	$ 13.85

				Unconstrained Domestic Crude Oil Prices at Coast if Brent = $120					
				WTI	LLS	Eagle Ford I	Eagle Ford II	Bakken I	Bakken II
Representative Refinery	API	Sulfur	Competitive Margin	$ 122.09	$ 120.28	$ 127.00	$ 134.02	$ 120.63	$ 126.33
				Implied Discount					
#1	45.0	0.15	$ 125.23	$ -	$ -	$ 1.77	$ 8.78	$ -	$ 1.09
#2	40.0	0.39	$ 121.47	$ 0.62	$ -	$ 5.54	$ 12.55	$ -	$ 4.86
#3	35.0	0.98	$ 116.58	$ 5.51	$ 3.70	$ 10.43	$ 17.44	$ 4.05	$ 9.75
#4	30.0	1.15	$ 113.29	$ 8.80	$ 7.00	$ 13.72	$ 20.73	$ 7.34	$ 13.04
#5	25.0	1.54	$ 109.37	$ 12.72	$ 10.91	$ 17.63	$ 24.65	$ 11.26	$ 16.96
#6	20.0	2.02	$ 105.34	$ 16.75	$ 14.94	$ 21.67	$ 28.68	$ 15.29	$ 20.99

As imports of lighter crude oils cease, due to displacement by domestic light crude oils, the competitive margin shifts into lower crude qualities. The data in Figure 7 suggests that the competitive margin in the US is in the API 35-40 window, which is consistent with Refinery #3 in Table 5. Noting the preceding discussion, LLS also happens to fall in this window. As can be seen, as we move into this competitive margin, every US crude oil is discounted relative to what it would price in an unconstrained market, even at a Brent price environment of $40 per barrel. Of course, as previously noted the price at the wellhead will be lower than the international parity price implied by equation (2) because the cost of transportation must also be considered, but that will not affect the discount as calculated in Table 5. Specifically, $P_i = \hat{P_i} + \tau$ where P_i

denotes the sales price at the coast (or point of delivery) for crude oil *i*, $\hat{I}_i$ denotes the wellhead price, and τ denotes the cost of transportation (and any other cost) to deliver from the wellhead to market.[5] Since the calculated discount reported in Table 5 applies to the sales price (P_i), it will also apply to the wellhead price equally. So, the implied discounts reported in Table 5 exist as a result of the inability to trade the domestic crude oil internationally.

The results in Table 5 and as expounded above highlight a very important point. The *capability* of the US refining sector to handle light, sweet domestic crude oils is not at issue, nor is it even a relevant metric for this discussion. This follows because if domestic crude oil prices are discounted sufficiently (to the competitive margin defined by the price of a similar quality imported crude oil), then refineries have incentive to use it. To the extent that this is suboptimal for the US refining configuration, an additional discount may be necessary to incentivize the purchase, but notice we are now discussing price, not quantity. In effect, the ban on crude oil exports provides a "no-cost call option" on domestic crude oil for domestic refiners, appoint to which we now will turn.

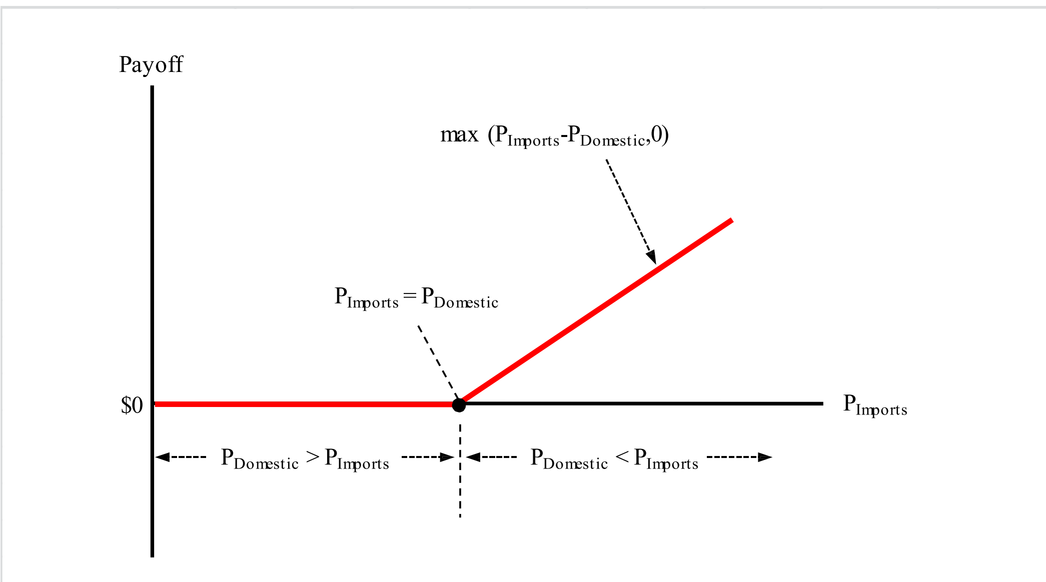
[5] The cost of transportation may indeed be higher in the current market than would be the case if the ban on exports did not exist. Specifically, the lack of an ability to aggregate volumes to access the international market will not encourage the development of pipelines, instead supporting smaller, lower capital cost options, such as rail. But, this is outside the scope of this study, and is the subject of ongoing Center for Energy Studies research.

III. The Export Ban as a "No Cost" Call Option and the Domestic Price of Gasoline

In this section, we consider the value of the constraint that the current policy on oil exports represents. We begin by using options theory in a relatively simplistic way for ease of exposition, and we focus only on the "refinery" as the consumer of domestically produced crude oil for the sake of simplicity. We then turn our analysis to the price of gasoline.

Consider Refinery X, which typically processes a medium quality crude oil, as in Figure 4 above. Refinery X has a choice. It can either (a) import a medium quality crude oil, or it can (b) buy and refine domestic light crude oil. The refiner will choose option (b) if the domestic light crude oil is a price competitive substitute, which will generally only occur if the domestic crude oil has no other marketable option. As indicated above, the abundance of domestic light crude oil relative to domestic refining capacity will determine how large a discount on domestic light crude is needed to encourage its use by Refinery X.

Figure 8 – Illustration of Payoff for a "No Cost" Call Option



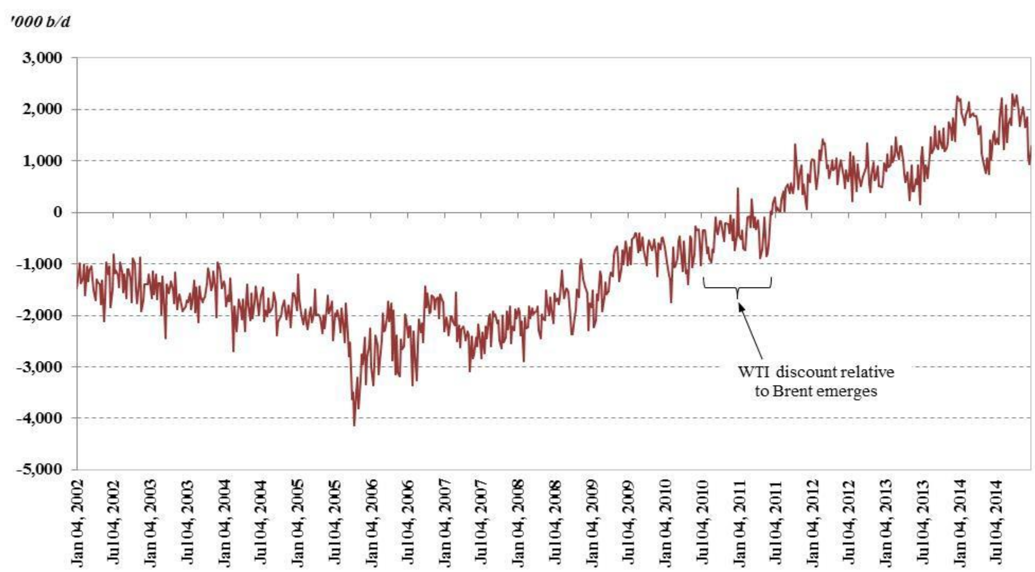
Refiner X, through policy, holds what amounts to a no cost call option on domestic crude oil (see Figure 8). If the price of domestic crude oil falls sufficiently *relative* to the price of imported crude oil of similar quality, the refiner will choose (b). But if the price of domestic crude oil rises relative to the import price, perhaps due to exports being allowed, the domestic refiner will choose (a). In either case, the refiner is maximizing profitability. Importantly, the refiner at the margin is indifferent to domestic versus imported crude oil and will operate where $P_{\text{Imports}} = P_{\text{Domestic}}$. Thus, only the refiners that are inframarginal see a positive payoff from exercising the implicit call option. In other words, the refiners of heavier crude oils who continue to import because the price discount is not sufficient to encourage use of domestic crude oils do not exercise the option (i.e.- choose (a)), and thus see no benefit.

Therefore, not all refiners benefit from the implicit call option that the current export policy creates. This raises an important point when considering the current policy; namely, the benefit accrues to a subset of refiners, but the costs accrue to all producers of light domestic crude oil. While this only considers first-order costs, ignoring the impacts on royalty payments and tax revenues paid at the local level where crude oil production occurs, it generally follows that the costs are more widely distributed. This, of course, begs the question, "How large are the first-order benefits and costs of the current policy?"

A complete accounting of the benefits and costs of the current policy is possible, but quite laborious. In particular, it requires knowledge of both the quantity and price of the crude oil purchased by each refiner. Then the value of the implicit call option could be calculated at a moment in time as well as across time to determine the accumulated value for a specific refiner as well as across the entire refining sector. Alternatively, since the accumulated industry-wide benefit of the implicit call option should be approximately equal to the cost borne by all crude oil producers, there is another approach. More specifically, the implicit call option effectively represents an income transfer mechanism across the petroleum product value chain, so we can approximate the accumulated industry-wide benefit/cost by assessing the discount (as calculated above) for each of the domestically produced crude oils multiplied by the quantity of each type of crude oil sold. Again, an exact accounting of this requires knowledge of the price and quantity of each crude oil sold by domestic producers over time. Such a precise calculation requires data that is not publicly available and thus is beyond the scope of this study. However, an options framework, assuming adequate data availability, can be used to assess the benefits/costs across the petroleum product value chain that results from the current ban on crude oil exports.

Despite the difficulty in providing a precise estimate of the accumulated benefits/costs of the implicit call option that current policy dictates, evidence is available that supports the use of such a framework. In particular, we can look at the evolution of trade in the petroleum product market to determine if there is data support for the notion that the implicit call option is being exercised by domestic refiners. We look to the petroleum product market because it faces no policy-motivated barriers to trade. As such, it is the point in the domestic petroleum product value chain where arbitrage with the international market can occur. This is also why an income transfer results across the petroleum product value chain when the implicit call option of purchases of domestic crude oil is exercised. Refiners can purchase discounted domestic crude oil, refine it, and sell petroleum products into a market with no trade restrictions, meaning exports are possible. The price in the petroleum product market, therefore, reflects international market equilibrium rather than domestic market equilibrium. This effectively enables the *inframarginal* refiners that are buying discounted domestic crude oil to buy at low price then sell their output at a higher price determined by the marginal crude oil to the international refined product market.

Figure 9 – US Net Exports of Petroleum Products

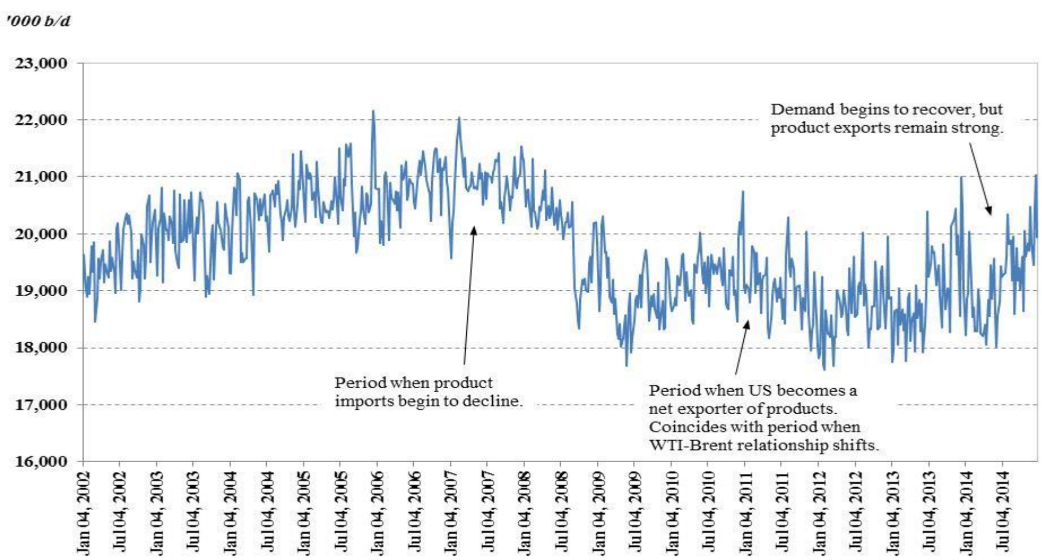


Source: US Energy Information Administration

In Figure 9, we see US net exports of petroleum products become positive in 2011. Moreover, the trend to becoming a net exporter coincides with the period in time where the relationship between Brent and WTI began to shift. This is consistent with the emergence of a strong arbitrage opportunity to the US refining sector due to domestic crude oil prices becoming discounted and domestic petroleum product demand faltering.

Importantly, the shift to becoming a net exporter of petroleum products occurred largely because demand in the US declined (see Figure 10) gradually between 2006 and 2008, then sharply in 2008/09. But the fact that there are no barriers to trade in petroleum product markets allowed domestic refiners to access international markets for product sales. Indeed, the ability to export petroleum products has been critical to the sustained health of the refining sector in the US.

Figure 10 – US Domestic Petroleum Product Demand



Source: US Energy Information Administration

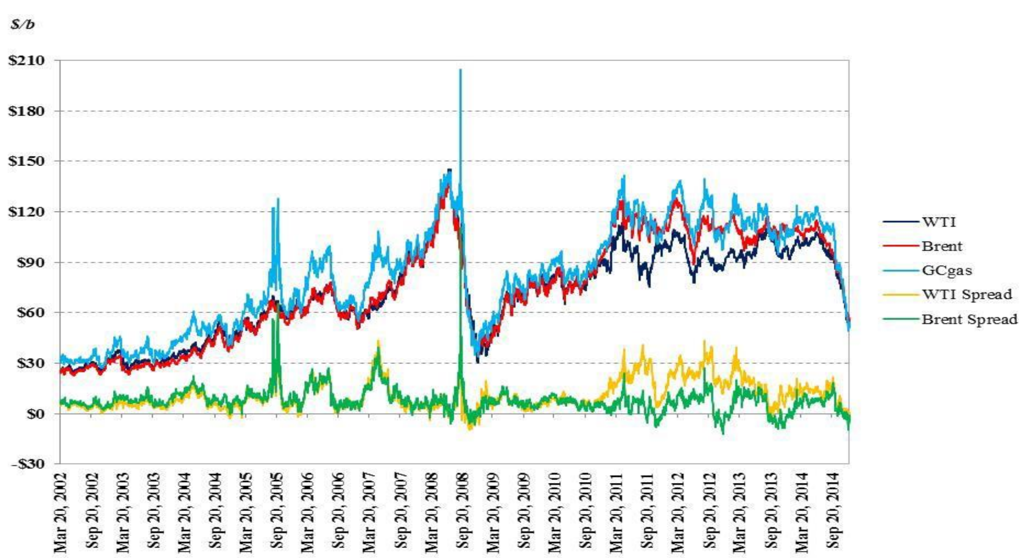
The argument that domestic petroleum product prices are determined in the international market because there are no barriers to trade is evidenced by data. We can see this in a relatively simple treatment by estimating the relationship between the price of WTI, denoted P_{WTI}, and the wholesale price of Gulf Coast gasoline, denoted P_{GC}. We can then repeat the analysis for the price of Brent and the price of Gulf Coast wholesale gasoline. So, we estimate the following

$$P_{GC,t} = \alpha_0 P_{WTI,t} + \sum_{i=1}^{12} \alpha_i D_i^{month} + \alpha_{13} D^{hur05} + \alpha_{14} D^{hur08} + \alpha_{15} D^{shift}$$

$$P_{GC,t} = \delta_0 P_{Brent,t} + \sum_{i=1}^{12} \delta_i D_i^{month} + \delta_{13} D^{hur05} + \delta_{14} D^{hur08} + \delta_{15} D^{shift}$$

where D_i^{month} is a monthly dummy variable that captures seasonal effects on the relationship between crude oil and gasoline prices, D^{hur05} and D^{hur08} are dummy variables to capture the impacts of the hurricane-related disruptions in 2005 and 2008, and D^{shift} is a dummy variable that is meant to capture any shift in the fundamental relationship between crude oil price and gasoline price taking a value of one after December 31, 2010, but is zero prior. We use daily price data nominated in $ per barrel spanning the period from January 2, 2002 through December 31, 2014. The data are plotted in Figure 11 and the estimation results are outlined in Table 6.

Figure 11 – Brent, WTI, and Gulf Coast Gasoline Prices (Daily, 1/2/2002-12/31/2014)



Source: US Energy Information Administration

There are a few things worth noting. First, the estimated coefficients α_0 and δ_0 are not statistically different, which indicates the other variables in the regression explain the differences that are visually evident in Figure 11. Second, the seasonal effects are pronounced and significant, confirming there is seasonal variation in the price of gasoline relative crude oil, with the largest effects occurring between March and September ($\alpha_3 \rightarrow \alpha_9$ and $\delta_3 \rightarrow \delta_9$, respectively), concurring with summer driving season. Third, the hurricane effects are very significant, which is consistent with observation; namely, the disruptive nature of the hurricanes of September 2005 and September 2008 are well documented and had a profound short term impact on gasoline prices relative to crude oil prices.

Table 6 – Estimation Results for Gasoline and Crude Oil Price Relationships

	Parameter	Std Err			Parameter	Std Err
α_0	1.0029	0.0052		δ_0	1.0011	0.0040
α_1	4.5948	0.4820		δ_1	6.0723	0.3773
α_2	6.9928	0.4958		δ_2	7.6168	0.3901
α_3	9.2443	0.4914		δ_3	10.5084	0.3846
α_4	10.9038	0.5013		δ_4	12.2720	0.3921
α_5	11.1245	0.4969		δ_5	12.6380	0.3883
α_6	9.3867	0.5047		δ_6	11.2683	0.3934
α_7	8.4471	0.5076		δ_7	10.2946	0.3956
α_8	9.0886	0.5031		δ_8	10.0408	0.3943
α_9	7.1557	0.5114		δ_9	8.6173	0.4001
α_{10}	4.4118	0.4898		δ_{10}	6.0762	0.3823
α_{11}	1.9164	0.4950		δ_{11}	3.6864	0.3865
α_{12}	1.6729	0.4837		δ_{12}	3.1597	0.3784
α_{13}	32.9847	1.4971		δ_{13}	34.5666	1.1883
α_{14}	63.6257	2.8886		δ_{14}	69.0974	2.2914
α_{15}	10.3829	0.3044		δ_{15}	-3.5029	0.2775
R^2	0.9946			R^2	0.9966	

Finally, and perhaps most importantly for this treatise, the shift in the prices of both Brent and WTI relative to gasoline is statistically significant in each regression, and the coefficients α_{15} and δ_{15} are statistically different from each other. The parameter estimates indicate that the price of WTI has been, on average, more than $10 per barrel lower relative to gasoline since the end of 2010, while the price of Brent has been about $3 per barrel higher relative to gasoline. The fact that the US is now a net exporter of petroleum products (since 2011) can explain some of this transition. In particular, as US exports of petroleum products increased since 2011, the arbitrage point for international gasoline and petroleum product prices has moved offshore. For example, to the extent that US gasoline exports are arriving in Europe, the point of arbitrage is now in Asia rather than the US gulf coast. Thus, the shift in the relative price relationship between gasoline and crude oil will reflect the cost to transport to the new point of arbitrage. Importantly, this will occur as long as the US is a net exporter of petroleum products, which is functionally tied to domestic refining capacity and domestic demand. The shift in WTI relative to gasoline cannot be explained in the same manner because WTI is not internationally fungible. Instead, WTI is landlocked, and its price must be set through arbitrage mechanisms that are farther downstream. Were the ban on exports to be lifted, it is likely that $\alpha_{15} \to \delta_{15}$, as the price of WTI would converge back into an equilibrium that reflects a full international arbitrage, similar to Brent. However, this would not equate to an increase in the price of gasoline. Rather, demand in the US is a much more important driver, all else equal, in determining the status of the US as a net exporter/importer going forward, and hence, the relationship between a fully arbitraged international crude oil price and domestic wholesale gasoline price.

In October 2014, the US Energy Information Administration (EIA) published its own analysis, “What Drives U.S. Gasoline Prices?” That research employed several techniques to evaluate the relationships between international gasoline prices and Brent and WTI. They also identified the end of 2010 as an important transition point and concluded, among other things, that Brent crude oil price is a more important determinant of US gasoline price across regions than the WTI crude oil price. In addition, the study concluded that lifting the ban on US crude oil exports would impact US gasoline prices through its effect on international crude oil prices and noted the impact of shifting trade on relative pricing. The approach taken in the EIA study is distinctly different from the approach taken herein, but the results are very similar. Thus, the result appears to be robust to methodology.

IV. Midstream Impacts

One implication of the current trade restriction is its impact on investment in the midstream – pipelines, rail, and port facilities, for example – to allow trade at the coasts into international markets. In general, when a barrier to trade exists, prices in the two markets on either side of the barrier cannot find an equilibrium that reflects quality differences and transportation costs. In fact, there is no incentive to develop capabilities to trade through the price differentials that emerge, precisely because the trade is prohibited. As such, if an assessment of the full cost of the trade restriction for the domestic economy is to be ascertained, we must understand the cost of infrastructure, the transportation cost of the trade, and the price differentials that would exist in an unconstrained environment. The last of these points, price differentials, was addressed above. Moreover, the price differentials are the signal that incentivizes, in an unconstrained market, investment in infrastructure to move to the coasts and expand port facilities to enable export. As noted above, if the US exports light crude oil, it will also import heavier crude oils as the current refinery configuration is optimized, which effectively amounts to a swap of a higher value crude oil for a lower value crude oil. Moreover, the ability to export petroleum products will not be compromised by exports of light crude oil. Rather, the primary determinant of this is domestic demand and refining capacity, while low natural gas prices – an oft underappreciated factor – have conveyed benefits for competitiveness relative to refiners abroad for virtually all refiners in the US.

So, what would lifting the export ban mean for the energy sector in the US? It would be transformative, provided the resource base has sustainable productive life. Significant investment capital would flow into pipeline and infrastructure development to aggregate to a location where transport to international markets could occur unimpeded. Investment in the midstream would eliminate the discounts for domestic crude oils, thus providing a price lift in the field for producers. Of course, the crudes would price at the wellhead in a manner that reflects international price parity less transportation costs. Nevertheless, in a market environment where profit margins are compressed due to overall lower prices, any reduction in the discount would carry significant implications for capital spending and employment in the sector. In turn, this carries positive implications for tax receipts. Any precise estimate of this is beyond the scope herein, and, quite frankly, not likely to be very accurate anyway given the uncertainties that exist in other domains, such as OPEC and general market response to greater US oil output, financial market developments and foreign investment flows, to name three. But, the qualitative implications are very clear as they follow directly from the economics of trade and investment.

In sum, the current policy carries costs for upstream participants that are quite obvious, but it also carries implications for the midstream that have not been fully internalized. Lifting the ban could invite capital flows into the upstream and midstream as a new trade opportunity is made possible. At the very least, the impacts of lifting the ban would be small, perhaps because the upstream opportunity needs higher international crude oil prices to remain viable and sustainable anyway. But, if that is the case, then lifting the ban will bear little consequence, as the US would shift back toward becoming more import dependent regardless. Thus, from the standpoint of the midstream opportunity, the cost of the current policy is clear, but any benefit is not. It is important to reconcile this with the current policy, particularly if we seek to provide domestic economic opportunity and enhance energy security.

V. The Concept of Energy Security

The concept of energy security gained prominence in public policy discourse following the oil price shocks of the 1970s. Indeed, the matter gains an even clearer focus when one notes that all but one recession since World War II has been preceded by a run up in the price of oil. This empirical revelation has prompted interest in designing policies aimed at mitigating the deleterious macroeconomic impacts of rising oil prices. In this context, "energy security" generally refers to the concept of ensuring an *adequate* and *stable* supply of energy at a *stable* and *reasonable* price. This goal is sought because there is a strong empirical correlation between macroeconomic malaise and high price/price volatility. In other words, as has been highlighted in the economic literature, recessions are highly correlated with energy market disruptions.

Note that we can capture energy security (and hence define a barometer for any policy aimed at achieving energy security) with three basic concepts: (i) adequacy of supply, (ii) stability of price, and (iii) relatively low price. First, adequacy of supply follows from the fact that energy is required for virtually all modern economic activity. Some sectors are, of course, more energy intensive than others – meaning some sectors may be more greatly impacted by changes in price or disruptions in supply – but energy input is a basic necessity for the modern economy. Second, price stability is important because irregular price volatility can be a source of uncertainty. To the extent uncertainty negatively impacts capital investment, this carries a negative macroeconomic impact. And third, the price level matters because it has a direct impact on household disposable income and industry budgetary considerations. If more financial resources are diverted to energy purchases, less is available for other activities.

Indeed, a large literature has emerged specifically investigating how energy (oil) prices impact an economy. The dramatic rise in oil prices in the 1970s and the subsequent recessions across multiple economies sparked research focused on a possible causal relationship between the two occurrences. Rasche and Tatom (1977), Darby (1982), and Bruno and Sachs (1982) found that indeed a negative relationship exists between oil price shocks and economic growth. A culmination of this early research is arguably the most famous article on the subject where Hamilton (1983) finds a connection between oil price fluctuations and business cycle, arguing that all but one post-World War II recession was preceded by a run-up in the price of crude. Since then, research has been grappling with this phenomenon.

To begin, high oil price and high oil price volatility have been attributed to higher production cost, which triggers inflation and a reduction in broad macroeconomic output indicators, such as Gross Domestic Product (GDP) or Industrial Production (IP).[6] This results in lower employment and investment levels.[7] Mork (1989) extended Hamilton's model into the late 1980s to encompass the dramatic decline in real oil price seen in the mid-1980s and noted that the relationship between oil price and the macroeconomy appears to be asymmetrical. In other words, a spike in oil price is detrimental to the economy, while a drop in the price does not necessarily lead to higher economic performance.[8] This led to a large literature on the origins of asymmetry. One pathway involves the role of uncertainty on investment. Bernanke (1983) and Ferderer (1996) showed that asymmetry could be a consequence of the uncertainty that a rapid change in oil price – up or down – can bring about. In fact, Ferderer lays out several potential "channels of transmission" from oil price to the macroeconomy that have been proposed in the literature to convey the correlation, some of which carry a causal tone.[9] These mechanisms can be summarized into

… inflationary effects:

- Increases in the price of oil (energy) lead to inflation, which lowers the quantity of real balances in an economy, thereby reducing consumption of all goods and services.

[6] See, for example, Hamilton (1983), Gisser and Godwin (1986), Burbidge and Harrison (1984), Tatom (1988), Huntington (1998), Coloni and Manera (2008), Man-Hwa Wu and Yen-Sen Ni (2011).
[7] See, for example, Carruth, Hooker and Oswald (1998) and Ferderer (1996).
[8] Evidence of asymmetry is found with respect to the impact of oil prices on a number of countries' economies, including countries in Asia (Cunado and Perez de Gracia (2005) and Abeysinghe (2001)), Europe (Cunado and Peres de Gracia (2003)), Latin America (Mendoza and Vera (2010)), and Africa (Chuku (2012)). As shown by Kang et al (2011) asymmetry is also present at the state level in the US.
[9] The literature is deep on these matters, involves many subtleties and variations on themes, and is hardly universal in its conclusions. The reader is referred to the following additional literature for more detail: Coloni and Manera (2008), Balke et al. (2002), Bjornland (2000), Esfahani et al. (2014), Cavalcanti et al. (2011), Al-Abri (2013), Kang et al. (2011), Mendoza and Vera (2010); Chuku (2012); Cunado and Peres de Gracia (2005), Abeysinghe (2001), Du et al. (2010), Baskaya et al. (2013), Hooker (1996), Barsky and Kilian (2004), Hamilton (1996), Hamilton (2011), Lee et al. (1995), Gronwald (2008), Miller and Ni (2011), Killian and Vigfusson (2011), Pinno and Serletis (2013)

- Counter-inflationary monetary policy responses to the inflationary pressures generated by oil (energy) price increases result in a decline in investment and net exports, and consumption to a lesser extent.

… trade balance effects:

- Oil (energy) price increases result in income transfers from oil (energy) importing countries to oil (energy) exporting countries. This, in turn, causes rational agents in the oil (energy) importing countries to reduce consumption, thereby depressing output. Interestingly, the literature notes that exporting regions tend to do better when prices rise, while importing regions do worse, which is consistent with the notion of income transfer through trade pathways.

… industrial influences:

- If oil (energy) and capital are complements in aggregate production, then oil (energy) price increases will induce a reduction in the utilization of capital as energy use is reduced. This, in turn, suppresses output.
- If it is costly to shift specialized labor and capital between sectors, then oil (energy) price increases can lower output by reducing factor employment in oil (energy) using sectors. If a recession is not protracted, the high costs of training will cause specialized labor to wait until conditions improve rather than seek employment in other sectors.

… and investment impacts:

- In the face of uncertainty about future price, which may arise when a price shift is unexpected, it is optimal for firms to postpone irreversible investment expenditures. Investments are irreversible when they are firm or industry specific. This, in turn, leads to a reduction in aggregate investment, a key component of macroeconomic activity.

Diversification of the overall energy supply portfolio is one means of reducing the cost of an oil market disruption, as long as oil prices and other energy commodity prices are not highly correlated. The ability to access a diversity of sources of energy supply to avoid economic dislocation is a crucial component in most energy security arguments. Notably, the energy intensity of an economy and the level of economic development have been found to bear influence on how oil price shocks are transmitted through the macroeconomy. In addition, economic structure matters, as evidence has been given that not all economic sectors are affected equally by oil prices.[10] As such, economic diversification is a critical path often raised when discussing the broader macroeconomic implications of changes in oil prices.

The concept of diversification is not limited to the overall energy supply portfolio; it can also refer to an ability to draw upon multiple sources for a single fuel. For example, any temporary market disruption can be overcome if there is an easily accessible alternative market outlet for the same fuel. This, in turn, mitigates the risk associated with uncertainty in demand (from seasonal influences, for example) or supply (due to unexpected disruptions, for instance). It follows, therefore, that diversification of supply *options* is generally viewed to be beneficial for energy security, a point that Europe has become all too familiar with over the past decade as tensions revolving around natural gas payments from Ukraine to Russia have resulted in temporary pressure reductions on pipelines providing supply to Europe from Russia traversing Ukraine. This motivates two important pathways in the energy security discussion: (1) storage and (2) fungibility through new avenues to enhance regional and international trade.

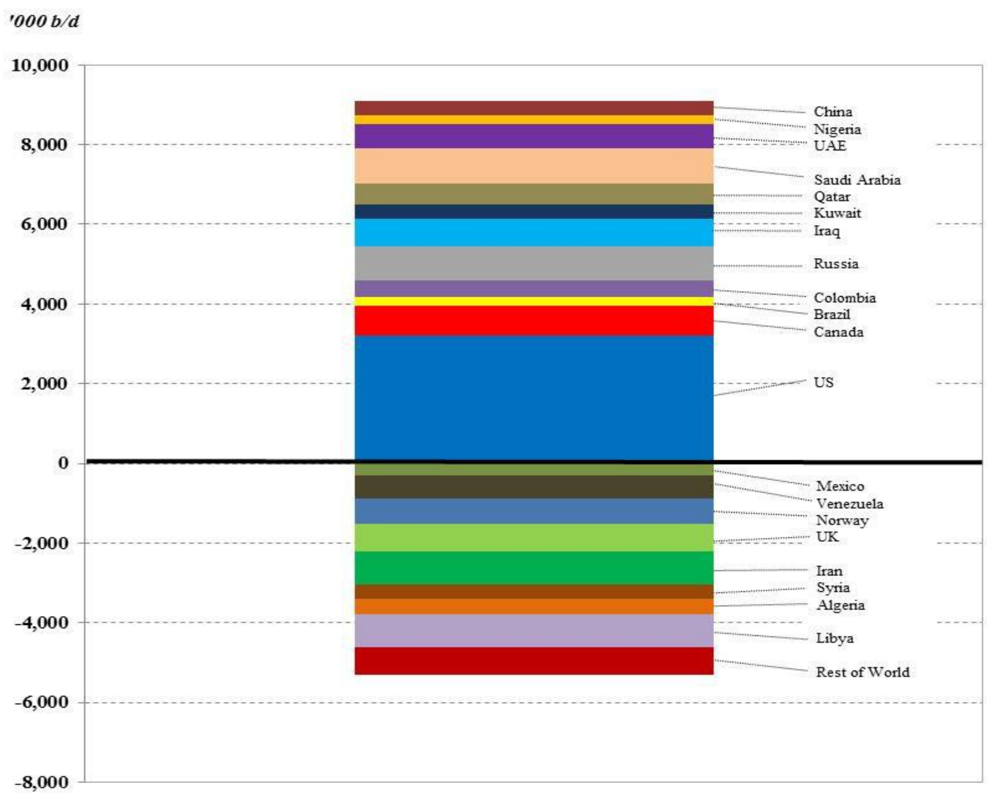
Interestingly, when the concept of energy security is raised, it has historically been, from the US-centric perspective, a discussion dominated by the need to secure supplies to sustain economic activity, or security of *supply*. However, from the producer's perspective, energy security refers to security of *demand*, or the need to ensure demand will be sufficient to support production and generate revenues. In the case of the world's oil exporters, this has often coincided with coming to grips with the balancing act of high near term prices while not encouraging demand destruction in the longer term. Recall, any temporary market disruption can be overcome if there is an easily accessible alternative market outlet for the same fuel. This principle applies to producers as well as consumers. At the time of this writing, the current US crude oil market is burgeoning with inventory, a fact that has seen WTI price drop to around $10 per barrel under Brent price, even in a sub-$60 global price environment. As noted in Table 3 above, the WTI price should be at just over $61 per barrel if Brent is at $60. Thus, the lack of ability to export is

[10] See, for example, Burbridge and Harrison (1984), Li and Ni (2002), and Huang (2008).

putting substantial pressure on domestic markets, thereby compromising domestic energy security from the standpoint of energy production.

The focus on energy *quantity* should not be the sole focus of policymakers. The literature demonstrates that *price* and *price volatility* are the mechanisms through which oil affects the macroeconomy. As such, the notion that adding US exports to the global market could add a source of supply from a relatively stable country should be considered. In fact, the last six years have borne witness to increased oil output from the US that has offset the production declines seen in countries such as Libya, Algeria, Syria, and Iran due to local strife and/or sanctions (see Figure 12).

Figure 12 – Change in Global Crude Oil Production by Country from 2008-2013



Source: BP Statistical Review

Given the above, it is apparent that growth in US domestic crude oil production over the last six years has added stability to the global oil market. In fact, absent the growth realized in US output, it is possible that prices would have reached much higher levels and been more volatile, notwithstanding supply responses in other parts of the world. Given the preponderance of findings in the energy security literature, this would have created a much more significant drag on the US economy as well as the entire global economy. As such, the impact that US exports could have on global market stability should not be understated, nor should it be disregarded in the calculus of future policy.

In the wake of the rapid growth of domestic production of light crude oil in the US, both perspectives – security of demand and supply – are now meaningful. The consumer economy that has long characterized the US is still relevant, but now the perspective of the producer should be considered if we are to meaningfully address energy security in an all-encompassing manner. A general yet simple justification of a policy-motivated constraint on trade would be that the aggregate economic impact on consumers far outweighs the aggregate economic impact on producers. However, absent a constraint on trade in derivative products, the effect of the constraint on trade becomes isolated to producers of the raw material, which renders its macroeconomic impacts to be considerably smaller.

With regard to the current ban on crude oil exports, because there is no such ban on trade in petroleum products, the primary beneficiary is domestic consumers of raw crude, such as refiners, while the consumers of petroleum products – the general public – are still subject to prices that are determined in the international market. Therefore, the energy security calculus reduces to one of comparing the economic impacts of a trade constraint on upstream producers and midstream players with the effect on refiners. While this can be interpreted as reducing the argument to being between two primary special interest groups, the *indirect* impacts must also be considered. In other words, the employment impacts, which are derivative of the relative labor intensities in the two competing sectors, are germane to the debate, as are the local and federal tax revenue implications, as well as the possible implications for petroleum product prices. All of these issues have been addressed in previous studies.

By and large, the general public and consumers of petroleum products do not see significant *direct* impacts from the existing policy, but the indirect impacts are potentially significant. While energy security is generally tied back to oil prices, it should be recognized that the general public does not directly consume oil; it consumes oil products. Therefore, given the fact that the current policy does nothing to insulate consumers from international price movements in petroleum products, it does not provide any broad energy security benefit. Indeed, as the constraint on exports becomes increasingly binding, the benefits of US production as a stable source of supply to the global market become muted. In turn, such benefits do not pass through to consumers of petroleum products because their price is determined in a fully arbitraged international market.

VI. Trade Enhances Energy Security

When discussing energy security, the focus is typically on price *level* and/or price *volatility* rather than quantity. In fact, various studies have shown that investment and consumption at the macroeconomic level is more greatly affected when prices suddenly and unexpectedly change (see, for example, Lee et al. (1995)). So, if energy security is a goal, then being able to cope with unanticipated shocks is vital. Regarding policy, pursuing measures that contribute to reasonable and relatively stable price levels will aid in achieving greater energy security.

If price changes rapidly over short periods of time, price is generally said to have high volatility.[11] Volatility can also occur in clusters, as might be the case when unexpected events create short-term stresses in the market. If this is the case, then we may have a price series that is characterized by periods of low volatility with periods of high volatility interspersed. It is generally these periods of high volatility that are of concern, particularly when they are *unexpected*. Increased uncertainty associated with elevated price volatility has been linked to changes in firm behavior, which translates to reduced investment, increased unemployment, and lower output (see Dixit and Pindyck (1994)). Since high price volatility is associated with negative economic outcomes, some have argued that artificially setting a price at a particular level would avert the consequences associated with volatility. However, such a policy intervention would mute the information carried in price movements, which can lead to inefficient levels of investment and consumption. Fortunately, it is a well-established principle that an unimpeded ability to trade a commodity, or high fungibility, reduces price volatility.

Fungibility can be enhanced through the use of inventories and/or through a greater number of trading partners. Inventories are a mechanism through which *intertemporal* arbitrage opportunities are enhanced by allowing commodities to be traded through time from low price

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[11] Price volatility is generally measured by examining the distribution of the log returns of price, defined as $R_t = \ln P_t - \ln P_{t-1}$. If price changes rapidly over short periods of time, then values of R_t will be large and price is said to have high volatility. However, if price is not changing very much, then R_t will be near zero and price is said to have low volatility. So, if the probability density function of R_t has what we call "fat tails," then it is generally said to exhibit high volatility and the price series is generally associated with greater uncertainty. If volatility occurs in clusters, a time series analysis known as GARCH (generalized autoregressive conditional heteroskedasticity) is employed for analysis. *Unexpected* shocks are then defined as price changes that move outside a particular interval (such as one standard deviation), where the interval is conditional on the estimation results.

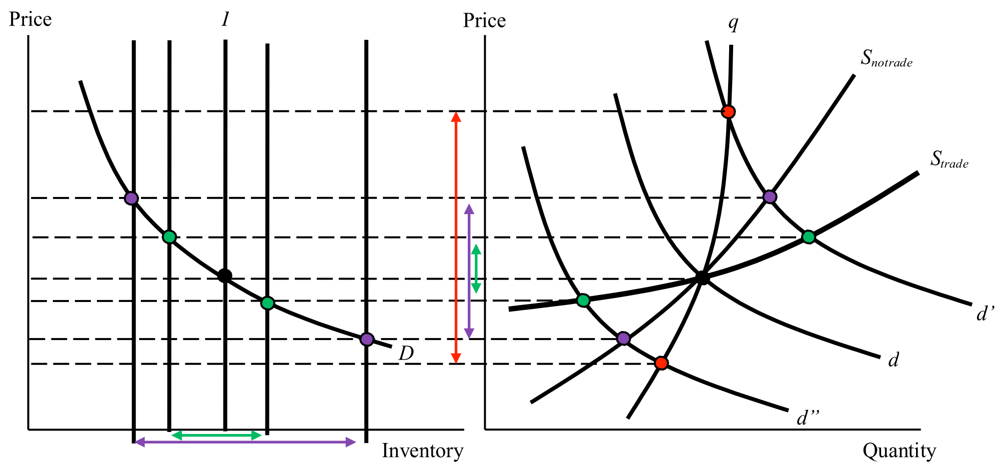
periods to high price periods. Similarly, increasing the number of trading partners enhances *spatial* arbitrage opportunities by expanding the potential trades that can be executed at any moment in time. For example, if a regional market experiences a shortage of supply relative to demand, the outcome absent additional sources of supply – through, for instance, imports from another region – would be an extreme price increase. However, if supplies from another region can be traded into the stressed region, then price will not rise as dramatically. Similarly, if supplies are bottlenecked in a particular region, the price in that region will decline until local demand increases or new demand sources are introduced – perhaps through exports to another region. In general, increased fungibility enhances the short run elasticity of supply as it allows more market mechanisms to mitigate unexpected movements in supply or demand.

The role of trade in mitigating price dislocations can be seen in many markets. For instance, there are recent examples of unanticipated events leading to the realization of constraints in natural gas markets, only to be subsequently alleviated by investment and trade. For example, the price of natural gas in Pennsylvania has recently declined due to an inability to move rapidly growing supply away from the producing areas of the Marcellus shale. This has encouraged investment in pipeline takeaway capacity as well as interest in LNG exports from the facility at Cove Point in Maryland. Another example lies in the global LNG market where Asian LNG prices jumped dramatically in the wake of an unexpected demand shock that was triggered by the nuclear disaster at Fukushima in Japan. The surprise shift in demand forced the realization of a constraint on the capability of existing supplies, but, in the wake of this, significant capital has flowed into the expansion of global LNG export capacity, including from the US. In sum, the fact that trade *can* occur incentivizes investment in new infrastructure to increase trading. This enhances fungibility, which ultimately recalibrates regional prices and mitigates price volatility. If a barrier to trade exists, as is the case with regard to US oil exports, there is no incentive for investment in infrastructure to facilitate trade, so an alternative arbitrage mechanism must emerge or a reduction in domestic production must occur.

In order to formally address these matters, we can examine the implications of trade for price formation using a class of models aimed at understanding the price stabilizing effects of storage capabilities (see, for example, Kawai (1983) and Jacks (1987)). We generalize the framework to highlight the role that trade plays in enhancing fungibility, which provides some interesting insights into understanding current US crude oil prices. Referencing Figure 13, we note three distinct outcomes defined by different market conditions:

1. We begin with the market equilibrium, defined by the equilibrium in red. Focusing only on the panel on the right, if demand, *d*, is high relative to domestic production capability, *q*, then unexpected swings in demand, denoted as *d'* to *d"*, can drive extreme price shifts.
2. When we introduce an inventory market, captured in the panel on the left, we note that storage injections and withdrawals will shift the inventory level, *I*, and result in an enhancement of short run deliverability, denoted as $S_{notrade}$. The ability to move volumes in and out of storage mitigates price volatility by facilitating *intertemporal* trade.
3. Finally, when we allow imports and exports to enter the market, we see short run deliverability, denoted as S_{trade}, is even further enhanced. This derives from the fact that imports (exports) will only occur if domestic price is high (low) relative to other regions. In this latter case, the ability to use inventories and the ability to trade further mitigates price volatility. Moreover, it reduces the need for storage injections/withdrawals.

Figure 13 – Trade, Storage, and Price Formation



There are a couple of points worth noting here that are germane to the current crude oil market. First, the ability to trade – both intertemporally via the inventory market and spatially through trade with another region – makes the deliverability curve for a commodity more elastic. Thus, unexpected movements in demand will not tend to be accompanied by large swings in price, and more stable prices due to the ability to trade through unexpected events is a desirable outcome in the quest for energy security. Second, the current WTI crude oil price is burdened by an inability to export oil from the US, which means the inventory market is the only mechanism for arbitrage to mitigate price volatility. However, should inventory capacity become stressed, then the ability to inject into storage disappears, and the deliverability curve, $S_{notrade}$, collapses to the case in Figure 13 in which there is no capability to arbitrage intertemporally or spatially. In other words, $S_{notrade}$ collapses to q. The outcome is an even more extreme decline in price. An obvious implication is that an ability to export circumvents this entire outcome. Namely, the ability to trade renders the need for storage injection/withdrawals to be lower, which conveys a lower overall risk of extreme price movements. It should be noted that the analysis above is relevant for understanding domestic price volatility *relative* to international price volatility. No restrictions on the ability to trade should render the two almost identical.

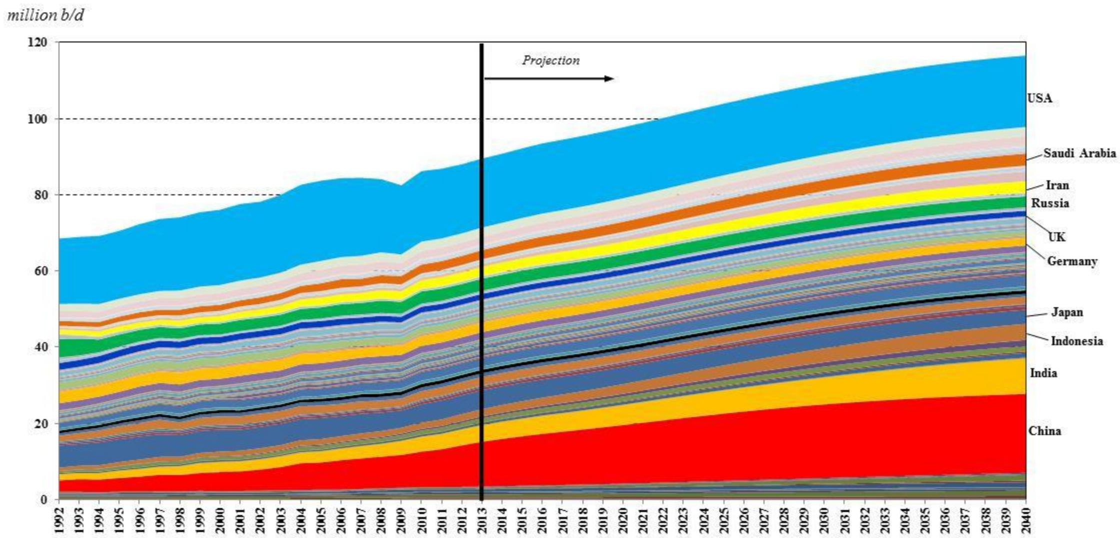
So, as seen in Figure 13, allowing exports would provide price support for domestic crude oil, which would generally be accompanied by a higher level of production. The model presented above is a relatively simple illustration of the effect of increasing fungibility. Specifically, the ability to augment domestic production capability with international trade renders the capability to deliver supply to the domestic market more elastic. This also has implications for price volatility, which, in turn, has implications for investment throughout the crude oil value chain.

Taking the above thesis one step forward, it is possible to discuss the implications for global crude oil markets if the US export ban is lifted. In the global crude oil market, new production opportunities are constantly needed to balance supply and demand at a *reasonable* and relatively *stable* price so that economic growth is not stymied. As seen in Figure 14, global crude oil demand is projected to increase to just short of 120 million barrels per day by 2040.[12] The majority of the projected growth will come from developing Asian economies, particularly China and India, but also several other Asia-Pacific countries. The ability of traditional Middle East oil producers to provide sufficient supplies to the global market may become compromised by

[12] Importantly, this is only one projection. Indeed, there are alternative outlooks that posit different growth rates, and even some that posit a peak in global demand at around 100 million b/d. According to the CES model for total primary energy demand, energy efficiency and other measures would have to drive a global reduction in energy intensity at a rate over 50% greater than witnessed historically in any single nation. Moreover, even if this does occur, the arguments herein are unaffected.

demand growth in those countries. In particular, demand in the countries of the Middle East is projected to grow among the fastest in the world, attributed to economic growth as well as heavy domestic subsidies on energy prices. Of course, a lifting of subsidies would abate the projected growth in those countries, but absent a significant shift in domestic energy pricing policy, these countries will be challenged to maintain, much less grow, exports. This, in turn, signals a need for new sources of supply from other parts of the world.

Figure 14 – Global Oil Demand Outlook by Country, 1992-2040



Source: Center for Energy Studies at Rice University's Baker Institute for Public Policy

Unconventional and deep water resources from countries such as Canada, Brazil, Argentina, Venezuela, and the US could play a major role in balancing the global oil market going forward, as could potential supplies from Mexico in the wake of energy reforms. In all, this could move the geopolitical compass toward North America and the Western Hemisphere more generally. Those countries with abundant, economically accessible resources with favorable investment climates – such as Canada and the US – could be global leaders in future supply developments. If such a future were to unfold, US foreign policy and geopolitical concerns would likely look very different in 20 years.

The importance of the US as a potential source of global oil supply over the longer term cannot be overstated. In fact, as referenced in Figure 12 above, the US has already played a critical role in balancing global oil markets in the wake of declining supplies due to economic depletion of reservoirs in the North Sea, lack of investment in Venezuela and Mexico, and regional civil strife and/or sanctions in Algeria, Libya, Syria, and Iran. Going forward, the role of the US as a stable supplier to global markets is conditional on the ability of US production volumes to access the global market. In addition, energy trade policy involving Canada and Mexico will define the role of the US, and North America more generally, as a secure source of supply for the global oil market. Indeed, the US could take a leadership role in transforming global trade in crude oil, potentially redrafting the international crude oil trade map. This would carry geopolitical benefits and establish the US as a trusted partner in discussions focused on a variety of matters in international trade more generally.

VII. Concluding Remarks

Over the past decade, innovative techniques involving the use of horizontal drilling and hydraulic fracturing have triggered unprecedented increases in production of crude oil, natural gas, and natural gas liquids from shale. With regard to crude oil specifically, the domestic production surge has led to a large decline in US crude oil imports in just the last six years and opened intense discussions about exporting crude oil. We have laid out a framework for discussing the relevant issues and applied different empirical tools to evaluate these matters.

Development in the Bakken and Eagle Ford shales has driven the bulk of the increase in domestic crude oil production to date, and the crude oils coming from those locations is generally lighter and sweeter than WTI and Brent. In an unconstrained market setting, this would normally equate to those crude oils pricing at a premium when delivered to market. However, this has not been the case, as prices indicate that the export ban already presents a binding constraint on the domestic market. As such, we developed an approach based on a hedonic pricing method to evaluate the extent of the discounts being realized on domestic crude oil prices over a wide range of global crude oil price environments, ranging from $30 to $150 per barrel. The results indicate that the current export ban matters even in a relatively low oil price environment. In fact, in a low price environment the need to address the export ban is heightened, as it could eliminate the current price discount thereby supporting profit margins and upstream activity.

The benefits of lifting the ban extend beyond the price uplift it could provide to the upstream. If the ban were lifted, it would immediately allow the sale of domestic crude oils into the international market where prices reflect differences in crude quality and therefore would be higher for the light crude oils being produced from domestic shale plays. This would, in turn, incentivize investment in the midstream aimed at moving domestic crude oils to the coast – through pipelines and other means – for export through port facilities, where additional investment would also be required. Therefore, the current ban on crude oil exports is also leaving investment in infrastructure unrealized.

In the wake of the domestic supply surge, the discount that has emerged is largely due to a shifting competitive margin for sales of domestic light crude oils. In particular, the US refining sector has backed out imports of light crude oil by substitution with domestic light crude oils. In fact, with growing domestic production, refiners are now backing out imported crude oils that are heavier than WTI and light oils from shale. However, since the refineries that normally import those medium quality crude oils have already sunk the investment costs to process the heavier crudes, they will only switch to domestically sourced lighter crude oils if they are priced competitively with the heavier crudes the refiners would normally buy. Hence, the domestic light crude oils must be discounted to be sold on that competitive margin. There is strong evidence that the competitive margin is consistent with crude oils of API 35-40, and LLS sits squarely in that window. In fact, LLS has priced fairly consistent with the results implied by the hedonic pricing method, but it has recently seen episodic discounts during periods of robust domestic storage and/or refinery turnarounds. However, if domestic production continues to grow the competitive margin will shift, and LLS will become consistently discounted relative to crude oils of similar quality in the international market. Regarding the domestic refining sector's handling of domestic light crude oil, it is not a matter of *capability*; it is a matter of *price*. Moreover, as discussed above, only the refiners that are inframarginal see any benefit from discounted domestic crude oil; those that normally refine heavier crude oils are not affected.

Indeed, refiners' ability to access foreign markets has provided them with new market outlet opportunities even as domestic demand for petroleum products has declined since 2006. Domestic refiners have reduced their imports of crude oil, effectively displacing them with domestic crude oil, while increasing the sale of refined products to the international market. Indeed, refinery capacity utilization in the US has remained robust, despite lower domestic petroleum product demand, because the US has become a net exporter of petroleum products over the last few years.

Some have argued that crude oil exports would increase gasoline prices in the US. However, because refined products, such as gasoline, can be freely exported, the prices of refined products sold in the US are in a parity relationship with international prices for refined products. Thus, the discounted prices of oil produced in the US are not reflected in US gasoline and refined product prices. Thus, removing the crude export ban, although it would raise the price of domestic crude oil, would not increase the price of gasoline in the US. In fact, the results herein indicate that the biggest determinant of US gasoline price is the price of oil in the international market. But it is also influenced by the point of arbitrage in the petroleum product market. Since the US emerged as a net exporter of petroleum products a few years ago, the results herein suggest the point of arbitrage in the global product market has shifted away from the US. However, if demand were to rebound to levels not seen since 2006/07, the point of arbitrage would shift back to the US, which, by itself, would lead to an increase in gasoline price, regardless of export ban. Thus, domestic demand is a very important factor in considering the price of domestic gasoline.

We also provide an in-depth analysis of the implications of lifting the crude oil export ban on energy security. Counterintuitive to some, removing the ban generates distinct energy security benefits by providing a more stable and secure source of crude oil to a growing global market. Greater stability would lessen international market price volatility, which will affect petroleum product prices. It is well documented that heightened price volatility is associated with macroeconomic malaise. Consumers purchase petroleum products, not crude oil. So, if allowing US crude oil exports increases fungibility thus dampening oil price volatility, to the extent that it reduces petroleum product price volatility an energy security benefit will be transmitted to US consumers. More generally, the US has the opportunity to lead an oil industry transformation that would see lines of global oil trade redrawn, as North American production, and Western Hemisphere production more generally, could capture a larger portion of the growing international market. This would, should it transpire, have tremendous benefits for US foreign policy endeavors in its dealings with hostile oil producing nations. It would also lend greater stability to the global crude oil market, thereby conveying benefits more broadly to the US and its allies.

Finally, we have not addressed the role of international production disruptions – such as civil strife, sanctions, or declines due to country-specific sector mismanagement – nor have we addressed the role of OPEC or national oil companies more generally. A full treatment of these matters is forthcoming in later research. But, with regard to the research presented herein, each of these international issues affect the general US consumer base regardless of the ban on US crude oil exports because they all impact the price of petroleum products, which, as previously noted, is determined in a fully arbitraged international setting. So, to the extent that US crude oil exports could reduce the impact of such unexpected disturbances on the global oil market, benefits would accrue to US consumers.

There are a number of other policy concerns that motivate an opposition to lifting the ban on crude oil exports. Perhaps one of the most compelling arguments for a number of constituents is that lifting the ban would result in more production and carry environmental costs. However, as pointed out by Bordoff and Houser (2015), it is more efficient to use environmental policies to address environmental concerns. Consideration of the US export ban is a trade policy issue, and, in general, trade policy should be used to address international trade affairs.

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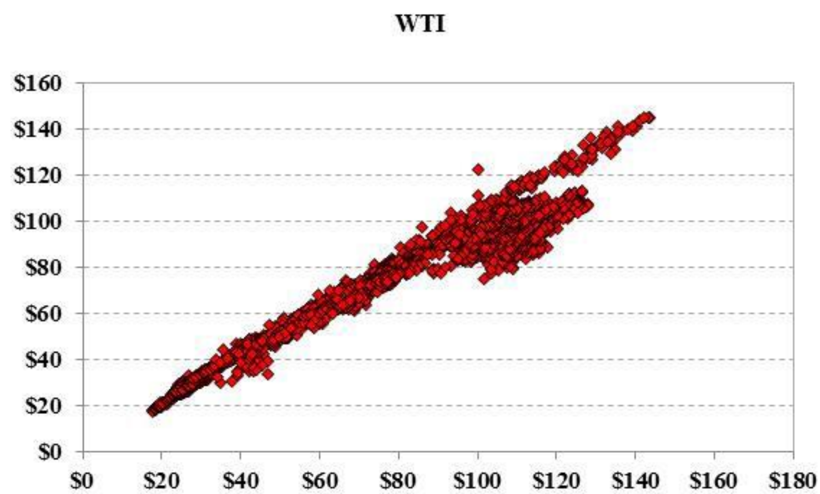
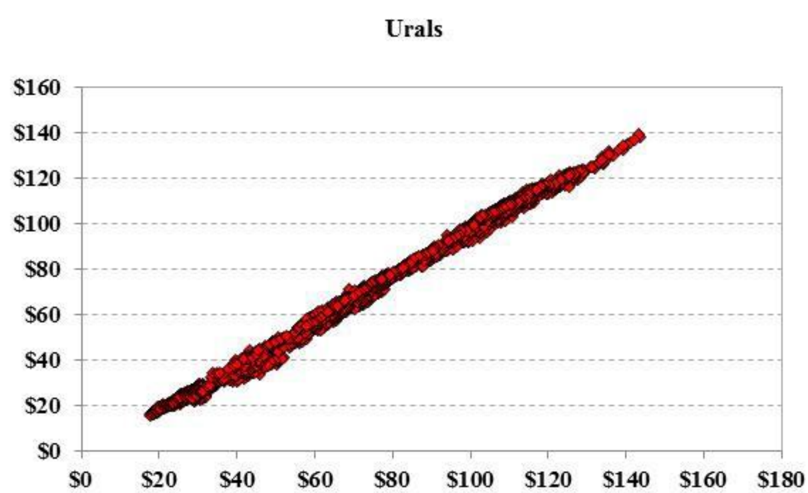
IX. Appendix

The following graphs highlight the point that every crude oil, except two, in the sample that was used in the panel analysis displays a very stable relationship to Brent crude. In fact, the North American crude oils that deviate from the linear pricing relationship demonstrated by the internationally traded crude oils only do so because of the binding constraints on trade that have impacted their prices. In each figure, the price of the respective crude oil is plotted against Brent, where Brent is on the x-axis. All time-series consist of daily data spanning the period from January 2, 2002, through December 31, 2014.

Figure A1 – Crude Oils Used in Analysis versus Brent





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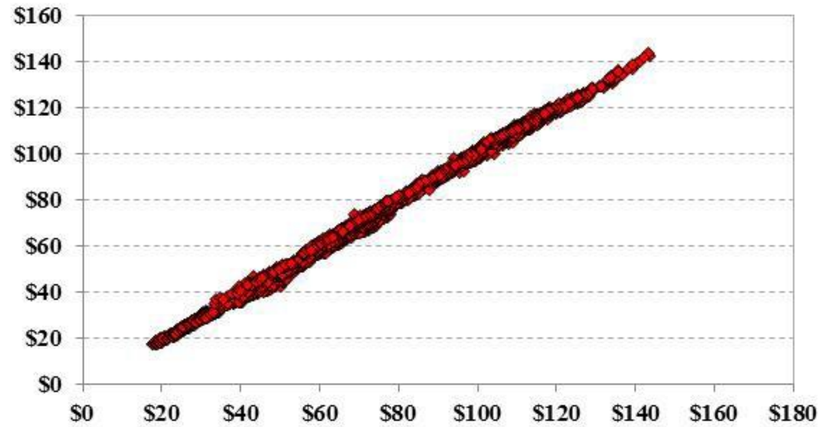

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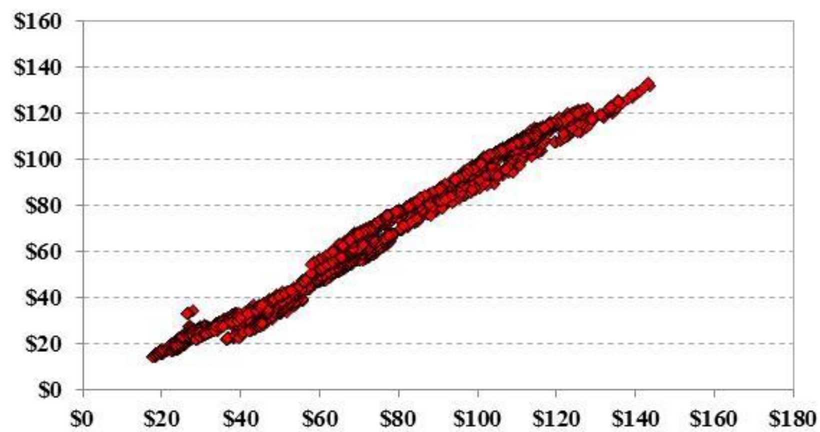

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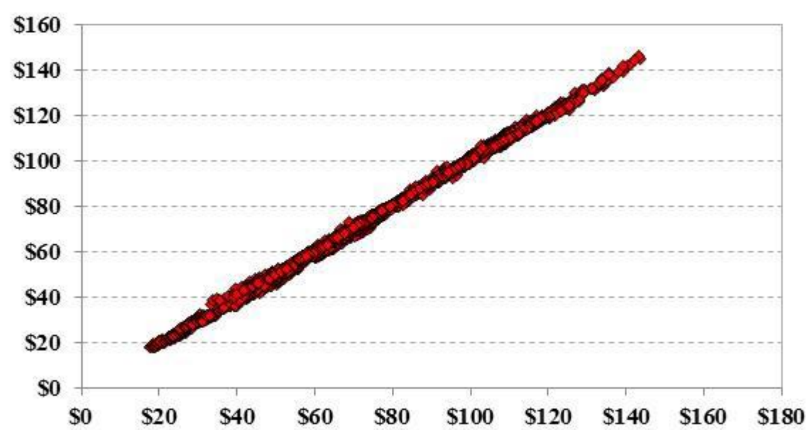

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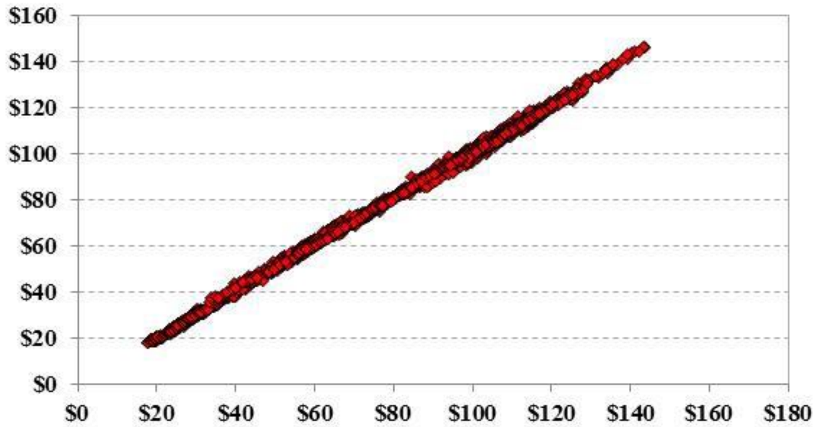

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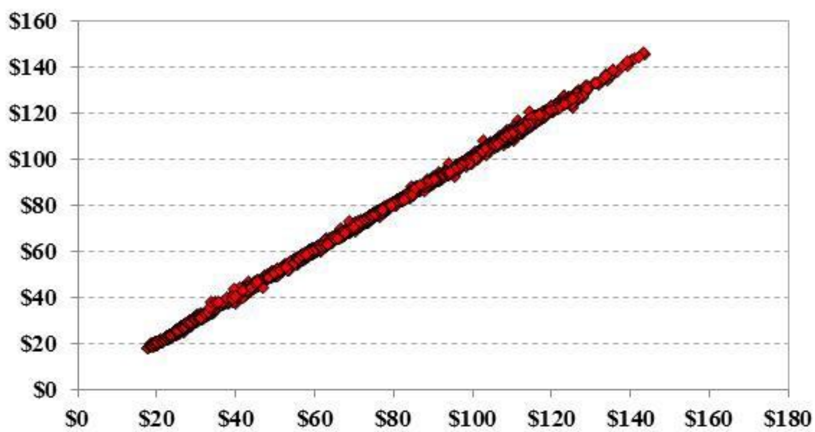

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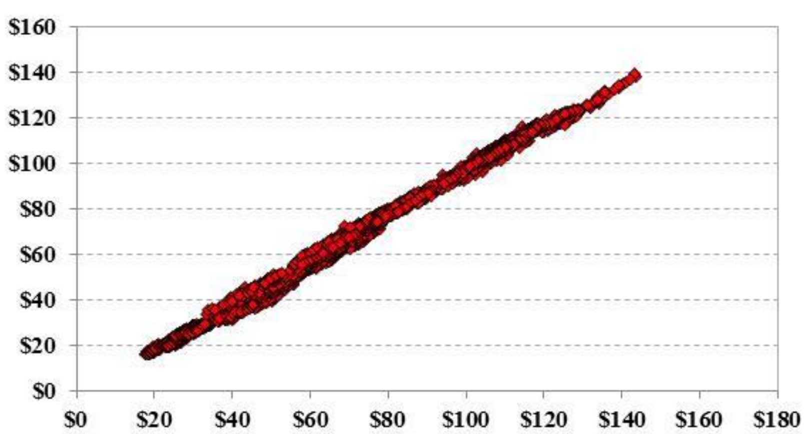

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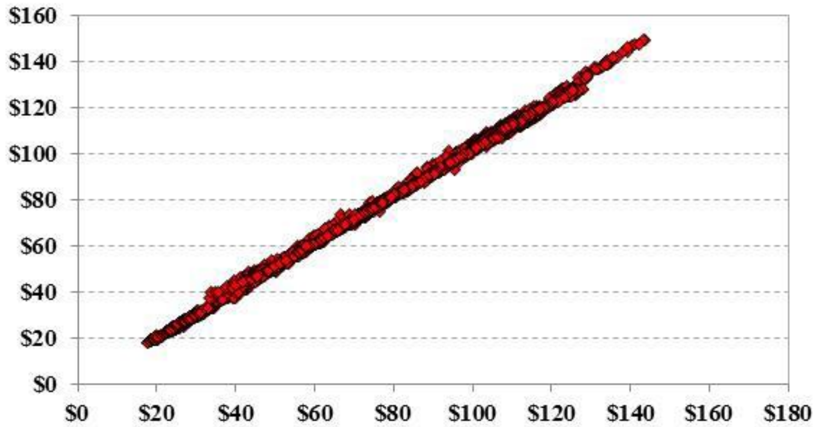

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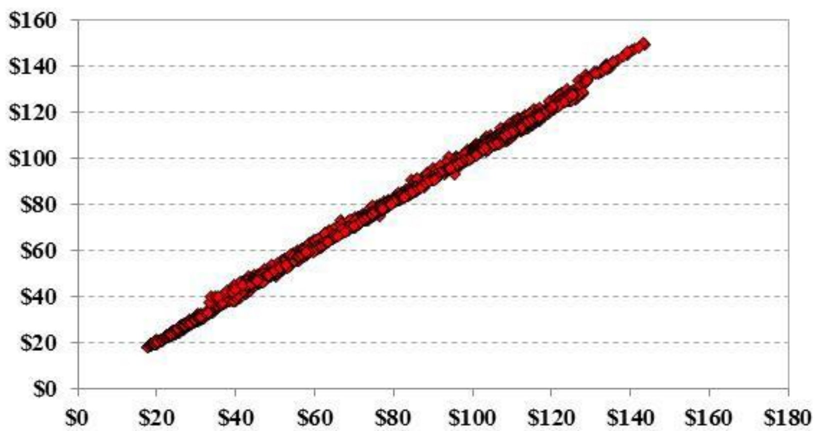

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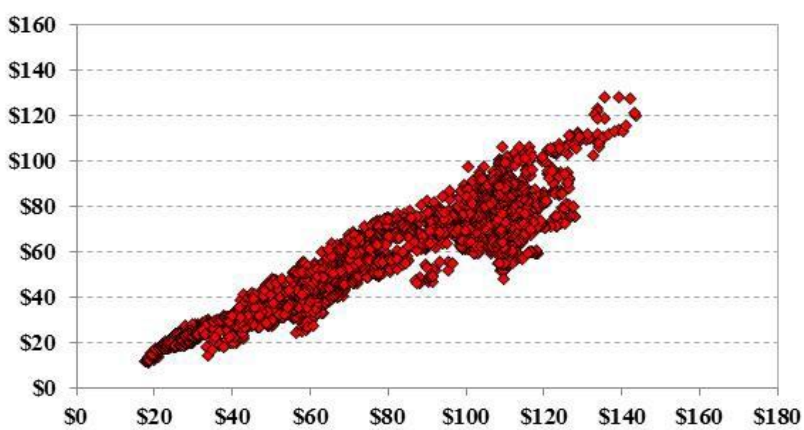

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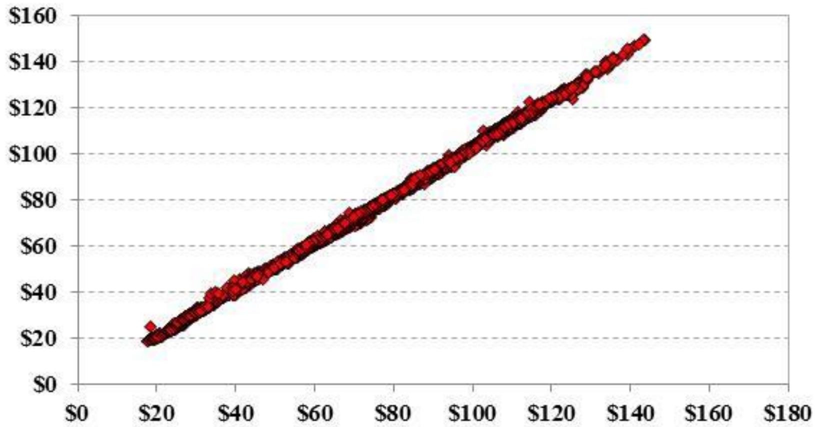

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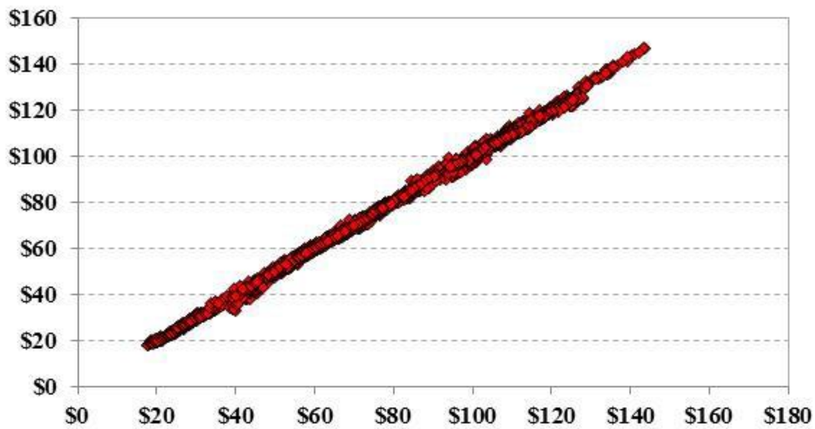

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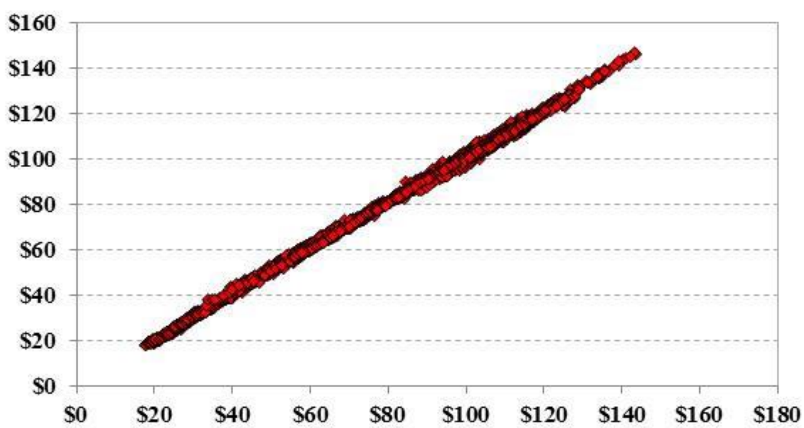

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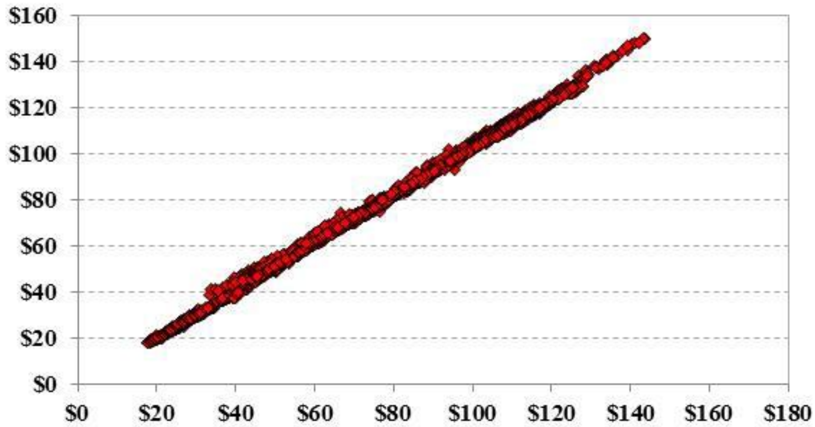

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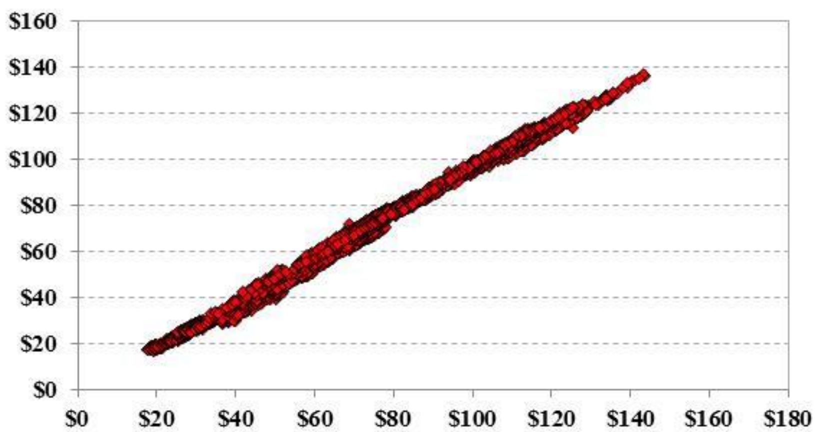

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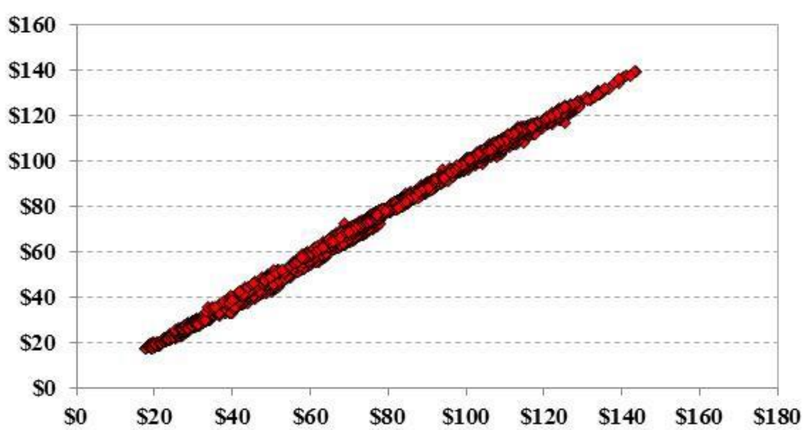

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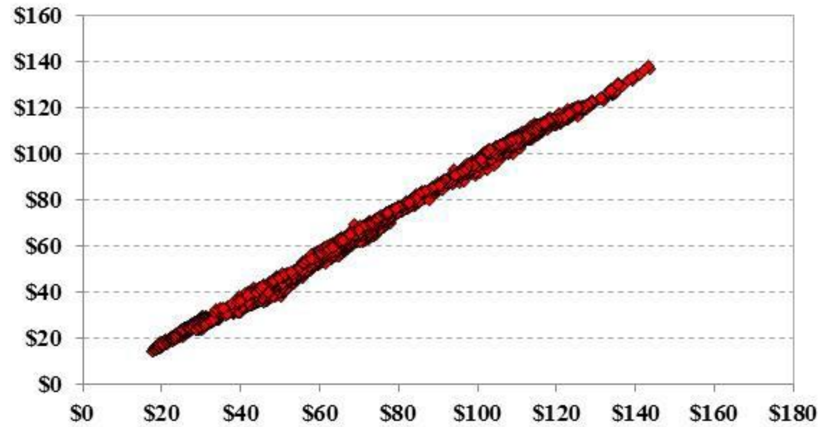

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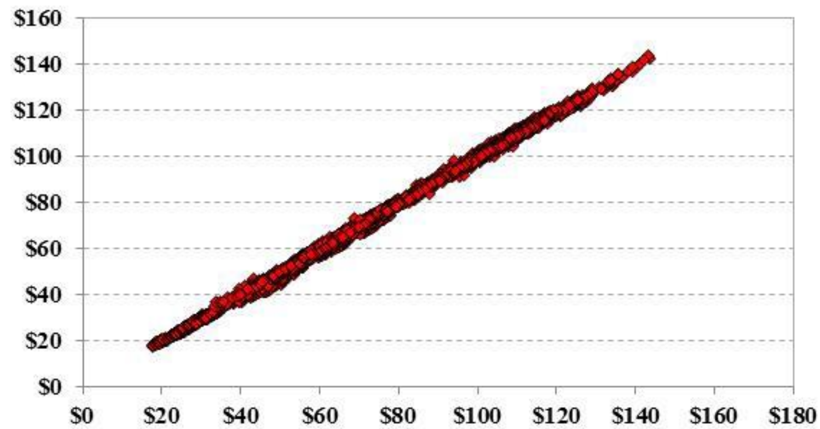

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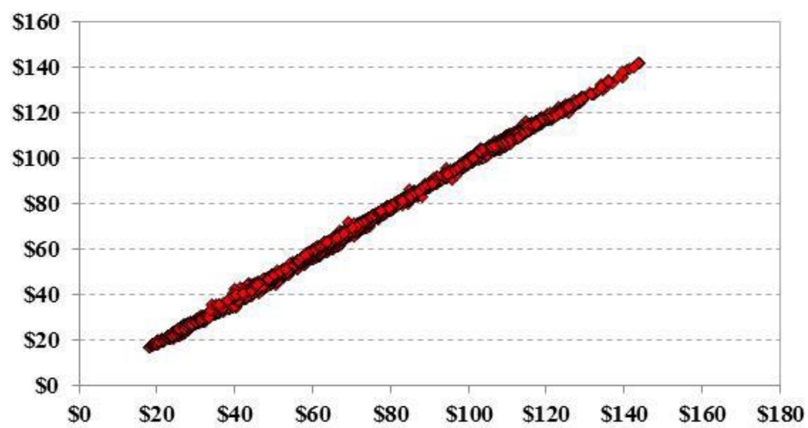

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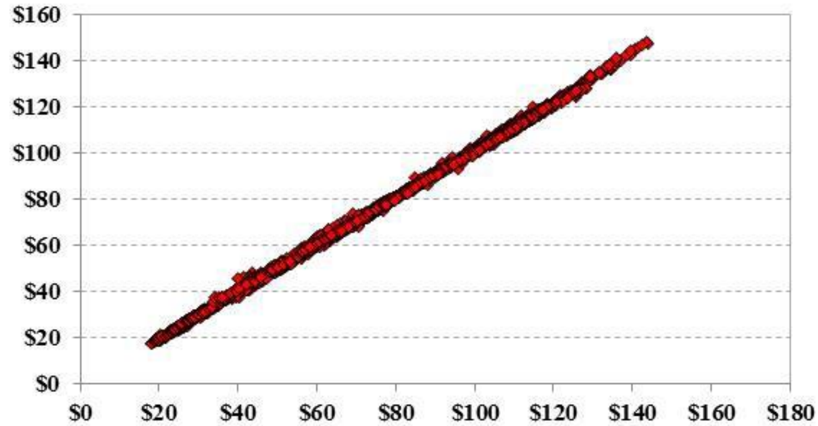

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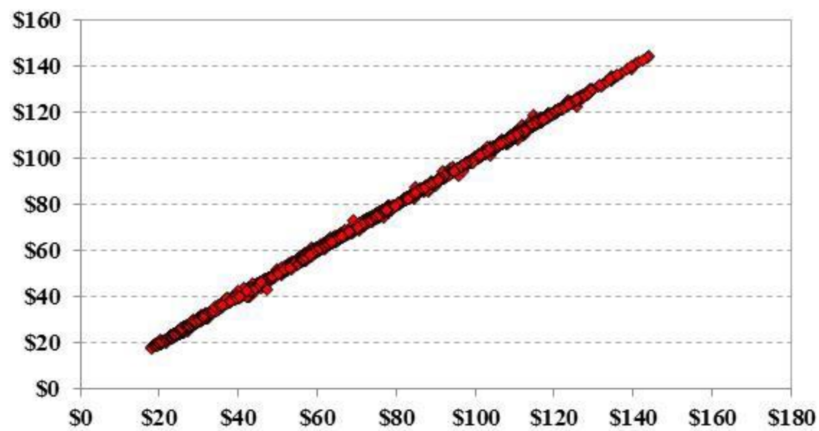

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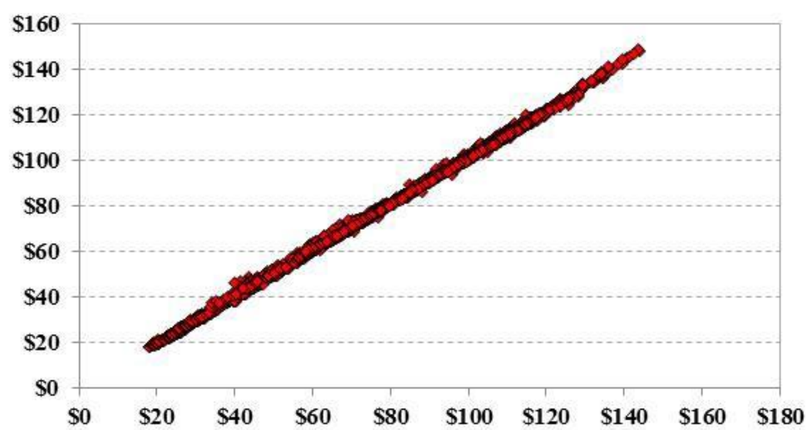

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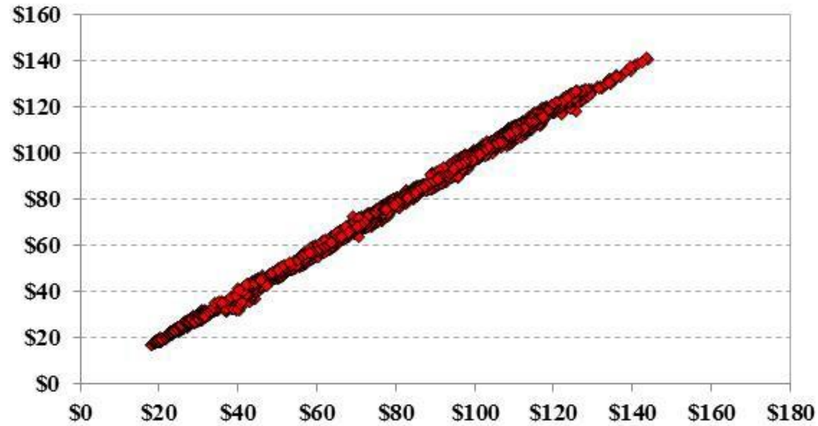

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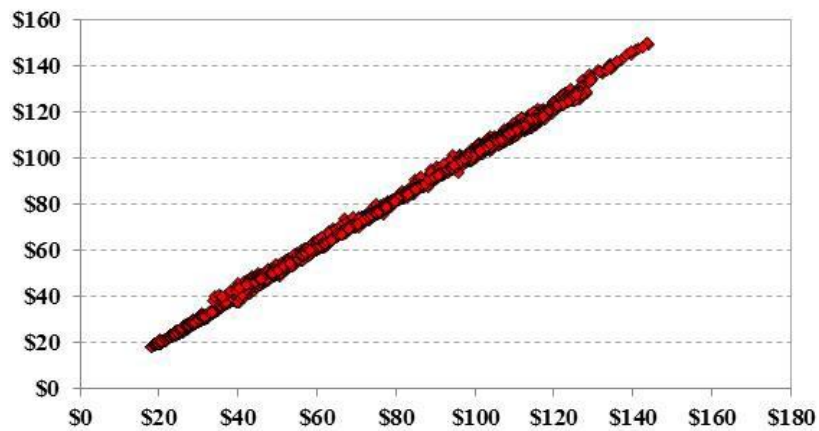

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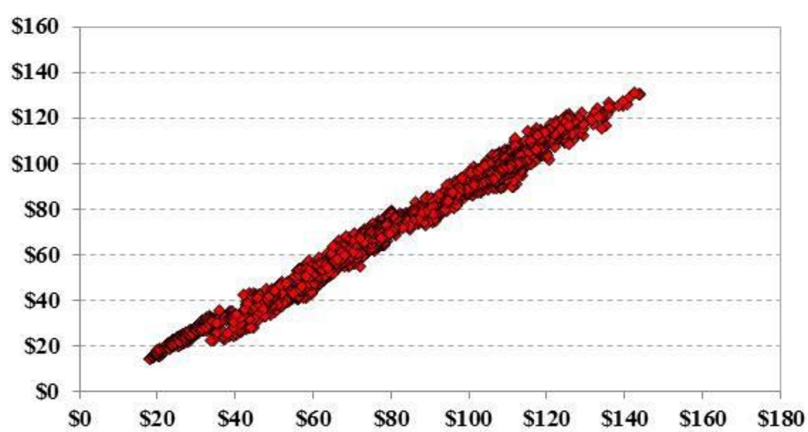

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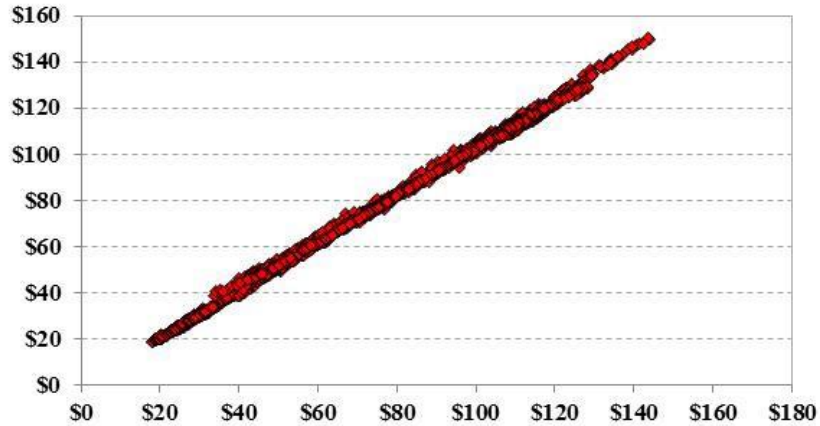

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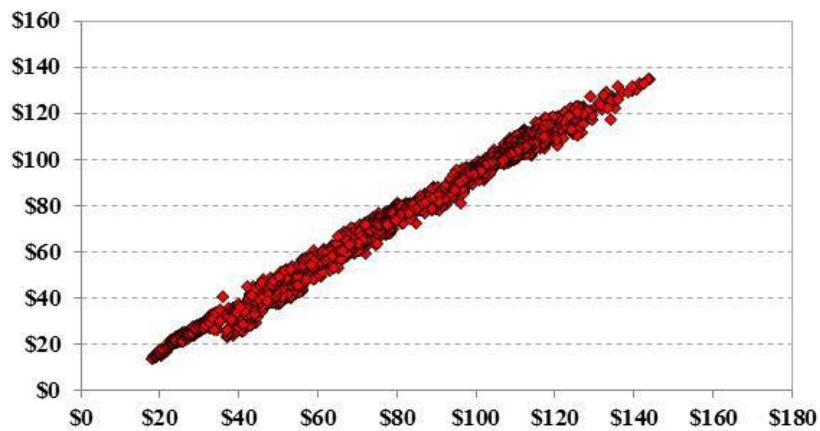
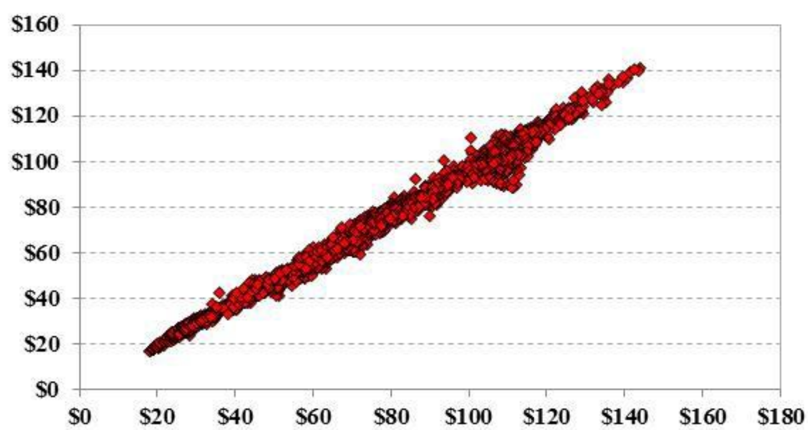


US Poseidon



An IHS Energy / IHS Economics report

Unleashing the Supply Chain

Assessing the economic impact of a US crude oil free trade policy

March 2015






Executive summary

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Additional resources

Appendices are available at www.ihs.com/crudeoilsupplychain. Additionally, the results included in this study are available on an interactive website that provides access to detailed data for the supply chain and congressional districts which can also be accessed through this website.

Study purpose

Building on prior work assessing the industry and macroeconomic impact of changing US policy to allow exports of US crude oil, this study examines the impact on an intricate and interdependent supply chain that supports the oil industry and has made the scale-up of tight oil production possible. The analysis considers 60 separate supply chain industries and provides granular impact analysis at the congressional district level to fully understand the economic and job growth impact across the nation.

This report draws on the multidisciplinary expertise of IHS, including upstream, downstream and macroeconomic teams across IHS Energy and IHS Economics. The study has been supported by a group of sponsors in numerous industries. The analysis and conclusions contained in this report are entirely those of IHS Inc., which is solely responsible for the contents herein.

Related reports

The "Great Revival" in US natural gas and crude oil production has caused significant market and economic shifts. IHS has provided continuing analysis of these developments, their impact on global oil markets, and their influence on the US economy and US competitiveness. Some of the current studies include:

$30 or $130? Scenarios for the Global Oil Market to 2020

These are momentous times for the oil market. We are in a world without OPEC—at least as we knew it. Companies and investors face a heightened degree of uncertainty about the future of oil supply, price, and demand. IHS addresses the uncertainty through a new study, *$30 or $130? Scenarios for the Global Oil Market to 2020*. IHS Scenarios provide a coherent, dynamic framework to discuss several potential futures for the oil market and to test decisions. Through interactive workshops, study participants participate in the scenario development and helping identify key supply, demand, and geopolitical drivers that will shape the oil market to 2020. Decision making is more robust when analysis takes into account more than one view of the future.

For more information, contact Danut Cristian Muresan, cristian.muresan@ihs.com.

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America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy is a three-volume series based on IHS analyses of each shale gas and tight oil play. It calculates the investment of capital, labor and other inputs required to produce these hydrocarbons. The economic contributions of these investments are then calculated using the proprietary IHS economic contribution assessment and macroeconomic models to generate the contributions to employment, GDP growth, labor income and tax revenues that will result from the higher level of unconventional oil and natural gas development. Volume 3 in the study includes state-by-state analysis of the economic impacts and projections of additional investment in manufacturing as a result of these supplies.

See more at http://press.ihs.com/press-release/economics/us-unconventional-oil-and-gasrevolution-increase-disposable-income-more-270#.

Unleashing the Supply Chain study sponsors

The following organizations provided support for this study. The analysis and conclusions in this study are those of IHS, and IHS is solely responsible for the report and its content.

Baker Hughes, Chaparral Energy, Chesapeake Energy, Chevron, Concho Resources, ConcocoPhillips, Continental Resources , Devon Energy, Energy Equipment and Infrastructure Alliance, EOG Resources, Exxon Mobil, General Electric, Halliburton, Helmerich & Payne , Hess, Marathon Oil, Newfield Exploration, Oasis Petroleum, Occidental Petroleum, Pioneer Natural Resources, QEP Resources, Rosetta Resources, and WPX Energy

Key findings

- The oil and gas industry depends on a diverse and far-reaching supply chain—a vast and interconnected network of labor, commodities, technologies, and information services across the United States.
- When oil prices are lower, the potential negative impact on jobs and the economy are more—not less—sensitive to further price discounts resulting from an export ban. For example, a $3 per barrel change in a $50 environment can have the same effect as a $10 change in a $100 environment.
- The export ban causes US crude oil prices to be discounted versus international crude oil prices—an effect that *reduces* US oil production, supply chain activity, and job growth, but *raises* US gasoline prices. As of this writing, the spread between the international (Brent) and domestic (WTI) crude prices has widened, ranging from $7 to $12 per barrel.
- The industries that produce, transport and process oil are highly capital-intensive, supporting an extensive and diverse supply chain. Beneficiaries of this investment include domestic companies in equipment and machinery, construction and well services, information technology, materials, and logistics, and in the professional, financial and other services sectors.
- The economic benefits of oil and gas activity throughout this extensive supply chain far exceed benefits to the industry itself. Every new production job creates three jobs in the supply chain and another six jobs in the broader economy. Contributions to Gross Domestic Product (GDP) also multiply: every dollar of GDP created in the oil and gas sector generates two dollars in the supply chain.
- Lifting the ban on crude oil exports increases supply chain jobs and economic activity by stimulating capital investment, increasing crude oil production, and lowering gasoline prices. Based on two levels of crude production analyzed in this report, the positive impact on the crude oil supply chain of lifting the export ban is expected to add $26 billion to $47 billion to GDP and support 124,000 to 240,000 jobs per year on average during the 2016–30 period. The impact from a policy change is greatest in the short term (2016-20).
- The broader US economic impact is $86 billion to $170 billion additional GDP and 394,000 to 859,000 additional jobs.
- The supply chain benefits from lifting the export ban reach into every state and almost every US congressional district, from oil-producing Texas and California to states such as Illinois, Florida and New York, which have diversified manufacturing and services economies. Massachusetts, with its strong information technology and professional and financial services industries, also benefits from free trade. And in Washington State, which has strong information technology and manufacturing sectors, the supply chain contribution is almost half of the total state impact of lifting the crude oil export ban. Additionally, Illinois, ranked only 14th for oil production, accounts for roughly 10% of the overall supply chain impact. Furthermore, 5 of its congressional districts are in the top 20 in terms of value added, accounting for about 5% of that supply chain impact.

Executive summary

A revival in US crude oil production—up 80% since 2008—is expanding economic activity across the nation through an interdependent, technology-driven supply chain. This supply chain encompasses dozens of important and diverse domestic industries well beyond what is commonly thought of as the "oil industry." Consumers are now paying substantially less for gasoline, largely due to the impact on global markets of higher US oil production. But lower oil and gasoline prices are just one benefit. In this report, IHS offers further analysis of the benefits that extend across the nation from free trade of crude oil—benefits that are also placed at risk by an outdated trade policy from an era of oil price controls that were abolished in 1981.

Crude oil production depends on an extensive supply chain—a vast network of interconnected labor, commodities and information that reaches into many communities and industries. For example, the diesel engines driving drilling rigs and hydraulic fracturing equipment are largely manufactured in the industrial heartland of Illinois, Indiana, Wisconsin, and Michigan. Many states — New York, Florida, Illinois, and Massachusetts, for example—with modest or negligible oil production sectors have strong manufacturing or service sectors supplying the oil industry in producing states. As IHS reported in its earlier report, *US Crude Oil Export Decision* (herein referred to as the *Export Decision*), if the trade ban is lifted, the number of US jobs is 394,000 to 859,000 higher each year, on average, under the Base Production and Potential Production cases, respectively, between 2016 and 2030. Supply chains represent a substantial share—about 30%—of the total jobs economy-wide: supply chain jobs under free trade average 124,000 to 240,000 annually in the Base and Potential cases, respectively.

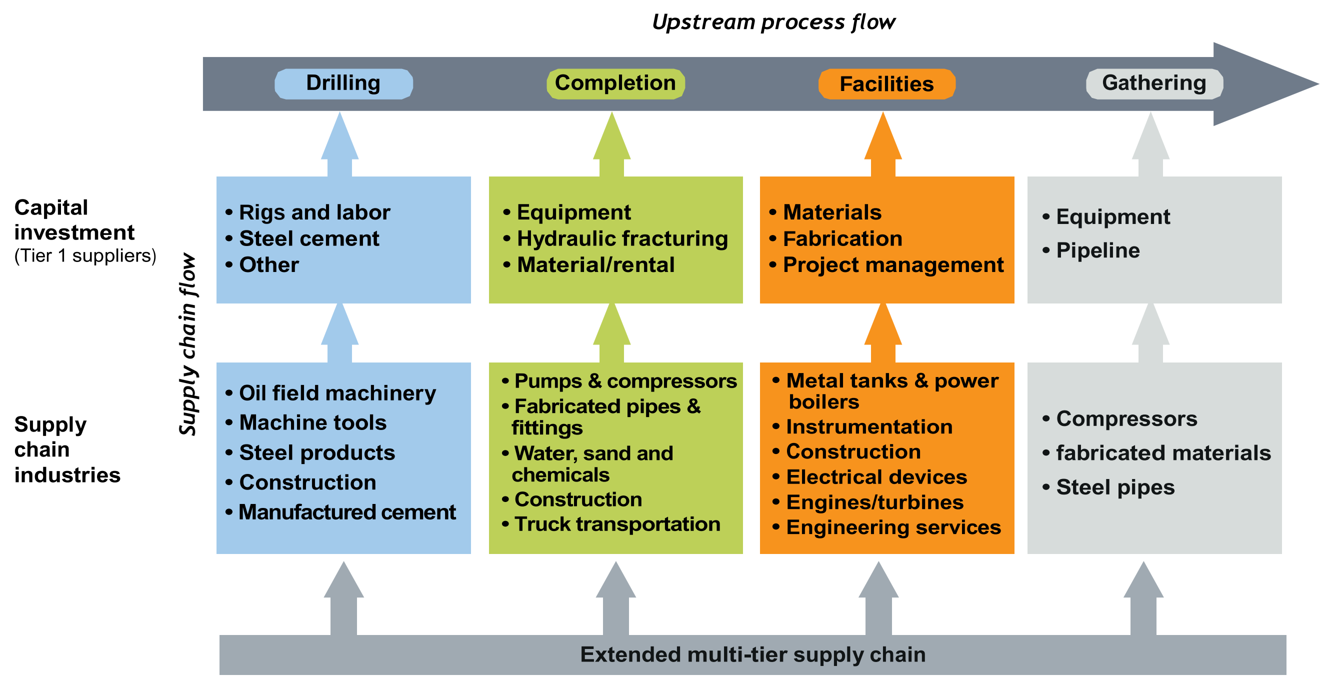
What is the supply chain?

This study, *Unleashing the Supply Chain: Assessing the economic impact of a US crude oil free trade policy*, tracks flows of capital expenditures through 60 industry sectors that comprise a large percentage of the oil industry's upstream supply chain. The supply chain is the extended network of companies providing the labor, commodities, technology, and information required to extract oil and deliver it to the midstream (transportation and logistics) and downstream (processing and marketing) sectors.[1] Capital investment and operating spending in the oil industry, as measured by direct spending within the oil industry's Tier 1 suppliers, trigger multiple streams of additional economic activity throughout an extended, multi-tiered supply chain that has wide geographical impacts at the national, state and local levels.[2]

1 Midstream specifically includes the pipelines, terminals and related logistics infrastructure used to move petroleum and downstream includes refining and product distribution.

2 Tier 1 suppliers are defined as those with whom upstream operators directly spend capital and operating funds.

Upstream supply chain



Source: IHS Energy

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The key driver of the widespread macroeconomic benefits is investment in the upstream and midstream oil and gas industries. This investment in US energy infrastructure significantly aided the return of US economic growth following the Great Recession. From 2008–13, while US GDP growth averaged 1.2% per year, economic output in the oil and gas industry grew four times faster, at 4.7%. Over the same period, total US employment declined by 0.1%, while oil and gas industry employment grew 4.3% per year. More broadly, the revolution in the production of "unconventional" oil and gas has been one of the major contributors to the US economic recovery; it is estimated by IHS to have added nearly 1% to US GDP annually, on average, over the past six years, explaining nearly 40% of overall GDP growth in that time.

These macroeconomic impacts would be enhanced by lifting the crude export ban as they extend through a diverse network of suppliers. Suppliers benefit from the investment required for the exploration, production, processing, and transport of oil and gas. In turn, suppliers of materials, capital equipment and services enable operators to deploy technology to commercialize their resources. The "multiplier effect" accelerates as Tier 1 suppliers require more production of goods and services and development of efficient technologies within their respective interlinking supply chains. This benefit cascades across the industrial economy and all states.

The diversity of primary sectors that serve the US oil and gas supply chain is depicted in the following graphic.

Primary sectors in the crude oil supply chain

Source: IHS Economics

The companies in this diverse and far-reaching supply chain contribute to employment and to every US state's economy—not just oil-producing states. The US oil revival has increased demand for industrial equipment and machinery, construction and well services, information technology, materials, logistics, and professional, and financial and other services and has spurred research and development investment across numerous industries.

Investment in crude production has a far-reaching impact on jobs, with about 10% of the total employment impact flowing directly to producers and another 30% into the supply chain. The remaining 60% derive from the broader impact of workers' increased income and spending due to higher levels of crude oil activity. In other words, for every job created in the oil and gas extraction sector, three jobs are created in the supply chain and another six jobs in the broader economy. In a similar fashion, contributions to Gross Domestic Product (GDP) also multiply: every dollar of GDP created in the oil and gas sector generates two dollars in the supply chain.[3]

High-quality supply chain jobs also lead to higher wages, reflecting their unique occupations and skill requirements. Supply chain jobs also stand out from other employment opportunities for their technological and innovative nature. The average wage rate in the oil and natural gas extraction and drilling sectors is $51.19 per hour, and the rate for the broader oil and natural gas extraction sector is $35.87 per hour.[4] This compares to an economy-wide average wage rate of $23.96 per hour. The supply

3 Relative to the broader supply chain, the oil and gas sector demonstrates higher productivity (output per worker) and a higher GDP contribution per unit of output. Thus, the oil and gas sector typically accounts for a higher proportion of GDP with fewer employees per unit of output. This explains the differential between the employment and GDP multipliers.

4 Using US Bureau of Labor Statistics (BLS) total annual wage and salary data and number of employees by sector

chain wage of $29.93 per hour is 25% above the national average.[5] Higher wages result in larger multiplier and income effects across the economy as more income is spent on general consumer goods and services by oil and gas and supply chain sector workers.

Great revival in US crude production and uncertain future

The large and rising production of US crude oil has significantly reduced US dependence on imported oil—imports last year accounted for just 27% of US oil demand, down from 60% in 2005. With crude oil production now over 9 million barrels per day, the United States is the world's third-largest crude-oil producer behind Saudi Arabia and Russia. It is the largest producer of oil and natural gas liquids combined.

Continued growth in the oil and gas industry and in the supply chain supporting it could be imperiled by low prices and outdated crude oil export policies that restrain market access and hinder future investment and production. In the early years of the industry's revival, higher oil prices were unusually stable and allowed for the emergence and advancement of a vibrant domestic tight oil industry. Production techniques improved, costs fell, and higher oil output per well was achieved. It is the success and rapid growth of US production that contributed to the global supply surplus that has driven down global oil prices over the past six months. Consumers are already reaping great benefits from this drop in prices.

Production will certainly be affected by low prices, but the pace and degree of the impact remains uncertain. The market price has been roughly halved, and the adjustment process is evolving. Many factors will influence the outcome. Oil markets are prone to cycles, which are often rapid and extreme and reflect the challenge of matching short-term changes in demand with long-term investment requirements. Price changes over the past decade reflect the constant changes occurring in oil market fundamentals, economic conditions and geopolitical events that affect oil prices. The monthly average price of Brent crude oil climbed from $30 per barrel in early 2004 to over $130 per barrel in July 2008 before falling to $40 per barrel in December 2008. Prices then rebounded, exceeding $70 per barrel by August 2009 and remained in the $100 per barrel range from early 2011 through August 2014. As of this writing, the US benchmark price is below $60 per barrel. Crude oil price volatility is expected to continue. While low prices are the primary challenge facing the industry in 2015, the ban on exports of US crude oil production will hinder or even cut short any recovery tomorrow.

The export policy problem

The US oil system is nearing gridlock due to a mismatch between the rapid growth of domestic light tight oil production and the inability of the US refining system to economically process the growing volumes. Seasonal gridlock occurred in the second half of 2013 due to refinery maintenance downtimes. But the rapidly declining crude oil price and the increasing storage of crude oil have so far overshadowed the risk of a more permanent and impending gridlock and reduced the domestic crude price discount to global prices. In fact, gridlock would have a doubly chilling effect on investment and job growth in an environment of lower and volatile global crude prices. The supply chain in every region of the nation has benefitted from investment in US oil production and infrastructure—benefits now put at risk.

The nation is benefiting today from increased employment, lower gasoline prices and an improved trade balance as growing US production puts downward pressure on international oil prices. Lifting the export ban and allowing US crude oil to trade into international markets removes a risk that the full benefits from potential US oil production are not realized. The *Export Decision* report in May 2014 examined the historical context of US export policies; the oil industry's response to a change in policy; and the estimated macroeconomic benefits from free trade accruing to US consumers and the broader US economy. The *Export Decision* analysis projected substantial increases in capital expenditures by upstream operators if the export ban is lifted, granting them access to global markets.

5 Based on a weighted average of the hourly wage rates for each of the supply chain sectors.

Since completion of the previous study, two notable market events have occurred. First, the global crude price has declined sharply, largely due to US production increases and weak demand, and second, the Bureau of Industry and Standards (BIS) has clarified existing rules that allow certain very light crude oil (condensate) to be exported as a "refined product" in defined situations involving sufficient processing.

Oil price decline

The rapid crude oil price decline—by roughly half since mid-2014—is a reminder of the cycles and uncertainty of oil and energy markets caused by the differing time scales of demand and supply adjustments. Producers are responding with reduced budgets, smaller drilling programs and cost cutting. While exploration and development costs are expected to also decline, the industry is expected to produce less crude oil as a result of the price decline, and the impact on employment is magnified throughout the supply chain.

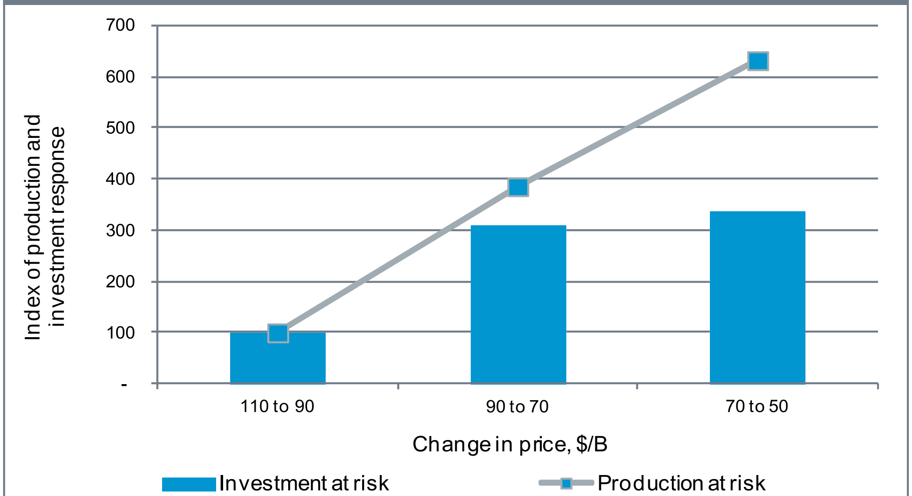
Lower global oil prices have the effect of increasing—rather than decreasing, as some might expect—the impact of the export ban. An export gridlock created by the ban would create a domestic oversupply resulting in US crude oil prices (for example, West Texas Intermediate) becoming disconnected and discounted from international prices, such as Brent crude. The resulting lower wellhead price for US producers dampens upstream investment and reduces economic activity and job creation. The resulting lower wellhead price for US producers dampens upstream investment; reduces economic activity and job creation; and, weakens the competiveness of US companies relative to their international peers.

These employment and economic benefits are increasingly sensitive to declines in crude oil prices. This is because the industry, at lower prices, has a "flatter" supply curve, which means that a small change in price results in a larger supply loss. Therefore, the risk from the export ban is higher in today's low-priced market.

To demonstrate this effect, consider an IHS study of the US onshore oil wells drilled in 2013, excluding Alaska. Each well's break-even price was calculated based on estimated costs and actual production. The total investment and production from this analysis is summarized in the graph using an index for the levels of production and investment put at risk as the price declines in $20 per barrel increments from $110 to $50.

As US prices move lower, the investment and production that becomes uneconomic and "at risk" accelerates. For example, the risk to investments in response to the price declining from $90 to $70 is about three times greater than when the price moves from $110 to $90. The production response is even stronger—about four times—as the price moves from $110 to $90 to $70. Therefore, if the crude export ban were to create a $10 per barrel price discount to global prices in today's already low price environment, it would have a much bigger impact on industry investment and production than it would have had in early 2014 when crude was selling for over $100 per barrel.

Impact of crude oil price reduction



Note: Based on breakeven price analysis of actual onshore oil wells drilled in US Lower-48 in 2013.
Source: IHS
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At today's lower global oil price, an export policy-related gridlock would have a doubly chilling effect on investment and job growth.

The industry is dynamic, and efficiencies in production are being realized each year. Still, there is good reason to believe that the shape of the 2013 supply curve is similar today and will remain so for the foreseeable future.

BIS clarification for condensate processing

Some types of very light crude oil (condensate) can be exported after transformation into petroleum products with sufficient processing, as explained by a nuanced clarification of existing regulatory definitions of crude processing.[6] The BIS has provided general guidance and has issued private rulings to a few companies to permit the export of this processed condensate petroleum (condensate product) from individual facilities that were approved based on equipment and processing configuration. Due to minimal processing, the main product has a broad boiling range and is similar to unprocessed condensate. The condensate product is unfinished and not usable as a fuel but only as a feedstock for further refining. More companies will be given permission or will otherwise be able to export this condensate product. These exports will provide some relief to the impending market gridlock. However, the volume of condensate product available for export remains unclear, because new infrastructure must be put into place to segregate this product stream. Condensate production is significant and estimated to be near 800,000 barrels per day (there is no industry standard for the definition of condensate); however, little of this production is coastal, and so, to prevent commingling, additional infrastructure is needed to move the condensate product to export terminals. This new infrastructure must be separate from the three existing infrastructures for crude oil and condensate, for natural gas, and for natural gas liquids (NGL). This segregation creates market and capital inefficiencies. Further, market distortions are likely to arise due to artificial distinctions between similar products (unprocessed condensate and condensate product). This policy-driven investment will likely duplicate more efficient facilities already in place, another example of the economic inefficiencies caused by the outdated crude oil export policy.

Despite a declining global oil price, the clarified classification of processed condensate, and the weaker US production outlook in the near-term, the crude oil export ban is a remnant of a long-past era that could constrain future US production growth and result in higher gasoline prices for US consumers. While the unpredictable events of the past six months may have delayed the most severe gridlock temporarily, these same events also highlight that this gridlock could return sooner than expected as US production growth is supported by greater efficiencies and lower costs. When a recovery occurs, the export ban is expected to retard investment, reduce energy security and self-sufficiency, and ultimately lead to higher gasoline prices and lower job creation.

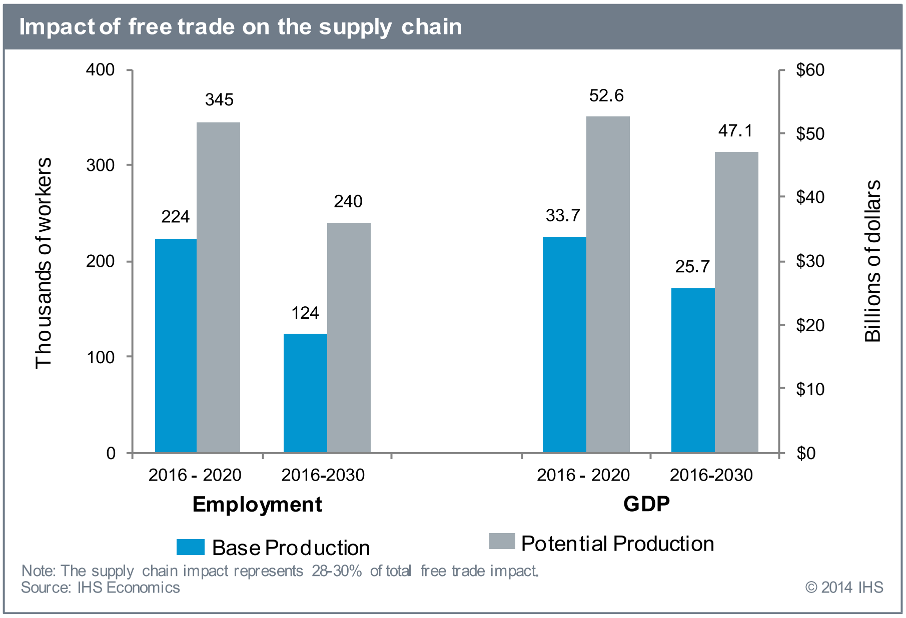
Free trade impacts on the supply chain

IHS has evaluated a change in crude export policy under each of two scenarios for US crude oil production levels:

- The Base Production Case provides a conservative view based on known defined oil and gas plays and assumes limited technology improvements over current performance.

- The Potential Production Case includes additional known, but less well defined areas of existing plays and assumes moderate drilling performance and technology improvements in the future.

These scenarios use production outlooks developed in mid-2014 in the *Export Decision* study—before the dramatic fall in oil prices. Since then, actual production and efficiency gains have been higher than forecasted but are now being offset by the expected effects of the price decline. IHS' current production forecast remains within the Base and Potential Production bands found in the prior study. The impact of moving from the current restricted trade policy to free trade is quantified for 60 industries in the petroleum production supply chain under each scenario.



Under each scenario, removing the crude oil export ban will have a dramatic economic impact across all US states in terms of more jobs, higher gross state product (GSP), and increased government revenue. The breadth of these trade impacts reflects the capital intensity of the oil industry and its reliance on inputs from a vast network of domestic goods and services suppliers around the United States. The short-term trade impact (2016–20) reflects a rapid increase in capital spending, while the long-term trade impact (2021–30) moderates as the economy adjusts to changes in the trailing level of investment and moves toward a new equilibrium with lower economic impacts.

Measuring the effects of free trade in crude export policy requires a fundamental understanding of the legion of suppliers that often operate out of the spotlight shining on the upstream (production), midstream (transportation and logistics) and downstream (processing and marketing) sectors. Removing the export ban will contribute to enhanced capital investment in this oil value chain, resulting in increased spending throughout the supply chain.

As beneficiaries of energy capital and operating expenditures, supply chain industries play a fundamental role in generating economic benefits nationwide as a result of a change in US crude oil export policy. The supply chain industries represent significant shares of this national impact in both the Base Production/ Potential Production cases, respectively, across all key economic indicators over the 2016–30 period analyzed:

- 31%/28% of the employment impact,
- 30%/28% of the GDP or value added,
- 38%/35% of labor income, and
- 33%/31% of cumulative government revenue.

The Base Production Case under free trade quantifies the value of the alternative path for a US economy benefitting from crude oil exports. In the Potential Production Case, the overall benefits to the supply chain are significantly higher under free trade (even though the percentage of benefits the supply chain is somewhat lower due partly to economies of scale).

Removing the crude export ban creates the following benefits in 2016–30 as higher activity levels work their way through oil industry's supply chain for the Base Production / Potential Production cases, respectively:

6 Processing at or near wellhead production.

- The crude oil supply chain will add $26 billion /$47 billion to GDP per year.
- Supply chain jobs will be 124,000/240,000 higher per year, on average.
- Labor income improves by about $158/$285 per year, on average, for each household.
- Cumulative government revenues from corporate and personal taxes attributed to supply chain industries reach $429 billion/$868 billion.

Broad benefits

The energy value chain encompasses all 50 states, but state sizes and populations vary widely. To evaluate the regional impact on a more equal population footing and to further quantify the breadth of the supply chain, the supply chain impacts were estimated for each US congressional district, as well as each state. The interdependencies throughout the US economy create an array of benefits in the supply chain and local economies. The key state and congressional district-level findings from the analysis include:

- The economic benefits vary considerably across supply chain industries and across the country. In states where the crude oil industry predominates, such as Texas, core supplier industries such as construction and well services are poised to reap the largest economic benefits in terms of jobs and value added, followed by professional services, which play a large role in supporting crude oil activity.
- In states with low crude oil production, such as Florida and New York, the benefits are distributed differently across the supply chain industries. In these states, key supplier industries that incur the largest benefit associated with the adoption of a crude oil free trade policy include the industrial equipment and machinery, professional services, financial services, and information technology sectors.

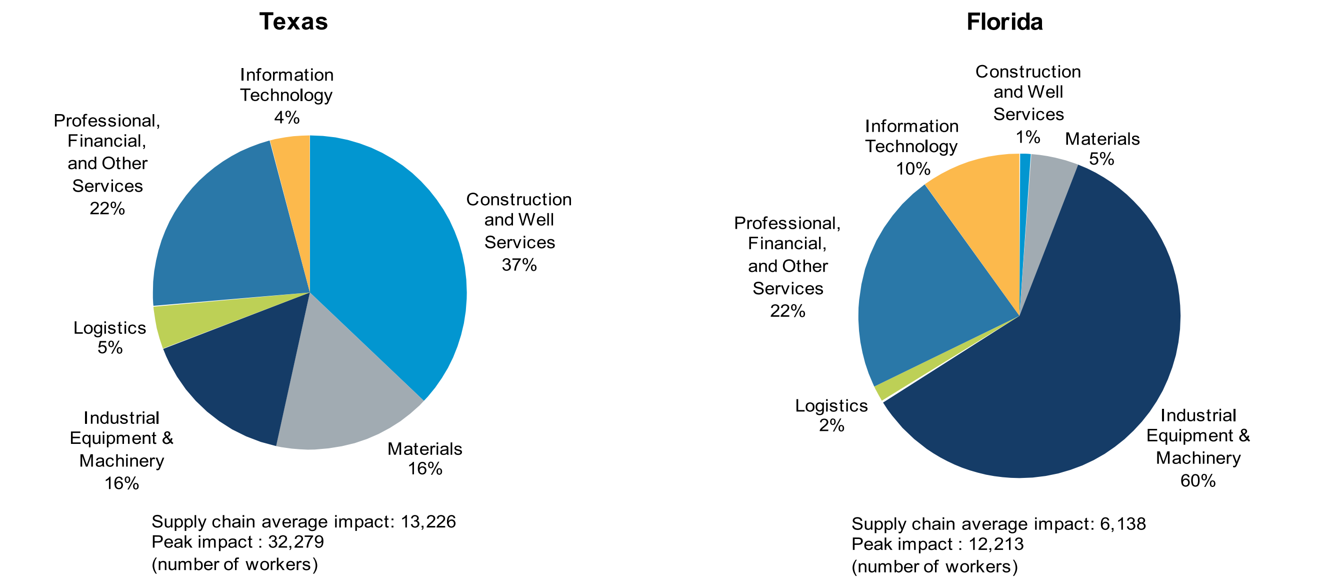
Defining the geographic contribution

The US economy benefits from the great diversity in its states and regions. Each state has unique economic, demographic, and geographic attributes, and they vary widely in size, resource endowment, climate, and population. To evaluate the regional impact on a more equal population footing and to further quantify the breadth of the supply chain, the supply chain impacts of lifting the export ban were estimated for each US congressional district, as well as for each state. The use of congressional districts, which are unique geographic units, allows us to achieve a reasonable equalization of each district's population, based on decennial US Census data.[7] Accordingly, the impact analysis on GDP, employment, labor income, and government revenue by congressional district provides robust metrics to analyze the geographic distribution of the benefits of a change in trade policy change across the supply chain.

7 Based on the 2010 Census estimates, all but 15 of the 435 congressional districts have populations within 10% of the national average.

The following two graphs represent the diversity of the supply chain impact in two states, one with large and one with small oil activity. The construction and well services core group in Texas experiences the largest benefits, while the benefits to Florida are distributed differently across the supply chain industries.

Supply chain employment impact — Base Production
(2016–30 average, difference free trade vs. restricted trade)



Source: IHS

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In states with a diverse and mature set of supplier industries, the supply chain can account for half of the value added from lifting the export ban. In Washington, for example, where the information technology (seismic and other software) and manufacturing sectors are expected to quickly expand, the supply chain contribution to GDP comprises 47% of the state's total benefit from higher crude oil exports over 2016–30. Illinois, an oil-producing state with diverse supplier industries, will derive 58% and 54% of the total GDP impacts from its supply chain under the Base and Potential Production cases, respectively.

California and Texas, two of the largest state economies, represent nearly 20% of US economic activity. They are not only large oil producers but also rank in the top five in terms of capital spending by oil producers. California and Texas are also the two largest states for their manufacturing activity and their strong diversified supply chain sectors. As a result, these two states are expected to yield the largest benefits from lifting the crude oil export ban in terms of supply chain jobs, value added, and labor income impacts. Under both production cases, California and Texas together account for about 25% of the total US supply chain jobs and labor income contributions and 20% of the value added contributions in 2016–30.

- Non-oil producing states such as Massachusetts and Maryland will also see strong growth in supply chain-associated government revenues in both production cases. They rank among the top 10 states in terms of the GDP and labor income impacts on their supply chain industries, suggesting strong ties between their supply chain activity and their government revenue from associated taxes.

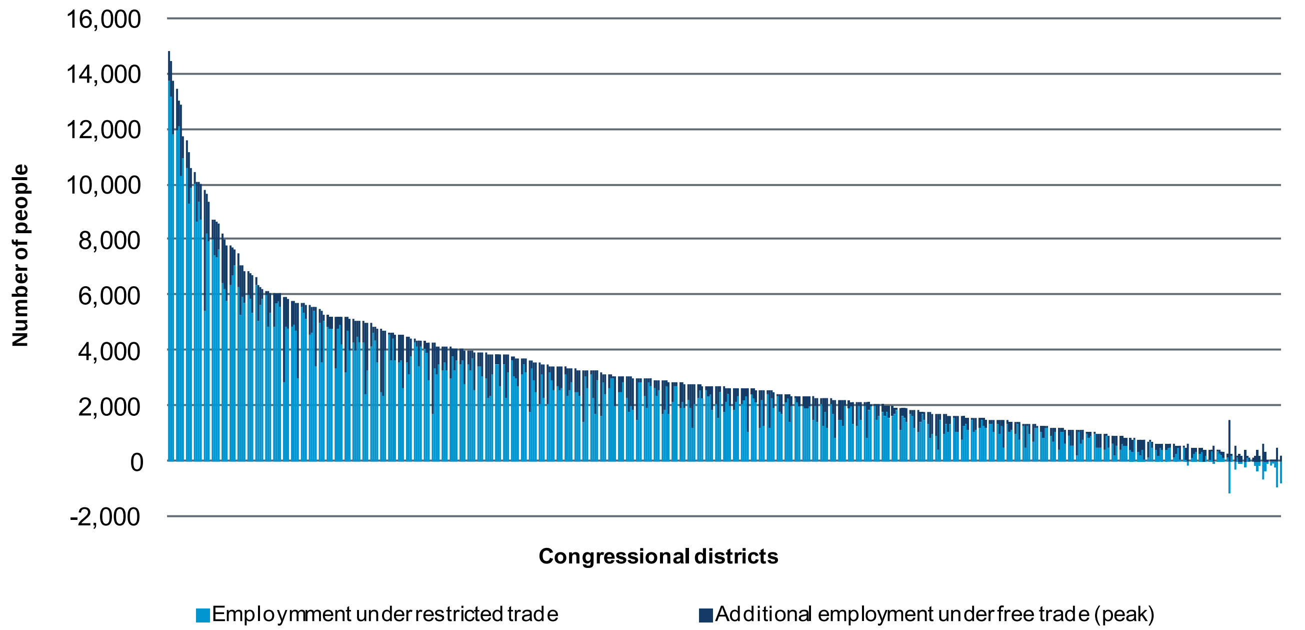
- As observed in the state-by-state analysis, the impact of a change in trade policy will be distributed across suppliers in congressional districts with crude oil activity, as well as in adjacent districts with supporting supply chain sectors. While nearly all congressional districts experience benefits, those districts with crude oil activity and strong supply chains will benefit most.

- Given the breadth of California's and Texas' oil production and the size of their mature supply chain sectors, these major oil-producing states have the largest number of affected congressional districts.

However, impacts will be felt in clusters of congressional districts in other states such as Illinois, Florida, and New York, mainly due to their diversified manufacturing and services sectors, and in Massachusetts due to its information technology and professional and financial services.

- The job impact of removing the export ban is spread across nearly every congressional district. The figure compares the peak annual jobs contribution under the free trade Base Production Case to the average net job gain per year under current policy trade for the time period.

Employment gains by congressional district – Base Production (average, 2016-30)



Source: IHS Economics

Sizing the benefits

The magnitude of the supply chain benefits is significant when compared with the size of entire industries in various states:

- Job impacts in the Base Production Case peak at 293,000 in 2018. That is slightly more than the 285,000 current US workers in the pharmaceutical and medicine manufacturing industry.
- In the Potential Production Case, job impacts peak at more than 439,000—roughly equal to all the non-farm workers in Delaware.
- The value added contribution to GDP from crude oil export supply chain activity reaches a maximum of $40 billion in the Base Production Case, roughly equal to South Dakota's $41 billion Gross State Product in 2014.

An IHS Energy / IHS Economics report

Unleashing the Supply Chain

Assessing the economic impact of a US crude oil free trade policy

March 2015

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Additional resources

Appendices are available at www.ihs.com/crudeoilsupplychain. Additionally, the results included in this study are available on an interactive website that provides access to detailed data for the supply chain and congressional districts which can also be accessed through this website.

Study purpose

Building on prior work assessing the industry and macroeconomic impact of changing US policy to allow exports of US crude oil, this study examines the impact on an intricate and interdependent supply chain that supports the oil industry and has made the scale-up of tight oil production possible. The analysis considers 60 separate supply chain industries and provides granular impact analysis at the congressional district level to fully understand the economic and job growth impact across the nation.

This report draws on the multidisciplinary expertise of IHS, including upstream, downstream and macroeconomic teams across IHS Energy and IHS Economics. The study has been supported by a group of sponsors in numerous industries. The analysis and conclusions contained in this report are entirely those of IHS Inc., which is solely responsible for the contents herein.

Related reports

The "Great Revival" in US natural gas and crude oil production has caused significant market and economic shifts. IHS has provided continuing analysis of these developments, their impact on global oil markets, and their influence on the US economy and US competitiveness. Some of the current studies include:

$30 or $130? Scenarios for the Global Oil Market to 2020

These are momentous times for the oil market. We are in a world without OPEC—at least as we knew it. Companies and investors face a heightened degree of uncertainty about the future of oil supply, price, and demand. IHS addresses the uncertainty through a new study, *$30 or $130? Scenarios for the Global Oil Market to 2020*. IHS Scenarios provide a coherent, dynamic framework to discuss several potential futures for the oil market and to test decisions. Through interactive workshops, study participants participate in the scenario development and helping identify key supply, demand, and geopolitical drivers that will shape the oil market to 2020. Decision making is more robust when analysis takes into account more than one view of the future.

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Oil: The Great Deflation

Through this framework series, IHS is providing insights and decision support to clients as they assess the impact and implications of the low oil price. IHS's unique breadth and depth of expertise spans the energy value chain and into adjacent industries and overall economies providing a fully integrated and objective perspective. The series provide a framework for more detailed discussions and consulting on a wide range of topics including: the tight oil and global production response, capital programs, cost deflation, storage and financial market influences, company strategies, demand response and asset transactions. The series is delivered through IHS Connect and a webinar series.

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America's New Energy Future

America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy is a three-volume series based on IHS analyses of each shale gas and tight oil play. It calculates the investment of capital, labor and other inputs required to produce these hydrocarbons. The economic contributions of these investments are then calculated using the proprietary IHS economic contribution assessment and macroeconomic models to generate the contributions to employment, GDP growth, labor income and tax revenues that will result from the higher level of unconventional oil and natural gas development. Volume 3 in the study includes state-by-state analysis of the economic impacts and projections of additional investment in manufacturing as a result of these supplies.

See more at http://press.ihs.com/press-release/economics/us-unconventional-oil-and-gasrevolution-increase-disposable-income-more-270#.

Unleashing the Supply Chain study sponsors

The following organizations provided support for this study. The analysis and conclusions in this study are those of IHS, and IHS is solely responsible for the report and its content.

Baker Hughes, Chaparral Energy, Chesapeake Energy, Chevron, Concho Resources, ConcocoPhillips, Continental Resources , Devon Energy, Energy Equipment and Infrastructure Alliance, EOG Resources, Exxon Mobil, General Electric, Halliburton, Helmerich & Payne , Hess, Marathon Oil, Newfield Exploration, Oasis Petroleum, Occidental Petroleum, Pioneer Natural Resources, QEP Resources, Rosetta Resources, and WPX Energy

Key findings

- The oil and gas industry depends on a diverse and far-reaching supply chain—a vast and interconnected network of labor, commodities, technologies, and information services across the United States.
- When oil prices are lower, the potential negative impact on jobs and the economy are more—not less—sensitive to further price discounts resulting from an export ban. For example, a $3 per barrel change in a $50 environment can have the same effect as a $10 change in a $100 environment.
- The export ban causes US crude oil prices to be discounted versus international crude oil prices—an effect that *reduces* US oil production, supply chain activity, and job growth, but *raises* US gasoline prices. As of this writing, the spread between the international (Brent) and domestic (WTI) crude prices has widened, ranging from $7 to $12 per barrel.
- The industries that produce, transport and process oil are highly capital-intensive, supporting an extensive and diverse supply chain. Beneficiaries of this investment include domestic companies in equipment and machinery, construction and well services, information technology, materials, and logistics, and in the professional, financial and other services sectors.
- The economic benefits of oil and gas activity throughout this extensive supply chain far exceed benefits to the industry itself. Every new production job creates three jobs in the supply chain and another six jobs in the broader economy. Contributions to Gross Domestic Product (GDP) also multiply: every dollar of GDP created in the oil and gas sector generates two dollars in the supply chain.
- Lifting the ban on crude oil exports increases supply chain jobs and economic activity by stimulating capital investment, increasing crude oil production, and lowering gasoline prices. Based on two levels of crude production analyzed in this report, the positive impact on the crude oil supply chain of lifting the export ban is expected to add $26 billion to $47 billion to GDP and support 124,000 to 240,000 jobs per year on average during the 2016–30 period. The impact from a policy change is greatest in the short term (2016-20).
- The broader US economic impact is $86 billion to $170 billion additional GDP and 394,000 to 859,000 additional jobs.
- The supply chain benefits from lifting the export ban reach into every state and almost every US congressional district, from oil-producing Texas and California to states such as Illinois, Florida and New York, which have diversified manufacturing and services economies. Massachusetts, with its strong information technology and professional and financial services industries, also benefits from free trade. And in Washington State, which has strong information technology and manufacturing sectors, the supply chain contribution is almost half of the total state impact of lifting the crude oil export ban. Additionally, Illinois, ranked only 14th for oil production, accounts for roughly 10% of the overall supply chain impact. Furthermore, 5 of its congressional districts are in the top 20 in terms of value added, accounting for about 5% of that supply chain impact.

Executive summary

A revival in US crude oil production—up 80% since 2008—is expanding economic activity across the nation through an interdependent, technology-driven supply chain. This supply chain encompasses dozens of important and diverse domestic industries well beyond what is commonly thought of as the "oil industry." Consumers are now paying substantially less for gasoline, largely due to the impact on global markets of higher US oil production. But lower oil and gasoline prices are just one benefit. In this report, IHS offers further analysis of the benefits that extend across the nation from free trade of crude oil—benefits that are also placed at risk by an outdated trade policy from an era of oil price controls that were abolished in 1981.

Crude oil production depends on an extensive supply chain—a vast network of interconnected labor, commodities and information that reaches into many communities and industries. For example, the diesel engines driving drilling rigs and hydraulic fracturing equipment are largely manufactured in the industrial heartland of Illinois, Indiana, Wisconsin, and Michigan. Many states — New York, Florida, Illinois, and Massachusetts, for example—with modest or negligible oil production sectors have strong manufacturing or service sectors supplying the oil industry in producing states. As IHS reported in its earlier report, *US Crude Oil Export Decision* (herein referred to as the *Export Decision*), if the trade ban is lifted, the number of US jobs is 394,000 to 859,000 higher each year, on average, under the Base Production and Potential Production cases, respectively, between 2016 and 2030. Supply chains represent a substantial share—about 30%—of the total jobs economy-wide: supply chain jobs under free trade average 124,000 to 240,000 annually in the Base and Potential cases, respectively.

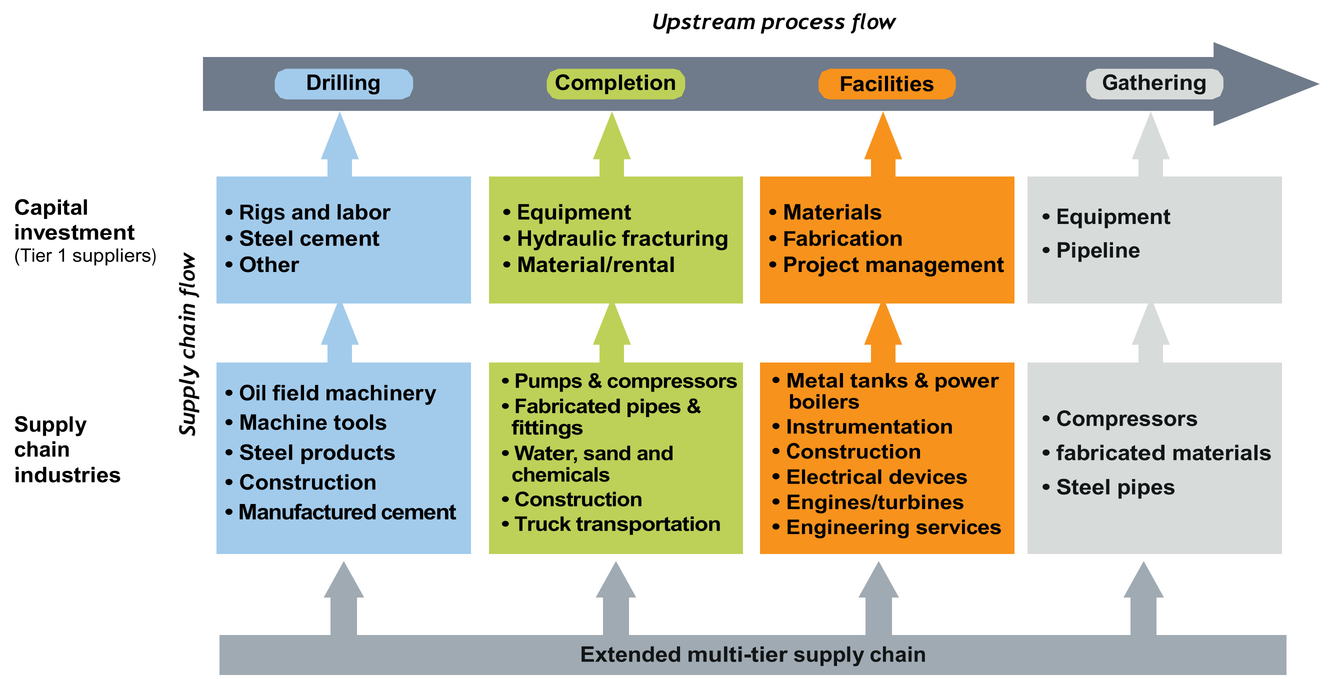
What is the supply chain?

This study, *Unleashing the Supply Chain: Assessing the economic impact of a US crude oil free trade policy*, tracks flows of capital expenditures through 60 industry sectors that comprise a large percentage of the oil industry's upstream supply chain. The supply chain is the extended network of companies providing the labor, commodities, technology, and information required to extract oil and deliver it to the midstream (transportation and logistics) and downstream (processing and marketing) sectors.[1] Capital investment and operating spending in the oil industry, as measured by direct spending within the oil industry's Tier 1 suppliers, trigger multiple streams of additional economic activity throughout an extended, multi-tiered supply chain that has wide geographical impacts at the national, state and local levels.[2]

1 Midstream specifically includes the pipelines, terminals and related logistics infrastructure used to move petroleum and downstream includes refining and product distribution.

2 Tier 1 suppliers are defined as those with whom upstream operators directly spend capital and operating funds.

Upstream supply chain



Source: IHS Energy

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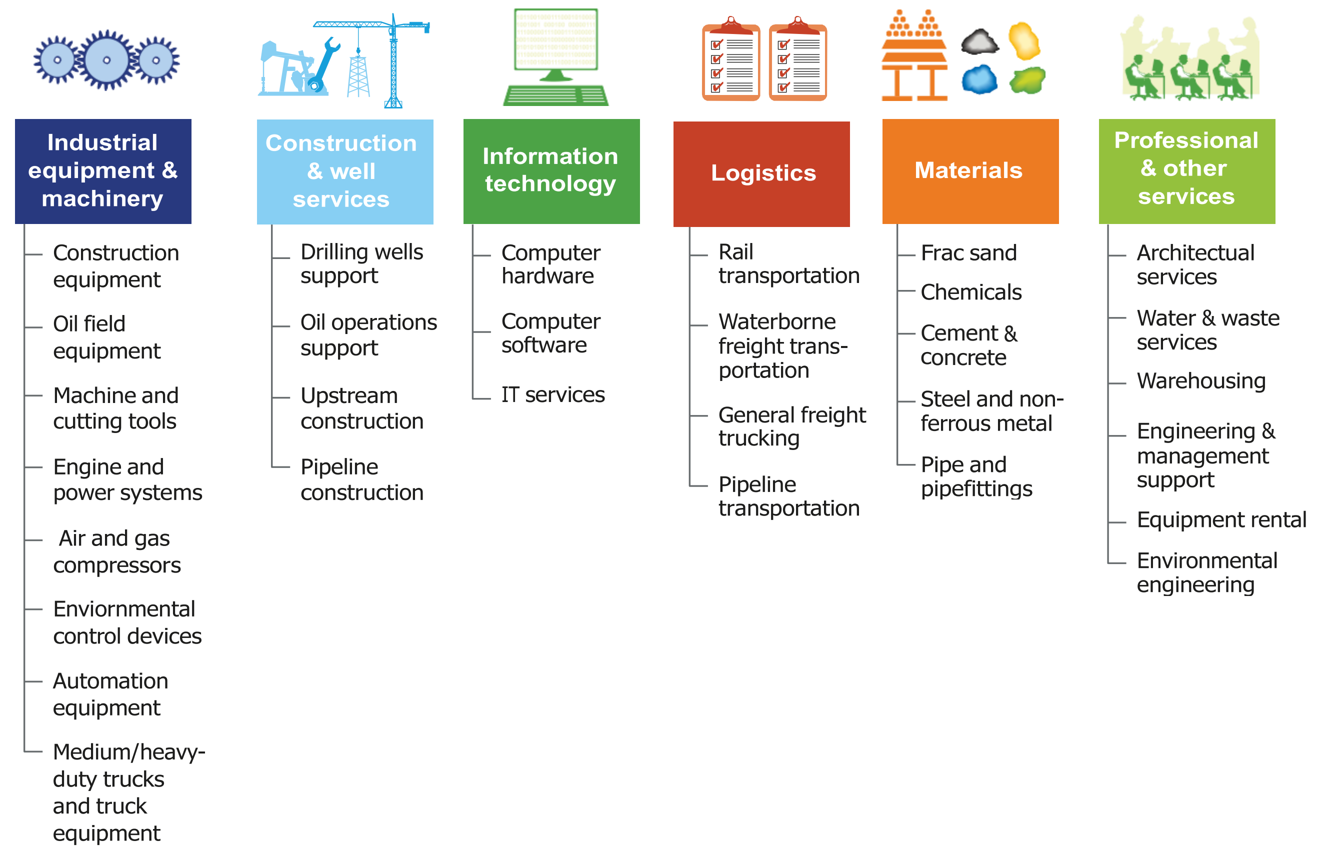
The key driver of the widespread macroeconomic benefits is investment in the upstream and midstream oil and gas industries. This investment in US energy infrastructure significantly aided the return of US economic growth following the Great Recession. From 2008–13, while US GDP growth averaged 1.2% per year, economic output in the oil and gas industry grew four times faster, at 4.7%. Over the same period, total US employment declined by 0.1%, while oil and gas industry employment grew 4.3% per year. More broadly, the revolution in the production of "unconventional" oil and gas has been one of the major contributors to the US economic recovery; it is estimated by IHS to have added nearly 1% to US GDP annually, on average, over the past six years, explaining nearly 40% of overall GDP growth in that time.

These macroeconomic impacts would be enhanced by lifting the crude export ban as they extend through a diverse network of suppliers. Suppliers benefit from the investment required for the exploration, production, processing, and transport of oil and gas. In turn, suppliers of materials, capital equipment and services enable operators to deploy technology to commercialize their resources. The "multiplier effect" accelerates as Tier 1 suppliers require more production of goods and services and development of efficient technologies within their respective interlinking supply chains. This benefit cascades across the industrial economy and all states.

The diversity of primary sectors that serve the US oil and gas supply chain is depicted in the following graphic.

Primary sectors in the crude oil supply chain



Source: IHS Economics

The companies in this diverse and far-reaching supply chain contribute to employment and to every US state's economy—not just oil-producing states. The US oil revival has increased demand for industrial equipment and machinery, construction and well services, information technology, materials, logistics, and professional, and financial and other services and has spurred research and development investment across numerous industries.

Investment in crude production has a far-reaching impact on jobs, with about 10% of the total employment impact flowing directly to producers and another 30% into the supply chain. The remaining 60% derive from the broader impact of workers' increased income and spending due to higher levels of crude oil activity. In other words, for every job created in the oil and gas extraction sector, three jobs are created in the supply chain and another six jobs in the broader economy. In a similar fashion, contributions to Gross Domestic Product (GDP) also multiply: every dollar of GDP created in the oil and gas sector generates two dollars in the supply chain.[3]

High-quality supply chain jobs also lead to higher wages, reflecting their unique occupations and skill requirements. Supply chain jobs also stand out from other employment opportunities for their technological and innovative nature. The average wage rate in the oil and natural gas extraction and drilling sectors is $51.19 per hour, and the rate for the broader oil and natural gas extraction sector is $35.87 per hour.[4] This compares to an economy-wide average wage rate of $23.96 per hour. The supply

3 Relative to the broader supply chain, the oil and gas sector demonstrates higher productivity (output per worker) and a higher GDP contribution per unit of output. Thus, the oil and gas sector typically accounts for a higher proportion of GDP with fewer employees per unit of output. This explains the differential between the employment and GDP multipliers.

4 Using US Bureau of Labor Statistics (BLS) total annual wage and salary data and number of employees by sector

chain wage of $29.93 per hour is 25% above the national average.[5] Higher wages result in larger multiplier and income effects across the economy as more income is spent on general consumer goods and services by oil and gas and supply chain sector workers.

Great revival in US crude production and uncertain future

The large and rising production of US crude oil has significantly reduced US dependence on imported oil—imports last year accounted for just 27% of US oil demand, down from 60% in 2005. With crude oil production now over 9 million barrels per day, the United States is the world's third-largest crude-oil producer behind Saudi Arabia and Russia. It is the largest producer of oil and natural gas liquids combined.

Continued growth in the oil and gas industry and in the supply chain supporting it could be imperiled by low prices and outdated crude oil export policies that restrain market access and hinder future investment and production. In the early years of the industry's revival, higher oil prices were unusually stable and allowed for the emergence and advancement of a vibrant domestic tight oil industry. Production techniques improved, costs fell, and higher oil output per well was achieved. It is the success and rapid growth of US production that contributed to the global supply surplus that has driven down global oil prices over the past six months. Consumers are already reaping great benefits from this drop in prices.

Production will certainly be affected by low prices, but the pace and degree of the impact remains uncertain. The market price has been roughly halved, and the adjustment process is evolving. Many factors will influence the outcome. Oil markets are prone to cycles, which are often rapid and extreme and reflect the challenge of matching short-term changes in demand with long-term investment requirements. Price changes over the past decade reflect the constant changes occurring in oil market fundamentals, economic conditions and geopolitical events that affect oil prices. The monthly average price of Brent crude oil climbed from $30 per barrel in early 2004 to over $130 per barrel in July 2008 before falling to $40 per barrel in December 2008. Prices then rebounded, exceeding $70 per barrel by August 2009 and remained in the $100 per barrel range from early 2011 through August 2014. As of this writing, the US benchmark price is below $60 per barrel. Crude oil price volatility is expected to continue. While low prices are the primary challenge facing the industry in 2015, the ban on exports of US crude oil production will hinder or even cut short any recovery tomorrow.

The export policy problem

The US oil system is nearing gridlock due to a mismatch between the rapid growth of domestic light tight oil production and the inability of the US refining system to economically process the growing volumes. Seasonal gridlock occurred in the second half of 2013 due to refinery maintenance downtimes. But the rapidly declining crude oil price and the increasing storage of crude oil have so far overshadowed the risk of a more permanent and impending gridlock and reduced the domestic crude price discount to global prices. In fact, gridlock would have a doubly chilling effect on investment and job growth in an environment of lower and volatile global crude prices. The supply chain in every region of the nation has benefitted from investment in US oil production and infrastructure—benefits now put at risk.

The nation is benefiting today from increased employment, lower gasoline prices and an improved trade balance as growing US production puts downward pressure on international oil prices. Lifting the export ban and allowing US crude oil to trade into international markets removes a risk that the full benefits from potential US oil production are not realized. The *Export Decision* report in May 2014 examined the historical context of US export policies; the oil industry's response to a change in policy; and the estimated macroeconomic benefits from free trade accruing to US consumers and the broader US economy. The *Export Decision* analysis projected substantial increases in capital expenditures by upstream operators if the export ban is lifted, granting them access to global markets.

5 Based on a weighted average of the hourly wage rates for each of the supply chain sectors.

Since completion of the previous study, two notable market events have occurred. First, the global crude price has declined sharply, largely due to US production increases and weak demand, and second, the Bureau of Industry and Standards (BIS) has clarified existing rules that allow certain very light crude oil (condensate) to be exported as a "refined product" in defined situations involving sufficient processing.

Oil price decline

The rapid crude oil price decline—by roughly half since mid-2014—is a reminder of the cycles and uncertainty of oil and energy markets caused by the differing time scales of demand and supply adjustments. Producers are responding with reduced budgets, smaller drilling programs and cost cutting. While exploration and development costs are expected to also decline, the industry is expected to produce less crude oil as a result of the price decline, and the impact on employment is magnified throughout the supply chain.

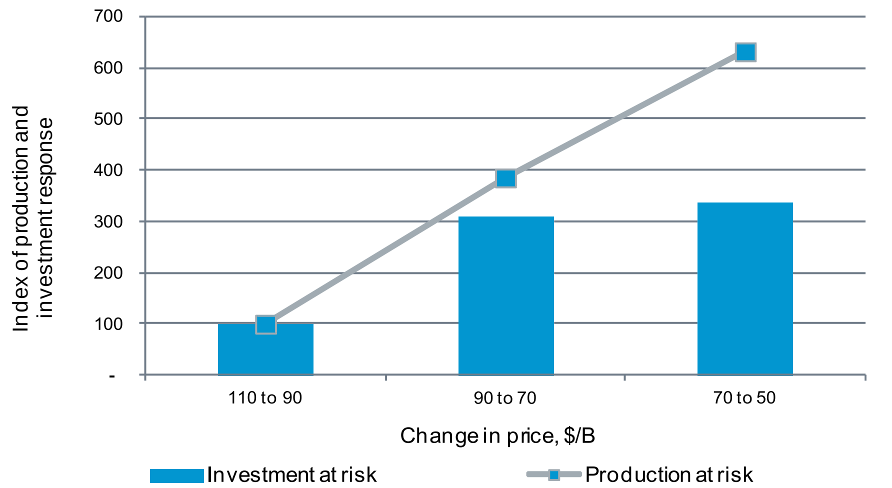
Lower global oil prices have the effect of increasing—rather than decreasing, as some might expect—the impact of the export ban. An export gridlock created by the ban would create a domestic oversupply resulting in US crude oil prices (for example, West Texas Intermediate) becoming disconnected and discounted from international prices, such as Brent crude. The resulting lower wellhead price for US producers dampens upstream investment and reduces economic activity and job creation. The resulting lower wellhead price for US producers dampens upstream investment; reduces economic activity and job creation; and, weakens the competiveness of US companies relative to their international peers.

These employment and economic benefits are increasingly sensitive to declines in crude oil prices. This is because the industry, at lower prices, has a "flatter" supply curve, which means that a small change in price results in a larger supply loss. Therefore, the risk from the export ban is higher in today's low-priced market.

To demonstrate this effect, consider an IHS study of the US onshore oil wells drilled in 2013, excluding Alaska. Each well's break-even price was calculated based on estimated costs and actual production. The total investment and production from this analysis is summarized in the graph using an index for the levels of production and investment put at risk as the price declines in $20 per barrel increments from $110 to $50.

As US prices move lower, the investment and production that becomes uneconomic and "at risk" accelerates. For example, the risk to investments in response to the price declining from $90 to $70 is about three times greater than when the price moves from $110 to $90. The production response is even stronger—about four times—as the price moves from $110 to $90 to $70. Therefore, if the crude export ban were to create a $10 per barrel price discount to global prices in today's already low price environment, it would have a much bigger impact on industry investment and production than it would have had in early 2014 when crude was selling for over $100 per barrel.

Impact of crude oil price reduction



Note: Based on breakeven price analysis of actual onshore oil wells drilled in US Lower-48 in 2013.
Source: IHS

At today's lower global oil price, an export policy-related gridlock would have a doubly chilling effect on investment and job growth.

The industry is dynamic, and efficiencies in production are being realized each year. Still, there is good reason to believe that the shape of the 2013 supply curve is similar today and will remain so for the foreseeable future.

BIS clarification for condensate processing

Some types of very light crude oil (condensate) can be exported after transformation into petroleum products with sufficient processing, as explained by a nuanced clarification of existing regulatory definitions of crude processing.[6] The BIS has provided general guidance and has issued private rulings to a few companies to permit the export of this processed condensate petroleum (condensate product) from individual facilities that were approved based on equipment and processing configuration. Due to minimal processing, the main product has a broad boiling range and is similar to unprocessed condensate. The condensate product is unfinished and not usable as a fuel but only as a feedstock for further refining. More companies will be given permission or will otherwise be able to export this condensate product. These exports will provide some relief to the impending market gridlock. However, the volume of condensate product available for export remains unclear, because new infrastructure must be put into place to segregate this product stream. Condensate production is significant and estimated to be near 800,000 barrels per day (there is no industry standard for the definition of condensate); however, little of this production is coastal, and so, to prevent commingling, additional infrastructure is needed to move the condensate product to export terminals. This new infrastructure must be separate from the three existing infrastructures for crude oil and condensate, for natural gas, and for natural gas liquids (NGL). This segregation creates market and capital inefficiencies. Further, market distortions are likely to arise due to artificial distinctions between similar products (unprocessed condensate and condensate product). This policy-driven investment will likely duplicate more efficient facilities already in place, another example of the economic inefficiencies caused by the outdated crude oil export policy.

Despite a declining global oil price, the clarified classification of processed condensate, and the weaker US production outlook in the near-term, the crude oil export ban is a remnant of a long-past era that could constrain future US production growth and result in higher gasoline prices for US consumers. While the unpredictable events of the past six months may have delayed the most severe gridlock temporarily, these same events also highlight that this gridlock could return sooner than expected as US production growth is supported by greater efficiencies and lower costs. When a recovery occurs, the export ban is expected to retard investment, reduce energy security and self-sufficiency, and ultimately lead to higher gasoline prices and lower job creation.

Free trade impacts on the supply chain

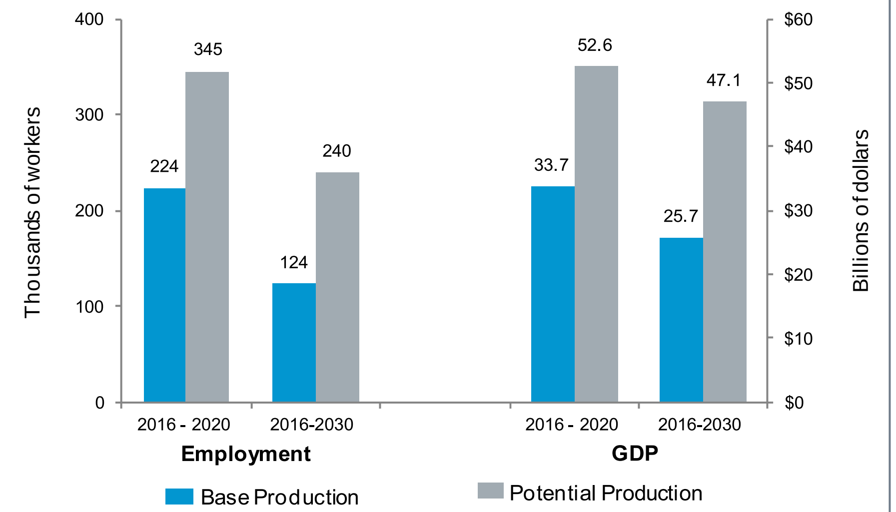
IHS has evaluated a change in crude export policy under each of two scenarios for US crude oil production levels:

- The Base Production Case provides a conservative view based on known defined oil and gas plays and assumes limited technology improvements over current performance.

- The Potential Production Case includes additional known, but less well defined areas of existing plays and assumes moderate drilling performance and technology improvements in the future.

These scenarios use production outlooks developed in mid-2014 in the *Export Decision* study—before the dramatic fall in oil prices. Since then, actual production and efficiency gains have been higher than forecasted but are now being offset by the expected effects of the price decline. IHS' current production forecast remains within the Base and Potential Production bands found in the prior study. The impact of moving from the current restricted trade policy to free trade is quantified for 60 industries in the petroleum production supply chain under each scenario.

Impact of free trade on the supply chain



Note: The supply chain impact represents 28-30% of total free trade impact.
Source: IHS Economics

Under each scenario, removing the crude oil export ban will have a dramatic economic impact across all US states in terms of more jobs, higher gross state product (GSP), and increased government revenue. The breadth of these trade impacts reflects the capital intensity of the oil industry and its reliance on inputs from a vast network of domestic goods and services suppliers around the United States. The short-term trade impact (2016–20) reflects a rapid increase in capital spending, while the long-term trade impact (2021–30) moderates as the economy adjusts to changes in the trailing level of investment and moves toward a new equilibrium with lower economic impacts.

Measuring the effects of free trade in crude export policy requires a fundamental understanding of the legion of suppliers that often operate out of the spotlight shining on the upstream (production), midstream (transportation and logistics) and downstream (processing and marketing) sectors. Removing the export ban will contribute to enhanced capital investment in this oil value chain, resulting in increased spending throughout the supply chain.

As beneficiaries of energy capital and operating expenditures, supply chain industries play a fundamental role in generating economic benefits nationwide as a result of a change in US crude oil export policy. The supply chain industries represent significant shares of this national impact in both the Base Production/ Potential Production cases, respectively, across all key economic indicators over the 2016–30 period analyzed:

- 31%/28% of the employment impact,
- 30%/28% of the GDP or value added,
- 38%/35% of labor income, and
- 33%/31% of cumulative government revenue.

The Base Production Case under free trade quantifies the value of the alternative path for a US economy benefitting from crude oil exports. In the Potential Production Case, the overall benefits to the supply chain are significantly higher under free trade (even though the percentage of benefits the supply chain is somewhat lower due partly to economies of scale).

Removing the crude export ban creates the following benefits in 2016–30 as higher activity levels work their way through oil industry's supply chain for the Base Production / Potential Production cases, respectively:

6 Processing at or near wellhead production.

- The crude oil supply chain will add $26 billion /$47 billion to GDP per year.
- Supply chain jobs will be 124,000/240,000 higher per year, on average.
- Labor income improves by about $158/$285 per year, on average, for each household.
- Cumulative government revenues from corporate and personal taxes attributed to supply chain industries reach $429 billion/$868 billion.

Broad benefits

The energy value chain encompasses all 50 states, but state sizes and populations vary widely. To evaluate the regional impact on a more equal population footing and to further quantify the breadth of the supply chain, the supply chain impacts were estimated for each US congressional district, as well as each state. The interdependencies throughout the US economy create an array of benefits in the supply chain and local economies. The key state and congressional district-level findings from the analysis include:

- The economic benefits vary considerably across supply chain industries and across the country. In states where the crude oil industry predominates, such as Texas, core supplier industries such as construction and well services are poised to reap the largest economic benefits in terms of jobs and value added, followed by professional services, which play a large role in supporting crude oil activity.
- In states with low crude oil production, such as Florida and New York, the benefits are distributed differently across the supply chain industries. In these states, key supplier industries that incur the largest benefit associated with the adoption of a crude oil free trade policy include the industrial equipment and machinery, professional services, financial services, and information technology sectors.

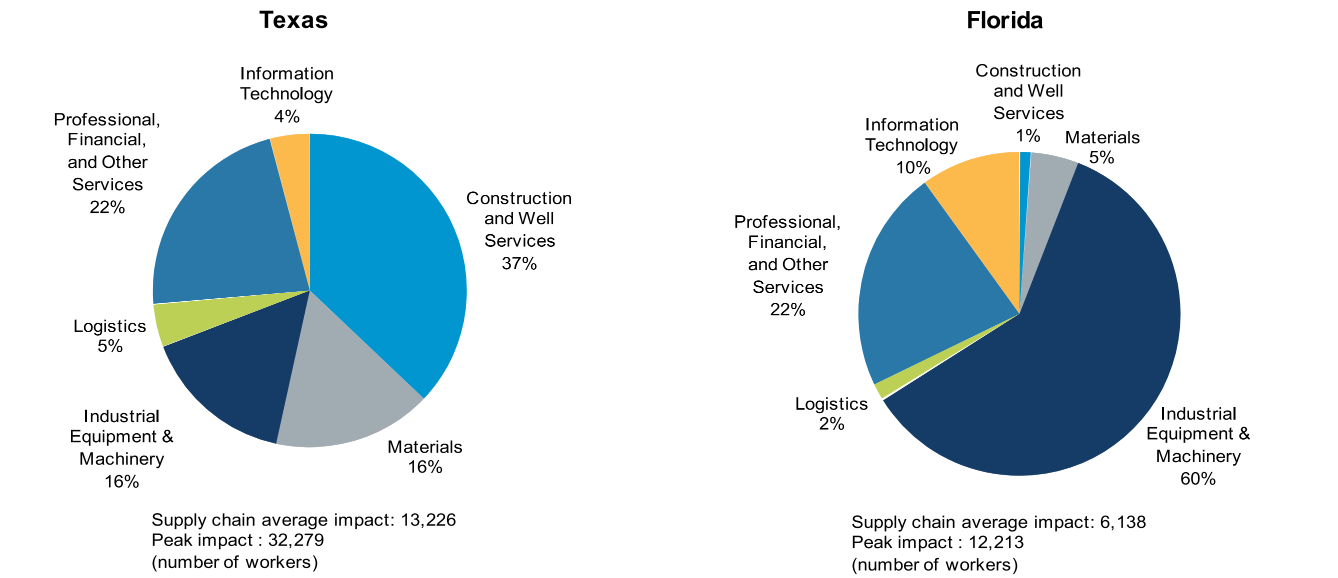
Defining the geographic contribution

The US economy benefits from the great diversity in its states and regions. Each state has unique economic, demographic, and geographic attributes, and they vary widely in size, resource endowment, climate, and population. To evaluate the regional impact on a more equal population footing and to further quantify the breadth of the supply chain, the supply chain impacts of lifting the export ban were estimated for each US congressional district, as well as for each state. The use of congressional districts, which are unique geographic units, allows us to achieve a reasonable equalization of each district's population, based on decennial US Census data.[7] Accordingly, the impact analysis on GDP, employment, labor income, and government revenue by congressional district provides robust metrics to analyze the geographic distribution of the benefits of a change in trade policy change across the supply chain.

7 Based on the 2010 Census estimates, all but 15 of the 435 congressional districts have populations within 10% of the national average.

The following two graphs represent the diversity of the supply chain impact in two states, one with large and one with small oil activity. The construction and well services core group in Texas experiences the largest benefits, while the benefits to Florida are distributed differently across the supply chain industries.

Supply chain employment impact — Base Production
(2016–30 average, difference free trade vs. restricted trade)



Source: IHS

In states with a diverse and mature set of supplier industries, the supply chain can account for half of the value added from lifting the export ban. In Washington, for example, where the information technology (seismic and other software) and manufacturing sectors are expected to quickly expand, the supply chain contribution to GDP comprises 47% of the state's total benefit from higher crude oil exports over 2016–30. Illinois, an oil-producing state with diverse supplier industries, will derive 58% and 54% of the total GDP impacts from its supply chain under the Base and Potential Production cases, respectively.

California and Texas, two of the largest state economies, represent nearly 20% of US economic activity. They are not only large oil producers but also rank in the top five in terms of capital spending by oil producers. California and Texas are also the two largest states for their manufacturing activity and their strong diversified supply chain sectors. As a result, these two states are expected to yield the largest benefits from lifting the crude oil export ban in terms of supply chain jobs, value added, and labor income impacts. Under both production cases, California and Texas together account for about 25% of the total US supply chain jobs and labor income contributions and 20% of the value added contributions in 2016–30.

- Non-oil producing states such as Massachusetts and Maryland will also see strong growth in supply chain-associated government revenues in both production cases. They rank among the top 10 states in terms of the GDP and labor income impacts on their supply chain industries, suggesting strong ties between their supply chain activity and their government revenue from associated taxes.

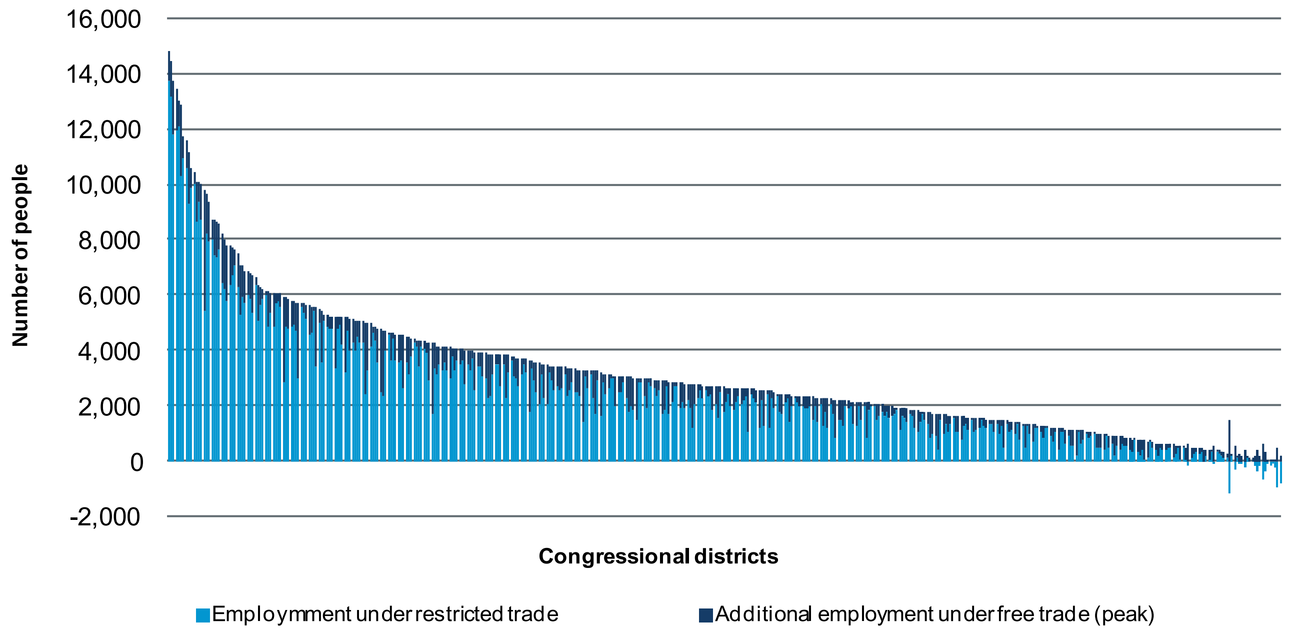
- As observed in the state-by-state analysis, the impact of a change in trade policy will be distributed across suppliers in congressional districts with crude oil activity, as well as in adjacent districts with supporting supply chain sectors. While nearly all congressional districts experience benefits, those districts with crude oil activity and strong supply chains will benefit most.

- Given the breadth of California's and Texas' oil production and the size of their mature supply chain sectors, these major oil-producing states have the largest number of affected congressional districts.

However, impacts will be felt in clusters of congressional districts in other states such as Illinois, Florida, and New York, mainly due to their diversified manufacturing and services sectors, and in Massachusetts due to its information technology and professional and financial services.

- The job impact of removing the export ban is spread across nearly every congressional district. The figure compares the peak annual jobs contribution under the free trade Base Production Case to the average net job gain per year under current policy trade for the time period.

Employment gains by congressional district – Base Production (average, 2016-30)



Source: IHS Economics

Sizing the benefits

The magnitude of the supply chain benefits is significant when compared with the size of entire industries in various states:

- Job impacts in the Base Production Case peak at 293,000 in 2018. That is slightly more than the 285,000 current US workers in the pharmaceutical and medicine manufacturing industry.
- In the Potential Production Case, job impacts peak at more than 439,000—roughly equal to all the non-farm workers in Delaware.
- The value added contribution to GDP from crude oil export supply chain activity reaches a maximum of $40 billion in the Base Production Case, roughly equal to South Dakota’s $41 billion Gross State Product in 2014.

Introduction

The renaissance in US crude oil production has reshaped the global petroleum market in less than a decade. The United States is now the world's third-largest crude oil producer behind Russia and Saudi Arabia and is closing in on both. The domestic oil industry's resurgence has driven a post-Great Recession recovery that has also transformed the US economy by reinvigorating our industrial competitiveness. US crude production has counterbalanced losses in other sectors, while greatly reducing global energy prices and economic risks. Even more remarkably, US oil and gas producers have been able to assert a more prominent role in the global crude market even though they lack access to markets outside of North America due to restrictions on crude oil exports under current by US law.

IHS' previous report concluded that continued crude oil export restrictions would depress US crude prices relative to international levels and reduce industry investment and slow the growth in domestic production. The economic benefits of lifting the export ban would accrue to broad swaths of the US economy, including consumers, by encouraging industry investment and limiting the impact of higher production on global crude oil prices.

This study evaluates the economic benefits of additional investment and production in the upstream oil sector should the export ban be lifted. It does so by analyzing how this investment impact flows through 60 industry sectors that are part of the crude oil supply chain.

When the first report was released, in May 2014, global crude prices hovered around $100 per barrel. That first analysis and this one were premised on crude prices maintaining a relatively high price environment through the outlook period. Since that time, several forces have dramatically lowered the near-term crude oil price. As the full impact of the success of crude oil production in this country has been absorbed into the global market, OPEC producers have made a conscious decision to defend their market share and sustain current output levels. These two factors together have driven the price of domestic and global crude down 50% over the past six months. Subsequent analysis by IHS has concluded that in this low price environment and amid OPEC's shifting market strategy, the current ban on US crude oil exports becomes more relevant and carries an even higher potential for economic harm if it is allowed to remain in place.

Companies participating in the supply chain catering to upstream oil and gas producers have benefitted significantly from the growth in hydraulic fracturing and horizontal drilling over the past 10 years. The intensity of labor, machinery and materials use on the well site has been a key demand driver for many of the 60 supply chain sectors, many of which have responded to increased energy production by increasing capacity and employment. While most machinery and materials suppliers still sell to a broad portfolio of customers, sustainable growth in the domestic oil and gas sector is providing business prospects that had been absent during the many years when US crude oil production was in decline. Despite the economic and technological advantages enjoyed by US upstream operators, the industry's growth is now endangered by both a real low crude oil price environment resulting from natural supply-demand forces and also by artificially low crude oil prices, which are a direct result of the export ban. Should export restrictions remain in place when domestic and global prices recover, both US producers and the supply chain on which they depend will be negatively affected. In addition, the geopolitical and consumer benefits of higher US crude production could be at risk.

US Crude Oil Export Decision overview

The 2014 *Export Decision* report examined the historical context, industry response, and potential impacts of a change to US crude oil export policies. The study also provided in-depth analysis of the implications for US and global oil markets should the ban be removed and assessed its national and state-level economic ramifications.

IHS quantified the macroeconomic effects on the United States and on individual state economies by examining industry activity under both a free trade environment and a restricted trade environment for two different crude oil production trajectories: the Base Production Case and the Potential Production Case. The Potential Production Case contains less conservative geologic and technical assumptions, leading to higher levels of future production. Two policy scenarios—Free Trade and Restricted Trade—were applied to the two production cases. The Free Trade scenario assumed that US crude oil could begin trading on the global market, while the Restricted Trade scenario assumed a status quo policy, which currently bans US crude oil exports.

The 2014 report's key findings on the benefits from the free trade of crude oil were as follows:

- Greater crude oil production and upstream investment. The differences between the free and restricted trade cases for US crude oil production and investment are quite large, ranging from 1.2 million barrels per day (B/D) and $66 billion in the Base Production Case to 2.3 million B/D and $82 billion in the Potential Production Case. These findings of higher investment and production hold true under a wide range of oil price environments.

- Higher US economic activity. The gains to gross domestic product (GDP) from lifting the ban in the Base Production Case with free trade would peak in 2018 at $135 billion—0.7% more than under the current, restricted trade policy. This peak impact is greater in the Potential Production Case, when GDP under free trade would be $221 billion, or 1.2%, higher.

- More jobs and lower unemployment. As a result of this higher economic activity, the employment gains due to free trade would be, on average, 394,000 higher in the Base Production Case and 859,000 higher in the Potential Production Case between 2016 and 2030. In the peak year, 2018, the jobs supported would be nearly 1 million in the Base Case and over 1.5 million in the Potential Case. The stronger labor market would increase the average US household's disposable income by $239 and $465 annually in the Base and Potential Production Cases, respectively, in 2016-2030.

- More government revenue. Total federal, state and local revenue from corporate, personal and energy-related taxes and royalties due to free trade would be expected to increase by a cumulative $1.3 trillion from 2016 through 2030 in the Base Production Case and by $2.8 trillion in the Potential Production Case.

- Widespread economic benefits. The benefits of freely traded crude oil would be distributed throughout the United States, and not just in the large oil-producing states: 24% of the future jobs supporting the oil industry would be located in states that produce little or no crude oil. This is due to the vast US network of supply chains that support crude oil production and investment.

Unleashing the supply chain overview

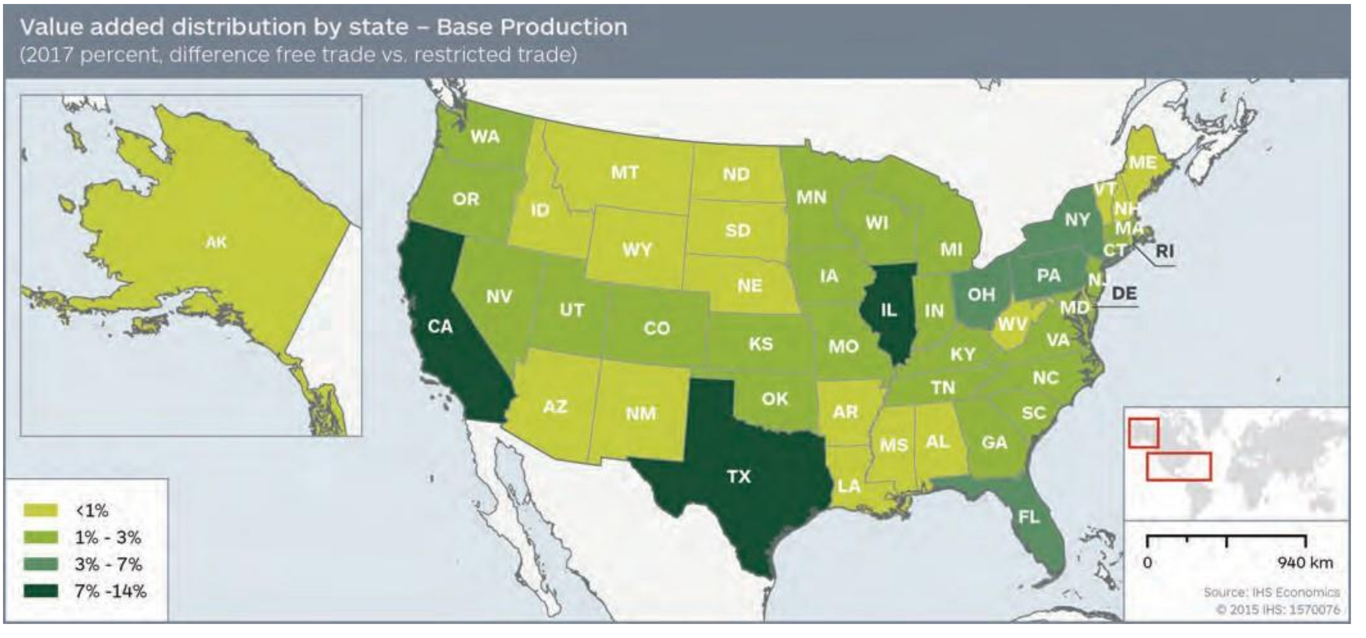
One compelling finding in the *Export Decision* report was that one-quarter of the economic benefits from the free trade of crude oil occurs in non-producing states due to the supply chain network supplying the revival of US oil production.

This report extends and deepens this research, examining the impact of upstream expenditures from lifting the trade ban on a diverse set of industry sectors—from steel and nonferrous metals to engines, pumping equipment, construction and professional services, and railroads. The economic impacts are assessed for four indicators: jobs, associated labor income effects, the value added of goods and services produced, and increased government tax revenue. The economic impacts are presented in terms of what would happen when moving from restricted trade to free trade for each production case.

This study provides detailed analyses of 60 supply chain sectors and also breaks down their contributions in each state and congressional district. The supply chain sectors fall into six core groupings:

- Construction and well services
- Industrial equipment and machinery
- Information technology
- Logistics
- Materials
- Professional and financial services.

Lifting the crude oil export ban will have a far reaching impact on the supply chain across all states. The supply chain across both producing and non-producing states reaps economic benefits. Among the non-producing states, machinery manufacturing in Illinois, information technology in Washington, and financial services and insurance in Connecticut are examples of beneficiaries of the crude oil export supply chain.



Report structure

This report contains four sections:

- **US crude oil analysis and economic inputs** provides a summary of the crude oil production and downstream industry basis for the macroeconomic and supply chain analysis.
- **National supply chain assessment** compares the economic contributions that free trade versus restricted trade would make to the US crude oil export supply chain in terms of employment, GDP, labor income, and government revenue.
- **State supply chain assessment** breaks down the economic contributions to the state level.

- Congressional district supply chain assessment presents the economic contributions at the congressional district level.

Additionally, two appendices explain the methodologies, research, and data relied upon for our analysis.

US crude oil analysis and economic inputs

Key insights

- Growth in US crude oil production continued unabated through 2014, reaching preliminary weekly estimates of 9.2 million B/D by January 2015, the highest production level since January 1983.[8] This approaches the peak production month in US history, 10 million B/D achieved in November 1970. The increase in production and drilling activity throughout 2014 confirms the potential provided by the revival of US tight oil.

- The global price of crude oil has fallen by about 50% since mid-2014 largely due to growing US tight oil production and declining US crude imports, which impact global oil markets. US consumers are saving over $700 million per day as a result on gasoline, diesel and heating oil. As the market rebalances, the crude oil price is forecast to recover moderately in the next few years and to nearly $90 per barrel after 2020.[9]

- US tight oil production—a relatively high-cost and price-responsive crude—is now an important marginal supply to balance the global oil market, and. US producers respond to price signals by changing their investments in drilling. However, the US crude oil export ban distorts the global price signal when domestic crude prices become discounted from global prices. The result would be lower US crude oil production and higher prices for global crude oil and gasoline.

- The recent decline in global oil prices increases the potential for economic hardship caused by the export ban—rather than decreasing them, as some might assume. At a lower price, production becomes more sensitive to small price changes—for example, a $3 change in a $50-per-barrel price environment can have the same effect on US production as a $10 change in a $100 environment. However, the US refining constraints and price discounts necessary to process additional volumes of light tight oil are nearly insensitive to crude price. Therefore, the US oil system gridlock is more constrained at a low crude price.

- Each oil well drilled and completed represents a substantial economic investment, with tens of millions of dollars expended both at the well head and in the infrastructure necessary to transport and process the production into usable consumer fuels. The direct capital investment associated with each well supports a vast supply chain covering everything from raw materials, such as sand and steel, to complex manufactured goods, such as engines, motors, and advanced computer and instrumentation systems. To successfully develop the producing wells, all of these industries work in concert across a vast coordinated supply network.

Review of previous findings

The United States currently is at the center of one of the most profound changes in the global oil industry since the 1970s. Advances in horizontal drilling and high-pressure fracturing, combined with improved application of these technologies in the oil field, have revived US crude production. Many believe substantial additional gains in crude output are possible. The dramatic shift in production has also highlighted issues pertaining to a longstanding but, to this point, largely benign set of policies related to the free trade of US crude oil.

In May 2014, IHS released the *US Crude Oil Export Decision* report, documenting an integrated and comprehensive view of the origins, petroleum industry impacts and macroeconomic effects associated

8 The US Energy Information Administration (EIA) began keeping weekly production estimates in January 1983.

9 Brent crude oil price on an annual average, inflation-adjusted basis.

with whether or not the US maintains or revises existing policies related to the export of domestically produced crude oil. The public report evaluated two prospective crude oil production forecasts:

- The Base Production Case
- The Potential Production Case

For each production case, two trade policy alternatives were analyzed:

- Restricted trade, which assumes that the current ban on US crude oil exports is maintained.
- Free trade, which allows exports of US-produced crude oil.

The forecast period for the analysis is 2016-2030. The main conclusion of this analysis is that the free trade of crude oil would have broad and positive impacts on job growth, trade, government revenue, and US economic output. The results of this analysis are summarized as follows:

Impact of free trade (vs. current restricted trade policy)

	Base Production Case	Potential Production Case
Crude oil production, average, 2016-30 (million B/D)	1.2	2.3
US gasoline price, average, 2016-30 (cents per gallon, real)	-8	-12
Fuel cost savings, cumulative, 2016-30 ($ billion)	265	418
Investment		
Peak annual investment ($ billion)	66 in 2017	82 in 2017
Cumulative oil production-related, 2016-30, ($ billion)	751	995
Cumulative refining-related, 2016-30, ($ billion)	-5	-21
Cumulative logistics-related, 2016-30	9	13
Cumulative investment, 2016-30, ($ billion)	755	986
Gross domestic product		
Peak growth (percent)	0.7 in 2018	1.2 in 2018
Peak ($ billion, real)	135	221
Average, 2016-30 ($ billion, real)	86	170
Net petroleum trade, average, 2016-30 ($ billion, real)	67	93
Employment		
Average, 2016-30 (thousand)	394	859
Peak (thousand)	964 in 2018	1,537 in 2018
Disposable income per household		
Average, 2016-30 ($, real)	238	466
Peak ($, real)	391 in 2018	733 in 2021
Cumulative government revenue (2016-30) ($ billion)	1,311	2,804

Source: IHS Energy Insight and IHS Economics © 2015 IHS

This report, *Unleashing the Supply Chain: Assessing the economic impact of a US crude oil free trade policy,* is organized into five sections that address the following topics related to the export ban and how it impacts both the oil industry and US economy as a whole:

- The historical origins of the existing ban, the policy objectives that it was originally intended to achieve, why these objectives are now irrelevant, and the current framework of US trade policy pertaining to crude oil.
- The outlook of US crude oil production under the Base Production Case and Potential Production Case, and the methodology, techniques, and analysis that IHS employed to develop these two production

forecasts. This section of the report also contains IHS' view of how both the near- and longer-term outlook for US crude oil production would change as the difference between domestic and international crude price widens (under restricted trade) and compresses (under free trade).

- An overview of the US refining system, focusing on how various grades of crude oil are processed using different types of refinery configurations, and the processing inefficiencies that accumulate when a refinery processes a crude oil that it was not designed to process. The limitations of the US and, specifically, the US Gulf Coast refining systems in processing increasing volumes of light crude oil produced from tight shale formations are translated into domestic crude oil price discounts, without the ability to export surplus light oil production to the international market.

- The price relationships between international crude oil, international gasoline, and US gasoline that exist and that remain connected, due to the free flow of trade, but that do not exist for US crude oil due to the lack of free trade. The empirical evidence demonstrates that discounted US crude oil has no impact on reducing US gasoline prices, and counterintuitively, allowing free trade of US crude oil and reestablishing the trade linkage between domestic and international crude oil will increase domestic crude oil prices and reduce US gasoline prices simultaneously.

- A summary of the national and state level economic impacts of moving from restricted to the free trade of US-produced crude oil. Translating the investment impacts of upstream oil and gas industry production under free trade to the broader economy creates material boosts to GDP, employment, disposable income per household, and government revenue and taxes.

- Appendix A of this report provides more detailed discussion and synopsis of the 2014 *US Crude Export Decision*. *Unleashing the Supply Chain* builds from the previous *Export Decision* analysis and evaluates the impact of lifting the ban at the more granular congressional district level. It also analyzes the degree to which the jobs and economic value-added occur within the oil and gas industry itself or how that spreads through the supply chain that supports the industry with material, labor, and goods. To ensure continuity between the two reports, the same analysis and the oil and gas sector impacts associated with the two production cases and the transition from restricted to free trade have been used.

Changes to the energy market outlook since May 2014

Since the IHS *US Crude Oil Export Decision*'s May 2014 release, two notable changes have occurred that bear discussion. First, the global crude price has declined sharply largely due to US production increases, and second, the Bureau of Industry and Standards (BIS) has provided clarification of existing rules to allow certain very light crude oil (condensate) to be exported as a "refined product" in certain situations involving sufficient processing.

The rapid crude oil price decline—by roughly half since mid-2014—is a reminder of the cycles and uncertainty of oil and energy markets and of the disparity between the speed of market and price changes and the oil industry's long-term investment horizon. In less than a year, changes in supply, demand and price have shifted dramatically. In comparison, a large oil-producing project typically takes five to eight years to plan, construct and bring online for a decade or more of production at the site.

Producers are responding to declining cash flow with reduced budgets, smaller drilling programs and cost cutting. The US tight oil drilling response is sensitive to the price decline and will experience a more rapid production impact than most producing areas due to the shorter investment cycle for these onshore plays and the relatively high rates of production declines in the first few years of operation of a tight oil well. This faster rate of decline means that if new drilling is curtailed, production will respond very quickly. While exploration and development costs are expected to also decline (partially offsetting budget cuts), the industry is expected to produce less crude oil as a result of recent oil price declines, and the impact on employment is magnified throughout the supply chain.

Global benchmark crude oil prices downward revision

As discussed in detail in this section and in the *Export Decision* report, a key influence on the development of US tight oil resources and production levels is the absolute price producers receive at the wellhead. If this price is substantially reduced, either through domestic policy or market forces, producers have less available capital for sustaining reinvestment and new well development. Since mid-2014, a number of factors have combined to shift the market and market sentiment, including:

- Continued robust US production growth of over 1 million B/D in 2014;
- Weaker-than-expected global oil demand growth resulting from weaker global economic growth;
- The return of Libyan production in August 2014 (which was later reduced after prices began to fall);
- A decision by OPEC and Saudi Arabia to maintain production and market share in the face of a declining oil price.

IHS estimates global market oversupply in 2014 and 2015 combined to be over 1 million B/D. The oversupply of crude oil, particularly light crude oil, has exerted substantial downward pressure on the fundamental price level of both global and US domestic crude oils, with the price of the Brent benchmark falling from $110 per barrel in June 2014 to around $50 a barrel by January 2015—more than a 50% reduction for all crude oil grades.

OPEC's response to this period of global oversupply represents at least a temporary deviation from its historic response to periods when oil supply exceeds demand. Following a meeting of OPEC member countries in November 2014, the producer group announced that they would hold their production constant and allow markets to find a new balance. Global oil prices are expected to be reduced sufficiently—and for long enough—to allow demand to increase and new production to be curtailed, bringing supply and demand back into equilibrium.

OPEC's logic is based on a view that their production is not the world's marginal supply of crude oil, and many OPEC members have lower investment costs for new production than then investment costs for new production from non-OPEC producers. If OPEC were to reduce production by its member countries to balance the market, raising prices at the same time, it would continue to support incremental production from higher-cost producers, supporting the loss of OPEC's overall market share. Analysis on the part of IHS supports key OPEC members' estimates of new well development breakeven costs that are well below the global average of $60 per barrel (on the basis of Brent crude).

With the majority of the growth in global oil production over the past four years coming from US tight oil, the proven scalability of US tight oil[10] and the relatively high average breakeven cost of US tight oil (about $75 per barrel) has resulted in an unanticipated shift in global oil market dynamics. At least during the current oil commodity cycle, the responsibility for balancing the oil market has been transferred from OPEC to non-OPEC producers, primarily the United States. If prices stay low enough for long enough to discourage some portion of US tight oil and other non-OPEC new well investments, then natural declines in existing production and demand growth are forecast to rebalance the market over the next 18 to 24 months. When demand growth overtakes supply growth, prices will rise to incentivize new US tight oil well investment and production and add supply consistent with incremental demand growth.

This theoretical behavior of how the market will rebalance and respond to the new price environment faces several challenges. First, the time required to bring new supply to market implies that supply responses will lag global demand signals, leading to greater price volatility and more exaggerated price cycles. In addition, the export ban can disrupt the global market price signal for US production. The

10 Unlike many conventional oil projects, such as the Gulf of Mexico and North Sea deep-water projects, US onshore tight oil development occurs by drilling lower productivity wells, rather than investing large amounts in a few expensive, high-producing wells. This results in tight oil being more responsive to changes in global prices as the incremental investment, duration to develop, and production of each new well are much lower than in large projects.

reliance on US tight oil to balance the global market increases the issues created by any disconnects between the price signal being sent by the global market and the one received by US tight oil producers.

US producer response and outlook

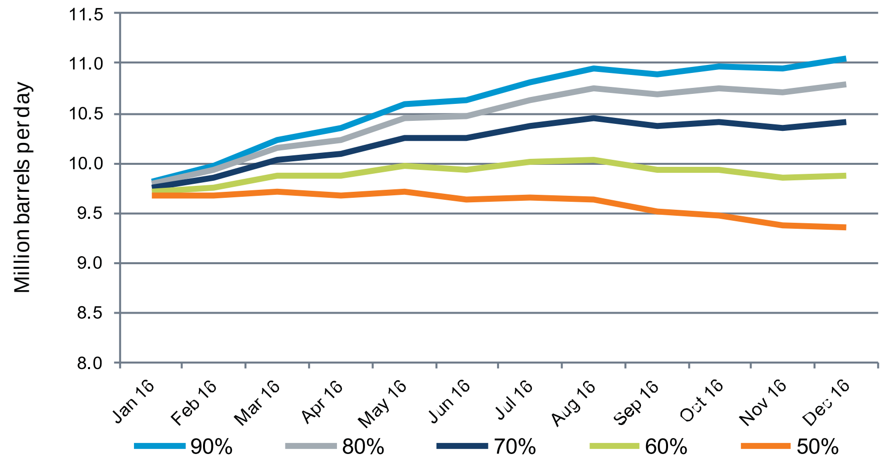
The oil price decline is causing a swift reaction in the 2015 capital investment plans of US tight oil producers. Capital budgets in some cases are being cut in half, and the number of active US land rigs is already down 25% from July 2014. In the previous analysis, IHS determined that an annual average $25 per barrel lower price at the well head between restricted and free trade results in a 25% reduction in US oil and gas upstream investment and a corresponding reduction of 400,000 B/D in US tight oil production after the first full year of lower prices, when the US light oil refining system reaches gridlock. Under the current $50 decrease in global and US crude oil prices, large reductions in upstream capital expenditure are materializing. Based on announcements by large drillers and producers of US tight oil, 2015 capital budgets have been reduced by approximately 35% and could be reduced even further over the course of the next two years if low prices persist. These lower capital budgets of US tight oil producers are predicated to some degree on a modest rebound in US crude prices by the second half of 2015, with announced expectations typically between $60 and $70 per barrel.

Although many US producers are reducing capital expenditures for future new well development, it is not anticipated that US production will immediately fall due to momentum in drilling and well completion programs and investment decisions made over the past few years. This is supported by the large inventory of US wells that have been drilled but not yet hydraulically fractured and completed. With drilling capital already sunk, new wells will continue to be brought online despite lower oil prices. Many producers appear to be employing the strategy of reducing investment in higher cost and developmental plays, while focusing capital on accelerating development plans in lower-cost and more prolific plays—"sweet spots" in various US tight oil formations. This investment shift is likely to delay the point where month-on-month US production growth stops and eventually begins to decline for a period of six to 12 months.

Another key outcome of declining prices—and a change from the previous analysis—is that drilling and completion costs are responding rapidly. The analysis performed for the 2014 report was premised on the assumption that as domestic prices dropped in response to the export ban, drilling costs would stay relatively high and remain tied to global drilling costs, since the price dislocation was specific to the US market. In the current market, however, with lower global prices and drilling activity, drilling and service-provider costs have responded accordingly. Costs have already fallen 10% and further declines are likely as the low price environment persists. Lower drilling costs globally and domestically will lower the breakeven costs for new well development and alter the relationship between wellhead prices and capital investment and production growth. As drilling costs fall, it will take a larger reduction in US wellhead prices to create the same production response as determined in the *US Crude Export Decision* report. This speaks to both the ongoing efficiency gains being realized for US tight oil drilling activity and the constantly shifting interaction between wellhead price, development costs, and overall production activity.

This IHS analysis evaluates this relationship between new well development costs, capital investment level, decline rates of US tight oil wells, and efficiency gains by the US upstream industry in this new era of dramatically lower prices. The chart shows various trend lines for how 2016 US production is expected to respond when 2016 investment in upstream capital projects is at varying percentages of 2014 investment.

US crude oil production outlook sensitivity cases (2016 upstream capital investment as a percent of 2014 upstream capital investment)

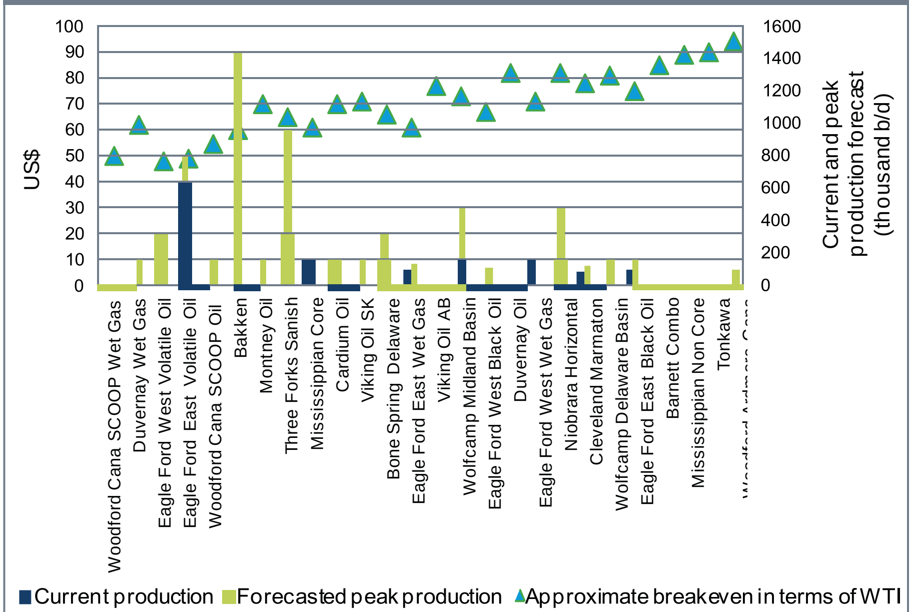


Source: IHS Energy

This outlook for potential 2016 production is premised on the IHS view that the current backlog of drilled, but not completed, wells and continued activity in tight oil formation sweet spots will increase US crude oil production from its current level of 9.2 million B/D to 9.7 million B/D during mid- and late 2015. This increase in production will occur despite the bearish price signals being sent by the global market. IHS' current outlook assumes that 2016 investment levels will be at 60% of 2014 levels and that the export ban is lifted, allowing US producers free trade of crude oil. The chart above points out the sensitivity of US production to upstream capital reinvestment: US production declines by 400,000 B/D when investment changes from 60% to 50% of 2014 investment levels. This difference could result from as small as a $5 dollar disconnect between domestic and international crude oil prices and is a key reason why the results of the first study remain valid in the new, lower price environment.

Another reason that capital investment levels and the US production outlook are more sensitive to small price discounts in the new low price environment is that large amount of US tight oil plays are currently near their breakeven levels. As shown in the chart, a far larger percentage of US tight oil is uneconomic at $50 per barrel than at $75 or $100. Large swaths of current drilling for new tight oil wells is profitable at $75 per barrel but not at $50 per barrel.

Production and play breakeven interplay



Note: Calculated with gas price at US$4/MMBtu flat and oil price at US$100/bbl flat.
Source: IHS Supply Analytics

In summary, US producers' decisions about investment and production are increasingly sensitive to US price discounts as the price of crude oil becomes lower. Essentially, at lower crude oil prices, the industry has a "flatter" supply curve, which means that smaller changes in crude oil prices result in a larger loss of supply. The implication is that the risk from the export ban is *increased* in the current low price market.

Current US crude prices

The rapid reduction in all global benchmark crude oil prices briefly narrowed the spread between US and international prices. This appears to have only been a transient condition for US producers, since domestic crude prices during the transition did not fall low enough to remain competitive with international imported grades or to cover the logistics costs to deliver domestic crude oil to the proper refining center. There is likely further room for US domestic prices to fall below international prices as equilibrium setting mechanisms are re-established.

This narrowing of the international-domestic price spread, commonly measured by the Brent-WTI price difference, had somewhat muted the US producer response through the end of 2014. As additional US production growth occurs in 2015 (albeit at a reduced rate), a widening of the Brent-WTI spread is projected under the current trade policy for the reasons discussed above and in the *Export Decision* report.

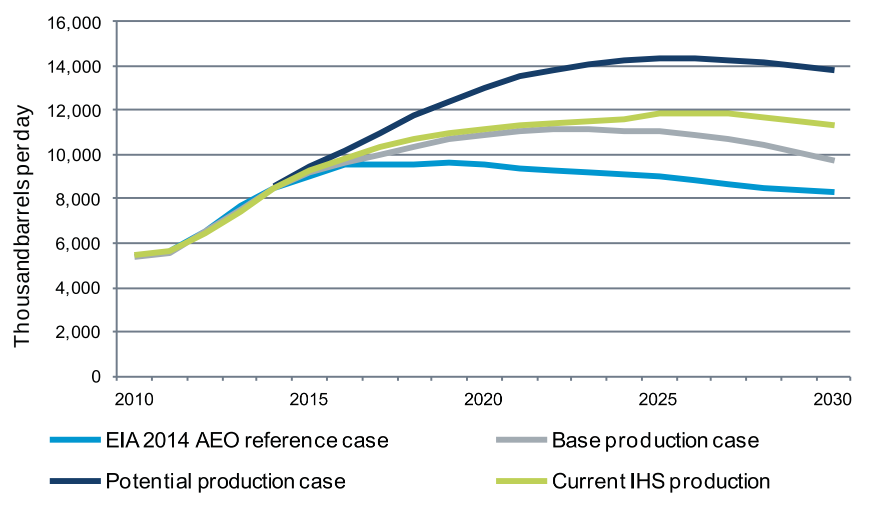
An increase in crude oil being placed in storage also supported a narrower price differential and may have obscured the impact of the export ban as prices declined. At the time of this report's release, US inventories of crude oil have risen to record levels, above 400 million barrels of US commercially available stocks, and the price difference between Brent and lower-priced WTI is again diverging to $8 to $10 per barrel, or a 15-20% discount, which is being incurred only by US producers.[11]

The result: US producers would be facing the doubly punitive impact of low global oil prices and a large domestic crude price discount compared with international prices that could further adversely affect upstream investment in oil and gas production and its associated economic and jobs growth. In short, the decline in global oil prices provides further incentive to remove the market distortions created by the ban on crude oil exports and avoid additional disruption to US crude oil producers.

IHS current US production forecast

IHS maintains US and global crude oil production forecasts, incorporating the latest data and information regarding expected production globally. Particularly in analyzing US unconventional production, where the pace of drilling and technological advancement are moving rapidly, the use of updated assumptions regarding typical well-production type curves, suitable drilling locations, market price signals, and the emergence of new unconventional plays have a large influence on the expected growth and ultimate peak production of US crude oil. IHS' current US crude production

IHS oil production forecasts compared to EIA Annual Energy Outlook (AEO) forecast



Note: EIA 2014 AEO released April 7, 2014

Source: IHS Energy, EIA

11 An additional 700 million barrel of crude oil is held in storage by the US strategic petroleum reserves (SPR).

outlook has been increased from the *Export Decision* Base Production Case developed in 2014, though not yet to the levels forecasted for the Potential Production Case. New projections show US production peaking at 12.9 million B/D in 2029; this 1.7 million B/D increase reflects stronger growth in the Bakken, Eagle Ford, West Texas, and deep-water Gulf of Mexico, as well as large efficiency gains realized during the current low price environment that will ultimately push the current outlook closer to the Potential Production Case.

It is noteworthy that the projection for 2016 of 9.9 million B/D of US production will eclipse the previous peak production year, 1970, which saw 9.6 million B/D of crude oil produced. However, if the lower price environment persists and contributes to a regime in which less investment capital is available, US production growth will eventually slow, putting upwards pressure on global prices in anticipation of lowered US production.

Our analysis supports the view that current, lower crude oil prices are the result of a transient over-supplied market that is likely to correct itself over the next two to three years. Several oil market factors are likely to rebalance the market and increase prices.

- Investment deferrals and cancellation of high-cost sources of production such as ultra-deep water, Canadian oil sands, and US tight oil projects.
- Recovery of economic growth in key regions, including Europe and China.
- Fragility of sustained production from Libya.
- Potential action by OPEC to reduce output.
- Destabilizing effects of lower crude price for high-cost producing nations that rely heavily on oil revenues to fund government budgets. A period of destabilization and unrest in any one of the large producing nations could rebalance markets by reducing supply and changing market sentiment.

Despite the near-term downward price correction, IHS' long term view remains similar to the prior outlook due in part to the expected efficiency gains generated during this current low price environment. Over the long term, as world demand for crude continues to grow and conventional reserves decline, more supplies will be needed from high-cost sources, such as deep-water, ultra-deepwater, extra-heavy oil—including the Canadian oil sands—and from plays in more demanding environments and marginal fields. While growth in US light tight production will be an important supplier to global oil markets in coming years, other supply will also be required to meet demand. Various factors such as project costs suggest that non-OPEC output growth outside of North America will slow and skew toward more expensive, harder-to-produce reserves. As this happens—around 2020 in our forecast—the real dollar Brent price rises to approximately $90 per barrel, the price level necessary to develop these more challenging resources.

The combination of the export ban and the United States as a higher cost crude supplier influenced by global market prices creates a new risk to US consumers. In the context of the export ban, the global crude oil market and recent decisions by OPEC that have shifted market balancing responsibility to non-OPEC producers creates the possibility of a new and large market distortion. As the market rebalances, demand responds to the lower price environment, eventually requiring new production. A higher price signal must emerge to incentivize increased production. Since US tight oil has the demonstrated ability to respond quickly to global price signals, it is reasonable to assume that as prices rise, the market expectation will be that a large portion of new supply will come from the United States. However, if US production of light tight oil is at a level where efficient light oil refining capacity is already being fully utilized, US domestic prices will become increasingly discounted to international prices. As each incremental barrel of US light oil production moves to less and less efficient US refining tiers, global prices will continue to rise until the US refining cost penalty to process US tight oil is fully offset and imports of heavy crude are displaced back into the international market to meet growing global demand.

When this occurs, the US ban on crude exports will be directly responsible for an increase in global crude oil and gasoline prices equal to the discount necessary to incentivize the processing of US light crude oil in US heavy crude oil refineries. This increase would be similar to the price decrease expected if the export ban is removed.

Processed condensate

A recent decision about what constitutes US oil that is eligible for exporting may also play a role in how the export ban discussion develops. In June 2014, it became public that two operating companies (Enterprise Products Partners and Pioneer Natural Resources) had received private rulings from the US Department of Commerce and Bureau of Industry and Security (BIS), that the degree of processing being done to condensate at certain field facilities would be defined as "distillation"—and neither of the resulting products are considered crude oil and thus not subject to the export ban. Under existing US policy, petroleum products that have been separated from whole crude or condensate through a distillation process are no longer subject to the controls that govern whole crude oil or condensate. Thus both the lighter petroleum liquids and heavier bottoms fractions produced when condensate is distilled could be freely exported as "refined products" and would not be subject to the trade controls that apply to crude oil. In the aftermath of this private ruling, the export of condensate product has been occurring, although volumes remain modest.

It has also become public knowledge that other market participants have applied for clarification and rulings on their distilled petroleum products from condensate. In addition, at least one market participant has announced that it will "self-classify" and export condensate product without receiving explicit endorsement from the BIS. However, the definitions of the processing required and what streams qualify remains unclear.

In December 2014, the Department of Commerce also issued a series of clarifications in its Frequently Asked Questions (FAQ) format regarding processed condensate, in an effort to provide further guidance and perhaps to aid operators in self-classifying, avoiding the need for new private rulings. The FAQs somewhat clarify the degree of processing necessary for fractionated streams to qualify for export. They do not, however, provide the technical details necessary to determine if processing is occurring in each situation. Notably, the FAQs did not attempt to define the difference between crude oil and condensate or to limit the application of the processing definitions to one or the other. However, the facilities described are typical of those used in the field to handle condensate, and the materials qualifying under the ruling are most likely to be condensates.

If sufficient volumes of US condensate production fall under this definition, the export of condensate product will loosen the impending market gridlock. However, the amount available for export remains unclear. The largest barriers to widespread adoption of condensate product exports are ongoing regulatory uncertainty.

New infrastructure must also be put into place to segregate this new policy-generated product. Condensate production is significant and estimated to be near 800,000 B/D. Yet, little of this production is coastal and so, to prevent commingling, infrastructure is needed to move the condensate product to export terminals.[12] This new infrastructure must be separate from the three existing infrastructures for crude oil, natural gas and natural gas liquids (NGL).[13] This required segregation creates market and capital inefficiencies. Further, market distortions are likely to arise due to artificial distinctions between similar products (unprocessed condensate and condensate product). This policy-driven investment will likely duplicate more efficient facilities already in place, another example of the economic inefficiencies caused by an outdated US crude oil export policy.

12 Condensate production is estimated due to a lack of an industry and statistical definition.

13 The infrastructure for crude oil can also be used for condensate as long as the condensate is not intended for export.

It is worth noting that condensate product is not a usable fuel but is, rather, a broad boiling range feedstock, like crude oil, that requires further refining to produce finished products for end use. Therefore, most exported condensate product will be sold to the same refiners that would purchase the unprocessed condensate. To date, the majority of US processed condensate exports have gone to refineries located in Northwest Europe and Asia—markets identified as most likely for condensate and light tight oil exports, should the ban be lifted.

Adjustments to energy results

Other than the new mapping to translate the state-level results the *Export Decision* study into congressional district level results for this report, the vast majority of outputs in IHS' energy analysis remain unchanged for the four production-trade cases—Base and Potential Production under restricted and free trade. One exception was a small downward revision (about 3%) in the restricted trade cases for midstream infrastructure spending associated with crude oil assets (pipeline, storage, marine, rail) to reflect the lower crude production brought on by lower prices, requiring less midstream infrastructure spending to support production. This adjustment was not made in the previous report but has been incorporated into these results.

Energy modeling methodology

National-level inputs

A key step in IHS' analysis of the US economic impact of free trade in crude oil is developing the necessary inputs to determine how production, pricing, and investment levels change in response to a policy change. There are six first-order results or outputs from the energy analysis that directly impact macroeconomic and supply chain comparisons of a free versus restricted trade policy environment:

- Changes in production of US crude oil, natural gas liquids, and associated natural gas, determined by applying domestic market price signals to the well head price under free and restricted trade and calculating a reduction in drilling levels associated with lower capital available for reinvestment under the current restricted trade policy in which an oversupply of domestic crude oil in US markets puts downward pressure on US crude prices.

- Changes in the Refiner Acquisition Cost (RAC), which is the average cost paid for domestic and international crude oil by US refiners. The RAC cost is several dollars lower, on average, over the forecast period with the current restricted trade policy in place. It should be noted that the RAC does not affect gasoline or refined product prices, because these prices are tied to international crude and products prices.

- Changes in direct capital investment across the upstream (production), midstream (transportation and logistics), and downstream (processing and marketing) sectors. The lower overall price level of domestic crude oil with restricted trade results in lower upstream direct capital investment by oil and gas producers. This investment is $751 billion less in the Base Production Case and $995 billion less in the Potential Production case during 2016-2030. This effect is only partially offset by more investment in the downstream sector in the restricted trade case; in comparison, downstream investments increase by $5 billion and $21 billion in the Base and Potential Production Cases, respectively. The level of midstream investment change moving from restricted to free trade is also relatively small: $9 billion less in the Base Production Case and $13 billion less in the Potential Production Case).

- Changes in the volume of crude oil and refined product imports. These changes are converted to dollar values (import volume multiplied by price). The impact of trade policy on the petroleum trade balance and total US balance of trade is evaluated.

- Changes in the volume of crude oil and refined product exports. Again, this is converted into a dollar value, and the impact on the petroleum trade balance and US trade balance of trade are evaluated.

- Changes in the price of domestic retail gasoline, diesel and other refined products. As discussed above, IHS' analysis concludes that free trade of crude oil lowers US gasoline prices due to the global price impact of higher US crude production on the world oil market.

These six primary energy inputs are developed for each production case (Base and Potential) and then modeled under either a free or restricted trade environment. When viewed in aggregate, this analysis provides a complete view of the petroleum energy landscape at the national level.

In comparing these four cases developed by IHS, it is important to note that the effects of a policy change are not four independent cases. A case must be compared against another case to evaluate how change in the crude oil trade policy or production outlook impacts the US economy. In the figure, cases that are adjacent to each other either horizontally or vertically can be compared, but comparisons cannot be made between cases diagonal to each other. For example, the Base Production/Free Trade Case to the Potential Production/Restricted Trade Case are not comparable and will not produce meaningful results since they start with different fundamental assumptions about how much US crude is produced.

Basis for production cases and trade policies

Production cases

Trade policies	**Base** IHS central planning forecast. Conservative view based on defined plays and assumes limited industry improvements.	**Potential** Includes additional potential but less well defined areas of existing plays, moderate industry drilling and technology improvements.
Restricted Current policies (including condensate treatment as crude).	Base Production / Restricted Trade	Potential Production / Restricted Trade
Free Trade to broad group of trading partners including Europe and Asia (India, China).	Base Production / Free Trade	Potential Production / Free Trade

Trade policy decision

Difference in underlying US production forecast view

Note: Each case starts with the same IHS macroeconomic and international crude oil price forecast

This clarification is also important distinction, because many pieces of the petroleum investment and supply outlook are unlikely to change when moving from a restricted to free trade policy environment or when comparing the Base Production and Potential Production cases. For example, the underlying price of natural gas and natural gas liquids and their associated infrastructure investment are not materially impacted by the transition to crude oil free trade. The trade policy associated with natural gas is already largely liberalized.

State-level inputs

The essence of translating the national level energy analysis and results to the state level requires ensuring that the crude oil production is properly allocated to each state. IHS accomplishes this by performing two separate analyses to the production of conventional and unconventional oil and associated natural gas. IHS maintains a detailed database that is regularly updated based on IHS internal analysis and on the history and forecasts of US crude production by type of commercial crude oil stream and by geographic region. Each stream is then allocated to individual states based on each state's historical production levels, expected decline rates (if applicable), and forecasted new well completion activity (mostly from the unconventional plays). For some commercial grades of crude, this is relatively straightforward since the shale formation resides in only one state. For example, Eagle Ford lies entirely within Texas and is allocated entirely to that state. The exact percentage allocation becomes more complex when a play—and its production—spans several states such as the Permian, Bakken, and Utica basins.

Once the state's level of forecasted production is determined, it is used to develop the expected number of new wells that must be drilled and completed. Well numbers assigned to each state are, in turn, used to calculate the direct capital investment in the upstream sector for each state. IHS correlates direct capital investment as a function of well completion level, using proprietary cost estimating tools and escalation factors to develop per-well costs for both new conventional and unconventional wells being drilled. The final step in calculating upstream capital investment for each state is to multiply the number of completed wells by the per-well cost for each broad category of well. Since crude production, which is driven by market price signals, is the piece of the analysis that changes most when moving between restricted and free trade policies, this this change also has the largest influence on economic growth and employment in the analysis.

IHS assumes that each state carries a single price at the well head for crude oil, though in actuality small differences exist across regions, states, and counties. This price is determined by indexing the well head price to the nearest price-benchmarking location and calculating likely logistics costs (for pipe, rail, and truck) to transport the crude oil to that location. When approximating well head crude oil prices at the state level, Texas has several large producing basins and benchmark pricing locations, posing a particular challenge in developing a uniform wellhead price for the state. This is solved by dividing Texas into three sub-regions (Gulf, Central, and West) and developing different wellhead marker prices for each sub-region.

To assess the impact of free trade through the remaining parts of the US energy sector (midstream transportation and logistics, and downstream processing and marketing), IHS developed a project-level database containing investment details, including capital costs and locations, for the majority of energy infrastructure projects currently under development in the United States. This project-level database tracks investments in processing, logistics, and storage across each of the three main hydrocarbon value chains: crude oil, natural gas, and natural gas liquids (NGLs). When evaluating investment trends for petroleum infrastructure, IHS has determined that publicly available information in financial statements and press releases are good sources for the location and volume of infrastructure projects under development for the next three to five years. To assess infrastructure spending required in the medium term through the end of the analysis forecast, IHS performs an assessment of the expected levels and locations of production for each hydrocarbon value chain, the existing capacity for processing and transportation, and whether or not an infrastructure deficit is likely to emerge during the forecast period. When IHS identifies a gap in the infrastructure required to bring production to market, an estimate is developed for the capital investment necessary to close that gap. This assessment of the level of infrastructure deficit (or overbuilding) in the four production-trade scenarios is largely driven by the difference in crude oil production for each scenario.

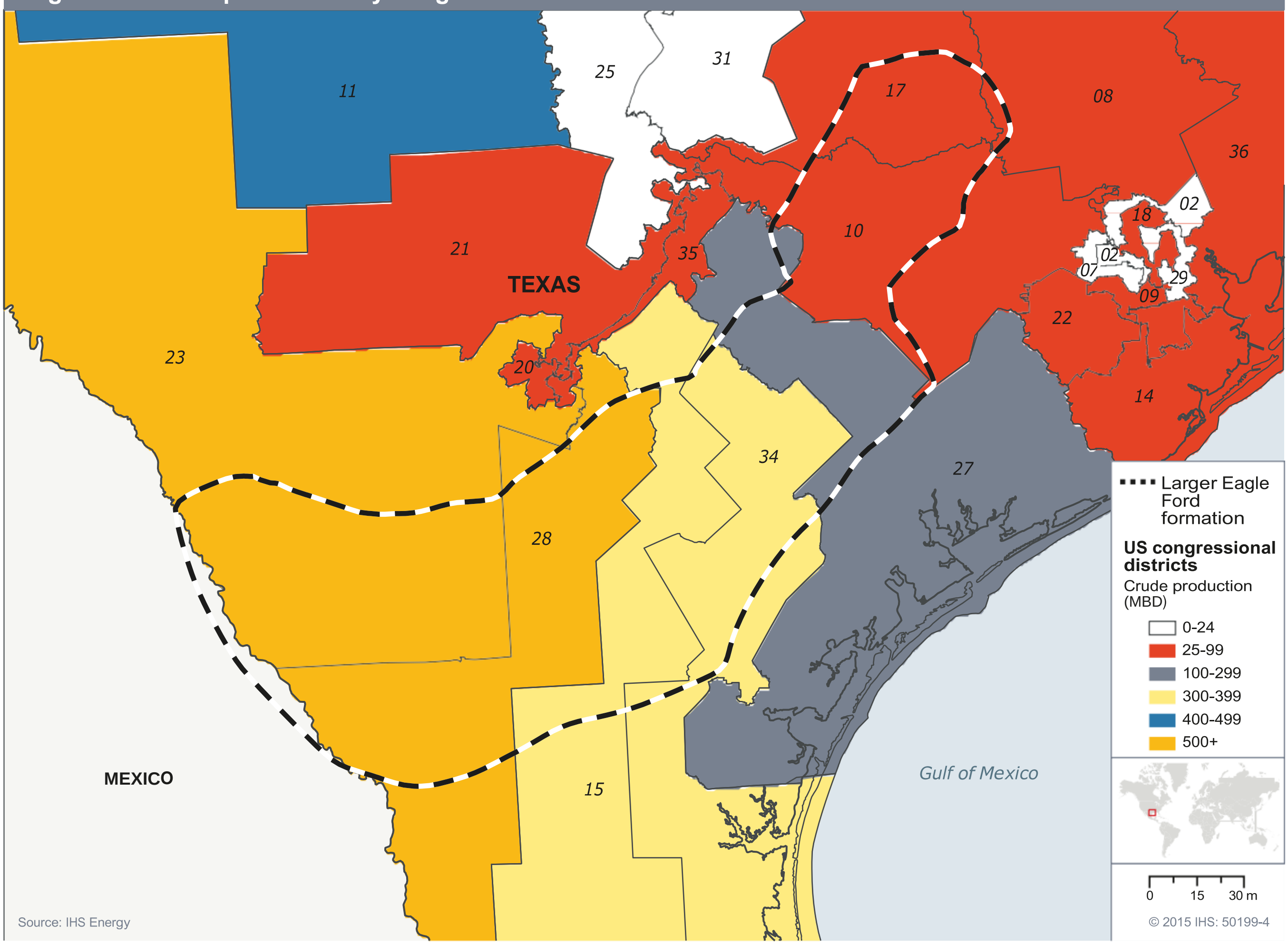
The analysis of where and how much infrastructure will be needed over the longer-term investment horizon is premised on IHS' experience and internal analysis of where infrastructure is likely to be added. Cost estimates of the necessary capital investment to build that infrastructure are developed internally. An example of this process can be found in the restricted trade cases where substantial additional investment is likely to be needed in simple refining capacity to process a surplus of light tight oil production that cannot be exported. Since the investment decisions for these projects have not yet been made, IHS uses internal estimating practices for the investment to add between 1 million B/D and 3 million B/D of simple crude processing capacity; we then make a determination that this capacity will probably be added in existing refining centers, such as the Louisiana and Texas Gulf Coasts. Similar analyses are performed for other components of the midstream and downstream supply chain for construction of pipelines, storage, loading and unloading facilities, rail car manufacturing, and crude marine tankers.

The remainder of the main energy inputs, such as RAC, crude oil and refined product trade (both imports and exports), and retail gasoline prices are assessed only at the national level and only have an impact on the national-level economic analyses and results. These pieces of the energy analysis are assumed to be evenly distributed across the states. However, an assessment is made of the states would be likely import and export crude oil, based on historic trade patterns and the presence of port and marine infrastructure.

Congressional-level inputs

Similar to converting national data to the state level, converting the state-level energy analysis to the congressional district level involves a similar process of data mapping and proportional allocation among districts. IHS' proprietary production databases and many state government departments monitor existing production on a county level. To convert this into congressional district data requires an assessment of what percentage of a county is contained in each congressional district, based both on the county's land area and the location of production. For the forecast, the detailed analysis of the

Eagle Ford crude production by congressional district: Base Production / Free Trade



unconventional plays and where future drilling locations are expected to be concentrated are overlaid on a current congressional district map to determine the state-level contribution allocated to each district. For major unconventional tight oil formations such as the Bakken, this is a straightforward exercise in Montana and North Dakota, which each have just one large congressional district. Allocating other tight oil plays is more involved. For example, Eagle Ford has several distinct producing windows (dry gas, wet gas, volatile oil, and black oil) spread across nine congressional districts.

For assessing the impact of crude oil production, once the congressional district allocation is complete, the same translation of changes in both production cases when going from restricted to free trade is calculated to arrive at the resulting changes in direct upstream capital investment. Next, the investment distribution is performed for the midstream and downstream investment databases for both production cases under free and restricted trade. The map below shows a large pipeline project under development to transport surplus light tight oil from the Midwest to refineries and storage terminals in the Gulf Coast. This pipeline crosses numerous congressional districts receiving investment by a single infrastructure project. (It's important to also note that there are situations in which a given project may not be realized if crude production levels are too low, and the project is not economically feasible.

As with the state level analysis, a constant crude oil well head price across congressional districts is assumed. This is identical to the price at the state or sub-region level.

Energy transfer partners—Trunkline conversion project

Source: IHS Energy

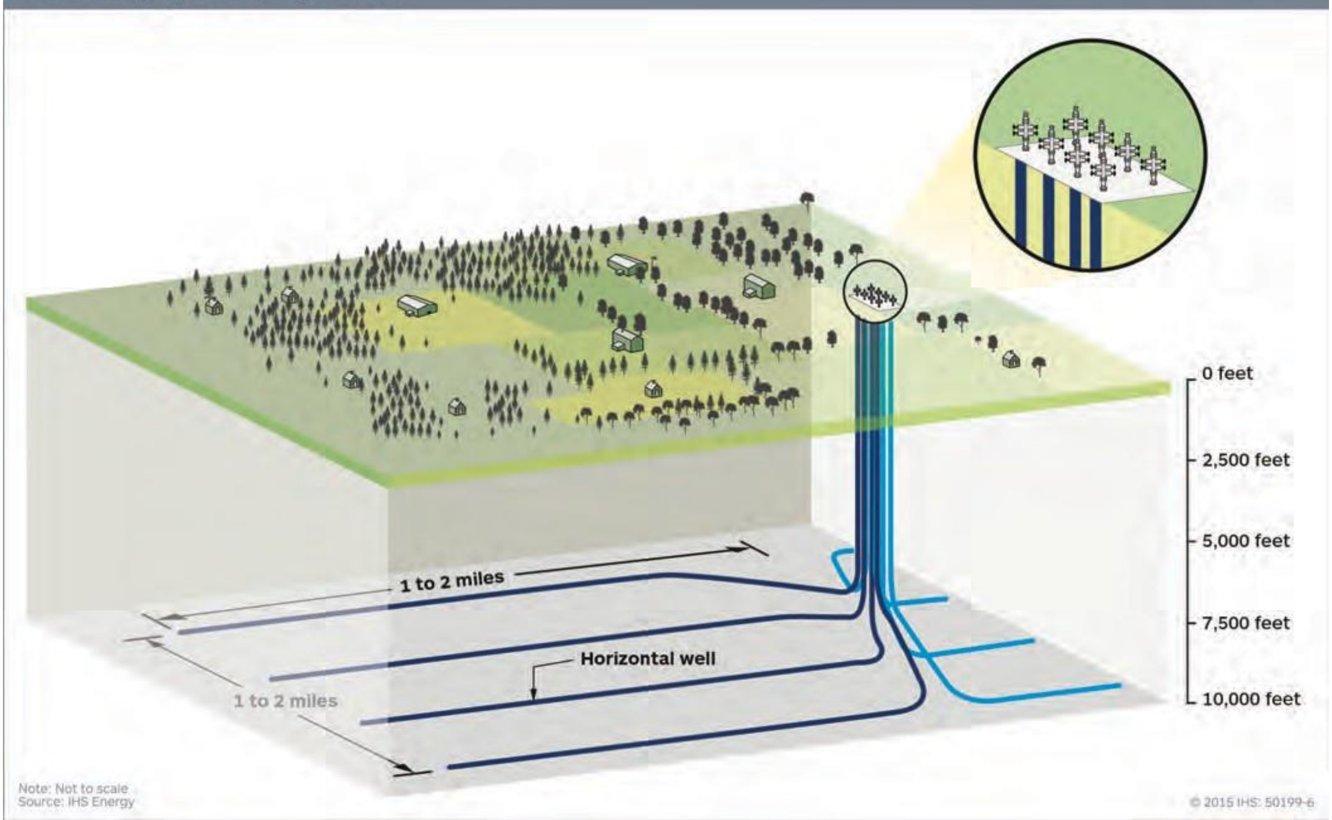
Anatomy of a crude oil well

What does it take to drill a crude oil well, and what kinds of supply chain are required to support it? What does it take to bore a hole and insert a six-inch pipe two miles underground, bending it at a right angle and then extending the pipe another two miles horizontally through a layer of oil-bearing rock with a thickness less than the length of a football field? The answer begins with a high degree of innovation, engineering sophistication and logistics coordination. It is not by coincidence that the economic unconventional oil (or gas) well of today resides in North America. The US oil industry has evolved rapidly over the last few decades, leveraging both high technology and manufacturing efficiencies to allow producers to reduce costs and continually optimize production. Further, the development and application of this technology has a multiplier effect within the supply chain to enable this growth. For both onshore and offshore wells (conventional vertical or horizontal unconventional), hydraulic fracturing stimulation is used to increase production rates and hydrocarbon recovery. An additional level of technical prowess is required at the surface during drilling and completion when a combination of cement, heavy mud, and reinforced steel casing are used to seal the well from the surface environment and from the surrounding water tables, this seal extends a half-mile underground.

The final phase is the "rocking horse" artificial lift system that pumps out the oil, surrounded by storage tanks. This surface-level simplicity masks the technical sophistication and engineering challenge involved in developing each well and obscures the complexity of the supply chain that made each well—and its economic contributions—possible. To illustrate this well-by-well contribution, the following discussion examines the anatomy of an average unconventional well, which is representative of those being drilled and completed in the US today. The analysis examines both the inputs into the typical well—labor, materials, and engineering expertise—and its outputs in terms of the uses of the hydrocarbons produced.

The typical well relevant to this discussion is an onshore unconventional well in the Bakken formation of North Dakota, although in reality there is wide variation in wells drilled in the Bakken and in other tight

Pad drilling typical configuration



Note: Not to scale
Source: IHS Energy
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oil formations. This typical well requires an $8 million direct capital investment to convert the site into a producing well that can be expected to produce for 10-15 years. This analysis is based on single wells, but it is important to note that a common practice in many tight oil formations is to use pad drilling, where 8 to 10 individual wells are drilled from a single location. Although the well heads are in close proximity on the pad, the process of bending and angling the drill pipe underground provides an average half-mile of spacing between the wells (known as 320 acre spacing), creating the fork pattern in the diagram below. This system lowers the cost of individual wells by allowing only one mobilization and demobilization of one drilling rig to drill multiple wells; at completion of each individual well, the rig “walks” several hundred feet to the adjacent well surface location. The pad concept also provides significant efficiencies by enabling the use of common infrastructure, such as storage tanks, separation and treatment equipment, and oil and gas gathering and compression systems that can be sized to accommodate a cluster of wells. The pad concept reduces the surface footprint required to develop these resources compared to the methods utilized pre-2000’s for onshore fields. In some cases, this has reduced the footprint by more than 90%, freeing up surface land for other uses.

Once the drilling or well pad location is selected, the first step in the drilling process is to prepare the drill site. This involves using earthmoving equipment (bulldozers, backhoes, excavators and graders) to prepare, clear and flatten a three to five-acre area (about 2 soccer fields) for the drill rig, stage equipment and materials, stage pressure pumping equipment, and the storage of mud, water, and other drilling fluids. Following site preparation, drilling the well can begin. The drill rig itself is a highly engineered, complex, and sophisticated system of machinery with primary, secondary, and safety systems working to achieve two main objectives:

- Drilling the bore hole using a rotary drill bit tipped with ultra-hard cutting material. As drilling occurs, segments of drill pipe, usually 30 feet or so in length, are screwed together, lowered and rotated, pushing on the drill bit to dig the bore hole. Drilling mud, a dense mixture of water, clay, additives, and various chemicals to control specific properties, is injected into the well bore where it is used as a cooling agent, helps circulate and remove rock fragments, stabilizes the well bore, and controls pressure and temperature conditions in the well bore.

- Successive laying and cementing of production casing to seal the well bore and, eventually, the producing well from the surrounding environment and to keep the well bore intact through the life of the well. Casing consists of steel pipe held in place and sealed using cement. The casing is placed in a telescoping arrangement consisting of typically four layers. The first and widest casing segment, known as the conductor casing, is 16 inches in diameter (it can be as wide as 3 feet) and extends 100 feet into the ground. Next, the surface casing is installed. Usually a little under 11 inches in diameter and installed to a depth typically set by regulatory agencies, the surface casing provides a steel and cement barrier between the well and groundwater reservoirs. In the Bakken formation, this is installed to a depth of half a mile or 2,200 feet. The third phase, known as the intermediate casing, usually has a diameter of 7-5/8 inches, and it is run for the remainder of the vertical length of the well, through the mitered right angle bend, and into the horizontal lateral—a total length of approximately 2 miles. The final section of casing, the smallest in diameter at 4-1/2 inches, is known as the production casing and extends another mile and a half into the producing formation. After each arrangement of casing and cement is completed, the drill bit is inserted through the casing and begins creating a new borehole, with mud circulating to cool the bit and carry cutting to the surface.

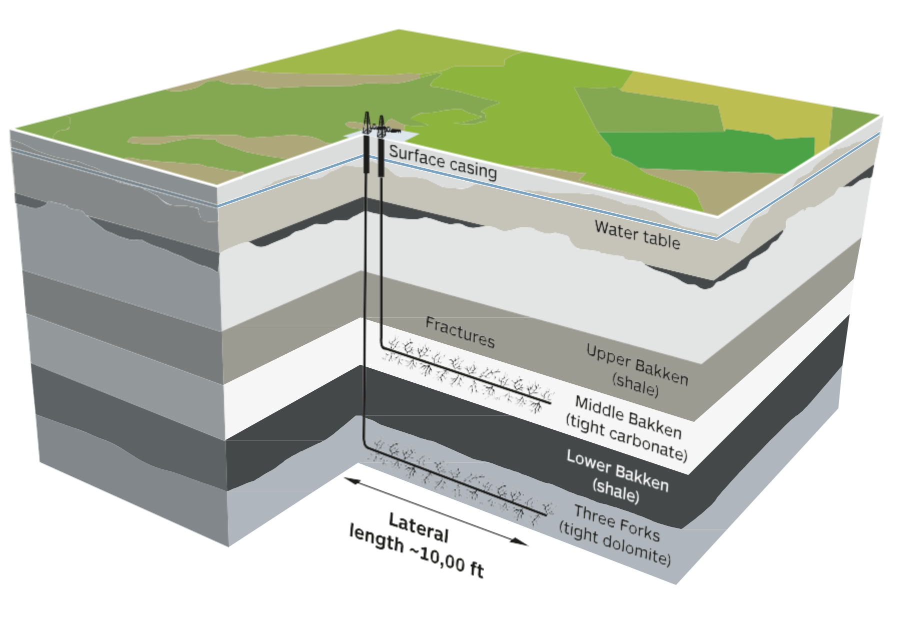
These functions are performed by the drilling rig, which consists of the derrick manifold and drilling assembly used to insert the drill bit, stem, and casing into the bore hole. The rig is typically powered by two or three high horsepower (1000+ HP) diesel or natural gas fueled engines, driving both electrical generators and mechanical drive systems. The primary drilling function is supported by the mud injection and circulation system, which consists of strainers, shakers, mixers, and pumps driven by the rig’s engines. Drilling activity is controlled from the primary control center - the “dog house”—where drilling technicians and operators control the speed and depth of drilling using advanced hydraulic-electric control systems. They also monitor conditions inside the well bore using sophisticated instrumentation, measuring downhole characteristics such as pressure, mud flow, and temperature.

The modern drill rig serves as a command hub that controls the flow of materials and the performance of drilling, casing, and completing the well. The key labor and materials required for this first phase of oil well completion include the following:

- Four to six drill bits, on average, are used per typical well, depending upon casing size and hole conditions.
- In 30-foot increments, 650 drill pipe segments are used for each well, and these segments are strung together and inserted and then extracted as the drill bit is removed.
- Four miles of casing pipe of varying diameters are used for each well. Although smaller in diameter, the amount of total casing pipe in 400 typical wells equals the length of pipe that would be used in the proposed Keystone XL pipeline. The number of new wells drilled in the United States this year would be equal to the length of pipe in perhaps eight Keystone XL pipelines.
- The typical well uses 1,470 bags of cement or 138,180 pounds.[14] To put this in perspective, at the anticipated level of 25,000 to 30,000 oil well completions per year, the drilling industry's annual use is roughly twice the amount of cement used in construction of the Hoover Dam.[15]
- Roughly 17,500 50-pound bags of mud are used in the typical well or almost 900,000 pounds—more than 64 elephants.
- The typical well takes 30 days to complete and employs a crew of approximately 50 individuals, working in rotating 12 hours shifts, 24 hours day. At this level of employment contribution, every 12 wells employ 50 US workers full-time. This figure does not include the indirect support associated with the logistics of bringing materials to and from the drill site.

The second phase of developing a typical unconventional oil well involves production stimulation through hydraulic fracturing and the completion of the well. The hydraulic fracturing phase progresses in several stages. The first stage is the perforation stage: the production case is punctured using a casing gun and explosive charges are used in specific locations along the borehole. These perforations create fractures in the shale rock that allow hydrocarbons to flow into the production casing. Then pressurized pumping pushes a slurry of water, sand or proppant, and other lubricity and corrosion control additives down the well borehole and through the perforations to further open the fracture cracks and hold them open using the proppant as a wedge in the pores of the rock. This is the first fracturing stage.

Bakken formation subsurface geology



Source: IHS Energy © 2015 IHS: 50199-7

After the initial fracturing stage is complete, a plug is inserted into the production casing. The process is then repeated up to 36 times, moving down the borehole, creating individual

14 At 94 pounds per bag.

15 Five million barrels of cement were used to construct the Hoover Dam, with each barrel assumed to weigh 376 pounds.

isolation and production stages. When all of the individual fracturing stages are complete, the isolation plugs are drilled out, allowing the injection slurry or "flowback" to return to the surface, where it is collected and stored for recycled use or disposal. This flowback of water and sand slurry is followed by oil and natural gas that pushes through the shale rock to the surface where it can be separated and processed. The final stage in the process involves the installation of an isolation valve manifold (typically consisting of six to eight large isolation valves), also known as a "Christmas Tree," which isolates and allows the flow of hydrocarbons into the production casing.

During the fracturing and completion stage, the drilling rig is temporarily replaced with a battery of pressure pumping trucks and portable storage tanks. The tanks both house the injection fluid and receive the flowback at the end stage of the process. The relevant supply chain activities for this phase in the crude oil well development cycle are the following:

- Up to 24 pressure pumping trucks are deployed, each consisting of a heavy duty vehicle, storage container, and high horse power slurry pumps (1500-2500 HP).

- Additional fracturing equipment includes two frac fluid suspension blending units feeding the pressure pumps, a manifold truck, specialized component blending and sand handling trucks feeding the main blenders, and a data acquisition/control van.

- An additional battery of onsite portable storage tanks are deployed to support operations, typically 50 rectangular steel frac tanks each with a capacity of 500 barrels.

- The pressure pumping crew employs an additional eight to 10 individuals to support this phase of the well development.

- On average, 50,000 barrels of fresh water are used during the fracking operation, with 25% or less recovered as very salty water. Typically the recovered water is injected back into the subsurface through a disposal well, adding considerable expense to the drilling. Recently research has focused on methods to recondition the recovered water for continued recycle and use in fracking other wells.

- Added to the water are 3-4 million pounds of sand per lateral. This mixture of sand and water comprises 99.5% of the slurry injection mix.

- The pressure pumping operation is interconnected with a large assembly of valves, steel pipe and hoses.

Once the pressure pumping and completion phase of the well is finished, support and gathering facilities are installed in the vicinity of the well or well pad. Its main purpose is to facilitate the bulk separation and primary treatment of oil from gas and gas from oil. This is done using equipment very similar to equipment found in a petroleum refinery or other hydrocarbon processing facility, such as pressure vessels or separators, heat exchangers, gathering pipelines, valves and isolation manifolds, pumps, compressors, measuring and control instrumentation, flares, stabilizer towers for further fractionation or distillation, and treatment towers to remove contaminants such as water, carbon dioxide, and hydrogen sulfide. The design and configuration of each separation and gathering facility is unique to the expected flow composition of the individual producing well. The end products from this initial processing and collection are typically stabilized crude oil or condensate that can be safely stored in atmospheric storage tanks and a rich or wet gas stream that is collected and compressed prior to transmission to a gas processing plant. The stabilized crude oil is stored and moved either by small gathering pipeline or truck to a central collection hub, usually the origin point of a larger pipeline system. For the rich gas, the next stage of processing involves a gas processing plant where natural gas liquids (NGLs) are separated from dry natural gas (methane).

Another feature usually installed at a producing well after the completion process is an artificial lift to help sustain higher production rates as the well bore pressure begins to decline. This consists of a lift or pumping system to help draw additional volumes of oil to the surface for processing. The most common artificial lift system is the rocking horse—also known as a drinking donkey—pump assembly gently rocking up and down.

So what does this typical well produce? In the first five years of production, a Bakken well will produce 70% of its expected total volume, consisting of the following:

- 220,000 barrels of crude oil, with an API gravity of 40-44 and sulfur below 0.2 wt%.[16]

- 35,000 barrels of mixed NGL (referred to as Y-Grade), consisting of 40% ethane, 25% propane, 20% butanes, and 15% of pentanes and molecules heavier than pentane (the heavy fraction is also commonly referred to as natural gasoline).

- 160 million dry cubic feet of natural gas used in home heating and cooking applications or as a primary power plant fuel for electricity generation.

The next step in the hydrocarbon supply chain is to transport the stabilized crude oil and rich gas through a combination of gathering systems and long-distance transmission lines. The rich gas is separated into dry gas and mixed NGLs in a gas processing plant. The NGLs in turn are fractionated (separated) into their components (ethane, propane, and normal and iso butane) in NGL fractionators. The individual NGL components are used in a wide array of end markets, such as petrochemical feedstocks, home heating and cooking fuel, gasoline blending components, and increasingly as a standalone transportation fuel. The petrochemical feedstocks are primarily used for producing olefins, the basis for a wide variety of plastics and derivatives.

Crude oil and condensate are moved in storage and pipeline infrastructure to refineries where they are processed into clean petrochemical and specialty products. After all the downstream separation and processing occurs, the output of a single Bakken crude oil well is converted into the following energy products:

- Plastics that supply the raw materials for a wide array of construction materials, industrial and consumer products to enable the construction of over 3,700 new homes (PVC piping, fixtures and other building and finishing materials).

- Propane to heat 7,000 New England homes annually.

- Gasoline to supply 1,030 US households annually.

- Jet fuel for 135 cross-country (Manhattan-Los Angeles) passenger jet flights on a Boeing 767 basis.

- Diesel fuel for a fully loaded 18 wheeler to make 4,600 cross-country trips.

- Marine fuel for a fully loaded grain tug barge to make six round trips up and down the Mississippi River.

- Natural gas to heat and provide cooking fuel for 470 US households annually.

Each stage of the process in converting the geological potential of a small plot of land into a producing well that provides US energy needs is supported by an industrial supply chain that extends well past what is delivered and physically consumed at the drill site. This supply chain can be as simple as proppant sand, which is mined in open pit quarries using earth-moving equipment in Minnesota and Wisconsin and then transported by rail in covered hoppers to plays in North Dakota, Oklahoma, and Texas. Other elements of the well development supply chain can be extraordinarily complex, such as the drill rig. A rig integrates detailed engineering and design with steel fabrication and assembly, eight to 16 high-pressure engine, pump, motor, and generator assemblies, fabricated pipe and fittings, electrical supply and distribution, hydraulic power supply and distribution, advanced control and computer systems, state-of the art instrumentation and monitoring devices, lifting and conveyance systems, industrial machinery such and storage tanks, strainers, and shakers, and many other components.

16 Weight percent

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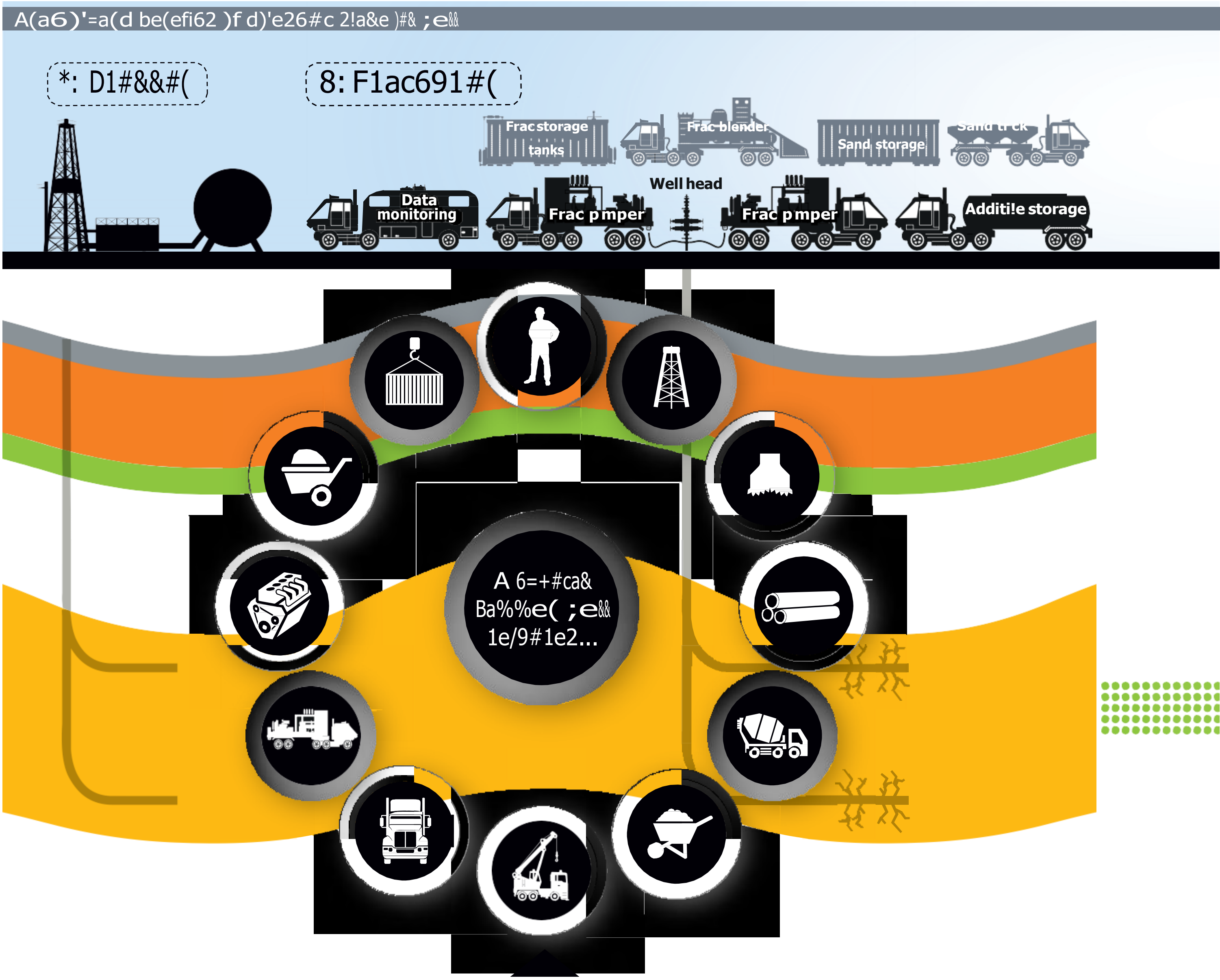

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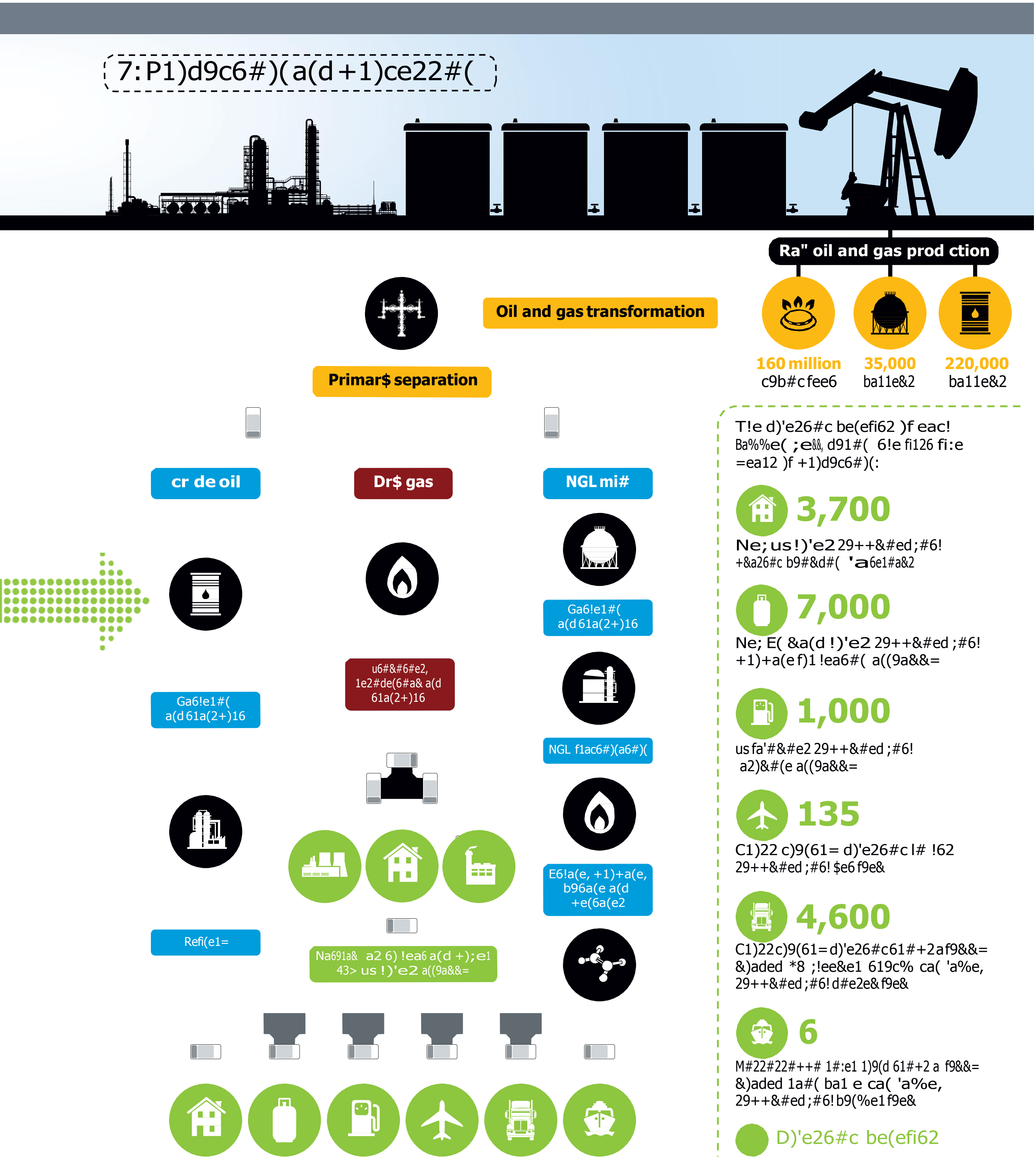

Raw oil and gas production
160 million
35,000
220,000
Oil and gas transformation
Primary separation
crude oil
Dry gas
NGL mix
3,700
7,000
1,000
135
4,600
6

National supply chain assessment

Key insights

- Lifting the 40-year ban on US crude oil exports will create significant benefits throughout the US crude oil supply chain. This impact is estimated at an additional $26 billion of Gross Domestic Product (GDP) annually, on average, between 2016 and 2030 in the Base Production Case. In the Potential Case, assuming higher levels of production, impact on GDP nearly doubles to over $47 billion annually under a free trade policy.
- As increased economic activity fuels job growth, the benefit to GDP translates to an increase of almost 124,000 supply chain jobs, on average, during 2016-30 in the Base Production Case. In the Potential Production Case, the average supply chain employment increase exceeds 240,000 jobs.
- On a per household basis, the net benefit of a US free trade policy for crude oil translates to an average gain of $158 in labor income per year in the Base Production Case and $285 in the Potential Production Case in 2016-30. These findings are in the absence of the recent drop in global oil prices. Consumer benefits are expected to strengthen as gasoline prices decline.
- The additional cumulative government revenue from corporate and personal income taxes attributed to the supply chain industries is approximately $429 billion in the Base Production Case and more than double that—$868 billion—in the Potential Production Case.
- The benefits of free trade extend across the entire US crude oil supply chain. While direct suppliers such as construction and well services witness the largest impact, indirect suppliers such as information technology and finance emerge as major contributors of additional jobs, value added to GDP, and labor income.
- The supply chain industries involved in upstream oil and gas drilling and production—construction and well services, machinery, and logistics—represent a substantial part of the overall benefits that a crude oil export policy change will have on the US economy. In the Base Production Case, the supply chain comprises 31% of the employment impact, 30% of the value added, 38% of labor income, and 33% of cumulative government revenue over the 2016-30 period. In the Potential Production Case, the supply chain comprises 28% of the employment impact, 28% of the value added, 35% of labor income, and 31% of cumulative government revenue over the 2016-30 period.

Introduction

The enduring message of the US energy renaissance is that all regions of the country partake in this economic transformation, either as a location of hydrocarbon development, as a participant in the upstream supply chain, or both. If the ban on US crude exports is lifted, the effects on the US economy would be immediate and significant. In this national section of the report, we describe the methodology used to assess how a change in crude oil export policy impacts upstream spending on the supply chain to support exploration and production activity. Consistent with the methods employed in the *US Crude Oil Export Decision*, the data and assumptions required to estimate the economic contributions of crude oil export activity include IHS upstream production profiles and the expected upstream capital and operating expenditures of firms engaged in exploration and production activity.

IHS defines the supply chain that supports US crude oil exports as 60 supplier industries classified by the North American Industry Classification System (NAICS).[17] These industries are segmented into six

17 The North American Industry Classification System (NAICS, pronounced "Nakes") was developed under the direction of the Office of Management and Budget as the standard used by federal statistical agencies in classifying business establishments for the collection, tabulation, presentation, and analysis of statistical data describing the US economy. Use of the standard provides uniformity and comparability in the presentation of these statistical data. NAICS is based on a production-oriented concept, meaning that it groups establishments into industries according to their similarities in the processes used to produce goods or services. NAICS replaced the Standard Industrial Classification (SIC) system in 1997. NAICS is a 2- through 6-digit hierarchical classification system, offering five levels of detail. Each digit in the code is part of a series of progressively narrower categories, and the more digits in the code signify greater classification detail.

principal groups (core groups): construction and well services, industrial equipment and machinery, information technology, logistics, materials, and professional, financial, and other services. The economic contributions associated with the US crude oil export supply chain, which are presented at a more detailed industry level, reflect upstream spending on the 60 supply chain industries.

Defining the US crude oil export supply chain

The export supply chain reaches deep into the manufacturing and service sectors of the US economy. The *US Crude Oil Export Decision* analysis focused on the economy-wide impact of increased crude oil exports. This analysis digs deeper to capture the discrete effects on supply chain participants at 4-, 5-, and 6-digit NAICS sector levels. IHS used multiple sources of information to identify the US crude oil export supply chain sectors: 1) extensive IHS research into the purchasing relationships associated with crude oil activity, including capital and operating spending and the goods and services procured; 2) IHS experience in conducting other studies analyzing the supply chain impacts associated with energy development; 3) proprietary IHS databases and analyses across the energy value chain and supply chain sectors; and 4) interviews by IHS researchers with major suppliers.

The sectors within the US crude oil export supply chain were assigned to one of six core groups:

- Construction and well services: Construction activity is pervasive in the energy value chain in oil-producing regions. Construction suppliers include general and specialty contractors and building trades. Well services include well drilling and other oil and gas field services performed on a contract basis.

- Industrial equipment and machinery: Off-highway equipment and industrial machinery are widely used throughout the value chain, including construction and access machinery; pumps and compressors; drilling and hydraulic fracturing equipment; power generators; and power boilers and heat exchangers. This category also includes component suppliers to equipment manufacturers, as well as equipment distributors and rental companies.

- Information technology: The information technology group is comprised of computer hardware, software and services utilized in all tiers of the supply chain. Seismic software technology has been a major innovation for unconventional discovery and exploration.

- Logistics: The transportation system supporting crude oil export activity consists of road, rail, water, and pipeline transportation. While truck transportation is, and will continue to be, a very large component of the oil supply chain logistics system, investment in pipeline, water, and rail capacity is expected to increase in the coming years.

- Materials: This category includes producers of a wide variety of raw materials such as steel and nonferrous metals sand, gravel, and other aggregates; chemicals and value-added services such as metal fabrication and distribution. Key materials include oil country tubular goods (OCTG) and other pipeline products, concrete for well casing, and sand and chemicals associated with hydraulic fracturing. These raw materials also make up the inputs for finished and semifinished supply chain goods such as the metal forgings and gears in machinery.

- Professional, financial, and other services: Typically associated with operational expenditures, the wide range of services includes environmental engineering services; occupational health and safety services; architectural and civil engineering services; and financial, insurance, and real estate services.

The following table shows where each of the 60 NAICS codes falls within the defined core groups.

Supply chain sectors by core group (NAICS code)

Industrial equipment and machinery

332410	Power Boiler and Heat Exchanger Manufacturing
332420	Metal Tank Manufacturing
3331	Construction, Mining and Agriculture Machinery Manufacturing
333515	Cutting and Machine Tool Manufacturing
333611	Turbine and Turbine Generator Manufacturing
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing
333613	Mechanical Power Transmission Equipment Manufacturing
333618	Other Engine Equipment Manufacturing
333911	Pump and Pumping Equipment Manufacturing
333912	Air and Gas Compressor Manufacturing
333922	Conveyor and Conveying Equipment Manufacturing
333991	Power-Driven Handtool Manufacturing
334512	Automatic Environmental Control Manufactuirng
334513	Industrial Control and Instrument Manufactuirng
334514	Totalizing Fluid Meter and Counting Device Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
334519	Other Measuring and Controlling Device Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing
336120	Heavy Duty Truck Manufacturing
336510	Railroad Rolling Stock Manufacturing
4231	Motor Vehicles and Parts - Wholesale
4234	Professional and Commercial Equipment - Wholesale
4238	Machinery and Equipment - Wholesale

Construction and well services

213111	Drilling Oil and Gas Wells
213112	Support Activities for Oil and Gas Operations
23t	Construction of New Nonresidential Manufacturing Structures
23tt	Construction of Other New Nonresidential Structures

Information technology

3341	Computer Hardware
5112	Computer Software
5415	Computer Services

Logistics

4821	Rail Transportation
483	Water Transportation
4841	General Freight Trucking
486	Pipeline Transportation

Materials

212321	Construction Sand and Gravel Mining
325120	Industrial Gas Manufacturing
325180	Other Basic Inorganic Chemical Manufacturing
327310	Cement Manufacturing
327320	Ready-mix Concrete Manufacturing
327331	Concrete Block and Brick Manufacturing
331110	Iron and Steel Mills and Ferroalloy Manufacturing
3312	Steel Product Manufactuirng
331315	Aluminum Sheet, Plate, and Foil Manufacturing
332996	Fabricated Pipe and Pipefitting Manufacturing
4233	Lumber and Construction Materials - Wholesale
4235	Metal and Minerals - Wholesale
4236	Electrical Goods - Wholesale
4237	Hardware, Plumbing, and Heating Equipment - Wholesale
4246	Chemical and Allied Products - Wholesale
444	Building Material - Retail

Professional, financial, and other services

2213	Water, Sewage and Other Systems
4931	Warehousing and Storage
524	Insurance carriers and related activities
52 ex 524	Finance
532412	Construction and Mining Equipment Rental and Leasing
5413	Architectural, Engineering, and Related Services
5416	Management, scientific, and technical consulting services
5419	Other Professional, Scientific, and Technical Services
562219	Other Nonhazardous Waste Treatment and Disposal
811310	Commercial and Industrial Machinery Repair and Maintenance

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS

National level results in this section are presented for these core supply chain groupings. In subsequent sections of this report, supplier industry results for the state level and selected congressional districts level will be presented.

Economic contribution methodology

Here we present the methodology for measuring the economic contribution of the supply chain impacts under the restricted trade and free trade scenarios. The results are presented in terms of the difference in levels of economic contribution between free trade and restricted trade for each case: the Base Production Case and the Potential Production Case. The findings are analyzed in the context of the national impacts associated with capital spending across the US crude oil export supply chain.

Using data and analyses from proprietary databases and the IMPLAN model,[18] IHS evaluated the impacts to the supply chain by applying a customized industrial structure of the US economy. The data categories in the model were tailored to the specific mix of equipment, materials, and services that characterize the US crude oil supply chain. IHS linked the IMPLAN model to its dynamic US and state macroeconomic models in order to augment the supply chain determination of employment, value added, and labor income impacts with a comprehensive dynamic modeling methodology employed in the *US Crude Oil Export Decision* report. IHS' baseline macroeconomic forecasts for the US and state economies were re-specified to assess the contribution on the 60 supply chain sectors if the export ban on US crude oil were eliminated. All models were run using the initial set of input assumptions and were calibrated. The resulting economic impact is measured in terms of jobs created or sustained, value added contribution to GDP, and employee wages and compensation. The calibration process compared the sum of the direct, indirect, and induced impacts (for all metrics) from the supply chain (IMPLAN) model and scaled it to the total impact from the state macroeconomic models. While all the supply chain sectors were selected from the direct and indirect effects (defined below), the induced effect was left out as it relates to the income effect.

The results are presented for the 60 supply chain sectors selected from direct and indirect contributions and are benchmarked to the total economic contributions obtained from the *US Crude Oil Export Decision*.

Direct Impacts: This is the effect of the core industry's output, employment, and income. For example, removing the US crude oil export ban will have implications for the energy value chain—its upstream (production), midstream (transportation and logistics), and downstream (processing and marketing) elements—in terms of capital expenditures and operating expenditures. These activities directly contribute to exploration (capital expenditures) and production activity (operating expenditures). Others directly involved in US crude oil export activities are midstream processing and pipeline transportation companies, downstream local distribution companies, and onsite construction service providers.

Indirect Impacts: Purchasing patterns of crude oil development indirectly contribute to all of the supplier industries. Changes in demand from the directly impacted industries lead to corresponding changes in output, employment, and labor income throughout each industry's own supply chains via inter-industry linkages. The affected supplier activities span the majority of US industries. For this crude oil export supply chain analysis, IHS has focused on the 60 major supply chain sectors.

18 The IHS modeling methodology for this study was based on IMPLAN (www.implan.com), an industry-standard system for assessing economic impacts, which IHS enhanced with data from its US Regional Economics Service. The IMPLAN system is built using Input-Output techniques that link interindustry and consumer transactions in a social accounting matrix for the region being assessed. This structure provides a foundation upon which models can be built that link sales in one industry sector with resultant sales in supplying sectors.

Economic contribution results

Employment

Higher levels of capital spending and production in the upstream segment translate both directly and indirectly to an increase in US employment. In the Base Case, supply chain jobs represent, on average, 31% of the increase in total US crude oil export-related employment in 2016-30, or about 124,000 jobs on average if the export ban is lifted. In the Potential Production Case, the supply chain contributes 28% of the increase in total US crude oil export-related employment, or about 240,000 jobs annually on average.

Employment: US crude oil export supply chain
(number of workers, difference free trade vs. restricted trade)

	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
US crude oil export supply chain	105,748	250,201	293,140	258,227	212,508	73,384	123,577
US crude oil export total	358,610	811,250	963,720	863,310	699,520	221,532	394,118
Supply chain share of crude oil export total	**29.5%**	**30.8%**	**30.4%**	**29.9%**	**30.4%**	**33.1%**	**31.4%**
Potential Production Case							
US crude oil export supply chain	149,521	351,675	439,578	414,198	371,202	187,413	240,020
US crude oil export total	521,500	1,206,160	1,536,730	1,483,210	1,320,000	681,645	858,932
Supply chain share of crude oil export total	**28.7%**	**29.2%**	**28.6%**	**27.9%**	**28.1%**	**27.5%**	**27.9%**

Source: IHS Economics

Removing the export ban will introduce an initial stimulus to the crude oil value chain and the economy in the early years that will amplify the impact. In the long run, as the system adjusts to the change, the economy is expected to converge to an equilibrium, resulting in a more moderate impact.

Employment contributions are spread across the entire supply chain, but are most prominent in sectors that support oil and natural gas operations and in the construction sector. For example, construction activity and related support services at well sites require architects, engineers, construction machinery, sand, concrete and fabricated metal to build the necessary infrastructure. The singular yet substantial length of the construction supply chain, as it relates to support for upstream activity, amplifies the second- and third-order indirect employment effects that originate with upstream investment under both production cases.

The five supply chain industries gaining the most employment from US crude oil export activity are concentrated in two core supply chain groups: the materials group and the construction and well services group. The top five industries are:

- Support Activities for Oil and Gas Operations (NAICS 213112)
- Construction of Other New Nonresidential Structures (part of NAICS 23 related to upstream construction activity)
- Architectural, Engineering, and Related Services (NAICS 5413)
- Construction Sand and Gravel Mining (NAICS 212321)
- Cutting and Machine Tool Manufacturing (NAICS 333515)

In the Base Production Case, IHS estimates that in 2018—the peak year for employment—the move to a free trade policy will add nearly 112,000 more jobs than the restricted trade policy in these five industries—representing 38% of the total jobs added across the supply chain.

Employment: US crude oil export supply chain – Base Production*
(number of workers, difference free trade vs. restricted trade)

Top-15 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
213112	Support Activities for Oil and Gas Operations	10,344	25,385	29,403	25,026	20,239	6,513	11,702
23tt	Construction of Other New Nonresidential Structures	9,324	23,633	27,316	23,044	18,896	5,945	10,778
5413	Architectural, Engineering, and Related Services	8,836	19,979	23,465	20,486	16,659	5,453	9,597
212321	Construction Sand and Gravel Mining	6,529	14,236	15,901	14,788	12,129	4,165	7,015
333515	Cutting and Machine Tool Manufacturing	6,543	13,952	15,547	13,876	11,304	3,950	6,715
3341	Computer Hardware	4,147	10,513	12,930	11,545	9,731	3,845	5,821
52_ex_524	Finance	4,244	9,842	11,603	10,279	8,402	2,930	4,911
333912	Air and Gas Compressor Manufacturing	3,505	8,887	10,959	9,718	8,111	2,874	4,662
3331	Construction, Mining and Agriculture Machinery Manufacturing	3,896	8,561	9,340	7,969	6,432	2,133	3,836
4841	General Freight Trucking	3,602	8,486	9,927	8,698	7,145	2,431	4,144
4235	Metal and Minerals - Wholesale	3,540	8,036	9,286	8,071	6,619	2,257	3,875
332996	Fabricated Pipe and Pipefitting Manufacturing	3,016	7,437	8,721	7,977	6,775	2,405	3,865
334519	Other Measuring and Controlling Device Manufacturing	2,535	6,480	8,021	7,715	6,676	2,736	3,919
5415	Computer Services	2,886	6,274	7,483	6,794	5,473	1,970	3,241
3312	Steel Product Manufactuirng	2,809	6,194	7,117	6,117	5,020	1,676	2,934
Top-15 US crude oil export supply chain total		**75,756**	**177,891**	**207,020**	**182,103**	**149,609**	**51,286**	**87,016**
US crude oil export supply chain total		**105,748**	**250,201**	**293,140**	**258,227**	**212,508**	**73,384**	**123,577**
US crude oil export total		**358,610**	**811,250**	**963,720**	**863,310**	**699,520**	**221,532**	**394,118**
Supply chain share of crude oil export total		**29.5%**	**30.8%**	**30.4%**	**29.9%**	**30.4%**	**33.1%**	**31.4%**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

In the Potential Production Case, which assumes higher levels of future oil production, IHS estimates that the move to a free trade policy in peak year 2018 will yield 158,000 more jobs than retention of the restricted trade policy in these five industries—representing 36% of the total additional jobs across the supply chain.

Employment: US crude oil export supply chain – Potential Production*
(number of workers, difference free trade vs. restricted trade)

Top-15 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
213112	Support Activities for Oil and Gas Operations	14,766	34,486	41,310	36,916	32,664	15,428	20,961
5413	Architectural, Engineering, and Related Services	12,710	29,975	36,479	34,111	29,347	14,158	18,947
23tt	Construction of Other New Nonresidential Structures	12,376	29,496	35,192	31,013	27,609	12,548	17,411
333515	Cutting and Machine Tool Manufacturing	9,067	19,976	24,870	23,610	21,019	10,180	13,356
212321	Construction Sand and Gravel Mining	8,130	16,502	20,421	19,641	17,964	8,918	11,456
3341	Computer Hardware	5,897	14,931	19,588	19,155	17,652	9,867	11,727
52_ex_524	Finance	5,980	13,816	17,515	16,658	14,935	7,749	9,760
3331	Construction, Mining and Agriculture Machinery Manufacturing	6,174	13,020	15,554	14,341	12,885	6,405	8,402
4841	General Freight Trucking	5,128	11,971	14,954	13,956	12,507	6,289	8,094
333912	Air and Gas Compressor Manufacturing	4,792	11,971	15,768	15,002	13,794	7,224	8,904
4235	Metal and Minerals - Wholesale	5,060	11,632	14,758	13,787	12,197	6,085	7,886
334519	Other Measuring and Controlling Device Manufacturing	3,825	10,253	14,041	14,735	13,726	7,647	8,870
332996	Fabricated Pipe and Pipefitting Manufacturing	4,117	9,853	12,653	12,322	11,480	5,950	7,329
3312	Steel Product Manufactuirng	4,078	9,321	11,807	10,969	9,617	4,707	6,191
327310	Cement Manufacturing	3,707	9,189	11,746	11,455	10,228	4,960	6,395
Top-15 US crude oil export supply chain total		**105,807**	**246,391**	**306,655**	**287,670**	**257,624**	**128,116**	**165,687**
US crude oil export supply chain total		**149,521**	**351,675**	**439,578**	**414,198**	**371,202**	**187,413**	**240,020**
US crude oil export total		**521,500**	**1,206,160**	**1,536,730**	**1,483,210**	**1,320,000**	**681,645**	**858,932**
Supply chain share of crude oil export total		**28.7%**	**29.2%**	**28.6%**	**27.9%**	**28.1%**	**27.5%**	**27.9%**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Value added

Lifting the restrictions on crude oil exports would augment the already sizable share of GDP contributed by the energy value chain. A large supply network serving upstream operators creates a multiplier effect by drawing value from the manufacturing and raw materials sectors that produce the finished goods supporting upstream activities. In the Base Case, the US crude oil export-related supply chain will contribute, on average, an additional $26 billion per year to the US economy over the 2016-30 period under a free trade policy. Under the Potential Case scenario, this nearly doubles to $47 billion annually under a free trade policy.

To put these contributions to GDP into perspective with other US industries, the Base Case contribution of $26 billion is equivalent to the total 2013 value-added contribution of dairy products manufacturers in the United States. The Potential Case value-added contribution is greater than that of the total US rail transportation sector.[19]

19 IHS US Industry Service data

IHS estimates that in the Base Case, the economic value of the supply chain industries, as measured by value added, accounts for nearly 30% of the US crude oil export policy impact between 2016 and 2030. More than a quarter of this impact is concentrated in the top five supplier sectors.

Value added: US crude oil export supply chain – Base Production*
($millions, real 2009, difference free trade vs. restricted trade)

Top-15 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
213112	Support Activities for Oil and Gas Operations	1,243	2,515	2,521	2,038	1,819	1,134	1,432
5413	Architectural, Engineering, and Related Services	1,217	2,242	2,246	1,903	1,719	1,066	1,333
23tt	Construction of Other New Nonresidential Structures	1,033	2,138	2,123	1,694	1,538	938	1,194
3331	Construction, Mining and Agriculture Machinery Manufacturing	1,158	2,120	2,002	1,686	1,515	1,015	1,242
333515	Cutting and Machine Tool Manufacturing	1,143	2,075	2,006	1,770	1,643	1,325	1,459
212321	Construction Sand and Gravel Mining	1,119	2,071	1,989	1,817	1,672	1,195	1,375
52_ex_524	Finance	984	1,819	1,821	1,561	1,426	995	1,171
3341	Computer Hardware	830	1,637	1,688	1,460	1,391	1,009	1,140
4235	Metal and Minerals - Wholesale	859	1,566	1,530	1,282	1,176	790	954
333912	Air and Gas Compressor Manufacturing	761	1,559	1,626	1,365	1,271	830	992
213111	Drilling Oil and Gas Wells	743	1,535	1,519	1,217	1,100	684	864
333611	Turbine and Turbine Generator Manufacturing	760	1,523	1,639	1,474	1,364	885	1,040
325120	Industrial Gas Manufacturing	663	1,244	1,194	964	869	575	712
334519	Other Measuring and Controlling Device Manufacturing	626	1,242	1,279	1,169	1,115	830	916
327310	Cement Manufacturing	624	1,188	1,182	1,030	936	579	716
Top-15 US crude oil export supply chain total		**13,762**	**26,474**	**26,363**	**22,431**	**20,556**	**13,850**	**16,539**
US crude oil export supply chain total		**21,234**	**40,606**	**40,480**	**34,494**	**31,701**	**21,754**	**25,737**
US crude oil export total		**72,770**	**132,895**	**134,950**	**118,655**	**106,298**	**73,013**	**86,380**
Supply chain share of crude oil export total		**29.2%**	**30.6%**	**30.0%**	**29.1%**	**29.8%**	**29.8%**	**29.8%**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Value added: US crude oil export supply chain – Potential Production*
($millions, real 2009, difference free trade vs. restricted trade)

Top-15 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
213112	Support Activities for Oil and Gas Operations	1,686	3,358	3,688	3,133	2,985	2,110	2,396
5413	Architectural, Engineering, and Related Services	1,746	3,350	3,641	3,256	3,018	2,339	2,560
3331	Construction, Mining and Agriculture Machinery Manufacturing	1,797	3,253	3,508	3,133	3,014	2,283	2,502
333515	Cutting and Machine Tool Manufacturing	1,603	2,919	3,207	2,936	2,871	2,538	2,594
23tt	Construction of Other New Nonresidential Structures	1,300	2,628	2,874	2,398	2,304	1,560	1,807
52_ex_524	Finance	1,356	2,541	2,862	2,595	2,515	2,061	2,165
212321	Construction Sand and Gravel Mining	1,432	2,491	2,771	2,586	2,550	2,002	2,123
333611	Turbine and Turbine Generator Manufacturing	1,152	2,317	2,745	2,616	2,565	2,014	2,103
3341	Computer Hardware	1,177	2,317	2,665	2,473	2,476	2,068	2,119
4235	Metal and Minerals - Wholesale	1,214	2,233	2,467	2,186	2,096	1,665	1,790
333912	Air and Gas Compressor Manufacturing	1,013	2,072	2,434	2,171	2,146	1,622	1,737
213111	Drilling Oil and Gas Wells	992	2,002	2,179	1,833	1,762	1,226	1,402
334519	Other Measuring and Controlling Device Manufacturing	938	1,873	2,166	2,093	2,093	1,797	1,809
325120	Industrial Gas Manufacturing	966	1,835	1,968	1,702	1,632	1,290	1,400
327310	Cement Manufacturing	954	1,798	2,010	1,897	1,884	1,381	1,490
Top-15 US crude oil export supply chain total		**19,325**	**36,986**	**41,185**	**37,008**	**35,912**	**27,954**	**29,997**
US crude oil export supply chain total		**29,763**	**56,967**	**63,503**	**57,138**	**55,515**	**44,307**	**47,064**
US crude oil export total		**103,358**	**194,745**	**220,868**	**206,133**	**198,340**	**162,775**	**170,080**
Supply chain share of crude oil export total		**28.8%**	**29.3%**	**28.8%**	**27.7%**	**28.0%**	**27.2%**	**27.7%**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Labor income

The additional production and capital investment prompted by a change in crude oil export policy from restricted trade to free trade will increase labor income in the supply chain. IHS research has found that the wages earned in these supply chain jobs are considerably higher than the average US wage. IHS estimates that labor income for the oil export supply chain will increase under a free trade policy by over $21 billion per year during the 2016-30 period in the Base Case and by over $39 billion per year in the Potential Case.

This export-led labor income contribution is particularly notable at a time when US wage growth remains sluggish, at about 2% annually. Wage austerity is even more pronounced in the broader US construction sector as wages remain flat from year to year due to a slow rebound in US housing starts. On an annual basis, however, lifting the crude export ban translates to a wage increase of $158 per year for each household in the Base Case and $285 in the Potential Case, on average, in the 2016-30 period.

Labor income: US crude oil export supply chain – Base Production*
($millions, real 2009, difference free trade vs. restricted trade)

Top-15 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
213112	Support Activities for Oil and Gas Operations	1,529	3,362	3,388	2,812	2,477	1,559	1,944
5413	Architectural, Engineering, and Related Services	1,269	2,568	2,577	2,204	1,979	1,235	1,530
23tt	Construction of Other New Nonresidential Structures	1,100	2,468	2,463	2,019	1,809	1,120	1,404
212321	Construction Sand and Gravel Mining	834	1,731	1,659	1,532	1,413	1,010	1,151
333515	Cutting and Machine Tool Manufacturing	847	1,692	1,645	1,464	1,365	1,116	1,212
3341	Computer Hardware	731	1,616	1,665	1,455	1,381	995	1,120
333912	Air and Gas Compressor Manufacturing	596	1,340	1,406	1,218	1,125	737	871
3331	Construction, Mining and Agriculture Machinery Manufacturing	643	1,300	1,228	1,035	925	603	744
52_ex_524	Finance	573	1,179	1,182	1,023	932	663	768
4235	Metal and Minerals - Wholesale	568	1,139	1,118	945	865	584	698
334519	Other Measuring and Controlling Device Manufacturing	512	1,127	1,158	1,059	1,007	755	828
5415	Computer Services	525	1,019	1,028	912	819	586	678
327310	Cement Manufacturing	494	1,009	1,004	877	797	485	602
325120	Industrial Gas Manufacturing	414	845	803	645	579	375	469
332996	Fabricated Pipe and Pipefitting Manufacturing	379	833	833	736	696	528	584
Top-15 US crude oil export supply chain total		**11,013**	**23,228**	**23,158**	**19,937**	**18,167**	**12,351**	**14,601**
US crude oil export supply chain total		**16,171**	**34,029**	**34,030**	**29,298**	**26,745**	**18,301**	**21,552**
US crude oil export total		**43,554**	**88,160**	**89,322**	**78,481**	**70,434**	**48,650**	**57,097**
Supply chain share of crude oil export total		**37.1%**	**38.6%**	**38.1%**	**37.3%**	**38.0%**	**37.6%**	**37.7%**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Labor income: US crude oil export supply chain – Potential Production*
($millions, real 2009, difference free trade vs. restricted trade)

Top-15 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
213112	Support Activities for Oil and Gas Operations	2,049	4,793	5,297	4,664	4,423	3,148	3,513
5413	Architectural, Engineering, and Related Services	1,616	3,750	4,093	3,672	3,398	2,669	2,881
23tt	Construction of Other New Nonresidential Structures	1,350	3,200	3,516	3,047	2,910	1,991	2,262
333515	Cutting and Machine Tool Manufacturing	1,024	2,311	2,559	2,365	2,323	2,080	2,092
3341	Computer Hardware	884	2,217	2,544	2,382	2,384	1,975	2,011
212321	Construction Sand and Gravel Mining	958	2,047	2,283	2,145	2,123	1,653	1,739
3331	Construction, Mining and Agriculture Machinery Manufacturing	916	2,010	2,192	1,975	1,908	1,413	1,542
333912	Air and Gas Compressor Manufacturing	717	1,781	2,083	1,919	1,899	1,454	1,529
334519	Other Measuring and Controlling Device Manufacturing	640	1,632	1,880	1,816	1,813	1,564	1,561
52_ex_524	Finance	700	1,627	1,836	1,681	1,627	1,347	1,396
4235	Metal and Minerals - Wholesale	697	1,580	1,757	1,578	1,510	1,195	1,271
327310	Cement Manufacturing	622	1,445	1,623	1,550	1,533	1,109	1,191
5415	Computer Services	626	1,408	1,608	1,516	1,461	1,242	1,269
325120	Industrial Gas Manufacturing	509	1,190	1,268	1,095	1,048	815	884
333611	Turbine and Turbine Generator Manufacturing	474	1,170	1,395	1,321	1,300	1,038	1,070
Top-15 US crude oil export supply chain total		**13,783**	**32,161**	**35,934**	**32,725**	**31,661**	**24,692**	**26,212**
US crude oil export supply chain total		**20,208**	**47,340**	**52,874**	**48,107**	**46,578**	**36,988**	**38,999**
US crude oil export total		**55,918**	**128,607**	**145,917**	**136,170**	**130,935**	**107,351**	**111,404**
Supply chain share of crude oil export total		**36.1%**	**36.8%**	**36.2%**	**35.3%**	**35.6%**	**34.5%**	**35.0%**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Government revenue

New investment in exploration and production stimulated by lifting export restrictions on US crude oil will flow through the supply chain and, as a consequence, will drive increases in federal, state and local tax receipts around the country. IHS estimates that total government revenues generated by crude oil export-related supply chain activity will roughly double, from $7 billion in 2016 to over $13.6 billion in 2020 in the Base Production Case and from $10 billion in 2016 to over $25 billion in 2020 in the Potential Production Case. To place these revenue totals in context, the president's budget in fiscal year 2014 provided $71.2 billion in discretionary funding for the Department of Education—and the additional government revenue from lifting the export ban could fund nearly 10% of this budget.[20]

Supply chain industries will account for nearly one-third of the total increases in government revenues resulting from a US crude oil export policy change to free trade. Over the entire 2016-30 forecast period, the following table shows that lifting the trade restrictions will generate government revenue in excess of $428 billion in the Base Production Case—enough to fund the president's fiscal year 2015 budget for the US Department of the Interior. And it will generate over $868 billion in the Potential Production Case;

20 http://www.whitehouse.gov/sites/default/files/omb/budget/fy2014/assets/budget.pdf

these cumulative crude oil export supply chain-related revenues will not only fund the Department of Interior but could also fund a four-year reauthorization of surface transportation infrastructure projects, with additional revenue remaining to fully fund the Department of Veterans Affairs in fiscal year 2015.[21]

Government Revenue: US crude oil export supply chain ($millions, nominal)

	2016	2017	2018	2019	2020	2021-30 total	2016-30 total
Base Production Case							
Federal personal and corporate taxes	6,011	14,710	15,734	12,961	10,643	273,737	333,797
State personal and corporate taxes	920	3,262	3,716	2,920	2,693	71,805	85,316
Local personal and corporate taxes	169	406	364	265	276	8,124	9,603
US crude oil export supply chain government revenue	**7,100**	**18,378**	**19,814**	**16,146**	**13,612**	**353,666**	**428,717**
US crude oil export government revenue total	**28,888**	**55,769**	**58,188**	**48,891**	**42,124**	**1,077,224**	**1,311,085**
Supply chain share of crude oil export total	**24.6%**	**33.0%**	**34.1%**	**33.0%**	**32.3%**	**32.8%**	**32.7%**
Potential Production Case							
Federal personal and corporate taxes	8,579	20,859	24,998	22,556	20,232	571,906	669,131
State personal and corporate taxes	1,220	4,302	5,434	5,044	4,723	158,136	178,859
Local personal and corporate taxes	267	593	621	512	508	17,947	20,448
US Crude oil export supply chain government revenue	**10,066**	**25,754**	**31,053**	**28,112**	**25,463**	**747,990**	**868,438**
US crude oil export government revenue total	**41,535**	**83,682**	**97,373**	**89,015**	**81,541**	**2,410,900**	**2,804,045**
Supply chain share of crude oil export total	**24.2%**	**30.8%**	**31.9%**	**31.6%**	**31.2%**	**31.0%**	**31.0%**

Source: IHS Economics

Economic contribution by core industry groups

IHS also identified and analyzed the economic effects on 60 supply chain sectors impacted by US crude oil capital expenditures. These sectors were divided into the same six core groups for analysis:

- Industrial equipment and machinery
- Construction and well services
- Information technology
- Logistics
- Materials
- Professional, financial, and other services

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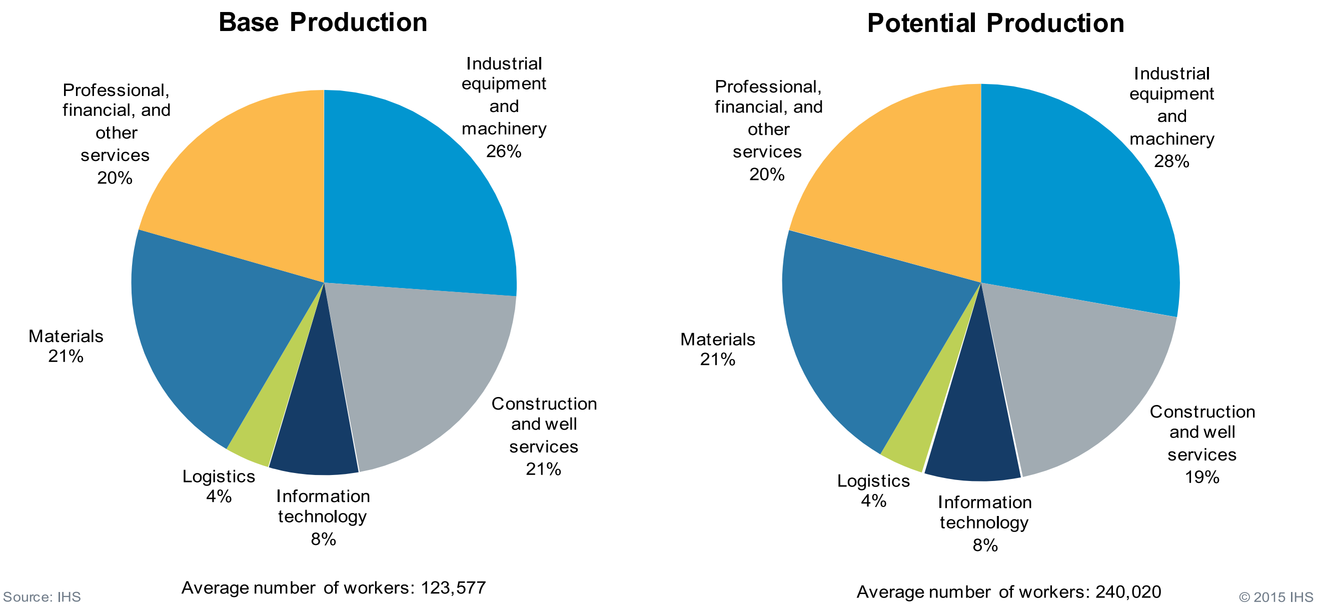
While the impact of lifting the export ban on each group varies significantly, the *distribution* of impacts among the groups is very similar in the Base Production and Potential Production cases, as can be seen in the following charts.

Employment share by core group
(2016–30 average, difference free trade vs. restricted trade)



Source: IHS

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The following section examines each of these core groups in terms of their individual contributions to employment, value added, and labor income.

Construction and well services

Companies in the construction and well services core group provide an array of specialized services to the crude oil industry, including well pad access, drilling support, and construction and maintenance of gathering systems and infrastructure. Construction and well services includes four supply chain sectors: Support Activities for Oil and Gas Operations (213112), Construction of Other New Nonresidential Structures (part of NAICS 23—construction of upstream facilities and structures), Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures), and Drilling Oil and Gas Wells (NAICS 213111).

Employment: US crude oil export supply chain – Construction and well services*
(number of workers, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
213112	Support Activities for Oil and Gas Operations	10,344	25,385	29,403	25,026	20,239	6,513	11,702
23tt	Construction of Other New Nonresidential Structures	9,324	23,633	27,316	23,044	18,896	5,945	10,778
213111	Drilling Oil and Gas Wells	1,448	3,552	4,061	3,447	2,807	902	1,622
23t	Construction of New Nonresidential Manufacturing Structures	1,642	3,527	4,342	3,805	3,140	947	1,728
Construction and well services total		**22,760**	**56,096**	**65,121**	**55,322**	**45,082**	**14,307**	**25,830**
Potential Production Case								
213112	Support Activities for Oil and Gas Operations	14,766	34,486	41,310	36,916	32,664	15,428	20,961
23tt	Construction of Other New Nonresidential Structures	12,376	29,496	35,192	31,013	27,609	12,548	17,411
23t	Construction of New Nonresidential Manufacturing Structures	2,734	6,906	8,213	7,971	6,460	2,848	4,051
213111	Drilling Oil and Gas Wells	2,001	4,704	5,587	4,931	4,360	2,010	2,779
Construction and well services total		**31,877**	**75,591**	**90,302**	**80,831**	**71,092**	**32,834**	**45,202**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Value added: US crude oil export supply chain – Construction and well services*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
213112	Support Activities for Oil and Gas Operations	1,243	2,515	2,521	2,038	1,819	1,134	1,432
23tt	Construction of Other New Nonresidential Structures	1,033	2,138	2,123	1,694	1,538	938	1,194
213111	Drilling Oil and Gas Wells	743	1,535	1,519	1,217	1,100	684	864
23t	Construction of New Nonresidential Manufacturing Structures	189	340	358	314	287	143	195
Construction and well services total		**3,208**	**6,529**	**6,521**	**5,262**	**4,744**	**2,900**	**3,684**
Potential Production Case								
213112	Support Activities for Oil and Gas Operations	1,686	3,358	3,688	3,133	2,985	2,110	2,396
23tt	Construction of Other New Nonresidential Structures	1,300	2,628	2,874	2,398	2,304	1,560	1,807
213111	Drilling Oil and Gas Wells	992	2,002	2,179	1,833	1,762	1,226	1,402
23t	Construction of New Nonresidential Manufacturing Structures	356	717	765	714	633	472	527
Construction and well services total		**4,334**	**8,705**	**9,506**	**8,078**	**7,684**	**5,368**	**6,133**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Labor income: US crude oil export supply chain – Construction and well service*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
213112	Support Activities for Oil and Gas Operations	1,529	3,362	3,388	2,812	2,477	1,559	1,944
23tt	Construction of Other New Nonresidential Structures	1,100	2,468	2,463	2,019	1,809	1,120	1,404
213111	Drilling Oil and Gas Wells	220	496	500	414	368	233	289
23t	Construction of New Nonresidential Manufacturing Structures	167	327	346	298	273	134	184
Construction and well services total		**3,016**	**6,653**	**6,697**	**5,543**	**4,927**	**3,046**	**3,820**
Potential Production Case								
213112	Support Activities for Oil and Gas Operations	2,049	4,793	5,297	4,664	4,423	3,148	3,513
23tt	Construction of Other New Nonresidential Structures	1,350	3,200	3,516	3,047	2,910	1,991	2,262
213111	Drilling Oil and Gas Wells	287	688	762	669	637	450	503
23t	Construction of New Nonresidential Manufacturing Structures	241	595	622	566	492	365	411
Construction and well services total		**3,927**	**9,275**	**10,197**	**8,944**	**8,462**	**5,954**	**6,690**

*The rank for all years is based on the 2017 ranking.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Extraction, drilling, and supply chain industries expanded despite slow US growth[22]

The obvious beneficiaries of the unconventional oil and natural gas boom have been the firms behind oil and gas extraction, drilling, operations support, pipeline construction and field machinery and equipment. Less obvious, however, is the remarkable employment growth in oil and gas industry subsectors. Jobs in the extraction sector grew by 46% between 2005 and 2012, a time when total US employment declined by 0.3%. Drilling jobs also expanded rapidly—by 61%—while employment more than doubled in the support services for oil and gas operations. Field machinery and equipment manufacturing employment grew by 67%, and pipeline and related structures construction employment expanded by 66%. It is notable that most of these are well-paying jobs. Wage growth in the oil and gas extraction sector also increased 6% in 2013. The number of firms in these key sectors has also grown as the total number of US employers declined between 2005 and 2012. The following is the growth in numbers of firms in four sectors:

- Oil and gas extraction, 4.9%
- Drilling oil and gas wells, 11.3%
- Support for oil and gas operations, 31.3%
- Pipeline and related structures construction, 14.3%

22 http://www.sbecouncil.org/2014/11/14/who-benefits-from-americas-energy-revolution-small-businesses-and-consumers/ and http://www.sbecouncil.org/2014/11/13/small-business-growth-from-natural-gas-production-and-exports/

Industrial equipment and machinery

Industrial equipment and machinery consists of a number of critical subgroups ubiquitous throughout the crude oil supply chain. They are also archetypes of how the impact of upstream capital investment cascades through the US manufacturing sector—far beyond the energy value chain and deep into the various equipment sectors that maintain lengthy supply chain networks of their own. Examples of major products in this category include drilling rigs, power systems, pumps, compressors, valves, well-monitoring instrumentation, and off-highway equipment such as excavators. Companies in this core group supply essential and highly sophisticated technology for crude oil extraction. Advanced information technology is often integrated into these capital goods to achieve greater drilling productivity, efficiency, and sustainability, while sophisticated process control and other automation technologies enable end-users to maximize equipment utilization and throughput. Equipment distribution, either through sales or rentals of machinery, is often accompanied by a variety of high-value services, including skilled operators, maintenance, and logistics. Many small and medium-sized enterprises are responsible for manufacturing and distributing machinery and equipment that is, in turn, supplied by even larger numbers of component suppliers and metal fabrication shops.

The largest industrial equipment and machinery sector of the upstream supply chain is Cutting and Machine Tool Manufacturing (NAICS 333515). This sector, under a free trade policy, is forecast to generate an additional 6,700 jobs per year over the 2016-30 period in the Base Case and an additional 13,400 jobs per year from 2016-30 in the Potential Case. This sector and the Air and Gas Compressor Manufacturing (NAICS 333912) are also the largest contributors of labor income to the supply chain; their combined contribution is estimated at an average $2.1 billion annually from 2016-30 in the Base Case and over $3.6 billion annually in the Potential Case.

Employment: US crude oil export supply chain – Industrial equipment and machinery*
(number of workers, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
333515	Cutting and Machine Tool Manufacturing	6,543	13,952	15,547	13,876	11,304	3,950	6,715
333912	Air and Gas Compressor Manufacturing	3,505	8,887	10,959	9,718	8,111	2,874	4,662
3331	Construction, Mining and Agriculture Machinery Manufacturing	3,896	8,561	9,340	7,969	6,432	2,133	3,836
334519	Other Measuring and Controlling Device Manufacturing	2,535	6,480	8,021	7,715	6,676	2,736	3,919
333611	Turbine and Turbine Generator Manufacturing	2,163	5,537	7,065	6,476	5,511	1,903	3,052
Top-5 total		**18,642**	**43,416**	**50,934**	**45,753**	**38,033**	**13,597**	**22,183**
US total		**26,437**	**62,536**	**73,645**	**66,000**	**55,084**	**20,076**	**32,298**
Potential Production Case								
333515	Cutting and Machine Tool Manufacturing	9,067	19,976	24,870	23,610	21,019	10,180	13,356
3331	Construction, Mining and Agriculture Machinery Manufacturing	6,174	13,020	15,554	14,341	12,885	6,405	8,402
333912	Air and Gas Compressor Manufacturing	4,792	11,971	15,768	15,002	13,794	7,224	8,904
334519	Other Measuring and Controlling Device Manufacturing	3,825	10,253	14,041	14,735	13,726	7,647	8,870
333611	Turbine and Turbine Generator Manufacturing	3,293	8,424	11,405	11,335	10,548	5,438	6,625
Top-5 total		**27,152**	**63,644**	**81,638**	**79,023**	**71,972**	**36,893**	**46,157**
US total		**38,186**	**91,051**	**116,812**	**112,711**	**102,908**	**53,866**	**66,689**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Value added: US crude oil export supply chain – Industrial equipment and machinery*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
3331	Construction, Mining and Agriculture Machinery Manufacturing	1,158	2,120	2,002	1,686	1,515	1,015	1,242
333515	Cutting and Machine Tool Manufacturing	1,143	2,075	2,006	1,770	1,643	1,325	1,459
333912	Air and Gas Compressor Manufacturing	761	1,559	1,626	1,365	1,271	830	992
333611	Turbine and Turbine Generator Manufacturing	760	1,523	1,639	1,474	1,364	885	1,040
334519	Other Measuring and Controlling Device Manufacturing	626	1,242	1,279	1,169	1,115	830	916
Top-5 total		**4,447**	**8,518**	**8,551**	**7,465**	**6,909**	**4,885**	**5,649**
US total		**6,615**	**12,699**	**12,738**	**11,055**	**10,291**	**7,471**	**8,541**
Potential Production Case								
3331	Construction, Mining and Agriculture Machinery Manufacturing	1,797	3,253	3,508	3,133	3,014	2,283	2,502
333515	Cutting and Machine Tool Manufacturing	1,603	2,919	3,207	2,936	2,871	2,538	2,594
333611	Turbine and Turbine Generator Manufacturing	1,152	2,317	2,745	2,616	2,565	2,014	2,103
333912	Air and Gas Compressor Manufacturing	1,013	2,072	2,434	2,171	2,146	1,622	1,737
334519	Other Measuring and Controlling Device Manufacturing	938	1,873	2,166	2,093	2,093	1,797	1,809
Top-5 total		**6,502**	**12,433**	**14,060**	**12,950**	**12,689**	**10,253**	**10,744**
US total		**9,532**	**18,322**	**20,678**	**18,910**	**18,605**	**15,474**	**16,052**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Labor income: US crude oil export supply chain – Industrial equipment and machinery*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
333515	Cutting and Machine Tool Manufacturing	847	1,692	1,645	1,464	1,365	1,116	1,212
333912	Air and Gas Compressor Manufacturing	596	1,340	1,406	1,218	1,125	737	871
3331	Construction, Mining and Agriculture Machinery Manufacturing	643	1,300	1,228	1,035	925	603	744
334519	Other Measuring and Controlling Device Manufacturing	512	1,127	1,158	1,059	1,007	755	828
333611	Turbine and Turbine Generator Manufacturing	365	793	858	767	712	471	547
Top-5 total		**2,963**	**6,251**	**6,296**	**5,543**	**5,134**	**3,683**	**4,201**
US total		**4,431**	**9,388**	**9,420**	**8,250**	**7,676**	**5,634**	**6,367**
Potential Production Case								
333515	Cutting and Machine Tool Manufacturing	1,024	2,311	2,559	2,365	2,323	2,080	2,092
3331	Construction, Mining and Agriculture Machinery Manufacturing	916	2,010	2,192	1,975	1,908	1,413	1,542
333912	Air and Gas Compressor Manufacturing	717	1,781	2,083	1,919	1,899	1,454	1,529
334519	Other Measuring and Controlling Device Manufacturing	640	1,632	1,880	1,816	1,813	1,564	1,561
333611	Turbine and Turbine Generator Manufacturing	474	1,170	1,395	1,321	1,300	1,038	1,070
Top-5 total		**3,772**	**8,904**	**10,109**	**9,396**	**9,244**	**7,549**	**7,795**
US total		**5,534**	**13,210**	**14,911**	**13,750**	**13,574**	**11,412**	**11,673**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Information technology

Information technology is essential to the efficient operation and management of all industrial systems, and the crude oil export sector is no exception. Companies in the export supply chain provide software, hardware, and technology services to achieve higher asset reliability, productivity, and systems performance, often under hazardous conditions in remote areas. Applications of these technologies range from analysis and visualization of seismic and drilling log data, aggregating data from subterranean sensors, managing the volume of injected hydraulic fracturing fluids to more routine enterprises, such as accounting, risk management, legal, and programming.

Employment: US crude oil export supply chain – Information technology*
(number of workers, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
3341	Computer Hardware	4,147	10,513	12,930	11,545	9,731	3,845	5,821
5415	Computer Services	2,886	6,274	7,483	6,794	5,473	1,970	3,241
5112	Computer Software	212	532	654	622	533	215	313
Information technology total		**7,244**	**17,318**	**21,068**	**18,961**	**15,738**	**6,030**	**9,375**
Potential Production Case								
3341	Computer Hardware	5,897	14,931	19,588	19,155	17,652	9,867	11,727
5415	Computer Services	3,945	8,949	11,587	11,388	10,193	5,484	6,727
5112	Computer Software	313	824	1,116	1,157	1,072	595	696
Information technology total		**10,156**	**24,703**	**32,291**	**31,700**	**28,918**	**15,947**	**19,149**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Value added: US crude oil export supply chain – Information technology*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
3341	Computer Hardware	830	1,637	1,688	1,460	1,391	1,009	1,140
5415	Computer Services	511	901	908	798	722	519	602
5112	Computer Software	119	235	241	217	205	148	166
Information technology total		**1,460**	**2,773**	**2,837**	**2,475**	**2,318**	**1,676**	**1,908**
Potential Production Case								
3341	Computer Hardware	1,177	2,317	2,665	2,473	2,476	2,068	2,119
5415	Computer Services	681	1,247	1,420	1,324	1,282	1,095	1,127
5112	Computer Software	175	348	401	382	379	319	325
Information technology total		**2,034**	**3,911**	**4,486**	**4,179**	**4,137**	**3,483**	**3,572**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Labor income: US crude oil export supply chain – Information technology*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
3341	Computer Hardware	731	1,616	1,665	1,455	1,381	995	1,120
5415	Computer Services	525	1,019	1,028	912	819	586	678
5112	Computer Software	58	126	130	117	110	79	88
Information technology total		**1,314**	**2,761**	**2,823**	**2,484**	**2,310**	**1,660**	**1,886**
Potential Production Case								
3341	Computer Hardware	884	2,217	2,544	2,382	2,384	1,975	2,011
5415	Computer Services	626	1,408	1,608	1,516	1,461	1,242	1,269
5112	Computer Software	72	181	208	199	197	164	167
Information technology total		**1,582**	**3,806**	**4,361**	**4,096**	**4,042**	**3,382**	**3,447**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Logistics

The record volume of current crude oil production is testing US transportation infrastructure as operators seek to get their product to market. Logistics services within the crude oil export sector move crude oil and associated natural gas via truck, rail, pipeline, or water from oil-producing regions to commercial centers for storage, refining or export. More than one mode of transportation is often necessary, requiring the services of a specialized logistics provider, particularly in remote areas where pipeline or rail transport capacity is limited or non-existent. Within the logistics core group, General Freight Trucking (NAICS 4841) accounts for the largest employment contributions stemming from crude oil export activity. In the Base Production Case, the net increase in the total number of logistics workers expected under a change to a free trade policy nearly doubles, from over 4,000 in 2016 to 8,000 in 2020. In the Potential Production Case, the net increase exceeds 5,800 in 2016 and swells to over 14,000 in 2020. Another significant economic impact comes from General Freight Trucking's value added contribution to GDP, which is estimated to average nearly $512 million more per year between 2016 and 2030 in the Base Case under free trade, compared to restricted trade, and almost $1 billion more per year during the same period in the Potential Case.

Employment: US crude oil export supply chain – Logistics*
(number of workers, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
4841	General Freight Trucking	3,602	8,486	9,927	8,698	7,145	2,431	4,144
4821	Rail Transportation	384	892	1,044	909	741	259	437
486	Pipeline Transportation	94	202	246	224	178	62	104
483	Water Transportation	15	34	40	36	29	10	17
Logistics total		**4,094**	**9,614**	**11,258**	**9,867**	**8,092**	**2,761**	**4,703**
Potential Production Case								
4841	General Freight Trucking	5,128	11,971	14,954	13,956	12,507	6,289	8,094
4821	Rail Transportation	552	1,286	1,624	1,525	1,358	710	896
486	Pipeline Transportation	130	286	372	368	330	187	224
483	Water Transportation	21	49	62	59	52	28	35
Logistics total		**5,832**	**13,592**	**17,012**	**15,909**	**14,247**	**7,214**	**9,249**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Value added: US crude oil export supply chain – Logistics*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
4841	General Freight Trucking	434	829	824	697	637	427	512
4821	Rail Transportation	121	223	221	188	171	116	139
486	Pipeline Transportation	55	96	98	87	76	53	63
483	Water Transportation	7	14	14	12	11	7	9
Logistics total		**618**	**1,161**	**1,156**	**983**	**895**	**603**	**723**
Potential Production Case								
4841	General Freight Trucking	604	1,153	1,282	1,140	1,104	856	923
4821	Rail Transportation	171	320	357	323	312	250	265
486	Pipeline Transportation	72	133	157	149	143	121	125
483	Water Transportation	10	20	22	20	19	16	17
Logistics total		**857**	**1,625**	**1,818**	**1,632**	**1,578**	**1,243**	**1,329**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Labor income: US crude oil export supply chain – Logistics*
($millions, real 2009, difference free trade vs. restricted trade)

		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
4841	General Freight Trucking	367	767	765	656	595	396	474
4821	Rail Transportation	85	174	172	146	133	90	107
486	Pipeline Transportation	77	147	153	139	119	81	96
483	Water Transportation	4	8	8	7	6	4	5
Logistics total		**533**	**1,096**	**1,098**	**948**	**853**	**571**	**683**
Potential Production Case								
4841	General Freight Trucking	464	1,075	1,202	1,087	1,049	806	862
4821	Rail Transportation	107	245	274	248	239	191	201
486	Pipeline Transportation	105	230	275	268	254	213	217
483	Water Transportation	5	11	13	11	11	9	9
Logistics total		**680**	**1,561**	**1,764**	**1,615**	**1,553**	**1,218**	**1,291**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Materials

A diverse set of companies provide a variety of materials to the crude oil export sector, either for use in drilling operations or indirectly as part of the supplier networks to other suppliers. These materials are classified as consumables that are directed to exploration and production operations or materials or material inputs used in manufacturing goods.

Consumables are used on a daily basis to support upstream, midstream, and downstream operations. They include steel tubing, drill bits, drilling mud, clay, sand, chemicals and other additives. They are used over the entire lifecycle of a well, from exploration, drilling, completion, production, and intervention to abandonment. The grueling nature of oil and gas exploration and production activity necessitates that the capital equipment used in drilling operations meet the demanding conditions of the drill site. For example, the metallic components within the drilling apparatus are often made of corrosion-resistant alloys, such as martensitic stainless steels (chromium-based alloys) and austenitic stainless steel (chromium and nickel-based alloys). Applications of these materials include downhole tubing and safety critical elements, wellhead and Christmas tree components, valves, pipelines, vessels, heat exchangers, and other pieces of equipment.

Within the materials core group, the subsectors with the largest economic contributions to labor income and value added are: Construction Sand and Gravel Mining (NAICS 212321), Wholesale Metals and Minerals (NAICS 4235), Cement Manufacturing (NAICS 327310), Industrial Gas Manufacturing (NAICS 325120), and Fabricated Pipe and Pipefitting (NAICS 332996). The subsectors with the largest economic contributions to employment are slightly different with Steel Product Manufacturing (NAICS 3312) replacing Industrial Gas Manufacturing.

The Construction Sand and Gravel Mining (NAICS 212321) sector benefits the most from crude oil export activity in terms of value added, employment, and labor income. Total sector employment supported by free trade under the Base Case is projected to increase from just over 6,500 additional workers in 2016 to more than 12,100 additional workers in 2020. In the Potential Case, employment is expected to increase from just over 8,100 additional workers in 2016 to nearly 18,000 additional workers by 2020. Value added in Construction Sand and Gravel Mining is expected to increase from an additional $1.1 billion in 2016 to an additional $1.7 billion in 2020 in the Base Case and from an additional $1.4 billion in 2016 to an additional $2.6 billion in 2020 in the Potential Case.

The companies operating in the wholesale trade sectors in Metals and Minerals (NAICS 4235) are also expected to steadily increase their employment under a free trade scenario. The number of these workers supported by free trade will increase from an average of over 3,500 in 2016 to over 6,600 in 2020 in the Base Case, and from an average of 5,100 workers in 2016 to over 12,200 workers in 2020 in the Potential Case.

Employment: US crude oil export supply chain – Materials*
(number of workers, difference free trade vs. restricted trade)

Top-5 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
212321	Construction Sand and Gravel Mining	6,529	14,236	15,901	14,788	12,129	4,165	7,015
4235	Metal and Minerals - Wholesale	3,540	8,036	9,286	8,071	6,619	2,257	3,875
332996	Fabricated Pipe and Pipefitting Manufacturing	3,016	7,437	8,721	7,977	6,775	2,405	3,865
3312	Steel Product Manufactuirng	2,809	6,194	7,117	6,117	5,020	1,676	2,934
327310	Cement Manufacturing	2,438	6,164	7,464	6,722	5,432	1,790	3,075
Top-5 total		**18,333**	**42,065**	**48,489**	**43,675**	**35,974**	**12,294**	**20,765**
US total		**22,774**	**52,632**	**60,853**	**54,366**	**44,718**	**15,402**	**25,957**
Potential Production Case								
212321	Construction Sand and Gravel Mining	8,130	16,502	20,421	19,641	17,964	8,918	11,456
4235	Metal and Minerals - Wholesale	5,060	11,632	14,758	13,787	12,197	6,085	7,886
332996	Fabricated Pipe and Pipefitting Manufacturing	4,117	9,853	12,653	12,322	11,480	5,950	7,329
3312	Steel Product Manufactuirng	4,078	9,321	11,807	10,969	9,617	4,707	6,191
327310	Cement Manufacturing	3,707	9,189	11,746	11,455	10,228	4,960	6,395
Top-5 total		**25,092**	**56,496**	**71,384**	**68,173**	**61,487**	**30,621**	**39,256**
US total		**31,689**	**72,058**	**90,499**	**85,911**	**77,316**	**39,165**	**49,941**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Value added: US crude oil export supply chain – Materials*
($millions, real 2009, difference free trade vs. restricted trade)

Top-5 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
212321	Construction Sand and Gravel Mining	1,119	2,071	1,989	1,817	1,672	1,195	1,375
4235	Metal and Minerals - Wholesale	859	1,566	1,530	1,282	1,176	790	954
325120	Industrial Gas Manufacturing	663	1,244	1,194	964	869	575	712
327310	Cement Manufacturing	624	1,188	1,182	1,030	936	579	716
332996	Fabricated Pipe and Pipefitting Manufacturing	513	1,018	1,012	886	851	655	722
Top-5 total		**3,778**	**7,088**	**6,907**	**5,980**	**5,505**	**3,794**	**4,480**
US total		**4,997**	**9,343**	**9,136**	**7,862**	**7,224**	**4,954**	**5,873**
Potential Production Case								
212321	Construction Sand and Gravel Mining	1,432	2,491	2,771	2,586	2,550	2,002	2,123
4235	Metal and Minerals - Wholesale	1,214	2,233	2,467	2,186	2,096	1,665	1,790
325120	Industrial Gas Manufacturing	966	1,835	1,968	1,702	1,632	1,290	1,400
327310	Cement Manufacturing	954	1,798	2,010	1,897	1,884	1,381	1,490
332996	Fabricated Pipe and Pipefitting Manufacturing	710	1,374	1,558	1,444	1,479	1,374	1,353
Top-5 total		**5,275**	**9,731**	**10,773**	**9,815**	**9,641**	**7,712**	**8,157**
US total		**6,998**	**12,970**	**14,350**	**13,003**	**12,693**	**10,164**	**10,777**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Labor income: US crude oil export supply chain – Materials*
($millions, real 2009, difference free trade vs. restricted trade)

Top-5 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
212321	Construction Sand and Gravel Mining	834	1,731	1,659	1,532	1,413	1,010	1,151
4235	Metal and Minerals - Wholesale	568	1,139	1,118	945	865	584	698
327310	Cement Manufacturing	494	1,009	1,004	877	797	485	602
325120	Industrial Gas Manufacturing	414	845	803	645	579	375	469
332996	Fabricated Pipe and Pipefitting Manufacturing	379	833	833	736	696	528	584
Top-5 total		**2,688**	**5,558**	**5,417**	**4,735**	**4,348**	**2,981**	**3,504**
US total		**3,586**	**7,369**	**7,209**	**6,258**	**5,733**	**3,911**	**4,618**
Potential Production Case								
212321	Construction Sand and Gravel Mining	958	2,047	2,283	2,145	2,123	1,653	1,739
4235	Metal and Minerals - Wholesale	697	1,580	1,757	1,578	1,510	1,195	1,271
327310	Cement Manufacturing	622	1,445	1,623	1,550	1,533	1,109	1,191
325120	Industrial Gas Manufacturing	509	1,190	1,268	1,095	1,048	815	884
3312	Steel Product Manufactuirng	506	1,133	1,252	1,114	1,057	855	908
Top-5 total		**3,292**	**7,395**	**8,183**	**7,482**	**7,271**	**5,627**	**5,993**
US total		**4,371**	**9,929**	**11,031**	**10,100**	**9,842**	**7,782**	**8,206**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Oil and gas activity supports US steel industry[23]

The US steel industry had high hopes of benefitting from the unconventional oil and natural gas boom, as evidenced by multiple examples of expansion in the steel tube and pipe manufacturing sector. More than 1.3 million metric tons of new OCTG production capacity has been commissioned in the USA since 2007, and total capacity is now approaching 10.5 million metric tons. According to the president of North American operations for Tenaris, Germán Curá, a fundamental reason for building a pipe plant in Texas, expected to be completed in 2016, is the proximity to the Eagle Ford Shale play. “It is one of the most promising fields in the industry,” Curá said. The plant will have an annual production capacity of 600,000 tons of seamless pipe used in drilling, producing, and transporting oil and gas. Sewickley, Pennsylvania-based Esmark, Inc. announced plans to convert a recently closed steel finishing mill into an industrial services manufacturing center to support oil and gas activities in September 2014. The company anticipates adding 50 to 75 jobs as part of its new endeavor.

However, domestic steel producers have struggled to compete with a growing influx of cheap imports, a situation that will only be made worse with the sharp reduction in demand now expected in 2015. In August 2014, the US International Trade Commission ruled in favor of the domestic steel industry in a case against foreign competitors that the United States had accused of dumping low-priced steel on US shores. The ruling paves the way for additional duties the Commerce Department levied on imported steel tubing from six countries: India, Korea, Taiwan, Turkey, Ukraine, and Vietnam. These trade sanctions will support the domestic steel industry’s efforts to capitalize on oil and gas sector spending, provided that upstream investment continues at 2013/2014 levels.

The ripple effects of the fall in the price of oil are already being felt across the oil and gas supply chain. OCTG suppliers across the country are idling capacity as demand drops and imports continue to flood the market. Major suppliers including Tenaris, Vallourec, US Steel, TMK Ipsco have all announced mill closures and layoffs, with declining oil prices cited among the reasons. As demonstrated in this study and in the Export Decision study, the entire supply chain depends on the health of the oil and gas industry. Policies that potentially impair industry activities, including the export ban, could produce similar ripple effects across the country.

Professional, financial, and other services

The energy value chain requires a diverse set of skills, starting with the standard array of accounting, insurance, Internet, legal, programming, and other professional services firms. This sector also includes highly specialized firms that provide remote catering, life support, temporary lodging, environmental site assessment and remediation services, soil and groundwater testing services, physical security, and analytical support services.

In the professional and other services core group, Architectural, Engineering, and Related Services (NAICS 5413) is the top sector in terms of both the number of workers and the value added to GDP under a free trade scenario, compared to the restricted status quo. This sector is estimated to add over 8,800 workers in 2016 in the Base Case, rising to a peak of nearly 23,500 in 2018. Potential Case employment expands from over 12,700 in 2016, peaking two years later at nearly 36,500 additional jobs. In terms of value added contribution, this sector is expected to increase more than $1.2 billion in 2016 and more than $1.7 billion in 2020 in the Base Case. In the Potential Case, the sector will increase its value added contribution by $1.7 billion in 2016 and by $3.0 billion in 2020 in a free trade environment.

23 http://www.mysanantonio.com/news/local_news/article/Tenaris-announces-1-5B-Eagle-Ford-pipe-plant-4282058.php; http://powersource.post-gazette.com/powersource/energyforum/2014/09/17/Is-shale-the-new-steel/stories/201409170003; http://triblive.com/business/headlines/7174309-74/solutions-steel-company#ixzz3JVKfOTUC; http://www.reuters.com/article/2014/08/22/usa-trade-steel-idUSL2N0QS10W20140822; http://www.usitc.gov/press_room/news_release/2014/er0822mm1.htm; http://www.cleveland.com/business/index.ssf/2015/01/us_steel_to_temporarily_lay_of.html.

Banking and finance sector invests in energy value chain[24]

The banking and finance sector has made numerous investments in the energy value chain in response to the ongoing boom in oil production. The significant cost to recover crude oil and sustain higher levels of production requires a range of finance vehicles. Specifically, private equity funds have appreciably increased their stake in unconventional oil and gas development since 2009, raising $157 billion to invest in energy, according to data from the intelligence firm, Preqin. Even five years into the resurgence of domestic oil and gas, private equity continues to attract new capital, raising nearly $32 billion in 2014 alone. Private equity executives said they believe that crude oil will continue to be an important source of power and fuel in 25 years.

The remaining industries ranked in the top five services sectors are expected to follow similar trends in terms of the employment, value added, and labor income generated by crude oil export-related activity. These industries include Management, Scientific, and Technical Consulting Services (NAICS 5416), Other Professional, Scientific and Technical Services (NAICS 5419), Insurance Carriers and Related Activities (NAICS 524), Water, Sewage and Other Systems (NAICS 2213), and Finance (NAICS 52 excluding 524).

Employment: US crude oil export supply chain – Professional, financial, and other services*
(number of workers, difference free trade vs. restricted trade)

Top-5 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
5413	Architectural, Engineering, and Related Services	8,836	19,979	23,465	20,486	16,659	5,453	9,597
52_ex_524	Finance	4,244	9,842	11,603	10,279	8,402	2,930	4,911
524	Insurance Carriers and Related Activities	1,814	4,423	5,099	4,310	3,473	1,135	2,031
5416	Management, Scientific, and Technical Consulting Services	1,755	4,141	4,938	4,413	3,634	1,296	2,123
2213	Water, Sewage and Other Systems	1,303	3,298	3,862	3,345	2,747	892	1,565
Top-5 total		**17,952**	**41,683**	**48,967**	**42,833**	**34,915**	**11,706**	**20,227**
US total		**22,440**	**52,004**	**61,194**	**53,710**	**43,793**	**14,807**	**25,414**
Potential Production Case								
5413	Architectural, Engineering, and Related Services	12,710	29,975	36,479	34,111	29,347	14,158	18,947
52_ex_524	Finance	5,980	13,816	17,515	16,658	14,935	7,749	9,760
5416	Management, Scientific, and Technical Consulting Services	2,483	5,902	7,526	7,245	6,515	3,440	4,272
524	Insurance Carriers and Related Activities	2,438	5,722	6,918	6,209	5,453	2,635	3,540
2213	Water, Sewage and Other Systems	1,909	4,607	5,563	5,023	4,497	2,126	2,858
Top-5 total		**25,519**	**60,022**	**74,001**	**69,245**	**60,746**	**30,109**	**39,375**
US total		**31,782**	**74,678**	**92,661**	**87,136**	**76,721**	**38,388**	**49,790**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

24 http://www.cnbc.com/id/102173514#

Value added: US crude oil export supply chain – Professional, financial, and other services*
($millions, real 2009, difference free trade vs. restricted trade)

Top-5 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
5413	Architectural, Engineering, and Related Services	1,217	2,242	2,246	1,903	1,719	1,066	1,333
52_ex_524	Finance	984	1,819	1,821	1,561	1,426	995	1,171
524	Insurance Carriers and Related Activities	424	821	799	646	580	377	470
5419	Other Professional, Scientific, and Technical Services	444	815	820	707	646	458	534
2213	Water, Sewage and Other Systems	327	671	667	547	499	323	396
Top-5 total		**3,397**	**6,367**	**6,353**	**5,364**	**4,870**	**3,219**	**3,903**
US total		**4,336**	**8,101**	**8,092**	**6,857**	**6,230**	**4,151**	**5,008**
Potential Production Case								
5413	Architectural, Engineering, and Related Services	1,746	3,350	3,641	3,256	3,018	2,339	2,560
52_ex_524	Finance	1,356	2,541	2,862	2,595	2,515	2,061	2,165
5419	Other Professional, Scientific, and Technical Services	610	1,144	1,291	1,179	1,141	955	994
524	Insurance Carriers and Related Activities	553	1,058	1,145	974	924	689	770
2213	Water, Sewage and Other Systems	458	919	1,005	857	831	598	670
Top-5 total		**4,722**	**9,013**	**9,943**	**8,861**	**8,430**	**6,641**	**7,159**
US total		**6,008**	**11,434**	**12,664**	**11,336**	**10,818**	**8,576**	**9,201**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Labor income: US crude oil export supply chain – Professional, financial, and other services*
($millions, real 2009, difference free trade vs. restricted trade)

Top-5 sectors		2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case								
5413	Architectural, Engineering, and Related Services	1,269	2,568	2,577	2,204	1,979	1,235	1,530
52_ex_524	Finance	573	1,179	1,182	1,023	932	663	768
5416	Management, Scientific, and Technical Consulting Services	302	625	629	546	499	348	405
524	Insurance Carriers and Related Activities	257	550	542	445	395	253	315
5419	Other Professional, Scientific, and Technical Services	241	486	489	427	387	275	319
Top-5 total		**2,641**	**5,408**	**5,419**	**4,646**	**4,193**	**2,774**	**3,336**
US total		**3,292**	**6,763**	**6,782**	**5,815**	**5,246**	**3,478**	**4,178**
Potential Production Case								
5413	Architectural, Engineering, and Related Services	1,616	3,750	4,093	3,672	3,398	2,669	2,881
52_ex_524	Finance	700	1,627	1,836	1,681	1,627	1,347	1,396
5416	Management, Scientific, and Technical Consulting Services	373	877	986	907	879	720	748
524	Insurance Carriers and Related Activities	311	721	789	687	648	477	528
5419	Other Professional, Scientific, and Technical Services	293	677	766	709	684	574	591
Top-5 total		**3,293**	**7,653**	**8,470**	**7,656**	**7,236**	**5,786**	**6,144**
US total		**4,114**	**9,559**	**10,610**	**9,601**	**9,105**	**7,240**	**7,692**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

In the next chapter, IHS' analysis of the economic contributions of US crude oil export activity reveals the geographical diversity of the supply chain. While the largest economic benefits accrue to supply chain sectors located in major oil-producing states, particularly especially California and Texas, considerable employment, value-added, and labor income is supported across most of the 50 states, including those with no economically recoverable hydrocarbons.

State supply chain assessment

Key insights

- The oil-producing states of California and Texas are expected to reap the largest benefits from a free trade crude oil export policy, together accounting for about 25% of total supply chain employment and labor income contributions and about 23% of the government revenue contributions over the 2016-30 period in both the Base Production and Potential Production Cases. California is ranked third in terms of capital spending, which, along with its strong diversified supply chain sectors, is expected to highly benefit the state under a free trade policy.

- Washington, Massachusetts and other states that do not produce crude oil still rank high in employment, labor income, and value-added economic contributions under free trade. In terms of labor income, Washington and Massachusetts contribute nearly 7% of the free trade's impact on the US supply chain in both the Base Production Case and the Potential Production Case.

- The supply chain accounts for nearly 50% of the overall economic impact of a free trade policy in several oil-producing and non-producing states. In Washington State, for example, the technology and manufacturing sectors are expected to grow rapidly in both the Base Production Case and Potential Production Case, and its supply chain contribution to GDP is expected to comprise 47% of the state's total impacts from higher crude oil exports over the 2016-30 period. Even a state like Illinois, a small oil-producing state with a diverse set of supplier industries, will derive 58% and 54% of the total value added impacts from the supply chain in the Base and Potential Production Cases, respectively.

- As previously indicated, the additional government revenue contributed by the supply chain is sizable under a free trade policy. The supply chain impact on cumulative government revenues represents nearly one-third of the total impact on oil export revenue, at $429 billion and $868 billion in the Base Case and Potential Case, respectively, over 2016-30 period. While California and Texas experience the largest net impacts of supply chain on their government revenue, non-oil producing states such as Massachusetts and Maryland will see supply chain-associated government revenues more than double over the 2016-30 time period in the Base Production Case and more than triple over that same period in the Potential Production Case.

- New York State has a diversified economy with a strong financial sector and many mature manufacturing industries that are expected to benefit from removing the crude oil export ban. In the long-term (2016-30), supply chain activity under free trade is expected to contribute an additional $2.1 billion on average per year to value added in the Base Production Case, while the average in the Potential Production Case exceeds $4 billion per year. New York's state and local governments are also expected to benefit: between 2016 and 2030, the cumulative impact on government revenue in the Base Production Case will exceed $37 billion and will reach almost $81 billion in the Potential Production Case.

Introduction

The effect of eliminating the ban on the export of crude oil will have far-reaching consequences for the US economy and within virtually every state. The effects of this policy change will go beyond crude oil exploration and development and will include manufacturing and service-related sectors present in every region. Some industries that stand to benefit—transportation, steel, professional and financial services—are dispersed across many states regardless of their proximity to active crude oil plays. Large and diverse state economies such as California, Texas, Illinois and New York are clear beneficiaries by virtue of their ability to fulfill supply-chain requirements. Other states, such as Ohio, Michigan and Pennsylvania, have large capital equipment manufacturing sectors, which are supported by their local materials and components suppliers.

This section of the report details the state-by-state economic impacts stemming from the first-order supply chain effects related to a prospective change in US crude oil export policy. As with the national analysis, this section presents the supply chain's economic contribution from the upstream (production), midstream (transportation and logistics), and downstream (processing and marketing) sectors after a change to US crude oil export policy. These supply chain impacts of changing to a free trade policy are presented in terms of their economic contributions under the Base Production Case and Potential Production Case. These supply chain networks reach into all regions of the United States, and the findings are presented for producing or non-producing states.

The first section presents the states that are expected to have the largest supply chain contributions under free trade to employment, value added, labor income, and government revenue.

The second section presents the main supplier industries benefitting from free trade of US crude oil and the selected detailed 6-digit NAICS sectors present in key states.

Methodology

While the first study, *US Crude Oil Export Decision*, used macroeconomic state models to assess the total economic impact of lifting the US crude oil export ban under two projection trajectories, this study utilizes Input/Output models to trace and assess the impacts at the sector- and supplier-industry levels. IHS has integrated and calibrated the two modeling approaches by embedding and linking the sectoral model within the IHS macroeconomic modeling system.

The model framework utilized in this analysis was established as a system of linked state economies to capture the flow of trade across state borders. As a result, the sourcing of supplies requisite for crude oil development activity impacts states that do not have an oil play within their borders. For example, oil development in North Dakota relies on companies that provide banking, financial, and insurance services in Chicago and New York City as well as professional services firms that might be located in Dallas, San Francisco and Boston. Capturing these connections highlights the indirect economic contribution even in non-producing states.

By focusing on the interaction of economic activity among the states, IHS provides a more careful analysis of state-level impacts resulting from a change in crude oil export policy. In addition, while the economic value created by oil production is attributed solely to states with plays, the allocation of capital expenditures across the 50 states is interconnected. Capital spending may be incurred at an oil production site, but the machinery and equipment, architectural and engineering services, materials, and other expenditures may occur in other locations far from production. To ensure that these effects are fully captured in the analysis, insights from the IHS Economics and IHS Energy teams, web-based primary research, and IHS proprietary databases were employed to appropriately allocate capital expenditures to the individual states.

IHS integrated information from a number of different proprietary and public sources to determine interstate trade flows. The analysis was supported by multiple industry sources, the IHS TRANSEARCH© Business Market Insight databases, and IHS expert judgment. For example, unconventional oil extraction employing hydraulic fracturing techniques requires sand with unique properties produced primarily in Wisconsin, Minnesota, Ohio, and Arkansas. Since not all states with unconventional oil or gas plays produce these distinctive sands, they must procure them from suppliers elsewhere (and are assumed to do so in the sectoral model). The IHS TRANSEARCH© trade-flow database was one of several sources used to determine the origin and destination of the various materials and equipment on a state level. This process was undertaken for all of the detailed capital expenditure categories (defined as various products and services). The set of products and services, and — in a producing state — the value of production, were input into the corresponding state model to assess the impact of the supply chain in each individual state's economy as determined by the multi-regional analysis capability and related coefficients of the IMPLAN model. The net result is an assessment of the supply chain across all state economies.

Unconventional oil activity impacts North Dakota and neighbor state's infrastructure

The advent of improved horizontal drilling and hydraulic fracturing techniques has resulted in unprecedented economic growth in North Dakota. Beginning in earnest around 2008, development of the Bakken and Three-Forks shale plays in North Dakota's Williston Basin resulted in a large influx of drilling operators and workers. Despite producing oil since the 1950s, this remote and sparsely populated region historically did not have a supply chain of the necessary scale to support drilling and production. As a result, energy supply chain growth was limited by inadequate infrastructure and housing, and the lack of availability of labor.

Due to the size and potential of the Bakken, an outsize share of the economic contributions in recent years has come from the upstream production sector of the energy supply chain. The massive increase in well drilling resulted in large economic contributions from Support Activities for Oil and Gas Operations (NAICS 213112). In addition, the region's lack of sufficient infrastructure led to large gains in Construction of New Nonresidential Manufacturing Structures and Other New Nonresidential Structures. Rapid development of new pipelines, rail, storage facilities, manufacturing facilities, and export facilities was needed to bring in supplies and ship out extracted crude and natural gas.

While the Bakken spans 16 counties on the western side of the state, all of North Dakota as well as some neighboring states have benefitted from the energy boom. The uptick in activity has transformed the city of Fargo, where manufacturing and business services firms weathered the recession very well and have seen a resurgence in activity as they supply the Bakken with needed inputs. Large numbers of new jobs have also been created in residential construction as homebuilding takes off to house the influx of new workers. Contractors in Fargo have seen a huge uplift in activity not only from the Williston Basin, but also from the city itself. Many construction firms in neighboring Minnesota are also acquiring work from their western neighbor. Finance, health services, and leisure/hospitality services have shown large employment gains necessary to keep pace with consumer demand from a swelling population. North Dakota's unemployment rate is by far the lowest among the states. In fact, labor shortages are one of the largest constraints for supply chain expansion, despite huge advances in wage growth.

The mining sectors of other states have also benefitted due to the fact that sand is input into the hydraulic fracturing process. A particularly hardy type of sand called "frac sand" is supplied by mines in Illinois, Minnesota, Wisconsin, and other states. Moving the sand and other inputs requires the expertise of shipping and logistics companies and has resulted in significant hiring in the transportation and warehousing sector. Operators in Minnesota and many other states in the region that supply North Dakota have seen a surge in business as a result.

Although the need for rig and wellhead workers is obvious, less visible is the need to fill many of the positions that support drilling operations. Everything from licensed commercial truck drivers to office workers are necessary to ensure the steady flow of crude and natural gas from the region. Power Fuels, a division of Nuverra Environmental Solutions, is the largest of many companies that provide support and services to drilling operations in the Williston Basin. Power Fuels announced the hiring of 300 new employees at the end of last year.

Economic contribution results

Employment

Our analysis shows that while the supply chain's economic contributions tend to be concentrated in oil-producing states such as California and Texas, other states, such as Washington and Massachusetts, also benefit significantly. For example, in the Base Production Case, the supply chain's contribution to employment under a free trade policy in Washington State was 3,600 more workers per year in 2016-2030. This supply chain share is nearly 47% of the total economic impact in the Base Production Case, which registers at just over 7,700 more workers per year. In the Potential Production Case, Washington State is expected to add an average of about 7,700 workers per year over 2016-30 under a free trade policy—about 45% of the total crude oil export employment impact of over 17,000 workers per year. The majority of the supply chain impact in Washington State is driven by computer software and hardware.

New York State supply chain sectors benefits despite a ban on hydraulic fracturing

New York State receives economic benefits through its supply chain, since the broader benefits commonly found in producing states have been diminished by New York's decision to maintain a ban on developing its own substantial natural gas resources. The Marcellus Shale play includes nearly the entire length of New York's southern border with Pennsylvania, and the Utica play extends into the western part of the state. For now, supplier industries within New York State can only supply products and services to support energy exploration and production in places like Pennsylvania, Ohio, and North Dakota.

Oil and natural gas production requires a significant financial investment, and New York City's extensive financial services sector is certainly playing a role in unconventional energy development. The rapid advances in energy exploration and production also require high-tech support, such as database management tools, big data analytics, visualization programs, and IT support functions provided by companies in the state.

The vast increase in oil and natural gas production, especially in Pennsylvania, has given rise to new logistics and an expansion of product distribution for New York and New England. Prior to the unconventional energy boom, this area had traditionally experienced markedly higher natural gas prices than other parts of the country due to its distance from supplies. Beyond the benefit to consumers, the expansion of the midstream pipeline network in New York has also led to jobs for construction workers and for suppliers of steel pipe and related support services.

California and Texas, home to significant onshore and offshore oil reserves and production, are the largest beneficiaries of new and ongoing crude oil activity. As they escalate their upstream activities with a removal of the crude oil export ban, their full-service supply chains have a considerable impact on the economies of these two states. Oil and gas support services, engineering and technical services, and finance, are expected to be among top-performing industries that benefit from lifting the export ban. In Base and Potential Production Cases, these two states together contribute a sizable amount—23% (Potential Case) to 25% (Base Case)—of the entire US supply chain's additional jobs over the 2016-30 period.

Top-10 employment contributions: US crude oil export supply chain – Base Production* (number of workers, difference free trade vs. restricted trade)

	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Supply chain employment contribution							
California	11,832	33,639	43,129	35,864	29,787	10,828	17,502
Texas	10,086	26,549	32,279	28,931	23,990	7,656	13,226
Illinois	8,138	16,590	17,644	15,052	12,106	4,010	7,309
New York	4,908	11,769	13,956	12,548	10,361	3,867	6,147
Ohio	5,346	10,504	10,475	8,469	7,019	2,404	4,390
Florida	4,238	10,075	12,213	11,956	10,458	4,313	6,138
Michigan	4,066	7,783	8,109	6,744	5,337	1,695	3,266
Pennsylvania	3,418	7,244	7,325	6,061	4,857	1,475	2,911
Oklahoma	3,016	6,759	7,628	6,596	5,192	1,416	2,890
Washington	2,769	6,743	8,204	7,347	6,064	2,295	3,605
Top-10 total	**57,816**	**137,656**	**160,961**	**139,568**	**115,173**	**39,959**	**67,384**
US total	**105,748**	**250,201**	**293,140**	**258,227**	**212,508**	**73,384**	**123,577**
Total crude oil export employment contribution**							
California	33,460	88,040	110,860	101,020	81,090	28,693	46,760
Texas	39,380	94,520	117,370	107,040	86,130	27,498	47,961
Illinois	18,290	35,880	39,140	33,830	27,540	8,783	16,167
New York	16,360	37,310	44,860	40,420	32,920	11,800	19,325
Ohio	15,110	30,150	33,290	28,890	23,700	7,735	13,899
Florida	22,440	47,660	56,160	51,440	42,960	16,718	25,856
Michigan	14,880	27,740	28,970	24,070	18,950	4,773	10,823
Pennsylvania	11,530	24,650	28,200	24,830	20,300	5,738	11,126
Oklahoma	8,690	18,790	22,440	19,950	15,600	4,156	8,469
Washington	6,000	14,510	17,800	16,270	13,330	4,766	7,705
Top-10 total	**186,140**	**419,250**	**499,090**	**447,760**	**362,520**	**120,660**	**208,091**
US total	**358,610**	**811,250**	**963,720**	**863,310**	**699,520**	**221,532**	**394,118**
Total state employment***							
California	16,096,504	16,342,006	16,541,530	16,713,653	16,894,796	17,594,008	17,235,238
Texas	12,163,160	12,407,719	12,620,211	12,821,439	13,032,535	13,931,590	13,490,731
Illinois	5,973,287	6,033,050	6,072,485	6,109,673	6,147,849	6,251,120	6,189,836
New York	9,226,393	9,297,202	9,332,432	9,355,131	9,387,961	9,509,108	9,446,013
Ohio	5,419,442	5,462,497	5,483,118	5,499,387	5,524,574	5,599,340	5,558,828
Florida	8,157,384	8,314,869	8,432,205	8,539,724	8,655,498	9,170,261	8,920,153
Michigan	4,225,864	4,256,515	4,274,943	4,289,212	4,306,502	4,361,901	4,331,470
Pennsylvania	5,924,842	5,977,881	6,007,078	6,031,570	6,067,636	6,149,923	6,100,549
Oklahoma	1,716,859	1,739,664	1,755,645	1,768,571	1,785,286	1,844,328	1,813,954
Washington	3,154,481	3,191,911	3,217,228	3,241,311	3,272,379	3,362,995	3,313,818
Top-10 total	**72,058,214**	**73,023,314**	**73,736,875**	**74,369,671**	**75,075,017**	**77,774,573**	**76,400,589**
US total	**143,787,425**	**145,272,475**	**147,731,000**	**150,800,050**	**153,014,100**	**156,645,980**	**153,804,323**

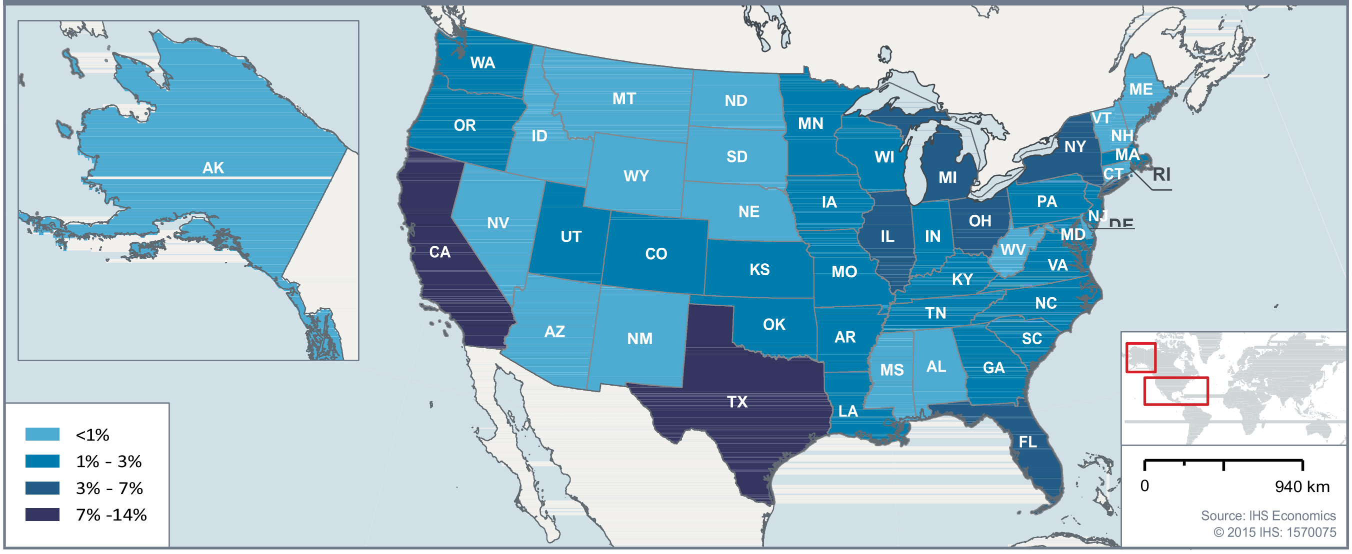
*The rank for all years is based on the 2017 ranking.

** Data are from the *US Crude Export Decision* report

*** Data are from the IHS US Regional Service forecast, November 2014

Source: IHS Economics

Employment distribution by state – Base Production
(2017 percent, difference free trade vs. restricted trade)



Many state economies will benefit from additional investment if the crude oil export ban is removed, though not all benefit equally. In the Potential Production Case, many of the same state economies that benefit from additional investment in production capacity thrive, but we also see newly emerging states that benefit from the free trade scenario, such as Georgia, due to their logistics and other midstream transport capabilities. California's supply chain sectors are expected to benefit on two fronts. First, its capital spending ranks third (after Texas and Oklahoma) and will have a strong impact on construction, well services, and related sectors. Second, California's diverse economic base will support intrastate oil activity and give it an edge in competing to provide information technology, professional services, and machinery and equipment to other states. While Midwestern states, including Ohio and Illinois, are among major producing states with strong supply chains that provide materials, machinery, equipment, and professional services, Washington, with its diversified industrial base and information technology, is heavily linked to oil and gas drilling and extraction. These second tier states will benefit from the removal of the crude oil export ban.

Top-10 employment contributions: US crude oil export supply chain – Potential Production*
(number of workers, difference free trade vs. restricted trade)

	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Supply chain employment contribution							
California	12,678	39,430	57,338	52,765	47,314	23,072	29,349
Texas	17,185	36,562	40,599	37,187	35,087	22,179	25,894
Illinois	10,716	22,667	26,909	24,138	20,969	9,444	13,323
New York	7,414	18,725	24,605	24,222	21,613	10,853	13,674
Florida	6,341	16,423	22,481	23,840	22,279	12,308	14,296
Ohio	5,673	11,996	13,601	12,081	10,778	4,946	6,906
Pennsylvania	5,725	11,884	13,251	11,851	10,444	4,402	6,478
Michigan	5,415	11,227	13,256	11,926	10,339	4,370	6,391
Georgia	4,388	10,220	13,271	12,849	11,479	6,181	7,601
Washington	4,104	10,027	12,903	12,673	11,488	6,414	7,689
Top-10 total	**79,639**	**189,161**	**238,215**	**223,531**	**201,791**	**104,170**	**131,602**
US total	**149,521**	**351,675**	**439,578**	**414,198**	**371,202**	**187,413**	**240,020**
Total crude oil export employment contribution**							
California	46,940	134,880	189,380	188,880	164,210	81,466	102,597
Texas	50,500	103,200	119,800	113,200	105,700	72,879	81,413
Illinois	25,370	53,240	64,770	60,500	53,550	26,953	35,131
New York	25,410	61,390	80,910	79,230	70,130	35,413	44,747
Florida	33,880	78,840	103,160	101,480	91,620	48,847	59,830
Ohio	21,200	46,730	58,600	55,610	49,290	24,025	31,445
Pennsylvania	19,300	43,890	55,780	53,570	47,260	21,934	29,276
Michigan	20,380	41,720	49,910	45,620	39,760	16,789	24,352
Georgia	19,740	46,020	59,620	58,210	52,200	27,811	34,260
Washington	9,120	22,150	28,730	28,390	25,590	14,305	17,135
Top-10 total	**271,840**	**632,060**	**810,660**	**784,690**	**699,310**	**370,422**	**460,185**
US total	**521,500**	**1,206,160**	**1,536,730**	**1,483,210**	**1,320,000**	**681,645**	**858,932**
Total state employment**							
California	16,096,504	16,342,006	16,541,530	16,713,653	16,894,796	17,594,008	17,235,238
Texas	12,163,160	12,407,719	12,620,211	12,821,439	13,032,535	13,931,590	13,490,731
Illinois	5,973,287	6,033,050	6,072,485	6,109,673	6,147,849	6,251,120	6,189,836
New York	9,226,393	9,297,202	9,332,432	9,355,131	9,387,961	9,509,108	9,446,013
Florida	8,157,384	8,314,869	8,432,205	8,539,724	8,655,498	9,170,261	8,920,153
Ohio	5,419,442	5,462,497	5,483,118	5,499,387	5,524,574	5,599,340	5,558,828
Pennsylvania	5,924,842	5,977,881	6,007,078	6,031,570	6,067,636	6,149,923	6,100,549
Michigan	4,225,864	4,256,515	4,274,943	4,289,212	4,306,502	4,361,901	4,331,470
Georgia	4,291,497	4,360,412	4,417,294	4,469,430	4,528,697	4,731,135	4,625,245
Washington	3,154,481	3,191,911	3,217,228	3,241,311	3,272,379	3,362,995	3,313,818
Top-10 total	**74,632,853**	**75,644,062**	**76,398,524**	**77,070,530**	**77,818,428**	**80,661,380**	**79,211,881**
US total	**143,787,425**	**145,272,475**	**147,731,000**	**150,800,050**	**153,014,100**	**156,645,980**	**153,804,323**

*The rank for all years is based on the 2017 ranking.

** Data are from the *US Crude Export Decision* report

*** Data are from the IHS US Regional Service forecast, November 2014

Source: IHS Economics

Labor income

Employment growth will also drive growth in labor income, amplifying consumer spending. In the Base Production Case, US crude oil supply chain activities will contribute nearly $22 billion in additional labor income per year between 2016 and 2030. Under a free trade policy, California has the most jobs in the crude oil supply chain sector, and it will enjoy the largest growth in labor income. Labor income under free trade is expected to increase from about $2.2 billion in 2016 to over $4.2 billion in 2020. Despite limited crude oil production activities, Massachusetts, Pennsylvania, and Washington will experience growing impacts related to labor income over the 2016-30 period, a function of their high-paying financial, professional services, and technology jobs.

As a consequence of the state employment impact, IHS expects labor income and value added to GDP to also exhibit similar rankings across states. However, due to varying wage rates across industries and across regions, some expected shifts are apparent in the state rankings.

Top-10 labor income contributions: US crude oil export supply chain – Base Production*
($millions, real 2009, difference free trade vs. restricted trade)

	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Supply chain labor income contribution							
California	2,242	5,327	5,711	4,627	4,270	2,773	3,327
Texas	1,641	3,769	3,921	3,410	2,966	1,782	2,235
New York	1,076	2,235	2,153	1,901	1,842	1,861	1,854
Illinois	1,118	2,190	2,101	1,812	1,650	1,233	1,413
Florida	723	1,474	1,506	1,378	1,285	814	967
Ohio	677	1,228	1,045	834	789	557	677
Massachusetts	498	1,125	1,149	1,012	928	621	728
Pennsylvania	567	1,068	893	722	663	410	534
Washington	500	1,028	1,041	923	877	721	772
Maryland	449	881	864	746	678	422	523
Top-10 total	**9,489**	**20,325**	**20,385**	**17,365**	**15,948**	**11,194**	**13,030**
US total	**16,171**	**34,029**	**34,030**	**29,298**	**26,745**	**18,301**	**21,552**
Total crude oil export labor income contribution**							
California	5,378	11,820	12,429	11,050	9,848	6,554	7,737
Texas	5,739	11,932	12,716	11,262	9,440	6,081	7,460
New York	2,950	5,934	5,820	5,194	4,997	5,113	5,068
Illinois	1,942	3,724	3,635	3,147	2,886	2,273	2,538
Florida	2,331	4,520	4,563	4,064	3,718	2,314	2,822
Ohio	1,446	2,671	2,495	2,127	1,995	1,509	1,722
Massachusetts	1,075	2,412	2,450	2,147	1,956	1,303	1,538
Pennsylvania	1,511	2,882	2,705	2,316	2,170	1,475	1,756
Michigan	1,353	2,430	2,256	1,874	1,680	1,180	1,426
Washington	926	1,896	1,936	1,749	1,650	1,349	1,443
Top-10 total	**24,650**	**50,221**	**51,006**	**44,931**	**40,341**	**29,151**	**33,511**
US total	**43,554**	**88,160**	**89,322**	**78,481**	**70,434**	**48,650**	**57,097**

*The rank for all years is based on the 2017 ranking.

** Data are from the *US Crude Export Decision* report

Source: IHS Economics

Top-10 labor income contributions: US crude oil export supply chain – Potential Production*
($millions, real 2009, difference free trade vs. restricted trade)

	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Supply chain labor income contribution							
Texas	2,920	6,930	7,940	7,336	7,000	5,171	5,589
California	2,168	5,872	7,098	6,162	6,055	4,823	5,039
New York	1,316	3,203	3,489	3,229	3,233	3,518	3,310
Illinois	1,342	2,978	3,261	2,912	2,776	2,299	2,417
Florida	903	2,173	2,491	2,398	2,368	1,820	1,902
Massachusetts	634	1,622	1,839	1,709	1,655	1,296	1,361
Washington	618	1,482	1,665	1,576	1,567	1,477	1,446
Pennsylvania	708	1,425	1,338	1,127	1,101	763	889
Ohio	643	1,307	1,275	1,078	1,061	857	929
Maryland	562	1,261	1,380	1,261	1,210	878	964
Top-10 total	**11,815**	**28,253**	**31,775**	**28,789**	**28,027**	**22,902**	**23,845**
US total	**20,208**	**47,340**	**52,874**	**48,107**	**46,578**	**36,988**	**38,999**
Total crude oil export labor income contribution**							
Texas	7,758	17,577	21,175	20,290	19,166	15,589	16,124
California	6,835	17,054	19,859	18,728	17,859	14,568	15,067
New York	3,736	8,821	9,692	9,027	9,016	9,926	9,303
Illinois	2,472	5,492	6,074	5,560	5,350	4,791	4,857
Florida	2,972	6,804	7,659	7,171	6,989	5,278	5,625
Massachusetts	1,402	3,557	4,014	3,720	3,582	2,796	2,949
Washington	1,181	2,813	3,185	3,033	3,003	2,832	2,769
Ohio	1,832	3,872	4,143	3,731	3,656	3,188	3,274
Michigan	1,683	3,456	3,672	3,246	3,109	2,511	2,685
Pennsylvania	1,920	4,214	4,479	4,041	3,959	3,092	3,302
Top-10 total	**31,792**	**73,660**	**83,952**	**78,549**	**75,688**	**64,570**	**65,956**
US total	**55,918**	**128,607**	**145,917**	**136,170**	**130,935**	**107,351**	**111,404**

*The rank for all years is based on the 2017 ranking.

** Data are from the *US Crude Export Decision* report

Source: IHS Economics

In each of the 10 states ranked highest for their contributions to labor income, their contributions under the Potential Production Case are about two times higher than in the Base Production Case over the 2016-30 period.

Illinois poised to benefit from oil and gas production

Based on new assessments of the New Albany Shale play and the potential for higher investment in a free trade scenario, Illinois is now considered a major producing state, with an annual average of more than 10,000 barrels per day of crude oil production. While production is all conventional, the IHS study assumes unconventional production emerges in Illinois in the 2016–2020 timeframe.

The economic benefits as unconventional drilling expands throughout the country can clearly be seen in Illinois' economy and throughout its multitude of supply-chain industries. The impacts are most noticeable in durable manufacturing, including construction and mining machinery, machine tools and engines and frac sand, as well as in wholesale trade and professional and financial services.

Illinois' diversified economy has the smallest concentration of manufacturing jobs—10% of Illinois' non-farm employment—among states in the East North Central. In fact, the state boasts the most diverse mix of industries in the region, including machinery manufacturing, which contributes to the unconventional supply chain throughout the country.

Chicago has a strong presence in fabricated metals, printing and publishing, food processing, chemicals, and rubber and plastics. These sectors don't necessarily contribute to the supply chain of the crude oil sector, but they do benefit from increased supply of oil and gas for fuel and feedstock.

Outside the Chicago metro area, Illinois' economic structure is dramatically different, with farming and food processing dominating the southern part of the state, and transportation and distribution centers served by the Mississippi River in the west. However, LaSalle County, which is 80 miles southwest of Chicago, is home to many sand mines, a valuable input into the hydraulic fracturing process. In recent years, companies such as U.S. Silica and Mississippi Sand have expanded operations and increased production to meet increased demand from the oil and gas boom.

With its diverse economic landscape, Illinois is well situated to reap many of the direct and indirect benefits of unconventional oil and gas extraction. The state has already experienced gains in terms of jobs and higher incomes as a result of supplying manufactured goods and services throughout the country—a trend that will continue as unconventional production develops in the state in the near term.

Government revenue

Sustained investment in US crude oil development has helped lift state economies and tax receipts since it began in earnest over the past decade. In response, many states have adjusted their economic development strategies to capitalize on growth opportunities associated with upstream, midstream, and downstream infrastructure. In this analysis of government tax receipts, the federal and state corporate and personal income taxes are combined to reflect the state-level tax impacts in each state. While major oil-producing states such as California and Texas will lead the way, the supply-chain industries in states lacking oil production such as Massachusetts and Maryland will experience even higher rates of growth in government revenues. In the Base Production Case, both Massachusetts and Maryland will see the impact from the move to free trade on total government revenue more than double in four years, 2016-. In the Potential Production Case, the impact from the move to free trade on total government revenue more than triples in that time.

State-level government revenue: US crude oil export supply chain*
($millions, nominal, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 total	2016-30 total
Base Production Case							
California	897	2,914	3,484	2,682	2,275	59,700	71,952
Texas	615	1,556	1,596	1,252	991	21,955	27,965
New York	464	1,286	1,436	1,211	1,072	31,555	37,024
Illinois	559	1,266	1,264	1,024	869	22,428	27,411
Ohio	334	730	680	516	440	10,827	13,527
Florida	264	621	677	594	501	14,332	16,987
Massachusetts	200	588	695	601	517	15,222	17,822
Pennsylvania	237	564	537	427	366	9,431	11,562
Maryland	178	497	563	479	414	12,483	14,614
Arizona	182	482	524	440	373	10,557	12,558
Top-10 total	**3,930**	**10,504**	**11,455**	**9,226**	**7,818**	**208,490**	**251,423**
US crude oil export supply chain total	**7,100**	**18,378**	**19,814**	**16,146**	**13,612**	**353,666**	**428,717**
US crude oil export total	**28,888**	**55,769**	**58,188**	**48,891**	**42,124**	**1,077,224**	**1,311,085**
Supply chain share of crude oil export total	**24.6%**	**33.0%**	**34.1%**	**33.0%**	**32.3%**	**32.8%**	**32.7%**
Potential Production Case							
California	950	3,347	4,668	4,102	3,719	108,895	125,680
Texas	1,090	2,384	2,493	2,143	1,998	55,715	65,822
New York	716	2,012	2,527	2,395	2,209	71,667	81,526
Illinois	792	1,812	2,090	1,842	1,658	46,284	54,478
Florida	415	1,029	1,288	1,223	1,097	32,353	37,404
Massachusetts	315	941	1,234	1,185	1,075	34,278	39,028
Pennsylvania	396	895	956	829	743	19,295	23,114
Ohio	374	848	917	780	698	18,554	22,171
Maryland	281	807	1,027	975	877	28,508	32,476
Virginia	248	693	859	782	684	20,881	24,148
Top-10 total	**5,576**	**14,768**	**18,057**	**16,256**	**14,759**	**436,431**	**505,847**
US crude oil export supply chain total	**10,066**	**25,754**	**31,053**	**28,112**	**25,463**	**747,990**	**868,438**
US crude oil export total	**41,535**	**83,682**	**97,373**	**89,015**	**81,541**	**2,410,900**	**2,804,045**
Supply chain share of crude oil export total	**24.2%**	**30.8%**	**31.9%**	**31.6%**	**31.2%**	**31.0%**	**31.0%**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Economic contribution by core industry groups within states

The crude oil supply chain is a complex and extensive group of industries permeating many sectors of the US economy. As previously stated, the 60 NAICS-based supply chain industries were broadly assigned to the following six core industry groups:

- Industrial equipment and machinery
- Construction and well services
- Information technology
- Logistics
- Materials
- Professional, financial, and other services

Construction and well services

Construction activity within the energy value chain has been one of the brightest areas of growth in the broader US construction market, particularly as the residential and commercial construction sectors have recovered slowly from the lingering effects of the Great Recession. Upstream site preparation and rigging and midstream pipeline development and capacity additions to downstream processing are stimulating robust demand for the skilled labor and materials required to build out the US energy infrastructure. Moreover, the US chemical manufacturing industry, reinvigorated by low-cost feedstocks produced in the unconventional oil and natural gas boom, continues to invest and upgrade manufacturing facilities throughout the United States.

The construction sector is among the first to benefit from new capital spending by oil and gas operators that must put the infrastructure in place before extraction activity can commence. As such, many economic impacts related to construction activity are front-loaded since once the infrastructure is built; future investment is generally limited to maintenance or retrofit.

In oil-producing states, growth in crude oil-related construction spending is limited to the construction required for oil exploration and production. Certain sectors within the construction industry are expected to decline in 2016-30 as they come off of peak development of midstream and downstream infrastructure; this includes the Construction of New Nonresidential Manufacturing Structures sector (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures). However, most upstream construction activities that create demand within the US crude oil supply chain are expected to continue to grow steadily in oil-producing states, as upstream investment continues under a free trade policy. Value added in Construction of Other New Nonresidential Structures (another part of NAICS 23—construction of upstream facilities and structures) is forecast to grow throughout the 2016-30 period in both crude oil production cases.

Value added: US crude oil export supply chain – Support Activities for Oil and Gas Operations Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
California	317	710	754	541	508	324	405
Texas	263	543	562	482	412	235	307
Ohio	110	190	167	137	131	95	113
Oklahoma	82	152	148	123	99	37	65
Kentucky	70	136	126	113	103	68	82
Indiana	62	106	97	81	73	50	61
Kansas	49	97	94	77	64	38	50
Utah	42	88	87	71	64	38	49
Colorado	37	79	80	67	59	46	52
Louisiana	30	77	80	76	72	62	64
Top-10 total	**1,061**	**2,177**	**2,194**	**1,767**	**1,585**	**991**	**1,246**
US total	**1,243**	**2,515**	**2,521**	**2,038**	**1,819**	**1,134**	**1,432**
Potential Production Case							
Texas	410	877	994	919	874	593	667
California	335	758	924	710	705	543	591
Pennsylvania	140	222	204	171	169	116	138
Ohio	125	215	215	187	188	155	165
Kentucky	96	174	169	135	125	81	100
Oklahoma	88	174	193	172	152	72	100
Indiana	86	147	149	123	114	80	95
Kansas	63	118	121	102	92	61	74
Utah	56	113	120	100	93	61	73
Illinois	56	100	107	93	89	80	83
Top-10 total	**1,455**	**2,899**	**3,197**	**2,712**	**2,601**	**1,841**	**2,085**
US total	**1,685.7**	**3,358.2**	**3,688.1**	**3,132.8**	**2,985.3**	**2,109.6**	**2,396.4**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Support Activities for Oil and Gas Operations (NAICS 213112), which include exploration services, excavating, and services related to well surveying, preparation, and clean-up, are expected to grow even more rapidly than construction activities. Support activities in California, Texas, and Ohio are among the largest beneficiaries of the free trade policy in both production cases, an obvious function of the fact these states are home to some of the nation's largest oil producers.

Value added: US crude oil export supply chain – Drilling Oil and Gas Wells Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
California	191	437	471	334	317	204	253
Texas	150	319	332	286	246	139	182
Pennsylvania	71	127	96	70	65	37	53
Ohio	63	109	91	71	69	48	59
Kentucky	45	88	83	76	69	46	55
Oklahoma	46	86	84	70	57	21	37
Illinois	37	67	63	53	49	39	44
Kansas	25	51	48	39	33	19	26
Colorado	22	49	50	41	37	28	32
Utah	22	47	47	38	34	20	26
Top-10 total	**673**	**1,382**	**1,362**	**1,079**	**976**	**602**	**766**
US total	**743**	**1,535**	**1,519**	**1,217**	**1,100**	**684**	**864**
Potential Production Case							
Texas	241	525	592	548	525	349	395
California	207	480	595	453	454	354	382
Pennsylvania	119	181	150	118	117	71	93
Ohio	75	127	120	100	101	79	88
Kentucky	63	116	112	88	81	50	64
Oklahoma	51	102	112	101	89	42	58
Illinois	54	98	105	91	87	76	80
Kansas	34	63	63	51	46	28	36
Utah	31	62	66	55	51	33	40
Colorado	29	62	65	55	52	40	44
Top-10 total	**903**	**1,815**	**1,980**	**1,660**	**1,605**	**1,122**	**1,279**
US total	**992**	**2,002**	**2,179**	**1,833**	**1,762**	**1,226**	**1,402**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Texas shale boom has major economic impact

Upstream oil and gas development in Texas is centered in the state's two largest shale plays: the Permian basin in West Texas and the Eagle Ford shale, spanning from south Texas through the eastern central part of the state. These plays have attracted billions of dollars in investment and are the state's largest economic development stories. Their impacts have also reverberated across many industries and counties in Texas. Employment has surged in the primary and fabricated metals and machinery manufacturing industries clustered within close proximity to the shale plays to meet energy sector demand for steel, fabricated pipes, pumps and turbines. There is also high demand for construction workers, transportation services, and engineers. Houston is a hub for energy services, boasting one of the highest concentrations of engineers in the country. The energy sector's presence is being increasingly felt in the state's other major metro areas too, including San Antonio and Austin, which have proximity to the Eagle Ford.

The state's energy supply chain will continue to experience immense growth in the coming years. NuStar Energy and Plains All American Pipelines have multi-year plans in place to expand their Texas pipeline capacity in the Eagle Ford shale and the Permian Basin, respectively. LyondellBasell will boost production of ethylene at its Corpus Christi plant and invest $400 million to increase its feedstock capacity by the end of 2015.

ExxonMobil Chemical Company is building an ethane cracker at its Baytown complex to provide ethylene feedstock for downstream chemical processing, including high-performance polyethylene lines at its Mont Belvieu plastics plant, which is also being expanded. Together, these projects represent a multibillion dollar investment that will support about 10,000 construction workers and add 350 permanent positions at the Baytown complex. It will also add long-term economic value to the region, with estimates of a roughly $870 million annual impact.[25]

Continued development in the energy sector will create new jobs, support strong wage growth, and create enormous wealth for the state. These impacts will be widely felt across the state and be a driving force behind Texas' enduring growth.

In Midwestern states such as Kentucky, Ohio, and Indiana—all with proximity to the New Albany and Utica Shale plays—the Construction of Other New Nonresidential Structures (part of NAICS 23) sector is estimated to benefit from the free trade policy in both production cases. Together, the top 10 states benefitting from this non-residential construction sector will contribute just over $1.0 billion each year on average to national GDP under the Base Production Case and more than $1.6 billion under the Potential Production Case between 2016 and 2030.

25 http://news.exxonmobil.com/press-release/exxonmobil-chemical-company-begins-multi-billion-dollar-expansion-project-baytown-texa

Value added: US crude oil export supply chain – Construction of Other New Nonresidential Structures Sector* ($millions, real 2009, difference free trade vs. restricted trade)							
Top-10 states	**2016**	**2017**	**2018**	**2019**	**2020**	**2021-30 average**	**2016-30 average**
Base Production Case							
California	274	628	672	472	451	282	354
Texas	202	428	443	379	329	182	240
Kentucky	67	133	123	112	103	67	80
Ohio	73	126	106	84	82	56	69
Indiana	70	121	112	94	85	57	70
Oklahoma	59	112	108	90	73	26	47
Pennsylvania	57	102	78	59	55	31	44
Kansas	41	84	79	64	54	30	41
Utah	38	82	80	65	59	34	44
Illinois	44	80	75	63	57	45	51
Top-10 total	**926**	**1,897**	**1,877**	**1,482**	**1,347**	**810**	**1,042**
US total	**1,033**	**2,138**	**2,123**	**1,694**	**1,538**	**938**	**1,194**
Potential Production Case							
Texas	307	664	749	688	660	426	489
California	282	649	802	604	607	457	501
Kentucky	89	163	157	122	113	67	88
Indiana	95	163	166	136	127	86	103
Ohio	83	142	135	114	117	90	99
Pennsylvania	92	140	118	95	95	57	74
Oklahoma	62	124	137	122	108	49	69
Illinois	61	109	116	100	96	81	86
Utah	50	102	107	88	82	51	63
Kansas	52	98	97	78	71	42	55
Top-10 total	**1,173**	**2,354**	**2,583**	**2,148**	**2,075**	**1,407**	**1,627**
US total	**1,300**	**2,628**	**2,874**	**2,398**	**2,304**	**1,560**	**1,807**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Industrial equipment and machinery

The US crude oil export supply chain for industrial equipment and machinery generates economic activity and value across all oil-producing states, and the ripple effects extend to many other industries in oil-producing and non-oil producing states. Industrial equipment and machinery companies require sophisticated and specialized tools and automated process control systems, as well as high-performance machinery capable of withstanding harsh environments. The supplier sector experiencing the most growth in the industrial equipment and machinery core group will be Construction, Mining and Agriculture Machinery Manufacturing (NAICS 3331).

Steady increases in their business due to growth in the oil and gas sector have prompted equipment manufacturers to dedicate more resources to growing their market share within the upstream production sector, awakening a market that had been in a 40-year decline. The growth in capital spending in the energy value chain also partly explains why some domestic equipment manufacturers to repatriate manufacturing back to the United States from lower-cost countries. Moreover, non-US producers of capital goods cite the booming US energy market as a reason to expand their operations in the United States.

Firms throughout the Midwest states support equipment manufacturing largely through an integrated network of suppliers clustered around capital goods activity. Ohio, Indiana, Wisconsin and Michigan, where manufacturing employment represents 15% to 20% of total state employment, are centers for making the raw materials (steel), components (gearing, electronics) and finished goods (compressors, earth-moving equipment) deployed at oil production sites. While the nameplate original equipment manufacturer is the most visible supplier to any well site, hundreds of suppliers that contributed to the finished piece of equipment are invisible beneficiaries of the energy value chain.

Within the industrial equipment and machinery core group, the Construction, Mining and Agriculture Machinery Manufacturing sector makes the largest single sector contribution to the growth in state value added under the free trade of crude oil. The top 10 states in this sector –five of them in the Midwest— are expected to contribute an additional $1.2 billion per year to GDP between 2016 and 2030 under a free trade policy in the Base Production Case. Due to the high concentration of off-highway machinery production in the Midwest, the 10 states together account for over 99% of the total GDP growth resulting from free trade. Similarly in the Potential Production Case, this sector in these 10 states is expected to contribute an additional $2.5 billion per year to GDP from 2016-30. Illinois, Missouri, Texas, and Wisconsin are expected to be the biggest beneficiaries of free trade in both production cases.

Value added: US crude oil export supply chain – Construction, Mining, and Agriculture Machinery Manufacturing Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
Illinois	464	839	791	673	611	470	539
Texas	125	268	274	230	204	133	162
Missouri	140	252	243	199	177	75	117
Wisconsin	105	199	195	179	165	100	122
Minnesota	99	169	150	124	109	74	93
Pennsylvania	92	144	99	69	58	27	48
Washington	68	125	124	109	101	91	96
Oklahoma	30	57	55	45	36	13	24
Virginia	18	37	39	36	33	20	24
Indiana	4	8	8	7	7	5	6
Top-10 total	**1,146**	**2,098**	**1,980**	**1,670**	**1,500**	**1,007**	**1,231**
US total	**1,158**	**2,120**	**2,002**	**1,686**	**1,515**	**1,015**	**1,242**
Potential Production Case							
Illinois	689	1,242	1,348	1,180	1,122	944	1,001
Wisconsin	249	443	500	487	491	356	382
Texas	190	415	458	421	411	311	334
Missouri	219	395	415	366	345	183	238
Washington	111	208	228	217	212	218	210
Minnesota	129	205	229	188	174	121	143
Pennsylvania	128	179	145	110	103	54	80
Oklahoma	36	74	81	70	62	28	41
Virginia	26	53	63	61	60	45	48
Indiana	7	12	13	11	11	8	9
Top-10 total	**1,784**	**3,227**	**3,480**	**3,110**	**2,992**	**2,269**	**2,485**
US total	**1,797**	**3,253**	**3,508**	**3,133**	**3,014**	**2,283**	**2,502**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

The second largest supply chain sector in the industrial equipment core group is Cutting and Machine Tool Manufacturing (NAICS 333515). An indispensable part of the supply chain, these companies transform essential metals and materials into the machinery and equipment used in the energy value chain. Under the Base Production Case, the top 10 states in the machine tool sector will add $1.4 billion more output annually in under free trade than under the current restricted trade between 2016 and 2030. Under the Potential Production Case, the top 10 states will add $2.6 billion in annual output over the same period. The top 10 states for Cutting and Machine Tool Manufacturing that will benefit are primarily located in the Midwest, with Michigan ranked first.

Value added: US crude oil export supply chain – Cutting and Machine Tool Manufacturing Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
Michigan	359	614	576	488	439	310	371
New York	201	410	446	448	458	522	478
Illinois	224	400	364	296	265	189	229
Colorado	87	190	197	176	155	114	130
Missouri	86	144	137	120	105	44	69
Wisconsin	57	95	82	69	60	31	45
New Jersey	39	76	81	77	74	53	59
Ohio	46	70	51	35	32	19	28
Indiana	18	31	28	24	22	16	19
Iowa	15	24	21	18	17	18	18
Top-10 total	**1,132**	**2,053**	**1,984**	**1,750**	**1,626**	**1,315**	**1,446**
US total	**1,143**	**2,075**	**2,006**	**1,770**	**1,643**	**1,325**	**1,459**
Potential Production Case							
Michigan	508	893	946	838	799	620	679
New York	329	669	801	832	877	1,071	948
Illinois	304	532	560	466	433	334	376
Colorado	112	240	264	241	226	170	186
Missouri	126	216	243	219	209	107	139
Wisconsin	70	105	120	98	91	51	66
New Jersey	49	95	113	112	112	92	94
Ohio	49	75	63	47	44	30	39
Indiana	24	40	41	35	32	23	27
Iowa	19	29	30	26	25	26	26
Top-10 total	**1,589**	**2,894**	**3,180**	**2,914**	**2,851**	**2,525**	**2,578**
US total	**1,603**	**2,919**	**3,207**	**2,936**	**2,871**	**2,538**	**2,594**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Colorado is branching out from its energy base

Colorado is well-situated to serve as a supplier for the crude oil sector. The northeastern corner of the state sits atop much of the Niobrara Shale basin. Colorado already had a rich history in mineral and petroleum extraction industries, which have thrived in recent years due to the rise in global energy prices. The state has also been very successful at branching out from its energy roots, and today it has one of the most diverse state economies in the country. Especially notable are the service industries in the Denver area that provide substantial support for Colorado's oil and gas boom. Given its history, Colorado has proved capable of ramping up production of oil and natural gas and getting product to end-users.

The majority of activity at the Niobrara Shale basin resides in Weld County. The Niobrara Shale basin area is expected to produce a large amount of oil and economic activity. Production and development started in 2007, and the economy of Weld County is showing tremendous growth. The labor market in Weld County is tightening, with unemployment reaching record lows and labor shortages being reported for non-energy jobs. Drilling, construction, materials and transportation jobs are all in high demand and are pushing up wages in the region. Companies from other regions are not only moving in to drill but also to support the supply chain. Halliburton, for example, has expanded its Colorado operations and hired 500 employees for a sand terminal to serve energy production demand, while A&W Water Service Inc., a Colorado company serving the oil and gas industry, has also shown significant growth from the drilling boom in the state.

The following is an excerpt from an article on Colorado Public Radio's website:[26]

> A&W Water Service in Fort Lupton, Colo., transports a lot of water through the oil fields -- more than 23,000 gallons a minute, around the clock. The company, a subsidiary of publicly traded Superior Energy Services, is the largest water transport business in the state.
>
> Gary Wright, president of A&W Water, says his family started the company in 1954. Business has ebbed and flowed over the years, he says, but today the company is at an all-time high. Wright says it has tripled in size over the last three years; today it employs 593 people—and is still hiring.
>
> Wright says the company's growth is good for the economy. In the last five years, A&W has spent $50 million on equipment alone. "So that creates jobs for manufacturing, the diesel fuel people that supply our fuel to us, the restaurants that the people go to and eat. Simple as something as work boots," Wright says.

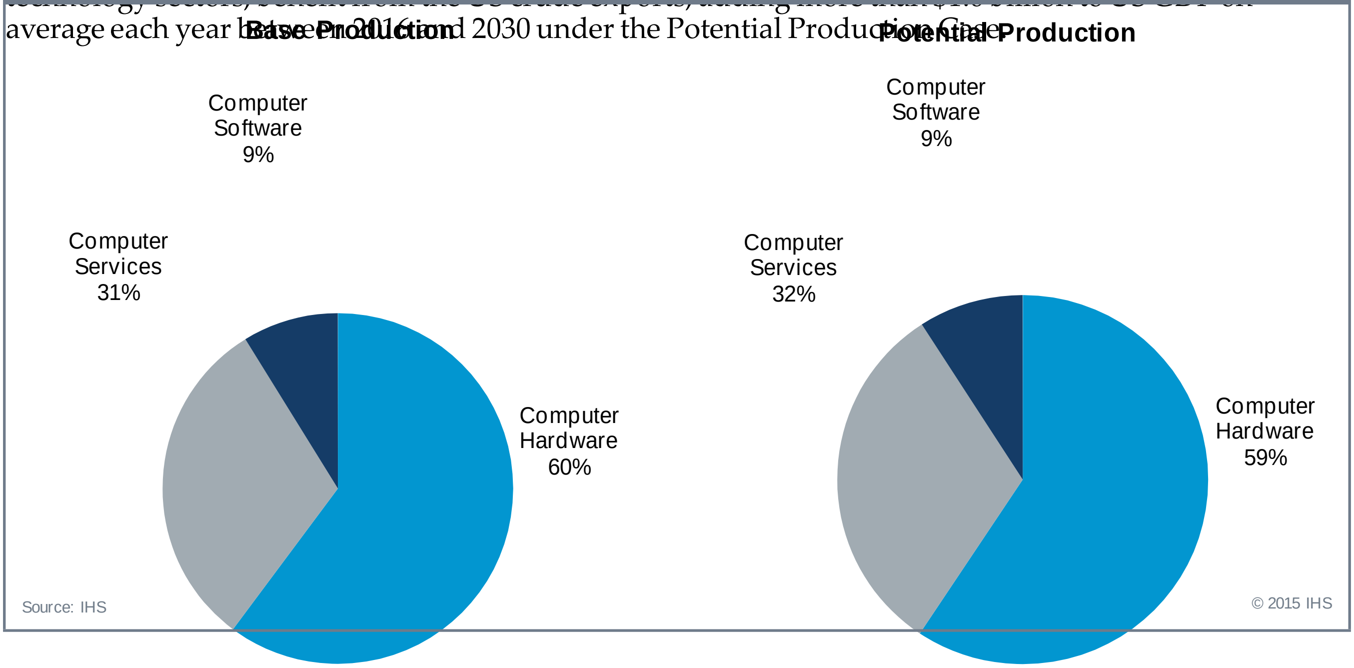
Denver—situated in the neighboring county—is also a linchpin in Colorado's oil and gas boom. The state has over 50,000 active wells, and the Denver metropolitan area employs a significant portion of all oil and gas jobs in the state due to its proximity to the drilling activity and its status as a regional business hub. Many of the jobs are in managerial, administrative, engineering, financial, and insurance companies that plan, develop and support field operations in oil and gas producing areas such as Weld County. Some of the nation's highest-earning oil and gas companies are headquartered in Denver, including DCP Midstream, QEP Resources, Whiting Petroleum, Cimarex Energy, SM Energy and MarkWest Energy. As new workers move into downtown Denver, higher occupancy rates and rising rents for commercial and residential properties are attracting investors. New commercial developments are being built outside of the city to help service rising demand. In addition, conference and meeting activity for these firms is a boon to the city's hospitality industry, with hotel and accommodation services adding new jobs as their vacancy rates shrink.

26 http://www.cpr.org/news/story/drilling-oil-and-gas-drives-colo-trucking-boom

Information technology

The information technology (IT) category includes three supply chain sectors: Computer Hardware (NAICS 3341), Computer Software (NAICS 5112), and Computer Services (NAICS 5415). Computer Hardware includes servers, personal computers and laptops, is the IT sector that will benefit most from the free trade policy under both production cases. In the Base Production Case, for example, computer [illegible] average each year between 2016 and 2030 under the Potential Production Case.

Information technology core group: Value added share by sector
(2016–30 average, difference free trade vs. restricted trade)



 Source: IHS

Value added: US crude oil export supply chain – Computer Hardware Sector* ($millions, real 2009, difference free trade vs. restricted trade)							
Top-10 states	**2016**	**2017**	**2018**	**2019**	**2020**	**2021-30 average**	**2016-30 average**
Base Production Case							
Washington	325	619	625	544	522	419	455
Massachusetts	230	447	465	417	390	262	305
California	84	200	231	180	178	109	131
Texas	39	85	90	79	72	42	52
New York	43	77	70	56	53	48	52
Illinois	33	63	64	58	55	41	45
Oregon	19	36	37	33	31	30	31
Florida	11	22	22	21	20	13	15
Colorado	9	20	22	20	19	14	16
Pennsylvania	10	17	13	10	9	5	7
Top-10 total	**801**	**1,586**	**1,638**	**1,418**	**1,351**	**983**	**1,108**
US total	**830**	**1,637**	**1,688**	**1,460**	**1,391**	**1,009**	**1,140**
Potential Production Case							
Washington	478	912	1,023	969	972	883	879
Massachusetts	346	676	782	739	730	574	601
California	93	223	301	250	261	191	202
Texas	54	119	138	129	128	85	95
New York	58	105	109	92	91	88	89
Illinois	49	95	108	103	104	86	88
Oregon	28	53	61	57	56	62	59
Florida	16	33	39	39	39	30	31
Colorado	11	25	29	27	28	22	23
Pennsylvania	12	19	16	13	14	8	10
Top-10 total	**1,146**	**2,261**	**2,604**	**2,419**	**2,424**	**2,031**	**2,077**
US total	**1,177**	**2,317**	**2,665**	**2,473**	**2,476**	**2,068**	**2,119**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Logistics

The logistics core group has four supply chain sectors: General Freight Trucking (NAICS 4841), Pipeline Transportation (NAICS 486), Rail Transportation (NAICS 4821), and Water Transportation (NAICS 481). States with oil production account for more than 80% of the total increase in economic benefits to GDP from logistics under a free trade policy. However, states without oil production are more dynamic—their value added contribution from logistics increased at a higher annual rate than the states with oil production.

Within logistics, the largest beneficiaries in every state of a change in US crude oil export policy will be companies involved in General Freight Trucking. This sector will continue to experience steady growth throughout the 2016-30 period. Major oil-producing states, especially Texas and California, will continue to drive this sector. But other states with General Freight Trucking sectors that will benefit from the free trade policy include North Carolina, Ohio, Illinois, and Pennsylvania. Nationwide, trucking's supply chain will bring over $500 million more, on average, each year to US GDP under the Base Production Case and almost $1 billion more under the Potential Production Case throughout the forecast period if the export ban is lifted.

Value added: US crude oil export supply chain – General Freight Trucking Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
California	49	112	123	92	87	57	69
Texas	43	89	93	81	71	42	53
North Carolina	31	55	55	49	45	25	32
Ohio	32	53	45	36	34	24	30
Illinois	25	45	43	37	34	27	30
Pennsylvania	26	44	35	27	25	15	20
Michigan	17	28	26	22	20	14	17
Oregon	12	23	23	21	19	19	19
Virginia	12	22	22	19	17	10	13
Indiana	13	22	21	18	16	11	14
Top-10 total	**258**	**493**	**488**	**402**	**370**	**244**	**297**
US total	**434**	**829**	**824**	**697**	**637**	**427**	**512**
Potential Production Case							
Texas	67	146	167	156	150	108	118
California	56	130	165	132	131	104	110
North Carolina	45	83	93	87	85	60	66
Illinois	37	67	74	66	64	55	57
Ohio	36	61	60	50	50	40	44
Pennsylvania	35	55	49	40	39	26	32
Michigan	23	41	43	38	36	28	31
Virginia	18	34	38	35	33	24	27
Oregon	17	33	38	35	34	36	35
Indiana	19	33	34	29	28	20	23
Top-10 total	**354**	**683**	**761**	**668**	**650**	**502**	**542**
US total	**604**	**1,153**	**1,282**	**1,140**	**1,104**	**856**	**923**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Materials

The materials core group includes manufacturers and suppliers of various raw material products such as iron and steel, non-ferrous metals, sand, gravel, cement, industrial gas, chemicals, and fabricated metals. Materials production output in the crude oil supply chain is expected to grow steadily throughout the 2016-30 period, with larger growth rates occurring in non-oil-producing states but with higher levels of value added contributions in the oil-producing states. Within materials, the largest value added contribution to GDP growth will come from the Construction Sand and Gravel Mining (NAICS 212321) sector. Other top-ranked sectors include Industrial Gas Manufacturing (NAICS 325120), used both in construction and in manufactured capital goods, and Cement Manufacturing (NAICS 327310).

The Construction Sand and Gravel Mining sector benefits both producing and non-producing states—but Minnesota, Illinois, and Wisconsin are the largest beneficiaries of a change in crude oil export policy. The top 10 state to benefit in this sector comprise about 97% of the total supply chain impact, adding more than $1.3 billion on average each year to US GDP under the Base Production Case in 2016-30 and adding more than $2.0 billion under the Potential Production Case.

Value added: US crude oil export supply chain – Construction Sand and Gravel Mining Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
Minnesota	250	471	473	448	425	368	383
Illinois	218	401	398	361	323	222	261
Wisconsin	181	316	293	262	231	125	169
Texas	102	219	228	196	173	110	135
Iowa	132	214	196	174	167	174	175
Tennessee	64	137	106	125	130	72	86
Arkansas	45	91	96	91	77	36	51
Missouri	37	63	61	53	47	21	32
Ohio	39	60	44	30	27	17	25
California	14	32	35	25	24	16	19
Top-10 total	**1,083**	**2,005**	**1,928**	**1,764**	**1,624**	**1,161**	**1,334**
US total	**1,119**	**2,071**	**1,989**	**1,817**	**1,672**	**1,195**	**1,375**
Potential Production Case							
Minnesota	336	602	710	694	701	657	641
Illinois	276	511	582	538	509	384	417
Wisconsin	231	381	442	408	395	256	295
Texas	122	267	301	280	273	198	215
Iowa	142	232	254	229	228	246	237
Tennessee	148	185	161	170	192	109	130
Arkansas	48	86	85	69	60	25	40
Missouri	43	76	86	78	76	42	52
Ohio	34	53	44	32	31	22	28
Indiana	18	31	32	28	27	20	23
Top-10 total	**1,398**	**2,425**	**2,698**	**2,527**	**2,492**	**1,959**	**2,076**
US total	**1,432**	**2,491**	**2,771**	**2,586**	**2,550**	**2,002**	**2,123**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Demand for cement, which is an input to concrete, is expected to experience solid growth under a change in crude oil export policy. Concrete is a critical material used at oil and gas well production sites, particularly for encasing wells. It is also essential to the construction of loading terminals, storage facilities, and pipelines. Cement Manufacturing (NAICS 327310) in Maryland is the largest beneficiary of the free trade policy under both production cases, adding over $500 million annually to US GDP in the Base Production Case and almost $1 billion in the Potential Production Case.

Value added: US crude oil export supply chain – Cement Manufacturing Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
Maryland	457	842	827	714	649	404	502
Idaho	92	195	208	185	161	60	96
California	10	23	25	17	16	11	13
Oregon	9	16	17	15	14	14	14
Alabama	6	15	15	16	18	11	12
Washington	8	15	14	12	12	11	11
Texas	7	15	15	13	11	6	8
South Dakota	5	11	10	12	11	14	12
New York	4	8	9	8	8	10	9
Illinois	4	7	7	5	5	4	4
Top-10 total	**603**	**1,148**	**1,146**	**998**	**905**	**545**	**683**
US total	**624**	**1,188**	**1,182**	**1,030**	**936**	**579**	**716**
Potential Production Case							
Maryland	699	1,288	1,409	1,287	1,236	896	992
Idaho	145	297	346	328	305	154	197
California	11	25	30	23	23	18	20
Washington	13	24	26	24	24	25	24
Oregon	12	23	26	24	24	26	25
Texas	11	23	25	23	22	15	17
South Dakota	14	22	45	88	139	128	106
Alabama	9	22	25	31	35	29	28
New York	8	16	18	18	18	22	20
Illinois	6	10	10	9	8	7	7
Top-10 total	**926**	**1,748**	**1,960**	**1,853**	**1,835**	**1,320**	**1,435**
US total	**954**	**1,798**	**2,010**	**1,897**	**1,884**	**1,381**	**1,490**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Professional, financial, and other services

Professional, financial, and other services are typically associated with operational expenditures, but these services represent a wide range of functions including environmental engineering, occupational health and safety, and financial, insurance, and real estate services.

Professional, financial, and other services identified as part of the US crude oil export supply chain are expected to expand through 2030, especially in Finance (NAICS 52_ex_54) and Architectural, Engineering, and Related Services (NAICS 5413)—another indication of the significance of construction activity within the US crude oil export supply chain. Architectural, Engineering, and Related Services is the largest sector in the professional, financial, and other services core group of the US crude oil export supply chain. Under the Base Production Case, this sector in California, Georgia, and Texas alone will add about $480 million to US GDP, on average, each year in 2016-30, following a move from restricted to free trade. Under the Potential Production Case, the crude oil export policy will bring $910 million on average each year in Georgia, Arizona, and California.

Value added: US crude oil export supply chain – Architectural, Engineering, and Related Services Sector* ($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
California	141	320	332	232	214	135	173
Georgia	164	304	295	285	257	134	176
Texas	114	210	215	195	182	107	132
Ohio	81	138	129	111	105	79	90
Pennsylvania	79	136	122	106	98	64	79
Illinois	66	114	112	90	84	66	75
Tennessee	64	105	115	85	67	20	42
New York	48	78	81	80	72	64	67
Virginia	35	61	65	63	53	26	36
Florida	39	60	59	50	42	25	33
Top-10 total	**830**	**1,527**	**1,525**	**1,296**	**1,172**	**720**	**904**
US total	**1,217**	**2,242**	**2,246**	**1,903**	**1,719**	**1,066**	**1,333**
Potential Production Case							
Georgia	229	425	453	447	433	287	324
Arizona	182	356	410	388	368	329	333
California	155	337	426	328	296	225	253
Texas	153	329	372	325	300	262	273
Tennessee	100	192	202	193	174	73	106
Illinois	89	169	171	150	141	131	136
Pennsylvania	94	156	157	138	135	101	113
Ohio	87	153	164	148	146	127	131
New York	71	116	135	138	127	120	119
Florida	56	90	96	82	75	53	62
Top-10 total	**1,217**	**2,323**	**2,586**	**2,336**	**2,195**	**1,708**	**1,849**
US total	**1,746**	**3,350**	**3,641**	**3,256**	**3,018**	**2,339**	**2,560**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Finance (NAICS 52_ex_524) is the second-largest sector within professional services. The financial sectors in California, Texas, and New York are expected to benefit most from a new crude oil export policy. Together, the top 10 states ranked in terms of their financial sector contributions will add more than $770 million each year to US GDP between 2016 and 2030 under the Base Production Case and more than $1.4 billion under the Potential Production Case.

Value added: US crude oil export supply chain – Finance Sector*
($millions, real 2009, difference free trade vs. restricted trade)

Top-10 states	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Base Production Case							
California	108	237	257	200	186	120	146
Texas	84	163	171	149	128	79	99
New York	85	150	146	128	123	125	126
North Carolina	75	134	134	119	111	61	79
Ohio	72	122	113	97	91	69	79
Illinois	63	111	107	93	86	69	77
Pennsylvania	53	91	82	69	64	42	52
Florida	52	90	90	78	71	43	54
Georgia	29	52	56	44	39	24	31
Connecticut	23	43	42	37	34	29	31
Top-10 total	**644**	**1,193**	**1,198**	**1,014**	**933**	**663**	**774**
US total	**984**	**1,819**	**1,821**	**1,561**	**1,426**	**995**	**1,171**
Potential Production Case							
California	123	273	339	282	277	219	232
Texas	126	265	309	289	274	209	224
New York	129	229	249	227	226	248	236
North Carolina	111	203	227	211	207	146	161
Illinois	91	164	183	167	161	148	149
Ohio	78	136	145	130	128	111	115
Florida	76	136	150	137	132	97	107
Pennsylvania	62	104	105	92	90	68	75
Georgia	45	85	101	88	83	65	70
Connecticut	35	64	71	65	64	61	61
Top-10 total	**877**	**1,658**	**1,878**	**1,689**	**1,642**	**1,372**	**1,431**
US total	**1,356**	**2,541**	**2,862**	**2,595**	**2,515**	**2,061**	**2,165**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

Congressional district supply chain

Key insights

- The impact of a free trade policy will be distributed across suppliers in congressional districts with crude oil activity as well as adjacent districts with supporting supply chain sectors. The average annual value-added impact over 2016-30 in 25 congressional districts—or 6% of all congressional districts—ranges from $150 million to $540 million. While about one in three districts have average impacts ranging from $50 million to $150 million, the remaining districts' impacts are less than $50 million.
- Future investment and future expected production, along with mature crude oil supply chain sectors, make Texas' and California's congressional districts the leaders in total impact. However, impacts will be felt in clusters of congressional districts in Illinois, Florida, New York, and other states mainly due to presence of diversified manufacturing and services. In Massachusetts, the impact will be felt in its information technology and professional and financial services.

Introduction

This section presents examples of the supply chain impact of removing crude oil export restrictions under the Base and Potential Production cases on a congressional district level. A primary reason to assess the congressional district-level impact is to examine and quantify the geographic effects that can occur as the oil market and supply chain activity respond to the policy change.

The impact of moving from restricted trade to free trade is expected to be distributed across suppliers in multiple districts within and among states, regardless of whether crude oil resources are actually being extracted in any of these districts. IHS first identified and estimated the investment in all of the congressional districts that are either active or are expected to participate in producing legacy or new crude oil under the Base or Potential Production Cases. The reach of the industry's supply chain was then traced and quantified through other congressional districts that were impacted.

As with the national and state assessment, this section presents the economic contributions of the crude oil supplier industries as a result of a repeal of the US crude oil export ban. The impacts are summarized in this section for both the Base Production Case and Potential Production Case in terms of the benefits of free trade, compared with continuing under the current restricted trade. The following table shows only those congressional districts with crude oil production that can expect capital investments in the energy value chain under both Base and Potential Production cases.

Congressional districts by state with crude oil value chain activity

	Production	Upstream	Midstream Base	Midstream Potential	Downstream Base	Downstream Potential
Alabama	1, 2, 4, 7		1, 7			
Alaska	0	0				
Arizona	0			1, 3, 4		
Arkansas	4	1, 2, 4	1, 4	1		
California	3, 5, 6, 7, 8, 9, 13, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 31, 35, 38, 39, 45, 47, 48	13, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 3, 31, 35, 38, 39, 45, 47, 48, 5, 6, 7, 8, 9	21, 23, 44, 5, 51,	36, 42, 44, 45, 48, 5, 51		
Colorado	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	2, 4	4		
Delaware			0			
Florida	1, 17, 19, 20, 25		1			
Georgia			11			
Illinois	12, 13, 15, 18	12, 13, 15, 18	11, 12, 14, 15, 16, 17, 18, 3	11, 12, 14, 15, 16, 17, 18, 3		
Indiana	8	8	1, 2,	1, 2,		
Kansas	1, 2, 3, 4	1, 2, 3, 4	1, 3, 4	1, 3, 4		
Kentucky	1, 2,	1, 2	1	1		
Louisiana	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6		1, 2, 3, 4, 6
Michigan	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,	1, 10, 11, 12, 13, 14, 2, 3, 4, 5, 6, 7, 8, 9	10, 12, 3, 6, 7, 8	10, 3, 6, 7, 87, 8		
Minnesota			7, 83, 4, 5, 6, 8			
Mississippi	1, 2, 3, 4	3	2, 3	1, 2,		
Missouri				3, 4, 5, 6, 8		
Montana	0	0	0	0		
Nebraska	3		1, 3	1, 3		
Nevada	2, 4,					
New Jersey			1, 10, 6			
New Mexico	1, 2, 3	1, 2, 3	2	2		
New York	23, 27		20, 26			
North Dakota	0	0	0	0		
Ohio	2, 4, 5, 6, 7, 9, 11, 12, 13, 14, 15, 16	13, 15, 16, 6, 7	10, 13, 6			
Oklahoma	1, 2, 3, 4, 5,	1, 2, 3, 4, 5	1, 2, 3, 4, 5,	1, 2, 3, 4, 5,		
Pennsylvania	3, 5, 9, 10, 11, 12, 14, 18	12, 14, 18, 3, 5, 9	1, 12, 5	1		
South Dakota	0		0	0		
Tennessee	7, 8,		8	8		
Texas	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 34, 35, 36	1, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 34, 35, 36, 4, 5, 6, 8, 9	1, 10, 11, 12, 13, 14, 15, 17, 18, 19, 2, 21, 22, 23, 25, 27, 28, 29, 30, 31, 33, 34, 35, 36, 4, 5, 6, 7, 8, 9	1, 10, 11, 12, 13, 14, 15, 17, 18, 19, 2, 21, 22, 23, 25, 27, 28, 29, 30, 31, 34, 35, 36, 4, 5, 6, 7, 8, 9	13, 14, 16, 27, 29, 35, 36	1, 10, 11, 13, 14, 15, 16, 19, 23, 25, 27, 28, 29, 34, 35, 36
Utah	1, 2, 3, 4	1, 2, 3, 4	1, 2, 31	1, 2		
Virginia						
Washington			1, 2, 3, 6	2		
West Virginia	1, 2, 3, 7	1, 2, 3				
Wisconsin			2, 3, 7	2, 3, 7		
Wyoming	0	0	0	0		

Source: IHS Energy

Methodology

State-level results were linked to congressional districts using two internal IHS sources. First, the IHS Energy team provided assumptions at the district-level for drilling, production, and other exploration activities. Second, the IHS Economics team provided detailed sector-level economic activity, by congressional district, found in the proprietary IHS Business Market Insights dataset. As described below, types of impacts from the supply chain model—direct, indirect, and induced economic impacts—were linked and integrated from states to congressional districts separately.

Direct impacts at the congressional district level are a function of both the economic activity's location, as provided by IHS Energy, and the baseline economic activity in IHS Business Market Insights data. This process assigns the share of the impact to the district where the direct activity occurred, while crediting the residual shares to other districts within the state as a function of the location of the baseline activity. This logic allows for intrastate sourcing of direct activity but assumes a higher probability that supply chain activity (if available) will occur at the location of the direct activity.

Indirect and induced impacts are distributed to congressional districts as a function of baseline economic activity for each congressional district from IHS Business Market Insights. This logic allows for intrastate sourcing of indirect and induced activity based on the statewide distribution of supplier industries and income induced.

Finally, once all direct, indirect, and induced economic impacts were distributed to congressional districts, a final validation process was applied to ensure that economic activity in a given sector is not assigned to a district where that sector does not exist in the baseline. This logic was implemented to ensure that constraints in the location of skilled labor and capital were enforced.

Economic contribution results

The findings of the IHS study indicate that the impact on congressional districts' supply chains of removing the crude oil export ban will be similar to the national and state impacts. Congressional district impacts will be strong during the initial five years of the forecast period as investment and production ramps up, followed by a slower and flatter impact toward the end of the forecast horizon. Although growth moderates after the initial five years, the supply chain industries will continue to generate modest positive economic and employment impacts for all relevant congressional districts.

We present a summary of the supply chain economic impacts on congressional districts for two key dimensions: employment and value added contributions to GDP. The results are presented for states with the most impacted districts and for the top-ranked districts in each of the most heavily impacted states.

Employment

Removing the US crude oil export ban not only impacts the supply chain industries in congressional districts with crude oil activity through investment and production. It also affects adjacent districts that support this crude oil activity, including the related supply chain. Congressional districts with high levels of crude oil activity and concentrations of diversified supplier industries will benefit substantially. Examples include California's 23rd congressional district north of Los Angeles (which includes Kern County), Texas' 11th district around Midland, Texas' 18th district around Houston, and Oklahoma's 3rd district in the western part of the state—all of which will experience increases in employment of more than 800 workers per year during the 2016-30 period.

States with fewer congressional districts have a tendency to funnel the economic impact on one or two districts with a relatively large presence in the diversified supply chain industries. For example, much of the benefits flowing to Nevada (which has four districts) and Oregon (which has five districts) are expected to primarily impact Nevada's 2nd district and Oregon's 3rd district where the supply chain sectors dominate.

Employment by congressional district: US crude oil export supply chain – Base Production*
(number of workers, difference free trade vs. restricted trade)

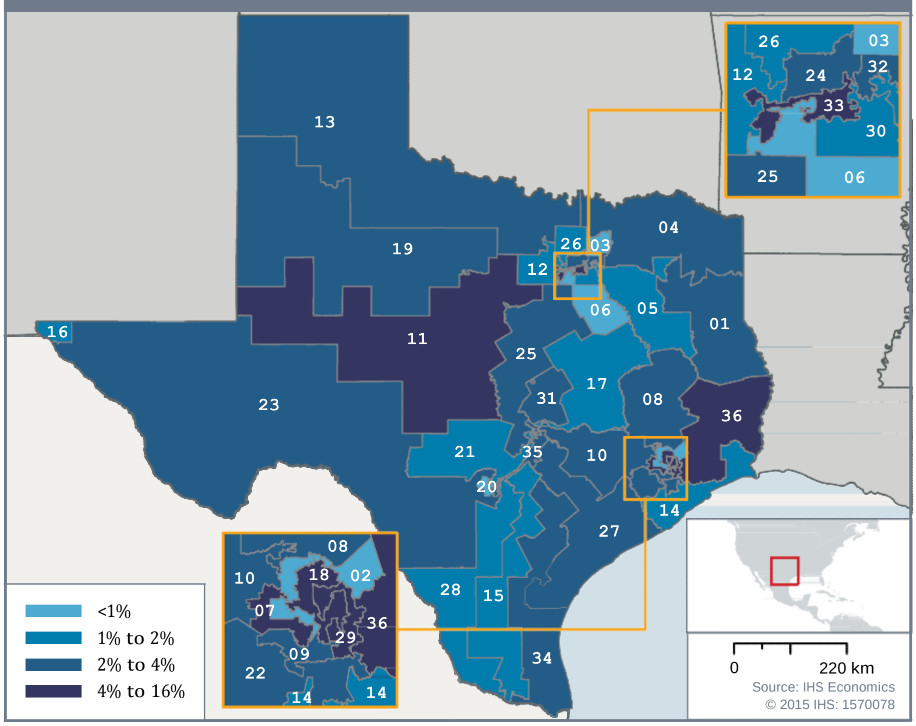
State	Congressional district	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
California	23	1,803	5,182	6,527	5,311	4,430	1,658	2,655
Illinois	8	1,322	2,746	2,959	2,595	2,106	690	1,242
Nevada	2	720	2,468	3,490	3,435	2,991	1,026	1,558
Oklahoma	3	1,006	2,283	2,589	2,250	1,774	489	986
New York	25	840	2,105	2,547	2,356	1,980	748	1,154
Texas	18	765	2,038	2,476	2,197	1,826	585	1,010
Illinois	16	980	2,015	2,170	1,906	1,504	476	889
Texas	11	661	1,782	2,170	1,941	1,594	507	881
Illinois	15	873	1,778	1,862	1,572	1,265	432	778
Oregon	3	740	1,767	2,121	1,934	1,567	511	882
Illinois	13	857	1,765	1,838	1,540	1,239	423	764
Oklahoma	5	784	1,749	1,967	1,702	1,338	365	746
Utah	1	715	1,744	2,043	1,756	1,422	460	819
North Carolina	12	773	1,653	1,934	1,769	1,488	496	839
Minnesota	7	680	1,593	1,904	1,828	1,515	570	881
US Total		**105,748**	**250,201**	**293,140**	**258,227**	**212,508**	**73,384**	**123,577**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics

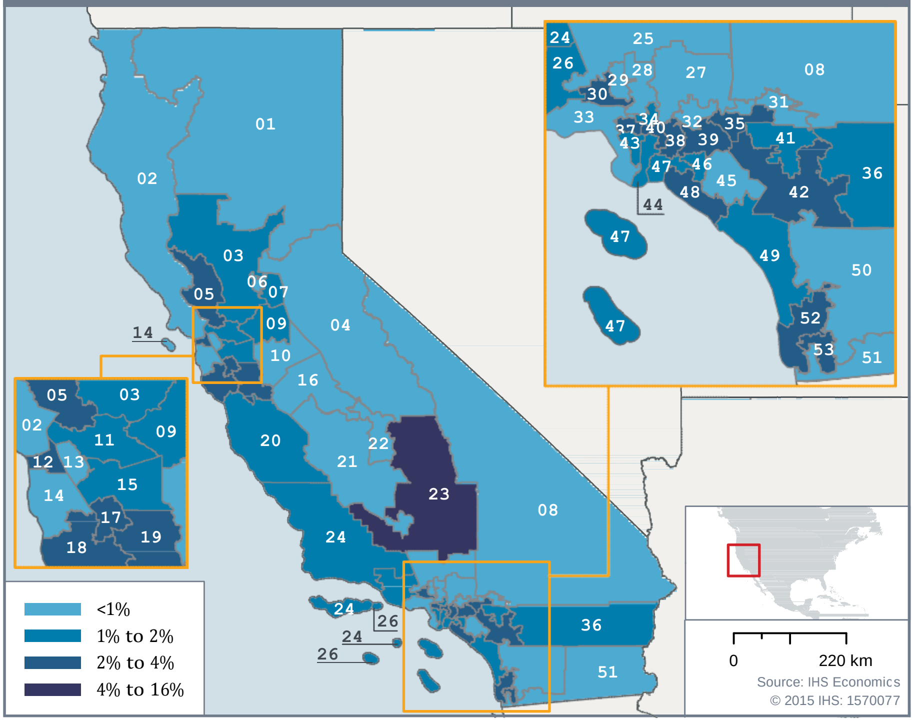
Some congressional districts will show only minimal effects of moving from restricted trade to free trade since there is no nearby direct activity. This tendency can be seen even in some districts in the two major oil-producing states of Texas and California.

Texas employment distribution by congressional district – Base Production
(2017 percent, difference free trade vs. restricted trade)



Another way to rank congressional districts is to examine the top four or five congressional districts in each of the 15 selected states for their job contribution. The tables below demonstrate the employment benefits to each of these district's supply chains under a free trade crude oil export policy. The largest impacts will be felt by companies operating in congressional districts in California, Texas, and Illinois. However, clusters of districts in Florida, New York, and Massachusetts will also experience noticeable effects.

California employment distribution by congressional district – Base Production (2017 percent, difference free trade vs. restricted trade)



Employment for top-5 congressional districts: US crude oil export supply chain -- Base Production* (number of workers, difference free trade vs. restricted trade)

State	Congressional district	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
Arkansas	4	474	1,154	1,395	1,288	1,008	290	548
Arkansas	2	403	971	1,153	1,000	783	223	436
Arkansas	1	282	707	853	794	627	176	335
Arkansas	3	178	421	495	430	338	94	187
California	23	1,803	5,182	6,527	5,311	4,430	1,658	2,655
California	42	474	1,367	1,820	1,569	1,328	483	759
California	38	433	1,219	1,599	1,362	1,131	408	655
California	39	399	1,209	1,555	1,285	1,050	355	603
California	40	374	1,088	1,456	1,252	1,058	392	610
Colorado	6	384	1,077	1,282	1,114	879	297	514
Colorado	7	374	1,051	1,358	1,199	983	365	574
Colorado	4	296	849	1,064	941	772	300	461
Colorado	3	276	792	978	856	695	265	416
Colorado	2	213	656	760	700	567	223	342
Florida	23	614	1,188	1,455	1,916	1,694	680	911
Florida	22	339	1,178	1,416	909	790	323	524
Florida	13	440	1,082	1,331	1,346	1,207	493	689
Florida	14	420	994	1,221	1,230	1,091	461	637
Florida	8	283	715	871	885	801	359	476
Illinois	8	1,322	2,746	2,959	2,595	2,106	690	1,242
Illinois	16	980	2,015	2,170	1,906	1,504	476	889
Illinois	15	873	1,778	1,862	1,572	1,265	432	778
Illinois	13	857	1,765	1,838	1,540	1,239	423	764
Illinois	18	791	1,548	1,631	1,378	1,101	358	669
Louisiana	6	393	1,210	1,491	1,396	1,150	320	589
Louisiana	3	353	1,099	1,345	1,255	1,047	304	543
Louisiana	1	152	469	581	544	452	132	234
Louisiana	2	134	401	487	444	363	102	190
Louisiana	4	125	383	463	426	351	99	182
New York	25	840	2,105	2,547	2,356	1,980	748	1,154
New York	22	644	1,482	1,626	1,322	1,058	370	655
New York	24	563	1,292	1,417	1,146	908	310	562
New York	27	522	1,280	1,549	1,420	1,197	463	706
New York	12	336	773	943	876	710	261	417
Ohio	16	750	1,489	1,494	1,221	1,017	353	633
Ohio	12	605	1,195	1,189	954	792	270	496
Ohio	15	561	1,111	1,122	915	761	265	475
Ohio	7	427	828	801	631	527	179	334
Ohio	6	413	822	810	650	546	187	341
Massachusetts	6	828	2,177	2,735	2,510	2,057	973	1,336
Massachusetts	5	447	1,143	1,470	1,330	1,138	513	711
Massachusetts	8	306	796	1,002	919	757	368	497
Massachusetts	3	212	575	718	659	547	249	347
Massachusetts	4	190	496	625	571	473	217	302

*The rank for all years is based on the 2017 ranking. All congressional districts displayed for states with less than 5 districts.

Source: IHS Economics

Employment for top-5 congressional districts: US crude oil export supply chain -- Base Production* (number of workers, difference free trade vs. restricted trade)

State	Congressional district	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
North Carolina	12	773	1,653	1,934	1,769	1,488	496	839
North Carolina	11	618	1,324	1,565	1,435	1,225	406	682
North Carolina	9	425	922	1,071	982	825	273	464
North Carolina	1	202	434	507	458	388	129	219
North Carolina	13	165	352	413	377	316	105	178
Oklahoma	3	1,006	2,283	2,589	2,250	1,774	489	986
Oklahoma	5	784	1,749	1,967	1,702	1,338	365	746
Oklahoma	1	475	1,045	1,173	999	778	204	434
Oklahoma	4	411	918	1,040	903	719	199	398
Oklahoma	2	341	764	860	741	584	159	326
Pennsylvania	18	398	845	853	704	564	170	338
Pennsylvania	5	315	655	620	486	381	109	237
Pennsylvania	14	283	594	615	517	414	127	246
Pennsylvania	13	258	556	594	507	411	127	240
Pennsylvania	9	226	478	468	375	298	89	182
Texas	18	765	2,038	2,476	2,197	1,826	585	1,010
Texas	11	661	1,782	2,170	1,941	1,594	507	881
Texas	7	581	1,524	1,851	1,669	1,406	452	770
Texas	29	545	1,466	1,791	1,612	1,342	434	740
Texas	36	551	1,437	1,734	1,546	1,275	405	706
Utah	1	715	1,744	2,043	1,756	1,422	460	819
Utah	2	490	1,213	1,433	1,261	1,035	346	593
Utah	4	455	1,094	1,278	1,098	886	283	509
Utah	3	164	393	460	397	319	102	183
Washington	7	549	1,345	384	360	287	111	269
Washington	2	522	1,293	1,570	1,395	1,160	441	690
Washington	9	530	1,273	1,242	1,128	942	349	573
Washington	1	403	986	2,861	2,519	2,077	780	1,109
Washington	3	294	716	865	769	636	245	382
Wisconsin	3	535	1,024	1,064	950	754	233	444
Wisconsin	4	465	967	1,054	984	812	274	468
Wisconsin	5	475	893	901	769	625	188	369
Wisconsin	6	461	887	924	815	658	211	390
Wisconsin	7	416	792	818	707	574	172	335
US Total		**105,748**	**250,201**	**293,140**	**258,227**	**212,508**	**73,384**	**123,577**

*The rank for all years is based on the 2017 ranking. All congressional districts displayed for states with less than 5 districts.

Source: IHS Economics

Value added

A free trade crude export policy will have a measurable impact on the nation's GDP, and this will be felt throughout the crude oil supply chain at the state and congressional district level. Congressional districts in California and Texas, two states with significant oil production and expected investment, are well-represented in the table below, which shows the US congressional districts that would experience the greatest value added boost under free trade.

Surprisingly, even though Illinois ranks as only the 14th highest state in terms of oil production, five of its' congressional districts rank in the top 20 in terms of their supply chain value added contribution. Together, these five districts account for 5% of the US supply chain impact, representing the single largest effect from free trade in crude oil—surpassing even California and Texas.

Value added by congressional district: US crude oil export supply chain – Base Production*
($million, real 2009, difference free trade vs. restricted trade)

State	Congressional district	2016	2017	2018	2019	2020	2021-30 average	2016-30 average
California	23	370	853	911	655	623	407	499
Nevada	2	258	602	708	683	653	545	557
Illinois	8	285	523	507	447	410	298	343
Illinois	18	270	451	426	362	326	237	280
Illinois	16	233	426	414	368	330	231	272
New York	25	213	404	397	360	354	360	356
Oregon	3	198	381	393	359	342	342	340
Illinois	13	203	370	346	291	265	209	238
Texas	18	177	370	384	330	290	174	220
North Carolina	12	178	319	317	283	262	145	187
New York	22	167	291	260	207	194	181	195
Washington	9	156	291	256	228	219	177	194
Texas	11	133	278	288	249	217	127	162
New York	24	157	274	245	194	180	165	180
Texas	29	123	260	270	235	207	125	156
US Total		**21,234**	**40,606**	**40,480**	**34,494**	**31,701**	**21,754**	**25,737**

*The rank for all years is based on the 2017 ranking.

Source: IHS Economics © 2015 IHS

In summary, the magnitude of the impact of removing the crude oil export on supply chain sectors within a congressional district will depend on two major factors—first, the degree of drilling and extraction activity, and second, the network of supply chains in the congressional district. In both the Base Production Case and the Potential Production Case, the initial ramp up of investment will make a strong impact in congressional districts. In the later years, the growth in investment and production moderates, and removing the ban will have modest—yet still positive—economic and employment impacts on congressional districts.

The network of companies that supply the US oil and gas industry reaches far beyond Texas, North Dakota, California and other states where oil is being extracted. This supply chain can be found in an engine manufacturing plant in Illinois, in Minnesota construction firms building on-site projects for producers next door in North Dakota, and in the Massachusetts and New York companies that provide sophisticated technology and financing to crude oil producers and their suppliers.

In this report, IHS analyzed the impact of lifting the current ban on oil exports and finds that a substantial share of the economic benefits would flow through to the supply chain. These benefits to the supply chain would have a positive impact on every US state and virtually every congressional district.

An IHS Energy / IHS Economics report

Unleashing the Supply Chain

Assessing the economic impact of a US crude oil free trade policy

March 2015






Appendix A: Summary of the *US Crude Oil Export Decision* report findings

About IHS (ihs.com)

IHS (NYSE: IHS) is the leading source of information, insight and analytics in critical areas that shape today's business landscape. Businesses and governments in more than 165 countries around the globe rely on the comprehensive content, expert independent analysis and flexible delivery methods of IHS to make high-impact decisions and develop strategies with speed and confidence. IHS has been in business since 1959 and became a publicly traded company on the New York Stock Exchange in 2005. Headquartered in Englewood, Colorado, USA, IHS is committed to sustainable, profitable growth and employs approximately 8,000 people in 31 countries around the world.

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Additional resources

Appendices are available at www.ihs.com/crudeoilsupplychain. Additionally, the results included in this study are available on an interactive website that provides access to detailed data for the supply chain and congressional districts which can also be accessed through this website.

Study purpose

Building on prior work assessing the industry and macroeconomic impact of changing US policy to allow exports of US crude oil, this study examines the impact on an intricate and interdependent supply chain that supports the oil industry and has made the scale-up of tight oil production possible. The analysis considers 60 separate supply chain industries and provides granular impact analysis at the congressional district level to fully understand the economic and job growth impact across the nation.

This report draws on the multidisciplinary expertise of IHS, including upstream, downstream and macroeconomic teams across IHS Energy and IHS Economics. The study has been supported by a group of sponsors in numerous industries. The analysis and conclusions contained in this report are entirely those of IHS Inc., which is solely responsible for the contents herein.

Related reports

The "Great Revival" in US natural gas and crude oil production has caused significant market and economic shifts. IHS has provided continuing analysis of these developments, their impact on global oil markets, and their influence on the US economy and US competitiveness. Some of the current studies include:

$30 or $130? Scenarios for the Global Oil Market to 2020

These are momentous times for the oil market. We are in a world without OPEC—at least as we knew it. Companies and investors face a heightened degree of uncertainty about the future of oil supply, price, and demand. IHS addresses the uncertainty through a new study, *$30 or $130? Scenarios for the Global Oil Market to 2020*. IHS Scenarios provide a coherent, dynamic framework to discuss several potential futures for the oil market and to test decisions. Through interactive workshops, study participants participate in the scenario development and helping identify key supply, demand, and geopolitical drivers that will shape the oil market to 2020. Decision making is more robust when analysis takes into account more than one view of the future.

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See more at http://press.ihs.com/press-release/economics/us-unconventional-oil-and-gasrevolution-increase-disposable-income-more-270#.

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Baker Hughes, Chaparral Energy, Chesapeake Energy, Chevron, Concho Resources, ConcocoPhillips, Continental Resources , Devon Energy, Energy Equipment and Infrastructure Alliance, EOG Resources, Exxon Mobil, General Electric, Halliburton, Helmerich & Payne , Hess, Marathon Oil, Newfield Exploration, Oasis Petroleum, Occidental Petroleum, Pioneer Natural Resources, QEP Resources, Rosetta Resources, and WPX Energy

Appendix A: Summary of the *US Crude Oil Export Decision* report findings

Origins of existing US crude oil policy

The ban on crude exports was adopted as part of a series of laws passed after the 1973 oil embargo and the four-fold increase in oil prices that followed. The embargo, followed by the Iranian Revolution in 1978–79, created great concern about the availability of oil supplies in a period of declining domestic production, political unrest, growing gasoline lines and consumer panic.

Price controls on crude oil and petroleum products had already been established prior to the oil embargo in an effort to fight inflation. The imposition of price controls and an effective price ceiling on crude oil and petroleum products were further legislated with the Emergency Petroleum Allocation Act (EPAA), passed a few weeks after the oil embargo. In many ways the EPAA was the key initiating legislation that placed the first official restrictions on total crude oil exports. In late 1973, crude oil and refined petroleum products were added to the commodity control list under the Export Administration Act of 1969, which placed significant restrictions on the export of crude oil.[1]

The Energy Policy and Conservation Act of 1975 was the next legislation to ban crude oil exports in response to the embargo and OPEC's price increases. The 1975 legislation was an omnibus bill that included everything from the establishment of automobile fuel efficiency standards, energy efficiency standards for appliances, and the strategic petroleum reserve to low-income weatherization assistance and policies encouraging utilities to burn coal instead of natural gas. The most contentious part, however, was the political battle over the extension of price controls on oil.

As for the ban on crude oil exports, the legislative record indicates that it was little discussed. But it was essential to keep the jerry-built system of price controls—on "old oil" and "new oil", "lower tier oil" and "upper tier oil", stripper oil, "released oil"—from collapsing under its own complexity. The ban prevented price-controlled domestic oil from being exported into the higher-priced world market "to escape domestic price regulation."[2] The crude oil export policies were added to and modified, particularly through amendments to the Mineral Leasing Act of 1920.

By the time the export ban was further codified in the 1979 Export Administration Act, the focus was on prohibiting exports to Japan of North Slope crude oil, which had begun to flow through the Trans-Alaska Pipeline in 1977. As one scholar wrote, "The legislative history makes clear" that the ban on oil exports "was directed against the export of oil produced from the Alaskan North Slope."[3] The prohibition on exporting Alaskan crude was eliminated by President Bill Clinton in 1996. President Clinton concluded that lifting the ban would improve economic growth, reduce dependence on foreign oil and increase jobs without an adverse impact on gasoline prices. But the volumes of North Slope production have fallen so low as to mean that exports have been only marginally economic in recent times. Nevertheless, the broader restriction persists even after its specific rationales—price controls and Alaskan oil—have disappeared.

The original controls on the unrestricted export of US crude oil also extended to refined petroleum products, as both were subject to the couple price control systems established in the early 1970s. Late in the 1970s, after a decade of experience with the cause, effect, and distortions caused by government market and price management, the political and academic sentiment shifted and the policies of the

1 Robert Bradley, *Oil, Gas, & Government: The US Experience Volume II* (Rowman & Littlefield Publishers, Inc., 1996), p. 770.

2 Oil and Gas Journal, October 6, 1975.

3 John. T. Evrard, "The Export Administration Act of 1979: Analysis of its Major Provisions and Impact on United States Exporters," *California Western International Law Journal, I:I982, pp. 37-39*. The article concludes: "The prohibition on the export of domestically-produced crude oil is, therefore, an exception to the general policy of encouraging free trade. This prohibition, however, seems to lack any persuasive rationale."

previous decade were slowly dismantled. The culmination of this occurred during the first week of President Ronald Regan's administration with the issuance of Executive Order 12287, which formally and expeditiously stated that "all crude oil and refined petroleum products are exempted from the price and allocation controls adopted pursuant to the Emergency Petroleum Allocation Act of 1973."[4]

Following the removal of the 1970s-era price control system in 1981, the Department of Commerce coordinated an interagency study group called the "Task Force on Export Control of Refined Products" to evaluate the issue of quantitative restrictions on the export of all refined petroleum products. In October 1981, this interagency panel concluded the following regarding the free trade of all refined petroleum products:

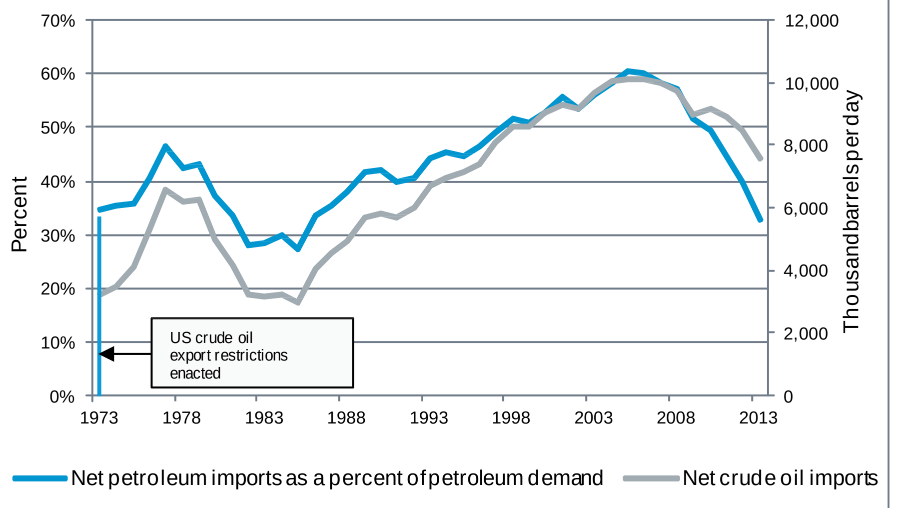
> "US consumers will benefit directly from the export of petroleum products because exports will permit US refineries greater flexibility in product output. The task force also advised that it anticipates the potential export market generally would be limited to spot situations resulting in increased US refinery efficiency.
>
> Free trade will benefit the balance of payment, take advantage of transportation efficiencies and allow the US to respond quickly to its potential international responsibilities."[5]

Following that, the ban on product exports was eliminated.

As for the crude oil export ban, it remains an artifact of an era when the federal government set oil prices, handed out import entitlements and allocated supplies. It was an era, as another scholar put it, when "the Federal Register became more important than the geologist's report." Direct government market management increased markedly. For example, the standard reporting requirements to what had become the Federal Energy Administration involved some 200,000 respondents from the private sector.[6] It was in that era that the federal government took on the responsibility of banning oil exports. But that time is long gone, along with the panic about shortages that defined it. All this provides the imperative to review the current crude oil export policy.

No matter the rationale of the 1970s policy prohibiting exports, there is scant evidence that crude export policy had much impact on US oil import reliance, although price controls, access to resources and demand trends probably did. In the years following the 1975 legislation, US oil imports have remained above 5 million B/D, fluctuating in response to domestic production, economic activity, and energy efficiency. Falling demand and imports during the early 1980s was related to a major recession, a shifting from residual fuel oil (RFO) to gas in the power sector, the impact of automobile fuel efficiency standards and (in the case of

US petroleum (crude oil and refined product) import dependence



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4 Federal Register, Volume 46, Number 26, Friday January 20, 1981, Executive Order 12287

5 Federal Register, Volume 46 Number 193, Tuesday October 8, 1981, Rules and Regulations 49109

6 Daniel Yergin, *The Prize: the Epic Quest for Oil, Money, and Power* (New York: The Free Press, 2009), p. 642.

imports) the build-up of new supply from Alaska. But that was a temporary downturn. Between 1975 and 2005, net imports rose from 36% to 60% of total US demand.

Since 2005, a steep fall has been registered in US import dependence – from 60% down to 27% for the first ten months of 2014. The multiple reasons for this include the drop in product demand from the Great Recession, the increase in domestic crude production from LTO and the increase in vehicle fuel efficiency. This dependence can be expected to fall further over the coming years as oil production increases and consumption remains relatively stable or declines.

Study case descriptions

IHS created two scenarios for the outlook for US oil production. The cases were developed based on the following: analyzing proprietary IHS databases and public data; utilizing proprietary forecast models and methodologies; and incorporating the perspectives and analyses of internal and external oil industry experts. The basis for the forecasts can be summarized as the following:

- The Base Production Case is predicated on the IHS central business planning forecast that provides a conservative view based on known defined oil and natural gas plays and assumes limited technical improvements from current performance.

- The Potential Production Case includes additional known but less well-defined areas of existing plays and moderate drilling performance and technology improvements in the future.

The US trade policy decision was then evaluated for each production case.

Basis for production cases and trade policies

Production cases

Trade policies	**Base** IHS central planning forecast. Conservative view based on defined plays and assumes limited industry improvements.	**Potential** Includes additional potential but less well defined areas of existing plays, moderate industry drilling and technology improvements.
Restricted Current policies (including condensate treatment as crude).	Base Production / Restricted Trade	Potential Production / Restricted Trade
Free Trade to broad group of trading partners including Europe and Asia (India, China).	Base Production / Free Trade	Potential Production / Free Trade

Trade policy decision

Difference in underlying US production forecast view

Note: Each case starts with the same IHS macroeconomic and international crude oil price forecast

After analyzing these cases, the Export Decision Report concluded the following:

- The growth in US crude oil production will come mainly from higher-cost unconventional resources, the development of which is predicated on the price levels of the last few years and the continued application of technology and innovation.

- Oil production growth will come primarily from the Bakken, Eagle Ford and Permian Basin areas, which produce a LTO or light sweet crude grade. This will result in increases in the volume of light oil in excess of the ability of US refineries to process it.

- Oil prices will be a primary driver of investment to increase production. Any actual or anticipated reduction in US crude prices because of export restrictions and other market supply-demand forces will prompt producers to reduce drilling in higher cost unconventional plays, resulting in lower production rates for LTO.

Forecasts have typically underestimated the growth of unconventional oil production. A main reason is the challenge of anticipating the speed of the industry's ability to apply new technology and innovation to continuously improve performance and lower costs.

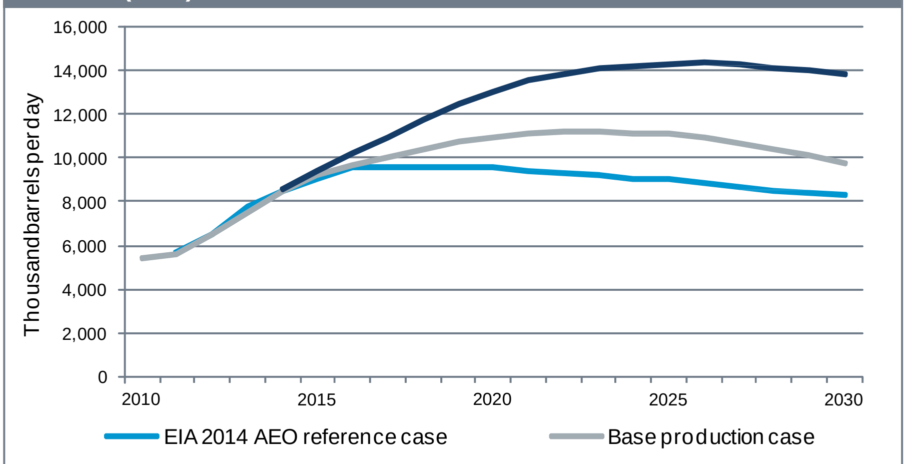
US crude oil production analysis

The upstream oil and gas producers in the United States have been revitalized by the emergence of unconventional "tight" oil resources. This has resulted in a substantial increase in US crude oil and total liquids production in the past half dozen years.[7] Total US daily production of crude oil increased from 5 million B/D in 2008 to 7.4 million B/D in calendar year 2013 and 9.0 million B/D by October 2014. This remarkable growth trend in crude output has profound implications for US and global oil markets. One critical issue concerns the capacity of the US downstream oil refining industry to efficiently handle increasing domestic output of light crude oil. Crude oil exports are for the most part banned.

The surge in US light oil supplies has already displaced similar quality imported light crude oil and is now testing refining capacity limits. Exports of crude oil under a free trade policy could resolve this issue, allowing oil producers to continue increasing their output without the wellhead discounts that are a disincentive to invest in increasing production Of key importance, it should be noted, is that wellhead price discounts do not translate into gasoline price discounts.

The US government's Energy Information Administration (US EIA) currently estimates crude oil output will peak at 9.6 million B/D in 2019 (compared to an April 2011 forecast of 5.9 million B/D) before production begins to decline.[8 9] Although IHS anticipates that

IHS oil production forecasts compared to EIA Annual Energy Outlook (AEO) forecast



Note: EIA 2014 AEO released April 7, 2014

Source: IHS Energy, EIA

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7 Liquids include NGLs, condensate and crude oil.

8 EIA Annual Energy Outlook, April 2011, Reference Case.

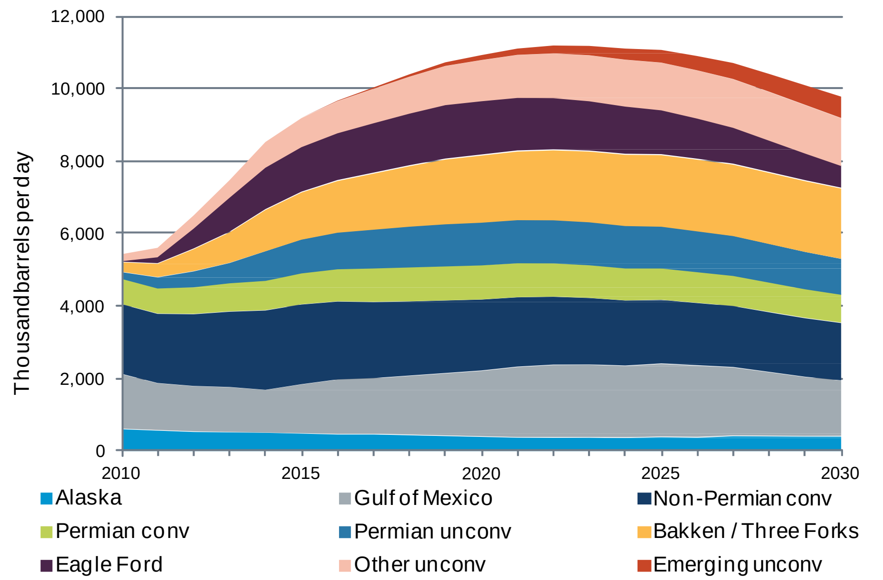
9 EIA Annual Energy Outlook, April 2014, Reference Case.

the next EIA Annual Energy Outlook will be closer to the current Short Term Energy Outlook, released in February 2015 projects US crude oil production to reach 9.5 million B/D by 2016.

However, our analysis, based on geology and production technologies, evolving oil plays and our database of producing wells in the United States suggest a different profile with a significantly higher peak output. The reasons are 1) improved performance at the well level; 2) an extensive inventory of drilling locations available from known defined and delineated reserves and contingent and perspective resources, particularly in tight oil or other unconventional oil plays; and 3) enhancements in producing technologies and the application of innovative operating practices.

The IHS Base Production Case projects increases in production through 2022, peaking at 11.2 million B/D.[10] The IHS Potential Production Case indicates a much higher output peak of 14.3 million B/D in 2026, with production declining only slightly by 2030.

US production forecast by play: Base Production Case



Source: IHS Energy © 2015 IHS

IHS outlooks are the result of a fundamental bottom-up analysis that begins with each contributing geologic play. These play-level forecasts were aggregated to develop the total US crude production forecasts. Nine major contributing plays, shown below, represent conventional onshore and offshore plays, as well as unconventional plays. Numerous sub-plays exist within each of these nine plays, all of which were aggregated to this level for ease of presentation.

For the unconventional crude oil production forecast, IHS used proprietary models that incorporate a fundamental bottom-up approach.[11] The methodology includes the following parameters for each play:

- Number of drilling locations: The geographic size of the play, with risking for different production boundaries within each play, down-spacing and the number of production zones.
- Type curve: An expected or average production profile over time that will be replicated for the forecasted wells. Type curves are developed based on recent well performance data and known trends within the play, such as down-spacing.
- Drill rig count and drilling cycle times: Historic rig counts and well completions are tracked by play and forecasted based on the maturity of the play, known drill plans and total industry drilling activity. Rig cycle times reflect the average number of drill days and are forecasted based on actual performance with conservative improvements in drilling efficiency.

10 The forecast for US crude production provided to IHS clients has been revised to a peak production of 11.9 million B/D in 2027, since the Phase I report was published.

11 Play level capital cost, operating cost and production forecasting models similar to those used to generate content for the Vantage database. Type curve generation using PowerTools and Harmony proprietary software and IHS well and production databases.

Within several of these tight oil plays, producers have identified very large quantities of oil-in-place.[12] However, at this time, recovery rates are very low. Even the Potential Production Case projects that a relatively small percentage of oil-in-place will be recovered before 2030 with known technology. This reflects a further degree of forecasting conservatism for both production forecasts.

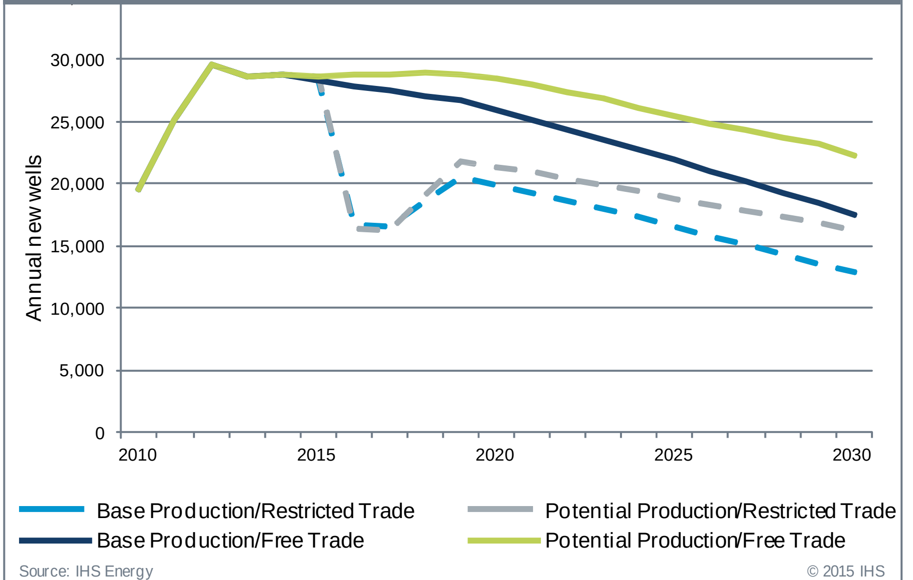
The methodology used here to assess the impact of the current, restricted trade impact included drilling activity reduction (less wells drilled) due to lower wellhead price levels and larger differentials between U.S. wellhead crude and international prices. As prices decline, some areas of tight oil plays become uneconomic. IHS maintains a detailed play-level cost and economic model, which provides breakeven costs that form the basis for determining the level of drilling reduction in each tight oil play. This reduced drilling leads to lower production through the production model above.

The price of oil and the expected trajectory of future oil prices are key determinants of investment in oil production. Because unconventional oil is typically at the high end of the industry's cost curve, unconventional plays are particularly sensitive to price expectations. For the past three years, the benchmark Brent oil price has stayed above $100 per barrel, providing the market incentive to explore and develop US tight oil plays.

The assessments of the Base Production Case and Potential Production Case have been predicated on long-term average prices in a $90-100 per barrel environment, and assuming the industry will be able to export oil that is in excess of domestic light crude refining capacity. At various points, market rebalancing will periodically drive prices lower. Near-term market prices have fallen below this price level due to an oversupplied market.

The US refining industry is reaching the limits of its ability to process the volumes of light tight oil (LTO) being produced. Thus, the general ban on exports of crude oil is discounting LTO prices from where they would otherwise be, negatively impacting producers' revenues, cash flows and profits. The LTO price discount is anticipated to range from $5-15 per barrel depending on which tier of the US refining system is required to process the surplus LTO. The level of price discounting experienced by producers at the well head is impacted by both the LTO refining discount and also the location of that production. Due to the inland location of many unconventional plays and the concentration of refineries in coastal regions, logistics costs to transport production to the end refining market often exceeds $10 per barrel. This combination of domestic refinery demand saturation and elevated logistics costs places a large portion of expected tight oil production at a particular sensitivity to price distortions and associated volatility.

Impact of trade policies on drilling activity in Base and Potential Production cases



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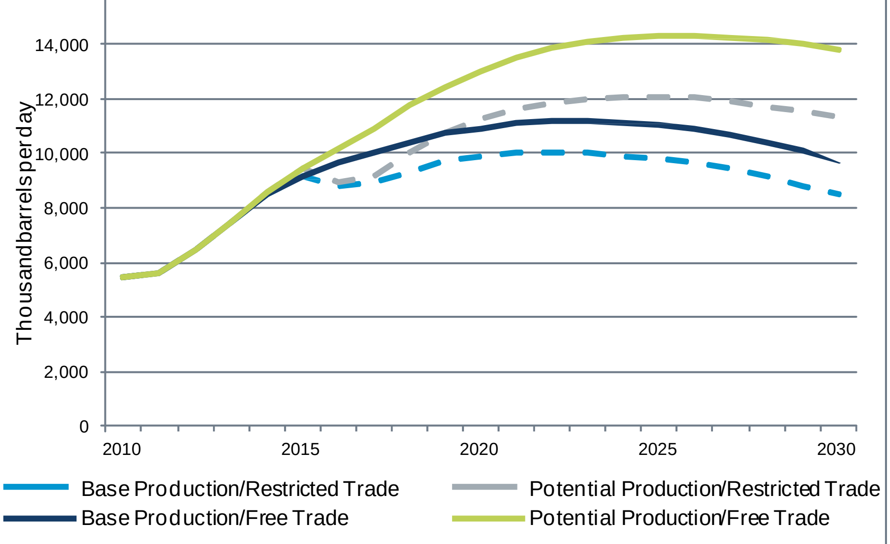
Drilling activity reached a plateau of nearly 30,000 new oil wells per year in 2013. In the unconstrained free trade policy environment, the number of new wells is expected to remain between 25,000 and 30,000

12 Oil-in-place refers to the total hydrocarbon content of an oil reservoir and is not to be confused with an oil reserve, which is an estimate of the economically recoverable portion of a reservoir.

through 2020 before tapering down to between 17,000 and 23,000 new wells by 2030 in the Base and Potential Production Cases, respectively. In contrast, we expect the number of wells to decrease more significantly with restricted trade policies in place because of lower wellhead crude prices and reduced investment.

These reductions in drilling will limit further production increases. A decline in forecasted production is expected as early as 2016. The cumulative impact will be a projected loss of over 1 million B/D in the Base Production Case if trade continues to be restricted and a loss of over 2 million B/D in the Potential Production Case through most of the forecast period.

Impact of trade policies on production in Base and Potential Production cases



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US refining system and LTO processing limitations

A primary focus for the Export Decision Report was to provide an in-depth assessment of the US and North America refining systems. Specifically it looks at the natural ability of the existing system to process specific grades of crude oil (namely light tight oil), what types and the pace of investments that are likely to be made to process additional LTO, where and when the limits of the US refining system to naturally absorb LTO will be reached, and what type of crude oil price discounting can be expected when surplus tight oil is processed in refineries designed for medium and heavy grades of crude oil.

The United States has the largest refining capacity of any country, with 133 operating refineries and a combined crude oil distillation capacity of 17.9 million B/D.[13] When the NAFTA partners—Mexico and Canada—are included, total refining capacity for North America increases to 21.8 million B/D. The US refining system is characterized not only by the number and size of refineries but also by a high number of world-class, high-complexity, full-conversion refineries with a substantial degree of petrochemical and specialty products integration.

US demand for the heavy portion of the barrel is minimal. Current US demand for the heavy portion of the barrel directly usable as finished products—lubricating oils, waxes, asphalt, residual fuel oil (RFO), and petroleum coke—is less than 5% of total US crude oil demand. The complexity and sophistication of the US refining system is driven by market forces that require conversion of anywhere from 30%60% of the crude oil barrel (the heavy portion) from products with almost no demand into high-demand, finished transportation fuels, including gasoline and diesel.

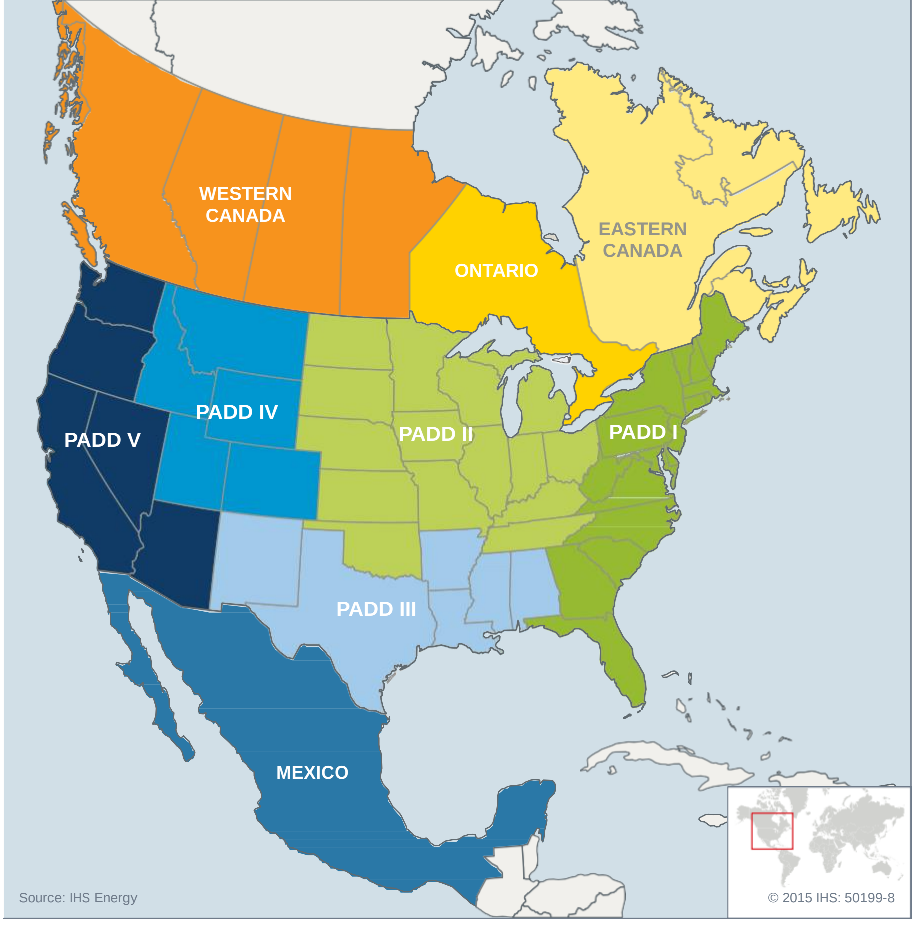
13 Stream Day Capacity or Maximum Capacity Averaged over 30 Days, Annual Average Capacity is typically about 95% of Stream Day Capacity.

Key region refining configurations
(million barrels per day)

	Total refinery capacity	Cracking configuration	Coking configuration	Percent cracking	Percent coking
United States	17.9	4.6	12.5	26%	70%
Europe	15.7	11.0	2.9	70%	18%
China	11.0	2.1	8.5	19%	78%
India	4.4	1.7	2.7	37%	62%
Russia	6.0	2.5	1.7	42%	29%
North America (inc. Mexico)	17.9	4.6	12.5	26%	70%

Source: IHS Energy © 2015 IHS

North America PADDs and Regions



Source: IHS Energy © 2015 IHS: 50199-8

A point of comparison in table is the refining systems of Europe and the United States. Even though both markets have a high demand for light clean products (LCP) the European refining system was largely designed around light sweet North Sea and North African crude oils[14]. Due to this, Europe's refineries never made large-scale investments to upgrade their cracking refineries into coking refineries. The United States, by contrast, invested heavily in its refining system to process heavy Canadian, Mexican and Venezuelan crude oils and needs a much higher percentage of coking configuration refineries to produce the same LCP output. Another market factor over the past two decades was that RFO demand remained higher in Europe due to less RFO inter-fuel competition from low-cost natural gas and coal compared to the US market.

For practical and logistical purposes, US petroleum supply and distribution data is subdivided into five Petroleum Administration Defense Districts (PADDs). Canada is subdivided into three refining regions, while Mexico is defined by one large refining region. Mexico is more isolated than the United States and Canada, as Mexico contains no cross-border crude oil pipelines with the United States and only small refined-product interconnections. In contrast, the United States and Canada represent a truly integrated crude oil and refined product distribution system, with numerous cross-border pipelines connecting the two countries, as well as growing rail (and road) connections.

14 Light Clean Products, used to describe the combination of gasoline, jet fuel, and diesel.

Due to a variety of factors such as refined product demand, local and regional availability of grades of crude oil, marine access and pipeline infrastructure, the refining system of each region has evolved differently over decades and often contains markedly divergent competitive positioning and footprints in terms of capacity, prevalent configuration type, and historic grade or crude slate.

Each region of the North American refining system plays a role in balancing the total inflows and outflows of crude oil into the US refining system. However, given the impending LTO oversupply, the importance of each refining region in North America is not proportional. PADD III in the Gulf Coast—with just over half of total US refining capacity—is expected to take center stage in coming years.

North American refining configuration
(million barrels per day)

Region	Number of refineries	Total distillation capacity (DC)	Total DC @ 90%	Topping / HDS	LSW cracking	LSR/MSR cracking	LSW coking	LSR/MSR coking	HSR coking
United States									
PADD I	9	1.3	1.1	0.1	0.8	0.1	-	0.3	-
PADD II	26	3.8	3.5	-	0.7	0.4	0.3	0.7	1.8
PADD III	52	9.2	8.2	0.3	1.1	0.7	0.6	3.8	2.7
PADD IV	16	0.6	0.6	-	0.2	0.1	-	-	0.3
PADD V	30	3.0	2.7	0.3	0.4	0.3	-	1.2	0.8
Total United States	133	17.9	16.1	0.8	3.1	1.5	0.9	6.1	5.6
Canada									
Eastern Canada	4	0.8	0.7	-	0.7	0.1	-	-	-
Ontario	5	0.5	0.4	0.1	0.1	0.2	-	-	0.1
Western Canada	8	0.7	0.6	-	0.3	-	-	-	0.3
Total Canada	17	1.9	1.7	0.1	1.1	0.3	-	-	0.4
Total North America	**150**	**19.8**	**17.8**	**0.9**	**4.1**	**1.8**	**0.9**	**6.1**	**5.9**

Source: IHS Energy

Particularly as they relate to substituting light domestically produced crude oil for heavier imports, decisions made by Gulf Coast refiners and the balancing steps taken by 1520 key refineries in the Gulf Coast region will drive the price signals and production impacts as the oversupply develops and persists. The role of refining centers outside of PADD III in affecting the North America crude balances and oil price is largely diminished after demand is initially saturated with domestic production.

PADD III is the largest, most diverse and sophisticated refining region in North America and represents the premier refining hub in the world. The Gulf Coast stands out in terms of the number of refineries (52), total distillation capacity (9.2 million B/D), significant petrochemicals integration and the presence of several truly world class facilities. To put this in perspective, PADD III alone is equivalent to 85% of the refining capacity in of all of China, which has the second-largest refining system in the world. Both with and without revisions to US trade policies, PADD III is expected to become the epicenter of LTO crude substitution, replacing sour imports with LTO and driving the crude oil price signals that IHS anticipates will emerge over the next 1224 months.

PADD III refined product demand stands at 3.3 million B/D, equivalent to only about one-third of the region's refining capacity. This large difference between refining capacity and demand enables PADD III to 1) cover most refined product deficits for the remainder of the United States, and 2) serve as the largest exporter of refined products globally. Most of the major refined product systems that supply the Midwest and East Coast originate in PADD III, coming from Houston, Beaumont or Baton Rouge. As a standalone nation, PADD III would be number one in terms of refined product exports.

A key point is that market and pricing dynamics are largely a function of crude processed and of decisions made by refineries to balance the availability of crude oils, versus the ability of the refining system to efficiently process those available crude oils. The 52 Gulf Coast refineries will be the main drivers of this dynamic. The market and pricing dynamics are complex, as all grades—domestic and imported—are in play. IHS expects these decisions to be driven by the economics of substituting one crude for another and by the size of the processing penalties incurred, as increasing volumes of lighter oil are processed in refineries that have been reconfigured for heavier and more sour grades of crude oil.

As LTO volumes have increased, the downstream industry has shifted quickly to optimize its refineries to capture the available margin from crude oil grades that are in oversupply or logistically disadvantaged and depressed in price. The increasing consumption of domestic LTO in the refining system is referred to as a crude substitution in which LTO replaces traditional crude oils. Crude substitution refers to the simple replacement of one crude grade with another.[15] The quality difference between the two crude oil grades, in conjunction with the refinery internal capacities and constraints, dictates the products that can be produced. Based on the product price and the crude price, the profit from each crude oil can be estimated. A refinery will make a crude substitution only if the profit improvement warrants it.

The increasing substitution of LTO is swiftly moving through a series of tiers, with each tier imparting a potentially more significant economic loss for the refiner. To overcome the loss and incentivize processing requires a more significant LTO price discount. While actual crude substitution varies by refinery, depending on configuration, scale, location and other factors, a generalization is useful in considering the overall refining system but particularly the PADD III supply and demand balance and pricing response. The LTO substitution tiers (or ways to process more LTO) include:

- Tier 1 – Displacement of Light Crude Imports: Replacement of light crude imports with similar quality light crude domestic production. On a quality basis this represents a like-for-like substitution and requires only a small amount of price discounting to incentivize, on the order of $0.50-$1.00 per barrel.

- Tier 2 – Optimum Processing in Light / Medium Sour Capacity: The substitution of light and medium sour quality imports for light sweet domestic production, where the refinery in question has the ability to process the entire light domestic barrel into finished products at full utilization. A crude discounting level of $1-$2 per barrel, or just the quality difference between the two crudes being considered, is necessary to incentivize this type of substitution.

- Tier 3 – Suboptimum Processing in Light / Medium Sour Capacity: A similar quality substitution as Tier 2 where the refinery in question does not have the ability to process the entire barrel into finished products at full utilization. The processing of light domestic surplus production results in the refinery producing increased volumes of lower value light and heavy naphtha that is sold at a discount to finished gasoline. A crude feedstock discount of $2-$4 per barrel is required to incentivize this tier of substitution.

- Tier 4 – Suboptimum Capacity Reduction in Medium Sour Capacity: As a final step, refiners have the option of processing additional LTO to the point that the higher naphtha distillation yield results in a lower utilization (known as a reduced crude charge rate). At this point, the refinery incurs the lost opportunity cost of forgoing the medium sour crude margin, as the total crude rate is reduced. An example of this is provided in the table below, which shows that adding 25% LTO to the refinery crude charge results in a total crude charge reduction of 15%. The lost margin associated with the lower utilization must be recovered by lower LTO pricing. When the US refining system enters this domestic crude substitution tier the price discount to incentivize this market behavior can exceed $15 per barrel.

It is important to note the increases in LTO runs over the coming years. A portion of this additional LTO will be processed in new topping capacity, but our analysis indicates that supply will outpace demand for

15 Refineries use sophisticated models to simultaneous optimize multiple crude purchase, product production and refinery operations to maximize profits.

the next several years, moving the Gulf Coast and the entire North American refining system into a structural Tier 4 operating mode. Our analysis of new refinery investments covers only what we think is economically competitive and has good probability of occurring.

Suboptimum capacity reduction in medium sour capacity (Tier 4)

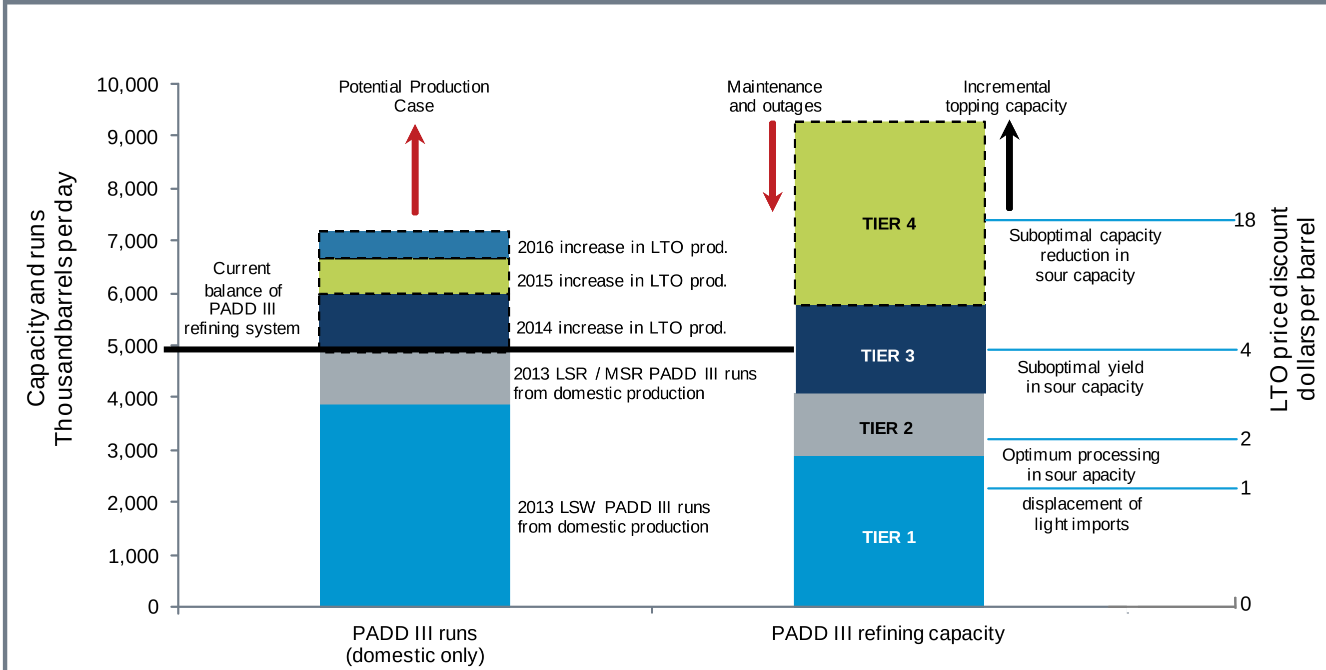
	Crude charge (barrels per day)	Naphtha yield (percent)	Naphtha yield (barrels per day)
Full medium sour processing			
Medium sour crude	200,000	25%	50,000
Light tight oil	0		
Total	**200,000**		**50,000**
			(Limiting capacity)
Light tight oil substitution for medium sour			
Medium sour crude	120,000	25%	30,000
Light tight oil	50,000	40%	20,000
Total	**170,000**		**50,000**
			(Limiting capacity)
Light tight oil percent of capacity	**25%**		
Crude charge reduction	**15%**		

Notes: Illustrative only; values rounded for presentation.

Source: IHS Energy

The following figure shows the US Gulf Coast processing tiers on the right side, with an estimated capacity to process LTO for each tier on the left side. The approximate LTO price discount associated with each tier is provided on the right axis. The price discounts for Tier 1 through Tier 3 are modest, rising from $14 per barrel, but increase sharply for Tier 4, to $15 per barrel. Current domestic crude runs for these refineries and the expected total LTO growth over the next few years are depicted on the left side of the figure. The remaining area—the arrow on top of the PADD III Runs column—includes imported crude oils (not shown). This figure supports IHS' conclusion that the Gulf Coast refining system is already operating in Tier 3, which is consistent with the level of LTO price discount observed in the market (maintenance periods aside) today.

US gulf coast refinery processing tiers and corresponding LTO discount



Source: IHS Energy

Continued growth in US production will drive deeper crude oil discounts (though not gasoline discounts), as less and less efficient refinery processing tiers are breached in an effort to process more and more LTO. The inability to export light crude oil creates an LTO price discount that provides a clear price signal for investments that is negative for producers and positive for refiners. The result is that refiners see significant risk in the form of potentially stranded investments if the export policy were to change, while producers see a risk that refiners will not invest and that prices will decline further. This market dynamic, which IHS terms Gridlock, effectively acts like a traffic jam.

Gridlock is driven not only by price signals between the US upstream (production) and downstream (processing and marketing) industries, but also by a heightened degree of uncertainty about future crude oil trade policy. This means investment to relieve system congestions will be slower in coming years, compared with a business environment of greater confidence about present and future policies.

Uncertainty about future US crude export policy exacerbates this Gridlock. Deeply discounted crude (well below the level of LTO price advantage from free trade) will significantly reduce the amount of capital that upstream participants will invest in additional drilling and production, eventually negatively affecting both US economic growth and production. Initially, some downstream participants have responded to the domestic crude discount and available export markets by adding select simple topping capacity. But they also have to recognize that a change in export policy could strand investments of this type. The United States will continue to import large quantities of heavy crude oil, but a liberalization of oil exports would allow crude to efficiently move to the highest-value markets, unlocking the Gridlock while providing greater benefits to the US economy and consumers.

Trade policy impact on crude oil and gasoline prices

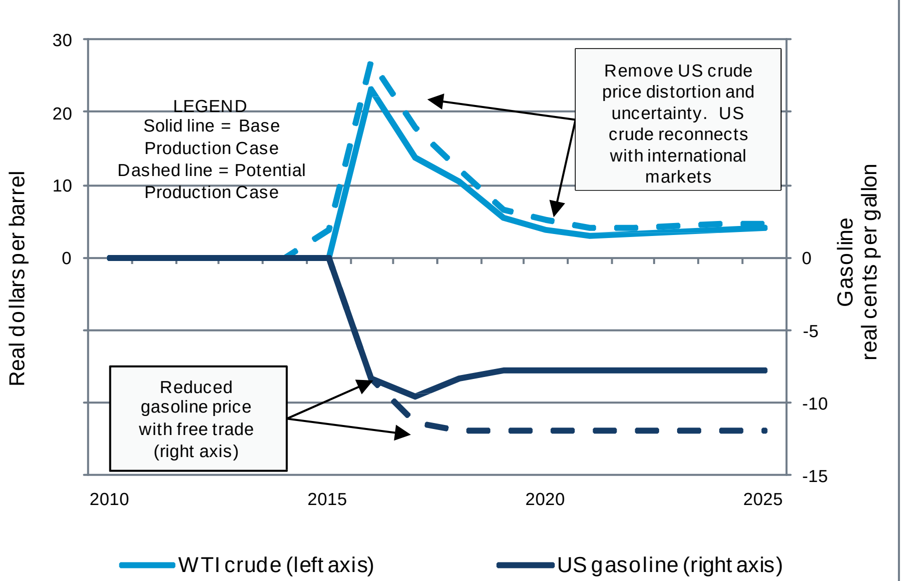
The price relationship between US crude oil and US gasoline cannot be considered in isolation from world markets.

Gasoline's tie to international crude through the free trade of refined products is based on changes in the global Brent price. But under the restrictive trade policy for domestically produced crude oil, the distorted pricing of US crude, evident in the LTO discount, has a fundamentally different pricing dynamic.

The shift of the US crude market to free trade will have the effect of lowering US gasoline prices. That is because as new crude supply is added to the global market; the international price of crude will fall, putting downward pressure on US gasoline prices. At the same time, free export of US crude oil would actually increase domestic crude prices, which will rise to meet higher international price levels, generating additional US output and adding to international crude supply.

The net gasoline and crude price changes for both Free Trade Cases is provided in the figure. This shows the dual

Free trade impact on US crude and gasoline



Source: IHS Energy © 2015 IHS

benefit of free trade: producers receive greater price certainty and somewhat higher crude prices and consumers receive lower gasoline prices as a result of the direct effects of greater global crude supply. Specifically, free trade would:

- Reduce gasoline prices paid by US consumers by an estimated 8 cents per gallon (Base Production) and 12 cents per gallon (Potential Production) over the entire forecast period. As US crude production increases by another 12 million B/D under free trade, lower prices in the global market result in lower US gasoline prices.

- Remove the price uncertainty associated with the discount on US light crude oil, generating the economic benefits of higher crude production, increased investment, higher employment, higher household income, an improved US petroleum trade balance and increased tax revenues.

An IHS Energy / IHS Economics report

Unleashing the Supply Chain

Assessing the economic impact of a US crude oil free trade policy

March 2015

Appendix B: Supply chain modeling methodology

About IHS (ihs.com)

IHS (NYSE: IHS) is the leading source of information, insight and analytics in critical areas that shape today's business landscape. Businesses and governments in more than 165 countries around the globe rely on the comprehensive content, expert independent analysis and flexible delivery methods of IHS to make high-impact decisions and develop strategies with speed and confidence. IHS has been in business since 1959 and became a publicly traded company on the New York Stock Exchange in 2005. Headquartered in Englewood, Colorado, USA, IHS is committed to sustainable, profitable growth and employs approximately 8,000 people in 31 countries around the world.

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Additional resources

Appendices are available at www.ihs.com/crudeoilsupplychain. Additionally, the results included in this study are available on an interactive website that provides access to detailed data for the supply chain and congressional districts which can also be accessed through this website.

Study purpose

Building on prior work assessing the industry and macroeconomic impact of changing US policy to allow exports of US crude oil, this study examines the impact on an intricate and interdependent supply chain that supports the oil industry and has made the scale-up of tight oil production possible. The analysis considers 60 separate supply chain industries and provides granular impact analysis at the congressional district level to fully understand the economic and job growth impact across the nation.

This report draws on the multidisciplinary expertise of IHS, including upstream, downstream and macroeconomic teams across IHS Energy and IHS Economics. The study has been supported by a group of sponsors in numerous industries. The analysis and conclusions contained in this report are entirely those of IHS Inc., which is solely responsible for the contents herein.

Related reports

The "Great Revival" in US natural gas and crude oil production has caused significant market and economic shifts. IHS has provided continuing analysis of these developments, their impact on global oil markets, and their influence on the US economy and US competitiveness. Some of the current studies include:

$30 or $130? Scenarios for the Global Oil Market to 2020

These are momentous times for the oil market. We are in a world without OPEC—at least as we knew it. Companies and investors face a heightened degree of uncertainty about the future of oil supply, price, and demand. IHS addresses the uncertainty through a new study, *$30 or $130? Scenarios for the Global Oil Market to 2020*. IHS Scenarios provide a coherent, dynamic framework to discuss several potential futures for the oil market and to test decisions. Through interactive workshops, study participants participate in the scenario development and helping identify key supply, demand, and geopolitical drivers that will shape the oil market to 2020. Decision making is more robust when analysis takes into account more than one view of the future.

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See more at http://press.ihs.com/press-release/economics/us-unconventional-oil-and-gasrevolution-increase-disposable-income-more-270#.

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The following organizations provided support for this study. The analysis and conclusions in this study are those of IHS, and IHS is solely responsible for the report and its content.

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Appendix B: Supply chain modeling methodology

Methodology and approach

This appendix presents the data requirements and the assumptions we used to model the supply chain economic impact assessment of removing the ban on crude oil exports. The approach was the same for both the Base and Potential Production Cases.

Data requirements and assumptions

IHS compiled the data required to undertake the supply chain economic impact assessment of removing the crude oil export ban. The upstream activity data was segmented to distinguish the economic activity by industry groupings. These activities were segmented in the direct contributions in terms of production and capital expenditures. These metrics were used as inputs to the IHS US Macroeconomic Model (US Macro Model) to assess the national macroeconomic impact and again in the IMPLAN model to assess the supply chain sector impact on state and congressional level basis. The models require average annual estimates for production and capital spending. The following sector activities were determined to be the major, direct contributors:

- Oil and natural gas extraction
- Oil and natural gas drilling
- Support activities for oil and natural gas
- Construction of facilities, related materials and machinery for hydraulic fracturing and completions, and construction of oil and natural gas pipeline

The IMPLAN model required production and capital expenditure values in nominal dollar terms. The production levels were transformed into value of output using the IHS oil price outlook used in the previous study, *US Crude Oil Export Decision*. Capital expenditures and support services for drilling, completion, facilities, gathering and processing were provided in nominal dollars for the baseline outlook period.

Upstream assumptions

This section discusses the production profiles and associated capital expenditures in the upstream sector for removing the crude oil export ban. Conventional and unconventional oil and natural gas differ only in terms of well construction; all other aspects from exploration to marketing are identical. Wells for unconventional oil and natural gas require long horizontal wellbores and multi-stage hydraulic fracture completions to produce low-permeability reservoirs. This study assumes exploration and production from both conventional and unconventional oil plays.

Capital expenditure at the upstream phase of oil is undertaken for well construction, drilling, well completion, facilities, and gathering. Capital expenditures, on cumulative basis, are expected to be $746 billion between 20162 and 2030 in the Base Production Case and $974 billion in the Potential Production case. Cumulative value of oil production over the same period is assumed to be $751 and $995 billion in the two production cases.

Well construction starts with detailed planning of a well's location, both at the surface and for the trajectory and target below ground. IHS Energy estimated that an unconventional oil well in a shale or tight sand play can cost between $3 million and $12 million to drill and prepare for production. The cost of a well depends on the well type, the vertical depth of the well bore, its lateral length, reservoir pressure, rock characteristics, and the number of fracture stages for wells that are hydraulically fractured.

After drilling is completed, the well is prepared to begin production. This phase is called well completion and it concentrates more than 50% of total upstream capital expenditures for unconventional oil. The costs of drilling and constructing a well and putting it into operation represent the lion's share of the upstream capital expenditures. These two phases also represent the central components of the total economic contributions of the upstream oil activity. In addition to preparing the wells for production, a large component of the capital expenditure is spent for gathering lines and facilities; these include construction contractors and equipment manufacturers and dealers. The tables below present the types of capital expenditures for upstream and the corresponding IMPLAN categories.

Capital expenditure inputs to the IMPLAN model: US crude oil export supply chain

IMPLAN sector	Description	% of category expenditure
Drilling		
28	Drilling oil and gas wells	7.1%
29	Support activities for oil and gas operations	22.3%
36	Construction of other new nonresidential structures	21.4%
160	Cement manufacturing	0.9%
171	Steel product manufacturing from purchased steel	21.4%
220	Cutting tool and machine tool accessory manufacturing	21.4%
357	Insurance carriers	3.7%
369	Architectural, engineering, and related services	1.8%
Completions		
26	Sand, gravel, clay, and ceramic, and refractory minerals mining and quarrying	14.4%
28	Drilling oil and gas wells	13.0%
29	Support activities for oil and gas operations	14.0%
33	Water, sewage and other systems	7.2%
36	Construction of other new nonresidential structures	5.3%
121	Industrial gas manufacturing	7.2%
125	All other basic inorganic chemical manufacturing	7.2%
201	Fabricated pipe and pipe fitting manufacturing	1.1%
206	Mining and oil and gas field machinery manufacturing	14.3%
226	Pump and pumping equipment manufacturing	7.3%
227	Air and gas compressor manufacturing	6.1%
335	Truck transportation	2.9%
Facilities		
36	Construction of other new nonresidential structures	15.3%
188	Power boiler and heat exchanger manufacturing	1.6%
189	Metal tank (heavy gauge) manufacturing	24.5%
201	Fabricated pipe and pipe fitting manufacturing	17.5%
206	Mining and oil and gas field machinery manufacturing	8.3%
222	Turbine and turbine generator set units manufacturing	1.6%
226	Pump and pumping equipment manufacturing	3.6%
227	Air and gas compressor manufacturing	1.6%
247	Other electronic component manufacturing	10.5%
251	Industrial process variable instruments manufacturing	7.0%
256	Other measuring and controlling device manufacturing	3.5%
369	Architectural, engineering, and related services	5.0%
Gathering		
201	Fabricated pipe and pipe fitting manufacturing	10.8%
206	Mining and oil and gas field machinery manufacturing	23.6%
227	Air and gas compressor manufacturing	65.6%

Source: IHS Energy Insight and IHS Economics

National assessment

Here we present the methodology for measuring the economic contribution of the supply chain impacts under the restricted trade and free trade scenarios. The results are presented in terms of the difference in levels of economic contribution between free trade and restricted trade for each case: the Base Production Case and the Potential Production Case.

Using data and analyses from proprietary databases and the IMPLAN model, IHS evaluated the impacts to the supply chain by applying a customized industrial structure of the US economy. The data categories in the model were tailored to the specific mix of equipment, materials, and services that characterize the US crude oil supply chain. IHS linked the IMPLAN model to its dynamic US and state macroeconomic models in order to augment the supply chain determination of employment, value added, and labor income impacts with a comprehensive dynamic modeling methodology employed in the US Crude Oil Export Decision. IHS' baseline macroeconomic forecasts for the US and state economies were re-specified to assess the contribution on the 60 supply chain sectors if the export ban on US crude oil were eliminated. All models were run using the initial set of input assumptions and were calibrated. The resulting economic impact is measured in terms of jobs created or sustained, value added contribution to GDP, and employee wages and compensation. The calibration process compared the sum of the direct, indirect, and induced impacts (for all metrics) from the supply chain (IMPLAN) model and scaled it to the total impact from the state macroeconomic models. While all the supply chain sectors were selected from the direct and indirect effects (defined below), the induced effect was left out as it relates to the income effect.

Direct Impacts: This is the effect of the core industry's output, employment, and income. For example, removing the US crude oil export ban will have implications for the energy value chain – its upstream (production), midstream (transportation and logistics), and downstream (processing and marketing) elements – in terms of capital expenditures and operating expenditures. These activities directly contribute to exploration (capital expenditures) and production activity (operating expenditures). Others directly involved in US crude oil export activities are midstream processing and pipeline transportation companies, downstream local distribution companies, and onsite construction service providers.

Indirect Impacts: Purchasing patterns of crude oil development indirectly contribute to all of the supplier industries. Changes in demand from the directly impacted industries lead to corresponding changes in output, employment, and labor income throughout each industry's own supply chains via inter-industry linkages. The affected supplier activities span the majority of US industries. For this crude oil export supply chain analysis, IHS has focused on the 60 major supply chain sectors.

State assessment

While the previous study, *US Crude Oil Export Decision*, used macroeconomic state models to assess the total economic impact of lifting the US crude oil export ban under two projection trajectories, this study utilizes Input/Output models to trace and assess the impacts at the sector- and supplier-industry levels. IHS has integrated and calibrated the two modeling approaches by embedding and linking the sectoral model within the IHS macroeconomic modeling system.

The model framework utilized in this analysis was established as a system of linked state economies to capture the flow of trade across state borders. As a result, the sourcing of supplies requisite for crude oil development activity impacts states that do not have an oil play within their borders. For example, oil development in North Dakota relies on companies that provide banking, financial, and insurance services in Chicago and New York City as well as professional services firms that might be located in Dallas, San Francisco and Boston. Capturing these connections highlights the indirect economic contribution even in non-producing states.

By focusing on the interaction of economic activity among the states, IHS provides a more careful analysis of state-level impacts resulting from a change in crude oil export policy. In addition, while the economic value created by oil production is attributed solely to states with plays, the allocation of capital expenditures across the 50 states is interconnected. Capital spending may be incurred at an oil production site, but the machinery and equipment, architectural and engineering services, materials, and other expenditures may occur in other locations far from production. To ensure that these effects are fully captured in the analysis, insights from the IHS Economics and IHS Energy teams, web-based primary research, and IHS proprietary databases were employed to appropriately allocate capital expenditures to the individual states.

IHS integrated information from a number of different proprietary and public sources to determine interstate trade flows. The analysis was supported by multiple industry sources, the IHS TRANSEARCH© Business Market Insight databases, and IHS expert judgment. For example, unconventional oil extraction employing hydraulic fracturing techniques requires sand with unique properties produced primarily in Wisconsin, Minnesota, Ohio, and Arkansas. Since not all states with unconventional oil or gas plays produce these distinctive sands, they must procure them from suppliers elsewhere (and are assumed to do so in the sectoral model). The IHS TRANSEARCH© trade-flow database was one of several sources used to determine the origin and destination of the various materials and equipment on a state level. This process was undertaken for all of the detailed capital expenditure categories (defined as various products and services). The set of products and services, and — in a producing state — the value of production, were input into the corresponding state model to assess the impact of the supply chain in each individual state's economy as determined by the multi-regional analysis capability and related coefficients of the IMPLAN model. The net result is an assessment of the supply chain across all state economies.

Congressional district assessment

State-level results were linked to congressional districts using two internal IHS sources. First, the IHS Energy team provided assumptions at the district-level for drilling, production, and other exploration activities. Second, the IHS Economics team provided detailed sector-level economic activity, by congressional district, found in the proprietary IHS Business Market Insights dataset. As described below, types of impacts from the supply chain model – direct, indirect, and induced economic impacts – were linked and integrated from states to congressional districts separately.

Direct impacts at the congressional district level are a function of both the economic activity's location, as provided by IHS Energy, and the baseline economic activity in IHS Business Market Insights data. This process assigns the share of the impact to the district where the direct activity occurred, while crediting the residual shares to other districts within the state as a function of the location of the baseline activity. This logic allows for intrastate sourcing of direct activity but assumes a higher probability that supply chain activity (if available) will occur at the location of the direct activity.

Indirect and induced impacts are distributed to congressional districts as a function of baseline economic activity for each congressional district from IHS Business Market Insights. This logic allows for intrastate sourcing of indirect and induced activity based on the statewide distribution of supplier industries and income induced.

Finally, once all direct, indirect, and induced economic impacts were distributed to congressional districts, a final validation process was applied to ensure that economic activity in a given sector is not assigned to a district where that sector does not exist in the baseline. This logic was implemented to ensure that constraints in the location of skilled labor and capital were enforced.

NAICS definitions

The categories listed represent the NAICS-based BLS industrial employment categories used in the analysis of the unconventional energy supply chain. The source of this information is the US Census' Bureau's official NAICS website: http://www.census.gov/eos/www/naics/index.html.

The categories are presented below in the order of the key industry segments of the unconventional supply chain.

Construction and well services

23 Construction of New Nonresidential Manufacturing Structures and Other New Nonresidential Structures

In non-producing states, the construction activities will be concentrated in rail, pipelines, and storage facilities. In the producing states, the construction activities will incorporate marine structures, facilities to export LNG, and manufacturing structures.

213111 Drilling Oil and Gas Wells

This US industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.

213112 Support Activities for Oil and Gas Operations

This US industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.

Industrial equipment and machinery

3331 Agriculture, Construction, and Mining Machinery Manufacturing

This industry comprises establishments primarily engaged in:

- Manufacturing oil and gas field machinery and equipment, such as oil and gas field drilling machinery and equipment; oil and gas field production machinery and equipment; and oil and gas field derricks and (2) manufacturing water well drilling machinery.
- Manufacturing underground mining machinery and equipment, such as coal breakers, mining cars, core drills, coal cutters, rock drills and manufacturing mineral beneficiating machinery and equipment used in surface or underground mines.
- Manufacturing farm machinery and equipment, powered mowing equipment and other powered home lawn and garden equipment.
- Manufacturing agricultural and farm machinery and equipment, and other turf and grounds care equipment, including planting, harvesting, and grass mowing equipment (except lawn and garden-type).
- Manufacturing powered lawnmowers, lawn and garden tractors, and other home lawn and garden equipment, such as tillers, shredders, yard vacuums, and leaf blowers.
- Manufacturing construction machinery, surface mining machinery, and logging equipment.

4231 Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers

This industry group comprises establishments primarily engaged in the merchant wholesale distribution of automobiles and other motor vehicles, motor vehicle supplies, tires, and new and used parts.

4238 Machinery, Equipment, and Supplies Merchant Wholesalers

This industry group comprises establishments primarily engaged in the merchant wholesale distribution of construction, mining, farm, garden, industrial, service establishment, and transportation machinery, equipment and supplies.

332410 Power Boiler and Heat Exchanger Manufacturing

This industry comprises establishments primarily engaged in manufacturing power boilers and heat exchangers. Establishments in this industry may perform installation in addition to manufacturing power boilers and heat exchangers.

332420 Metal Tank (Heavy Gauge) Manufacturing

This industry comprises establishments primarily engaged in cutting, forming, and joining heavy gauge metal to manufacture tanks, vessels, and other containers.

333112 Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing powered lawnmowers, lawn and garden tractors, and other home lawn and garden equipment, such as tillers, shredders, yard vacuums, and leaf blowers.

333515 Cutting Tool and Machine Tool Accessory Manufacturing

This US industry comprises establishments primarily engaged in manufacturing accessories and attachments for metal cutting and metal forming machine tools.

333611 Turbine and Turbine Generator Set Units Manufacturing

This US industry comprises establishments primarily engaged in manufacturing turbines (except aircraft); and complete turbine generator set units, such as steam, hydraulic, gas, and wind.

333612 Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing

This US industry comprises establishments primarily engaged in manufacturing gears, speed changers, and industrial high-speed drives (except hydrostatic).

333613 Mechanical Power Transmission Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing mechanical power transmission equipment (except motor vehicle and aircraft), such as plain bearings, clutches (except motor vehicle and electromagnetic industrial control), couplings, joints, and drive chains.

333618 Other Engine Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing internal combustion engines (except automotive gasoline and aircraft).

333911 Pump and Pumping Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing general purpose pumps and pumping equipment (except fluid power pumps and motors), such as reciprocating pumps, turbine pumps, centrifugal pumps, rotary pumps, diaphragm pumps, domestic water system pumps, oil well and oil field pumps and sump pumps.

333912 Air and Gas Compressor Manufacturing

This US industry comprises establishments primarily engaged in manufacturing general purpose air and gas compressors, such as reciprocating compressors, centrifugal compressors, vacuum pumps (except laboratory), and nonagricultural spraying and dusting compressors and spray gun units.

333922 Conveyor and Conveying Equipment Manufacturing

This US industry comprises establishments primarily engaged in manufacturing conveyors and conveying equipment, such as gravity conveyors, trolley conveyors, tow conveyors, pneumatic tube conveyors, carousel conveyors, farm conveyors, and belt conveyors.

333991 Power-Driven Handtool Manufacturing

This US industry comprises establishments primarily engaged in manufacturing power-driven (e.g., battery, corded, pneumatic) handtools, such as drills, screwguns, circular saws, chain saws, staplers, and nailers.

334419 Other Electronic Component Manufacturing

This US industry comprises establishments primarily engaged in manufacturing electronic components (except bare printed circuit boards; semiconductors and related devices; electronic capacitors; electronic resistors; coils, transformers and other inductors; connectors; and loaded printed circuit boards).

334512 Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use

This US industry comprises establishments primarily engaged in manufacturing automatic controls and regulators for applications, such as heating, air-conditioning, refrigeration and appliances.

334513 Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables

This US industry comprises establishments primarily engaged in manufacturing instruments and related devices for measuring, displaying, indicating, recording, transmitting, and controlling industrial process variables. These instruments measure, display or control (monitor, analyze, and so forth) industrial process variables, such as temperature, humidity, pressure, vacuum, combustion, flow, level, viscosity, density, acidity, concentration, and rotation.

334514 Totalizing Fluid Meter and Counting Device Manufacturing

This US industry comprises establishments primarily engaged in manufacturing totalizing (i.e., registering) fluid meters and counting devices. Examples of products made by these establishments are gas consumption meters, water consumption meters, parking meters, taxi meters, motor vehicle gauges, and fare collection equipment.

334516 Analytical Laboratory Instrument Manufacturing

This US industry comprises establishments primarily engaged in manufacturing instruments and instrumentation systems for laboratory analysis of the chemical or physical composition or concentration of samples of solid, fluid, gaseous, or composite material.

334519 Other Measuring and Controlling Device Manufacturing

This US industry comprises establishments primarily engaged in manufacturing measuring and controlling devices (except search, detection, navigation, guidance, aeronautical, and nautical instruments and systems; automatic environmental controls for residential, commercial, and appliance use; instruments for measurement, display, and control of industrial process variables; totalizing fluid meters and counting devices; instruments for measuring and testing electricity and electrical signals; analytical laboratory instruments; irradiation equipment; and electromedical and electrotherapeutic apparatus).

336112 Light Truck and Utility Vehicle Manufacturing

This US industry comprises establishments primarily engaged in (1) manufacturing complete light trucks and utility vehicles (i.e., body and chassis) or (2) manufacturing light truck and utility vehicle chassis only. Vehicles made include light duty vans, pick-up trucks, minivans, and sport utility vehicles.

336120 Heavy Duty Truck Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing heavy duty truck chassis and assembling complete heavy duty trucks, buses, heavy duty motor homes, and other special purpose heavy duty motor vehicles for highway use or (2) manufacturing heavy duty truck chassis only.

336510 Railroad Rolling Stock Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing and/or rebuilding locomotives, locomotive frames and parts; (2) manufacturing railroad, street, and rapid transit cars and car equipment for operation on rails for freight and passenger service; and (3) manufacturing rail layers, ballast distributors, rail tamping equipment and other railway track maintenance equipment.

Information technology

3341 Computer and Peripheral Equipment Manufacturing

This industry comprises establishments primarily engaged in manufacturing and/or assembling electronic computers, such as mainframes, personal computers, workstations, laptops, and computer servers; and computer peripheral equipment, such as storage devices, printers, monitors, input/output devices and terminals. Computers can be analog, digital, or hybrid. Digital computers, the most common type, are devices that do all of the following: (1) store the processing program or programs and the data immediately necessary for the execution of the program; (2) can be freely programmed in accordance with the requirements of the user; (3) perform arithmetical computations specified by the user; and (4) execute, without human intervention, a processing program that requires the computer to modify its execution by logical decision during the processing run. Analog computers are capable of simulating mathematical models and comprise at least analog, control, and programming elements.

5112 Software Publishers

This industry comprises establishments primarily engaged in computer software publishing or publishing and reproduction. Establishments in this industry carry out operations necessary for producing and distributing computer software, such as designing, providing documentation, assisting in installation, and providing support services to software purchasers. These establishments may design, develop, and publish, or publish only.

5415 Computer Services

This industry comprises establishments primarily engaged in providing expertise in the field of information technologies through one or more of the following activities: (1) writing, modifying, testing, and supporting software to meet the needs of a particular customer; (2) planning and designing computer systems that integrate computer hardware, software, and communication technologies; (3) on-site management and operation of clients' computer systems and/or data processing facilities; and (4) other professional and technical computer-related advice and services.

Logistics

4821 Rail Transportation

This industry comprises establishments primarily engaged in operating railroads (except street railroads, commuter rail, urban rapid transit, and scenic and sightseeing trains). Line-haul railroads and short-line railroads are included in this industry.

483 Water Transportation

Industries in the Water Transportation subsector provide water transportation of passengers and cargo using watercraft, such as ships, barges, and boats. The subsector is composed of two industry groups: (1) one for deep sea, coastal, and Great Lakes; and (2) one for inland water transportation. This split typically reflects the difference in equipment used. Scenic and sightseeing water transportation services are not included in this subsector.

4841 General Freight Trucking

This industry group comprises establishments primarily engaged in providing general freight trucking. General freight establishments handle a wide variety of commodities, generally palletized, and transported in a container or van trailer. The establishments of this industry group provide a combination of the following network activities: local pickup, local sorting and terminal operations, line-haul, destination sorting and terminal operations, and local delivery.

486 Pipeline Transportation

Industries in the Pipeline Transportation subsector use transmission pipelines to transport products, such as crude oil, natural gas, refined petroleum products, and slurry. Industries are identified based on the products transported (i.e., pipeline transportation of crude oil, natural gas, refined petroleum products, and other products).

Materials

3312 Steel Product Manufacturing from Purchased Steel

This industry group comprises establishments primarily engaged in manufacturing iron and steel tube and pipe, drawing steel wire, and rolling or drawing shapes from purchased iron or steel.

423 Merchant Wholesalers, Durable Goods

Industries in the Merchant Wholesalers, Durable Goods subsector sell capital or durable goods to other businesses. Merchant wholesalers generally take title to the goods that they sell; in other words, they buy and sell goods on their own account. Durable goods are new or used items generally with a normal life expectancy of three years or more. Durable goods merchant wholesale trade establishments are engaged in wholesaling products, such as motor vehicles, furniture, construction materials, machinery and equipment (including household-type appliances), metals and minerals (except petroleum), sporting goods, toys and hobby goods, recyclable materials, and parts:

- 4233 Lumber and Other Construction Materials Merchant Wholesalers
- 4235 Metal and Mineral (except Petroleum) Merchant Wholesalers
- 4236 Household Appliances and Electrical and Electronic Goods Merchant Wholesalers
- 4237 Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers
- 4246 Chemical and Allied Products Merchant Wholesalers: this industry group comprises establishments primarily engaged in the merchant wholesale distribution of chemicals, plastics materials and basic forms and shapes, and allied products.

212321 Construction Sand and Gravel Mining

This US industry comprises establishments primarily engaged in one or more of the following: (1) operating commercial grade (i.e., construction) sand and gravel pits; (2) dredging for commercial grade sand and gravel; and (3) washing, screening, or otherwise preparing commercial grade sand and gravel.

325120 Industrial Gas Manufacturing

This industry comprises establishments primarily engaged in manufacturing industrial organic and inorganic gases in compressed, liquid, and solid forms.

325180 Other Basic Inorganic Chemical Manufacturing

This industry comprises establishments primarily engaged in manufacturing basic inorganic chemicals (except industrial gases and synthetic dyes and pigments).

327310 Cement Manufacturing

This industry comprises establishments primarily engaged in manufacturing portland, natural, masonry, pozzolanic, and other hydraulic cements. Cement manufacturing establishments may calcine earths or mine, quarry, manufacture, or purchase lime.

327320 Ready-Mix Concrete Manufacturing

This industry comprises establishments, such as batch plants or mix plants, primarily engaged in manufacturing concrete delivered to a purchaser in a plastic and unhardened state. Ready-mix concrete manufacturing establishments may mine, quarry, or purchase sand and gravel.

327331 Concrete Block and Brick Manufacturing

This US industry comprises establishments primarily engaged in manufacturing concrete block and brick.

331110 Iron and Steel Mills and Ferroalloy Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) direct reduction of iron ore; (2) manufacturing pig iron in molten or solid form; (3) converting pig iron into steel; (4) making steel; (5) making steel and manufacturing shapes (e.g., bar, plate, rod, sheet, strip, wire);

(6) making steel and forming pipe and tube; and (7) manufacturing electrometallurgical ferroalloys. Ferroalloys add critical elements, such as silicon and manganese for carbon steel and chromium, vanadium, tungsten, titanium, and molybdenum for low- and high-alloy metals. Ferroalloys include iron-rich alloys and more pure forms of elements added during the steel manufacturing process that alter or improve the characteristics of the metal being made.

331315 Aluminum Sheet, Plate, and Foil Manufacturing

This US industry comprises establishments primarily engaged in (1) flat rolling or continuous casting sheet, plate, foil and welded tube from purchased aluminum; and/or (2) recovering aluminum from scrap and flat rolling or continuous casting sheet, plate, foil, and welded tube in integrated mills.

332996 Fabricated Pipe and Pipe Fitting Manufacturing

This US industry comprises establishments primarily engaged in fabricating, such as cutting, threading, and bending metal pipes and pipe fittings made from purchased metal pipe.

Professional and other services

2213 Water, Sewage and Other Systems

This industry comprises establishments primarily engaged in:

- Operating water treatment plants and/or operating water supply systems. The water supply system may include pumping stations, aqueducts, and/or distribution mains. The water may be used for drinking, irrigation, or other uses.
- Operating sewer systems or sewage treatment facilities that collect, treat, and dispose of waste.
- Providing steam, heated air, or cooled air. The steam distribution may be through mains.

4931 Warehousing and Storage

This industry comprises establishments primarily engaged in:

- Operating merchandise warehousing and storage facilities. These establishments generally handle goods in containers, such as boxes, barrels, and/or drums, using equipment, such as forklifts, pallets, and racks. They are not specialized in handling bulk products of any particular type, size, or quantity of goods or products.
- Operating refrigerated warehousing and storage facilities. Establishments primarily engaged in the storage of furs for the trade are included in this industry. The services provided by these establishments include blast freezing, tempering, and modified atmosphere storage services.
- Operating bulk farm product warehousing and storage facilities (except refrigerated). Grain elevators primarily engaged in storage are included in this industry.
- Operating warehousing and storage facilities (except general merchandise, refrigerated, and farm product warehousing and storage).

52 Finance and Insurance

The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:

1. Raising funds by taking deposits and/or issuing securities and, in the process, incurring liabilities. Establishments engaged in this activity use raised funds to acquire financial assets by making loans and/or purchasing securities. Putting themselves at risk, they channel funds from lenders to borrowers and transform or repackage the funds with respect to maturity, scale, and risk. This activity is known as financial intermediation.

2. Pooling of risk by underwriting insurance and annuities. Establishments engaged in this activity collect fees, insurance premiums, or annuity considerations; build up reserves; invest those reserves; and make contractual payments. Fees are based on the expected incidence of the insured risk and the expected return on investment.

3. Providing specialized services facilitating or supporting financial intermediation, insurance, and employee benefit programs.

In addition, monetary authorities charged with monetary control are included in this sector.

The subsectors, industry groups, and industries within the NAICS Finance and Insurance sector are defined on the basis of their unique production processes. As with all industries, the production processes are distinguished by their use of specialized human resources and specialized physical capital. In addition, the way in which these establishments acquire and allocate financial capital, their source of funds, and the use of those funds provides a third basis for distinguishing characteristics of the production process. For instance, the production process in raising funds through deposit-taking is different from the process of raising funds in bond or money markets. The process of making loans to individuals also requires different production processes than does the creation of investment pools or the underwriting of securities.

Most of the Finance and Insurance subsectors contain one or more industry groups of (1) intermediaries with similar patterns of raising and using funds and (2) establishments engaged in activities that facilitate, or are otherwise related to, that type of financial or insurance intermediation. Industries within this sector are defined in terms of activities for which a production process can be specified, and many of these activities are not exclusive to a particular type of financial institution. To deal with the varied activities taking place within existing financial institutions, the approach is to split these institutions into components performing specialized services. This requires defining the units engaged in providing those services and developing procedures that allow for their delineation. These units are the equivalents for finance and insurance of the establishments defined for other industries.

The output of many financial services, as well as the inputs and the processes by which they are combined, cannot be observed at a single location and can only be defined at a higher level of the organizational structure of the enterprise. Additionally, a number of independent activities that represent separate and distinct production processes may take place at a single location belonging to a multilocation financial firm. Activities are more likely to be homogeneous with respect to production characteristics than are locations, at least in financial services. The classification defines activities broadly enough that it can be used both by those classifying by location and by those employing a more top-down approach to the delineation of the establishment.

Establishments engaged in activities that facilitate, or are otherwise related to, the various types of intermediation have been included in individual subsectors, rather than in a separate subsector dedicated to services alone because these services are performed by intermediaries, as well as by specialist establishments, the extent to which the activity of the intermediaries can be separately identified is not clear.

The Finance and Insurance sector has been defined to encompass establishments primarily engaged in financial transactions; that is, transactions involving the creation, liquidation, change in ownership of financial assets; or in facilitating financial transactions. Financial industries are extensive users of electronic means for facilitating the verification of financial balances, authorizing transactions, transferring funds to and from transactors' accounts, notifying banks (or credit card issuers) of the individual transactions, and providing daily summaries. Since these transaction processing activities are integral to the production of finance and insurance services, establishments that principally provide a financial transaction processing service are classified to this sector, rather than to the data processing industry in the Information sector.

Legal entities that hold portfolios of assets on behalf of others are significant and data on them are required for a variety of purposes. Thus for NAICS, these funds, trusts, and other financial vehicles are the fifth subsector of the Finance and Insurance sector. These entities earn interest, dividends, and other property income, but have little or no employment and no revenue from the sale of services. Separate establishments and employees devoted to the management of funds are classified in Industry Group 5239, Other Financial Investment Activities.

5241 Insurance Carriers[1]

This industry group comprises establishments primarily engaged in underwriting (assuming the risk, assigning premiums, and so forth) annuities and insurance policies and investing premiums to build up a portfolio of financial assets to be used against future claims. Direct insurance carriers are establishments that are primarily engaged in initially underwriting and assuming the risk of annuities and insurance policies. Reinsurance carriers are establishments that are primarily engaged in assuming all or part of the risk associated with an existing insurance policy (or set of policies) originally underwritten by another insurance carrier.

5413 Architectural, Engineering, and Related Services

This industry comprises establishments primarily engaged in:

- Planning and designing residential, institutional, leisure, commercial, and industrial buildings and structures by applying knowledge of design, construction procedures, zoning regulations, building codes, and building materials.
- Planning and designing the development of land areas for projects, such as parks and other recreational areas; airports; highways; hospitals; schools; land subdivisions; and commercial, industrial, and residential areas, by applying knowledge of land characteristics, location of buildings and structures, use of land areas, and design of landscape projects.
- Applying physical laws and principles of engineering in the design, development, and utilization of machines, materials, instruments, structures, processes, and systems. The assignments undertaken by these establishments may involve any of the following activities: provision of advice, preparation of feasibility studies, preparation of preliminary and final plans and designs, provision of technical services during the construction or installation phase, inspection and evaluation of engineering projects, and related services.
- Drawing detailed layouts, plans, and illustrations of buildings, structures, systems, or components from engineering and architectural specifications.
- Providing building inspection services. These establishments typically evaluate all aspects of the building structure and component systems and prepare a report on the physical condition of the property, generally for buyers or others involved in real estate transactions. Building inspection bureaus and establishments providing home inspection services are included in this industry.
- Gathering, interpreting, and mapping geophysical data. Establishments in this industry often specialize in locating and measuring the extent of subsurface resources, such as oil, gas, and minerals, but they

1 For the purpose of the supply chain model, we have segmented NAICS 5241 (Insurance Carriers) out of the overall NAICS 52 to assess a more granular assessment.

may also conduct surveys for engineering purposes. Establishments in this industry use a variety of surveying techniques depending on the purpose of the survey, including magnetic surveys, gravity surveys, seismic surveys, or electrical and electromagnetic surveys.

- Performing surveying and mapping services of the surface of the earth, including the sea floor. These services may include surveying and mapping of areas above or below the surface of the earth, such as the creation of view easements or segregating rights in parcels of land by creating underground utility easements.
- Performing physical, chemical, and other analytical testing services, such as acoustics or vibration testing, assaying, biological testing (except medical and veterinary), calibration testing, electrical and electronic testing, geotechnical testing, mechanical testing, nondestructive testing, or thermal testing. The testing may occur in a laboratory or on-site.

5419 Other Professional, Scientific, and Technical Services

This industry group comprises establishments engaged in professional, scientific, and technical services (except legal services; accounting, tax preparation, bookkeeping, and related services; architectural, engineering, and related services; specialized design services; computer systems design and related services; management, scientific, and technical consulting services; scientific research and development services; and advertising, public relations and related services).

532412 Construction, Mining, and Forestry Machinery and Equipment Rental and Leasing

This US industry comprises establishments primarily engaged in renting or leasing heavy equipment without operators that may be used for construction, mining, or forestry, such as bulldozers, earthmoving equipment, well-drilling machinery and equipment, or cranes.

562219 Other Nonhazardous Waste Treatment and Disposal

This US industry comprises establishments primarily engaged in (1) operating nonhazardous waste treatment and disposal facilities (except landfills, combustors, incinerators and sewer systems or sewage treatment facilities) or (2) the combined activity of collecting and/or hauling of nonhazardous waste materials within a local area and operating waste treatment or disposal facilities (except landfills, combustors, incinerators and sewer systems, or sewage treatment facilities). Compost dumps are included in this industry.

811310 Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance

This industry comprises establishments primarily engaged in the repair and maintenance of commercial and industrial machinery and equipment. Establishments in this industry either sharpen/install commercial and industrial machinery blades and saws or provide welding (e.g., automotive, general) repair services; or repair agricultural and other heavy and industrial machinery and equipment (e.g., forklifts and other materials handling equipment, machine tools, commercial refrigeration equipment, construction equipment, and mining machinery).

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Center on Global Energy Policy

Navigating the U.S. Oil Export Debate

By Jason Bordoff and Trevor Houser

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EXECUTIVE SUMMARY

Recent innovations in the oil and gas sector have catalyzed a renaissance in US production and a dramatic turnaround in America's international energy trade position. US crude oil production has increased from 5 million barrels per day (b/d) in late 2006 to 9 million b/d in late 2014. Total petroleum production is over 12 million b/d, making the US the largest liquids supplier in the world. Rising production and declining petroleum consumption has reduced US import dependence from 60 percent to 26 percent over the past eight years.

Although the US will likely continue to consume more oil than we produce, and thus remain a net petroleum importer, there are growing concerns about the ability of the US refining system to absorb future growth in domestic crude production. Virtually all the recent and projected growth in US crude output is lighter weight and lower sulfur than the Canadian, Mexican, Venezuelan and Middle Eastern crudes many US refineries are currently configured to process. Refineries elsewhere in the world process light oil, but under current law, US crude oil exports are largely (though not entirely) prohibited. The growing mismatch between domestic crude supply and domestic refining capacity is prompting a re-evaluation of these export restrictions.

There are both proponents and opponents of increasing the amount of crude oil that can be exported from the United States. Domestic oil producers worry that without access to foreign markets, they will have to discount their oil to incentivize refiners to process it at existing facilities or cover the investment required to build new ones. Lower market prices for US crude producers could reduce upstream investment and future domestic production growth. Many refiners worry that allowing crude oil exports will raise domestic crude prices, harm their competitiveness and reduce the incentive for new refining investments. Consumers worry that exporting oil could increase gasoline and diesel prices and leave them more vulnerable to future international supply disruptions. And some environmental groups worry that allowing exports will result in more shale development domestically and more greenhouse gas emissions globally.

This report reviews the origin and current form of US crude export restrictions and analyzes the energy market, economic, security, geopolitical, trade and environmental implications of modifying or lifting those restrictions.

In short, we find:

- The original rationale for crude export restrictions no longer applies. Today's oil market looks very different than in the 1970s when current crude oil export restrictions were first put in place. At that time, the US had adopted domestic price controls to combat inflation and crude export restrictions were necessary to make those price controls effective. While price controls have long since fallen away, crude export restrictions remain.
- If recent production growth rates continue, a shortage of US light crude refining capacity will likely reduce domestic crude prices relative to international levels, slowing the pace of upstream investment and future crude output. Modifying or removing crude export restrictions would prevent this from occurring by allowing domestic producers to compete in global markets.
- Permitting companies to export crude oil in greater quantities may reduce the rents refiners receive relative to leaving current restrictions in place, but will likely decrease the price Americans pay for gasoline, diesel and other petroleum products and benefit the US economy as a whole.
- While the nature of the impact of lifting crude export restrictions is relatively clear, the timing and magnitude is highly uncertain. The recent decline in oil prices will slow the pace of US production growth and may delay the point at which domestic light crude refining capacity shortages occur. The speed and cost at which refiners could add or re-

configure capacity is unknown, as is the response of producers elsewhere in the world to any change in US supply.

- In light of these and other variables, we estimate lifting current crude export restrictions could increase US crude production anywhere between 0 and 1.2 million barrels per day on average between now and 2025, and reduce domestic gasoline prices by between 0 and 12 cents per gallon.
- Allowing exports would make the US more resilient, not less, to supply disruptions elsewhere in the world. Greater integration into global markets would make US oil supply more responsive to international market developments, mitigating the impact on American consumers and the US economy of production losses in other countries.
- Lifting crude export restrictions is consistent with past and present US trade policy priorities, would enhance US credibility in current and fu- ture trade negotiations, and avoid creating a prec- edent that could harm US trade policy objectives down the road.
- Increased US crude production can weaken the economic power, fiscal strength and geopolitical influence of other large oil producing countries. The magnitude of any export policy-driven impact is small, however, relative to recent oil market developments. More important for US foreign policy are the current crude trade relationships retained and new ones created if export restrictions are modified or lifted, along with the potential for greater US diplomatic leverage in future application of sanctions or pursuit of other objectives.
- To the extent allowing exports lowers crude oil and petroleum product prices, global oil demand will increase, along with oil-related CO_2 emissions. While we do not believe export restrictions are an appropriate or cost-effective way to reduce CO_2 emissions, it is critical that more aggressive policy actions in other areas are taken to demonstrate that boosting domestic supply can be consistent with meeting our climate objectives.

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INTRODUCTION

The application of hydraulic fracturing, horizontal drilling and seismic imaging to unlock oil from shale and other tight geologic formations has catalyzed a renaissance in US production and a dramatic turnaround in America's international energy trade position. US crude oil production has increased more than 70 percent over the past eight years, from just over 5 million barrels per day (b/d) in late 2006 to 9 million b/d in late 2014.[1] Combined with a more than 100 percent increase in output of natural gas liquids (NGLs), US oil production is approaching 12 million b/d.[2] Biofuels and refinery gains increase over- all US liquids output by another 2 million b/d, making the United States the world's largest producer.[3]

Although the United States will likely remain a net crude importer for the foreseeable future, there are growing concerns about the ability of the US refining system—much of which is currently configured to process heavy, sour imported crude—to absorb rapidly growing domestic light tight oil (LTO) production. Processing LTO in a refinery optimized for heavy crudes changes the mix of products produced (e.g., gasoline, diesel, kerosene, and fuel oil) and can reduce overall refinery sales revenue. Building new refineries to process domestic LTO takes both time and money. There are refineries elsewhere in the world configured to process light oil, but under current US law crude oil exports are largely prohibited.

US oil producers worry that without access to foreign markets, they will have to discount their oil to incentivize refiners to process it at existing facilities or to cover the investment required to build new ones. Lower domestic oil prices would reduce the revenue producers earn on their current output and could impact drilling activity and thus future growth in supply. Refiners worry that allowing crude oil exports will cause them to lose revenue, potentially becoming unprofitable in some cas-es, and reduce the incentive for investment in new domestic capacity. Consumers worry that lifting crude export restrictions could increase gasoline and diesel prices and leave them vulnerable to future international supply disruptions. For many environmental groups, allowing crude exports exacerbates existing concerns over the local and global environmental impact of the US oil and gas renaissance.

This report, a collaboration between the Center on Glob- al Energy Policy at Columbia University and the econom- ic research firm Rhodium Group, attempts to help both policymakers and stakeholders navigate this complex issue by providing an overview of the origin and current form of crude export restrictions in the United States and an objective, fact-based assessment of the energy market, economic, security, geopolitical, trade, and environmen- tal implications of modifying or lifting those restrictions. The report is organized in seven sections:

1. The origin of US oil export limits. Current export restrictions were adopted during the 1970s, a period of extreme economic interventionism, including econo- my-wide wage and price controls. By 1981 the price controls on crude oil had been eliminated, but export restrictions persisted. At several points since the 1970s, presidents from both political parties have taken steps to relax these restrictions for targeted reasons—from addressing excess production of heavy California crude oil to fostering free trade in energy with Canada to opening markets for Alaskan crude. The recent spike in US crude production has prompted a reevaluation of crude export restrictions as a whole.

2. What's driving the current debate. We examine the renaissance in US oil production and how it is changing the country's energy trade position. We provide an overview of the domestic refinery system and its ability to process additional LTO. We discuss the factors determining when and to what extent the current crude export restrictions will distort market outcomes on a persistent and significant basis, including the impact of the recent drop in oil prices.

3. The economic impacts of allowing exports. This section begins with a discussion of what economic the-

Although the United States will likely remain a net crude importer for the foreseeable future, there are growing concerns about the ability of the US refining system—much of which is currently configured to process heavy, sour imported crude—to absorb rapidly growing domestic light tight oil (LTO) production.

ory and empirical evidence can tell us about the impact of allowing crude exports on producers, refiners, and consumers. We review all major crude oil export studies conducted to date and explain the assumptions and methodological choices that determine their findings. We identify the variables that will determine the impact of allowing crude exports on domestic production, refined petroleum prices, and overall economic output. We suggest a likely range of potential impacts based on both our review of existing studies and assessment of current oil market dynamics.

4. Energy security consequences. For decades, policymakers have extolled the benefits of "energy independence." Allowing crude exports would increase US integration in global oil markets, seemingly at odds with long-held energy security objectives. We stress-test past energy security assumptions and evaluate both the pros and cons of greater energy interdependence.

5. Geopolitical and trade policy considerations. We examine the consistency of current crude export restrictions with existing international trade commitments and implications for current and future trade talks. We review the broader geopolitical implications of allowing crude exports, including the impact on US diplomatic leverage and specific bilateral relationships.

6. Environmental risks. We discuss the local environmental risks associated with domestic tight oil production, and quantify the potential impact on global greenhouse gas (GHG) emissions of allowing crude exports.

7. Policy options. We describe the policy tools available to policymakers to modify current export restrictions if they choose to do so, including both congressional and administrative actions.

THE ORIGIN OF OIL EXPORT RESTRICTIONS

The 1970s shook the oil industry to the core and brought energy security to the fore of American public consciousness. Resource nationalization, the end of the dominance of the "Seven Sisters" international oil companies, the Arab oil embargo, andthe revolution in Iran redrew the global energy map.

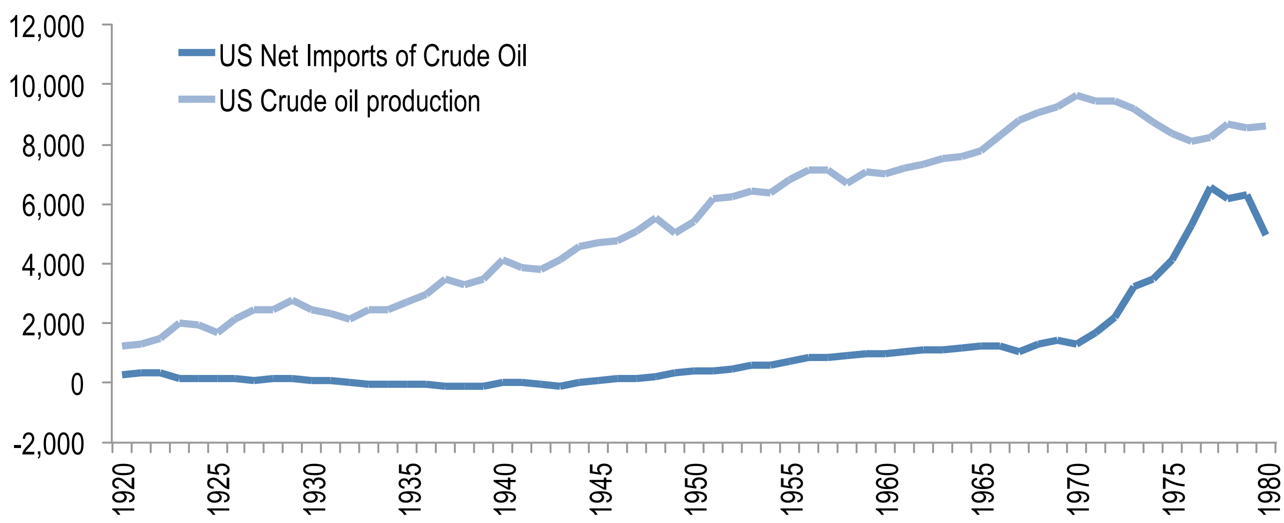
These events in the 1970s are often credited with giving rise to concerns about oil "scarcity" that ultimately led to restrictions on the export of oil. But the seeds of the oil export ban were sown years earlier. Preceding the export ban was more than a decade of oil import restrictions aimed at addressing the threat to US producers posed by cheap Middle East crude. Despite these protections, US oil production peaked in 1970 and began a decades-long decline.

The peak in production immediately preceded a series of far-reaching economic measures by President Nixon to fight rising inflation, rising unemployment, and a growing US balance of payments deficit. Nixon started by taking the US dollar off the gold standard and followed up with econo- my-wide price and wage controls. Oil exports were not an issue at first, as the price of crude within the United States was higher than international levels. After the 1973 Arab oil embargo, however, international crude prices soared, giv- ing US producers an incentive to sell their crude abroad. To defend domestic price controls, the government introducedoil export restrictions. While price controls have long since been abandoned, oil export restrictions persist.

WHERE OIL TRADE RESTRICTIONS GOT THEIR START

While current export laws date back to the 1970s, the United States began restricting oil trade in the 1950s. At that time cheap oil from Venezuela and the Middle East

Figure 1: US crude oil production and net crude oil imports 1920–1980
(1,000s b/d)



Source: EIA.

A BRIEF HISTORY OF OIL PRICE REGULATION

The Nixon administration's ninety-day freeze on prices, including oil, in August 1971 was Phase I of what came to be a four-phase program of price controls.[1] The price controls applied to more than just oil, but oil was usually treated differently than other goods during each subsequent phase. Phase II of the price controls in November 1971 were more flexible than Phase I by allowing prices to be raised to reflect increases in input costs, but oil prices were effectively frozen at Phase I levels. Oil supply issues became more acute, and regional heating oil shortages emerged in the winter of 1971. Gasoline shortages hit in the summer of 1972.[2] And the heating oil shortages were repeated in the winter of 1972–1973, especially in inland areas without access to imported products.[3] In early 1973, the economy-wide price control regime had moved to Phase III, which was a voluntary version of the Phase II controls. Under this voluntary system, the ongoing heating oil shortage resulted in a very sharp increase in heating oil prices. As a result, in March 1973 the administration set a special rule reimposing strict price controls on the twenty-three largest oil companies (accounting for 95 percent of oil sales).[4]

The large firms subject to these Phase III price controls had a reduced incentive to import oil because they could not pass along the increasing prices for imported crude oil, and a reduced incentive to invest in expanding production, which contributed to the supply crunch. Moreover, smaller producers and refiners were exempt from price controls, providing them with a competitive advantage and leading to increased calls for the federal government to become involved in not just setting prices of oil products but in regulating a "fair" allocation of oil.

In response to generally rising prices through the first half of 1973, the Nixon administration instituted a sixty-day economy-wide price freeze from June to August 1973. After August 1973, the price control system moved to Phase IV, again with the petroleum industry subject to a separate set of more stringent price controls.

The core of these Phase IV price controls on oil was a two-tiered pricing system for domestic crude oil. To try to remove the disincentive for investing in more production, the system distinguished between "old oil" and "new oil." Old oil was that from fields already in production, while new oil was that from fields in which the government was hoping to spur development.[5] The price for old oil was controlled, but the price for new oil was not (imported oil also remained uncontrolled).[6] To administer the system, the federal government had to become heavily involved in administering an increasingly complex set of allocation rules.

These Phase IV oil price controls and allocation rules were later codified and extended by the Emergency Petroleum Allocation Act of 1973, passed in November 1973.

Price controls remained in place until President Carter began to phase them out in 1979, part of an effort to boost domestic production, with President Reagan completing their elimination in 1981.

was making its way to US shores in rising volumes, threatening more expensive domestic production (Figure 1). In response, President Eisenhower limited imports of crude oil, refined fuel, and unfinished oils under the Mandatory Oil Import Program (MOIP) in 1959.[4] The rationale behind the import restrictions was that "crude oil and the principal crude oil derivatives and products are being imported in such quantities and under such circumstances as to threaten to impair the national security."[5] The concern was not just increased US import dependence, but also that domestic production capacity would wither in the face of the surplus of foreign supply. MOIP import limits resulted in up to a 70 percent premium for US oil relative to oil produced in the Middle East and spurred an increase in domestic oil production.[6] US crude output rose by nearly 2.6 million b/d between 1959 and 1970,[7] the second largest expansion in US history, behind only the nearly 3.6 million b/d increase in US crude production over the last five years.[8] While protectionist measures did result in greater US production, critics argued they also resulted in excessive resource depletion, created "deadweight" economic losses, facilitated an unjustified transfer of wealth to refiners who were allocated import rights and could thus obtain cheaper international crude, and drove up prices for US consumers relative to those in other nations.[9]

Despite artificially high domestic oil prices, US consumption grew rapidly. US gasoline demand expanded by 46 percent between 1960 and 1970 due to overall economic growth, suburbanization, and the proliferation of large, inefficient passenger vehicles.[10] Increasing amounts of petroleum products were also being used in factories, pow- er plants, and homes, partly in response to air pollution concerns that prompted utilities to switch from coal to less-polluting oil.[11]

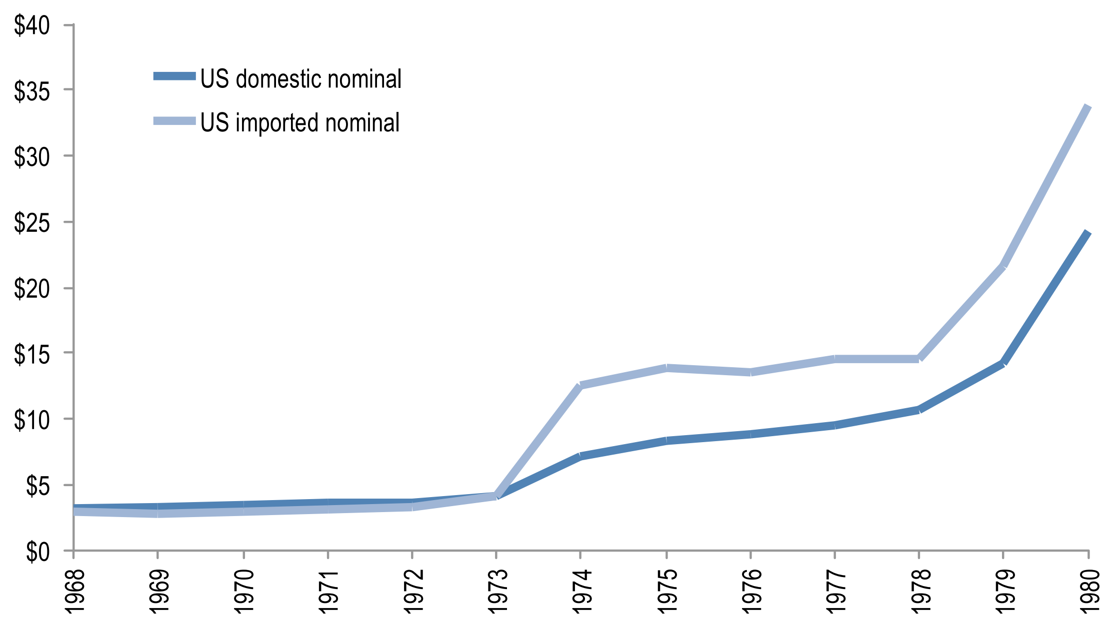
INFLATION AND PRICE CONTROLS

The first signs of an oil supply crunch were already emerging by 1970, with warnings about potential brownouts, blackouts, and fuel rationing in some regions.[12] US crude production peaked in 1970 at just over 9.6 million b/d. In March 1971, for the first time in a quarter century, the Texas Railroad Commission allowed all-out production at 100 percent of its capacity, a historic watershed in the US oil industry that ended the practice of holding actual production below capacity, providing the world with a security reserve that could be called on in times of emergency.[13]

As oil production headed into its long decline, and demand showed no sign of slowing, it was clear that imports would have to make up a larger proportion of US supply. In recognition, import quotas under the MOIP began to be relaxed throughout 1970 to bring in more oil supplies.[14] Imports as a share of total oil consumption thus rose from 19 percent in 1967 to 36 percent in 1973.[15]

At the same time, the economy was experiencing worrying levels of inflation (as high as 6 percent annually in 1970),[16] high levels of unemployment, and a sharp deterioration in the US balance of payments. With political pressure mounting to address these economic issues and an election looming in 1972, President Nixon took several unprecedented economic steps. On August 15, 1971, he announced a plan that included taking the US off the gold standard, and instituting a 90-day economy-wide freeze on wages and prices—including on oil.[17] The temporary freeze turned into a program of various price and wage control measures that persisted for the next three years— and continued for the next decade for crude oil (See box, "A Brief History of Oil Price Regulation").[18]

Figure 2: Prices paid by US refiners for domestic and imported crude oil
In nominal US dollars/barrel



Source: EIA, "Crude Oil Refiner Acquisition Costs."

THE EMERGENCE OF EXPORT RESTRICTIONS

Even before the Arab oil embargo caused an oil scarcity panic, the phrase “energy crisis” had already emerged as part of the American political vocabulary along with growing concern that a major supply problem loomed.[19] In April 1973 Nixon delivered his second energy mes- sage to Congress outlining additional measures to spur greater development of all domestic energy resources and improving conservation measures. For oil, he not only discussed greater domestic production but an- nounced that he was abolishing the import quota sys- tem because domestic supply could no longer keep up with demand.[20]

Then, in October 1973, the Arab oil embargo jolted the energy system by taking 5 million b/d off the world oil market at a time when demand was growing at an annual rate of nearly 8 percent.[21] As concerns about energy sup- plies swelled, President Nixon announced Project Inde- pendence, which laid out conservation measures and plans to develop reserves in an effort to make the country energy independent by 1980.

When President Nixon had first imposed petroleum price controls, domestic US crude prices (around $3.50 per barrel) were higher than the prevailing global oil price (at less than $3 per barrel in 1970). By 1974, glob- al oil prices had risen to $12.52 per barrel while domes- tic oil prices averaged $7.18, thus creating an incentive for producers to look abroad to sell at higher prices, which would have undermined the price control system (Figure 2).

The Emergency Petroleum Allocation Act of 1973

The Emergency Petroleum Allocation Act (EPAA) of 1973, passed on 27 November 1973, codified and ex- tended the complex set of Phase IV oil price controls and allocation regulations that had been adopted earlier that year.[22] The EPAA also determined that “shortages of crude oil, residual fuel oil, and refined petroleum product caused by inadequate domestic production, environmental con- straints, and the unavailability of imports sufficient to sat- isfy domestic demand, now exist or are imminent.”[23] The stated purpose of the EPAA was to authorize and direct the president to exercise specific temporary authority to deal with the artificial oil shortage by allocating oil sup- plies, including ensuring that such supplies were allocated to end users in the United States. To implement the export restriction in the act, crude oil was controlled for short supply reasons under the Export Administration Act of 1969, which authorized the president to limit exports of resources determined to be scarce. This action subjected exports of crude and refined products to regulation and licensing by the Bureau of East West Trade (predecessor to the Bureau of Industry and Security [BIS]), which would allocate limited oil exports to countries based on preexist- ing trade relations.[24]

The Trans-Alaska Pipeline System Act

The Trans-Alaska Pipeline System (TAPS) Act sought to speed up development of Alaska’s vast North Slope re- sources, which had been discovered in 1968. The devel- opment of those resources had been held up in part by environmental concerns regarding their extraction and in part by a debate over the pipeline route that would be used to get the crude to market.

Lawmakers from the northern Midwest favored a pipe- line through Canada, which would feed regional refin- eries. Proponents of an alternative pipeline to a port at Valdez, Alaska, argued that this would be the quickest way to get crude to market. Opponents argued that a sea route meant some of the oil would end up in Japan, the market where it would likely fetch the highest price. Indeed, a 1971 study by the Department of the Interior found that British Petroleum, which owned 50 percent of the Prudhoe Bay field reserves, had signed an agreement with a group of Japanese oil companies “which would include marketing an undisclosed amount of (Alaskan) crude oil in Japan.”[25]

The compromise TAPS Act, passed shortly before the EPAA in 1973, selected the route to the Port of Valdez and amended the Minerals Leasing Act (MLA) of 1920 to forbid the export of crude from any pipeline granted rights of way through Section 20 of that act, subject to some exceptions discussed later.[26]

The act allowed some exports with countries bordering the United States, exports of convenience of transport (i.e., through the Panama Canal to the US Gulf Coast),[27] or ex- changes for equal quantities of crude oil for the efficiency of trade, which helped protect the vital Canadian-US cross border trade.[28]

CONGRESS MAKES OIL EXPORT RESTRICTIONS PERMANENT

While the Arab oil embargo ended in March 1974, heightened political attention to oil shortages and security of supply persisted. President Gerald Ford highlighted energy independence in his 1975 State of the Union message and signed the Energy Policy and Conservation Act (EPCA) into law in December 1975. EPCA expanded the two- tiered oil pricing system into a three-tiered system, created the Strategic Petroleum Reserve, made the United States a member of the International Energy Program (IEP) through the newly formed International Energy Agency, and increased fuel efficiency requirements. It also direct- ed the president to "promulgate a rule prohibiting the ex- port of crude oil and natural gas produced in the United States," with some exceptions, including those necessary for participation in the IEP. This was a more direct statu- tory export prohibition than that in the EPAA.

EPCA provided authority and discretion to the president by allowing him to make a "class of seller or purchaser, country of destination, or any other reasonable classification or basis as the President determines" exempt from the ban, as long as it is determined to be in the national interest and align with the purpose of EPCA. In considering the national interest, the presidential finding must take into account that EPCA does not interfere with exchanges of crude oil with foreign governments or persons for the convenience of increased efficiency of transportation, temporary exports for convenience or increased transport efficiency and which will later be reimported, or historical trading relations with Canada and Mexico. With respect to price controls for crude oil, EPCA gave the president the authority to loosen them and to do away with them entirely anytime after 1979.

As the government moved to create laws governing the development of oil and natural gas resources, it expanded efforts to increase domestic production through the Naval Petroleum Reserve Production Act (NPRPA) of 1976 and the Outer Continental Self Lands Act (OCSLA) Amend- ments of 1978. In all these cases, production is "subject to all of the limitations and licensing requirements of the Ex- port Administration Act." And exports are only permitted if the president finds such exports "are in the national interest" and "will not diminish the total quantity or quality of petro- leum available in the United States" or, in the case of OCS- LA, "will not increase reliance on imported oil or gas."[29]

THE EVOLUTION OF EXPORT RESTRICTIONS THROUGH EXECUTIVE BRANCH ACTION

Findings by both the president and the secretary of commerce subsequently altered these laws. President Jimmy Carter announced in June 1979 a phased decontrol of oil prices as part of an effort to stimulate domestic production, while international oil prices spiked from $14 a barrel to $35 a barrel in early 1981 following the Iranian Revolution.[30] In his first executive order upon entering office in 1981, President Ronald Reagan finished the job by eliminating the remaining price controls for oil and refined products.[31]

In October 1981 the Department of Commerce removed quantitative limits on the export of all refined products. An interagency task force had concluded that allowing exports of refined products would be in the national interest, that the domestic economy was no longer threatened by excessive drain of a scarce natural resource, and that US consumers would benefit if refiners had greater marketing flexibility.[32]

In 1985 President Reagan determined export of crude oil to Canada for internal consumption was in the national interest, as part of a declaration liberalizing energy trade between the two countries. The findings were made un- der EPCA, Section 28 of the MLA, the Trans-Alaska Pipe- line Authorization Act, and the OCSLA.[33] Notably, crude transported over the Trans-Alaska Pipeline or derived from the Naval Petroleum Reserves was excluded.

Using authority delegated by the president pursuant to section 103 of EPCA in 1976, the secretary of commerce determined (also in 1985) that exports of crude oil from Alaska's Cook Inlet were in the national interest and should not be subject to the restrictions in EPCA, NPRPA, OCS- LA, or MLA. The finding cited the incentives that would be created for exploration and development of domestic crude, transportation, and for the energy security of our al- lies, and said the initiative "will also encourage other coun- tries to remove trade barriers to US goods and services. It does not affect our energy security as we retain the flexibil- ity to react to changes in the world's available oil supply."[34]

In 1988 President Ronald Reagan allowed certain additional oil exports to Canada as part of the United States–Canada Free Trade Agreement. Up to 50,000 b/d of crude transported over the Trans-Alaska Pipeline were allowed to be shipped to Canada, as well as oil derived from the National Petroleum Reserves.[35]

In 1992 President George Bush found that exports of heavy California crude (API of 20 degrees or lower) of up to 25,000 b/d were in the national interest.[36] Production of heavy California crude had eclipsed the ability of the state's refiners to process that quality crude, resulting in a surplus that was driving down prices at the same time that the world oil price had crashed. The California Independent Petroleum Association at the time noted that demand for the crude in the state was also weakening due to new state air quality restrictions, and that due to the Jones Act tanker laws, the heavy California crude could not be marketed into the US East Coast competitively against foreign heavy crude.[37] Rather than abandon certain wells, the export outlet was deemed to provide a potential price boost that would make continued production economic.

Exports of crude oil from Alaska's North Slope were allowed under a finding by President Bill Clinton in 1996, which stated that exports of crude oil that had been transported over rights-of-way granted in Section 203 of the Trans-Alaska Pipeline Authorization Act were in the national interest.[38] The finding followed the passage of a law by Congress in 1995 that authorized such exports subject to a presidential determination. Along with determina- tions that the exports would not diminish the total quan- tity or quality of oil available to the United States and that it would not cause shortages or sustained oil price increases significantly above world market levels, it was noted in the Federal Registry that only US-flagged and -owned vessels (but not necessarily US-built) were allowed to carry TAPS oil for export. Critics of the ban on ANS exports had attacked it on claims that development of Alaskan oil was restricted, as prices into the domestic market did not promote production and were limiting economic and jobs growth. The General Accounting Office found in a 1999 study that lifting the ban resulted in higher Alaskan North Slope and California oil prices than would otherwise have been the case, and thus "future production should increase because the ban was lifted."[39]

CURRENT REGULATIONS GOVERNING PETROLEUM EXPORTS

Crude oil

Current BIS regulations reflect these various administrative decisions over the years to create specific categories of allowable exports of crude oil. Crude oil exports are not allowed unless they fit into one of the following categories, for which an export license from BIS is required, or upon an individualized showing that export is in the national interest:[40]

- Exports from Alaska's Cook Inlet
- Exports to Canada for consumption or use therein
- Exports in connection with refining or exchange of strategic petroleum reserve oil
- Exports of heavy California crude oil up to an average volume not to exceed 25,000 b/d
- Exports that are consistent with certain international agreements
- Exports that are consistent with findings made by the president under an applicable statute
- Exports of foreign origin crude oil where the exporter can demonstrate that it has not been commingled with oil of US origin
- Exports pursuant to an exchange meeting statutory criteria

As noted above, exports from Alaska's North Slope are also permitted under a license exemption. (The regulations refer to exports transported by pipeline over rights of way granted via the Trans-Alaska Pipeline System, which covers only Alaska North Slope crude.)

If the application to BIS falls within one of these categories, it is presumed to be permissible and is generally granted in a timely fashion. The largest category of exports is typically to Canada. There have also been increasing volumes of foreign crude (mainly from Canada) that have been re-exported from the United States. These require that the exporter can demonstrate to BIS that the oil has not been commingled with oil of US origin. Recent reports have noted that Canadian crude has been re-exported, albeit in relatively small amounts, to Italy, Singapore, Spain, and Switzerland.[41]

Beyond these permitted categories, BIS will also review other applications on a case-by-case basis and "generally will approve such applications if BIS determines that the proposed export is consistent with the national interest and the purposes of the Energy Policy and Conservation Act (EPCA)." BIS explains that certain kinds of transactions will be considered to meet that standard, the most important of which are swaps.

According to BIS, a swap is in the national interest when it:

- will result *directly* in the importation into the US of an *equal or greater quantity* and an *equal or better quality* (emphasis added) of crude oil or of a quantity and quality of petroleum products . . . that is not less than the quantity and quality of commodities that would be derived from the refining of the crude oil for which an export license is sought;
- will take place only under contracts that may be terminated if the petroleum supplies of the US are interrupted or seriously threatened; and
- in which the applicant can demonstrate that, for compelling economic or technological reasons that are beyond the control of the applicant, the crude oil cannot be reasonably marketed in the US.

There is considerable uncertainty as to precisely how this regulatory language might be implemented. It may be challenging for applicants to demonstrate that the crude could not be reasonably marketed in the United States for "compelling economic or technological reasons." After all, there is some price at which refiners will take the crude (either making necessary capital investments in equipment to run more light crude and/or reducing total throughput), raising the question of how large the differential needs to be between US and world crude prices to be a "compelling economic reason."

Additionally, light oil is typically valued more highly than heavy oil in the global market and thus could be considered better quality. In the United States, however, significant refinery investments have been made to process heavy crude (see following section). As a result, exchange applications may have difficulty demonstrating that the heavy oil being imported is of "equal or better quality" than the light oil being exported. This may be addressed, potentially, by importing more heavy crude than the export volume, demonstrating the better margin yield for domestic refiners of processing imported heavy oil, or by importing product rather than crude.

BIS ADMINISTRATION EXPORT LICENSES FOR SHORT SUPPLY CONTROLS

In September of 1979, Congress passed the renewal of the Export Administration Act, which regulates exports of dual-use goods and technologies (i.e., goods with civilian uses that could also "contribute to the military potential" of other countries), and exports of scarce goods to protect the economy from the "excessive drain" of scarce materials. The 1979 EAA did not independently repeat the export restriction on domestically produced crude oil, as that restriction was already in place pursuant to EPCA.

Licenses are controlled by the department's Bureau of Industry and Security, and the rules of licensing are spelled out in the Export Administration Regulations, which implement the provisions of the EAA's short supply control list. While EPCA directs the president to restrict crude oil exports, it is through the authority granted by the EAA to the president that BIS promulgated regulations to control exports for national short supply purposes, as well as national security and foreign policy.

Over the years, the number of goods controlled for short supply reasons has dwindled. Short supply controls currently cover only crude oil, unprocessed western red cedar from federal or state lands under harvest contracts entered into after 30 September 1979 (excluding unprocessed western red cedar timber harvested from public lands in Alaska, private lands, and Indian lands), and horses exported by sea for the purpose of slaughter.

The 1979 EAA expired in 1989 but has been reauthorized several times over the years. The last reauthorization expired in 2001, and it has since been extended by presidents using the authority granted in the International Emergency Economic Powers Act through a declaration of national emergency.[1]

Under BIS regulations, the distinction between crude oil and refined products turns on whether the liquid hydrocarbons at issue have been processed through a crude distillation tower.

For most of these categories of permissible exports, a license is required from BIS. That licensing process is not public, so we do not know how many licenses have been granted or how many applications have been submitted. The lack of transparency is due to the sensitive national security issues, such as dual-use technologies, that BIS often deals with in its licensing regime, as well as the commercial sensitivity of crude oil export licenses that are granted on a cargo-by-cargo basis. This is in contrast, for example, to the public approval process for natural gas exports, which are granted for a period of time to a particular entity.

Refined products

Refined product exports are allowed and do not require a license. This means that the distinction between "crude oil" and "refined products" is crucial to current export policy.

Under BIS regulations, the distinction between crude oil and refined products turns on whether the liquid hydrocarbons at issue have been processed through a crude distillation tower. In the regulations,[42] crude oil is defined as a mixture of hydrocarbons that:

- existed in liquid phase in underground reservoirs;
- remains liquid at atmospheric pressure after passing through surface separating facilities; and
- which has *not been processed through a crude oil distillation tower* (emphasis added).

According to this definition, any liquid hydrocarbon that has been through a crude oil distillation tower is not crude oil, and therefore can be exported without a license. Indeed, as discussed in the following section, the United States today is the largest refined petroleum exporter in the world. Product exports are mostly out of the Gulf Coast, while product imports are mostly to the East Coast.[43]

Generally, people had understood the requirement of processing through a distillation tower to equal being processed through a full-fledged refinery, or at least to be separated into multiple, unfinished product streams. Recently, various companies have been investing in less expensive condensate splitters (costing hundreds of millions of dollars as opposed to billions of dollars for a full-fledged refinery) along the Gulf Coast to process crude oil for export. And, as explained in the next section, at least two recent BIS classification rulings indicate that even simpler processing of stabilization followed by treatment through a distillation tower qualifies very light crude oil, known as "condensate," for export as a refined product.

On 30 December 2014, BIS issued a set of FAQs that identified six factors it will consider, among others, in determining whether liquid hydrocarbons have been "processed through a crude oil distillation tower."[44] In short, BIS requires that the distillation process materially transform the crude oil inputs into a chemically distinct output that is of different API gravity and has a particular purpose other than just making the crude exportable, such as use as feedstock, diluent or gasoline blend stock.

While it will be necessary to see how BIS applies these criteria in practice in order to fully understand their impact, the new FAQs make clear a few important points. First, BIS has clearly indicated that "processes that utilize pressure reduction alone to separate vapors from liquid or pressure changes at a uniform temperature, such as flash drums with heater treaters or separators, do not constitute processing through a crude oil distillation tower." Second, it is clear that companies may now export lightly processed condensate that has been both stabilized and processed through a field distillation tower, as was approved in the summer of 2014 for at least two other companies (discussed in the next section).

Indeed, given that a license is not needed to export refined product, the new BIS FAQs should make it easier for other companies, including the many reportedly with pending classification requests at BIS, to self-certify their cargoes as available for export and bypass BIS classification rulings altogether. Third, although much of the commentary around the new FAQs focused on their impact on condensate exports, with projections of condensate exports in the range of 300,000 to 500,000 b/d,[45] the language of the FAQs applies to all liquid hydrocarbons, and it remains to be seen whether simple processing with a distillation tower of light oil (e.g., 40 or 45 API gravity) would also be sufficient to make the light oil exportable as refined product.

Condensate

Condensate is very light hydrocarbon liquid. While there is no precise definition, it is generally considered to be higher than 50 degrees API gravity.[46] Condensate is treated differently for export purposes depending on its source—even if the liquid from the different sources are chemically essentially the same thing. Condensate that comes straight off a wellhead—so-called lease condensate—is considered crude oil from the perspective of BIS regulations and thus is not exportable without a license.[47] "Plant condensate"[48] that results from the processing of natural gas, on the other hand, is allowed to be exported.

Recently, BIS issued at least two classification rulings[49] to Pioneer Natural Resources and Enterprise Product Partners that, according to public reports of the nonpublic rulings, found that Eagle Ford condensate that has been both stabilized and processed through a field distillation tower[50] is considered refined product and, thus, can be exported. The reports of these rulings took many by surprise because this is a much simpler process than that used in a full-fledged refinery.

There remains some uncertainty about how much processing of the condensate is required to classify it as a refined product rather than crude oil. As discussed in the prior section, that uncertainty was significantly mitigated by recent FAQs released by BIS that seem to make clear that the sort of lightly processed condensate approved for export by Pioneer and Enterprise will be permissible for others to export as well. This clarification is important because stabilization and field distillation towers are much cheaper than splitters, hydroskimmers, or distillation towers at refineries.

Some observers have noted that potential conflict exists with BIS treatment of lease condensate as crude oil in the first place since the BIS regulations state that crude oil "existed in liquid phase in underground reservoirs." But most lease condensate exists in a gas phase underground and condenses at atmospheric conditions.[51] This legal claim may face difficulty, however, because the BIS regulations explicitly include "lease condensate" in the definition of crude oil.[52]

THE CURRENT DEBATE OVER EXPORTING US OIL

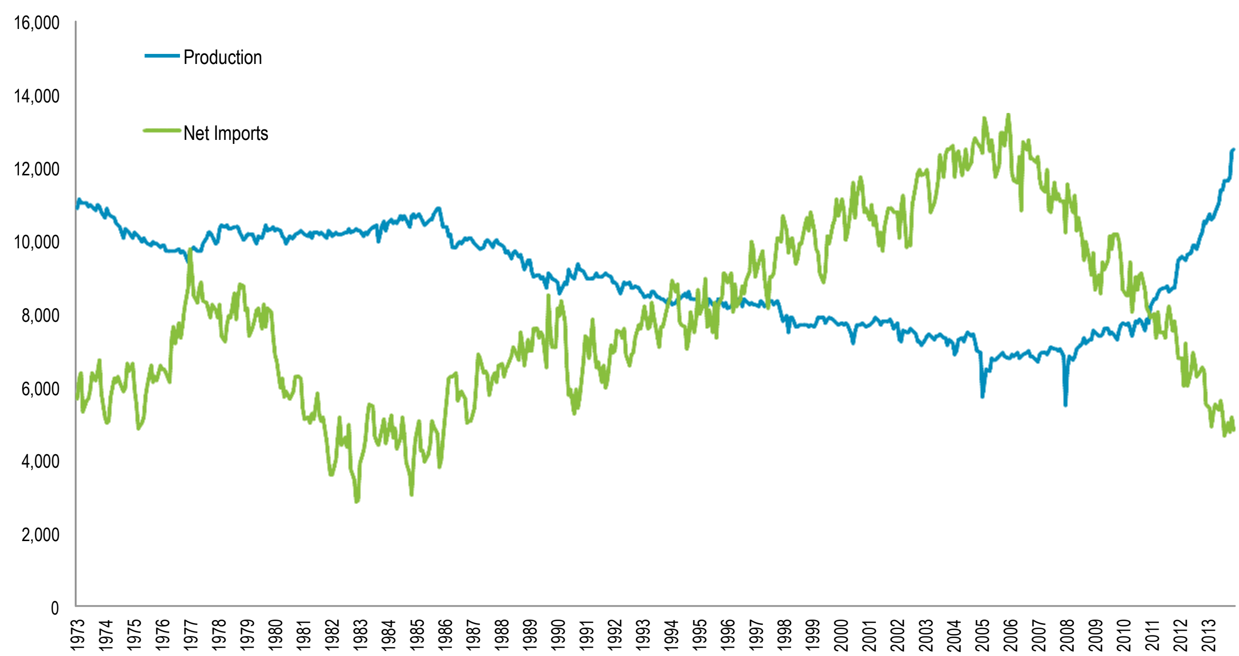
THE US OIL BOOM

While US oil export restrictions have evolved gradually over the past forty years, US oil market conditions changed dramatically over the past few years, prompting a reevaluation of export restrictions in their entirety. The application of hydraulic fracturing, horizontal drilling, and seismic imaging to tight oil formations has catalyzed a renaissance in US oil production. After peaking at 11.3 million b/d in 1970, US production began a multi-decade decline, falling to 6.8 million b/d in 2006.[53] US oil demand grew by 6 million b/d over the same period, leaving the country dependent on imports for up to 60 percent of total supply.[54] Since 2008, however, US oil production has recovered dramatically. Crude supply is up more than 3.8 million b/d as of September 2014, to 8.86 million b/d, with significant gains in 2012, 2013 and 2014.[55] Production of oil-like natural gas liquids (NGLs) from shale and other gas wells has doubled from 1.7 to 3.3 million b/d,[56] bringing the total US supply to 11.9 million b/d. This surge has entirely erased the previous multidecade decline (Figure 3).

While US oil supply has grown, demand has declined nearly 1.8 million b/d since 2006.[57] Vehicle efficiency has improved significantly due to both high oil prices and new federal fuel economy standards.[58] Changing driving patterns have limited the growth of vehicle usage.[59] Tax incentives and federal mandates for ethanol have further eroded the domestic market for gasoline.[60]

In the face of falling demand, the surge in domestic crude production has translated into a sharp reduction in the US

Figure 3: US oil production and net imports 1973-2014
Crude, condensates and NGLs, 1,000s b/d



Source: EIA, Monthly Energy Review, December 2014.

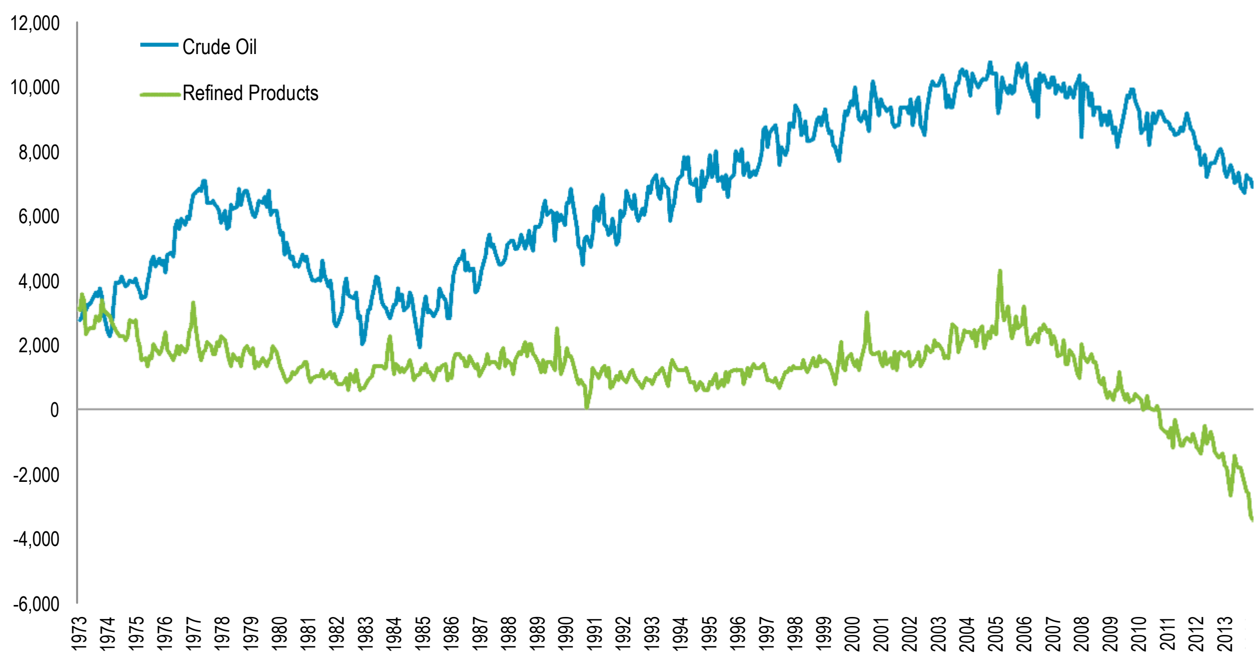
petroleum trade deficit. In 2006 the United States imported more than 12 million b/d, on net, of crude oil and refined petroleum products (Figure 3). During the first three quarters of 2014, that number fell to 5.2 million b/d. As discussed above, there is no legal restriction on the export of refined pe- troleum products, and in less than a decade the United States has gone from being the world's largest product importer to the largest exporter of refined products on a gross basis (and second largest on a net basis).[61] In 2006 the United States imported 2.5 million b/d of net gasoline, diesel, fuel oil, and other petroleum products (Figure 4). During the first three quarters of 2014, the United States exported 2.2 million b/d net. Net US crude imports have fallen from 10.1 million b/d to 7.1 million b/d over the same period.

GETTING THE OIL TO MARKET

This dramatic turnaround in US oil production has upend- ed the domestic oil transportation system. When US crude production was declining, most new pipeline and refinery investments were made to facilitate the transport and pro- cessing of imported crude. Pipelines were built out to move crude from the US Gulf Coast to refineries in the Midwest. More than half of all US refining capacity is located along the US Gulf Coast (Table 1) known as the "PADD 3" region in the oil industry (see separate box on the PADD system), close to large import terminals. Another quarter of US ca- pacity is on the East and West Coasts (PADD 1 and PADD 5 respectively). That leaves a little less than a quarter of US capacity in interior states (PADD 2 and PADD 4), where much of the recent surge in US oil production has occurred.

As these "Midcontinent" refineries became quickly saturat- ed with domestic crude, much of it produced in the Bakken region of nearby North Dakota, producers began seeking out other markets.[62] Over the past few years pipelines run- ning from the Gulf of Mexico inland have been reversed, and midstream companies have scrambled to build addi- tional capacity. In the absence of sufficient pipeline capacity, producers have returned to shipping oil by rail, a practice previously abandoned due to relatively high transportation costs (Figure 5). Rail shipments have given East Coast and, increasingly West Coast, refineries access to domestic crude.

Figure 4: Crude and refined product net imports
1,000s b/d



Source: EIA, Monthly Energy Review, December 2014.

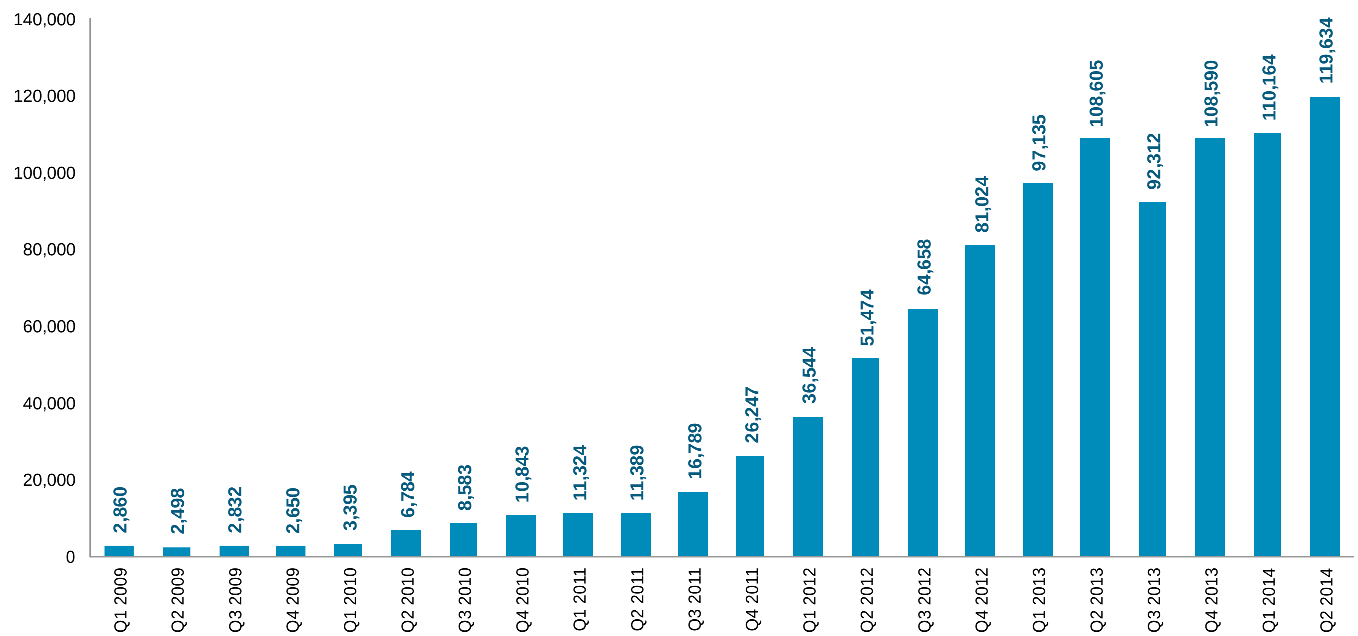
Table 1: US refining capacity (2013)

Region	Nelson Complexity Index[63]	Bottom of the Barrel Index[64]	Sulfur Content (%)	API Gravity (degrees)	Capacity (operable, 1,000 b/d)	Production (gross input, 1,000 b/d)	Utilization Rate (%)
PADD 1	8.99	0.44	0.76	34.40	1,295	1,079	83.3
PADD 2	9.88	0.52	1.45	33.14	3,769	3,378	89.6
PADD 3	11.57	0.58	1.52	30.03	9,094	8,154	89.7
PADD 4	8.50	0.41	1.42	34.00	630	580	92.1
PADD 5	11.16	0.64	1.39	27.76	3,029	2,533	83.6
US TOTAL	10.84	0.56	1.43	30.79	17,818	15,724	88.2

Source: Oil & Gas Journal, EIA and Rhodium Group estimates.

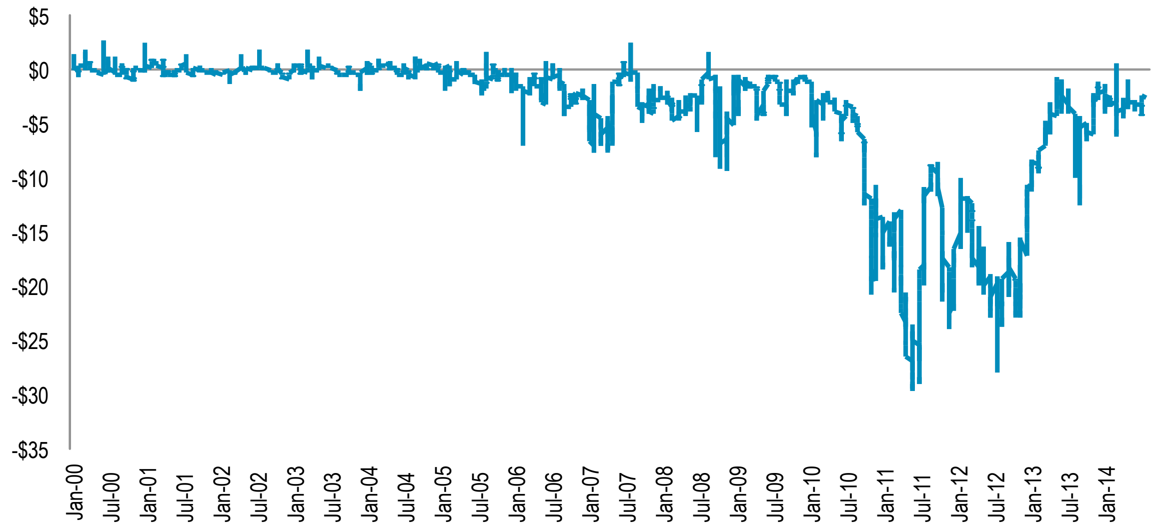
The lag between domestic production and take-away capacity to move oil from the Midcontinent to the Gulf Coast resulted in a sizeable discount for inland crude prices, such as West Texas Intermediate (WTI), the US oil benchmark priced in Cushing, Oklahoma, and coast- al crude prices, such as the Louisiana Light Sweet (LLS) crude produced offshore in the Gulf of Mexico (Figure 6). Between 2011 and 2013, WTI sold for $15 per barrel less on average than LLS because of WTI's relatively limited market opportunities. As transportation bottlenecks have improved, and inland producers are able to get their prod- uct to Gulf Coast refineries, that price gap has closed. But due to the nature of those Gulf Coast refineries, many of which have invested heavily to process specific kinds of imported crude oil, there are concerns about how much domestic crude they can absorb.

Figure 5: Crude by rail
Originated carloads of crude oil on Class I railroads



Source: American Association of Railroads.

Figure 6: WTI-LLS spread
USD per barrel



Source: Bloomberg.

A MISMATCH BETWEEN DOMESTIC SUPPLY AND REFINERY DEMAND

As noted in Table 1, PADD 3 refineries have more than 9 million b/d of combined refining capacity. In 2006 three-quarters of the oil they processed was imported. That has

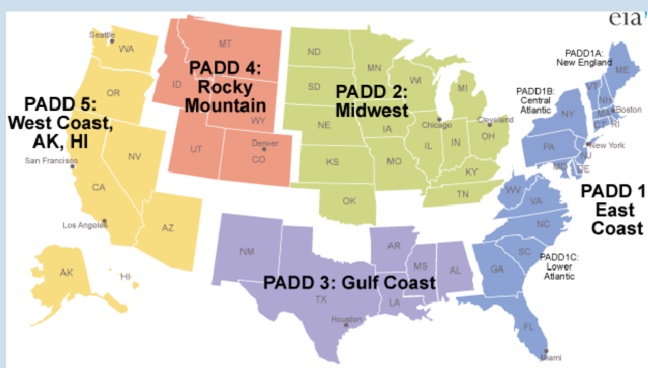
lion b/d of crude and unfinished oils from abroad, there are limits to how much they will be willing to switch to domestically produced oil.[65]

Crude oil is not a single chemical compound, but rather many, many compounds that are combinations of hydro-

THE PADD SYSTEM

The United States is divided into five so-called Petroleum Administration for Defense Districts (PADDs). These were originally established during World War II with the aim of allocating petroleum products within the war economy. The administration system was abolished by 1946, but PADDs are still widely used for data collection and statistical reporting purposes.[1]

Figure 7: Petroleum Administration for Defense Districts (PADDs)



Source: EIA.

Table 2: Crude quality definitions

		API Gravity	Sulphur Content
Ultra Light		More than 50°	Generally low
Light	Sweet	35° to 50°	Less than 0.5%
	Medium Sour		0.5% to 1.0%
	Sour		More than 1.0%
Medium	Sweet	26° to 35°	Less than 0.5%
	Medium Sour		0.5% to 1.0%
	Sour		More than 1.0%
Heavy	Sweet	10° to 26°	Less than 0.5%
	Medium Sour		0.5% to 1.0%
	Sour		More than 1.0%
Extra Heavy		Less than 10°	Generally high

Source: EIA.

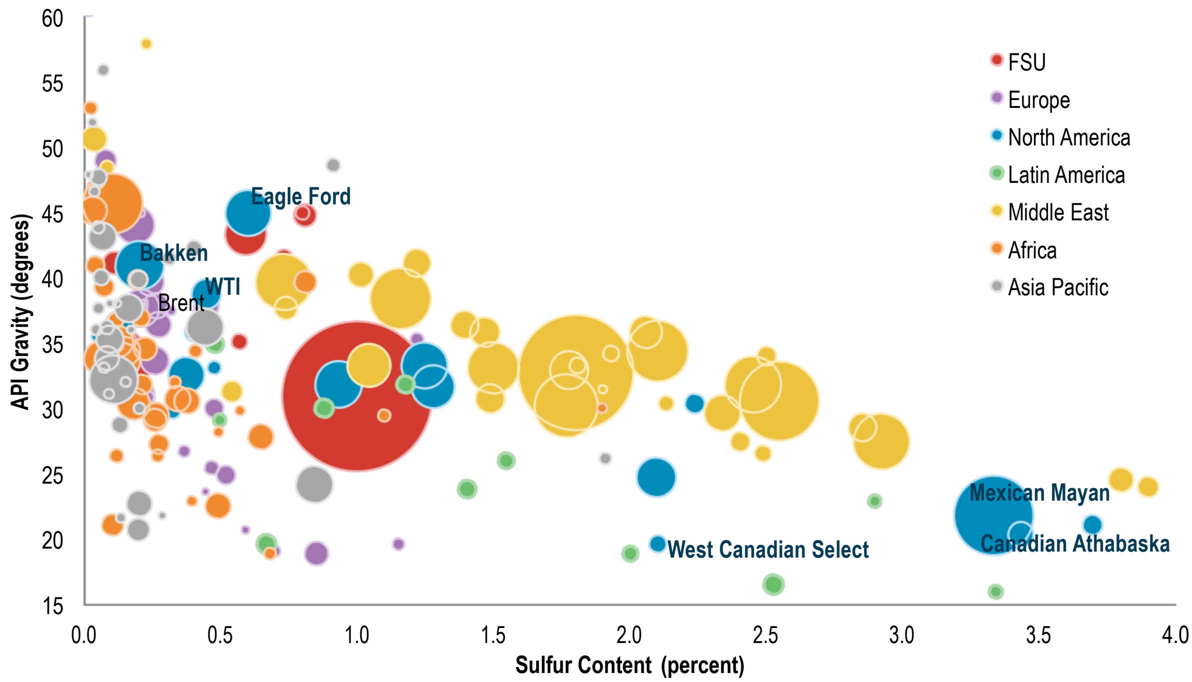
teristics. Two of the most important are density and sulfur content. A crude's density determines what kind of equipment is needed to process it and the mix of refined products it yields. The industry assesses crude density using the API gravity standard, developed by the American Petroleum Institute. A crude's API gravity is a measure of its density relative to water, denominated in degrees. The Energy Information Administration (EIA) describes crudes with an API gravity greater than 35 degrees as "light," those between 27 degrees and 35 degrees as "medium" and those below 27 degrees as "heavy" (Table 2). Very light oil is often referred to as condensate, not crude. Light crudes can be processed in relatively simple refineries to produce high value light petroleum products like gasoline, diesel and jet fuel. Producing a similar amount of light product from heavier crudes requires additional equipment, like catalytic crackers and cokers.

Crudes also vary in sulfur content. In most countries, including the United States, the sulfur must be removed in the refining process so the resulting gasoline, diesel, jet fuel and fuel oil meet sulfur emission standards. This requires additional equipment. Crudes with a sulfur content of less than 0.5 percent are generally referred to as "sweet," while those with a greater than 1 percent sulfur content are referred to as "sour." Crudes with a sulfur content between 0.5 percent and 1 percent are often referred to as "medium sour."

The crude being produced from tight oil formations in the United States is both light and sweet, and often referred to as "light tight oil," or LTO.[66] Crudes produced from the Bakken formation in North Dakota, for example, have an API gravity between 40 and 45 degrees and sulfur content below 0.2 percent. That is close to both the WTI benchmark and the international Brent benchmark crude, both of which are light and sweet (Figure 8). Crudes produced from Eagle Ford shale in Texas are even lighter, with roughly half of the barrels above 45 degrees.

In contrast, the average barrel of oil processed by a PADD 3 refinery in 2013 had an API gravity of 30 degrees and sulfur content of 1.5 percent (Table 1). PADD 3 refineries are some of the most complex in the world (Table 3), thanks to billions in investment over the past twenty years aimed at processing heavier Canadian, Mexican, and Venezuelan crudes and higher-sulfur crudes from the Middle East. *Oil & Gas Journal* publishes an annual survey of global refineries. In this survey, the complexity of a refinery is reflected in two indicators—the comprehensive Nelson Complexity Index (NCI) and *Oil & Gas Journal*'s Bottom of the Barrel Index (BoBI)—focused specifically on a refinery's ability to process heavier crudes (although simple refineries do sometimes process medium and heavy crudes to make fuel oil for power generation). In 2013 the United States had a NCI of 9.9 versus a global average of

Figure 8: US crude in context
API Gravity (y-axis), sulfur content (x-axis), and production volume (bubble size)



Source: Energy Intelligence and Rhodium Group estimates.

6.9, and a BoBI 0.52 vs. a global average of 0.28. Within the United States, PADD 3 refineries had a NCI of 11.6 and a BoBI of 0.58.

It is entirely possible for a complex PADD 3 refinery to process domestically produced LTO—indeed, they are processing significant quantities today by blending it with other crudes. At some point, however, increasing the LTO share of the crude slate becomes economically challenging as processing limits are encountered, primarily with respect to the refineries' capabilities to process "light ends" (e.g., naphtha,

Table 3: Global refining capacity (2013)

Region	Number of Refineries	Capacity (operable, th bbl/d)	Nelson Complexity Index	Bottom of the Barrel Index
United States	124	17,815	9.88	0.52
Other North America	23	3,497	8.54	0.38
South America	64	5,860	5.33	0.28
Western Europe	94	13,582	7.67	0.27
Eastern Europe	89	10,602	5.72	0.15
Africa	45	3,218	4.01	0.11
Middle East	44	7,393	4.27	0.14
Asia Pacific	162	25,279	5.26	0.20
Total	**645**	**87,246**	**6.87**	**0.28**

Source: Oil & Gas Journal and Rhodium Group estimates.

butane, propane, and gas). Even with additional investment to run higher volumes of LTO, refineries will be challenged by the lower-valued light products that LTO yields and by the inability to fully utilize expensive downstream upgrad- ing equipment, resulting in a reduction in the quantity of some high-value products, especially diesel and jet fuel.

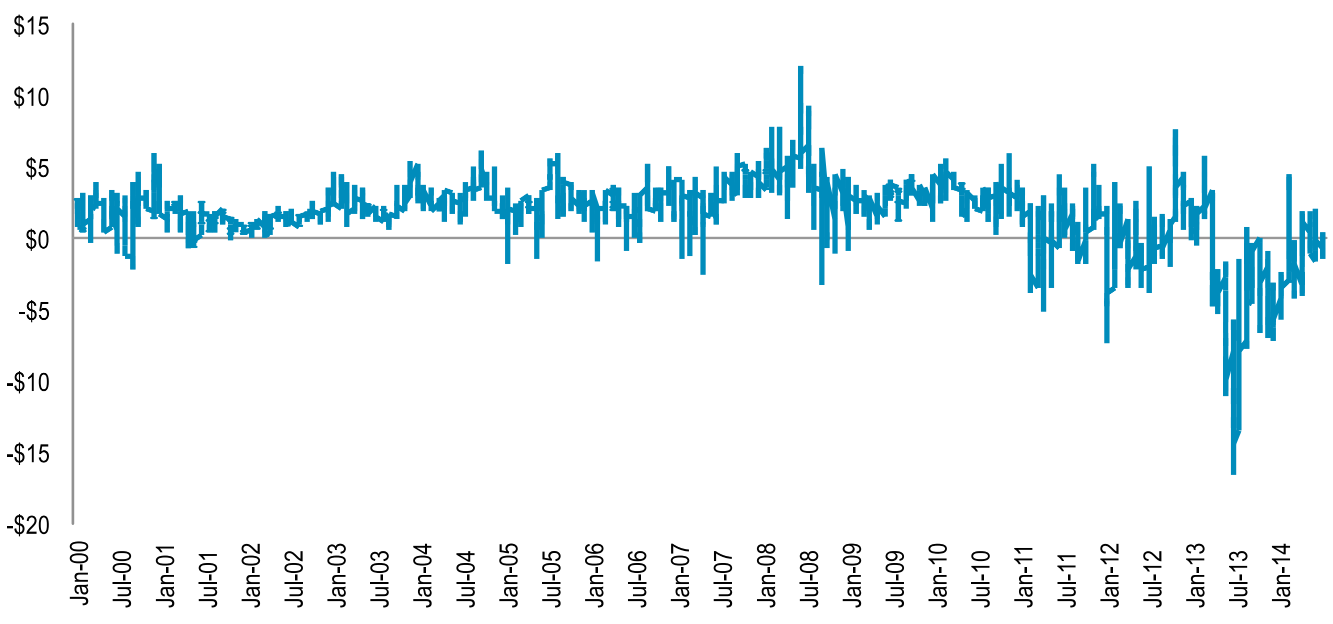
Since some refiners will be displacing lower cost heavy and medium crudes, idling the high cost processing equipment that allowed them to do this, they will likely require a discount from domestic crude producers to justify this change in crude slate. An alternative to backing out heavier imports in existing refineries is to build new refining capacity configured specifically for domestic LTO. Some of this has already started to occur, mostly via splitters or small expansions in areas with advantaged access to the growing volumes of domestic crude, such as Montana, North Dakota, Utah, and Texas. As crude production continues to grow, and with export restrictions still in place, additional "crude-to-product" facilities will be constructed.

New refineries come at a cost as well, however. The capital expenditures entailed must be recovered, either through higher refined product prices or discounted crude acquisition costs. Uncertainty over whether the administration may change existing export policies, combined with permitting and regulato-ry barriers, may also constrain additional refining investment.

WHEN DO EXPORT RESTRICTIONS BEGIN TO BITE?

Because of this mismatch between domestic crude production and United States refinery configuration, restrictions on crude exports have already begun to distort market outcomes, even though the United States remains a large crude importer on net. LLS is a light sweet crude, similar to WTI, Bakken, Eagle Ford, and the international benchmark Brent. Unlike WTI or other inland US crudes, however, there are no transportation barriers between LLS and Gulf Coast refineries. Due to this proximity, LLS has traditionally traded at a slight premium to Brent (Figure 9). In October and November of 2013, however, LLS trad- ed at a $9 discount to Brent, on average. This was due to a combination of three factors—the alleviation of transportation bottlenecks that brought more inland LTO to the Gulf Coast, seasonal refinery maintenance (known as "turnaround") that reduced Gulf Coast crude demand,

Figure 9: LLS-Brent spread
USD per barrel



Source: Bloomberg.

and the loss of Libyan production that left the global market short of light crude and caused Brent crude prices to rise. Were US companies allowed to export crude, the seasonal weakness in domestic refinery demand would likely have been reduced by foreign demand for LTO, keeping the LLS-Brent spread more in line with historical averages.

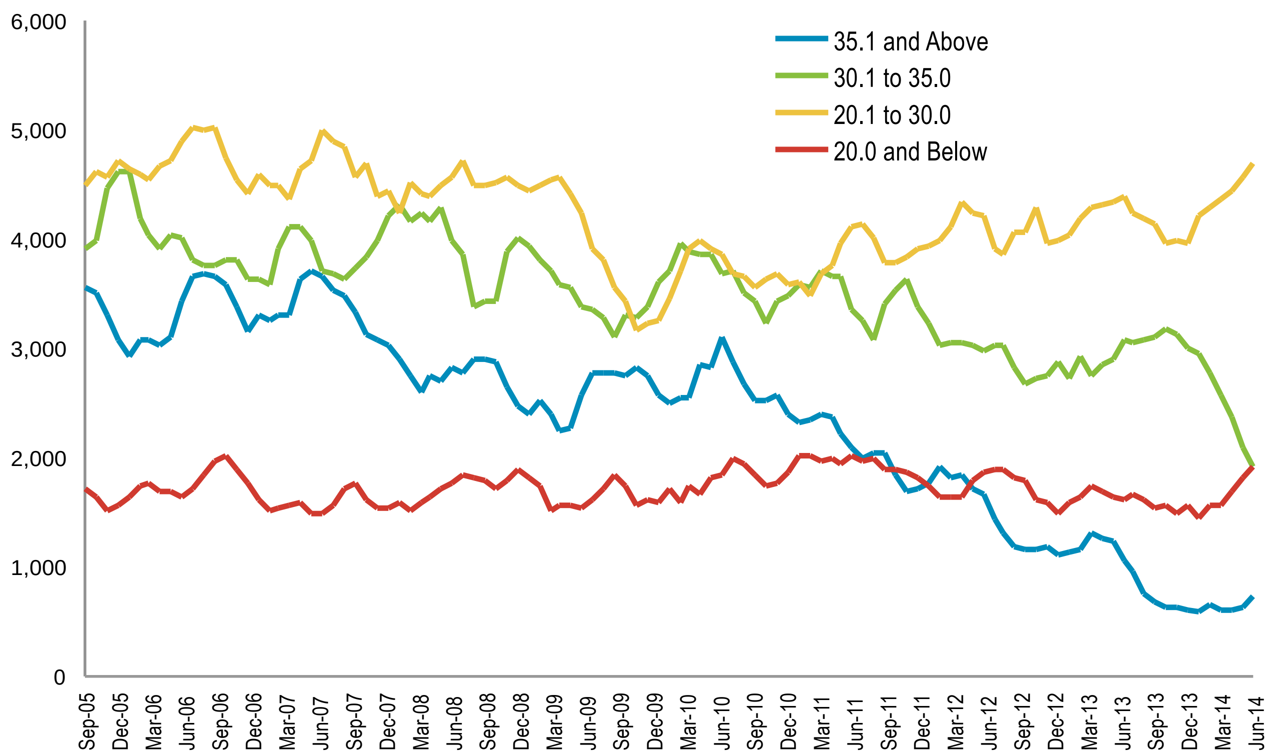
The LLS-Brent spread closed by the end of 2013 and remained small during the 2014 maintenance season. This suggests the market impact of crude export restrictions has thus far been small. When export restrictions start distorting markets on a persistent and significant basis depends on the future rate of US crude production growth, the ability to further displace imports, and the ability to expand exports currently allowed under US law.

Displacing imports

Foreign light crude (35 degrees and above) has been almost entirely backed out of the US refining complex due to the availability and cost competitiveness of domestic LTO. In 2006 the United States imported 3.3 million b/d of light crude. During the first three quarters of 2014, the United States only imported 637,000 b/d of light crude (Figure 10). The principal foreign casualty of lower US demand for imported light crude has been West African producers, Nigeria in particular. In 2006 the United States imported 1.8 million b/d of West African crude. During the first three quarters of 2014, that number fell to 273,000 b/d (Figure 11). This has put downward pressure on West Afri- can crude prices. With the Atlantic Basin now a net crude producer, West African crudes must compete with Latin American and traditional Middle East suppliers in Asia. With refining overcapacity and increasing ability to pro- cess heavy, sour oil in Asia, West African differentials have been compressed, creating an indirect benefit from the US tight oil boom for struggling European refiners who can now access light oil more cheaply.

Lighter medium crude imports (30 to 35 degrees) have also fallen, from 4 million b/d in 2006 to 2.7 million

Figure 10: US crude imports by API gravity 1,000 b/d, three month moving average



Source: EIA, "Petroleum and Other Liquids: Data," 2014.

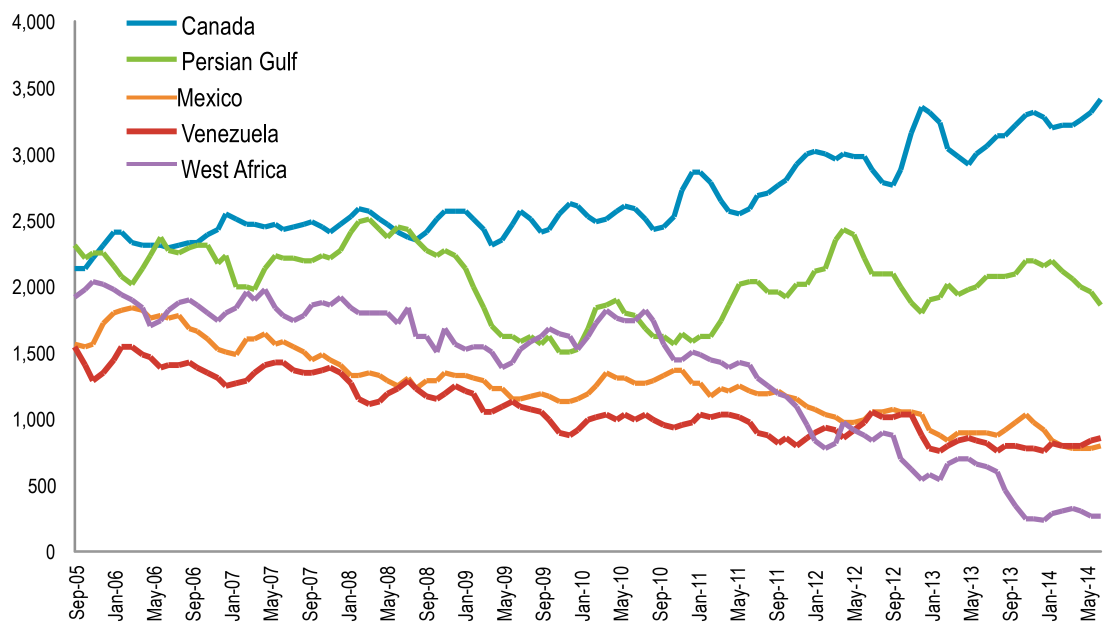
b/d during the first three quarters of 2014. The ability of US LTO to further displace medium imports is limit-ed by the economics of blending and the willingness of some Persian Gulf producers to lose US market share. Saudi Arabia, for example, has reduced exports to the United States but continues to demonstrate an interest in retaining a significant foothold in the US market—to maintain diversity of buyers, to supply the massive Motiva refinery on the Gulf Coast (which is half-owned by Saudi Aramco, the country's national oil company), and potentially for strategic considerations.[67] Iraqi, Mexican and Venezuelan crude exports to the United States face similar challenges, and those governments will face similar dilemmas over whether retaining US market share is a strategic priority and how much of a price discount they are willing to accept to do so.

Increasing exports

As discussed previously, US crude exports are allowed in some cases, most notably to NAFTA partner Canada. Along with backing out light oil imports to the United States, the biggest outlet for US light oil production to date has been to displace other light imports to Canada. US exports to Canada have skyrocketed over the past couple of years, from 67,000 b/d in 2012 to nearly 300,000 b/d during the first three quarters of 2014 (Figure 12). There are limits on the ability of Canada alone, however, to absorb much more US crude. In 2013, Canada imported an average of 600,000 b/d of light crude oil, out of 640,000 b/d of total oil imports.[68]

The crude export exceptions under current law that allow for exports to countries other than Canada permit much lower volumes. The recent move by the Commerce Department to approve the export of lightly processed condensate, however, has opened up another modestly sized export channel. If the administration were to con-tinue to approve condensate export requests as suggested by the BIS December 2014 FAQs discussed earlier, it is estimated that anywhere from 300,000 to 500,000 b/d or more of condensates might eventually be exported from the United States.[69]

Figure 11: US oil imports by country of origin
1,000 b/d, three month moving average



Source: EIA, "Petroleum and Other Liquids: Data," 2014.

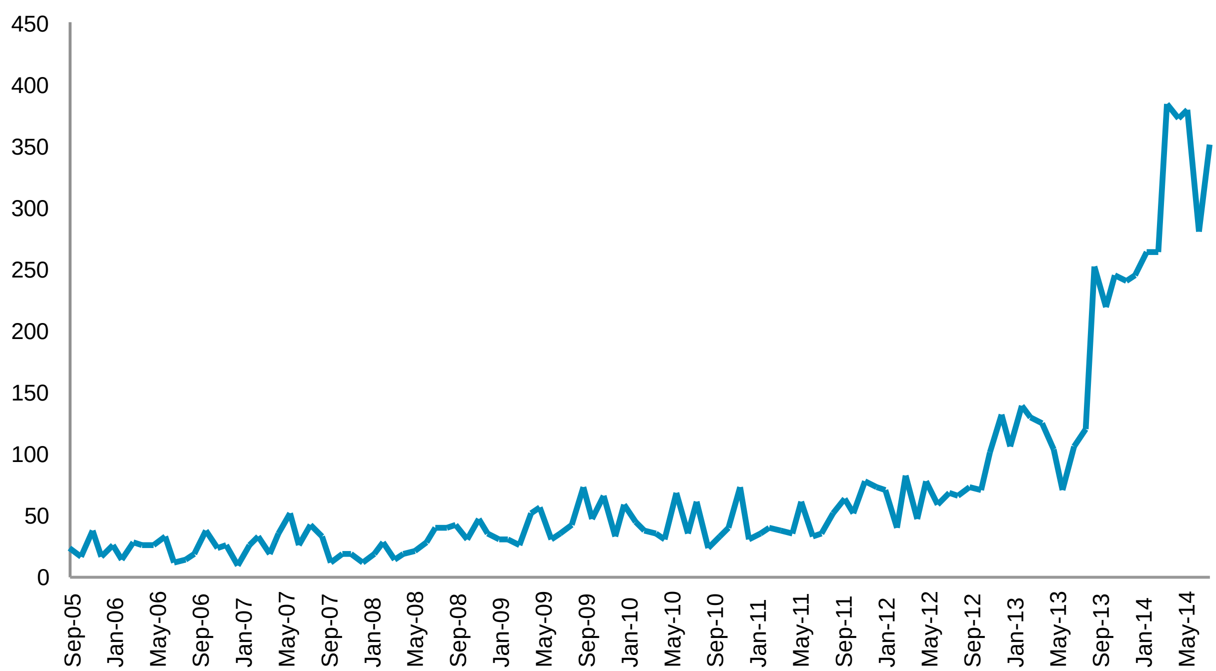
When does the point of saturation occur?

Estimating exactly how much additional US LTO production can be absorbed by domestic refineries without significant yield declines or capacity additions is challenging. Refinery consultants Turner Mason estimate that absent additional refinery investment, the domestic market will reach saturation on a nonseasonal basis when crude production reaches 10 to 11 million b/d.[70] This is similar to the findings of recent studies by consultancies ICF[71] and NERA.[72]

When will that occur? In November 2014 US crude production was 9.1 million b/d.[73] In the Reference case of their 2014 Annual Energy Outlook, the EIA sees US crude production peaking at 9.6 million b/d in 2019, never reaching Turner Mason's estimated point of satura-tion.[74] In the EIA's High Oil and Gas Resource side case, which has been a better predictor of US crude produc- tion in recent years than the Reference case, output passes 10 million b/d in 2016.[75] US oil production passes 10 million b/d that year in a number of private sector forecasts, including Citigroup, Goldman Sachs, and energy consultancy Rystad. Other research puts the point of saturation lower than 10 million b/d. A recent study from energy consultancy IHS, for example, estimates that market saturation will occur at between 9 and 10 million b/d of domestic crude production.[76]

Since these production estimates were made, there has been a sharp drop in both US and global oil prices. Brent prices have fallen from a high of $115 per barrel in June 2014 to below $65 a barrel as of mid-December 2014. WTI prices have fallen from $108 per barrel to below $60 over the same period. It is too early to assess the magnitude of the impact of this decline in oil pric- es (if sustained) on the US crude production outlook, but directionally it will reduce production growth and delay the point at which the domestic market reaches saturation.

Figure 12: US crude exports to Canada 1,000 b/d



Source: EIA, "Petroleum and Other Liquids: Data," 2014.

THE ECONOMIC IMPACT OF ALLOWING EXPORTS

If and when the point of saturation is reached, what will the impact be on US crude production, refinery investment, gasoline prices, and economic performance? And what would the effect be of modifying or removing current export restrictions? This question has become the subject of considerable speculation among policymakers, industry, and the press, and the focus of a growing number of economic studies. To help guide stakeholders through this debate, we provide an overview of the relevant economic theory and highlight insights that can be derived from empirical experience. We provide an apples-to-apples comparison of existing studies that seeks to quantify the potential impact, and describe the variables that matter most in determining outcomes. Finally, we bound the range of potential impacts given current energy market uncertainty, and attempt to put those impacts in a broader economic context for different stakeholders.

ECONOMIC THEORY AND EMPIRICAL EVIDENCE

As detailed in a companion piece by Ken Medlock at Rice University's Baker Institute, trade restrictions inhibit commodity flows, which, in turn, affects price formation.[77] In a competitive global crude market without any trade restrictions, the selling price for a barrel of crude produced in the United States will be determined by the cost of producing the marginal barrel globally—adjusted for transportation costs and differences in crude quality. Indeed, there is generally a very tight correlation in crude selling prices, regardless of geographic origin. Trade restrictions, however, can create a disconnect between the global price of crude and the price producers in a particular country are able to charge by limiting their market options.

The domestic crude infrastructure bottlenecks that emerged in the United States in 2010 and 2011 offer an empirical example of how trade restrictions could impact domestic crude prices once the point of saturation is reached. As discussed previously, a shortage of pipeline capacity going from the US Midcontinent to coastal refineries created an inland crude surplus that led to an average $15 discount between Cushing, Oklahoma, and the Gulf Coast for a barrel of similar quality crude between 2011 and 2013. At the margin, lower domestic wellhead oil prices will lead to lower domestic crude production, whether due to infrastructure constraints or export restrictions.

If domestic crude prices are likely to be higher if export restrictions are lifted, won't domestic gasoline, diesel, and other refined product prices also rise? Indeed, concern about the potential impact on American consumers is the reason most frequently cited for leaving current crude export restrictions in place.[78] However, both economic theory and empirical evidence suggest refined product prices would fall, not rise, as explained in the box "What About Gasoline Prices?"[79]

While an increase in domestic crude production and decrease in domestic refined product prices resulting from a modification of current crude export restrictions would likely harm the profitability of US refiners compared to the rents they might capture with such a restriction in place, it would help the US economy as a whole. Houser and Mohan (2014)[80] find that the US shale boom has increased overall economic output in three ways:

1. increased investment in oil and gas production and demand for the labor and equipment associated with that investment;
2. lower household and business energy costs due to a decline in oil and gas prices; and
3. improved terms of trade as both the price and quantity of imported oil and gas declines.

The magnitude of these benefits depends not only on the extent of the production increase and price decline, but also the overall state of the US economy. The economic benefits are greater when the economy is operating below full employment, such as it is today. To the extent removing current crude export restrictions increases domestic crude production and reduces refined product prices, the nature of the economic impact will be similar to that of the US shale boom overall.

EXISTING ESTIMATES

While economic theory and empirical evidence strongly suggests that lifting current export restrictions will directionally increase domestic crude production, reduce gaso- line and other refined product prices, and increase economic output, the magnitude of the impact is highly uncertain.

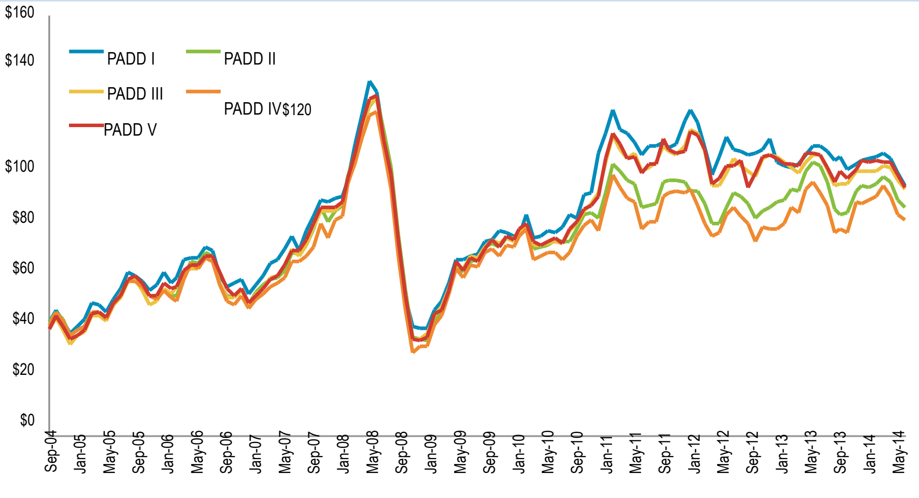
Over the past year a number of studies have been published attempting to quantify the impact of modifying or removing current crude export restrictions. The first, commissioned by the American Petroleum Institute (API), was conducted by energy consultancy ICF Inter- national and published in March 2014.[81] The second ma- jor study, also commissioned by US oil producers, was published by consultancy IHS in May 2014.[82] A third major study was conducted by economic consultancy NERA and published by the Brookings Institution in September 2014.[83] In October, the Aspen Institute pub- lished a study conducted in cooperation with the MAPI Foundation and Inforum Forecasting at the University of Maryland (referred to as the MAPI study in this report), which focused on the impacts of lifting crude export restrictions on US manufacturing, largely adopting the IHS estimates of the impact of the ban on crude produc- tion and product prices.[84]

WHAT ABOUT GASOLINE PRICES?

Perhaps the key issue, substantively and politically, in the debate about whether to allow crude exports has been the perception that such a move would push up prices at the pump for consumers. Both economic theory and empirical evidence, however, suggest refined product prices would fall, not rise, if exports were allowed.

There is a relatively liquid global market for refined products, just as there is for crude oil. The wholesale price of gasoline in the United States, for example, is generally determined by the marginal cost of producing a gallon of gasoline around the world, adjusted for quality and transportation costs. Unlike crude oil, however, there are no restrictions on gasoline exports, and thus no reason to expect a similar price discount. If the United States reaches the point of saturation and we see a trade policy–driven discount in domestic crude prices similar to the infrastructure-driven discount experienced over the past few years, the cost to refiners of producing gasoline, diesel, and other products will fall. But there is no reason why the domestic refiners would

Figure 13: Refinery acquisition cost of crude by PADD USD per barrel



Source: EIA, "Refiner Acquisition Cost of Crude Oil."

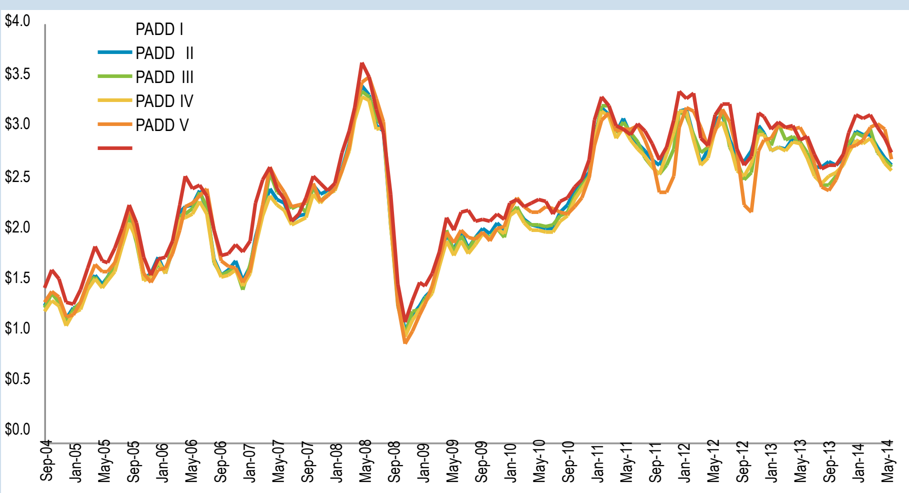
Partially in response to these studies, a refiner advocacy group called Consumers and Refiners United for Domestic Energy (CRUDE) commissioned an analysis by consultancy Baker & O'Brien, which was also released in late September 2014.[85] As the policy debate surrounding crude exports has grown, a number of investment banks have also begun assessing the impact of the current restrictions as well.

In analyzing the same policy question, these studies arrive at very different results. The ICF study, for example, finds that allowing crude exports would result in a very small increase in domestic production—between 100,000 and 400,000 b/d on average between 2015 and 2025 depending on the scenario (Figure 15). In the IHS study, lifting crude export restrictions boosts domestic production by 1.0 to 1.7 million b/d over the same peri-od. As it was largely based on the IHS analysis, the MAPI study shows similar results. The NERA study projects the largest increase in domestic crude production between 2015 and 2025 from lifting export restrictions—between 1.1 and 2.8 million b/d on average, depending on assumptions about the US tight oil resource base. Goldman Sachs (GS) sees US crude production growing by 1.5 million b/d in 2020 if exports are allowed.[86] The Bak-er & O'Brien study estimates that planned refinery capacity will be sufficient to absorb all projected growth in domestic crude production but does not explicitly model the impact of that refinery investment on wellhead crude pricing or production rates.

pass those savings along to consumers. US refiners will have access to global product markets and the ability to sell gasoline and diesel abroad at prevailing global prices.

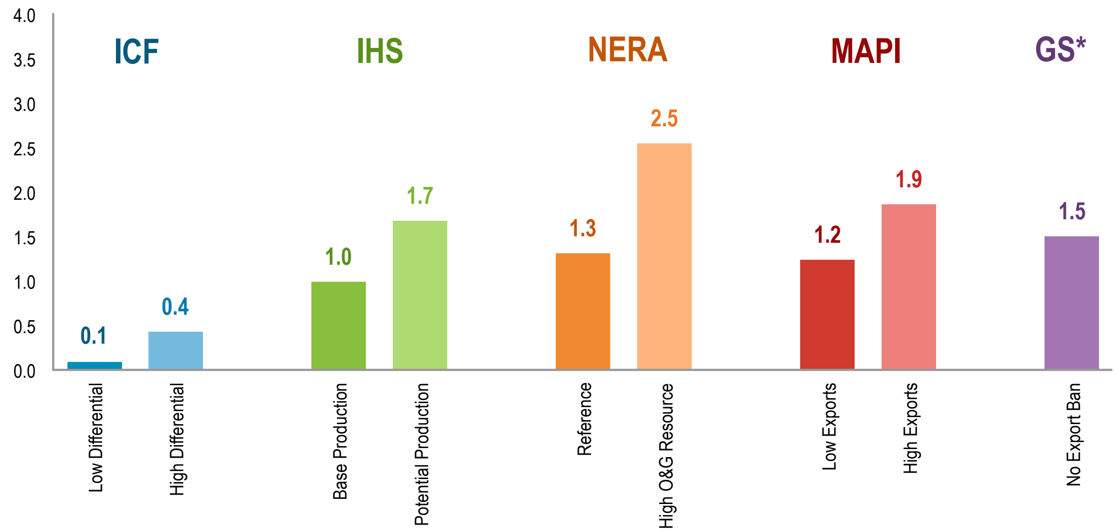
Indeed, this is exactly what's occurred over the past few years. Between 2011 and 2013, PADD 2 refiners paid 16 percent less, on average, per barrel of crude than PADD 1 refiners, thanks to infrastructure bottlenecks between the US Midcontinent and the East Coast (Figure 13). PADD 4 refiners paid 22 percent less. Yet the price of gasoline sold by PADD 2 and PADD 4 refiners was only 1 percent and 1.4 percent lower than PADD 1 refiners over this period respectively (Figure 14). Lower crude costs improved refiner profitability but did not lower prices for consumers. Likewise we would not expect refiners to pass on an export restriction-driven discount in domestic crude costs in refined product prices. To the extent that such a domestic crude discount reduces US crude production, it would increase global crude prices. Higher global crude prices would translate into higher global marginal refining costs which would raise the global price of gasoline, diesel and other refined product prices from which domestic product prices are set.

Figure 14: Wholesale gasoline price by PADD USD per gallon



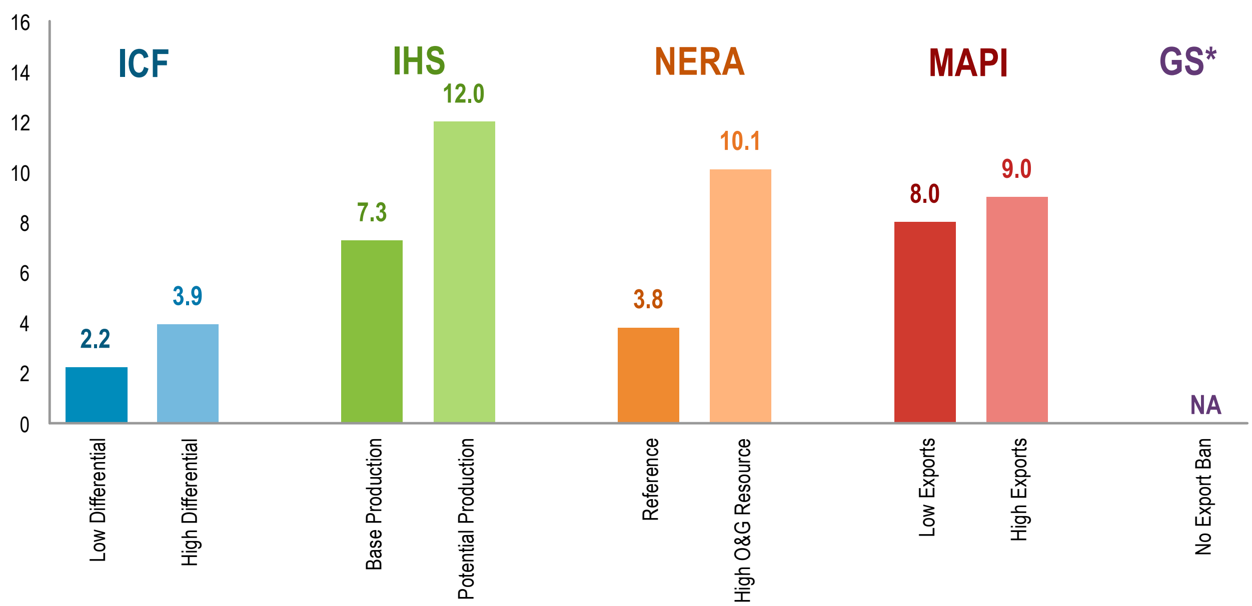
Source: EIA, "Refiner Gasoline Prices by Grade and Sales Type."

Figure 15: Increase in US crude production from lifting export restrictions, 2015–2025
Million b/d



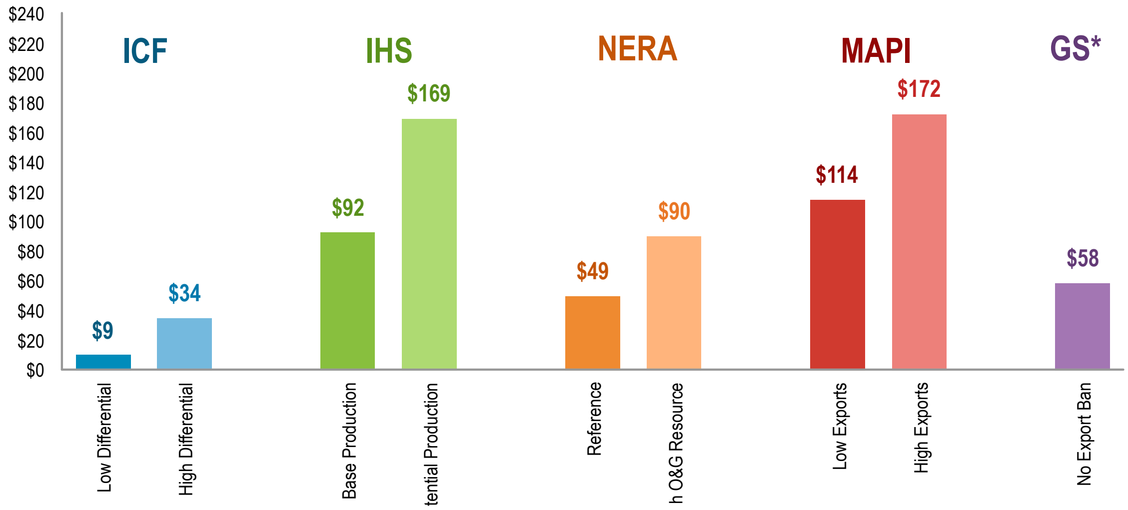
Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs, and Rhodium Group estimates.
*2020 only.

Figure 16: Reduction in refined product prices from lifting crude export restrictions, 2015–2025 2013 cents per gallon



Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs and Rhodium Group estimates.
*2020 only.

Figure 17: Increase in GDP from lifting crude export restrictions, 2015–2025
Billion 2013 USD



Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs and Rhodium Group estimates.
*2020 only.

Not surprisingly, the projected impact of lifting crude export restrictions on domestic refined product prices varies considerably across studies as well. The ICF study projects a 2 to 4 cent per gallon decline, on average between 2015 and 2025, while IHS expects 7 to 12 cents (Figure 16). Most of this is explained by the difference in projected US crude production response to lifting export restrictions, but other modeling assumptions matter as well. For example, in its High Oil and Gas Resource scenario, NERA projects a crude production increase 65 percent larger than in the IHS Potential Production case, but resulting in a reduction in refined product prices that is 16 percent lower. Neither the GS nor Baker & O'Brien studies estimate—or if so, they do not report—the impact of allowing crude exports on refined product prices.

The largest difference among the studies is in the projected economic impact of allowing crude exports. In the ICF study, US GDP is up to $34 billion higher on average between 2015 and 2025 if exports are allowed, or 0.18 percent (Figure 17). In the IHS Potential Production scenario, GDP is $169 billion higher, on average, during that period, or 0.9 percent. Despite projecting an increase in crude production growth from allowing exports that is considerably higher than IHS, NERA finds a GDP benefit roughly half the IHS level. MAPI finds GDP benefits even larger than IHS, while GS estimates that lifting the crude ban would be a net economic drag until late in the decade when allowing exports increases GDP.[87] Interestingly, the GDP gains from allowing exports fall dramatically by 2030 in the IHS Base Production and NERA Reference scenarios, while in the ICF Low Differential scenario they increase over time (Table 4).

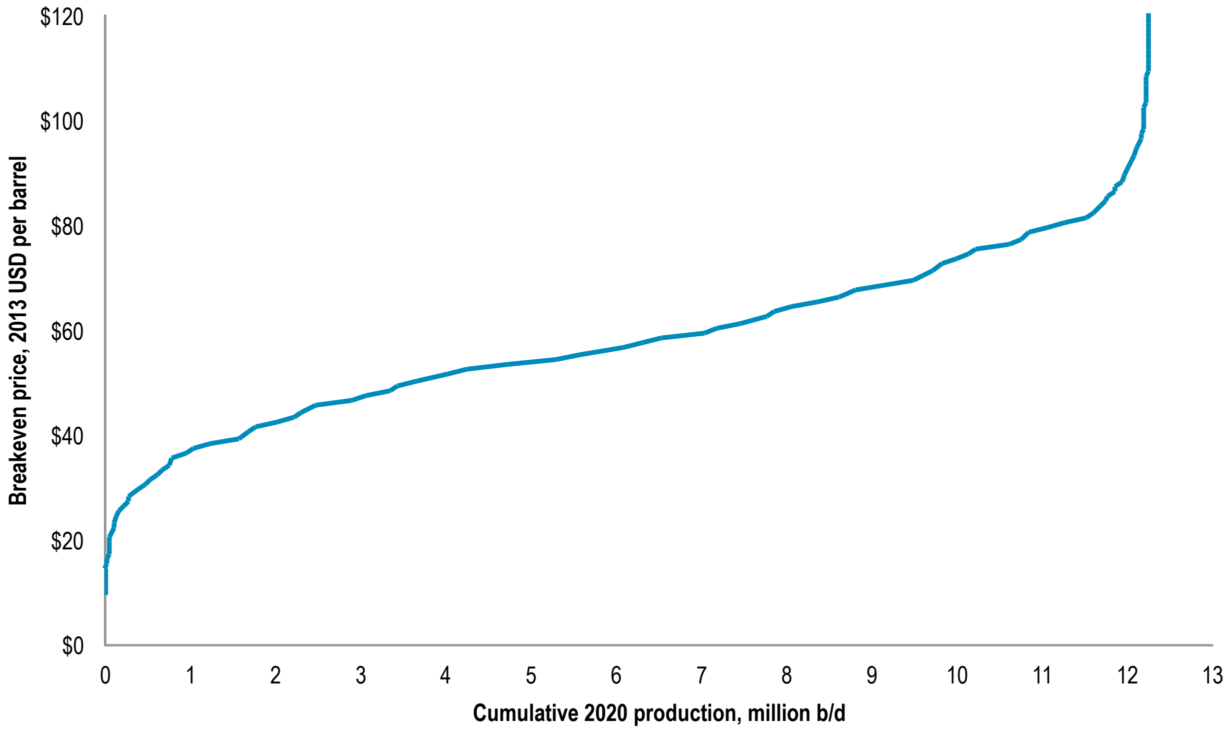
UNDERSTANDING THE VARIABLES

To help policymakers and other stakeholders compare these existing studies, as well as evaluate for themselves which future they think most likely to eventuate, and under what circumstances, we walk through the individual variables that will determine the ultimate impact of allowing crude exports, identify the assumptions existing studies make for each, discuss alternative assumptions that could be made, and map out the resulting effects on US crude production, refined product prices, and US economic growth.

Table 4: Impact of allowing crude oil exports

		2015	2016	2017	2018	2019	2020	2025	2030	2035
Increase in US Crude Prices ($ per barrel)										
ICF	Low Differential	0.8		2.2			2.4	3.9	2.3	1.3
	High Differential	7.8		7.2			5.4	3.7	2.3	1.3
IHS	Base Production	0.0	23.2	13.7	10.6	5.5	3.8	3.9		
	Potential Production	3.9	26.8	17.8	12.5	6.5	4.9	4.9		
NERA	Reference	12.0					10.0	5.0	3.0	2.0
	High O&G Resource	14.0					17.0	21.0	25.0	27.0
MAPI	Low Exports	0.0	24.9	20.1	16.2	11.0	7.9	6.3		
	High Exports	0.0	23.9	19.0	15.1	9.9	6.8	5.0		
GS	No Export Ban	4.8	8.6	7.5	6.5	5.5	4.5			
Increase in Crude Production (million bbl/d)										
ICF	Low Differential	0.0		0.1			0.1	0.2	0.2	0.2
	High Differential	0.2		0.4			0.5	0.5	0.3	0.1
IHS	Base Production	0.0	0.8	1.1	1.2	1.0	1.1	1.2	1.3	
	Potential Production	0.0	1.2	1.8	1.7	1.6	1.8	2.2	2.4	
NERA	Reference	1.5					1.3	0.4	0.2	0.2
	High O&G Resource	2.1					2.8	3.5	3.8	4.2
MAPI	Low Exports	0.0	0.3	0.6	0.9	1.2	1.4	2.2		
	High Exports	0.0	0.4	0.9	1.3	1.7	2.1	3.3		
GS	No Export Ban	0.0	0.0	0.0	0.5	1.0	1.5			
Reduction in Global Crude Prices (2013 USD per barrel)										
ICF	Low Differential	0.2		-0.1			0.3	0.5	0.5	0.6
	High Differential	0.7		0.7			1.1	1.1	0.6	0.3
IHS	Base Production	0.0	3.8	4.1	3.8	3.3	3.5	3.5	3.5	
	Potential Production	0.0	3.6	4.8	5.1	5.0	5.1	5.7	5.6	
NERA	Reference	4.0					2.0	1.0	1.0	0.0
	High O&G Resource	7.0					6.0	6.0	7.0	8.0
MAPI	Low Exports	0.0	2.1	2.1	2.1	2.2	2.2	2.5		
	High Exports	0.0	3.1	3.1	3.2	3.3	3.3	3.7		
GS	No Export Ban	0.0	1.0	1.9	2.8	3.6	4.5	0.0		
Reduction in Refined Product Prices (2013 cents per gallon)										
ICF	Low Differential	2.2		2.1			0.0	0.5	1.5	2.9
	High Differential	3.4		3.9			2.0	2.0	1.8	2.1
IHS*	Base Production	0.0	-8.1	-9.4	-8.3	-7.7	-7.7	-7.7		
	Potential Production	0.0	-8.1	-11.4	-11.9	-11.9	-11.9	-11.9		
NERA	Reference	9					4	0	1	0
	High O&G Resource	12					11	10	10	10
MAPI	Low Exports	0.0	3.0	6.0	8.0	8.0	8.0	8.0		
	High Exports	0.0	5.0	8.0	9.0	9.0	9.0	9.0		
GS	No Export Ban									
Increase in US GDP (billion 2013 USD)										
ICF	Low Differential	3		8			11	16	18	24
	High Differential	20		33			39	36	23	13
IHS	Base Production	-2	72	133	135	118	107	81	32	
	Potential Production	-5	104	195	220	206	199	174	105	
NERA	Reference	66					39	15	8	4
	High O&G Resource	95					83	102	141	193

Figure 18: US crude oil supply curve, 2020



Source: Rystad and Rhodium Group estimates.

Global oil price

One of the most important variables in shaping the impact of allowing crude exports is the projected global oil price. Different oil assets have different economics, and in a low oil price environment, less US crude will be produced. Figure 18 depicts energy consultancy Rystad's estimate of the breakeven price of all oil wells currently expected to be producing in 2020 measured in 2013 USD per barrel. Rystad estimates that there is roughly 12 million b/d of potential US crude supply in 2020 with a breakeven price of $100 or less, but only 10 million b/d with a breakeven price of $75 or less.[88]

Based on this simplified cost curve, if the average wellhead price in the United States were to fall from $100 a barrel to $75 a barrel in 2020, production would fall by 2 million b/d relative to where Rystad otherwise projects it to be. That could happen as a result of either a discount in US prices relative to international levels or a reduction in global oil prices. All the studies referenced above (with the exception of the Baker & O'Brien report) explore the impact of the former, but comparing them requires understanding the global oil price outlook against which they are applying a domestic discount. Thinking through different global oil price scenarios is also important, because if global prices were to fall considerably, US production growth could moderate to a level where the point of saturation is never reached. This point has been driven home by the sharp drop in crude oil prices during the second half of 2014. Given that the US supply curve is most likely nonlinear (i.e., the production impact of a 10 percent decline in price depends on where price and production are before the decline), the global oil price will also shape the degree to which US production changes for a given discount between wellhead and international prices, as well as whether such a discount due to domestic market saturation comes to pass. For example, in the Rystad supply curve, a $10 discount has a larger percentage impact on US LTO production when prices are at $80 per barrel than when they are at $100 a barrel.

Figure 19 compares international crude price projections from existing studies, assuming exports are allowed, alongside the EIA's 2014 Annual Energy Outlook projections for three scenarios (Reference, Low Oil & Gas Resource and High Oil & Gas Resource) and for Rystad's reference case supply projections. With the exception of NERA and GS, there is pretty tight convergence across studies between $96 and $99 a barrel on average between 2015 and 2020 in real 2013 USD. The GS report uses a $91 per barrel average price projection over that period, while the NERA study uses $86–$87. After 2020 there is more divergence, ranging from $99 per barrel on average between 2020 and 2030 in the NERA High Oil & Gas Resource case to $118 per barrel in the MAPI report.

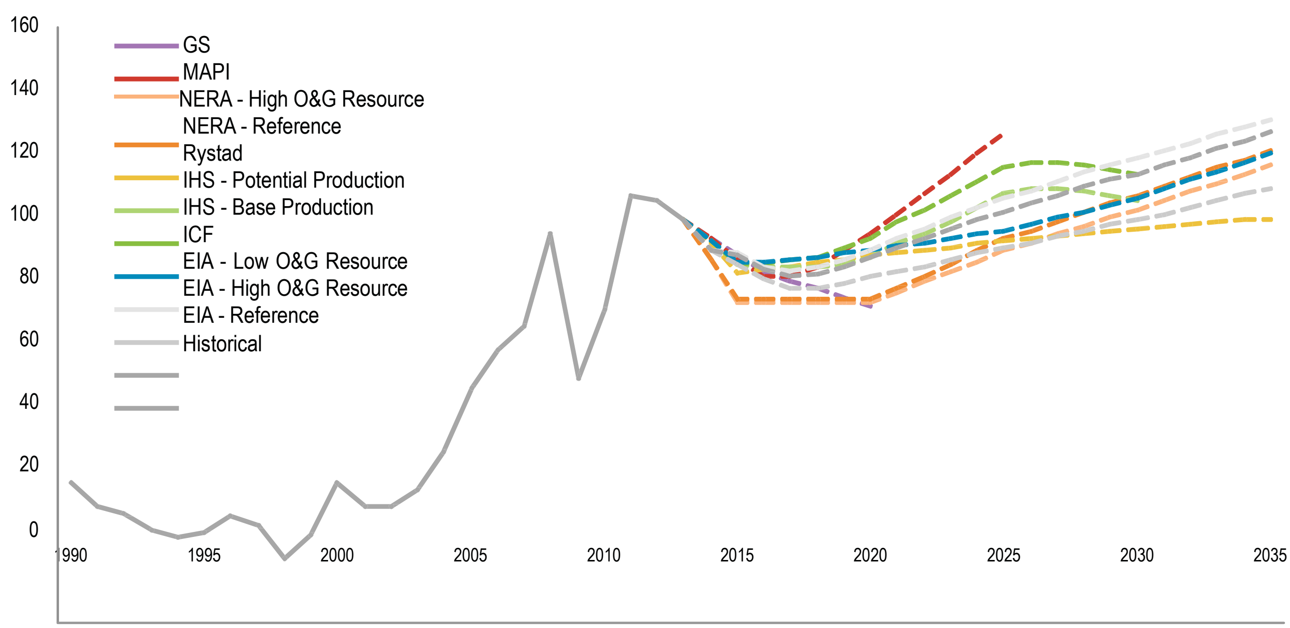
There are two important takeaways from this comparison. First, global oil price assumptions are not a major factor in explaining the significant differences in study results. Second, existing analysis has explored a fairly narrow range of possible oil price futures, and one that looks increasingly outdated given the sharp drop in global oil prices during the second half of 2014 and significant downward revision in many analysts' price projections[89] out to 2020. As mentioned previously, both spot and futures prices for Brent and WTI were significantly below the projections included in Figure 19 at the time this study went to press.

US resource base

How much oil the United States produces at a given price is the second major variable in assessing the energy market and economic impact of allowing crude exports. Given the dramatic and unexpected turnaround in US crude production over the past few years, this variable is also among the hardest to project, and indeed there is wide variation among the crude production forecasts used in the existing studies. Figure 20 compares these forecasts, all in a scenario in which the exports are freely allowed. The EIA 2014 projections are included for reference, along with Rystad's central production forecast.

Each study uses a slightly different approach to forecasting US crude production. The ICF study uses their Detailed Production Report (DPR) to project drilling activity likely to occur at a given oil price.[90] While they have

Figure 19: International crude price projections in surveyed reports 2013 USD per barrel, absent crude oil export restrictions



one of the higher oil price projections of the group in the short term ($98 per barrel on average between 2015 and 2020), they have a relatively low crude production forecast. Output is less than 8.5 million b/d in 2015 (a little below August 2014 levels) and reaches 9.3 million b/d in 2017 and 10.6 million b/d in 2020. ICF only includes one production projection in their report in a scenario where exports are allowed. Their Low Differential and High Differential scenarios focus on export-restricted futures only.

The IHS study includes two production projections, one called Base Production and the other Potential Production. Like ICF, they model both based on forecasted drilling activity at a given oil price. The difference between the two is assumed level of drilling technology improvement and availability of less well understood tight oil plays. In the Base Production scenario, crude output grows to 9.25 million b/d in 2015, 10 million b/d in 2017, and 11 mil- lion b/d in 2020. In the Potential Production scenario, US crude output reaches 13 million b/d in 2020 and peaks at more than 14 million b/d between 2020 and 2030. The MAPI report claims to adopt the IHS energy market assumptions and has a crude production forecast somewhere between the two IHS scenarios.

The NERA study takes a different approach to projecting US crude production from the ICF or IHS reports. Rather than model drilling activity directly, they take the production forecasts from the EIA Reference and High Oil & Gas Resource cases as their Reference (REF) and High Oil & Gas Resource (HOGR) scenarios in the presence of export limitations. They then construct a piecewise linear function[91] to estimate how US LTO and condensate production would increase if the crude ban were lifted. Below $55 and $40 per barrel they assume no LTO or condensate is produced respectively. Above those prices, they build a supply curve based on the annual price and production projections from the EIA under each scenario. For example, in the EIA HOGR scenario, in 2020 wellhead oil pric- es are $87.85 per barrel in 2020 and LTO production is 6.49 million b/d. The following year, wellhead oil prices rise to $88.16 and LTO production grows to 6.85 mil- lion b/d. Therefore, NERA assumes that a $0.31 change in wellhead prices (if prices are in the $87-$89 per bar- rel range) results in a 360,000 b/d change in production. They take the price and production point estimates for each year of the EIA projections to build out their US LTO supply curve.

NERA finds a large (and persistent, in the HOGR scenario) domestic price discount due to the export ban (discussed later). For example, in the HOGR scenario in 2025, domestic LTO prices are $76 a barrel with the ban and $97 without it. When they apply the $21 per barrel increase in LTO prices from lifting the ban to their "with ban" supply curve, 2025 US crude production grows from 11.7 million b/d to 15.2 million b/d, the highest of any of the forecasts by a comfortable margin.

NERA's methodology raises several questions. While the EIA's Annual Energy Outlook assumes the crude export ban remains in place, it results in a relatively small discount between domestic and international prices. For example, in the EIA High Oil & Gas Resource case, Brent prices are $101 per barrel in 2025, measured in real 2013 dollars (Figure 19). Domestic wellhead prices are $94 a barrel, relatively close to NERA's "no ban" HOGR case. Yet production in EIA's modeling is 12.5 million b/d in 2025, substantially lower than NERA's 15.2 mil- lion b/d. NERA's supply curve, and the EIA projections upon which it is based, are internally inconsistent. The National Energy Modeling System (NEMS) used by EIA to produce their Annual Energy Outlook models well-by-well drilling activity explicitly, the combined effect of which is the overall crude production numbers NERA uses to build its supply curve. A reported change in total crude production from one year to the next is not sim- ply the result of the year-on-year change in crude pric- es but rather drilling decisions made both in that year and previous years based on current and projected crude prices. As discussed below, when we model NERA's well- head price projections endogenously in NEMS, we see a supply response very different than that reported in the NERA study.

The GS report has the highest 2020 crude projections (the last year of the study's forecast) at 14.4 million b/d. GS has recently revised down their estimates, however, due to falling global oil prices. US crude production in all the existing studies, as well as the Rystad central projections, is above the EIA Reference case after 2017. None of the studies explore a low resource or low production scenario.

Figure 20: Crude production forecasts
Million b/d, absent crude oil export restrictions

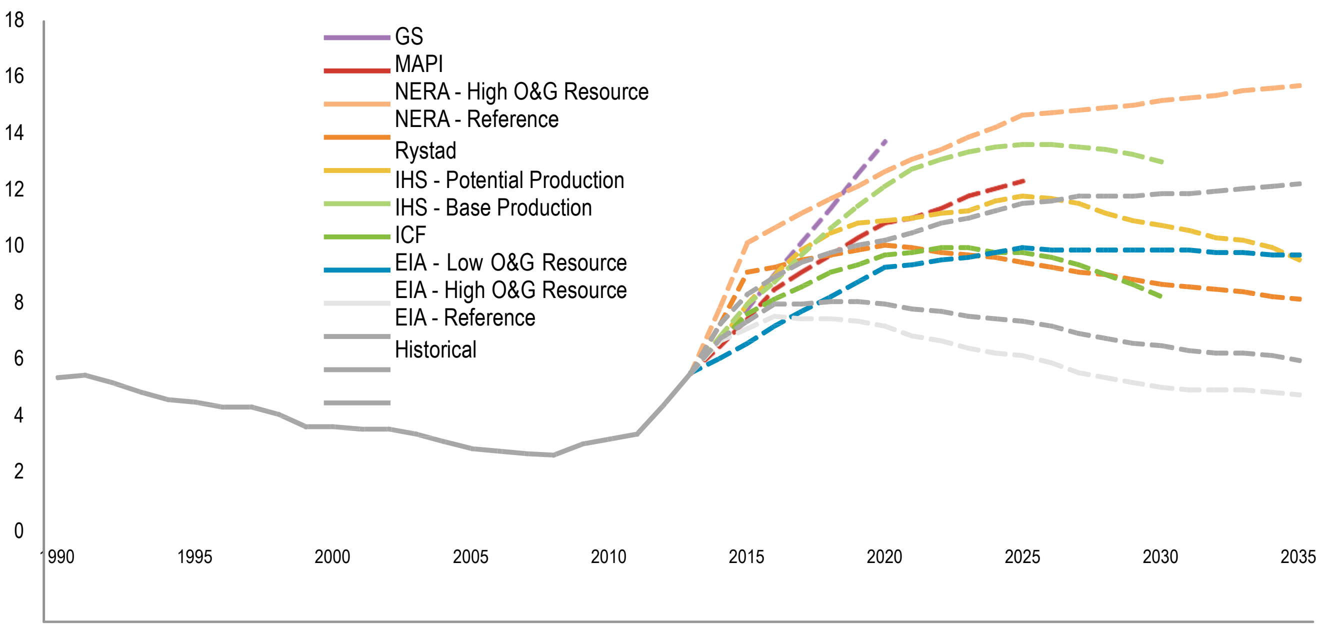
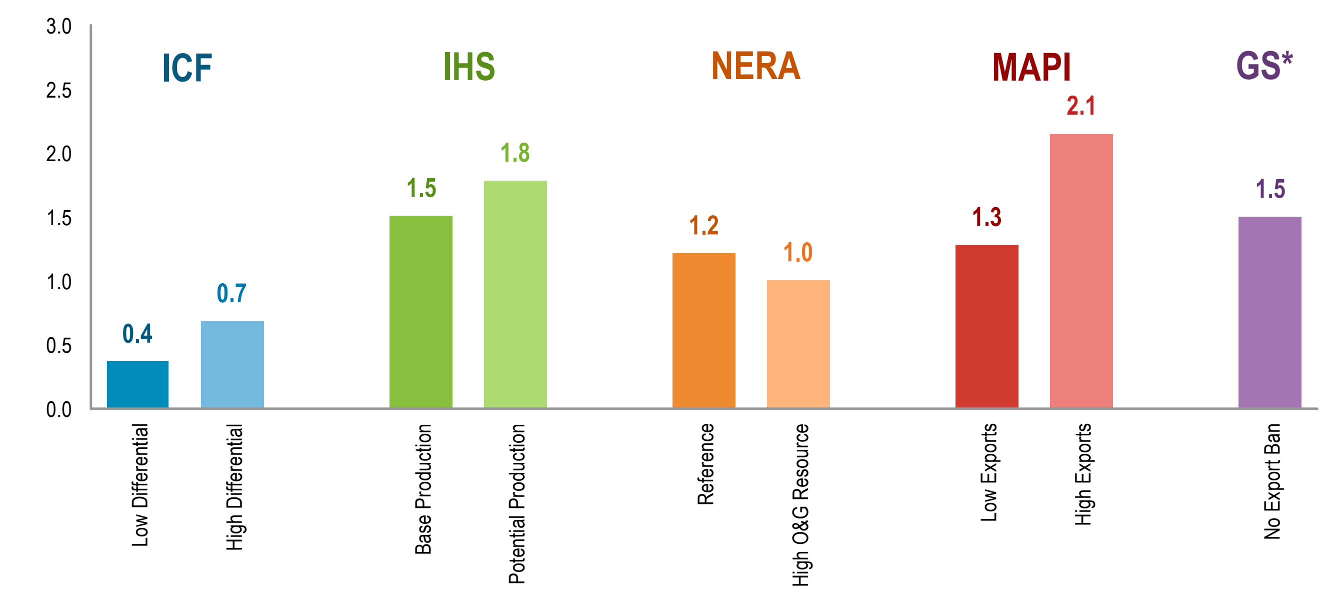


Figure 21: US crude supply elasticity
Change in crude production/change in wellhead price, 2015–2025 average



Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs and Rhodium Group estimates.
*2020 only.

SUPPLY ELASTICITY

In economics, the price elasticity of supply is a measure of the sensitivity of supply of a given good to changes in price.[1] For oil production, supply elasticity measures how the number of barrels produced changes with well-head price. Supply elasticity is expressed as the percent change in supply over the percent change in price.

If elasticity is greater than one, the good is said to be "elastic." Elastic supply means that the percentage change in quantity supplied will be greater than the percentage change in price. The more elastic supply is, the more sensitive it is to changes in price. If elasticity is less than one, the good is said to be "inelastic." Inelastic supply means that percentage change in quantity supplied is less than the percentage change in price. If elasticity is equal to one, the good is said to be "unit elastic," which means that percentage change in quantity supplied moves one for one with the percentage change in price (e.g., if price falls by 10 percent, then supply falls by 10 percent).

The other important US resource base assumption in shaping study outcomes is the responsiveness of US production to changes in wellhead price, or the price elasticity of domestic supply (see "Supply Elasticity" box). That responsiveness depends on a host of factors, including the current cost of production, the extent to which oil companies and service providers reduce costs when under price pressure, and the timing and duration of a given drop in wellhead prices. The net effect of these factors determines the magnitude of the impact on domestic crude oil production of a given export ban-driven discount in domestic crude prices. Figure 21 shows the average price elasticity of US crude supply between 2015 and 2025 from the ex- isting export studies. In the ICF study, the average price elasticity of US supply is between 0.4 and 0.7 on average between 2015 and 2025. In the IHS study (and by exten- sion the MAPI study) the supply elasticity is considerably higher—1.5 to 1.8 between 2015 and 2025—on par with the GS estimates for 2020. The NERA elasticities are in the middle at 1 to 1.1.

All these elasticities are considerably higher than the estimates of long-term oil supply elasticity found in the academic literature (0.15 to 0.25),[92] though robust econometric estimates are hard to come by. That is not surprising, as tight oil production is often considered more price elastic than traditional sources of oil supply.[93] We explored the elasticity of US tight oil supply in the NEMS model by running the model over a range of price paths holding the resource base constant. We found supply elasticities between 0.1 to 0.5, depending on the base price and year.

The Oil & Gas Module in NEMS models production in a similar manner to the ICF and IHS studies, adjusting drilling activity based on well economics and current and forecast crude oil prices. While more simplified, we also explored the implicit price elasticity in the Rystad supply curve and found elasticities ranging from 0.1 to 1 between $100 a barrel and $60 a barrel, with the elasticity growing as base oil price declines.

The drop in global and domestic crude oil prices during the second half of 2014 should provide empirical evidence on the price elasticity of US tight oil supply. If production falls considerably, the elasticities in the IHS, NERA, MAPI and GS studies, though higher than past estimates, may be correct. The number of new drilling permits fell sharply in the fourth quarter of 2014,[94] and a number of US producers have reduced their 2015 investment plans.[95] There are several reasons, however, why declines in drilling permits and new capital investment may lead to proportionally smaller declines in actual production. These include productivity improvements, the disproportionate share of production that comes from a small number of "sweet spots," and the large number of drilled but uncompleted wells.[96] Short-term factors, such as hedging or lease terms, may induce a firm to continue operating at a loss for a period of time, so we may not have a firm grasp on tight oil price elasticity until well into 2015.

If US crude production does not sharply decline in absolute terms, however, the price elasticities used in the IHS, NERA, MAPI and GS analysis will need to be significantly revised. Take, for example, the supply response projected in the IHS study. In their Base Production scenario, wellhead prices fall from $87 per barrel in 2015 to $73 per barrel in 2016 if the crude ban remains in place. As a result, production falls from 9.2 million b/d to 8.8 million b/d over that period. If the crude ban is lifted, wellhead prices rise to $96 per barrel in 2016 and crude production grows to 9.7 million b/d. Thanks to the decline in global oil prices (not the export ban), front month WTI prices had fallen to below $56 per barrel by the time we went to press, with prices further out on the curve trading below $64 per barrel through 2016.[97] Using the IHS elasticities, US production should fall well below 8 million b/d. The NERA analysis assumes US LTO production will stop entirely if prices fall below $55 per barrel. Yet, a number of analysts are now projecting US producers will be able to cut costs and maintain production growth, albeit at a slower pace, in a low-price environment.[98]

Refinery economics

Arguably the single most important variable in shaping the impact of export restrictions on domestic crude production and product prices is the ability and willingness of US refineries to adapt. The ICF, IHS, and NERA studies all employ detailed petroleum models to assess the response of US refineries to growing domestic LTO supply. The ICF study uses two scenarios to assess the range of possible refinery responses. Their Low Differential scenario assumes all current light crude imports are displaced along with a larger share of current medium crude imports, at no cost. Announced refinery capacity comes online without delay. In the High Differential scenario, refineries have greater difficulty displacing imports and new projects are delayed. In the Low Differential scenario, domestic crude price discounts due to the ban start out at a couple of dollars per barrel and peak at $4 a barrel in 2025 (Figure 22). In the High Differential case, the discount starts out at nearly $8 per barrel in 2015 but drops to $4 in 2025 and $2 in 2030 as additional refinery capacity comes online. These relatively small discounts, combined with a comparatively inelastic US supply base, explains why ICF projects considerably smaller crude production increases from allowing exports than the other studies.

Crude production growth is faster in the IHS study than the ICF report, pushing the United States to the point of saturation sooner. There is a lag in building sufficient new refining capacity, resulting in a $23 to $27 per barrel discount for domestic crude in 2016, depending on the scenario. IHS expects refiners to respond to this price spread by building relatively low-cost, simple refineries such as "toppers" and "hydroskimmers,"[99] bringing the price discount down to $4 to $5 a barrel by 2020, the level needed to recoup refinery capital expenditures. This lag between price signal and new investment is consistent with the US experience with ultra-low sulfur diesel regulations.[100] The 2016–2020 discount has large and lasting impacts on US crude production in the IHS analysis, however, as evidenced by the relatively high supply elasticity shown in Figure 21.

The opposite is true in the NERA study. While NERA uses a lower supply elasticity than IHS, they are considerably more pessimistic regarding the ability of US refineries to adapt. In their analysis, refineries refuse to make any capital expenditures that cannot be paid back in two years or less due to uncertainty about the future of the crude export ban. In the High O&G Resource case, this results in a persistent and growing domestic crude discount, up to $27 a barrel in 2035.

We asked leading refinery consultant Turner Mason to assess the cost and scale of refinery capacity additions necessary to absorb the projected crude production increase in the EIA Reference and High Oil & Gas Resource scenarios, as well as an Upper Bound scenario consistent with the IHS Potential Production case.[101] In Turner Mason's view the point of saturation is never reached in the EIA Reference case but occurs in 2016 in the High Oil & Gas Resource and Upper Bound scenarios. If only processed condensate could be exported, they anticipate the industry will respond to projected crude production growth by building condensate stabilizers and ultra-low sulfur diesel hydroskimmers. In the High Oil & Gas Resource scenario, Turner Mason projects 3 to 4 condensate stabilizers and 13 to 15 hydroskimmers would be required, at a combined cost of $13 to $16 billion. In the Upper Bound scenario, that grows to 30 to 35 stabilizers and/or hydroskimmers at a cost of $26 to $31 billion. Recouping this investment will require a $5.00 to $6.50 per barrel discount, in Turner Mason's estimation—similar to the findings in the IHS report. If exports are restricted completely, including of processed condensate, the projected stabilizers would be replaced by higher-cost hydroskimmers, and the total investment required would rise by $1 billion. The eventual per barrel price discount would not change, although the probability of a sharper increase in the discount in the near term would rise, since the additional hydroskimming units would require longer lead times.

The Turner Mason analysis, like the IHS study, assumes there are no significant barriers to new refinery investments (though there is a bit of a lag in the IHS report). Given uncertainty over whether the administration will change export policy, refiners may require more than the normal 10 percent after-tax internal rate of return (IRR) Turner Mason applied in its analysis. Capital costs may escalate due to competition for construction labor and material both from other refinery projects and a host of new energy infrastructures being built along the Gulf Coast. And regulatory environmental requirements may slow the pace of refinery construction. All of these developments would increase project costs and the domestic crude discount required to pay for them.

Global oil market response

The final variable is how the international oil market responds to a change in US production if US crude exports are permitted. This will determine the impact on refined product prices and a significant share of the potential economic benefits. Unlike refinery economics and the US resource base, existing studies use a relatively consistent set of assumptions about international oil market behavior.

First, all the studies assume that international crude prices will decline somewhere between $1.7 and $3 dollars per barrel for every additional one million b/d of oil the United States produces (Figure 23). That implies price elasticity of international crude supply higher than the US estimates included in these studies but consistent with the academic literature. In reality there is considerable uncertainty surrounding the reaction of foreign producers, OPEC in particular, to growth in US LTO production. The NERA study was the only one to explore a range of potential OPEC responses. In their base case, OPEC competes in the market like any other producer. Alternatively, if OPEC reduces production to keep prices at pre-export levels, US crude production rises even more, but the international crude price reduction is considerably smaller. If OPEC maintains output in the face of an export-driven increase in US production, international crude prices fall more than in the base case, but this takes some of the steam out of US crude production growth.

Figure 22: Domestic crude price discount due to export restrictions 2013 USD per barrel

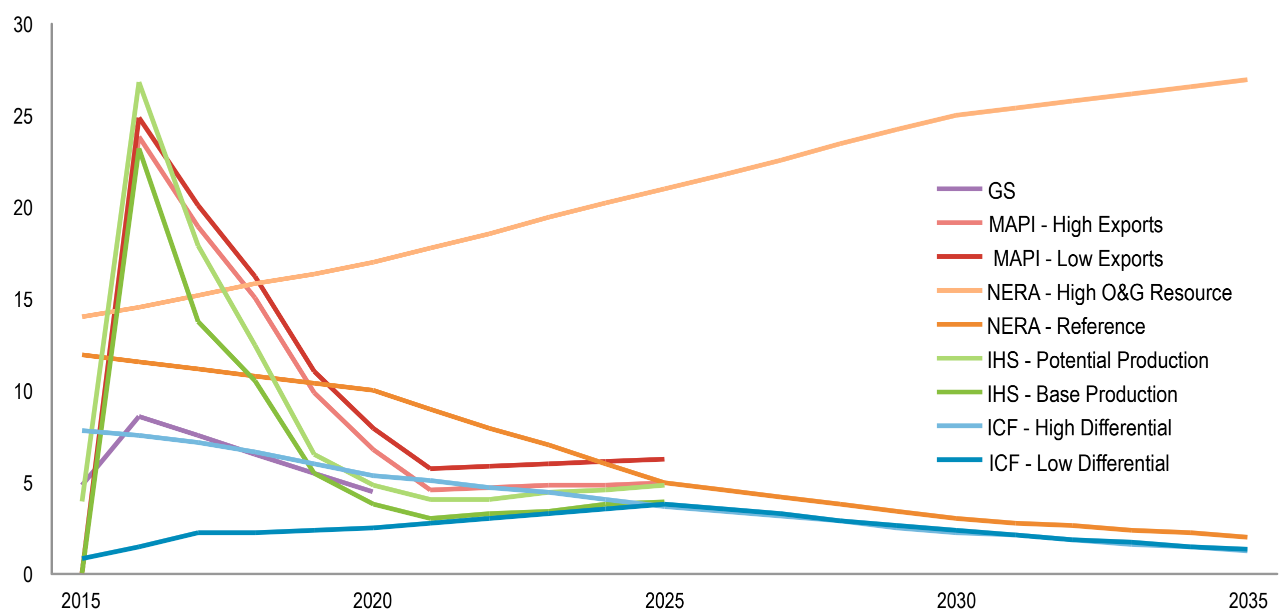
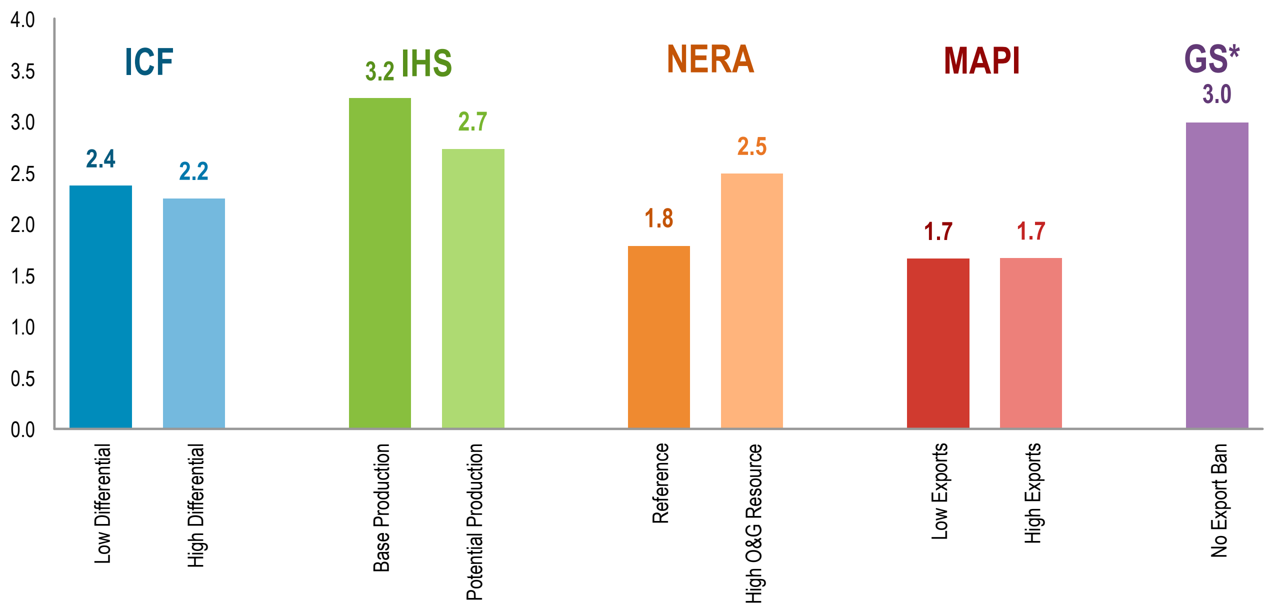


Figure 23: Crude price response

2013 USD per barrel reduction in international crude prices per million b/d increase in US crude production, 2015-2025



Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs, and Rhodium Group estimates.
*2020 only.

There is also a great deal of consistency across studies in the assumed relationship between international crude prices and domestic refined petroleum prices (Figure 24)—in step with the economic theory and empirical evidence cited at the beginning of this section. NERA, IHS, and MAPI as- sume that for every $1 per barrel decline in international crude prices, domestic gasoline prices will fall by 1.7 to 2.9 cents. ICF is a bit of an outlier, with a 4.1 cent decline in the High Differential case, and a change too small to derive a meaningful elasticity in the Low Differential case. Resources for the Future similarly found that allowing crude exports would lower gasoline prices 1.7 to 4.5 cents.[102]

While the relationship between international crude pric-es and US refined product prices is strong and empirical- ly validated (see "What About Gasoline Prices?" box), US decisions regarding the crude export ban could alter glob-al refining balances. If the ban remains in place, US re-finers should add capacity, causing foreign refiners to ad-just by slowing capacity additions. Global product prices in this scenario should be higher overall than if the ban were lifted because US crude supply will be lower and international crude costs higher. If foreign refiners did not adjust in response to US refinery investment, how-ever, there could be excess global refinery capacity, which would at the margin reduce global product prices (to the detriment of refiners). The latter case may be more likely, as there is already overcapacity in global refining, new additions are still planned, and European refineries may continue to increase utilization rates, taking advantage of the rising supplies of cheaper light crude in the Atlantic Basin created as US imports decline.

BOUNDING THE POSSIBILITIES

Given this wide range of market variables, what, if anything, can be said about the magnitude of the impact of lifting export restrictions on domestic crude production and re-fined product prices? If we treat all variables above as equally likely, the increase in US crude production between 2015 and 2025 from lifting export restrictions could be anywhere from 100,000 b/d (ICF Low Differential scenario) to 4.4 million b/d (combining the IHS Potential Production supply elasticity with the NERA High Oil & Gas Resource discount). The reduction in refined product prices could be anywhere between 1 cent per gallon (ICF Low Differential crude production projections combined with NERA international crude and product price response) and 58 cents per gallon (the IHS international crude price response to 4.4 million b/d of domestic crude production growth and ICF High Differential estimate of refined product price response to change in international crude prices). We offer the following observations to help policymakers and other stakeholders try to narrow that range.

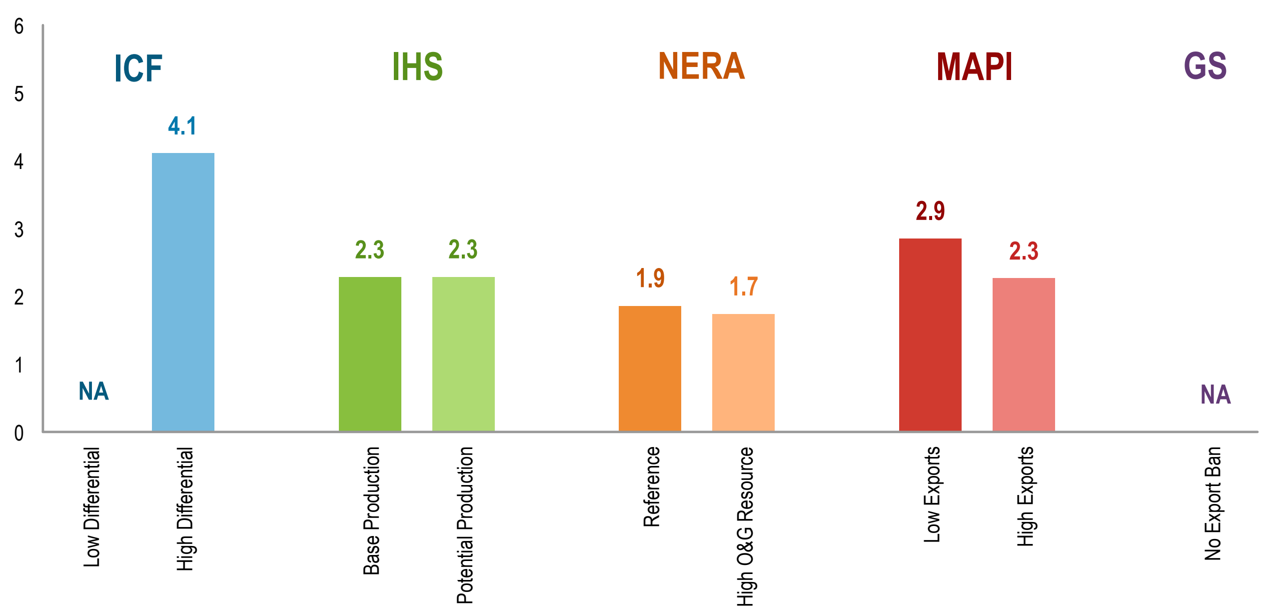
US resource base

In terms of potential US production in the absence of the crude ban, we are comfortable treating the NERA High Oil & Gas Resource scenario as an unlikely outlier because of the way in which it is derived from the EIA High Oil & Gas Resource scenario. Likewise, we believe there are good odds the price elasticity of US supply is considerably lower than the 1.5 to 1.8 found in the IHS, MAPI, and GS studies. When we run the price paths from these studies through EIA's NEMS, or map them against the Rystad cost curve, we find considerably smaller changes in US crude production. While the price elasticity of tight oil supply is likely considerably higher than academic estimates of crude supply elasticity more broadly, and may very well be underestimated in NEMS or in a simple cost curve comparison, there is good reason to question elasticities as high as 1.5 to 1.8. Indeed, several analysts have recently suggested US crude production will be more resilient than projected in these studies.[103] The Rystad cost curve shown in Figure 18 suggests US supply elasticity rises as oil prices fall. But the drilling and other service costs used to produce that cost curve may also now be outdated as lower crude prices lead to cost compression across the oil production supply chain.

Refinery economics

At the US crude production levels predicted in IHS and NERA studies, as well as in the EIA High Oil & Gas Resource case, we would expect there to be sufficient delays, investor risk aversion, and cost inflation to result in domestic crude discounts to Brent crude of slightly more than the $5 to $6.50 engineering estimates provided by Turner Mason or included in the IHS study. How long this

Figure 24: Refined product price reduction
2013 cents per gallon reduction in domestic product prices per 2013 USD per barrel reduction in international crude prices, 2015-2025



Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs, and Rhodium Group estimates.

larger discount lasts would depend in part on the outlook for export policy changes and the extent and duration of completion for engineering and construction labor from other large energy projects along the Gulf Coast. On the other hand, we believe the NERA study is overly pessimistic on the ability of US refiners to respond, as investors are unlikely to ignore the prospect of profiting from a discount of $20 or more for domestic crude relative to international prices for two solid decades due solely to policy risk that can be hedged through financial markets, although inducing such private sector investments through export restrictions is not economically efficient.

International market response

While there is a high degree of alignment among existing studies on the international market response to increased US crude production, in reality this is an area of considerable uncertainty. While in the past market observers have generally assumed OPEC will offset a large share of non-OPEC production growth to defend prices, current OPEC behavior in response to the US shale boom casts doubts on the cartel's ability or desire to offset non-OPEC supply. This means the reduction in global oil prices and domestic gasoline prices for a given increase in US crude production could be larger than existing studies estimate. Short-term responses to market changes must be distinguished, however, from longer-term decisions that OPEC members may or may not make to invest in production capacity.

The key country in this regard is Saudi Arabia, the only OPEC member that retains any meaningful amount of spare capacity and which has frequently been seen as the "swing supplier" to balance oil markets. The results of the November 2014 OPEC meeting, in which the producer group decided not to remove oil from the market to sup- port prices, suggest OPEC, in particular Saudi Arabia, may not feel capable of cutting enough production to support prices or want to lose that much market share. The Saudis have indicated that they require cuts from fellow OPEC and non-OPEC members alike to support prices, yet such co-ordinated discipline seems increasingly unlikely.[104] Iran and Venezuela face a severe budgetary squeeze from falling prices, challenging their ability to meet social commitments that maintain political stability and creating a powerful incentive to evade OPEC production quotas. Production in Libya is already sharply reduced due to domestic conflict. Iraq, like other OPEC members, is working aggressively to capture market share in Asia. Outside OPEC, Russia is extremely vulnerable to falling oil prices, especially in the face of western sanctions, so it is not willing to cut output. Moreover, the ability of the Saudis to offset the glut of light crude created by rising US oil flows by cutting medium and heavy production may be limited.[105] Clearing out the oversupply from the Atlantic Basin might require painful supply reductions from African OPEC producers such as Nigeria and Angola.[106] For these reasons, OPEC's ability to play its historical role as a market balancer may be substantially weakened by the US light oil boom in the short to medium term, although many forecasters see OPEC market share growing after 2020.[107]

Global oil prices

The sharp decline in global oil prices during the second half of 2014 due to rapid US supply growth, the return of disrupted barrels from Libya and other countries, and weak demand raises questions about the US production projections included in most of the existing crude export studies. As stated earlier, spot and futures prices both for Brent and WTI were considerably lower when we went to press than price forecasts used in any of the existing crude export studies, and if current crude prices persist and the supply elasticities used in the IHS and NERA studies are correct, their US production outlooks will need to be considerably revised, which would push back the point at which domestic market saturation might be reached. We are more optimistic about the resilience of US producers to current oil prices and therefore skeptical of the high supply elasticities used by IHS, NERA, and others, but lower oil prices will certainly have some impact both on the growth rate of US crude production and the effect of lifting current export restrictions.

Putting it together

Based on the above assessment and current oil market uncertainty, lifting current restrictions on crude oil exports would likely lead to higher domestic production of 0 to 1.2 million b/d on average between 2015 and 2025. The lower-bound estimate captures production scenarios in which market saturation never occurs, such as under the EIA's 2014 Annual Energy Outlook Reference Case. While the EIA's Reference Case projection is the lowest among those surveyed in this report, crude oil prices are now significantly lower than the prices used in all the projections included, which creates downside risk to their production forecasts.

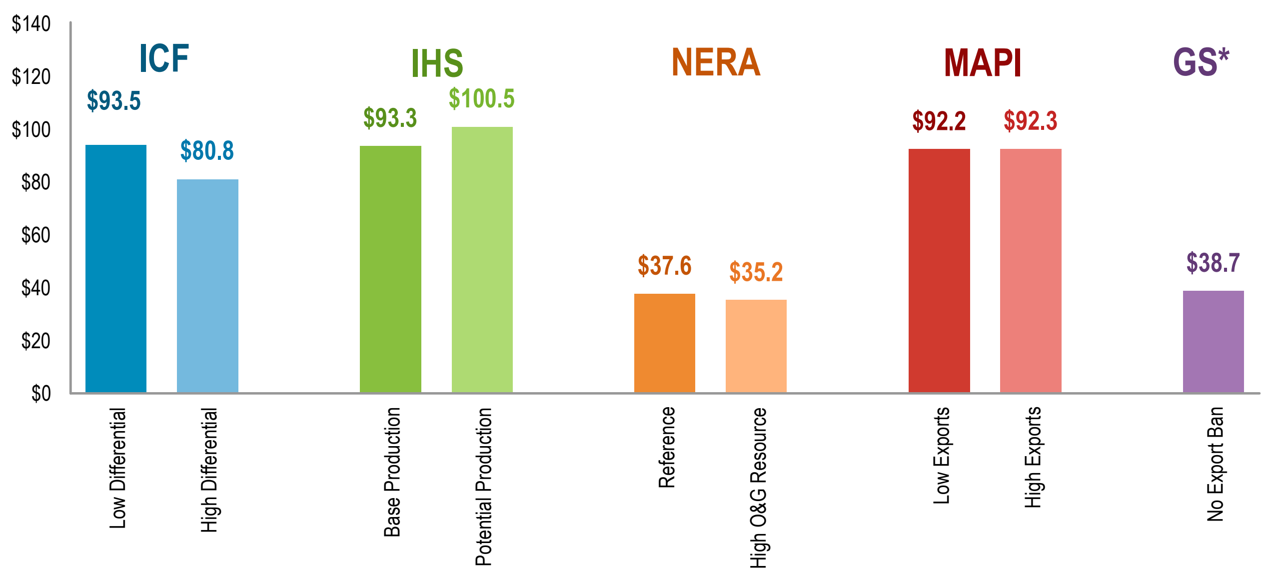
To arrive at our upper-bound estimate of 1.2 million b/d, we assume that global crude prices return to $100 per barrel quickly and that US production in the absence of export restrictions averages 12 million b/d between 2015 and 2025 (the upper end of the projections surveyed in this report). To evaluate the maximum likely impact of the ban in this environment, we assume a $10 per barrel average discount for domestic crude between 2015 and 2025 and a price elasticity of domestic supply of 1.0—the highest of any point on the Rystad supply curve and more than twice as high as the highest point found in the NEMS modeling we performed across a range of crude price scenarios. We believe a supply elasticity of 1.0 is a safe upper-bound estimate, even though it is below that used in the IHS and MAPI studies. An elasticity significantly lower than 1.0 is more appropriate if US shale production proves to be resilient in the face of the recent price drop, as several analysts project.[108] Also, while the change in US production at the upper end of our range is below that found in the high production scenarios in the IHS, MAPI, and NERA studies, we believe it could result in an equally large reduc- tion in refined product prices due to a more relaxed OPEC response (up to 12 cents per gallon in our analysis). This is equally, if not more, important from an economic standpoint than the change in US crude production growth. Complete methodological detail is available online at http://www.rhg.com/crudeexports.

FROM ENERGY TO ECONOMICS

What effect will an increase in US crude production and decrease in refined product prices have on US economic growth? Houser and Mohan (2014) find that as a result of the shale gas and tight oil boom, US economic output will be up to 2.3 percent higher in 2020 than it would have been otherwise thanks to higher production and low- er prices.[109] Likewise, in examining the impact of removing crude export restrictions, the existing studies find a positive impact on growth.

The magnitude of that impact varies due not just to the underlying energy market results (for example, the extent of the increase in US crude production and reduction in refined product prices) but also the economic methodology employed in each study. For example, the NERA and GS studies find roughly half the econom- ic benefit of each barrel of additional US crude pro-

Figure 25: Increase in GDP from lifting crude export restrictions
Billion 2013 US per million b/d of additional US crude production, 2015–2025



Source: ICF, IHS, NERA, Aspen Institute, Goldman Sachs and Rhodium Group estimates.
*2020 only.

duction between 2015 and 2025 as the ICF, IHS, and MAPI studies (Figure 25).

The ICF, MAPI, and GS studies employ partial equilibri- um models that sum the "direct," "indirect," and "induced" economic impacts of an increase in crude production and a decrease in refined product prices, and a decline in refinery profit margins and investment. Direct impacts are those that occur within a given sector, such as oil production. Indirect impacts are the knock-on effects in industries that supply the directly impacted sectors, such as manufacturers of the steel pipe used for oil drilling. Induced impacts are in industries affected by changes in labor compensation in directly and indirectly impacted sectors, for example the restaurants where oil workers spend their paychecks. The GS study arrives at different results than the ICF and MAPI studies, which are based on different estimates of the relative partial equilibrium impact of increased oil production versus refinery utilization and investment—for example, they believe the direct, indirect, and induced economic benefits of increased domestic refinery utilization outweigh the direct, indirect and induced economic costs of lower domestic crude production, at least for a period of time.

In contrast, the NERA study employs a general equilibrium model that captures additional economic effects. For example, increased investment and employment in the oil and gas sector means less labor and capital available for other types of economic activity. These general equilib- rium dynamics produce a "net" economic benefit that is smaller than the "gross" economic benefit found in partial equilibrium studies.

When the economy is recovering from recession, as the US economy still is today, the "net" numbers are closer to the "gross" because there is surplus labor and capital available for employment/investment. The IHS study employs a macroeconomic model that captures short-term business cycles within a long-term equilibrium framework. With an assumption that the US economy will not return to full employment for several years, the IHS study finds larger net economic impacts between 2015 and 2025 than the NERA report (harmonized for projected increase in crude production). These gains dissipate with time, however, as the economy returns to full employment. For example, in the IHS Potential Production case, US GDP is 1 percent higher in 2020 if export restrictions are lifted, but only 0.4 percent higher in 2030. That means GDP *growth* between 2020 and 2030 is lower in the crude export case, though the overall *level* of GDP remains higher.

As with the shale gas and tight oil boom itself,[110] an increase in domestic production and reduction in refined product prices resulting from a change in US crude export policy can help accelerate the pace of US economic recovery. The investment in refining capacity required if export restrictions remain in place would have the same sort of stimulative effect as upstream oil and gas production but would not produce the same decline in refined product prices with its attendant economic benefits. In the context of the US economy as a whole, the magnitude of the benefit of lifting crude export restrictions is modest, but it is a benefit all the same. That directional impact, combined with the geopolitical considerations described in the following chapter, should guide policymakers thinking about more than point estimates of the impact on US GDP one or two decades from now, which are difficult to make given the fast-changing nature of both the US and global oil market.

THE ENERGY SECURITY CONSEQUENCES OF ALLOWING OIL EXPORTS

A DIFFERENT OIL MARKET

The previous section described the potential energy market and economic impact of lifting crude export restrictions given relatively stable global oil market conditions. But those export restrictions were adopted in response to severe global supply disruptions, starting with the Arab oil embargo of 1973. President Nixon's Project Independence, aimed at achieving oil self-sufficiency by 1980, was intended to protect the country from physical oil supply shortages. Now that oil self-sufficiency is potentially within reach, won't lifting crude export restrictions put the country at risk by leaving it dependent on imported oil while exporting domestic production to other countries?

Today's oil market is very different than it was during the 1970s. At that time, most oil was sold under long-term contracts.[111] A disruption in contracted shipments could result in a physical shortage for the buyer because of the lack of strategic and commercial stockpiles or a spot market where buyers could find alternative sources of supply. In the intervening years, the oil market has become the largest and most liquid commodity market on earth, with the vast majority of cargos bought and sold for a price indexed to benchmark spot crude prices and mature pricing hubs in regions including Europe (Brent), the United States (WTI), and the Middle East (Dubai). A supply disruption in one country increases crude prices globally, which incentivizes both additional sources of supply and greater conservation and efficiency.[112]

In response to the supply disruptions of the 1970s, major oil consuming countries have also established strategic reserves held by governments or companies, which can be released to add supply to the market during large disruptions to provide insurance against particularly severe global supply shocks. The International Energy Agency was cre-

LESSONS FROM TRADE IN REFINED PETROLEUM

Less than a decade ago, the United States was the largest importer of petroleum products in the world. Access to those global markets allowed supply to keep pace with rising US gasoline demand. In recent years, however, the market has changed dramatically. US petroleum product demand has declined, especially for gasoline, due to improved vehicle efficiency, changing driving patterns, and the increasing substitution of nonpetroleum fuels such as ethanol for crude-based components. As crude production in the United States has swelled, so has the production of petroleum products, reflecting a combination of discounted domestic crude prices, complex refining capacity, access to export markets, and lower natural gas prices that boost refinery economics.[1] Total gross exports of finished petroleum products, natural gas liquids, other liquids including ethanol, and crude oil topped 5.3 million b/d in July and August 2014, up a staggering 4 million b/d since 2005.

Despite the turnaround in the US refined product trade balance, free product trade continues to provide US energy markets with much needed flexibility. Due to refinery configurations, as well as other factors, including Jones Act shipping costs,[2] some regions of the United States remain net importers of refined petroleum products. The United States became a net exporter of distillate in 2008 and has imported gasoline for decades. Yet in each of the last two winters, when gasoline demand was low, the United States became a net exporter of gasoline for brief periods of time—a remarkable reversal of past trends.[3] Access to the global market during these periods allowed refiners to continue to run at high capacity notwithstanding these seasonal variations, which boosted gasoline supply overall both in the United States and the global market. Restrictions on export of gasoline and diesel would have removed this incentive and likely raised US pump prices.

ated to coordinate and manage standards for international reserves and responses to oil market emergencies among OECD countries. In recent years, efforts have been made to extend reserve management practices to major non- OECD countries such as China, India, and Brazil.

Another major change over the past four decades has been the development of global refined product markets. Refiners can now sell their products globally and distributors can look abroad for their gasoline, diesel, fuel, and LPG, and there are mature refined product spot markets in New York, Rotterdam, Singapore, and elsewhere, and a growing volume of international refined product trade. As men- tioned earlier, the United States is now the largest refined product exporter in the world. This means that refined product prices in the United States are set by the glob- al market, and that the United States cannot disconnect itself from global markets, barring new restrictions on re- fined product trade. "Energy independence," as the term is most often used, is not a viable option. Even if the United States achieves crude self-sufficiency, American businesses and consumers will still be vulnerable to global oil supply disruptions.[113] As noted in the box "Lessons from Trade in Refined Petroleum," international product trade has also meant that the market can respond more efficiently to changing patterns of global supply and demand.

THE BENEFITS OF INTERDEPENDENCE

The interdependence of the US and global oil market is not a bad thing. While politicians have extolled the bene- fits of "energy independence," most scholars have preferred to focus instead on "energy security,"[114] defined broadly as the availability (Are supplies on the market?), accessi- bility (Can you get to them?), and affordability (Can you get them at a competitive price?) of energy resources.[115] Indeed, better integrating US crude into global oil markets can improve both US and global energy security by all three measures.

Permitting US crude exports can mitigate the impact of an international supply disruption on the price Americans pay at the pump. As discussed previously, US refined prod- uct prices are set by global crude prices, and the impact of an international crude supply disruption on global crude prices depends on the speed at which other sources of crude supply can come online. US tight oil is the largest marginal source of global oil supply today. It is also relatively quick to bring production online and less capital intensive compared to other marginal crude sources, meaning it likely would respond faster to changes in global prices than conventional oil production.[116] If current crude export restrictions result in a meaningful disconnect between international and domestic crude oil prices, an increase in global crude prices as the result of a non-US supply disruption will not be fully passed through to US crude producers, reducing their incentive to scale up production to offset supply disruptions elsewhere in the world.

The United States derives benefits from its participation in global oil markets, which allow it to mitigate the im- pact of supply disruptions, whether domestic crude pro- duction losses or disruptions in long-term import supply. As discussed in the "US Response to Supply Disruptions" box, large-scale US crude production losses due to extreme weather are not uncommon. The ability to offset these outages through increased imports confers an energy security benefit to the United States. Global market integration is also critical in helping the United States adjust when traditional sources of imports are disrupted, as occurred with Venezuelan imports in 2002/2003. While crude export restrictions do not prevent the United States from tapping global markets for imports, were other countries to adopt similar policies, the United States would lose this source of supply flexibility and security. As a matter of principal, moreover, crude export restrictions are inconsistent with the US enjoying the benefits of petroleum trade and the US commitment to free and open markets.

As discussed in previous sections, lifting current crude export restrictions would increase US production, although the size of this growth is unknown. To the extent that US supply is less prone to disruption than the global average due to political stability, an increase in US output could also reduce the severity and frequency of large global supply shocks by increasing the share of stable oil supplies to the global market.[117]

THE ECONOMIC SECURITY IMPLICATIONS OF TRADE AND DEMAND

Lifting current crude export restrictions would also dampen the economic impact of a given global oil price shock within the United States in other ways. Broadly speaking,

US RESPONSE TO SUPPLY DISRUPTIONS

Over the past decade, extreme weather events have had a substantial impact on crude production and refining along the Gulf Coast. Twice in the past ten years, in 2005 and 2008, hurricanes shut in 100 percent of offshore Gulf of Mexico production for at least several days. In the case of Hurricanes Katrina and Rita in 2005, 50 percent or more of production was shut in for 12 weeks. The damage in 2008 was not as severe, and the recovery was more rapid, resulting in approximately 20 percent of production remaining shut in after twelve weeks.[1]

These hurricanes also caused substantial Gulf Coast refining outages, up to 5 million b/d in 2005 and 4 million b/d in 2008.

In response to the 2005 supply disruption, the IEA coordinated a release of 60 million barrels of crude oil and petroleum products from strategic reserves. Refiners and wholesalers substantially increased refined product imports to offset the loss of domestic supply.[2] Gasoline imports also increased during the 2008 supply disruption, though to a lesser degree.[3]

Several years earlier, in December 2002, Venezuelan opposition forces seeking the removal of Hugo Chavez from power started a general strike, which resulted in a temporary oil production loss of about 3 million b/d. Although the political buildup to the strike had been closely watched by industry and the US government, the size and duration of the oil production decline took both by surprise.[4] Subsequently, in March 2003, the US invaded Iraq, which again impacted supply and price.

The Venezuelan supply disruption impacted the United States more than any other country. Over the course of two months, US imports of crude and refined products from Venezuela dropped from more than 1.6 million b/d in November 2002 to 400,000 b/d in January 2003.[5] Though many US refineries were heavily dependent on Venezuelan crude, by February 2003 they had managed to replace all lost Venezuelan supply with imports from other countries.[6]

In both cases of disruption, the adverse impact of the disruption was significantly eased by the ability of the US to access the global petroleum market and increase imports of crude oil and refined products from other countries, along with the use of government-held strategic stocks. The US benefits from the integration of the global petroleum market, and restrictions on crude oil exports are inconsistent with that principle.

oil price shocks impact the US economy in three ways.[118] First, they increase business costs and reduce real household income. Second, they put upward pressure on prices economy-wide, which can result in tighter monetary policy. Third, as long as the United States is a net oil importer, oil shocks deteriorate the country's terms of trade and can result in large temporary increases in the country's current account deficit.

To the extent lifting crude export restrictions increases US production, net US oil imports will decline. This is true even though gross imports increase as more light oil is exported and more heavy oil imported than would be the case were the export restriction to remain in place. In a recent report, the White House Council of Economic Advisers (CEA) found the "resilience of the economy to international supply shocks—macroeconomic energy security—is enhanced by reducing spending on net petroleum imports and by reducing oil dependence."[119] This is due both to the smaller terms of trade penalty from an oil price shock, and the fact that more of the increase in oil producer revenue stays within the United States. Figure 26 shows CEA's estimate of the difference in the impact on GDP of a 10 percent increase in oil prices where net oil imports represent 1 percent of total GDP versus a scenario where they are higher, representing 2 percent of total GDP.[120]

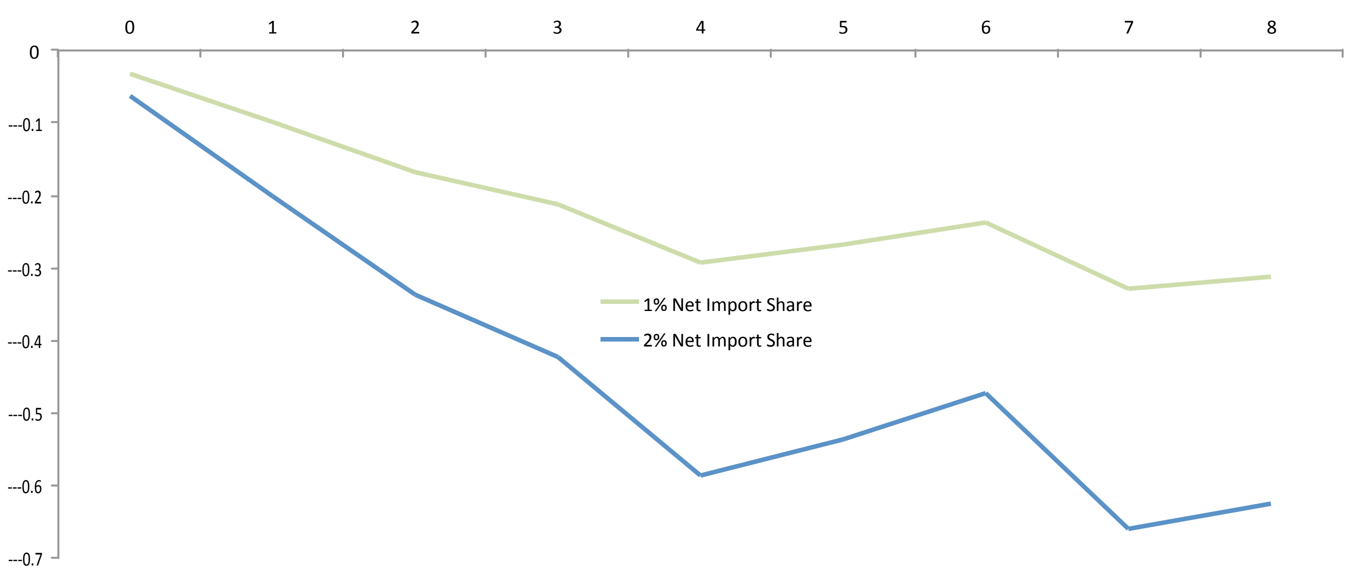
On the other hand, if lifting crude export restrictions results in a decrease in gasoline and other refined product prices (as our previous discussion suggests it would), US oil demand will grow, exacerbating the impact of a given change in prices on household incomes, business expenses and overall inflation. Given the magnitude of the potential refined product price decline projected in existing crude export studies, the impact on overall US oil demand would be small (likely 5 to 15 percent of the increase in production) so overall net imports would still decline. Assessing the net impact of higher demand and lower net imports is beyond the scope of this paper, but it is likely considerably smaller than the security and other benefits from greater global market integration.

MORE EXTREME SUPPLY DISRUPTION SCENARIOS

Thus far we have been discussing supply disruptions of a magnitude that increase global prices, but do not result in a widespread physical scarcity. What about more severe scenarios, such as global military conflict or the complete loss of a major producer like Saudi Arabia or Russia? If the United States suddenly found itself in a position where it could not import crude oil regardless of price, would we regret having lifted crude export restrictions?

Though this likely goes without saying, the United States will always have the ability to halt crude oil (as well as refined product) exports if it is in the country's national interest to do so. The more important question is how quickly refiners would be able to switch from imported to domestic crude were such a scenario to arise. There would certainly be adjustment costs. As discussed in the previous section, running light crudes through a complex refinery can result in yield loss, and building hydroskimmers takes time and money. The scale of investment is relatively minor relative to the broader economic and military costs that would likely accompany such a severe supply disruption scenario. Preserving current crude export restrictions purely as a hedge against such low-probability outcomes is high-cost insurance. Other options are likely more efficient, such as reconfiguring the strate- gic petroleum reserve to better suit the rapidly evolving US oil market landscape.

Figure 26: Estimated cumulative effect of 10 percent oil price shock on GDP
Percent change in GDP, quarters after shock



Source: White House Council of Economic Advisers.

GEOPOLITICAL AND TRADE POLICY CONSIDERATIONS

Since the founding of the postwar global trading system, the United States has been a leading proponent of open trade. For most of that time the United States was a net energy importer, so access to international energy and natural resource supplies was an important trade policy priority. The United States has also traditionally supported open international trade on the principle that it improves economic welfare both for importers and exporters. With the surprise turnaround in US oil production and trade balance, and with crude export restrictions beginning to distort trade outcomes, America's commitment to free trade principles is now being put to the test.

EXISTING TRADE COMMITMENTS

Crude oil is considered a good and thus subject to the disciplines of the General Agreement on Trade and Tariffs (GATT) and the World Trade Organization (WTO). Several GATT provisions are relevant to current crude export restrictions. Article XI disciplines the use of nonfiscal export restrictions, such as quotas, export bans, or nonautomatic export licensing.[121] It states:

> *No prohibition or restriction other than duties, taxes or other charges, whether made effective through quotas, import or export licenses or other measures, shall be instituted or maintained by any contracting party on the importation of any product of the territory or any other contracting party or on the exportation or sale for export of any product destined for the territory of any other party.*

An allowance is made under Article XI:2(a) for "export prohibitions or restrictions temporarily applied to prevent or relieve critical shortages of foodstuffs or other products essential to the exportation of the contracting party." A country imposing an export restriction could also argue the policy qualifies for one of the exceptions under Article XX, such as Article XX(g), which justifies measures "relating to the conservation of exhaustible natural resources." The United States has a long history of successfully arguing against the use of such exceptions in export restriction cases.

In 1987, the United States challenged a provision of the 1976 Canadian Fisheries Act that prohibited the exportation of some types of herring and salmon. Canada argued that its export restrictions were integral to their overall West Coast fisheries conservation and management regime and were thus justified under Article XX(g) of the GATT.[122] A dispute settlement panel found that while salmon and herring were "exhaustible natural resources" and Canadian export restrictions did have some relationship to their conservation, that was not their primary aim and thus an Article XX(g) exception did not apply.

The United States in June 2009 requested WTO dispute settlement consultations with China regarding export restrictions imposed on bauxite, coke, fluorspar, magnesium, manganese, silicon carbide, silicon metal, yellow phosphorus, and zinc—important raw material inputs into steel and other manufacturing processes.[123] The EU and Mexico did the same, and in December a single WTO dispute panel was established.[124] China argued that the restrictions were justified under Article XI:2(a) and Article XX(g), among other defenses. In its July 2011 report, the WTO panel rejected China's claims. Regarding XI:2(a), the Panel found that XI:2(a) only applies to measures taken for a limited time to address a particular crisis causing a critical shortage. The Panel also found that China did not have a basis for an Article XX(g) exception to many of the US, EU and Mexican complaints, due to special provisions included in its WTO accession agreement, but that in any event the Chinese policy did not meet the Article XX(g) test because export restrictions were not coupled with "restrictions on domestic production or consumption."[125] In January 2012, the WTO Appellate Body upheld this decision.[126]

Two months after the Appellate Body ruling, the United States challenged other Chinese export restrictions on the same grounds, this time covering rare earth resources, including tungsten and molybdenum.[127] Canada, the EU and Japan subsequently joined the consultations. China again claimed an Article XX(g) exception. As with the raw materials case, the dispute panel found that China could not claim the exception under given terms of its WTO accession agreement, but that in any event the exception would not apply because the export restrictions were designed to achieve industrial policy rather than conservation goals and that China did not place a similar focus on restricting domestic production and consumption.[128] This decision was also upheld by the Appellate Body.

Should the United States choose to maintain current crude export restrictions, it could be in the position of having to make the same Article XX(g) exception arguments that it successfully defeated in the Canadian and Chinese trade disputes described above. The precedent established in those cases would likely make such an Article XX(g) defense challenging. The United States would likely need to show the restrictions were related to the conservation of natural resources and that the export restrictions were matched with similarly aggressive efforts to reduce domestic oil demand and production.

The United States could also argue for an Article XXI exception on national security grounds.[129] This is the exception generally cited in defense of US short supply controls on crude oil and refined petroleum products and dual-use military items. But Article XXI only allows an essential security exception "taken in time of war or other emergency in international relations." Commenters have not- ed that although short supply restrictions have never been challenged before the WTO, they are suspect, as they are permanent, rather than in response to a temporary emergency.[130] Beyond the Article XI disciplines, US export restrictions could also come under the disciplines of the WTO's Agreement on Subsidies and Countervailing Measures (ASCM) if they result in a significant discount for domestic crude compared to international crude. Trading partners could accuse the United States of subsidizing domestic refineries at the expense of foreign competitors.

CURRENT AND FUTURE TRADE TALKS

Equally, if not more, important as assessing the consistency of current crude export restrictions with existing US international trade commitments, is assessing the implications of maintaining them on other US trade policy priorities. Were the United States to be challenged in the WTO and succeed in arguing for an Article XX(g) or Article XXI ex- ception, it would create a precedent that could limit the ability of the US to challenge other countries export restrictions in the future. Beyond the case law, it could also damage US credibility in arguing for the removal of domestic energy subsidies or export restrictions more broadly, or win non-energy concessions in current trade talks with the European and Asian countries.

In the negotiations over the Transatlantic Trade and Investment Partnership (TTIP), for example, the Europeans have argued for the inclusion of an energy chapter and the elimination of US energy export restrictions. In its initial negotiating position, the EU noted that for energy and raw materials an agreement should include "the elimination of export restrictions, including duties or any measure that have a similar effect."[131] A subsequently leaked EU non-paper highlighted the crisis in Ukraine as an example of the threats to EU energy supply security that free trade in energy could help address.[132] It also noted the success of US-EU cooperation in challenging China's export restric- tions, and how maintaining export restrictions would undermine those efforts. "Combatting resource nationalism, together vis-à-vis third countries while at the same time allowing for export restrictions to exist between us sends the wrong message to our partners and offers some of these resource-rich countries a great opportunity to interpret trade rules in a way which is detrimental to our economies."

As the United States Trade Representative noted upon the conclusion of the China raw materials case, "by upholding rules on fair access to raw materials, this decision is a win not only for the United States, but also for every nation that respects the principles of openness and fairness. Those principles are the pillars of the rules-based global trading system, and we must protect them vigilantly."[133]

GEOPOLITICS

All else equal, an increase in US crude production resulting from the removal of current crude export restrictions would reduce non-US crude production and global crude oil prices. Using global supply-and-demand elasticities both from the academic literature and existing crude ex- port studies, even a 1.2 million b/d increase would have a relatively modest impact on global oil prices (a decline of $0 to $4 per barrel on average between 2015 and 2025) and non-US oil supply (a decrease of 200,000 to 1.0 million b/d on average between 2015 and 2025) relative to a global oil market expected to be producing more than 80 million b/d of crude oil (excluding other liquids) during that period (full methodology available at http://www.rhg.com/crudeexports). Still, it is useful to consider the potential geopolitical effects, if only directionally. Obviously, this effect also depends upon OPEC's response to an increase in US supply and whether OPEC producers offset the increase by cutting output.

Lower global crude prices and lower non-US crude production reduces the economic power, fiscal resources and geopolitical influence of large oil producing countries, from Saudi Arabia to Canada. Additional supply on the market also increases competition and reduces any one country's ability to leverage its resources to gain geopolitical influence. Conventional wisdom is that reducing oil revenue for geopolitical rivals like Russia and Iran is a geopolitical benefit to the United States. That is certainly the theory behind the recent application of financial sanctions against Russia and Iran. There is also a view that reducing the oil market share of autocratic allies like Saudi Arabia will free the United States to pursue other foreign policy objectives like human rights protection and democratization.[134]

Reducing foreign producers' oil revenue and market share could have negative geopolitical consequences as well. After several years with oil prices at $100 or above, oil-producing countries have significantly increased oil-funded spending on domestic social programs, domestic security, and national defense.[135] A sharp drop in oil prices such as the one that occurred in the second half of 2014 will challenge the sustainability of those fiscal plans, raising the prospect of political unrest. That could be positive, if current autocratic regimes become more democratic. It could also lead to broader instability in the Middle East, Africa, and Latin America, with attendant national security risks for the United States.

It is important not to overstate the magnitude of these impacts, either positive or negative. Even a 1.2 million b/d increase in US crude production as a result of lifting crude export restrictions could easily be overwhelmed by other market events. Despite the notable inability of OPEC to reduce output at its November 2014 meeting, OPEC, and Saudi Arabia in particular, will continue to play on outsize role in the global oil market in the longer term.[136] This is due both to its current and projected market share[137] and its unique ability to hold spare production capacity, which is defined as the ability to bring production online within 30 days and sustain it for more than 90 days.[138] This ability to play the role of swing supplier has given Saudi Arabia unique market power and geopolitical influence but also helped balance the market in response to short-term supply disruptions or demand shocks.[139] The political fate of oil-producing countries will be determined much more by other factors, such as the baseline crude-oil price out- look and domestic fiscal discipline. But at the margin, an export-driven increase in US oil production would likely geopolitically advantage the United States.

More trade

While the impact of lifting crude export restrictions on US production and global prices is uncertain and likely modest in the global context, the impact on US oil trade flows may be significant. With export restrictions in place, US refiners will continue to switch from imported to domestic crude and add capacity to handle more domestic supply, thus backing out more imports. If export restrictions are lifted, imports will be higher than they would otherwise be and the United States will likely export additional light tight oil production—although the global market for light oil and condensate is not without its limits. While net US oil imports will be lower without the export restrictions, thanks to an increase in domestic production, gross crude imports will be higher, as refiners import a certain type of crude that is best suited to their refineries and producers export other types of crude to better-suited refineries abroad, as discussed in previous sections.

This increased trade, both of imports and exports, could have geopolitical consequences. Given the size and liquidity of the global oil market, *where* a country buys its crude from should theoretically make little difference in the event of a supply disruption. But the supply security concerns of politicians and defense planners mean specific bilateral trade flows can have significant geopolitical implications in practice.[140] Oil importing countries, from the United States to Japan, have long attached special importance to their bilateral relationship with crude trading partners. The importing country is often seen as the subjugate in such relationships, though, ironically, Chinese oil imports are generally seen by the West as providing Beijing with geopolitical leverage. Yet like all freely entered commercial engagements, the benefits of trade are mutual. Beyond the direct economic gains, trade generally improves bilateral relations more broadly, opens new lines of communication and reduces the odds of conflict.[141] Lifting crude export restrictions extends US geopolitical influence by maintaining current trade relationships on the import side and generating new ones through exports.

Diplomatic leverage

As with international trade, the most significant geopolitical impact of lifting crude export restrictions might be on overall US diplomatic leverage and credibility rather than direct market or security outcomes. Recent application of financial sanctions to achieve foreign policy objectives provides an excellent example.

While sanctions have long been a feature of the US foreign policy arsenal, they are being used in increasingly novel and targeted ways, often against large energy producing countries, not only to cut off energy flows but also to isolate them from international financial and commercial systems through financial tools, pressure, and market forces.[142]

Two recent examples are the imposition of financial sanctions on Iran and Russia, two of the world's largest oil producers. In both cases, success required addressing concerns both within the United States and other countries that global oil prices would not spike in response to a sanctions-driven loss of supply. That concern was most acute in the Russian case, as the country is responsible for more than 10 percent of global crude oil supply, and resulted in narrower sanctions targeted at future oil investment rather than current oil supply.[143] Oil price concerns were also a major obstacle in building international support for much broader sanctions against Iran.

The United States has prohibited trade with Iran for years.[144] In 2011 it designated a number of Iranian elites as engaged in terrorism or nuclear proliferation, making both US and foreign companies and individuals doing business with these Iranian elites subject to sanction under the Comprehensive Iran Sanctions and Accountabil-ity Act (CISADA).[145] Later that year, the US Congress included provisions in the National Defense Authorization Act (NDAA) that instructed the administration to persuade other countries to "significantly" reduce their purchases of Iranian crude oil or face sanctions in the United States.[146]

With crude oil prices spiking to $125 per barrel shortly after the NDAA was signed into law, US diplomats had a difficult task in persuading Iran's oil buyers to reduce purchases and diversify their sources of supply. Iran's customers were concerned about their ability to find alternative sources of supply without putting further upward pressure on prices. Saudi Arabia's decision to increase production helped placate these fears, as did speculation of a stockpile release by IEA member countries (particularly since IEA countries had released strategic oil reserves the prior year, in June 2011, in response to the Libya disruption). The rapid growth in US production was also a significant factor.[147] It increased the range of supply options available to other countries by displacing US imports, and helped moderate the increase in global oil prices resulting from a loss in Iranian supply.

To the extent that maintaining US crude export restrictions reduces US production growth, future attempts to build international support for sanctions against oil-producing countries may be less successful. More important, it will be tough for US diplomats to press other countries to reduce crude imports from a target country in the interest of global peace and security if the United States is unwilling to help make alternative supplies available.

ENVIRONMENTAL CONSIDERATIONS

While an increase in US crude oil production resulting from a modification or removal of current export restrictions has economic, security, and foreign policy benefits, it also carries environmental risks.

LOCAL ENVIRONMENTAL IMPACTS

Development of oil and gas from shale and other tight formations poses environmental risks that must be managed at both the state and federal level. US tight oil and shale gas production is set to grow independent of export policy decisions, so it is critical that states and the federal government continue to improve the level of regulation and enforcement. There are a number of local risks that have been identified with development of shale gas and oil.[148] While a full accounting of the research into the impacts of shale development is beyond the scope of this study,[149] an advisory board to the US Secretary of Energy identified four main areas of concern: "(1) Possible pollution of drinking water from methane and chemicals used in fracturing fluids; (2) Air pollution; (3) Community disruption during shale gas production; and (4) Cumulative adverse impacts that intensive shale production can have on communities and ecosystems."[150] Best-practice regulations continue to be developed and improved and can be implemented at modest cost.[151] For example, the International Energy Agency found that drilling shale wells at the highest standards for safety increases production costs by only 7 percent.[152]

CLIMATE CHANGE CONSEQUENCES

Lifting current crude oil export restrictions has global environmental implications as well. According to the Environmental Protection Agency (EPA)'s greenhouse gas (GHG) emission inventory, the production and transportation of oil was responsible for 32 million metric tons (MMT) of carbon dioxide (CO_2) or other GHGs in 2012, measured on a CO_2-equivalent basis (CO_2e).[153] That's relatively small in context of the 6,256 MMT of gross GHGs the United States emitted that year. More consequential are CO_2 emissions from the combustion of refined petroleum products in vehicles, buildings, and industrial facilities, which accounted for 34 percent of total US GHG emissions in 2012. Oil combustion is responsible for a smaller share of emissions outside the United States but still accounts for nearly a quarter of the global GHG total.[154]

To the extent US crude exports increase domestic production and lower oil and gasoline prices, changing US crude oil export restrictions would likely lead to higher US and global oil-related GHG emissions by increasing consumption globally. Crude exports may also impact international crude and refined product trade flows, although this latter consideration is quite minor. The transport of crude and refined product accounts for only 1.1 to 2.5 percent of the "wells-to-wheels" GHG emissions from a barrel of oil, depending on the type of fuel (Figure 27). Therefore, we focus our analysis on the impact of lifting crude export restrictions on global oil production and consumption, excluding consideration of trade flow effects.[155]

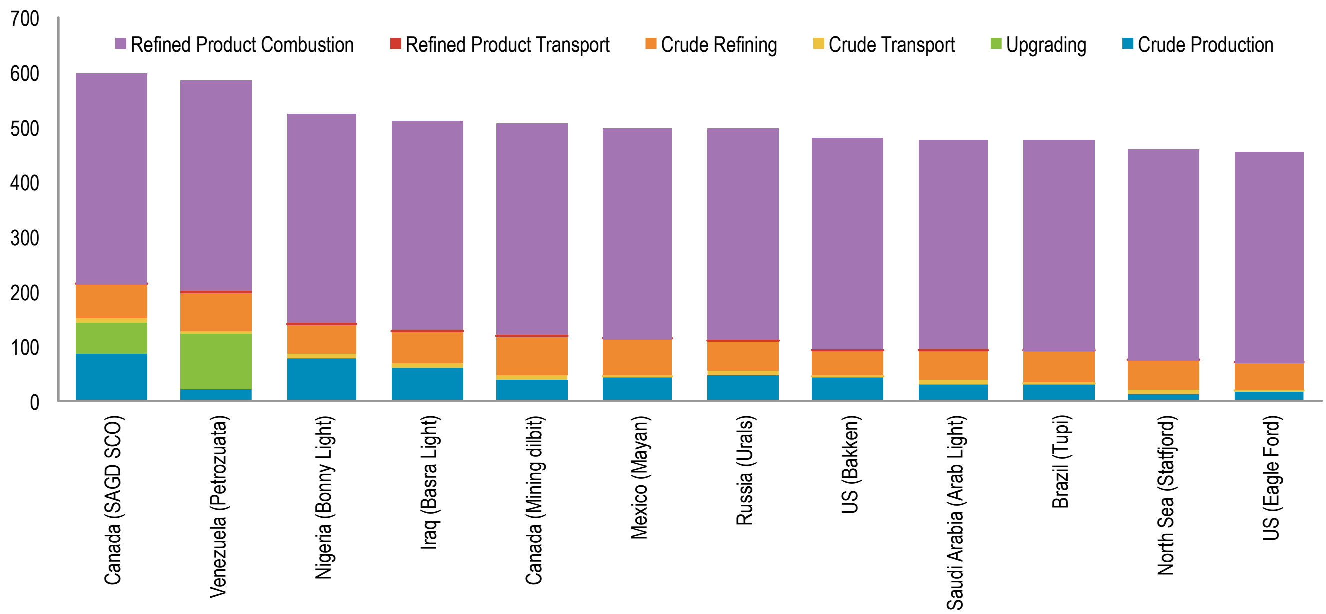
As discussed previously, our analysis suggests that lifting current crude oil export restrictions could increase US crude production by anywhere between 0 and 1.2 million b/d on average between 2015 and 2025. Assessing the global GHG impact of this increase requires answering two separate questions:

1. How much of the increase in US production is offset by a decrease in production elsewhere in the world—i.e., how much does total global supply and demand increase on net?

2. Where does the decrease in non-US production occur?

The answer to the first question depends on price elasticity of global oil demand (how responsive global crude demand is to a change in global crude price) and the price elasticity of non-US crude supply (how responsive non-US crude production is to a given change in global crude price). There is a wealth of academic literature that attempts to econometrically estimate the long-term price elasticity of

Figure 27: Wells-to-wheels crude oil GHG emissions
$kgCO_2e$/barrel of refined product



Source: IHS CERA 2012 and IHS Energy 2014. Includes emissions from upstream fuels used to produce, upgrade or refine crude oil (wide boundary).

global oil demand. Estimates vary depending on the time period and region of study, but most fall between –0.072[156] and –0.3.[157] An elasticity of –0.072 means that a 1 percent reduction in global crude prices would lead to a 0.072 percent increase in global crude demand. An elasticity of –0.3 increases the demand response to 0.3 percent. The EIA uses a non-US demand elasticity of –0.25 in their Annual Energy Outlook modeling. The ICF study uses an elastic- ity of –0.23. NERA starts with an elasticity of –0.1 that grows to –0.5 over time. IHS does not report their specific demand elasticity estimates.

Empirically deriving the long-term price elasticity of global oil supply is much more challenging due to the rapidly changing cost structure of global oil production and the presence of a large producer cartel (OPEC). The few estimates available range from 0.15 (IMF 2012) to 0.25 (Krichene 2002). A supply elasticity of 0.15 means that a 1 percent increase in global crude price would result in a 0.15 percent increase in global crude supply. An elasticity of 0.25 would increase the supply response to 0.25 percent. The EIA uses a non-US supply elasticity of 0.25 in their modeling. ICF uses an elasticity of 0.281. NERA uses an elasticity of 0.3 that grows to 1.0 over time.

On the one hand, it may be in OPEC's collective interest to offset an increase in US production with domestic sup- ply cuts to try to prevent a drop in global oil prices and maximize export revenue. That would result in a higher price elasticity of non-US crude supply. For example, the NERA study includes side cases in which OPEC cuts production to fully offset the increase in US output. The price elasticity of non-US crude supply is over 3.5 on average between 2015 and 2025 in this scenario, as opposed to 0.4 in NERA's core High Oil & Gas Resource scenario where OPEC production decisions are made based on marginal cost. While US production increases by 3.3 million b/d on average between 2015 and 2025, OPEC supply cuts mean global demand only increases by 200,000 b/d. In NERA's default High Oil & Gas Resource scenario, US production grows by 2.8 million b/d on average between 2015 and 2025 and global demand grows by 900,000 b/d.

On the other hand, OPEC has a mixed track record at best of functioning effectively as a cartel, as already discussed. This is particularly true during periods when global demand growth is weak and non-OPEC supply is expanding. When that occurred in the 1980s, OPEC cohesion broke down and crude prices collapsed. With market conditions somewhat similar today, there is speculation that Saudi Arabia and other OPEC countries will continue to be reluctant to cut output and instead let prices stay low so that other producers are forced to scale back. Such behavior (which lowers the price elasticity of global oil supply) is great for consumers but also means that a given increase in US production will result in a larger increase in global oil demand. Although it is too early to rule out OPEC cuts in the current environment, the recent meeting of OPEC in November 2014 adds further weight to the view that OPEC may not act as a cartel to cut back production in response to a further increase in US supply.

Given the uncertainty around the long-run price elasticity of both crude oil supply and demand, a 1.2 million b/d increase in US production due to removing current export restrictions could result in anywhere between a 0 and 1 million b/d increase in global crude demand (see Rhodium Group GHG analysis at http://www.rhg.com/crudeexports).[158] As mentioned above, the GHG emissions from this increase in demand will depend on the GHG-intensity of US LTO production versus the 200,000 to 1.2 million b/d of non-US crude production displaced. Projecting which sources of crude production will decline in response to an increase in US output is even more challenging than estimating the magnitude of that decline. We assess the net GHG impact of a 0 to 1 million b/d net increase in global crude demand under two scenarios:

Scenario 1: All the reduction in non-US crude output occurs in relatively GHG-intensive sources of production. As a proxy we use synthetic crude oil (SCO) produced from the Canadian oil sands using the Steam Assisted Gravity Drainage (SAGD) production process. IHS estimates the wells-to-wheels GHG emissions from this crude source is 598 kilograms of CO_2e per barrel of refined product (Figure 27).

Scenario 2: All the reduction in non-US crude output occurs in relatively GHG-light sources of production. As a proxy we used Statfjord crude produced in Europe's North Sea. IHS estimates the wells-to-wheels GHG emissions from this crude source is 459 kilograms of CO_2e per barrel of refined product (Figure 27).

In reality, a range of crudes will likely be displaced by higher US LTO production, but this approach was selected to provide upper and lower bound estimates. For the United States, we assume the increase in LTO production will have a wells-to-wheels GHG profile of 467 kilograms of CO_2e per barrel, an average of IHS's estimates of the Bakken (479) and the Eagle Ford (455) oils.

Using this approach, if easing export restriction resulted in 1.2 million b/d of increased US LTO production, the net impact on global GHG emissions would be –57 to +168 $MMTCO_2e$. A smaller increase in US production would result in a smaller increase (or at the other end of the range a smaller decrease) in CO_2 emissions.

In factoring potential GHG emissions into any policy decision regarding current crude oil export restrictions, the fact that the majority of any increase in crude oil demand (and associated CO_2) would occur outside the United States is an important consideration. International climate diplomacy is organized around the principle that countries have autonomy in determining how to reduce emissions within their borders. There is great variation across countries both in natural resource endowments and economic circumstances, and each country has its own political considerations and constraints. Making progress on climate thus requires affording countries the flexibility to design domestically tailored emission reduction strategies. For some countries, renewable energy deployment might make the most sense. For others, reducing deforestation may be a better initial focus. The countries in which oil demand could increase if US export restrictions are lifted may welcome the reduction in oil prices and prefer to reduce emissions in other parts of their economies. They also have the option of preventing lower prices from translating into higher demand (and associated emissions) through vehicle efficiency improvements or fossil fuel subsidy reform. But those are choices best left to them to make.

It is also important to consider the cost of addressing GHG emissions through crude export restrictions relative to other policy choices. There are a wide range of more cost-effective policy options for reducing global GHG emissions, from EPA's recently proposed CO_2 emissions standards for existing power plants, to federal regulation of fugitive methane emissions from oil and gas production, to extended heavy-duty vehicle standards or tightened light duty vehicle standards. And these emission reductions would all occur at home.[159]

POLICY OPTIONS

Much discussion has focused on whether lawmakers will "lift the ban" on crude oil exports. Events throughout 2014, however, have made clear that while there are statutory restrictions on crude oil exports, there are also a number of exceptions to those restrictions, and a range of options for further loosening restrictions should policymakers wish to do so. Indeed, under current law crude exports are expect- ed to reach around 500,000 b/d by early 2015, up from 27,000 b/d on average during the 2000s.[160] The United States now exports more crude oil than OPEC member Ec- uador.[161] These levels could rise further even absent govern- ment action through a combination of exports to Canada, re-exports, processed condensate exports, and exports from Alaska.[162] Allowing crude exports above these levels, howev- er, would require action by the administration, using legal authority it has under existing law, or action by Congress to change those laws. Broadly speaking, there are four potential policy routes to ease the crude export restrictions.

USE OF PRESIDENTIAL NATIONAL INTEREST AUTHORITY

First, the president has the authority under EPCA to allow crude oil exports based on a national-interest determination by making a "class of seller or purchaser, country of destination, or any other reasonable classification or ba- sis as the president determines" exempt from the ban. As noted earlier, this authority has been used by three other presidents on five different occasions. The president could make such a national interest finding for a certain group of nations—for example, that it is in the national interest to permit crude exports to free trade agreement countries or to NATO allies. Whatever the category of countries, if the goal is to ensure that the US oil price is not artificially discounted relative to the world price, it would be important to ensure the countries permitted for export provide adequate refinery demand for US light crude oil. Alternatively, the president could allow crude oil exports of a certain quality, such as above 40 or 45 degrees API gravity, acknowledging how the US oil production outlook has changed and how it is mismatched with legacy US refining capacity. The president could also find it is in the national interest to lift the export ban entirely.

FLEXIBLE ADMINISTRATIVE INTERPRETATION OF EXISTING REGULATIONS

Second, the Department of Commerce could proceed with a flexible approach in its application of existing laws and regulations. This approach seems to have been evident recently when it granted classification rulings to Pioneer and Enterprise to export condensate processed through stabilizers that include a simple distillation tower.[163] And it was further evident when BIS on December 30 2014 issued a set of FAQs that identified six factors it will consider, among others, in determining whether liquid hydrocarbons have been "processed through a crude oil distillation tower."[164] As discussed previously, these factors make clear that other companies may now export lightly processed condensate that has been both stabilized and processed through a field distillation tower, and may open the door beyond condensate to some exports of light oil (e.g., 40 or 45 API gravity) processed through simple and cheaper (around $150 to 200 million) stabilization and distillation units.[165] The volume of condensate and light oil that will be permissible to export will be determined by how flexi- bly and permissively BIS interprets the new FAQs that it has issued. Because the classification rulings are not public, it is difficult to know exactly how the FAQs will be applied in practice and what reasoning is used to reach findings about what may or may not be exported.

Similarly, the Commerce Department may be asked to approve licenses for exchange transactions. As noted above, that will require Commerce to make determinations about such questions as how to determine whether one type of crude is "of an equal or greater quality" to another, or whether a batch of crude "cannot reasonably be market- ed in the US" for "compelling economic or technological reasons."[166]

The volume of condensate and light oil that will be permissible to export will be determined by how flexibly and permissively BIS interprets the new FAQs that it has issued.

To the extent Commerce has some discretion to be more or less permissive in how it applies existing regulatory language to create certain pathways to ease the current export restriction, adopting a more flexible approach may provide more outlets for light oil and condensate.

Beyond condensate and exchanges, Commerce has the authority to approve exports on a case-by-case basis "if BIS determines that the proposed export is consistent with the national interest and the purposes of the Energy Policy and Conservation Act (EPCA)." Presently the regulations specify the types of transactions that will generally be approved, such as exchanges, although it notes "BIS will consider all applications for approval." Commerce could take an expansive view of the types of transactions it will approve on a case-by-case basis and could further amend its regulations to specify additional types of transactions beyond exchanges that will generally be approved, for example, light oil above a certain API gravity threshold.

ADMINISTRATIVE MODIFICATION OF EXIST- ING REGULATIONS

Third, the Department of Commerce could change the existing regulations to loosen the export restriction. Because there is no definition of crude oil in EPCA, such a change could be done by the Department of Commerce, although it would likely require a notice and comment rulemaking under the Administrative Procedure Act. For example, it might consider whether to modify the definition of crude oil in the BIS regulations to explicitly exclude condensate (defined as a certain API gravity, say 50 degrees and above). This would allow condensate to be exported straight from the wellhead, rather than requiring that it be processed into a refined product so it could be sold abroad.

At present, the same exact condensate molecules may in some cases already be treated differently for the purposes of export, depending on whether they came from the field or from a natural gas processing plant, so such a change would have some justification in addressing that inconsistency. Moreover, such a change would be consistent with the way crude is defined in several other contexts.[167] Notwithstanding sanctions, Iranian exports have increased recently because they are exporting a larger volume of condensate, which is not considered crude under the existing sanctions law.[168] This creates the rather ironic outcome that Iran can export condensate because the law does not consider it crude oil, while US producers cannot because the law does consider it crude oil.

Such a regulatory change would raise thorny questions—for example, exactly how does one define condensate? And if the definition is just based on an API gravity level, can different crudes be mixed to create a blend crude that meets that cutoff point?

Allowing condensate exports via the application of more flexible administrative interpretation, either minimally processed as refined product or directly from the wellhead, is appealing as a political matter because it can be done with minimal modifications to existing regulations instead of requiring a presidential national interest finding. More- over, such an approach would allow time for the public and policymakers to develop a greater understanding of the magnitude of the potential market problem and existing uncertainties about the cost of accommodating a lighter crude slate.

While allowing condensates to be sold to other countries would be a meaningful adjustment to current export restrictions, there are limitations policymakers should consider. It is important to bear in mind that condensate exports provide some relief but do leave the fundamental market problem largely unaddressed. While condensate production has grown rapidly, the EIA estimates it accounts for only 10 percent of the total increase in US light oil supply growth since 2011.[169] Allowing condensate exports, lightly processed or direct from the wellhead, is projected to result in exports of roughly 300,000 to 500,000 b/d and thus put off the potential light sweet surplus by roughly one to two years, although the oil price drop may extend this period by slowing the rate of US production growth.[170]

CONGRESSIONAL ACTION

Finally, Congress could change the law. Although this would provide the most long-term certainty, and would be necessary to completely remove the export restriction rather than just narrow its scope or create national interest exceptions to it, the current challenges evident with passing any legislation through Congress suggest this may not be likely any time soon. While incoming Senate Energy Committee chair Lisa Murkowski has been very vocal in supporting lifting the restriction, few other members of either party have yet spoken out forcefully on the issue.[171] That is not surprising, given political sensitivity to gasoline prices and the public perception that domestic oil supply should be kept within the United States in an attempt to lower domestic gasoline prices.[172] Unlike some other energy production–related issues, such as the highly visible Keystone XL decision, which often break down along par- ty lines, supporting oil exports may be perceived as politically perilous by politicians of both political parties.

CONCLUSION

Today's oil market looks very different than it did in the 1970s, when current crude oil export restrictions were first put in place. At that time, the United States had adopted domestic price controls to combat inflation, and crude export restrictions were necessary to make those price controls effective. While price controls have long since fallen away, crude export restrictions remain. They have been modified over time to reflect market changes, but the current US tight oil boom is putting the regime as a whole to the test.

We find that the original rationale for crude export restrictions no longer applies. If recent production growth rates continue, we will exhaust the ability of existing refineries to process additional US light crude within the next few years. If that happens, current crude export restrictions will distort market outcomes, reducing US crude output, increasing the price of gasoline and other refined product prices, and harming the US economy. While the direction of the impact is clear, the magnitude and timing is highly uncertain, and has likely been overstated in some recent analysis. This is particularly true given the recent drop in global oil prices, which all else equal will slow the rate of US production growth and delay the point at which current crude export restrictions really begin to bite.

Allowing free trade in crude oil would not, as many fear, harm US energy security. Indeed, at the margin, it would make the United States more resilient to supply disruptions elsewhere in the world. Lifting crude export restrictions would also be consistent with past US trade policy positions and be supportive of current trade policy objectives. And increased US production can weaken the economic power, fiscal strength and geopolitical influence of other large oil producers, as the recent oil price drop has demonstrated.

To the extent that allowing crude exports increases overall US production and thus lowers oil and gasoline prices here and around the world, it will likely lead to more global consumption and thus CO_2 emissions relative to what they otherwise would have been. While we do not believe export restrictions are an appropriate or cost-effective way to reduce CO_2 emissions, it is critical that more aggressive policy actions be taken to address climate change. Full implementation of recently proposed CO_2 emission standards for existing power plants under the Clean Air Act, regulation of fugitive methane emissions from oil and gas production, extension of fuel economy standards for heavy-duty vehicles, and strengthened fuel economy standards for light-duty vehicles are all cost-effective and meaningful steps. We can support domestic production while still meeting our climate change objectives, but that requires new policy to reduce US oil consumption and production-related GHG emissions, as well as action in other sectors.

NOTES

1 Preliminary weekly data from the US Energy Information Administration shows that US crude oil production topped 9 million b/d in November 2014. See "Petroleum and Other Liquids: Weekly US Field Production of Crude Oil," http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WCRFPUS2&f=W.

2 Consistent with the practice of the International Energy Agency (IEA) and US Energy Information Administration (EIA), this study uses the term "oil" to refer to crude oil, condensates, and natural gas liquids (NGLs). EIA defines lease condensates as light liquid hydrocarbons recovered from lease separators or field facilities at associated and nonassociated natural gas wells, and natural gas liquids as a group of hydrocarbons including ethane, propane, normal butane, isobutane, and natu- ral gasoline (generally including natural gas plant liquids and all liquefied refinery gases except olefins). For more detailed definitions, see the EIA "Glossary" http://www.eia.gov/tools/glossary/index.cfm?id=A.

3 IEA, "Oil Market Report," December 2014. At the time of publication, Russia and Saudi Arabia still surpassed the United States in crude oil production.

4 Imports of these fuels were limited to a fixed percentage of domestic oil production. Imports to the West Coast were less stringent, as were imports of residual fuel to the United States. For further details, see J. Kalt, *The Economics and Politics of Oil Price Regulation* (Cambridge, MA: MIT Press, 1981), p. 6.

5 Presidential Proclamation 3279 (1959), http://www.presidency.ucsb.edu/ws/?pid=11676.

6 D. Yergin, *The Prize: The Epic Quest for Oil, Money and Power* (New York: Simon and Schuster, 1992), p. 539.

7 EIA, "Petroleum and Other Liquids: US Field Production of Crude Oil," http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS2&f=M.

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40 BIS, "Short Supply Controls," https://www.bis.doc.gov/index.php/forms-documents/doc_download/968-754.

41 EIA, "This Week in Petroleum," 22 October 2014, http://www.eia.gov/petroleum/weekly/archive/2014/141022/includes/analysis_print.cfm. EIA information for September 2014 also indicates that there was a re-export to Germany. Energy Information Administration, "Petroleum and Other Liquids: Exports by Destination," http://www.eia.gov/dnav/pet/pet_move_expc_a_EPC0_EEX_mbblpd_m.htm.

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43 In June 2014, the East Coast (PADD 1) accounted for 918,000 b/d of the 1.76 million b/d of product imports; the Gulf Coast (PADD 3) accounted for 2.7 million b/d of the total 3.76 million b/d product exports.
See Energy Information Administration, "Petroleum and Oth- er Liquids: Exports," 26 November 2014, http://www.eia.gov/dnav/pet/pet_move_exp_dc_nus-z00_mbblpd_m.htm.

44 The BIS FAQ states: "The factors BIS will consider in reviewing commodity classifications to determine whether the product has been 'processed through a crude oil distillation tower' include, among others:

(1) Whether the distillation process materially transforms the crude oil, by using heat to induce evaporation and condensation, into liquid streams that are chemically distinct from the crude oil input;

(2) The change in API gravity between the input of the process and the output of the process;

(3) The change in percentage of different types of hydrocarbons between the input and output of the process;

(4) Whether the streams resulting from distillation have purposes other than allowing the product to be classified as exportable petroleum products, such as use as petrochemical feedstock, diluent, and gasoline blendstock;

(5) Whether the distillation process utilizes temperature gradients and has significant internal structures, such as trays or packing, and differentiated output streams;

(6) Whether the distillation uses towers with more mechanical complexity and heat, higher residence time, internal structures that promote condensation and better separation, and a consistent quality liquid streams (also called cuts or fractions) than equipment used to separate vapors and liquids for transportation needs."

For further details, see BIS, "FAQs—Crude Oil and Petroleum Products," 30 December 2014, http://www.bis.doc.gov/index.php/policy-guidance/faqs.

45 See A. Sen, "BIS clarifies US condensate exports; no material policy change but may encourage self-certification," Energy Aspects, 30 December 2014; E. Morse et al., "Out of America," Citi Research, September 2014, IHS, "US Crude Oil Export Decision: Assessing the impact of the export ban and free trade on the US economy," May 2014, p. III-22; Turner Mason analysis at: http://energypolicy.columbia.edu/turnermasonanalysis.

46 The International Energy Agency, for example, defines condensate as having an API gravity above 50. International Energy Agency, "Glossary;" A. Sider, "What is Condensate? Introducing America's New Oil Export," *Wall Street Journal*, 25 June 2014, http://blogs.wsj.com/corporate-intelligence/2014/06/25/what-is-condensate-introducing-americas-new-oil-export/.

47 15 Code of Federal Regulations 754.2(a). There is no definition of "lease condensate" in the BIS regulations. The EIA defines lease condensate as "light liquid hydrocarbons re- covered from lease separators or field facilities at associated and nonassociated natural gas wells. Mostly pentanes and heavier hydrocarbons. Normally enters the crude oil stream after production." EIA, "Glossary," http://www.eia.gov/tools/glossary/index.cfm?id=Lease.

48 The EIA defines plant condensate as: "One of the natural gas liquids, mostly pentanes and heavier hydrocarbons, recovered and separated as liquids at gas inlet separators or scrubbers

in processing plants," EIA, "EIA's Proposed Definitions for Nat- ural Gas Liquids," http://www.eia.gov/petroleum/workshop/ngl/pdf/definitions061413.pdf.

49 Classification rulings are a tool used to seek guidance from BIS on what commodity a product would be classified under. Thus, if a company has any uncertainty about whether the liquid hydrocarbon at question is a petroleum product (rather than crude oil) they can obtain formal guidance from BIS in a private letter ruling.

50 Stabilization is the process of heating the oil to remove the volatile light gases, like propane and butane, which is often done to make the liquid safe for transport. A distillation tower requires the use of heat—as well as cycles of evaporation and condensation—to fractionate the feedstock. While stabilization is one effect of processing in a distillation tower, stabilization alone in other equipment would not be adequate to create an exportable product, even when heat is used. J. Dweck, "US Crude Oil Exports: Developments in the Regulatory Trenches," presentation at EIA 2014 Energy Conference, 14 July 2014, http://www.eia.gov/conference/2014/pdf/presentations/jacobdweck.pdf.

51 P. Brown, et al., "US Crude Oil Export Policy: Background and Considerations," Congressional Research Service, 26 March 2014 (R432442), p. 12.

52 15 Code of Federal Regulations 754.2(a).

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Center on Global Energy Policy

CONGRESS OF THE UNITED STATES
CONGRESSIONAL BUDGET OFFICE

CBO

The Economic and Budgetary Effects of Producing Oil and Natural Gas From Shale

DECEMBER 2014

Notes

All years referred to in this report are calendar years, not fiscal years. Numbers

in the text and tables may not add up to totals because of rounding.

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The Economic and Budgetary Effects of Producing Oil and Natural Gas From Shale

Summary

Recent advances in combining two drilling techniques, hydraulic fracturing and horizontal drilling, have allowed access to large deposits of shale resources—that is, crude oil and natural gas trapped in shale and certain other dense rock formations.[1] As a result, the cost of that "tight oil" and "shale gas" has become competitive with the cost of oil and gas extracted from other sources. Virtually nonexistent a decade ago, the development of shale resources has boomed in the United States, producing about 3.5 million barrels of tight oil per day and about 9.5 trillion cubic feet (Tcf) of shale gas per year. Those amounts equal about 30 percent of U.S. production of liquid fuels (which include crude oil, biofuels, and natural gas liquids) and 40 percent of U.S. production of natural gas. Shale development has also affected the federal budget, chiefly by increasing tax revenues.

The production of tight oil and shale gas will continue to grow over the next 10 years—by about 30 percent and about 60 percent, respectively, according to a recent projection by the Energy Information Administration (EIA).[2] Another EIA estimate shows that the amount of tight oil and shale gas in the United States that could be extracted with today's technology would satisfy domestic oil consumption at current rates for approximately 8 years and domestic gas consumption for 25.[3]

1. For convenience, the term "shale resources" in this report includes energy supplies contained by formations of low-permeability rock that is not shale, such as limestone and fine-grained sandstone.

2. Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

How Will Shale Development Affect Energy Markets? Total domestic production of oil and natural gas will continue to be higher than it would have been without shale development, reducing the prices of those energy supplies. The lower prices, in turn, will increase domestic consumption of oil and gas, domestic consumption of energy overall, and net exports of gas, while decreasing the production of oil and gas from conventional resources, net imports of oil, and the use of competing fuels.

Shale gas has affected energy prices in the United States more strongly than tight oil has, and it will continue to do so. Indeed, the Congressional Budget Office (CBO) estimates that if shale gas did not exist, the price of natural gas would be about 70 percent higher than currently projected by 2040—whereas if tight oil did not exist, the price of oil would be only about 5 percent higher. One reason for the difference is that shale gas is more plentiful than tight oil, relative to the size of their domestic markets. Another is that the North American market for natural gas is relatively insulated from conditions elsewhere by high transportation costs, so the effects of higher or lower domestic production on market prices are concen- trated within the continent; oil, by contrast, is heavily traded in a worldwide market that diffuses the effects of domestic production on prices. (Oil prices are thus influ- enced by events that occur elsewhere in the world. For example, the recent sharp drop in crude oil prices—as of the end of November 2014, they had dropped about

3. Those estimates are based on Energy Information Administration, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States* (June 2013), www.eia.gov/analysis/studies/worldshalegas/; and on Louis Sahagun, "U.S. Officials Cut Estimate of Recover- able Monterey Shale Oil by 96%," *Los Angeles Times* (May 20, 2014), http://tinyurl.com/pnknuct.

one-third from their recent peak in June—was caused not by any sudden or dramatic increase in the supply of tight oil during that period but by other factors, such as a rapid increase in Libyan production and a slowdown of con- sumption in Europe and Asia.)

EIA's projections of the development of shale resources are the most detailed currently available, and CBO con- siders them an appropriate basis for estimating the poten- tial economic and budgetary effects of shale develop- ment. Nonetheless, like all projections of the future, they are subject to significant uncertainty. Many factors con- tribute to the uncertainty; for example, the abundance of shale resources, the fraction of those resources that will be recoverable with evolving technology, and the costs of recovering that fraction are not known for certain. Projec- tions of more or less shale development would lead to larger or smaller estimates of the economic and budgetary effects.

How Will Shale Development Affect Economic Output?

The technological innovations behind hydraulic fractur- ing and horizontal drilling make existing labor and capi- tal—whether they are employed in shale development, in industries using natural gas or oil, or in industries using products derived from natural gas or oil—more produc- tive than they otherwise would be. That heightened pro- ductivity has increased gross domestic product (GDP) and will continue to do so.

Shale development also boosts GDP in other ways. The increase in GDP just described represents increased income, which allows people and firms to save and invest more in productive capital, and the higher productivity just described increases wages, raising the amount of labor available. Both the increased capital and the increased labor raise GDP. In addition, in the near term, shale development causes labor and capital to be used that would otherwise be idle, again raising GDP. In the longer term, however, whether shale resources are avail- able or not, the labor and capital available in the econ- omy will be used at roughly their maximum sustainable rates, so the additional labor and capital used to produce shale resources or energy-intensive goods will mostly be drawn away from the production of other goods and ser- vices. As a result, there will be no net change in GDP through that last route, although GDP will continue to be increased by shale development in the other ways just described.

On net, CBO estimates that real (inflation-adjusted) GDP will be about two-thirds of 1 percent higher in 2020 and about 1 percent higher in 2040 than it would have been without the development of shale resources. The actual effect on GDP could be higher or lower than that estimate, depending on the uncertain factors noted above—the abundance of shale resources, the fraction of those resources that will be recoverable, and the cost of developing that fraction—as well as on other considerations.

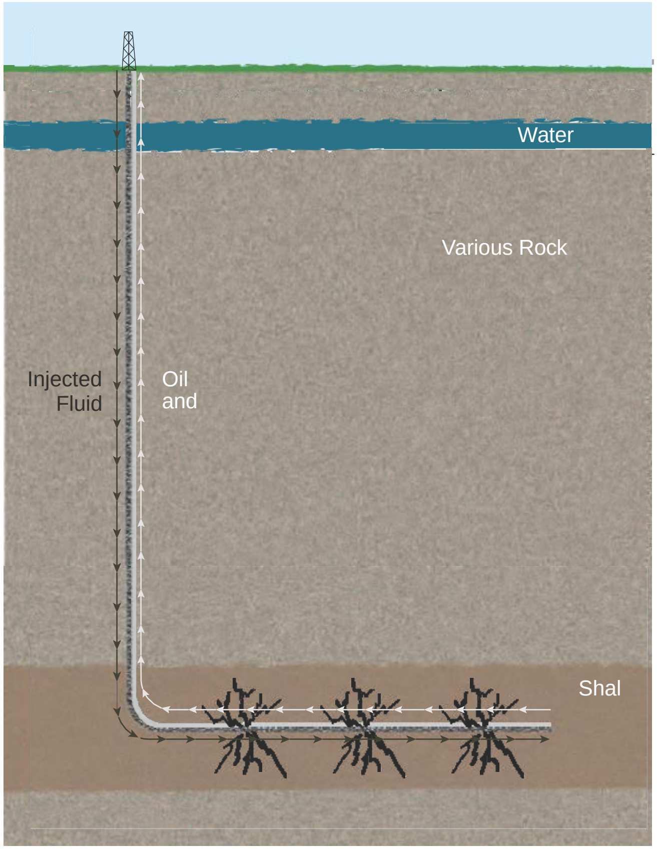
How Will Shale Development Affect the Federal Budget?

The increase in GDP resulting from shale development has increased federal tax revenues, and it will continue to do so. That increase will be slightly larger than the GDP increase in percentage terms, CBO expects. Specifically, CBO estimates that federal tax revenues will be about three-quarters of 1 percent (or about $35 billion) higher in 2020 and about 1 percent higher in 2040 than they would have been without shale development.

Shale production also contributes to federal receipts through payments that the developers of federally owned resources make to the government—but that contribu- tion has been modest and will continue to be, because most shale resources are not on federal land. Working from EIA's projections of the future production of tight oil and shale gas, and also from its own forecasts of oil and natural gas prices, CBO estimates that federal royal- ties from shale (minus the amounts that the federal government transfers to the states) will be about $300 million annually by 2020.

What Policy Options Would Affect Shale Development?

There are a number of ways that the Congress could affect shale development and thus affect the oil and gas markets, economic output, and the federal budget. This report considers options that would change export policies—easing the current ban on exports of crude oil, repealing it, or changing the government's criteria for judging applications to export liquefied natural gas (LNG)—and concludes that the options would probably increase domestic production but have little effect on



Source: Congressional Budget Office.

prices. That increase in production would probably make GDP and federal revenues slightly higher than they would be under current export policies.

Policy choices related to environmental regulation, such as whether the federal government should regulate fur- ther the environmental effects of shale development

or leave such decisions to the states, are outlined in Appendix A. The Congress could also affect shale devel- opment through policies not considered here, such as those related to the infrastructure used to transport and process domestic shale gas and tight oil.

Hydraulic Fracturing and Shale Resources

Hydraulic fracturing, used with horizontal drilling and other advances in drilling technology, is a way to reach and extract natural gas and oil locked in certain rock for- mations, especially shale formations.[4] Some forms of hydraulic fracturing have been used to extract fossil fuels since the 1950s, but the method was not successfully combined with horizontal drilling for another 30 to 40 years, and it began to have a substantial impact on natural gas and oil production only in the past decade.

The process (often called fracing or fracking) begins with drilling a vertical well to the depth of a shale formation and, from there, drilling a horizontal well into the forma- tion, which is much wider than it is thick (see Figure 1). A high-pressure mixture of water, chemicals, and small particles is pumped into the well to create fractures in the formation. Those fractures are held open by the particles as the injected fluid is withdrawn. Oil and gas then flow from the fractures into the well and up to the surface.

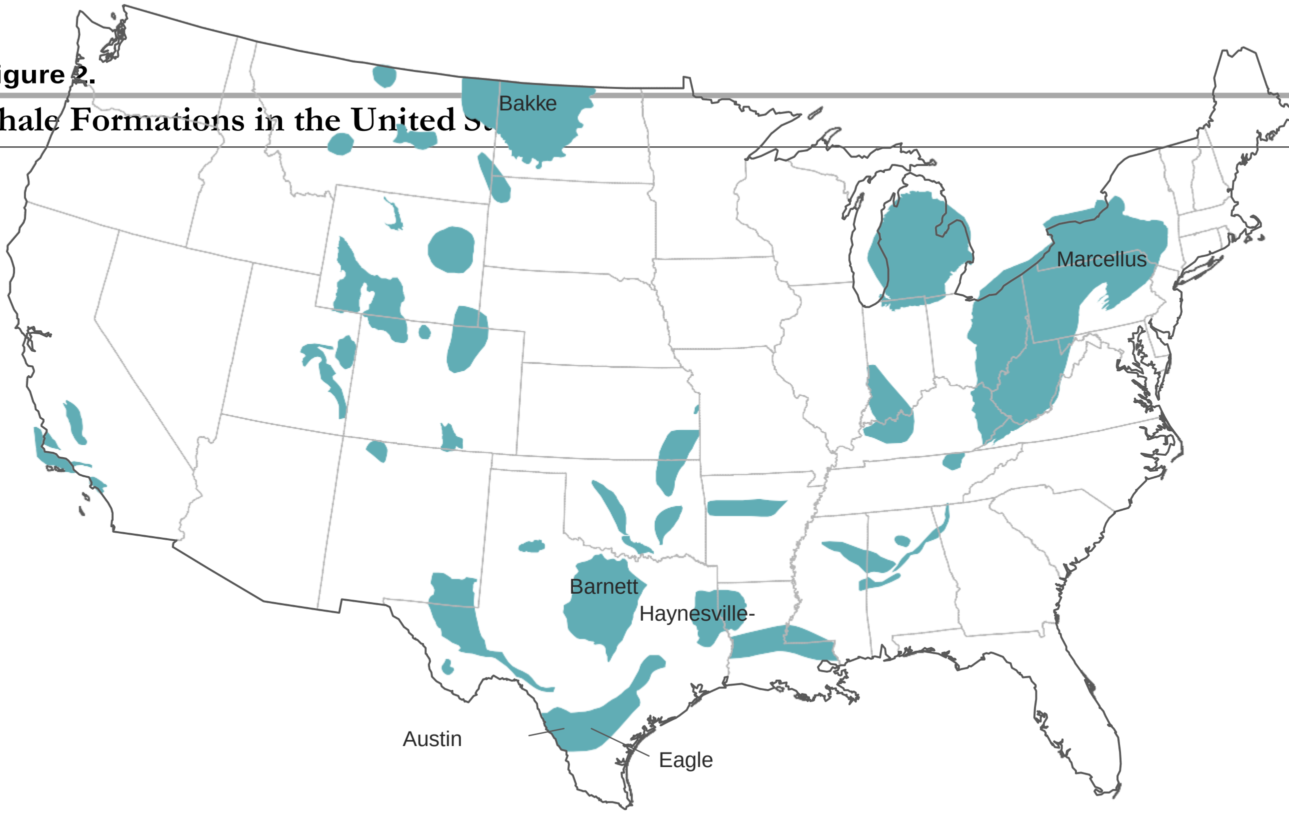
According to EIA estimates, of the shale gas in the United States that is technically recoverable—that is, that could be developed with current technology—25 percent is in the Marcellus Shale formation, which is located mainly in New York, Pennsylvania, and West Virginia (see Figure 2). The formations with the next-largest quantities of shale gas are the Haynesville-Bossier Shale in Texas and Louisiana, containing an estimated 15 percent of techni- cally recoverable resources; the Eagle Ford Shale in Texas, containing about 10 percent of those resources; and the Barnett Shale, also in Texas, and also containing about 10 percent of those resources.

The Eagle Ford and Austin Chalk Shales in Texas, which are found at different depths but underlie some of the same land, together account for about 40 percent of

4. This report focuses on shale development recently enabled by the use of hydraulic fracturing and horizontal drilling. It does not consider the use of those techniques to produce "tight gas" (that is, natural gas extracted from less dense geologic formations), because such development has occurred for many years, or to enhance pro- duction from conventional oil and gas supplies. Nor does it con- sider kerogen shale (also known as oil shale), another kind of rock from which oil can be produced, because the oil is not extracted with hydraulic fracturing and its generally high cost is expected to keep production low for the foreseeable future.

Figure 2.

Shale Formations in the United States



Source: Congressional Budget Office based on data from the Energy Information Administration, "Detailed Oil and Gas Field Maps" (accessed October 2, 2014), http://go.usa.gov/VKt4.

technically recoverable tight oil. An additional 20 percent is in the Bakken Shale in North Dakota and Montana.[5]

5. The percentages in these two paragraphs are based on the most recently available data that distinguish shale gas from tight gas: Energy Information Administration, U.S. Crude Oil and Natural Gas Proved Reserves, 2012 (April 2014), Tables 2 and 4, www.eia.gov/naturalgas/crudeoilreserves; Energy Information Administration, *Assumptions to the Annual Energy Outlook 2013* (May 2013), Table 9.3, http://go.usa.gov/vvne; and Louis Sahagun, "U.S. Officials Cut Estimate of Recoverable Monterey Shale Oil by 96%," *Los Angeles Times* (May 20, 2014), http://tinyurl.com/pnknuct. More recent data do not distinguish shale gas from tight gas, but they do show a notable development: that the Spraberry/Wolfcamp Shale in Texas has become an important source of technically recoverable tight oil. See Energy Information Administration, *Assumptions to the Annual Energy Outlook 2014* (June 2014), Table 9.3, http://go.usa.gov/sagw.

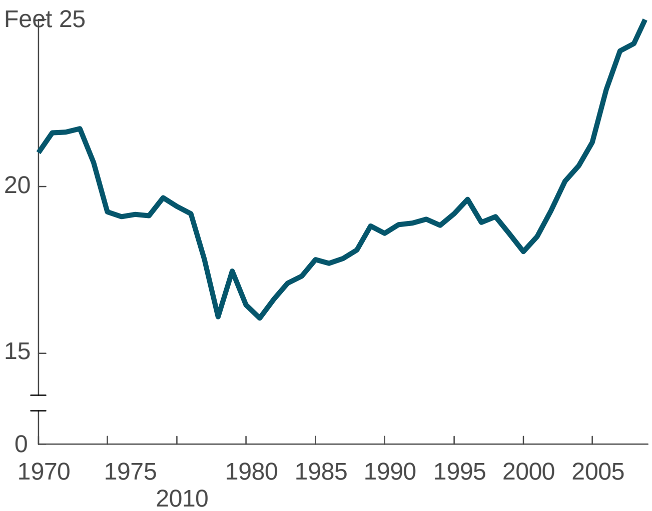
Effects on Energy Markets

The production of shale gas and tight oil has risen dramatically over the past decade. The shale gas increase has been so large that, if it came from a separate country, that country would now be the world's third-largest natural gas supplier (behind first-place Russia and the U.S. sup- plies not from shale). Because of shale gas, domestic production of all natural gas is on pace to increase for the ninth straight year and has reached record highs (see Figure 3). With that increase in production, the wholesale price of natural gas in North America fell by about 70 percent, in inflation-adjusted terms, between 2008 and 2012, reaching its lowest level since 1998

Figure 3.

Annual Production of Natural Gas in the United States

Trillions of Cubic Feet



Source: Energy Information Administration, "U.S. Dry Natural Gas Production" (accessed November 14, 2014), http://go.usa.gov/7XgQ.

Note: Production in 2014 is an estimate based on monthly totals from January through September.

(see Figure 4).[6] Though gas prices rebounded somewhat in 2013 and 2014, they remain low compared with the recent historical record.

The production of crude oil in the United States has also boomed, with domestic output up for the fifth straight year because of tight oil. But the increase in tight oil production, unlike the corresponding increase in shale gas, has had only a modest impact on prices.[7] As this report discusses below, the increase in tight oil is small relative to domestic oil consumption, and oil prices, unlike gas prices, are determined in a global market.

Shale development has affected other energy markets as well; for example, it has reduced the demand for coal. As the production of shale gas and tight oil increases, its effects on other energy markets—such as those for coal, for nuclear and renewable energy, and for energy-conserving equipment—will also increase. In addition, some analysts predict that energy-intensive production activities will increasingly relocate to the United States to take advantage of low gas prices.

Trends in the Markets for Shale Gas and Tight Oil

According to EIA's projections, supply and demand con- ditions will keep the production of shale gas and tight oil growing in coming years—in fact, growing enough so that the overall domestic production of oil and gas will continue to grow, reversing the trend of the past several decades. Because of the growth in production, the domestic price of gas will be lower than it would have been in the absence of shale resources; so will the price of oil, though to a lesser extent. Those lower prices will boost oil and gas consumption and net exports of refined products and natural gas. (The quantity of exports will depend partly on federal policy choices, as the next section discusses.)

Production. EIA expects the production of shale gas to rise from 9.5 Tcf in 2013 to 20 Tcf in 2040. That increased production will be responsible for almost all the growth in overall U.S. gas supplies, which are pro- jected to rise 13 Tcf over that time, from 24 Tcf in 2013 to 37 Tcf in 2040.

Also, EIA projects that the production of oil from shale formations will be 1.4 million barrels per day higher in 2020 than in 2013 but only 0.2 million barrels per day higher in 2040 than in 2013. That projection includes both tight oil and natural gas plant liquids, such as eth- ane, propane, and butane, which are sometimes obtained

6. Energy Information Administration, "Natural Gas Prices" (accessed November 4, 2014), http://go.usa.gov/Kfch. Retail prices paid by final buyers of natural gas have declined less sharply, because part of the retail price of natural gas covers the cost of gas transportation and taxes—costs that do not change as the whole- sale price of gas declines. In addition, partly because of differences in the percentage of retail prices that cover the cost of transporta- tion and taxes, not all buyers have seen the same declines in retail prices: The declines have been greatest (roughly 60 percent since 2008) for large buyers, such as industrial users and electricity pro- ducers, and smallest (about 25 percent) for residential customers.

7. Crude oil prices have declined by about a third in recent months, but not because of any sudden or dramatic increase in the avail- ability of shale resources. Other factors, such as a rapid increase in Libyan production and a slowdown of consumption in Europe and Asia, have had a greater influence. A sustained reduction in crude oil prices would reduce U.S. production of both conven- tional oil and tight oil in the near term, but the degree to which the recent weakness in oil prices will persist is unclear. All else being equal, lower trajectories for the price of oil or the produc- tion of tight oil through 2020 or 2040 would reduce CBO's estimates of the economic and budgetary effects of tight oil in those years.

in the production of shale gas and are good substitutes for certain petroleum products. EIA expects that the production of tight oil alone will grow from 3.5 million barrels per day in 2013 to a peak of 4.8 million by about 2020; it will then fall back to 3.2 million by 2040, as production from existing wells wanes and new wells in less promising areas yield less oil. Natural gas plant liquids are projected to increase modestly but more steadily, from 2.5 million barrels per day in 2013 to 3 million in 2040.

Prices. The availability of shale energy (that is, shale gas and tight oil that come to the market) should lessen the growth of energy prices in the years ahead. Shale gas will probably have a larger impact in that way than tight oil will. One reason is simply that shale gas is more plentiful, relative to domestic consumption. Shale gas production today equals about 35 percent of total U.S. gas consumption, whereas tight oil production equals only about 15 percent of U.S. consumption of liquid fuels. By 2040, according to EIA's most recent long-term projection, shale gas will account for about 60 percent of all natural gas consumed in the United States, but tight oil will still represent only about 15 percent of all liquid fuels consumed.[8]

Another reason that U.S. natural gas markets will be more affected than domestic oil markets by shale energy is that they have far less international exposure. Natural gas markets are broadly split into three regions—North America, Europe, and Asia—and gas is transported within each of those regions by pipeline at relatively low cost. But the cost of transporting gas *between* regions is significant, primarily because it must undergo costly liquefaction before being shipped on oceangoing vessels. Therefore, little trade occurs between regions, and prices in the three markets are largely independent of one another. Crude oil, by contrast, can be moved around the world at relatively low cost by tanker ship or pipeline, which means that oil prices are approximately the same around the world. The effects of domestic shale gas production will therefore be concentrated in North America, whereas the effects of domestic tight oil production will be diffused internationally.[9]

Though shale energy is expected to lessen the growth of energy prices, continued growth in demand means that those prices will nevertheless continue to rise. EIA currently projects a doubling of the real price of natural gas in North America by 2040, as well as a roughly 30 per- cent increase in the real price of oil worldwide. Prices would be still higher if the production of U.S. shale energy turned out to be lower than EIA expects. For example, according to a recent EIA analysis, if shale resources turned out to be only half as abundant as the agency projected in its baseline scenario, domestic prices in 2040 would be about 40 percent higher for gas and somewhat less than 3 percent higher for oil than they would be under the baseline scenario.[10] (Similarly, CBO estimates that if shale resources did not exist at all, the price effects would be roughly twice as large, with gas and oil prices in 2040 that were roughly 70 percent and 5 per- cent higher, respectively, than currently projected.)

Consumption and Net Exports. Because of the lower prices that will result from shale development, the domestic consumption of gas will be higher than it would have been in the absence of shale resources; net exports of natural gas (that is, international consumption of domestically produced gas) will also be higher. Of the expected 13 Tcf increase in natural gas production between 2013 and 2040, EIA projects that 53 percent (about 7 Tcf) will be reflected in greater net exports and 47 percent (about 6 Tcf) in increased domestic consumption (see Figure 5). Roughly 75 percent of that projected increase in domestic consumption will be in the electric power and industrial sectors.

The electric power sector's increased consumption of gas will result not only from that sector's higher overall production of electricity but also from the growing importance of gas relative to other fuels. The EIA projection shows that by 2040, natural gas's share of the total fuel used in the electric power sector will grow from 21 percent to 25 percent; renewable fuels' share will also grow,

8. Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

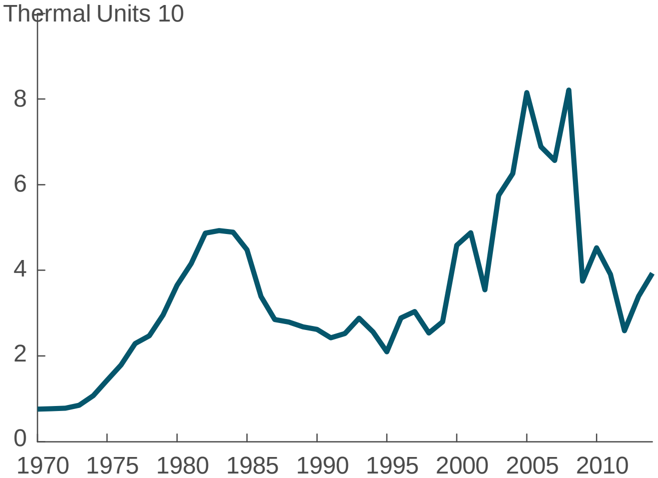
9. For a broader discussion of geographic price differences in world energy markets, see Congressional Budget Office, *Energy Security in the United States* (May 2012), www.cbo.gov/publication/ 43012.

10. Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB). The "low-resource" sce- nario includes reductions in tight gas resources as well as in tight oil and shale gas resources. Economically viable shale gas is much more plentiful than tight gas, however, and accounts for about four-fifths of the total 2040 difference in gas production between that scenario and EIA's baseline scenario.

Figure 4.

Average Annual Price of Natural Gas

2012 Dollars per Million British Thermal Units



Source: Congressional Budget Office based on data from the Energy Information Administration, "U.S. Natural Gas Wellhead Price" (accessed November 4, 2014), http://go.usa.gov/7X2G, and "Henry Hub Natural Gas Spot Price" (accessed November 4, 2014), http://go.usa.gov/7X2z.

Note: Prices shown from 1970 through 2012 are average wellhead prices for gas produced nationally. Because the 2013 and 2014 averages are not available yet, averages for those years are derived from a historical relationship between average wellhead prices and the prices recorded at the Henry Hub natural gas pipeline interconnection in Louisiana. The Henry Hub price is commonly used as a benchmark for wholesale gas prices throughout North America. CBO converted prices into 2012 dollars by means of the GDP (gross domestic product) deflator.

while those of coal and nuclear power will shrink. In the industrial sector, by contrast, the increased use of natural gas is expected to be roughly in line with that sector's growth.

Unlike the consumption of natural gas, the consumption of liquid fuel will be slightly lower in 2040 than in 2013, decreasing by about 1 percent, EIA estimates. The main reason is that changes in driving habits and improvements in vehicles' fuel economy are expected to reduce U.S. demand for liquid fuels. Also, the use of natural gas in the transportation sector is expected to grow, further lowering demand for petroleum.

The United States is currently a net importer of natural gas and of liquid fuels; that is, it consumes more than it produces (see Figure 6). But the production of shale resources has significantly reduced net imports—from nearly 4 Tcf of natural gas in 2007 to about 1.5 Tcf in 2013, and from 12.5 million barrels per day of liquid fuels in 2005 to 6.2 million in 2013. EIA projects that the United States will become a net exporter of natural gas in 2017 and remain so through 2040.[11] However, EIA expects the country to remain a net importer of liquid fuels throughout the projection period; net imports are projected to decline to about 5 million barrels per day as tight oil production increases, to stay steady for a few years, and then to return to current levels by 2040, as tight oil production falls.

Policy Options Related to Exports and Their Effects on Domestic Prices

To the extent that federal policy allows oil and gas to be imported and exported, their domestic prices reflect supply and demand not only in the United States but in other countries as well. Analysts and policymakers are currently proposing various changes to policies governing exports of crude oil and liquefied natural gas. In CBO's view, such changes would probably increase domestic oil and gas production, but they would probably have only a small effect on the domestic price of gas and a negligible effect on the domestic price of oil (which, again, is largely determined in the world market).

As this report discusses below, increases in oil and gas production resulting from shale development have boosted U.S. economic output and federal receipts and will continue to do so. The further increases in produc- tion that would result from the changes in export policies considered here would also have positive economic and budgetary effects, but smaller ones.

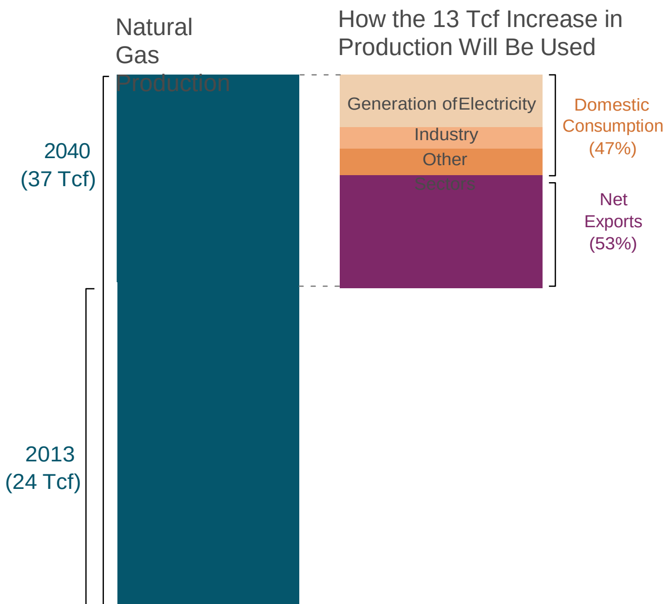
Exports of Crude Oil. Federal law prohibits the export of domestically produced crude oil, with few exceptions.[12] In 2013, only about 1 percent of crude oil produced in the United States (about 120,000 barrels per day) was

11. Ibid.

12. The President is authorized to approve exports of crude oil that are in the national interest. With a few exceptions, such approval takes the form of a license from the Commerce Department's Bureau of Industry and Security. That bureau's policy is to approve certain categories of export applications—the most important category being exports to Canada for consumption or use there—and to review other applications on a case-by-case basis.

Figure 5.

Natural Gas Production in the United States in 2013 and 2040



Source: Congressional Budget Office based on data from the Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA- 0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

Note: Tcf = trillion cubic feet.

exported, essentially all of it to Canada.[13] In contrast, federal policy does not restrict U.S. exports of refined petroleum products or of natural gas plant liquids, biofuels, and other nonpetroleum liquids. Together, exports of those fuels totaled 3.6 million barrels per day in 2013—a record high—with roughly half of that volume consisting of gasoline and diesel fuel.

Policy Options. Because U.S. supplies of crude oil have grown so dramatically in recent years, some policymakers have called for the ban on crude exports to be repealed. Current policy could also be changed less dramatically. For example, exports might be permitted not only to Canada but to certain other countries as well, such as Mexico, the countries of Central America, or all nations with which the United States had free-trade agreements (FTAs). Alternatively, the volume of allowed exports could be capped, or exports could be restricted to particu- lar grades of crude oil.

Potential Effects of Those Options. Outright repeal of the ban on crude exports would probably lower world prices of oil and of liquid fuels produced from oil, but only slightly, and changes that left some export prohibitions in place would lower world prices even less. The reason is that prices depend on the total worldwide supply of crude oil, and the increase in total supply would probably be much smaller than the increase in the volume of U.S. crude exports. One recent study, for example, estimated that if the ban was repealed, U.S. crude exports would increase by as much as 1.5 million barrels per day, but world supply would increase by no more than 200,000 barrels per day—less than one-quarter of one percent of the current total.[14] Two factors explain the difference. First, what contributes to the total worldwide supply of oil is not U.S. *exports* but U.S. *production*, which would rise much less than exports would. For instance, the study estimated that if the ban was repealed and crude exports rose by about 1.5 million barrels per day, U.S. oil production would rise by only about 500,000 barrels per day.[15] (Domestic consumption would not change much, however, because U.S. crude *imports* would be higher as well, as the next paragraph explains.) Second, the net increase in world production would be smaller even than the increase in U.S. production, because the U.S. increase would drive some competing high-cost supplies from the market.

Perhaps counterintuitively, U.S. consumers of gasoline, diesel fuel, and other oil products would probably benefit, along with domestic oil producers, if the ban was repealed; domestic refiners would be adversely affected,

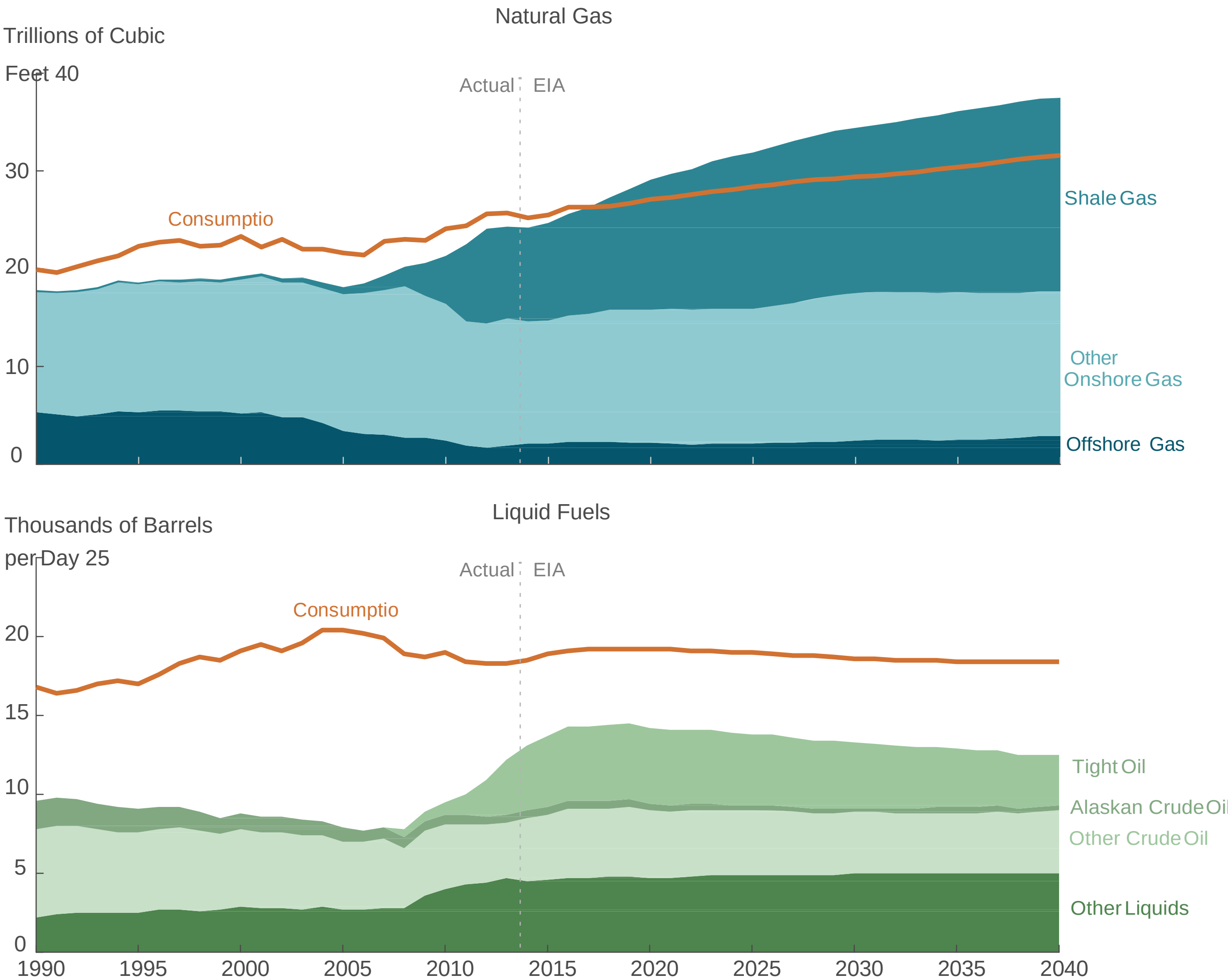
13. Energy Information Administration, "Petroleum & Other Liquids—Exports by Destination" (accessed December 8, 2014), http://go.usa.gov/8Nvx.

14. ICF International, *The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs* (submitted to the American Petroleum Institute, March 2014), http://tinyurl.com/nnr8hxg.

15. A more recent study yielded similar findings: In its baseline projections, lifting the ban on U.S. exports of crude oil raised those exports by no more than 1.8 million barrels per day and world crude oil production by no more than 300,000 barrels per day. See Robert Baron and others, *Economic Benefits of Lifting the Crude Oil Export Ban* (submitted by NERA Economic Consulting to the Brookings Institution, September 2014), www.nera.com/67_8673.htm.

Figure 6.

Consumption and Supply of Natural Gas and Liquid Fuels in the United States



Source: Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

Notes: Tight oil is crude oil extracted from shale and certain other dense rock formations by means of hydraulic fracturing. The category "Other Liquids" consists of natural gas liquids, biofuels, and processing gain (the additional barrels of petroleum produced by refining crude oil into heavier and lighter products).

EIA = Energy Information Administration.

as would foreign oil producers. Consumers would benefit from small reductions—5 to 10 cents per gallon, in the baseline scenario of a recent study—in the domestic prices of oil products, because those prices depend pri- marily on the world price of crude oil, which would decline slightly once lower-priced U.S. crudes were avail- able in the international market.[16] By contrast, the prices of domestic light crude oils (which include tight oils) seen by some U.S. crude oil producers and petroleum refiners would rise. Refineries in the United States are better configured than refineries abroad to process heavy crudes, so under the current ban, light crudes are less valuable—and therefore sell for less—in the United States than in the global market.[17] If the ban was repealed, some domestic refiners would continue to buy light crudes, and others would increase their imports of heavy crudes; in either case, the cost of their crude oil inputs would be higher than it had been under the ban, and because they would continue to sell their refined products at levels closely linked to the world price of oil, their profits would fall.

Exports of Natural Gas. The United States trades signifi- cant quantities of natural gas with Canada and Mexico. Using pipelines, it currently exports about 1.6 Tcf per year to those two countries, and it imports about 2.9 Tcf per year, virtually all of it from Canada.[18] The pipelines through which gas travels between Canada, the United States, and Mexico create a unified North American market in which the price of gas is determined by the total supply and demand of all three countries. Once the United States is a net pipeline exporter, as EIA projects it will be within a decade, domestic gas prices will be higher than they would be without pipeline exports.[19]

The only way to transport significant volumes of natural gas to countries that are not connected to the United States by gas pipelines is to liquefy the gas and move it by ship. The United States has very little capacity to do that, because it was expected until recently to be a substantial importer for decades to come.[20] But as hydraulic fractur- ing and related technologies have become widespread in the United States, natural gas has become much cheaper here than in foreign markets; in 2013, average gas prices were about three times higher in Europe and about four times higher in Japan, both of which are large gas con- sumers.[21] Such price differences, if they last, could make selling LNG overseas profitable, despite the significant cost of liquefying natural gas, transporting it, and con- verting it back into gaseous form.

Policy Options. Restrictions on gas trade by pipeline are not allowed under the free-trade agreements that the United States has with Canada and Mexico. Exports of LNG, however, are subject to restrictions under current law, which the Congress could modify in various ways.

Currently, the construction of facilities to liquefy and export natural gas requires approval from the Federal Energy Regulatory Commission (FERC), and the exports themselves must be approved by the Department of Energy (DOE). Prospective exporters can apply for blan- ket authority to ship LNG to countries in either or both of two groups: those with FTAs with the United States that cover natural gas and those without such agreements.

16. Ibid.

17. For example, for more than three years, the price of West Texas Intermediate (WTI)—a domestically produced light crude whose price is used as a benchmark for the prices of other U.S. crude oils—has been lower than the price of Brent, a North Sea oil that is broadly representative of other world crude supplies, despite the fact that WTI is higher-quality and usually slightly more expen- sive. Without the ban on U.S. crude exports, the relationship between those prices would more closely reflect the historical pat- tern, so that the price of WTI would rise relative to that of Brent.

18. Energy Information Administration, "U.S. Natural Gas Exports and Re-Exports by Country" (accessed November 4, 2014), http://go.usa.gov/NfKF, and "U.S. Natural Gas Imports by Country" (accessed November 4, 2014), http://go.usa.gov/Nf8B. A major reason that the United States both exports gas to Canada and imports gas from it is that some of the imports are reexported to Canada. Because it has limited pipeline infrastructure to move gas from its western regions, where most of its gas is produced, to its east, Canada serves its eastern demand by exporting gas to the western United States and importing it from the eastern United States.

19. The United States has not been a net pipeline exporter since the 1950s. By 2040, EIA expects pipeline exports to triple and imports to decline by 30 percent. See Energy Information Admin- istration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

20. Only one LNG export facility is currently operating in the United States, and it is scheduled to export less than 0.1 Tcf of LNG over the next two years. See ConocoPhillips, "Kenai LNG Exports" (accessed August 25, 2014), http://tinyurl.com/o36td07.

21. World Bank, "World Bank Commodities Price Data (The Pink Sheet)" (December 2, 2014), http://tinyurl.com/qjbfqmf (PDF, 233 KB).

Exports to countries without FTAs, which account for roughly 80 percent of LNG imports worldwide, require DOE to determine that the exports would be in the public interest; DOE regards LNG exports to FTA countries as automatically being in the public interest.

As of October 2014, four LNG export terminals, pro- posed for Louisiana, Maryland, and Texas, had received approval for construction and for exports to countries without FTAs; if those terminals are built in the next sev- eral years, their combined capacity of about 2.5 Tcf will represent roughly 8 percent of North American gas con- sumption. Four more facilities, proposed for Florida, Louisiana, and Oregon and having a combined capacity of 1.5 Tcf, have recently been authorized by DOE to export LNG to countries without FTAs, but none of them have received approval for construction from FERC. All told, the roughly 30 applications that have sought full approval from FERC and DOE would create facilities that could export about 13 Tcf of LNG per year, an amount equal to roughly 40 percent of the natural gas consumed in North America.[22]

If the Congress wanted to change LNG export capacity, it could alter the criteria for DOE's approval of such exports to countries without FTAs. For example, it could require DOE to treat applications to export to those countries the same way that it treats applications to export to FTA countries—that is, automatically assuming that they are in the public interest. Such a change would speed the review process and make approvals more likely. Alternatively, the Congress could change the federal review process to make approvals of LNG exports less likely. For instance, when determining whether to allow LNG exports to a country without an FTA with the United States that covered natural gas, DOE could be required to give particular weight to the effects that the resulting higher domestic gas prices would have on low- income households in this country.

Potential Effects of Those Options. If the pending applications were approved, and export capacity of 13 Tcf per year was built and fully used, that 40 percent decline in supply in North America would boost gas prices consid- erably (unless suppliers greatly increased production in response to even a small price increase). But that much capacity might be approved without being built or fully used, in which case the actual volume of LNG exports might be much smaller. Whether approval of facilities led to construction and use would depend heavily on whether the difference between North American and overseas gas prices remained large enough to justify the costs of producing and exporting LNG.

On the one hand, today's large price gap could narrow—for example, if some new LNG facilities began operating, increasing the supply of natural gas overseas and reducing its price there while raising it here. The price gap could also narrow if major foreign suppliers of natural gas increased production to protect their market share; if new overseas gas resources, particularly shale gas, came to market; or if North American demand grew faster than supply. On the other hand, the price gap could widen further in the future, giving domestic firms an even bigger incentive to export gas—if, for example, worldwide demand for gas remained high but little additional LNG liquefaction and export capacity was built outside North America, or if North American gas supplies grew faster than demand.

A 2012 study commissioned by DOE analyzed future gas prices in various scenarios with different supply and demand conditions and different amounts of available export capacity. Most of the scenarios showed a future gap between U.S. and international gas prices too small to create much overseas demand for U.S. LNG; exports in those scenarios were accordingly small or nonexistent, even if a large amount of export capacity was approved.[23] Those findings were broadly confirmed in a 2014 update of the study (not commissioned by DOE), which found that under expected supply and demand conditions, allowing 2 Tcf or more of export capacity would result in only a 2 percent to 5 percent increase in domestic gas prices.[24] However, in scenarios in which sizable export capacity was approved and fully used, domestic prices would rise more sharply. For example, the more recent study estimated that with exports of about 4 Tcf per

22. Department of Energy, "Summary of LNG Export Applications of the Lower 48 States" (accessed November 4, 2014), http://go.usa.gov/KfYj.

23. W. David Montgomery and others, *Macroeconomic Impacts of LNG Exports From the United States* (submitted by NERA Economic Consulting to the Department of Energy, December 2012), http://go.usa.gov/KfGd (PDF, 4 MB).

24. Robert Baron and others, *Updated Macroeconomic Impacts of LNG Exports From the United States* (submitted by NERA Economic Consulting to Cheniere Energy, Inc., March 2014), http://tinyurl.com/p5vcjl9.

year—an amount consistent with the capacity of projects already approved by DOE, including those awaiting approval from FERC—domestic natural gas prices would probably be about 15 percent higher than they would have been with no export capacity. It also estimated that with exports of about 13 Tcf per year—roughly the capacity of all LNG facilities that have been approved or are currently seeking approval—prices would be 30 per- cent to 45 percent higher. But to support such high exports, overseas demand for LNG from the United States or U.S. supplies of shale resources (or both) would have to be much higher than projected by EIA at the time the studies were conducted.

EIA's most recent projection, which CBO uses in its base- line scenario, has the United States exporting about 2 Tcf per year of LNG by 2020 and about 3.5 Tcf by 2040.[25] Taking into account differences in the economic condi- tions underlying EIA's projection and those underlying the studies discussed above, CBO estimates that the pro- jected 3.5 Tcf of exports would increase domestic gas prices in 2040 by 10 percent or less, relative to the prices that would exist with no exports of LNG.[26]

To the extent that market conditions supported LNG exports, making capacity available to allow those exports would raise GDP—in part because more domestic gas would be produced, but also because the gas would be sold overseas at higher prices than at home. However, that increased GDP would not accrue to people in the United States uniformly. Higher prices for gas exported overseas would mean greater profits for U.S. gas producers; but the fact that domestic prices, too, would rise would mean that U.S. gas consumers faced higher costs. One of the studies mentioned above estimated that an increase in North American gas prices of $1 per mil- lion British thermal units, or Btus (about five times the increase found in the baseline scenario of the 2014 update to the DOE study), would increase costs for gas and electricity by $50 per year for U.S. households with annual income less than $20,000 and by $90 per year for those with annual income above $100,000.[27] Some households—for example, those that owned shares of companies that produced gas, those that owned land in gas-rich areas, and those with members employed in the gas industry—would enjoy higher income that at least partly offset, if not outweighed, the increased gas and electricity costs.

Another effect of LNG exports would be to increase the integration of the North American gas market with the European and Asian markets. That would both increase the exposure of domestic consumers to supply shocks overseas and ameliorate the domestic effects of reductions in North American supplies. However, a full consider- ation of the effects of LNG exports on household income and market integration is beyond the scope of this report.[28]

Uncertainty in the Projections

Projections of shale development's impact on energy mar- kets are inherently uncertain. A recent illustration of the uncertainty was EIA's energy market forecast in 2012, which projected that 2013 tight oil and shale gas produc- tion would total 0.9 million barrels per day and 7.6 Tcf, respectively.[29] The agency now expects 2013 production to have totaled 3.5 million barrels per day and 9.4 Tcf.[30]

25. Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

26. CBO's calculation combined information from two sources: pro- jections of future gas prices and production levels from EIA's *Annual Energy Outlook 2014 With Projections to 2040*; and esti- mates of the price sensitivity of gas production and of the relation- ship between gas production and LNG exports from Robert Baron and others, *Updated Macroeconomic Impacts of LNG Exports From the United States*.

27. Michael Levi, *A Strategy for U.S. Natural Gas Exports*, Discussion Paper 2012-04 (Brookings Institution, June 2012), http://tinyurl.com/nsxo7zo. The study's estimates were based on EIA's Residential Energy Consumption Survey for 2005, the latest information available at the time. Using data now available for 2009 does not materially affect those average costs. See Energy Information Administration, "Residential Energy Consumption Survey" (2009), Table CE2.1, http://go.usa.gov/8Kvz (XLS, 52 KB).

28. Other policy considerations not discussed here include the effects of extending the benefits of trade in natural gas to countries that do not agree to certain provisions that generally accompany free- trade agreements (such as safer conditions for workers and envi- ronmental protection) and the possibility that some actions that the United States might take to constrain LNG exports could prompt international challenges under the rules of the World Trade Organization.

29. Energy Information Administration, *Annual Energy Outlook 2012 With Projections to 2035*, DOE/EIA-0383(2012) (June 2012), http://go.usa.gov/7dhz.

30. Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

There are many reasons for the uncertainty. Some involve the future availability of shale resources and others the future demand for those resources. Uncertainty also exists about the factors that have affected recent gas prices, and those factors influence estimates of future prices.

The Availability of Shale Resources. The main reason for the difficulty of projecting the market effects of shale development, CBO believes, is uncertainty about the future availability of shale resources. To estimate future availability, analysts must assess three items, each of which is itself uncertain:

- The total quantity of shale resources in the ground;
- The quantity of technically recoverable resources at various points in the future, which is the fraction of total resources that could be recovered at each of those points with the technology then available; and
- The costs of developing those technically recoverable resources (which are relevant to future availability because developers would not extract resources that could be developed only at an exorbitant cost).

What makes the first two items uncertain is clear: Not all shale resources have been identified, and improvements in technology are difficult to predict. In 2011, for exam- ple, the U.S. Geological Survey (USGS) released an estimate of technically recoverable shale gas from the Marcellus Shale that, because hydraulic fracturing and horizontal drilling had made more resources recoverable, was about 40 times larger than its previous estimate, which was issued in 2003.[31] However, in its annual esti- mates, EIA had expected even greater growth, so it low- ered its estimate of the shale gas present in the Marcellus by about 65 percent after considering the USGS find- ing.[32] Similarly, on the basis of production trends and a revised understanding of the area's geology, EIA recently lowered its estimate of technically recoverable tight oil reserves in California's Monterey Shale formation by 96 percent.[33]

31. James L. Coleman and others, *Assessment of Undiscovered Oil and Gas Resources of the Devonian Marcellus Shale of the Appalachian Basin Province, 2011*, FS 2011-3092 (U.S. Geological Survey, August 2011), http://pubs.usgs.gov/fs/2011/3092/.

32. Energy Information Administration, *Annual Energy Outlook 2012 With Projections to 2035*, DOE/EIA-0383(2012) (June 2012), http://go.usa.gov/7dhz.

The third item, the cost of developing technically recov- erable resources, is uncertain for many reasons. One is that limited information exists about the rate at which tight oil and shale gas wells become less productive over time. Initial evidence suggests that production declines much more rapidly for tight oil and shale gas wells than for conventional oil and gas wells; some estimates suggest that it falls 80 percent or more over the first three years of operation. However, because shale wells have not been in operation very long, it is difficult to draw firm conclu- sions about their lifetime rates of production. If the pro- ductivity of tight oil and shale gas wells turns out to decline more slowly than experts project, current esti- mates will have overstated the cost of producing a given quantity of shale energy from a given quantity of resources. The reverse will be the case if productivity declines more quickly than expected.

Another reason that production costs are uncertain is that limited information is available about the distribution of well productivity. A recent analysis found that the amount of shale gas that new wells in the same rock for- mation yielded in the first few months was distributed very unevenly, with high production from relatively few wells and low production from the rest.[34] As production diminishes in the areas that were developed first because they were considered the most promising, and as develop- ment moves into other areas, the percentage of wells that are highly productive may fall, raising the cost of finding such wells and thus the average cost of developing shale resources. Alternatively, if exploration methods improve, the percentage of wells that are highly productive may increase.

The Demand for Shale Energy. Domestic and foreign demand for shale energy depends on many uncertain fac- tors, such as population growth, economic growth, the cost of conventional oil and gas, the cost of other com- peting energy sources, and the energy intensity of the economy (that is, the average amount of energy used in

33. Louis Sahagun, "U.S. Officials Cut Estimate of Recoverable Monterey Shale Oil by 96%," *Los Angeles Times* (May 20, 2014), http://tinyurl.com/pnknuct.

34. J. David Hughes, *Drill, Baby, Drill: Can Unconventional Fuels Usher in a New Era of Energy Abundance?* (Post Carbon Institute, February 2013), www.postcarbon.org/drill-baby-drill/.

producing a dollar's worth of GDP).[35] None of those factors can be forecast with precision. For instance, driving habits in the future, the supply of conventional oil and gas, and the cost of generating electricity from renewable fuels might differ from what is currently expected. Projec- tions of foreign demand are subject to additional uncer- tainty about transportation costs, other costs of trade, and foreign governments' trade policies.

The Factors Influencing Recent Gas Prices. Still another source of uncertainty in estimates of the effects of shale development involves the extent to which the recent declines in gas prices reflect factors other than the increased availability of shale gas. At least three such factors may be at work. First, the recent recession and slow economic recovery have reduced gas prices by reducing demand. Second, producers may be supplying more gas than they would have otherwise, given current prices, because of the boom in gas development that occurred in the second half of the last decade, when gas prices were much higher. Third, gas production is being supported by oil prices, which have been fairly high until recently. Gas producers in areas rich in natural gas plant liquids—which, as this report noted earlier, are sometimes obtained in the production of shale gas and are good sub- stitutes for certain petroleum products—have been will- ing to produce and sell natural gas at a loss so that they can obtain those liquids, the prices of which are more closely linked to the price of crude oil than to the price of natural gas.[36]

The more those three factors (or others) have been responsible for today's low gas prices, the smaller a role has been played by the current availability of shale gas, and the more estimates may overstate the future sensitivity of gas prices to the availability of shale gas.

35. Consumers who want to purchase gas or oil do not specifically demand shale gas or tight oil. Here, "demand for shale energy" at a given price refers to the excess of demand for the fuel at that price above the amount of the fuel supplied from conventional resources.

36. Researchers recently concluded that a highly productive gas well in the Barnett Shale required a price of about $3 per million British thermal units (mmBtu) of gas to generate a 10 percent rate of return in the absence of natural gas plant liquids, but only about 50 cents per mmBtu if such liquids were present. See Peter Behr, "Barnett Shale Has Surprisingly More to Give, Texas Researchers Find," *EnergyWire* (September 25, 2013), www.eenews.net/energywire/stories/1059987786.

Suppose, for instance, that more of the decline in gas prices since 2008 resulted from the economic slowdown than a particular model accounts for, and that less resulted from the growth of shale gas availability. In that case, the model would have overestimated the past effects of shale gas availability on prices, and projections based on that model would similarly overestimate the future effects of shale gas availability on prices.

Effects on Economic Output

In the long run, CBO estimates, the development of shale resources will lead to higher GDP by increasing the productivity of existing labor and capital and by increasing the amount of labor and capital in use. Specifically, CBO projects that real GDP will be 0.7 percent higher in 2020 and 0.9 percent higher in 2040 than it would have been without shale development.

In recent years, shale development has probably had a larger effect on GDP, having employed labor and capital that would otherwise have been unused because of weak demand for goods and services. That larger effect will probably persist over the next few years—that is, as long as interest rates remain low and output remains distinctly below its maximum sustainable level. But after output moves back toward its maximum sustainable level, labor and capital used to produce shale resources or gas-intensive goods will mostly be drawn away from the production of other goods and services, which means that shale development will have a smaller net effect on GDP.

In the Next Few Years

Shale development has boosted GDP in recent years and will continue to do so. However, CBO has not quantified the effect over the next few years, because shale development's short-term effects on the economy, other than on the output of oil and gas, are especially difficult to measure. Those effects include increased investment in the oil and gas industry and in industries that support it; increased investment and production in other industries because energy prices are lower than they would otherwise be; and increased demand for goods and services because of greater household income—all of which increase GDP. Shale development also reduces the amount of labor and capital available for other uses and reduces the production of energy from conventional resources; those effects reduce GDP.

Increased Output of Oil and Gas. Shale development has increased U.S. output of tight oil and shale gas, raising GDP. The market value of shale gas produced in 2013 (reflecting the contributions of both the gas industry and the other industries that supply goods and services used to produce shale gas) was about $35 billion. In the same year, the market value of tight oil, including natural gas plant liquids produced by hydraulic fracturing, was about $160 billion. Combined, sales of shale gas and tight oil therefore totaled about $195 billion, or roughly 1.2 percent of GDP.

Increased Investment in the Oil and Gas Industry and in Supporting Industries. Shale development has probably raised GDP in recent years through greater spending on the development of new wells. Between 2004 and 2012, investment in the oil and gas extraction industry increased from 0.4 percent of GDP to 0.9 percent.[37] However, that increase included investment in conventional oil production that probably would have occurred even without shale development because of the sharp rise in oil prices over that period. CBO did not estimate how much of the increase in investment could be attributed to shale development.

In addition, industries that support the oil and gas sector have spent more on new facilities and equipment, such as pipelines and trains, as a result of shale development. CBO did not quantify that increase in investment either.

Increased Investment and Production in Other Industries. Industries that use natural gas intensively—such as the steel, petrochemical, fertilizer, and electricity industries—have expanded production to take advantage of energy prices that are lower than they would have been without shale development. Such industries have become more competitive internationally because of the fall in energy prices in the United States: A number of new U.S. petrochemical and fertilizer facilities are being planned, for example, and one company is in the process of mov- ing two methanol plants from Chile to Louisiana.[38] Thus, shale development has boosted GDP by raising investment in, and production from, energy-intensive industries—but it is very difficult to estimate the magnitude of that effect.[39]

Increased Demand. Higher employment resulting from shale development, along with a larger capital stock resulting from increased investment in the development and use of shale resources, has led to higher household income and thus greater demand for goods and services. Some of that increased demand has been met by the additional production from the energy-intensive industries described above. However, much of the increase has been for products supplied by firms that do not directly benefit from lower natural gas and oil prices. In order to meet the increased demand, those firms have increased employment and investment, which has raised GDP still further in the short term.

Less Labor and Capital Available for Other Uses. The effects described above have shifted some workers and capital away from other uses, which means that some economic activity has been forgone. That forgone output has partly offset shale development's positive effects on GDP. Although CBO has not quantified the forgone output, the fact that the economy's slow recovery from the recent recession has left many resources underused suggests that the amount is small.

Less Production From and Investment in Conventional Energy Resources. As shale development has made energy prices lower than they would have been otherwise, the production of gas and oil from some conventional supplies has become unprofitable and has therefore been abandoned, and some investment in conventional sources of gas and oil has not been undertaken. Similarly, electric utilities' substitution of natural gas for coal has reduced production from and investment in coal mining. The for- gone production and investment, like the reduced output from sectors that lost labor and capital, has partly offset shale development's positive effects on GDP. CBO

37. CBO calculated that increase with data from the Bureau of Economic Analysis, "Fixed Assets Accounts Tables," Table 3.7ESI (accessed September 20, 2014), http://go.usa.gov/vwCC.

38. Methanex Corporation, *Annual Report 2013* (Methanex, March 2014), http://tinyurl.com/lwhxkma (PDF, 601 KB).

39. According to one report, the effect of hydraulic fracturing on investment by energy-intensive industries has been small so far but could grow in the future; see Jan Hatzius and others, *Is the Economy Gaining "Fracktion?"* US Economics Analyst 13/42 (Goldman Sachs, October 2013). Another has found that the fall in the price of natural gas since 2006 is associated with a 2 percent to 3 percent increase in activity for the entire manufacturing sector; see William R. Melick, *The Energy Boom and Manufacturing in the United States*, International Finance Discussion Papers 1108 (Board of Governors of the Federal Reserve System, June 2014), http://go.usa.gov/vvDW (PDF, 672 KB).

estimates that conventional gas production falls by about one-tenth the amount of an increase in shale gas production, which means that the resulting loss in GDP in 2013 was probably small.[40] The effect of reduced investment in conventional energy on GDP in 2013 is harder to quantify.

In the Longer Term

Shale development will raise GDP in the longer term in two ways: increasing the productivity of existing labor and capital, and increasing the amount of labor and capital in use. CBO estimates that, as a result, real GDP will be 0.7 percent higher in 2020 and 0.9 percent higher in 2040 than it would have been without shale development, although those estimates are subject to considerable uncertainty.[41] The longer-term effects of shale development on GDP will probably be smaller than the near-term effects described above (see Box 1).

Increased Productivity. Shale development raises GDP by increasing the productivity of labor and capital. That increased productivity is projected to make GDP 0.4 percent higher in 2020 and 0.5 percent higher in 2040 than it would have been in the absence of shale development.

Some of the increased productivity comes from the labor and capital used in shale development itself, which are more productive because of hydraulic fracturing and horizontal drilling than they would have been without those techniques. CBO estimates that the value of the tight oil and shale gas produced in both 2020 and 2040 will be about 1.3 percent of real GDP. But in the absence of hydraulic fracturing and horizontal drilling, CBO estimates, the labor and capital now projected to be used to produce that output would contribute only about 1.0 percent to GDP in 2020 and about 0.9 percent in 2040. The boost to GDP from reallocating labor and capital into the production of tight oil and shale gas is the difference between those estimates: about 0.3 percent of GDP in 2020 and 0.4 percent in 2040. (For details about that estimate and others in this section of the report, see Appendix B.)

Another component of the increased productivity resulting from shale development comes from replacing high-cost conventional oil and gas with shale resources. Because less labor and capital are now required to produce the same amount of oil and gas, the shift frees up labor and capital, which are used to produce other goods, thereby increasing GDP. However, because the reduction in conventional oil and gas will be modest, the resulting increase in GDP will be small in both 2020 and 2040.

The rest of the increased productivity comes from labor and capital that are used more efficiently elsewhere in the economy because of increased consumption of oil and gas. As energy-intensive products and methods of pro- duction grow cheaper, the same amount of output can be produced with less labor and capital. For example, as the cost of generating electricity from gas has fallen, some electric utilities have increased their productivity by switching from coal to gas. Through such shifts, GDP will be about 0.1 percent higher in both 2020 and 2040 than it would have been without shale development, CBO estimates.

Higher output would also result if shale development led manufacturing to become a larger share of the economy and if labor was generally more productive in manufacturing than in other sectors. However, recent earnings data do not demonstrate that labor productivity is higher in manufacturing. Although the average weekly earnings of employees in manufacturing were higher than those of all private-sector employees in 2013, hourly earnings were about the same, meaning that most of the difference in weekly earnings was due to a longer average workweek in manufacturing.

Increased Total Labor and Capital. Shale development will also raise GDP by increasing the amounts of labor and capital used in the economy, in CBO's assessment. That increase will happen in at least two ways. First, the increase in output generated by higher productivity that

40. That CBO estimate is based on Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

41. Those estimates assume no restrictions on exports of LNG in 2020 and beyond. If the difference between domestic and overseas gas prices increased demand for U.S. exports of LNG, but those exports were constrained because federal permits had not been issued, the increases in GDP would be lower. Such a constraint would keep domestic LNG prices lower than they would be other- wise, which would benefit domestic businesses and households that used gas; however, those benefits would not fully offset the loss to gas producers. See W. David Montgomery and others, *Macroeconomic Impacts of LNG Exports From the United States* (submitted by NERA Economic Consulting to the Department of Energy, December 2012), http://go.usa.gov/KfGd (PDF, 4 MB).

Box 1.

Why the Economic Effects of Shale Development Will Be Larger in the Near Term

The positive effects of shale development on gross domestic product (GDP) are partly offset by output that is forgone when labor and capital are shifted away from other uses. That offsetting effect has not been large so far, in the Congressional Budget Office's assessment, because the economy's slow recovery from the recent recession has left many resources unused. However, the effect will be larger once the economy moves back toward producing its maximum sustainable level of output. At that point, the labor and capital shifted into the production of shale resources or energy-intensive goods and services will mostly be drawn away from the production of other goods and services. Consequently, shale develop- ment's net effect on GDP is likely to be smaller in the longer term than in the near term.

The redistribution of labor and capital will occur in various ways. For example, some higher-cost production of natural gas from conventional resources will become unprofitable, pushing labor and capital elsewhere. The composition of domestic production will shift toward energy-intensive manufacturing and away from other industries. And increased net exports of natural gas and oil will boost the value of the dollar, making goods produced in the United States more expensive relative to U.S. imports and therefore leading to reduced production of those goods. (Economists refer to that phenomenon as Dutch disease, remembering the discovery in 1959 of the Groningen gas field in the Netherlands, which led to large exports of natural gas and a surge in the value of the Dutch currency in the late 1960s and early 1970s—and thereby made Dutch manufacturing less competitive.) The increase in the value of the dollar will probably be small, but it will affect all U.S. exports and imports and would probably have a dis- cernible effect on the economy.

A recent study illustrates the difference between shale development's effects on GDP in the near term and in the longer term. An average of the conservative and optimistic scenarios in the study indicates that shale resources are expected to boost maximum sustainable GDP by 0.65 percent and actual GDP by 1.35 percent between 2013 and 2020. The difference between those estimates illustrates the additional response of GDP to shale development when the economy is not operating at its maximum sustainable level of output.[1]

1. See Trevor Houser and Shashank Mohan, *Fueling Up: The Economic Implications of America's Oil and Gas Boom* (Peterson Institute for International Economics, 2014), Chapter 4, http://bookstore.piie.com/book-store/6567.html.

was described above will result in additional income; part of that income will be saved and then invested, increasing the capital stock. Second, the higher productivity will increase wages, improving the return to workers from each hour of work and encouraging them to work more. Because of those effects, CBO estimates, GDP will be 1.3 percent higher in 2020 and about 0.4 percent higher in 2040 than it would have been without shale development.[42]

Other effects of shale development on the total amounts of labor and capital (and in turn on GDP) are highly uncertain, so CBO did not estimate them. For example, if the industries that produce and use natural gas and oil, or those that supply infrastructure for shale development, are more capital-intensive than those that see production fall as a result of shale development, the demand for capital and thus the overall return on investment in the United States will be higher. That higher rate of return will lead to increases in private saving and in capital inflows from abroad. But under the same circumstances, companies' desire to replace labor with capital will reduce the return to working, reducing the labor supply.

Other Considerations. Two more considerations should be mentioned that are related to shale development's effects on the economy in the longer term. One involves a reduction in the dollar cost of U.S. imports; the other involves uncertainty in the estimates of economic effects.

The Cost of Imports. Shale development confers an economic benefit that raises the standard of living in the United States but does not show up as greater GDP. Specifically, increased net exports of natural gas and oil boost the value of the dollar, making imports cheaper and allowing consumers to buy more and businesses to invest more for a given quantity of exports and a given amount of GDP. CBO has not quantified that effect, however.

Uncertainty. CBO's estimates of shale development's effects on GDP are accompanied by significant uncertainty of various kinds. The estimates rest on baseline projections of the prices of shale gas and tight oil, of the quantities of those fuels produced in the United States, and of the profitability of that production—and as is explained earlier (in the section "Uncertainty in the Projections"), all of those projections are uncertain, because of underlying uncertainty about demand for natural gas and oil, demand for other forms of energy, the availability of shale resources, and exploration and production technology.

CBO therefore estimated the effects of shale development not only according to those baseline projections but also under two alternative scenarios. In the first scenario, prices, production, and profitability are all lower than projected in the baseline. Prices of natural gas and oil (reflecting recent EIA projections of price uncertainty) are about 25 percent lower in 2015 than they are in the baseline projection, then grow more slowly than they do in the baseline, and are about 50 percent lower by 2040. The production of shale gas and tight oil is about 40 percent lower than in the baseline by 2040, a figure that is consistent with what EIA calls its low-resource scenario. And the average cost of producing shale gas rises 75 percent as quickly as the price of natural gas, compared with 50 percent as quickly in CBO's baseline projection.[43]

In the second alternative scenario, the three factors are all *higher* than projected in the baseline. The prices of natural gas and oil start out about 35 percent higher than they are in CBO's baseline projection and grow to be roughly 50 percent higher.[44] The production of shale gas and tight oil is about 40 percent higher than in the baseline by 2040; and profitability is higher because the average cost of producing shale gas rises only 25 percent as fast as the price of natural gas.

In the first scenario, shale development makes real GDP 1.4 percent higher in 2020 and 0.3 percent higher in 2040 than it would have been otherwise. (The effect is smaller in 2040 because the economy then will be larger relative to the market value of shale energy in the sce- nario.) In the second scenario, GDP is 1.3 percent higher in 2020 and nearly 2 percent higher in 2040 because of shale development.

Effects on the Federal Budget

The development of shale resources affects two kinds of federal receipts. The first, federal tax revenues, rise as shale development boosts GDP. The second, payments to the government by private developers of federally owned resources, also increase with shale development—but not much, because most of the nation's shale gas and tight oil is not owned by the federal government.

42. Some researchers have estimated that shale resources will have a much larger impact on the total amount of labor and capital used in the economy in 2020, resulting in a much larger impact on GDP. For example, one report estimates that shale energy could add a net 1.7 million permanent jobs by 2020 and boost GDP by 2 percent to 4 percent; see Susan Lund and others, *Game Changers: Five Opportunities for US Growth and Renewal* (McKinsey & Company, July 2013), http://tinyurl.com/mazev4d. Another report estimates that new energy supply may create 2.7 million to 3.6 million jobs by 2020, on net, and boost GDP by 2 percent to 3 percent; see Edward L. Morse and others, *Energy 2020: North America, the New Middle East?* (Citigroup, March 2012), http://tinyurl.com/mo7k7dt. Those researchers' estimates of net jobs created are much higher than CBO's. The difference probably arises because the other researchers think that labor sup- ply responds more strongly to increases in wages; that in 2020, the economy will still not be producing its maximum sustainable level of output (so underused labor could still be drawn into shale development without reducing the labor available to other indus- tries); or both. For a detailed discussion of CBO's estimating approach, see Appendix B.

43. That average cost will rise because more costly resources will be profitable to develop as natural gas prices rise. The projection that it will rise more slowly than natural gas prices is consistent with EIA projections that shale gas will continue to grow as a share of overall U.S. gas production.

44. The larger initial departure from baseline prices—35 percent, compared with 25 percent in the first scenario—is consistent with EIA's recent price forecasts, which in turn reflect market expectations (shown in futures prices and trading prices for options contracts) that near-term prices have more potential to be higher than expected than to be lower than expected. See Energy Information Administration, *Short-Term Energy Outlook* (November 2014), www.eia.gov/forecasts/steo/outlook.cfm.

Tax Revenues

The development of shale resources has increased economic activity in recent years and will continue to do so, as the previous section explains. That increased activity is reflected in higher income of various kinds, such as wages and salaries, income from partnerships and sole proprietorships, dividends, and corporate profits. And because that higher income is subject to a combination of individual income taxes, corporate income taxes, and payroll taxes, shale development increases federal tax revenues as well.

CBO expects the effect of shale development on revenues to be slightly higher in percentage terms than the effect on GDP. As the previous section also mentions, CBO estimates that real GDP will be 0.7 percent higher in 2020 and 0.9 percent higher in 2040 than it would have been without shale development. On the basis of that increase in GDP, CBO estimates that revenues will be higher by 0.8 percent (or about $35 billion) in 2020 and by 1.0 percent in 2040 than they would have been with- out shale development.[45]

In arriving at those rough estimates for 2020 and 2040, CBO assumed that the net effect of shale development on GDP would be allocated among the various types of taxable and nontaxable income, and across households in different tax brackets, in the same proportions in which overall GDP was expected to be allocated. Because the United States has a progressive individual income tax system—that is, one in which income in higher brackets is taxed at higher rates—that assumption led to the conclusion that shale development would have a greater effect on revenues than on GDP, in percentage terms. (By contrast, if the GDP added by shale development was unusually concentrated among people in the lowest tax bracket, shale development might have a smaller percentage impact on revenues than on GDP.)

45. Congressional Budget Office, *Updated Budget Projections: 2014 to 2024* (April 2014), www.cbo.gov/publication/45229, and *The 2014 Long-Term Budget Outlook* (July 2014), www.cbo.gov/publication/45471.

Payments for Federally Owned Resources

The federal government receives payments from private developers of federally owned oil and gas. In the case of onshore oil and gas, about 90 percent of the payments are royalties on production; the rest are payments to obtain leases and rent on leases not yet put into production. All of the payments go initially to the U.S. Treasury, but under current law, the federal government generally pays about half to the states from which the resources were extracted. After adjusting for those payments to states, CBO estimates that net federal royalties from all onshore oil and gas leases will average about $1.4 billion a year over the 2015–2024 period.[46]

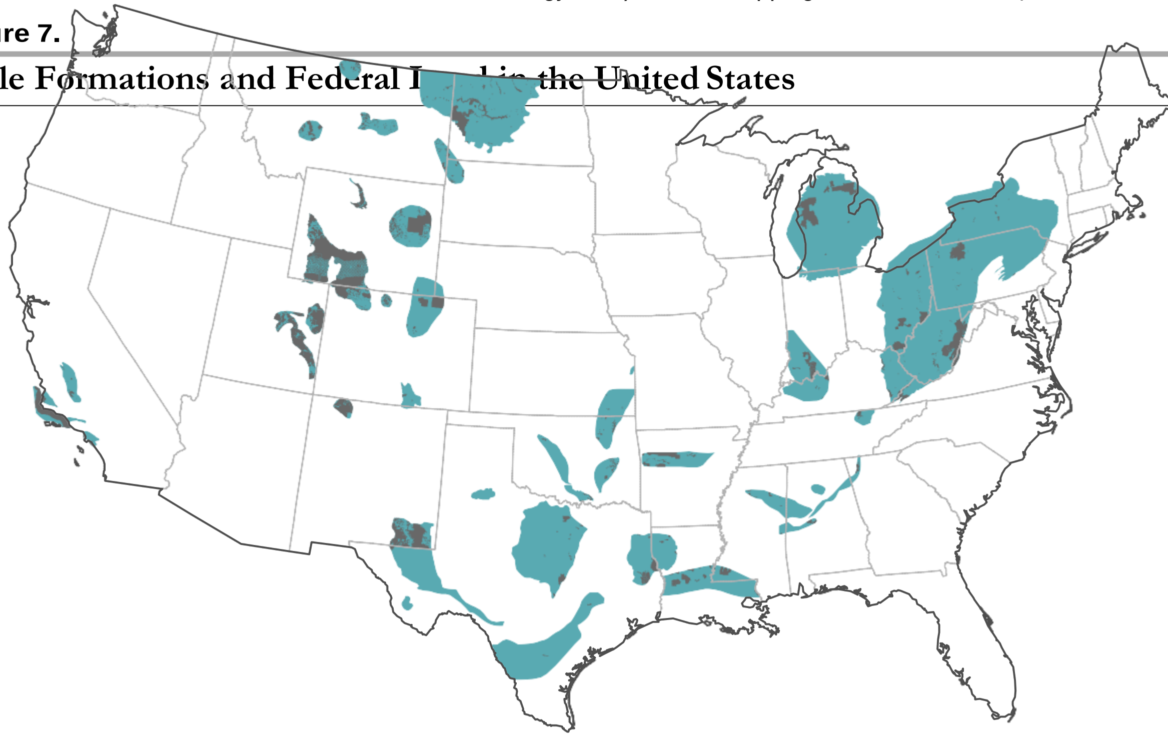
The portion of those royalties attributable to tight oil and shale gas production is uncertain because the government does not supply data breaking down production from federal lands by geologic formation. However, on the basis of information from state agencies and EIA, CBO estimates that in 2012, shale gas probably accounted for about 3 percent of onshore natural gas produced from federal land and tight oil for about 25 percent of onshore oil produced from federal land. Those estimates accord with the observation that few of the country's current and potential sources of shale gas and tight oil lie beneath federally owned land (see Figure 7).[47] For example, the Rocky Mountain region, which accounts for almost all of the natural gas (including shale gas) produced on federal land, is a minor source of the nation's supply of shale gas, yielding less than 1 percent of the total through 2024, according to EIA's projections.

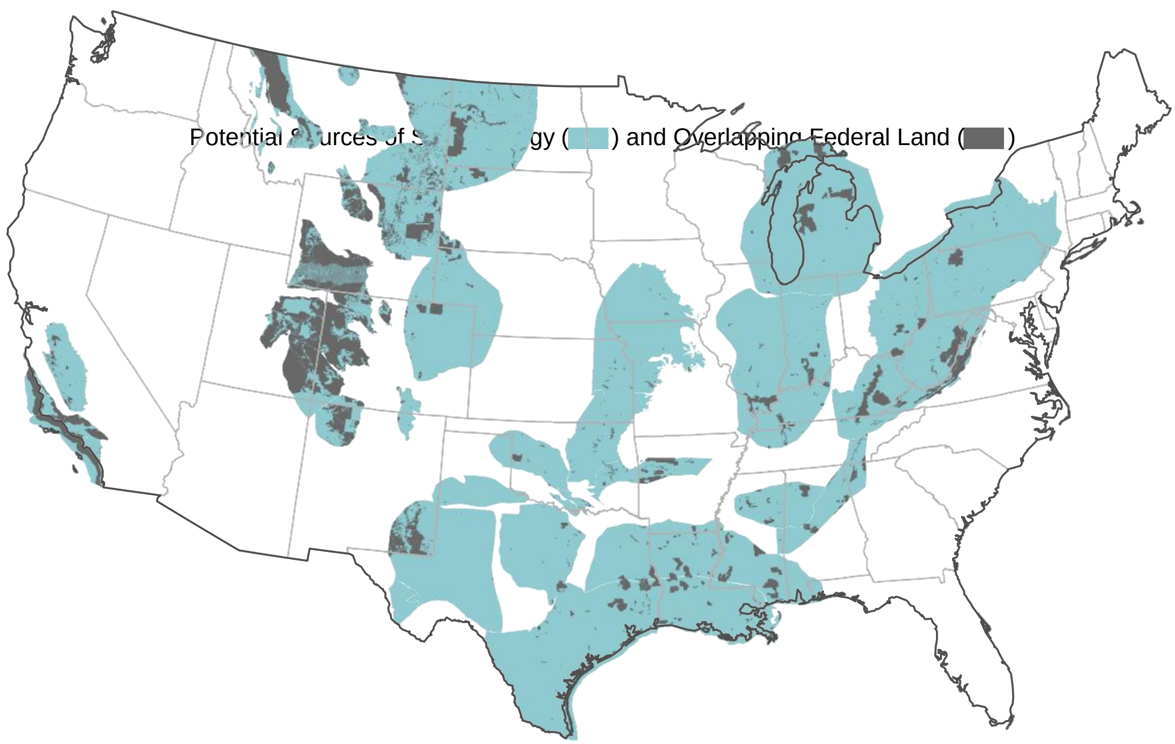
46. That figure is based on Congressional Budget Office, *An Update to the Budget and Economic Outlook: 2014 to 2024* (August 2014), www.cbo.gov/publication/45653. The 2015–2024 period is CBO's standard 10-year projection period.

47. Energy Information Administration, *Annual Energy Outlook 2012 With Projections to 2035*, DOE/EIA-0383(2012) (June 2012), p. 57, http://go.usa.gov/7dhz; David W. Houseknecht and others, *Assessment of Potential Oil and Gas Resources in Source Rocks of the Alaska North Slope, 2012*, FS-2012-3013 (U.S. Geological Survey, February 2012), http://pubs.usgs.gov/fs/2012/3013/; and David W. Houseknecht, *Assessment of Potential Oil and Gas Resources in Source Rocks (Shale) of the Alaska North Slope 2012—Overview of Geology and Results* (U.S. Geological Survey, 2012), pp. 5, 7–9, http://go.usa.gov/KfeH (PDF, 4 MB).

Figure 7.

Shale Formations and Federal Lands in the United States





Source: Congressional Budget Office based on data from the Energy Information Administration, “Detailed Oil and Gas Field Maps” (accessed October 2, 2014), http://go.usa.gov/VKt4, and from the U.S. Geological Survey, “Federal Lands of the United States” (accessed October 2, 2014), http://go.usa.gov/vdzT.

Note: Shale energy is oil and natural gas extracted from shale and certain other dense rock formations by means of hydraulic fracturing.

In addition, the production of shale energy reduces the value of natural gas produced from federal *offshore* leases. That reduction diminishes the royalties (which are based on sales value) paid by the developers of those resources, and it therefore also diminishes the net effects of shale development on federal receipts.

On the basis of the preceding estimates and CBO's current forecast of oil and gas prices, along with EIA's projections of domestic production, CBO estimates that net federal royalties from tight oil and shale gas will total about $300 million a year by 2024. CBO anticipates that most of those royalties will come from the production of tight oil in the southeastern corner of New Mexico and in the Rocky Mountain region.[48] As with other estimates in this report, the $300 million figure is subject to substantial uncertainty.[49]

48. Total royalties from those regions will be higher because of the production of tight gas, which is not addressed in this report.

49. Various proposals have been made over the years for the federal government to increase the royalties that it receives by expanding access to energy resources on federally owned land. For more information, see Congressional Budget Office, *Potential Budgetary Effects of Immediately Opening Most Federal Lands to Oil and Gas Leasing* (August 2012), www.cbo.gov/publication/43527.

A

Effects on the Environment

Various observers are concerned that the development of shale resources may reduce the availability of water for other uses or contaminate it. They also have concerns, as well as hopes, about the effects of shale production on greenhouse gas emissions. The Congressional Budget Office (CBO) has not attempted to predict the future environmental consequences of shale develop- ment: The data about those consequences so far are not comprehensive enough, future consequences could differ from past ones because of the increasing scale of shale development, and future technological and regulatory developments are unclear. Instead, this appendix dis- cusses the environmental effects of shale development on the basis of research and experience to date.[1] It also exam- ines whether the federal government or state or local governments would be more likely to make economically efficient decisions about managing those effects.

Water Availability

Because hydraulic fracturing typically requires large quantities of water, shale development can contribute to strains on freshwater supplies. To date, conflicts between shale development and other uses of water have not been widespread, but some local ones have occurred.[2] In April and July of 2012, for example, after the flow volumes of local streams dropped below predetermined levels because of below-normal precipitation, the Susquehanna River Basin Commission temporarily suspended some arrangements for water withdrawals, most of which were related to shale development. Such conflicts may inten- sify as shale development increases. One study estimates that freshwater withdrawals by the oil and gas industry in Texas's Haynesville-Bossier Shale will reach more than 3 billion gallons annually between 2020 and 2035— which is more than double the 2010 amount and corre- sponds to about 6 percent of total current water use in the area.[3]

Shale developers can reduce the amount of freshwater that they require by reusing it. However, the potential for reusing water at a particular site depends on how much flows back from the well, the cost of treating it so that it can be reused, and the freshwater sources and disposal options available in the area. For example, in the Marcellus Shale, where underground disposal wells for used water are scarce, some operations reuse nearly all of the water that flows back from their wells—but doing so reduces their freshwater needs by 30 percent at most, because much of the water that is pumped into the

1. The environmental effects discussed here are those that are associ- ated particularly with shale development; effects that involve oil or gas more generally, such as leaks from pipelines, are not discussed. Concerns about local air pollution are also not discussed, because potential policies to address those concerns are similar to potential policies to address greenhouse gas emissions, which are discussed below.

2. Agriculture and thermoelectric power generation each account for about 40 percent of freshwater withdrawals nationwide; the rest is used by residences, businesses, and industry (including shale development). See Molly A. Maupin and others, *Estimated Use of Water in the United States in 2010*, Circular 1405 (U.S. Geological Survey, November 2014), http://pubs.usgs.gov/circ/1405/.

3. Texas Water Development Board, "Historical Water Use Estimates," county table for 2010 (accessed January 2014), http://go.usa.gov/KftG; Jean-Philippe Nicot and others, *Oil and Gas Water Use in Texas: Update to the 2011 Mining Water Use Report* (prepared by the Bureau of Economic Geology, University of Texas at Austin, for the Texas Oil and Gas Association, September 2012), http://go.usa.gov/KfzC (PDF, 3 MB); and Jean-Philippe Nicot, Bureau of Economic Geology, University of Texas at Austin, personal communication (January 8, 2014).

ground remains there.[4] Replacing freshwater in hydraulic fracturing with treated, nonpotable water or hydrocarbon-based fluids could also reduce demands on freshwater resources, but it is too soon to know whether such technological developments will prove widely effective and cost-competitive.

In general, rights to use freshwater are controlled by states and are more limited than typical property rights, so water is not bought and sold in a free market.[5] For example, some state laws prevent those whose use returns water to the local environment from selling their water rights to those whose use does not do so. During water shortages, other state laws may subject all holders of water rights to proportional reductions in use; alterna- tively, more recent holders may be required to reduce their use so that those who preceded them in obtaining rights to the same source of water can claim their full allocation. Because of such limitations, the amount of water that shale operations use may be smaller than the amount that would maximize the benefit of such water use to society. On the other hand, shale operations may have access to more water than the most socially benefi- cial amount if their impact on the environment is not appropriately regulated or reflected in market prices (say, by charges that cover wastewater treatment costs and other environmental impacts).

Water Quality

Concerns about the effect of shale development on water quality involve various sources of potential contamination: sediment from the construction of drilling platforms; drilling fluids; various chemicals, which constitute up to 2 percent of the fracturing fluid injected into a well; the liquid removed from a well, which can include not only the fracturing fluid but also material from the shale formation (such as saltwater, organic compounds, heavy metals, and radioactive substances); and the extracted shale resources themselves.

Some of those contaminants might affect surface water, some might affect groundwater, and some might affect both (see Table A-1). However, certain routes of potential contamination—inadequate cleaning of the liquid removed from a fractured well before wastewater treat- ment facilities discharge it to surface water, for example, or underground migration from disposal wells to groundwater—are less likely than others, in part because they are regulated under the federal Clean Water Act of 1972 (CWA) or the federal Safe Drinking Water Act of 1974 (SDWA). In some cases, routes of potential contamina- tion not currently regulated by the federal government could be addressed by regulations promulgated under state and local laws, especially those governing oil and gas production; in other cases, they already are, with varying degrees of stringency.[6]

Other provisions of the SDWA focus not on blocking contamination routes but on setting maximum concentrations of certain contaminants in water distributed by public drinking-water systems. Those provisions do not currently cover any of the 59 fracturing-fluid additives that companies have disclosed using routinely; however, limits for three of them—acetaldehyde, ethylene glycol, and methanol—are under consideration by the Environ- mental Protection Agency (EPA).[7] The SDWA concen- tration limits do not apply to private wells of drinking water, which serve about 15 percent of the U.S. population.

4. See Brian D. Lutz, Aurana N. Lewis, and Martin W.Doyle, “Generation, Transport, and Disposal of Wastewater Associated With Marcellus Shale Gas Development,” *Water Resources Research*, vol. 49, no. 2 (February 2013), pp. 647–656, http://tinyurl.com/o9moyxc; and Matthew E. Mantell, “Deep Shale Natural Gas and Water Use, Part Two: Abundant, Affordable, and Still Water Efficient” (paper presented at the 2010 Ground Water Protection Council Annual Forum, Pittsburgh, Pa., September 27–29, 2010), p. 9, http://tinyurl.com/qxk2djc (PDF, 877 KB).

5. The federal government does have some influence on water allocations. See Congressional Budget Office, *How Federal Policies Affect the Allocation of Water* (August 2006), www.cbo.gov/publication/18035.

6. See Nathan Richardson and others, *The State of State Shale Gas Regulation* (Resources for the Future, June 2013), http://tinyurl.com/kwbt7l4 (PDF, 5 MB).

7. FracFocus, “What Chemicals Are Used” (accessed December 4, 2014), http://tinyurl.com/44m94y2; Environmental Protection Agency, “Drinking Water Contaminants” (accessed December 4, 2014), http://water.epa.gov/drink/contaminants/index.cfm; and Environmental Protection Agency, “Contaminant Candidate List 3” (accessed December 4, 2014), http://go.usa.gov/KG3m. The existing limits do cover four chemicals (benzene, ethyl- benzene, toluene, and xylene) that are less commonly present in fracturing fluid but that may be present in fracturing fluid con- taining diesel, which is used at perhaps 2 percent of wells; see Mike Soraghan, “Hydraulic Fracturing: Diesel Still Used to ‘Frack’ Wells, FracFocus Data Show,” *EnergyWire* (August 17, 2012), http://tinyurl.com/puduv5m.

Of course, regulations may not be effective in meeting their stated goals, or they may meet their goals but at excessive cost. Thus, an important question to ask about the regulations related to shale development is whether they have positive net benefits—that is, benefits (which depend partly on the extent of compliance) minus costs (which include enforcement costs). A second important question is whether those net benefits could be increased by making the regulations more or less stringent. A third is whether the regulations reflect adequate scientific understanding of the risks associated with the larger-scale shale development anticipated for the future. At the request of the Congress, the EPA is writing a report on the potential effects of hydraulic fracturing on resources of drinking water; it should provide information relevant to those questions.[8]

Greenhouse Gas Emissions

Some observers are hopeful that shale development will result in lower overall greenhouse gas emissions because burning natural gas releases less carbon dioxide, a greenhouse gas, than burning other fossil fuels does. Specifically, when measured per unit of energy output, carbon dioxide emissions from natural gas combustion are about 45 percent lower than from coal combustion and about 30 percent lower than from oil combustion.[9] However, the effect on greenhouse gas emissions of replacing coal or oil with shale gas depends not simply on the fuels' dif- ferent emissions during combustion but also on their different emissions during extraction, transport, process- ing, and distribution.[10] Moreover, shale gas that does not displace coal or oil almost certainly increases total emis- sions unless technology is used to control the emissions. And emissions from all fossil fuels may increase as shale development raises gross domestic product and increases the demand for energy.

Natural gas can more easily substitute for coal than for oil, because both gas and coal are commonly used to gen- erate electricity. In fact, gas has been replacing coal in electricity generation for decades; that trend is expected to continue, partly because of the lower gas prices result- ing from shale development. In contrast, there is little current potential for natural gas to replace oil, whether as transportation fuel or for heating: Few vehicles run on natural gas, and only about 10 percent of heating is fueled by oil (some of which, moreover, occurs in areas where gas lines do not exist).[11]

The effects on greenhouse gas emissions of substituting shale gas for coal are difficult to estimate. A key factor is emissions of methane, the primary component of natural gas, during the initial phases of shale gas extraction. Methane is a more powerful greenhouse gas than carbon dioxide; the latest report of the Intergovernmental Panel on Climate Change estimates that methane's impact on the climate, per unit of mass, is 84 times greater than car- bon dioxide's over a period of 20 years and 28 times greater over 100 years.[12] The quantity of methane emis- sions depends critically on how producers handle the gas that emerges as the fracturing fluid injected into a well returns to the surface before the main extraction of shale energy. They might release it into the atmosphere; burn it off to reduce its climate impact, a process called flaring; or capture it with "green completion" technologies, which reduce total emissions by 90 to 95 percent and are the most effective way to minimize their impact on the

8. When the report is published, it will be available at www2.epa.gov/hfstudy.

9. Energy Information Administration, "Voluntary Reporting of Greenhouse Gases Program Fuel Emission Coefficients" (January 31, 2011), Table 1, www.eia.gov/oiaf/1605/coefficients.html.

10. For an overview of the measurement of emissions from natural gas systems, see A. R. Brandt and others, "Methane Leaks From North American Natural Gas Systems," *Science*, vol. 343, no. 6172 (February 14, 2014), pp. 733–735, http://tinyurl.com/lfbaay6.

11. Congressional Budget Office, *Energy Security in the United States* (May 2012), www.cbo.gov/publication/43012.

12. See Intergovernmental Panel on Climate Change, *Climate Change 2014: Synthesis Report* (IPCC, 2014), p. 100, Box 3.2, Table 1, http://www.ipcc.ch/report/ar5/syr/. The impact of methane in the short term is of concern because near-term global warming may trigger a rapid, nonlinear shift from one climate state to another without the possibility of reversal; for example, see Dave Levitan, "Quick-Change Planet: Do Global Climate Tipping Points Exist?" *Scientific American* (March 25, 2013), http://tinyurl.com/ kbf247y.

Table A-1.

Possible Routes of Water Contamination by Shale Development

Contamination Route	Applicable Federal or State Regulation	Additional Information
Surface Water		
Sediment transported by storm water	Such contamination is regulated by CWA, but only if it violates a water quality standard; it is also regulated by some states.[a]	
Spills, overflows, and seepage from storage pits and tanks	CWA requires oil and gas producers to have plans to prevent and contain certain spills; in some cases, it requires discharge permits and pollution prevention plans.[b]	Some spills have occurred because of equipment failures that developers, viewing them as unlikely, had not addressed in their prevention plans.
Inadequate cleaning of flowback water—which consists of fracturing fluid and fluid from the rock formation that surface after hydraulic fracturing—by wastewater treatment facilities	Commercial and industrial sources of wastewater that would pose problems for wastewater treatment facilities are required by general standards in CWA regulations to pretreat their wastewater. Specific CWA standards for the pretreatment of flowback water from shale gas wells are expected to be proposed.[c] Some states also regulate the discharge of flowback water to wastewater treatment facilities.	Shale operations may not fully comply with pretreatment requirements. For example, CWA violations in the Allegheny River watershed between 2007 and 2011 were associated with wastewater from the Marcellus Shale processed at three Pennsylvania wastewater treatment plants between 2007 and 2011. Since mid-2011, because of a combination of state prohibitions and voluntary actions, shale operators have generally not sent flowback to Pennsylvania wastewater facilities that cannot provide pretreatment. Outside the Marcellus Shale area, underground disposal wells are more widely available, and developers therefore have less economic incentive to dispose of flowback water through wastewater treatment plants.
Groundwater		
Spills	CWA regulations designed to protect surface water may also protect groundwater.[d]	
Underground migration from rock formations targeted by developers	SDWA regulations apply to hydraulic fracturing only in the cases (about 2 percent of the total) in which the fracturing fluid includes diesel.[e]	Typically, the target formation is separated from sources of groundwater used for consumption by thousands of feet of rock.[f] Some exceptions may exist: A preliminary Environmental Protection Agency report found that some hydraulic fracturing operations in Wyoming that occurred less than 500 feet below depths reached by drinking-water wells may have contaminated deeper

portions of the groundwater aquifer that the wells drew from.[g]

Continued

Table A-1. **Continued**

Possible Routes of Water Contamination by Shale Development

Contamination Route	Applicable Federal or State Regulation	Additional Information
Groundwater (Continued)		
Underground migration from leaking wells	The federal government does not regulate well integrity; some states do.	Methane contamination of some drinking- water wells in Pennsylvania and Texas has been linked to leakage from hydraulically fractured shale gas wells.[h] Also, in 2011, Pennsylvania's Department of Environmental Protection fined a shale gas developer for contaminating well water. Water may contain methane for reasons unrelated to hydraulic fracturing, so it can be difficult to assign responsibility unless water samples were taken before shale development began.
Underground migration from disposal wells	Disposal wells require an SDWA permit.[i]	SDWA permits are issued after the government has determined that the rock formation where a disposal well will be located is sufficiently isolated from groundwater.

Source: Congressional Budget Office.

Note: CWA = Clean Water Act; SDWA = Safe Drinking Water Act.

a. Sec. 303 of the Clean Water Act of 1972, Public Law 92-500 (codified at 33 U.S.C. §1313 (2012)).

b. Sections 301, 311, 402, and 404 of the Clean Water Act, P.L. 92-500 (codified at 33 U.S.C. §§1311, 1321, 1342, and 1344 (2012)); 40 C.F.R. §117 (2013).

c. Clean Water Act; 40 C.F.R. §437 (2013); and Notice of Final 2010 Effluent Guidelines Program Plan, 76 Fed. Reg. 66302 (October 26, 2011).

d. Sec. 340 of the Clean Water Act, P.L. 92-500 (codified at 33 U.S.C. §1314 (2012)).

e. Sec. 1421 of the Safe Drinking Water Act of 1974, P.L. 93-523 (codified at 42 U.S.C. §300h(d) (2012)); and Mike Soraghan, "Hydraulic Fracturing: Diesel Still Used to 'Frack' Wells, FracFocus Data Show," *EnergyWire* (August 17, 2012), http://tinyurl.com/puduv5m.

f. See George E. King, "Hydraulic Fracturing 101" (paper presented at the Society of Petroleum Engineers Hydraulic Fracturing Technology Conference, The Woodlands, Texas, February 6–8, 2012), http://tinyurl.com/nt3r3w7 (PDF, 7 MB); Stephen G. Osborn and others, "Methane Contamination of Drinking Water Accompanying Gas-Well Drilling and Hydraulic Fracturing," *Proceedings of the National Academy of Sciences*, vol. 108, no. 20 (May 17, 2011), pp. 8172–8176, http://tinyurl.com/5w227nj; and Nathaniel R. Warner and others, "Geochemical Evidence for Possible Natural Migration of Marcellus Formation Brine to Shallow Aquifers in Pennsylvania," *Proceedings of the National Academy of Sciences*, vol. 109, no. 30 (July 24, 2012), pp. 11961–11966, http://tinyurl.com/ckfheor.

g. Dominic C. DiGiulio and others, *Investigation of Ground Water Contamination Near Pavillion, Wyoming*, EPA 600/R-00-000 (draft, Environmental Protection Agency, December 2011), http://go.usa.gov/KGNG (PDF, 15 MB). "Less than 500 feet" is a CBO conversion from metric data on page xi of the report.

h. Thomas H. Darrah and others, "Noble Gases Identify the Mechanisms of Fugitive Gas Contamination in Drinking-Water Wells Overlying the Marcellus and Barnett Shales," *Proceedings of the National Academy of Sciences*, vol. 111, no. 39 (September 13, 2014), pp. 14076– 14081, www.pnas.org/content/111/39/14076.

i. Safe Drinking Water Act; 40 C.F.R. §144.31 (2013).

climate.[13] The relative use of those three options is not well documented, and estimates vary widely.[14] In October 2012, the federal government began requiring shale gas developers either to use green completions or to flare their emissions.[15] By January 2015, green completions will be required for new hydraulic fracturing at gas wells, although a few categories of wells, such as those used to look for gas rather than to extract it, will still be allowed to flare.[16] There are no such requirements for oil wells.

Because of differences in production methods, shale gas that substitutes not for coal or oil but for gas from other sources increases total emissions of greenhouse gases when emission controls are not in place during the drill- ing and extraction phases.[17] Subsequent production activ- ities, such as transport, processing, and distribution, may be even more significant sources of methane emissions, but they are essentially the same for shale gas and conven- tional gas.[18]

A given volume of shale gas increases greenhouse gas emissions even more when it substitutes for energy sources other than fossil fuels—such as nuclear plants, windmills, and solar panels—because those energy sources emit no greenhouse gases at all in use. (A compre- hensive comparison of those energy sources with shale gas would include the emissions associated with the construc- tion of facilities, energy production, processing, and transport.) Similarly, when shale gas does not displace other energy sources but simply increases total energy use, all of the emissions resulting from its production, distribution, and use are net additions. All things being equal, such an increase in energy use would be the likely result of lower prices for natural gas and other forms of energy. For instance, families might choose to keep their homes warmer in the winter because the cost was lower; for the same reason, firms might reduce their investments in energy-efficient technologies. Also, the faster economic growth spurred by cheaper energy would increase demand for energy in general, including fossil fuels.

Environmental Policy in a Federal System of Government

There are a number of ways in which the government may influence the environmental effects of shale develop- ment: choosing standards for water use, water quality, and greenhouse gas emissions; deciding on the acceptable methods of meeting those standards; and funding related research. Federal policymakers may wish to consider whether the current division of regulatory responsibilities among federal, state, and local governments is likely to lead to decisions that maximize the net benefits to society.[19]

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13. Environmental Protection Agency, "Summary of Requirements for Processes and Equipment at Natural Gas Well Sites" (accessed December 4, 2014), http://go.usa.gov/KGYe (PDF, 412 KB), and *Proposed New Source Performance Standards and Amendments to the National Emissions Standards for Hazardous Air Pollutants for the Oil and Natural Gas Industry* (July 2011), pp. 3–6, http://go.usa.gov/KGgH (PDF, 2 MB).

14. For instance, one 2012 assessment assumed that on a national basis, 70 percent of the methane emissions associated with extrac- tion were captured, 15 percent were flared, and 15 percent were released into the atmosphere. The Environmental Protection Agency, by contrast, assumed that half of those emissions were flared and half released. See Francis O'Sullivan and Sergey Paltsev, "Shale Gas Production: Potential Versus Actual Greenhouse Gas Emissions," *Environmental Research Letters*, vol. 7, no. 4 (Novem- ber 26, 2012), http://iopscience.iop.org/1748-9326/7/4/044030/; and Environmental Protection Agency, *Inventory of U.S. Green- house Gas Emissions and Sinks: 1990–2011*, 430-R-13-001 (April 2013), pp. 3-61 and 3-62, http://go.usa.gov/KGTT (12 MB).

15. The requirements, issued under the authority of the Clean Air Act, targeted emissions not of greenhouse gases but of volatile organic compounds and toxic air pollutants.

16. A recent study of the methane emissions from 27 hydraulically fractured wells of companies that voluntarily participated in the study found that two-thirds of the wells—generally, those with the largest potential methane emissions—captured or controlled methane produced during the initial phases of extraction, proba- bly in part because of the new and emerging regulatory require- ments. The remaining one-third released methane into the atmosphere, but those wells had much lower emissions potential, on average. See David T. Allen and others, "Measurements of Methane Emissions at Natural Gas Production Sites in the United States," *Proceedings of the National Academy of Sciences*, vol. 110, no. 44 (October 29, 2013), pp.17768–17773, www.pnas.org/content/early/2013/09/10/1304880110.

17. National Energy Technology Laboratory, *Environmental Impacts of Unconventional Natural Gas Development and Production*, DOE/NETL-2014/1651 (May 2014), pp. 39–56, http://go.usa.gov/vvXh (PDF, 3.1 MB).

18. See Francis O'Sullivan and Sergey Paltsev, "Shale Gas Production: Potential Versus Actual Greenhouse Gas Emissions," *Environmen- tal Research Letters*, vol. 7, no. 4 (November 26, 2012), http://tinyurl.com/l2r8tcn.

19. For more on environmental policy in a federal system of government, see Congressional Budget Office, *Federalism and Environmental Protection: Case Studies for Drinking Water and Ground-Level Ozone* (November 1997), www.cbo.gov/publication/10546.

Standards

There is a stronger rationale for states and localities to set environmental standards for shale development if the costs and benefits of controlling the environmental effects of such development occur solely within their borders. The effects of shale development on the availability of water for other uses may be limited to a local area (which would not necessarily be a single local jurisdiction), or they may extend to a broader region—for instance, by affecting groundwater levels in regional aquifers. Similarly, the effects of shale development on water quality may be confined to a local area or extend beyond state boundaries. Rising or falling greenhouse gas emissions have global effects.

Other considerations include which level of government has the most information about underlying costs and benefits; whether centralizing the process of setting standards would yield savings in administrative costs; and the objectives and capabilities of different levels of government. For example, federal policymakers might choose standards that gave greater weight to environmental costs than state standards would, because states' objectives include competing with each other for industries and jobs.

Methods of Meeting Those Standards

There is a stronger rationale for a state or local role, rather than a federal one, in deciding which methods may be used to meet environmental standards if the opportunities and costs of available methods vary among areas. For example, the cost of addressing water quality concerns associated with hydraulic fracturing can vary by locality, depending in part on whether local geology allows producers to dispose of wastewater in underground disposal wells; a federal decision to require that method of disposal might therefore be overly costly in some areas.

Another consideration is whether a particular method of meeting environmental standards would be more cost-effective if it was put to use on a large scale; if so, the argument for federal regulation is stronger. That argu- ment is also stronger when a method of meeting environ- mental standards would have effects outside the state in which it was used. And constraints on states' willingness and ability to select efficient methods of meeting stan- dards would likewise argue for federal regulation, just as such constraints on local governments would argue for state regulation.

Research

If many states face the same type of environmental problem, a stronger rationale exists for the federal government to determine and fund a research agenda related to that problem. An example is research to determine precisely how much methane is emitted by the development of shale gas, because such research would help inform policies on greenhouse gas emissions in many states and at the federal level. If the endeavor was left to the states, some studies that would be worthwhile to the nation as a whole might not be undertaken, because they would not be justified by the benefits to a single state or even a small group of them. Further, research conducted by one state might be duplicated by another if the states failed to coordinate plans or share findings.

B

The Basis of CBO's Estimates of Longer-Term Effects on Economic Output

The Congressional Budget Office (CBO) estimates that real (inflation-adjusted) gross domestic product (GDP) will be 0.7 percent higher in 2020 and 0.9 percent higher in 2040 than it would have been without the development of shale resources. The analysis underlying those estimates involved two main steps:

- CBO compared a recent energy market projection by the Energy Information Administration (EIA) in which shale resources were available in the United States to an alternative projection by CBO in which those resources were not available. CBO estimated energy prices and quantities for that alternative projection by extrapolating from EIA's estimates of the effects on energy markets of differences in future amounts of shale energy production.
- Using the two sets of projections, CBO estimated the impact that different quantities and prices in energy markets would have on GDP, focusing on increases in the productivity of existing labor and capital and increases in the amount of labor and capital in use.

Oil and Natural Gas Markets With and Without Shale Resources

CBO analyzed the domestic consumption and net exports of oil products (defined here to include fuels derived from petroleum as well as other liquid fuels, such as ethanol, biodiesel, and natural gas plant liquids) and of natural gas in the projections with and without shale resources, as well as the market prices of oil and natural gas in those two projections. The analysis also took account of the profitability of shale development in the projection that included shale resources. In addition, CBO constructed alternative cases to account for uncer- tainty about future production levels, energy prices, and profitability of shale gas production.

Consumption and Net Exports of Oil and Natural Gas With and Without Shale Resources

The absence of shale resources would reduce the overall domestic production of oil and natural gas, as well as the domestic use and net exports of natural gas and oil products. However, the magnitudes of those effects differ: CBO estimates that 60 percent of a reduction in the amount of domestic shale gas produced would be reflected in lower domestic gas consumption, that roughly 5 percent would be met by an increase in the production of natural gas not from shale, and that the remaining 35 percent would be reflected in lower exports or higher imports. In contrast, CBO estimates that only 10 percent of a reduction in the amount of tight oil pro- duced would take the form of lower domestic oil con- sumption, that roughly 20 percent would reflect an increase in the domestic production of crude oil from other sources, and that about 70 percent would be absorbed by greater net imports.[1]

1. In this appendix, references to tight oil include not only crude oil that is extracted from shale by means of hydraulic fracturing but also CBO's estimate of the portion of the production of natural gas plant liquids—forms of natural gas that substitute for certain petroleum products—that is produced by hydraulic fracturing. Increased production of shale gas sometimes causes more natural gas plant liquids to be produced, increasing supplies of liquid fuels.

Those values are averages of the values resulting from EIA's estimates of the sensitivities of future consumption levels to the availability of shale energy production.[2] Dif- ferences in market size explain the different effects. Because overseas transport to and from North America is more costly for natural gas than for crude oil, U.S. production of shale gas has a comparatively large effect on North American gas prices and thus a comparatively large effect on U.S. gas consumption. In contrast, U.S. production of tight oil has a comparatively small effect on world oil prices, so changes in that production have a relatively small effect on domestic oil consumption and are primarily reflected in changes in net exports.[3]

Thus, given EIA's baseline projection that shale gas production will be about 9.5 trillion cubic feet (Tcf) in 2014, CBO projects that in the absence of that produc- tion, total domestic gas production would be about 9.0 Tcf lower (because conventional production would increase by about 0.5 Tcf), domestic consumption would be about 5.5 Tcf lower (roughly 60 percent of 9.5 Tcf), and net exports would be about 3.5 Tcf lower (through lower exports or higher imports). CBO similarly estimates that the domestic production, consumption, and net exports of oil products would all be lower in 2014— by 3.9 million, 0.5 million, and 3.4 million barrels per day, respectively—in the absence of the estimated 4.8 million barrels per day of liquid fuels attributable to shale development.[4] CBO's projections of the production and consumption of oil and natural gas with and without shale resources are shown in Figure B-1.

Market Prices of Oil and Natural Gas With and Without Shale Resources

Given the estimated differences in the domestic consumption of oil products and natural gas with and without shale resources, the differences in market prices supporting those consumption levels can be calculated by using the elasticity of demand for those fuels. Elasticities measure the percentage change in the production or the consumption of a good for each 1 percent change in the price. Given the estimated reduction in consumption when shale resources are not available (measured relative to the baseline projection, in which they are available), the percentage difference in market prices ($\%\otimes P$) is given by the following equation:

$$\%\otimes P = \frac{\%\otimes D}{\varepsilon_d}$$

In that equation, $\%\otimes D$ refers to the percentage differ- ence in the consumption of oil products or natural gas, and ε_d is the elasticity of demand with respect to differences in the market price of oil or gas.

On the basis of EIA's most recent long-term outlook, CBO estimates the long-term elasticities of demand for oil products and for natural gas to be about -0.5 each, so that a 20 percent increase in the price of oil products or natural gas would reduce the amount of oil and gas con- sumed by 0.5 times as much, or 10 percent. For instance, domestic gas consumption in 2040 would be about 11.5 Tcf lower in the absence of shale supplies, CBO estimates; that 11.5 Tcf is about 35 percent of 2040 domes- tic consumption in the baseline projection, implying that gas prices (given the elasticity of demand) would be about 70 percent higher without shale supplies, as Figure B-2 shows. Again, U.S. production of tight oil will have a smaller effect on world prices, which would be about 5 percent higher otherwise, because U.S. tight oil as a share of world liquid fuel supplies is much smaller than U.S. shale gas as a share of North American gas supplies.

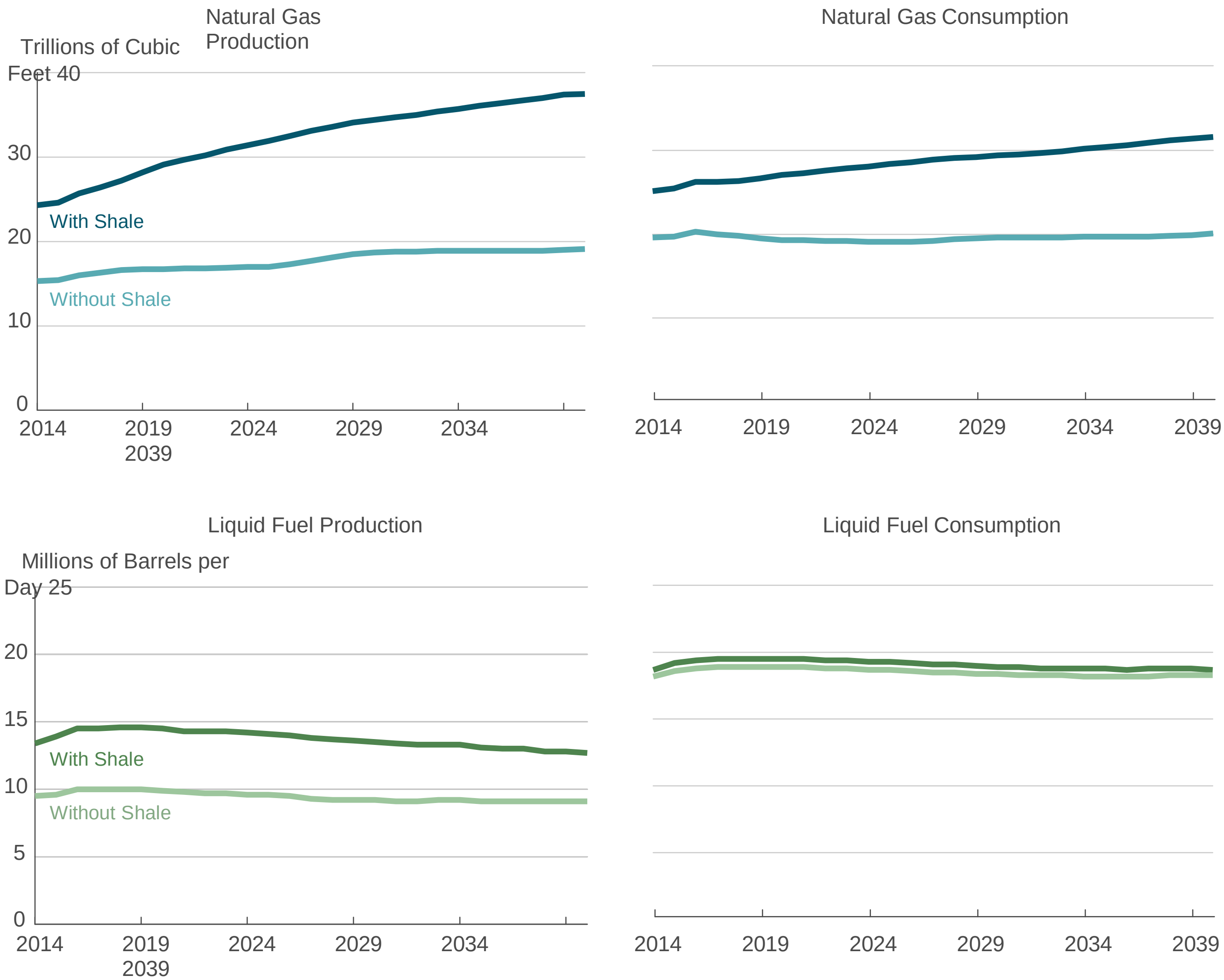
2. Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB). The estimates are based on changes in the consumption of gas or of total liquid fuels rela- tive to changes in the production of shale gas or tight oil between EIA's "low-resource scenario" and its baseline case. CBO's estimate reflects the five-year average of those ratios from 2036 to 2040 to control for any year-to-year variability and to reflect longer-term conditions stemming from the historical absence of shale resources (rather than the near-term effects that would result from a sudden increase or decrease in the availability of shale resources).

3. Although sensitivities at a moment in time are not directly comparable with changes that occur over time, CBO's estimated effects are qualitatively consistent with the fact that observed consump- tion levels have not grown as fast as shale energy production, in part because of decreases in conventional production. For instance, from 2001 to 2013, U.S. shale gas production increased by 9 trillion cubic feet (Tcf) per year, conventional gas production fell by 4.5 Tcf, and gas consumption increased by 3.5 Tcf. See Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

4. The estimate of 4.8 million barrels per day in 2014 consists of EIA's projected tight oil production—about 4.1 million barrels per day—and 0.7 million of the 2.5 million barrels per day that EIA projects for natural gas plant liquids. The remaining 1.8 mil- lion barrels per day of natural gas plant liquids correspond to the average production of those liquids from 2006 to 2009, just before the boom in shale gas and tight oil production. See EIA's *Annual Energy Outlook* for 2014 and for 2006 through 2009.

Figure B-1.

Effects of Shale Resources on the Domestic Production and Consumption of Natural Gas and Liquid Fuels



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

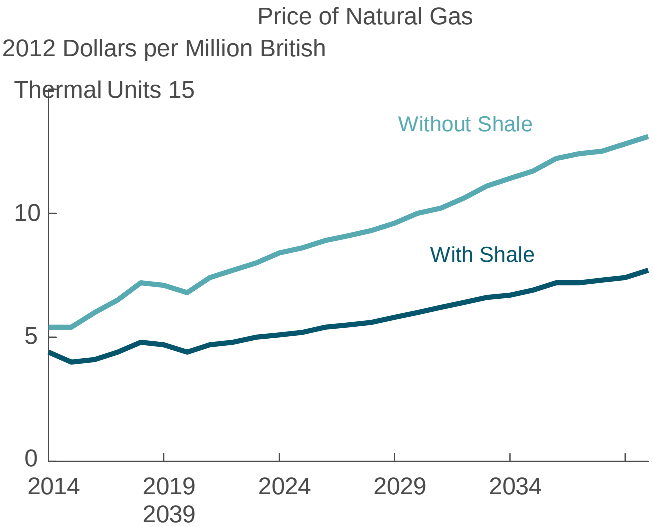
Notes: Production and consumption amounts for natural gas and liquid fuels when shale resources are present (labeled "With Shale Resources") are the Energy Information Administration's most recent long-term projections. Projections when shale resources are not present (labeled "Without Shale Resources") are CBO's estimates.

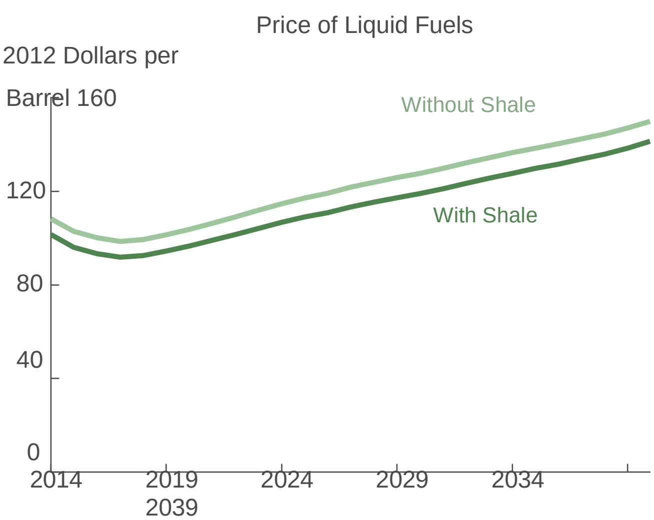
The category "Liquid Fuel" includes crude oil, biofuels, natural gas plant liquids, and other liquid fuels.

The projections for all years are based on the assumptions that the economy is producing close to its maximum sustainable level of output and that energy markets are stable. As the text explains, CBO expects that the actual effects would be somewhat different in the short term.

Figure B-2.

Effects of Shale Resources on the Price of Natural Gas and Liquid Fuels





Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

Notes: Market prices for natural gas and liquid fuels when shale resources are present (labeled "With Shale Resources") are the Energy Information Administration's (EIA's) most recent long-term projections. Projections when shale resources are not present (labeled "Without Shale Resources") are CBO's estimates. CBO reports prices in 2012 dollars because that was the basis that EIA used when modeling its projections in real (inflation-adjusted) terms.

The category "Liquid Fuels" includes crude oil, biofuels, natural gas plant liquids, and other liquid fuels.

The projections for all years are based on the assumptions that the economy is producing close to its maximum sus- tainable level of output and that energy markets are stable. As the text explains, CBO expects that the actual effects would be somewhat different in the short term.

Combining those estimated price effects with estimates of production volumes, CBO calculates that the value of U.S. oil and gas production in 2020 in the absence of shale development would be about $495 billion (mea- sured in 2012 dollars), as opposed to $645 billion with shale development.[5] In 2040, the value of U.S. oil and gas production would be roughly $760 billion without shale development, as opposed to $950 billion with it.

Profitability of Shale Development

Excess returns from producing shale resources—that is, revenues less production costs—contribute to GDP. They represent the difference between the output of labor and capital when used to produce shale resources and the out- put of that labor and capital when used elsewhere in the economy.[6] Those excess returns are determined by the volume of tight oil and shale gas expected to be produced in future years and the difference between the market prices of oil and natural gas and the average break-even cost of producing shale resources—that is, the lowest average price necessary for developers of shale resources to cover their costs of labor and capital.

CBO's estimates of the current and future break-even costs of tight oil and shale gas production are based on recent estimates from the International Energy Agency (IEA).[7] IEA estimates that current production costs of tight oil worldwide range from $60 to $100 per barrel

5. In CBO's baseline projection, in which shale resources are assumed to be available, 29.1 Tcf of gas are expected to be pro- duced in the United States during 2020 at a price of $4.40 per million British thermal units (mmBtu). Because there are roughly
1.03 mmBtu in each thousand cubic feet (mcf) of gas and 1 Tcf equals 1 billion mcf, sales of natural gas will total about $130 bil- lion (29.1 multiplied by 1.03 multiplied by $4.40 multiplied by 1 billion). With total liquid fuel production expected to be
14.5 million barrels per day and an oil price of $97 per barrel (assumed to be the same for nonpetroleum fuels), sales of liquid fuels are expected to total about $1.4 billion per day (14.5 million multiplied by $97), or $515 billion per year. In the absence of shale resources, CBO projects, 2020 gas and oil prices would be
$6.90 per mmBtu and $103 per barrel; U.S. gas and oil produc- tion would be 16.7 Tcf and 9.9 million barrels per day; and total spending on natural gas and liquid fuels would be about
$495 billion.

6. The labor and capital used to produce shale energy include what is used to produce goods and services subsequently employed in shale development—for example, the labor and capital used to produce the concrete that, in turn, provides the casing of a new well.

7. International Energy Agency, *Resources to Reserves 2013: Oil, Gas and Coal Technologies for the Energy Markets of the Future* (IEA, 2013), www.iea.org/w/bookshop/add.aspx?id=447.

(in 2013 dollars). CBO estimates that the average break-even cost of U.S. tight oil is the midpoint of IEA's range of world costs—that is, $80 per barrel. That figure is consistent with the fact that the production of U.S. tight oil became significant in the last few years, as world oil prices climbed past $100 per barrel. For shale gas, CBO estimates that the current break-even production cost in the United States is $3 per million British thermal units (mmBtu), at the low end of IEA's worldwide range of $3 to $10 per mmBtu (in 2013 dollars). One reason for that estimate is that investment in shale gas in the United States has remained robust even as gas prices have fallen below $4 per mmBtu. Another reason is that world pro- duction of shale gas has been concentrated in the United States; domestic production costs are probably lower than in countries where development is proceeding more slowly.

CBO expects that break-even costs will grow in real terms as real prices for oil and gas grow. As market prices rise, companies will develop shale gas and tight oil that are more costly to produce, thereby raising the average cost of production. Specifically, CBO models the average break-even cost for tight oil as growing at the same rate at which real prices for crude oil do, so that the inflation- adjusted break-even cost grows from $80 per barrel in 2014 to about $110 per barrel by 2040. For shale gas, however, CBO models the inflation-adjusted break-even cost as growing at half the rate expected for the real price of natural gas, so that the real break-even cost grows from $3 per mmBtu in 2014 to about $4 per mmBtu by 2040. CBO's different expectations for shale gas and tight oil are broadly consistent with EIA projections that shale gas production will grow as a share of total U.S. gas production in coming decades because it will become relatively cheaper, while tight oil's share of total U.S. production of liquid fuels will not change significantly.

CBO estimates that inflation-adjusted excess returns in 2020 will total roughly $20 billion for shale gas, an estimate based on about 13 Tcf of production, a price of $4.40 per mmBtu, and a break-even cost of $2.90 per mmBtu. CBO also estimates—on the basis of about 5.6 million barrels per day of expected production, a price of $97 per barrel, and a break-even cost of $75 per barrel—that inflation-adjusted excess returns in 2020 will total $45 billion for tight oil. In 2040, CBO expects inflation-adjusted excess returns to total about $75 billion for shale gas and $50 billion for tight oil.

Uncertainty About Projections

Shale energy production, market prices of gas and oil, and the profitability of shale gas production may be significantly higher or lower than CBO projects in its baseline. All things being equal, higher production, market prices, and profitability would mean larger effects on GDP. To illustrate the uncertainty accompanying its base- line estimates, CBO generated alternative projections of those three factors.

CBO constructed a range of shale production quantities on the basis of a recent EIA "low-resource" projection in which the total amount of gas and oil recoverable from each shale gas and tight oil well was 50 percent lower than in EIA's baseline projection.[8] Comparing the two projections, CBO calculated the percentage difference in the number of Btus of shale gas and tight oil produced each year. CBO then obtained its range of shale production quantities by increasing or decreasing its baseline projections for shale gas and tight oil production by those year-by-year percentages.[9] The resulting percentage deviations from baseline production levels are shown in Figure B-3.

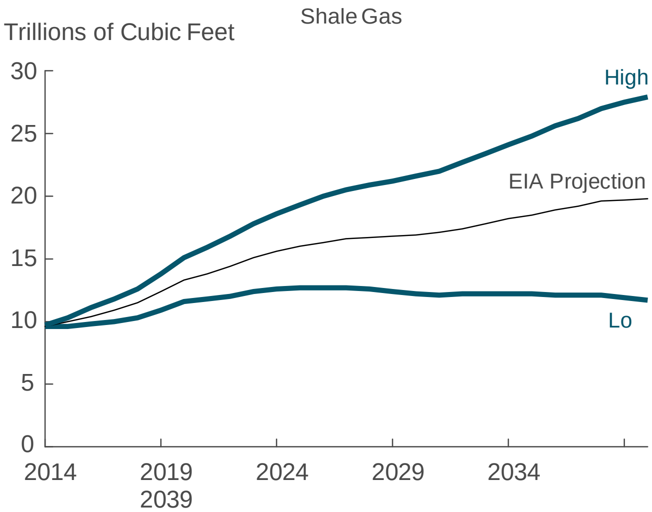
To generate alternative projections of market prices, CBO relied on EIA's most recent long-term outlook, which includes projections for higher and lower oil prices. (CBO used the market price of crude oil to approximate the price of liquid fuels, which include crude oil, the petroleum products produced from it, and other liquids, such as biofuels and natural gas plant liquids.) In the absence of analogous EIA projections for natural gas prices, CBO used the same percentage increase and decrease (relative to the baseline projections) that it did for the price of oil. The high and low prices that CBO obtained for natural gas and oil are shown in Figure B-4.

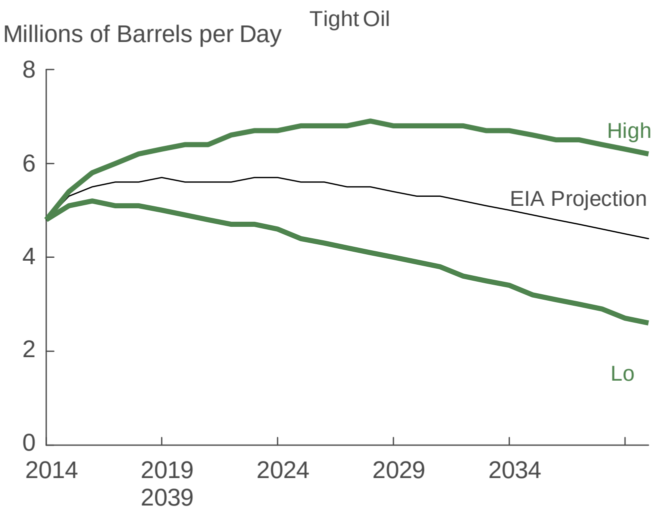
8. See the low-resource scenario in Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB). The actual production of shale gas and tight oil in that scenario falls by less than 50 percent because the effects of the decline take some time to materialize and because higher market prices promote the development of additional wells.

9. EIA also analyzed a high-resource scenario in which shale gas and tight oil wells were more productive than they were in the agency's baseline projection. CBO did not use that scenario to calculate any of its range of shale production quantities because the scenario included changes to *conventional* oil and gas supplies that were not included in EIA's low-resource scenario.

Figure B-3.

Projected High and Low Production of Shale Gas and Tight Oil





Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

Notes: Here, the production of tight oil includes not only crude oil that is extracted from shale by means of hydraulic fracturing but also CBO's estimate of the portion of the production of natural gas plant liquids—forms of natural gas that substi- tute for certain petroleum products—that is produced by hydraulic fracturing.

EIA = Energy Information Administration.

To measure the sensitivity of CBO's findings to the prof- itability of producing shale gas, CBO considered cases in which break-even costs for shale gas grew at 25 percent and 75 percent of the yearly change in gas prices, rather than the 50 percent assumed in the baseline projection.

In dollar terms, excess returns from shale gas production are greatest if the market price of gas is high and the break-even cost of production is low; conversely, excess returns are smallest if the market price of gas is low and the break-even cost is high.

When evaluating the effects of greater or lesser availability of shale energy supplies, CBO included price effects resulting from those differences in supplies. For any given assumption about other factors affecting prices—whether those factors lead to high prices, baseline prices, or low prices—more abundant shale energy supplies will, all else being equal, reduce those prices. Similarly, those prices will be higher if supplies are less abundant. CBO used the same approach that was outlined above to calculate the effect of more or less shale production on those price sce- narios: More (or less) abundant shale gas or tight oil boosts (or lowers) consumption levels, leading to a per- centage change in market prices that is calculated by means of the elasticity of demand.

Effects of Shale Development on Economic Output in the Longer Term

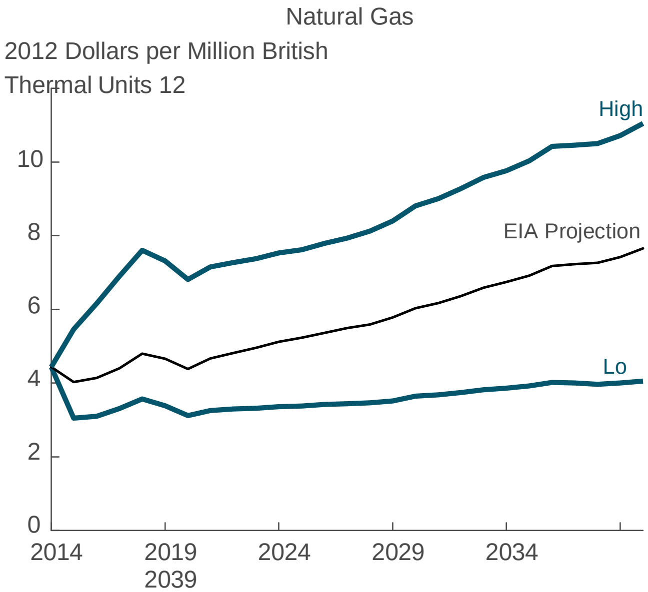
Real GDP will be higher in the longer term than it would have been without the development of shale resources. CBO estimates that, by increasing the productivity of labor and capital, the production and use of shale gas will make GDP about 0.2 percent higher in 2020 and about 0.4 percent higher in 2040 than it would have been otherwise, and the production and use of tight oil will make GDP about 0.2 percent higher in both of those years (see Table B-1). Moreover, because that higher pro- ductivity of labor and capital will induce a greater supply of labor and capital in the economy, shale development will further increase GDP by roughly 0.3 percent and 0.4 percent in 2020 and 2040, respectively. All told, CBO's baseline long- term projection for real GDP is 0.7 percent higher in 2020 and 0.9 percent higher in 2040 than it would have been without the development of shale resources.[10]

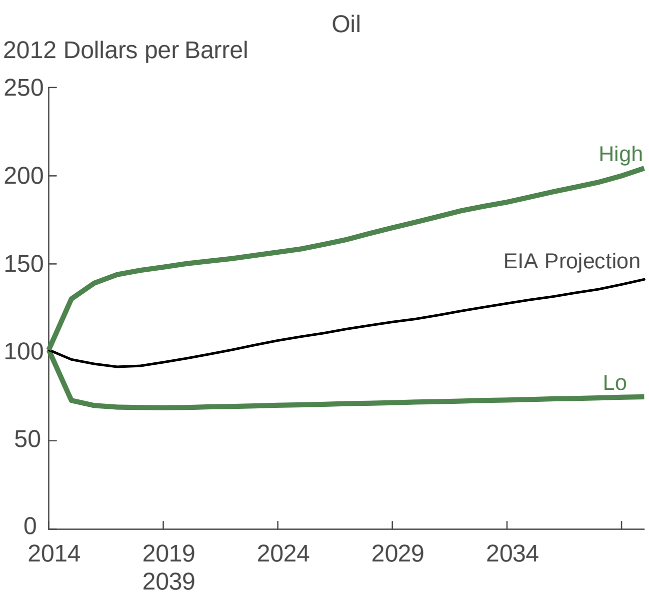
CBO's analysis focused on the effects on GDP in the lon- ger term—that is, after the economy moves back toward producing its maximum sustainable level of output. In the near term, the increase in GDP associated with

10. Because of rounding, the total change in real GDP is slightly less than the sum of the component changes.

Figure B-4.

Projected High and Low Market Prices of Natural Gas and Oil





Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2014 With Projections to 2040*, DOE/EIA-0383(2014) (April 2014), http://go.usa.gov/8KyF (PDF, 12 MB).

Notes: CBO reports prices in 2012 dollars because that was the basis that EIA used when modeling its projections in real (inflation-adjusted) terms.

EIA = Energy Information Administration.

increased production and use of shale resources is greater because the firms producing and using more shale resources use some labor and capital that would otherwise have been underused. For example, in the current economic environment, some of the workers employed by businesses engaged in hydraulic fracturing would otherwise have been unemployed. In the economic environment that CBO expects in the long run, however, such workers would otherwise have been employed in other jobs.

Effects of Shale Gas on the Productivity of Labor and Capital

To think about the long-term effects of shale gas on productivity and hence on GDP, consider Figure B-5 on page 39, which shows two hypothetical supply curves for natural gas: one that does not include shale gas and one that does. The supply curve without shale gas is line S1, and it intersects the demand curve for natural gas—line D—at point A, showing that without shale gas, the market for natural gas would clear (that is, demand would equal supply) at a price of $4 per thousand cubic feet (mcf).[11] Once shale gas becomes available, the total supply of natural gas shifts to S2, meaning that more gas is available at a lower price. The horizontal difference between S1 and S2 is the amount of shale gas supplied at a given price. For example, at a price of $3 per mcf, the supply of shale gas is the horizontal difference between the quantities represented by points E and B. The market now clears at point B, at a price of $3.

The gain in GDP in the long run from that outward shift of the supply curve closely corresponds to the area enclosed by points A, B, and C. The gain is composed of three parts:

- The gain from the increased productivity of labor and capital used to produce shale gas, which corresponds to the area enclosed by points B, C, and E;

11. The market that determines the domestic price of natural gas includes supply and demand in Canada and Mexico. To focus on the effects on GDP in the United States, the reader should inter- pret the supply curves, S1 and S2, as representing domestic sup- ply, and the demand curve, D, as representing demand net of supplies from Canada and Mexico.

Table B-1.

Effects of U.S. Shale Development on GDP

Percent	Effect on GDP 2020	Effect on GDP 2040
Increased Productivity of Labor and Capital Shale gas		
Gain in productivity of labor and capital producing shale gas	0.1	0.3
Gain in productivity from producing shale gas instead of conventional gas	*	*
Gain in productivity from increased consumption of gas	0.1	0.1
Subtotal	0.2	0.4
Tight oil		
Gain in productivity of labor and capital producing tight oil	0.2	0.2
Gain in productivity from producing tight oil instead of conventional oil	*	*
Gain in productivity from increased consumption of oil	*	*
Subtotal	0.2	0.2
Total	0.4	0.5
Additional Supply of Labor and Capital	0.3	0.4
Total Effect of U.S. Shale Development on GDP	0.7	0.9
Memorandum:[a]		
Gains in Productivity of Labor and Capital Producing Shale Resources	0.3	0.4
Gains in Productivity From Producing Shale Resources Instead of Conventional Resources	*	*
Gains in Productivity From Increased [illegible]	0.	0.

Source: Congressional Budget Office.

Notes: Totals may not match because of rounding.

Tight oil is crude oil extracted from shale and certain other dense rock formations by means of hydraulic fracturing. GDP = gross domestic product; * = between zero and 0.05 percent.

a. These lines add shale gas's effects on GDP (shown above in the table) to tight oil's effects on GDP (also shown above in the table).

- The gain in productivity from producing shale gas instead of more expensive conventional gas, which corresponds to the triangle with corners at points A, E, and F; and

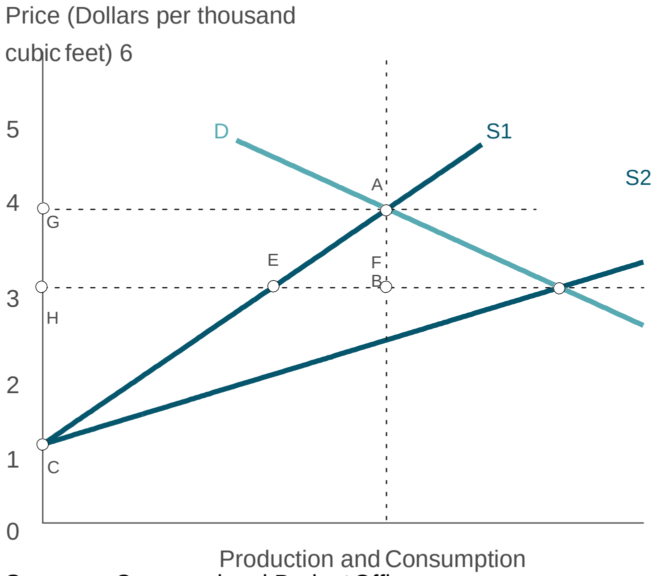
- The gain in productivity from the increased consumption of gas by domestic businesses and households, which is included in the area enclosed by points A, B, and F.[12]

Gains From the Increased Productivity of Labor and Capital Producing Shale Gas. In the longer run, the development of shale gas leads to higher GDP in part because labor and capital can be used more productively to produce shale gas than to produce other output. In Figure B-5, that gain is shown by the area between the two supply curves and below $3 per mcf—the triangle bounded by points B, C, and E. In Figure B-6, the same gain is shown by the area above the supply curve S3— which is a supply curve for shale gas alone—and below $3; it is also a triangle bounded by points B, C, and E. (The distance from B to E in Figure B-5 represents the quantity of shale gas produced at the new equilibrium price—the same quantity represented by the distance from B to E in Figure B-6. The areas of the two triangles bounded by points B, C, and E in the two figures are the same because their bases and heights are the same.)

12. The area enclosed by points A, B, and F also includes the gain to foreign users that are able to consume more natural gas. In calculating the gains to U.S. GDP, CBO considered only the changes in domestic consumption.

Figure B-5.

Hypothetical Long-Run Market for Natural Gas



Source: Congressional Budget Office.

Note: Line D is the hypothetical demand curve for natural gas pro- duced in the United States. Lines S1 and S2 are the supply curves for natural gas without and with shale resources.
Points A and B denote the price and quantity of natural gas produced in the United States in those two cases.

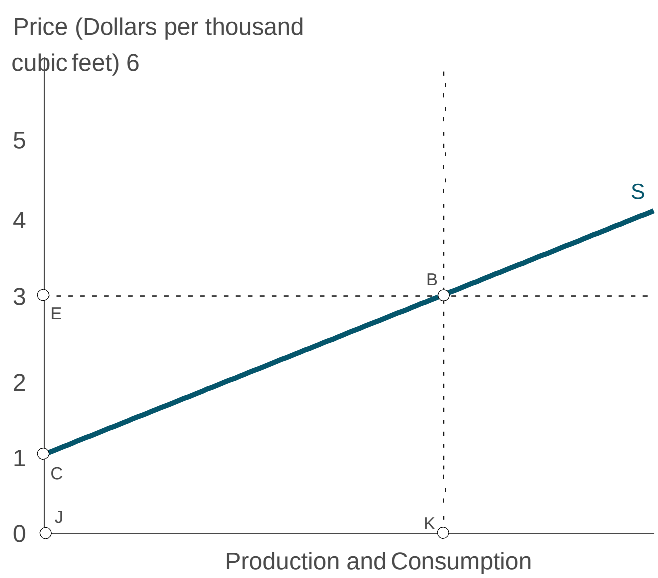
At any point along S3 in Figure B-6, the addition to GDP from the production of shale gas is the vertical dis- tance between the supply curve and the price of gas. For example, at point C, a firm is willing to supply shale gas at a long-run price of $1 per mcf or more because the cost of labor and capital used by that firm to produce 1 mcf of gas is $1. That $1 of labor and capital would be produc- ing $1 of GDP if employed in other industries. At a price of $3, the shift of labor and capital from other industries generates an extra $2 of GDP, the vertical difference between points C and E. To take another example: At point B of Figure B-6, the production of an additional 1 mcf of shale gas is profitable only if the long-run price is $3 or more. Because the labor and capital used to pro- duce that gas could produce $3 of GDP elsewhere, there is no net gain in GDP from the production of shale gas that is also valued at $3.

Another way to think about the gain in GDP from the production of shale gas is to subtract the total cost of producing shale gas from the total value of that gas. The cost is the quantity of gas produced multiplied by the break-even cost, and it is shown by the area enclosed by points B, C, J, and K in Figure B-6. The value of the gas produced is its price multiplied by the quantity pro- duced, which is shown by the rectangle whose corners are points B, E, J, and K. The difference is represented by the triangle enclosed by points B, C, and E.

CBO estimated the long-term gain in GDP from the pro- duction of shale gas by multiplying its estimate of the amount of shale gas produced (which would correspond to the distance between points B and E in Figure B-6, though that figure, again, is hypothetical) by the differ- ence between the price of that gas and CBO's estimate of the average break-even cost of that production (which would be equivalent to the vertical midpoint of the sup- ply curve between points B and C). CBO estimates the GDP gain from the production of shale gas to be 0.1 per- cent of GDP in 2020 and 0.3 percent in 2040. In 2012 dollars, the 2040 estimate is about $75 billion, which is based on projections that shale gas production in 2040 will total about 20 billion mcf; that the market price of gas will be about $8 per mcf; and that the average break- even cost of shale gas will be about $4 per mcf.

Figure B-6.

Hypothetical Long-Run Supply Curve for Shale Gas



Source: Congressional Budget Office.

Note: Line S3 is the supply curve for shale gas. Point B denotes the quantity of shale gas produced in the United States at a price of $3 per thousand cubic feet.

The gains in GDP from producing shale gas are greater in the near term than in the long term. When labor and capital are underused, some of the resources used to produce shale gas would not otherwise be producing GDP. In that case, the gain to GDP from producing shale gas is represented not only by the triangle enclosed by points B, C, and E in Figure B-6 but also by part of the area enclosed by points B, C, J, and K.

Gains in Productivity From Producing Shale Gas Instead of Conventional Gas. The gain in GDP from sub- stituting shale gas for conventional gas that is no longer economical to produce because of the lower price of gas corresponds to the triangle enclosed by points A, E, and F in Figure B-5. A firm willing to supply additional conventional gas at point A requires a price of $4 per mcf because it uses $4 of labor and capital. Displacing that conventional gas with shale gas produced at a cost of $3 thus frees up $1 of labor and capital for other uses, increasing GDP by $1. A firm willing to supply addi- tional conventional gas at point E uses $3 of labor and capital to produce that gas, so replacing it with shale gas at $3 per mcf does not add to GDP.

The savings that consumers of natural gas realize because of the fall in price from $4 to $3 is represented by the rectangle enclosed by points A, F, H, and G in Figure B-5. Most of those savings do not add to GDP but instead represent a transfer from producers to consumers of natural gas. Within that rectangle, only the savings in production costs, which are represented by the triangle outlined by points A, E, and F, add to GDP.

CBO estimated the gain in GDP from substituting shale gas for conventional gas by multiplying the estimated difference in U.S. production of conventional gas by one- half the difference between the projected price of gas and the estimated price that would prevail in the absence of shale resources. The gain in GDP is projected to be very small in both 2020 and 2040—less than 0.05 percent of GDP—because the production of conventional gas is expected to be only about 5 percent lower than it would have been without shale resources.

Gains in Productivity From Increased Consumption of Gas. The development of shale resources also raises GDP as consumption of cheaper gas frees up labor and capital for other uses, allowing the economy to produce a greater value of goods and services with the same total amount of labor and capital. In Figure B-5, those gains are included in the triangle enclosed by points A, B, and F. (That triangle also includes gains to foreign firms that use more natural gas. Those gains do not contribute to U.S. GDP, and CBO excluded them from its calculations.)

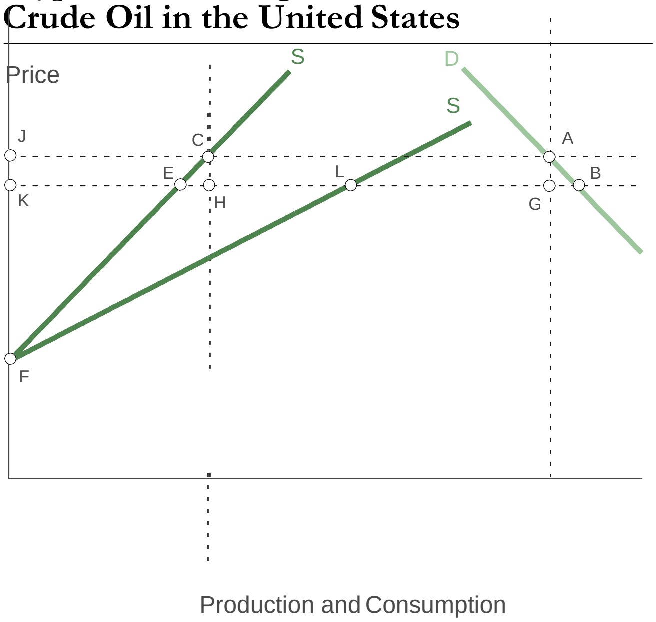
As the price of natural gas falls, productivity increases for two reasons. First, some firms are able to reduce their cost of producing goods and services by substituting cheaper gas for labor, capital, or other inputs. For example, an electric utility might generate more electricity from gas and less from coal. Second, the composition of output produced in the economy changes as households and firms shift toward goods and services that are gas- intensive and thus become relatively less costly to produce. For example, households might buy more tires, fertilizer, and plastic containers, and spend less on clothes.

In both cases, the benefit to the economy of each additional thousand cubic feet of natural gas used is the difference between the highest price at which that gas would be purchased, represented by the heights of the points along demand curve D in Figure B-5, and its actual selling price. Consider, for example, an electric utility willing to buy an additional 1 mcf of natural gas at a price up to $4—the level of demand represented by point A in the figure. That willingness to spend up to $4 reflects the utility's ability to substitute the gas—as well as the costs of using it—for other resources that together cost the same amount. For instance, the utility might buy 1 mcf of gas costing $4, plus $5 of other necessary goods and services, to generate electricity that was previously gener- ated from coal at the same total cost of $9. If, instead, the gas costs $3, producing electricity with gas instead of coal reduces the utility's costs by $1 (the distance between points A and F), and the $1 of labor and capital that is no longer needed to generate electricity can produce an addi- tional $1 of output elsewhere in the economy.[13] Addi- tional consumption of natural gas by firms whose demand is represented by points between A and B on the demand curve would free up smaller amounts of labor and capital, and GDP would increase by amounts

13. The utility itself might not reduce its use of labor and capital, but those resources would be freed up elsewhere in the economy—particularly in coal production and related activities. Note that the effect on the *composition* of GDP exceeds the effect on its size: In this hypothetical situation, the output of the natural gas industry increases by $3 and GDP increases by $1.

Figure B-7.

Hypothetical Long-Run Market for Crude Oil in the United States



Source: Congressional Budget Office.

Note: Line D is the hypothetical demand curve for crude oil consumed in the United States. Lines S1 and S2 are the domestic supply curves for crude oil without and with shale resources. Points A and B denote the price and quantity of crude oil consumed in the United States in those two cases. Points C and L denote the price and quantity of crude oil supplied by U.S. producers in those two cases.

between $1 and zero for each additional 1 mcf of gas used.

Similar logic applies in the case of shifts in demand toward goods and services that are more gas-intensive. For an additional unit of a gas-intensive product, a house- hold or firm at point A is willing to pay $4 per mcf for the natural gas that went into making the product, plus the other costs of the product, instead of spending the same total amount on other goods or services. If natural gas costs $4 per mcf, then such a shift does not increase GDP, though it does change GDP's composition: The same total quantity of resources not used to produce the goods or services forgone is used to produce the addi- tional unit of the gas-intensive product. If natural gas instead costs $3 per mcf to produce, the buyer's shift to the gas-intensive product reduces the total production costs of the goods purchased, and each additional 1 mcf used frees up $1 of resources that can produce additional GDP.

CBO estimated the gain in GDP by multiplying the esti- mated change in U.S. consumption of gas by one-half the difference between the projected price of gas and the esti- mated price that would prevail in the absence of shale resources. The gain in GDP is projected to be 0.1 percent in 2020 and also in 2040.

Effects of Tight Oil on the Productivity of Labor and Capital

The effects on GDP of the domestic production of tight oil differ from those of the domestic production of shale gas because oil is traded in a global market. Thus, most of the gains from greater consumption of tight oil will occur outside the United States. However, all of the gains from using labor and capital more productively to produce tight oil than they could be used for other purposes will add to U.S. GDP—by 0.2 percent of GDP in 2020 and 2040, CBO estimates.

Gains From the Increased Productivity of Labor and Capital Producing Tight Oil. The gains in GDP associated with using labor and capital to produce tight oil instead of other goods and services are illustrated in Figure B-7. The availability of tight oil shifts the supply curve of all

U.S. crude oil from S1 to S2. The price of oil, established in the world oil market (which is not shown), falls from point J to point K. As a result, U.S. consumption of crude oil increases along the demand curve from A to B. The supply of conventional crude oil produced domesti- cally falls from H to E, but the total domestic production of crude oil increases from H to L. Imports of crude oil fall, as the difference between the domestic demand for crude oil and the domestic supply narrows from the dis- tance between A and C to the distance between B and L.

Most of the increase in GDP comes from the fact that labor and capital can be used more productively to pro- duce tight oil than to produce other output. Using the same approach that it used when analyzing shale gas pro- duction, CBO estimated the long-term gains in GDP from the production of tight oil by multiplying its esti- mate of the amount of tight oil produced (which would correspond to the distance between points L and E in Figure B-7) by the difference between the price of that oil (point K) and CBO's estimate of the average break-even cost of that production (which would be equivalent to the midpoint of the supply curve between points F and L). CBO estimates that the production of tight oil will increase GDP by 0.2 percent in 2020 and 2040. In 2012 dollars, the 2040 figure is about $50 billion, which is based on projections of 4.4 million barrels per day (or about 1.6 billion barrels per year) of tight oil production in 2040; a price of roughly $140 per barrel; and an average break-even cost of about $110.

Gains in Productivity From Producing Tight Oil Instead of Conventional Oil. The gain in GDP from sub- stituting tight oil for conventional oil that is no longer economical to produce because of the lower price of oil corresponds to the triangle bounded by points C, E, and H in Figure B-7. CBO estimated that gain in GDP by multiplying its estimate of the change in U.S. production of conventional oil by one-half the difference between the projected price of oil and the hypothetical price in the absence of shale resources. The gain is proportionally much smaller than the analogous gain for shale gas because oil is traded in a global market, which implies that the percentage impact of shale development on world oil prices is much smaller than the percentage impact on U.S. gas prices and thus that the effect on U.S. production of conventional oil is also much smaller. As a result, the effect on GDP will be very small in both 2020 and 2040, CBO projects.

Gains in Productivity From Increased Consumption of Oil. To a small degree, GDP rises as firms substitute cheaper oil for labor and capital and as goods and services produced using oil become cheaper to produce than other goods and services. The gain to GDP is reflected in the triangle bounded by points A, B, and G. Because the production of tight oil will have relatively little impact on the price of crude oil, CBO estimates that U.S. consumption of crude oil will be essentially unchanged and that the effect on GDP will be very small in both 2020 and 2040. (The majority of the gains from using more crude oil will accrue outside the United States.)

Effects of Shale Gas and Tight Oil on the Supplies of Labor and Capital

The increases in GDP associated with increased productivity would spur further increases in GDP by increasing the supplies of labor and capital. As GDP rises, households have more income to save and invest; most of the additional savings are invested domestically. That investment increases the capital stock, thus increasing the economy's productive capacity and raising GDP. In addition, higher labor productivity is reflected in higher wages, which encourage people to work and lead to an increase in the number of hours worked, likewise raising GDP. The two effects reinforce each other: A larger capital stock boosts labor productivity and wages, and an increase in the number of hours worked increases saving and investment.

CBO estimates that those indirect effects of shale development will raise GDP by 0.3 percent in 2020 and by 0.4 percent in 2040. Those estimates are based on projections of an increase of 0.1 percent in the number of hours worked in both years and of increases in the capital stock of 0.7 percent in 2020 and 0.9 percent in 2040. The projected changes in hours worked are derived from CBO's estimate that the elasticity of labor supply is 0.19 (so that a 1 percent increase in GDP per hour worked boosts the labor supply by 0.19 percent).[14] The changes in the capi- tal stock are based on the expectation that saving and investment rise proportionally with output, so that in the long run, the percentage increase in the capital stock is equal to the percentage increase in output. CBO converted the changes in hours worked and capital stock into a change in GDP on the basis of a coefficient for labor in the production function of 0.7 and a coefficient for capital of 0.3.

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14. Congressional Budget Office, *How the Supply of Labor Responds to Changes in Fiscal Policy* (October 2012), www.cbo.gov/publication/43674. CBO's labor supply elasticity is the sum of its estimates of the substitution elasticity (how much an increase in wages increases the amount of labor supplied because working becomes more valuable relative to other uses of people's time) and of the income elasticity (how much an increase in wages allows people to work fewer hours while maintaining their standard of living).

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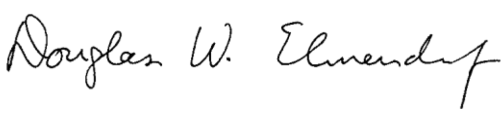
About This Document

This Congressional Budget Office (CBO) report reflects research undertaken in support of the agency's baseline economic projections, which serve as the basis for its budget projections. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Ron Gecan and Natalie Tawil of CBO's Microeconomic Studies Division and Mark Lasky of the Macroeconomic Analysis Division wrote the report, with contributions from Mark Booth of the Tax Analysis Division, Kathleen Gramp and Jeff LaFave of the Budget Analysis Division, and Charles Pineles-Mark of the Health, Retirement, and Long-Term Analysis Division, and with guidance from Perry Beider, Wendy Edelberg, and Joseph Kile. Terry Dinan, Peter Fontaine, Pamela Greene, Teresa Gullo, and Andrew Stocking provided comments.

Philip Budzik of the Energy Information Administration, Ian Duncan of the University of Texas, Jan Hatzius of Goldman Sachs, Robert Howarth of Cornell University, Robert Jackson of Stanford University, Shashank Mohan of Rhodium Group, W. David Montgomery of NERA Economic Consulting, Sreenivas Ramaswamy of McKinsey & Company, and Duane Zavadil of Bill Barrett Corporation also commented. The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.

Jeffrey Kling reviewed the report, Benjamin Plotinsky edited it, and Maureen Costantino prepared it for publication. An electronic version is available on CBO's website (www.cbo.gov/publication/ 49815).



Douglas W. Elmendorf Director

December 2014

Independent Statistics & Analysis
U.S. Energy Information Administration

What Drives U.S. Gasoline Prices?

October 2014

Independent Statistics & Analysis
www.eia.gov

U.S. Department of Energy
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Preface

U.S. oil production has grown rapidly in recent years. U.S. Energy Information Administration (EIA) data, which reflect combined production of crude oil and lease condensate, show a rise from 5.6 million barrels per day (bbl/d) in 2011 to 7.4 million bbl/d in 2013. EIA's *Short-Term Energy Outlook* (STEO) projects continuing rapid production growth in 2014 and 2015, with forecast production in 2015 averaging 9.5 million bbl/d. While EIA's *Annual Energy Outlook* (AEO) projects further production growth, its pace and duration remain uncertain, as shown by the significant differences between Reference case and High Oil and Gas Resource case projections, which differ in both the timing and level of the highest volume of U.S. crude oil production. EIA's next update to the AEO will raise projected production significantly in the Reference case.

Recent and forecast increases in domestic crude production have sparked discussion on the topic of how rising crude oil volumes will be absorbed. Given the likelihood of continued growth in domestic crude production, and the recognition that some absorption options, such as like-for-like replacement of import streams, are inherently limited, the question of how a relaxation in current limitations on crude exports might affect domestic and international markets for both crude and products continues to hold great interest for policymakers, industry, and the public. In response to multiple requests, EIA is developing analyses that shed light on this question.

A change in current limitations on crude oil exports could have implications for both domestic and international crude oil prices. To the extent that current limitations on exports cause domestic crudes to sell at lower prices than could occur if those limitations were relaxed, such a relaxation could raise the price of domestically produced oil. If higher prices for domestic crude were to spur additional U.S. production than might otherwise occur, the increase to global crude oil supply could reduce the global price of crude. The extent to which domestic crude prices might rise, and global crude prices might fall, depends on a host of factors, including the degree to which current export limitations affect prices received by domestic producers, the sensitivity of future domestic production to price changes, the ability of domestic refiners to absorb domestic production, and the reaction of key foreign producers to changes in the level of U.S. crude production.

While crude oil prices matter to those involved in producing oil or refining oil into products, most Americans, and the policymakers who represent and serve them, are mainly concerned with the price of gasoline and other refined products. With U.S. gasoline consumption running at 8.8 million bbl/d and the average retail price of gasoline for all grades at $3.58 per gallon, the average American household spent $2,600 on gasoline in 2013. Recognizing that the possible relaxation of current export limitations could cause the prices of domestic and international crude grades to move in opposite directions (the former tending to rise, the latter tending to fall) one question of interest to policymakers and the public is which crude prices, domestic or international, matter most to the determination of gasoline prices in the United States. This paper focuses on that question, and also explores how linkages across regional and international markets where gasoline is sold have evolved over time and influence gasoline pricing in domestic markets.

While the linkages that motivate the hypothesis that a relaxation of limitations on crude oil exports could cause domestic and international crude grades to move in opposite directions are briefly discussed above, the extent of any actual change in domestic production or the domestic or international price of crude oil that might follow from a relaxation of crude oil export limitations is not addressed in this paper. EIA is undertaking further analyses that will examine those issues and expects to report additional results over the coming months.

Executive Summary

This analysis provides context for considering the impact of rising domestic light crude oil production on the price that U.S. consumers pay for gasoline, and provides a framework to consider how changes to existing U.S. crude oil export restrictions might affect gasoline prices.

Given the likelihood of continued growth in domestic crude production, and the recognition that some absorption options, such as like-for-like replacement of imported crude oil streams, are inherently limited, the possibility that a relaxation of current policy limitations on crude exports might affect domestic and international markets for both crude oil and products, particularly gasoline, is an important issue.

EIA's analysis of the factors affecting U.S. gasoline prices is twofold. The analysis first considers the relationship between U.S. spot gasoline prices and international and domestic spot crude oil prices, represented by Brent and West Texas Intermediate (WTI), respectively. The second part of the analysis focuses on the interrelationship of U.S. and worldwide gasoline prices and the extent to which global gasoline prices are important in determining U.S. gasoline prices. This analysis takes into account regional and global gasoline supply/demand balances and arbitrage, as well as how the competitive advantage of U.S. Gulf Coast (USGC) refineries is changing the dynamics of U.S. regional and global gasoline pricing.

Key observations from EIA's analysis of the relationship between gasoline and crude oil prices include:

- Brent crude oil prices are more important than WTI crude oil prices as a determinant of U.S. gasoline prices in all four regions studied, including the Midwest.
- The effect that a relaxation of current limitations on U.S. crude oil exports would have on U.S. gasoline prices would likely depend on its effect on international crude oil prices, such as Brent, rather than its effect on domestic crude prices.
- The WTI crude oil price lost much of its power to explain changes in U.S. gasoline prices after 2010, when its differential to Brent crude became wider and more volatile.
- The Brent crude oil price lost very little of its power to explain changes in U.S. gasoline prices in the post-2010 period.

Key observations from EIA's analysis of global gasoline price relationships include:

- Gasoline is a globally traded commodity and, as a result, prices and changes in prices are highly correlated across global spot markets.
- Gasoline balances and flows around the world are changing.
  - Increasing demand in Asia, Latin America, and the Middle East has been outpacing increases in gasoline production in those regions.
  - Demand is declining in the United States, but refinery production of gasoline is rising, resulting in increases in U.S. exports of gasoline into the global market.

- Demand is declining in Europe, adding to its gasoline oversupply; excess European gasoline now competes with increased exports from the United States.
- Because of these changing supply and demand patterns, global gasoline price relationships are changing; USGC and Chicago spot gasoline prices, which are closely linked, are now often the lowest in the world during the fall and winter months.

- U.S. gasoline exports grew rapidly from 2009-2012 but have since leveled off; however, Gulf Coast gasoline is now being exported to more distant markets, routinely including Africa and, during the winter months, Asia.

Gasoline and Crude Oil Price Relationships

Part 1: The relationship between gasoline prices and crude oil prices

Crude oil is the main input cost in the production of gasoline, and changes in crude oil price, along with changes in gasoline market conditions, drive changes in wholesale and retail gasoline prices. EIA estimates that about two-thirds of the price of gasoline at the pump is attributable to the refinery cost of crude oil. When the price of crude oil changes, the price of wholesale gasoline adjusts concurrently to reflect the increased refinery input cost, other market factors being equal.

Past EIA research and analysis[1] has shown that changes in wholesale gasoline spot prices have a consistent and predictable effect on changes in retail gasoline prices. Other factors equal, a $1-per-barrel change in the price of crude oil will result in a $1-per-barrel, or $0.024-per-gallon (1/42 of $1 because there are 42 gallons in one barrel) change in the price of wholesale and retail gasoline. Statistical analysis demonstrates about half of the change in crude oil price is passed through to retail prices within two weeks of the price change, all other market factors equal.[2]

U.S retail gasoline prices are generally determined by four broad elements: 1) the price of crude oil, 2) refining costs and profit margins, 3) retail and distribution costs and profit margins, and 4) taxes.[3] Elements three and four compose the retail segment of the supply chain, and they tend to be relatively stable. Because this paper addresses how gasoline prices change over time, it focuses on the first two elements, which account for most of the variability in retail prices.

Prices for a wide array of crude oils and wholesale gasoline specifications are available in markets, or trading hubs, around the world. These prices are commonly called spot prices. The spot market is often the first pricing point for petroleum products such as gasoline. At this level, sales of product for immediate delivery take place at a convenient transfer point, such as a refinery, port, or pipeline junction. The spot price for a product reflects the cost of crude oil and other inputs to refiners as well as the costs and profits of processing that crude oil into products.[4]

Because the purchases and sales reflected by spot prices generally occur in actively traded markets with many participants, they very quickly reflect market supply and demand conditions for that commodity. It is this variability in crude oil prices and spot gasoline prices that causes most of the variation in retail gasoline prices.

Prior to 2011, the question of whether Brent was more or less significant than WTI in determining U.S. gasoline prices was not very important. Historically, the price spread between Brent and WTI was relatively narrow and consistent, reflecting the cost of moving light sweet crude from the North Sea or West Africa to the United States (Figure 1). However, beginning in mid-2010, growing deliveries of

[1] Gasoline Price Pass-through (January 2003): http://www.eia.gov/petroleum/archive/gasolinepass.htm

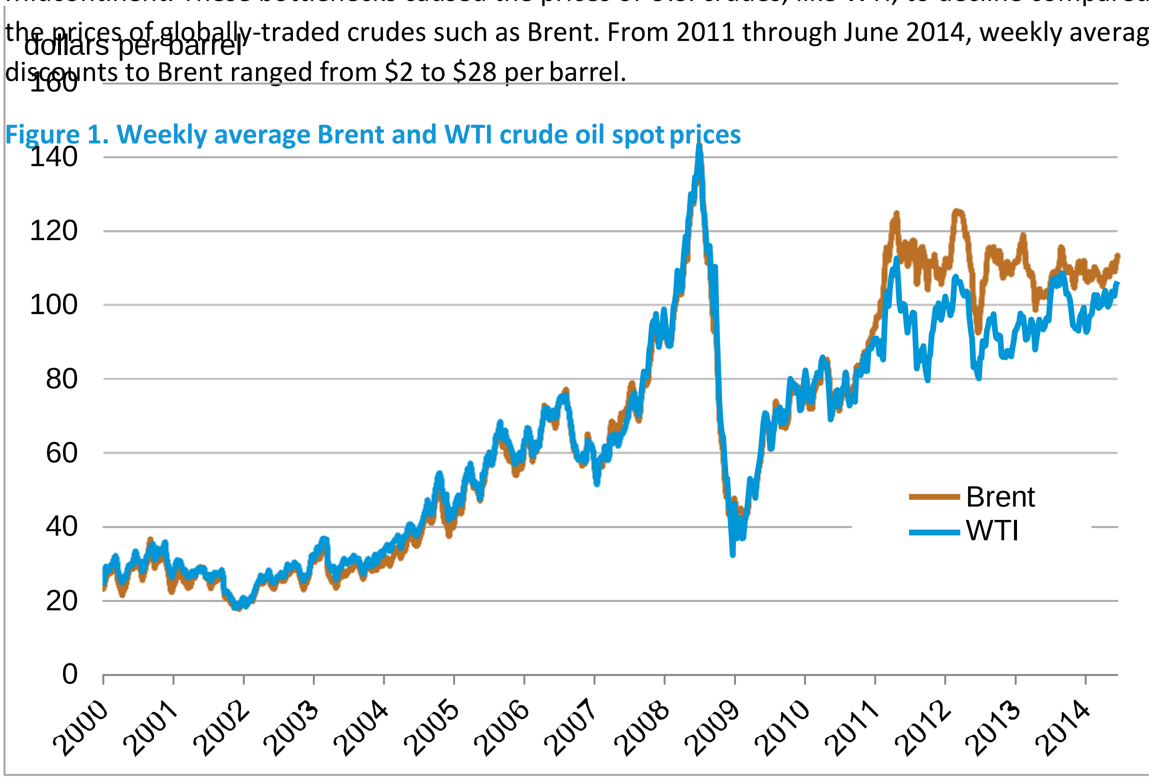
[2] While EIA recognizes that wholesale gasoline and crude oil prices are interdependent, because demand for crude oil is very highly related to the demand for refined products, this analysis focuses on the first order relationship between changes in crude oil price and wholesale gasoline price.

[3] http://www.eia.gov/petroleum/gasdiesel/pump_methodology.cfm

[4] *This Week In Petroleum* (November 24, 2010): http://www.eia.gov/petroleum/weekly/archive/2010/101124/twipprint.html

Canadian crude oil to Cushing, Oklahoma, and increasing U.S. light sweet crude oil production from tight oil formations, such as Bakken, Permian, and Eagle Ford, caused transportation bottlenecks in the U.S. Midcontinent. These bottlenecks caused the prices of U.S. crudes, like WTI, to decline compared with the prices of globally-traded crudes such as Brent. From 2011 through June 2014, weekly average WTI discounts to Brent ranged from $2 to $28 per barrel.

Figure 1. Weekly average Brent and WTI crude oil spot prices



Source: Bloomberg LP.

As WTI prices declined relative to Brent, U.S. gasoline prices generally maintained their previous relationship with Brent. From 2000 through 2010, the average annual spread between the U.S. average regular gasoline retail price and Brent spot price was $0.91 per gallon (Figure 2). From 2011 through 2013, the retail spread to Brent averaged $0.92 per gallon, almost unchanged from the 2000-2010 period. The relationship between spot gasoline in major markets across the United States and Brent also remained generally constant over the entire period.

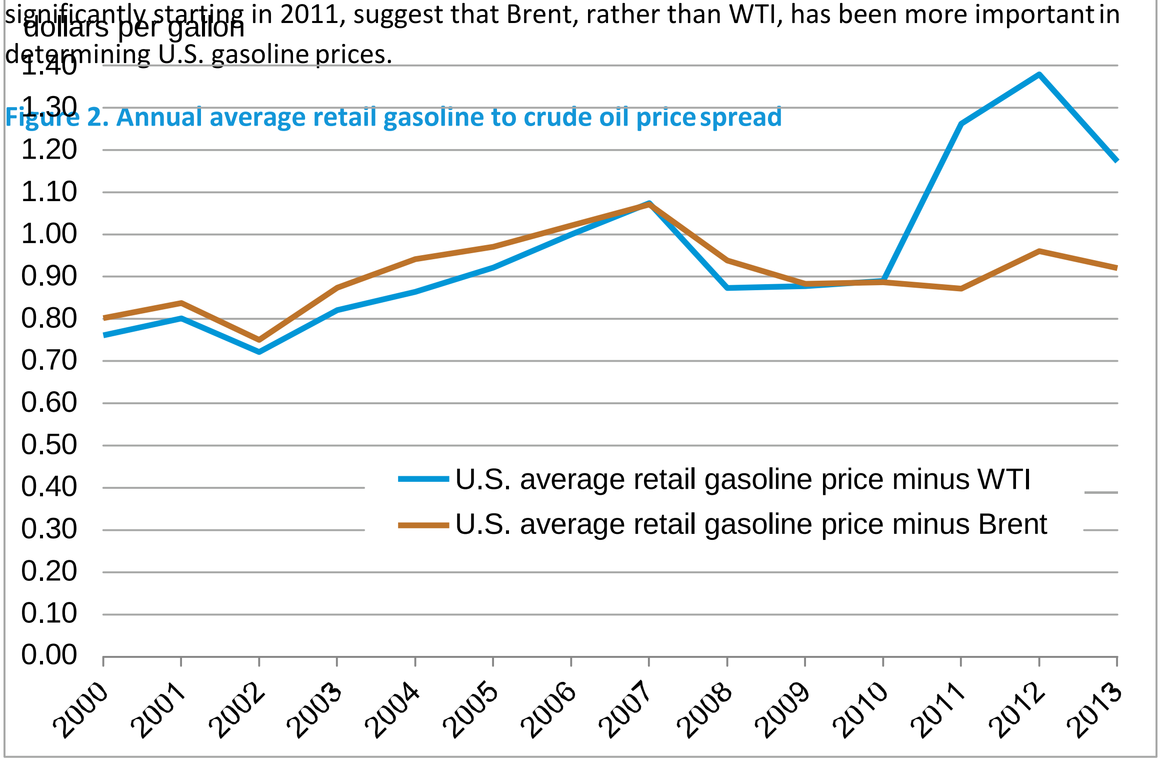
Unlike the spread between gasoline and Brent, the spread between gasoline and WTI changed significantly when Brent and WTI prices diverged in 2011. From 2000 through 2010, the average annual spread between the U.S. average regular gasoline retail price and the WTI spot price was $0.87 per gallon.[5] However, from 2011 through 2013, the spread between the price of retail gasoline and WTI crude oil was significantly higher, ranging from $1.17 to $1.38 per gallon. In the United States, WTI

[5] During this period the highest average annual spread of $1.07 per gallon occurred in 2007 when global gasoline supply was extremely tight. The spread between gasoline and Brent was also $1.07 in 2007.

prices are more widely quoted than Brent prices by press and media outlets, and the price of WTI is often reported as *the* price of crude oil. As a result, the change from historical levels in the price difference between retail gasoline prices and WTI prompted questions about whether the relationship between crude oil and retail gasoline prices had changed. While not as visible to consumers, a similar shift occurred between the price of WTI and the spot price of gasoline at major markets across the United States.

The consistency over time of the pricing relationship between gasoline and Brent crude oil, and the apparent change in the pricing relationships between gasoline and WTI when Brent and WTI diverged significantly starting in 2011, suggest that Brent, rather than WTI, has been more important in determining U.S. gasoline prices.

Figure 2. Annual average retail gasoline to crude oil price spread



Source: U.S. Energy Information Administration and Thomson Reuters.

The issue of which crude oil matters most for U.S. gasoline prices is particularly relevant as policymakers in the Executive Branch and Congress consider the possibility of changes in current limitations on crude oil exports. To the extent that current limitations on exports cause domestic crudes to sell at lower prices than could occur if those limitations were relaxed, such a relaxation could raise the price of domestically produced oil. If higher prices for domestic crude were to spur additional U.S. production than might otherwise occur, the increase to global crude oil supply could reduce the global price of crude. The extent to which domestic crude prices might rise, and global crude prices might fall, depends on a host of factors, including the degree to which current export limitations affect prices received by domestic producers, the sensitivity of future domestic production to price changes, the ability of domestic refiners to absorb domestic production, and the reaction of key foreign producers to changes in the level of U.S. crude production.

The extent of any actual change in domestic production or the domestic or international price of crude oil that might follow from a relaxation of crude oil export limitations, which will be the subject of further analyses, is beyond the scope of this paper. However, the possibility that prices of domestic crudes, such as WTI, and international crudes, such as Brent, would move in opposite directions highlights the importance of understanding which type of crude drives U.S. gasoline prices, which may be the most salient petroleum product price for the public and many policymakers.

For this reason, EIA decided to undertake statistical modeling to dig deeper into the question of how gasoline prices are linked to various types of crude oil. Despite the evidence reviewed above suggesting that Brent was more important than WTI, EIA developed its statistical analysis in a symmetric fashion, running specifications for both Brent and WTI in parallel.

The analysis considers the relationship of weekly changes in spot gasoline prices in the four regions of the United States that have viable spot markets for gasoline (New York Harbor (NYH), USGC, Chicago, and Los Angeles) as a function of weekly changes in the spot price of Brent and WTI crude oils and the change in the deviation of regional gasoline inventories from the most recent five-year average level. The deviation in regional inventory was included as a proxy for regional gasoline supply-demand conditions. The period covered by the analysis begins in 2000 and continues through June 2014.

The analysis examines the gasoline-crude oil price relationships over two periods. The first period runs from 2000 through year-end 2010, a period when the Brent-WTI spread was consistently narrow. During the second period, which begins in January 2011 and continues through the end of June 2014, the Brent-WTI spread was typically wider and quite volatile. The econometric equations test how well Brent and WTI crude oil prices independently explain changes in gasoline prices in each of the two periods. They also examine whether adding the other crude oil as an independent variable (e.g., adding a Brent component into the equation where WTI is the explanatory variable) in the form of the Brent-WTI spread improves the explanatory power of the equation.

The econometric analysis supports three important findings:

1. For both the 2000-2010 and 2011-2014 periods, the equations in which the Brent price was used as the independent variable have more explanatory power than the equations in which WTI was the independent variable. This holds true for all regional markets, including the Midwest.
2. The equations that use Brent as the independent variable lose very little explanatory power from period one (2000-2010) to period two (2011-June 2014), while equations with WTI as the independent variable lose considerable explanatory power from period one to period two.
3. Introducing the Brent-WTI spread to equations in which WTI is the independent variable significantly improves the explanatory power of the equations, while introducing this spread to equations that use Brent as the independent variable does not significantly improve the explanatory power.

Together, these findings support the conclusion that the Brent crude oil price is more important than WTI crude oil price as a determinant of U.S. gasoline prices. The second conclusion shows that this was the case during both times of narrow and stable Brent-WTI spreads and times of relatively wide and volatile spreads.

A detailed discussion of the econometric analysis and results is included in the Statistical Methodology for Relationships between Gasoline and Crude Price appendix of this report.

Part 2: Global gasoline price relationships

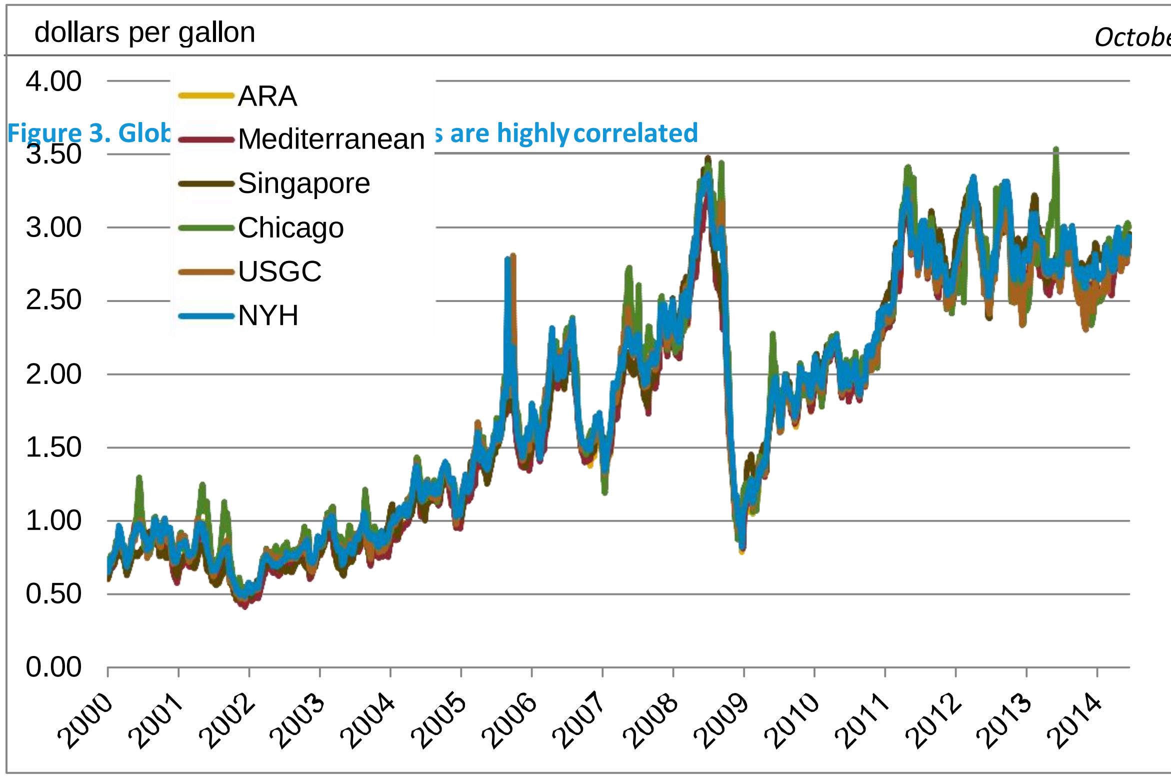
The previous section shows that Brent prices, rather than WTI prices, are the main crude oil price determinant of spot, and therefore retail, U.S. gasoline prices. However, crude oil prices are not the sole determining factor for spot gasoline prices. Spot gasoline prices are also a function of the wholesale gasoline margin, often referred to as the gasoline crack spread, i.e., the difference between spot gasoline price and crude oil price. Wholesale gasoline margins take into account supply/demand conditions for gasoline at the prevailing crude oil price, including refining costs and refining profits. Together, the price of Brent crude oil and the wholesale gasoline margin in a given market compose that market's spot gasoline price.

The major markets for gasoline in the United States include NYH, the USGC, Chicago, and Los Angeles. Outside the United States, the major gasoline market hubs are Amsterdam-Rotterdam-Antwerp (ARA), the Mediterranean, and Singapore. NYH, the USGC, ARA, and the Mediterranean are part of the actively traded Atlantic Basin petroleum market. Chicago is directly linked to the Atlantic Basin market through infrastructure connections to the USGC. Singapore is a major trading hub in the Pacific Basin market, which also includes Los Angeles.

Prices at these different trading hubs are linked through arbitrage, and the differences between prices at different trading hubs reflect transportation costs between the regions, differences in gasoline quality, such as octane rating, and regional supply/demand balances. Gasoline moves from markets with surplus supply to markets in need of supply based on these price differences. This means that spot gasoline prices in markets that produce more gasoline than they consume, assuming no difference in quality specifications, need to be lower than prices in markets that consume more gasoline than they produce, in order to encourage gasoline to flow from the market with excess supply to the market in need of supply. In this way, the price of gasoline in different locations both in the United States and around the world is set by supply and demand conditions in the various regional markets that make up the global market.

Because the United States is an active participant in the global petroleum market as both an exporter and importer of gasoline, U.S. gasoline prices are tied to global gasoline prices. As quality specification differences among the major gasoline markets are relatively small, and because gasoline can be shipped between markets for a relatively low cost, the price differences among the major gasoline trading hubs tend to be small and price movements highly correlated (Figure 3).

Figure 3. Glob… s are highly correlated



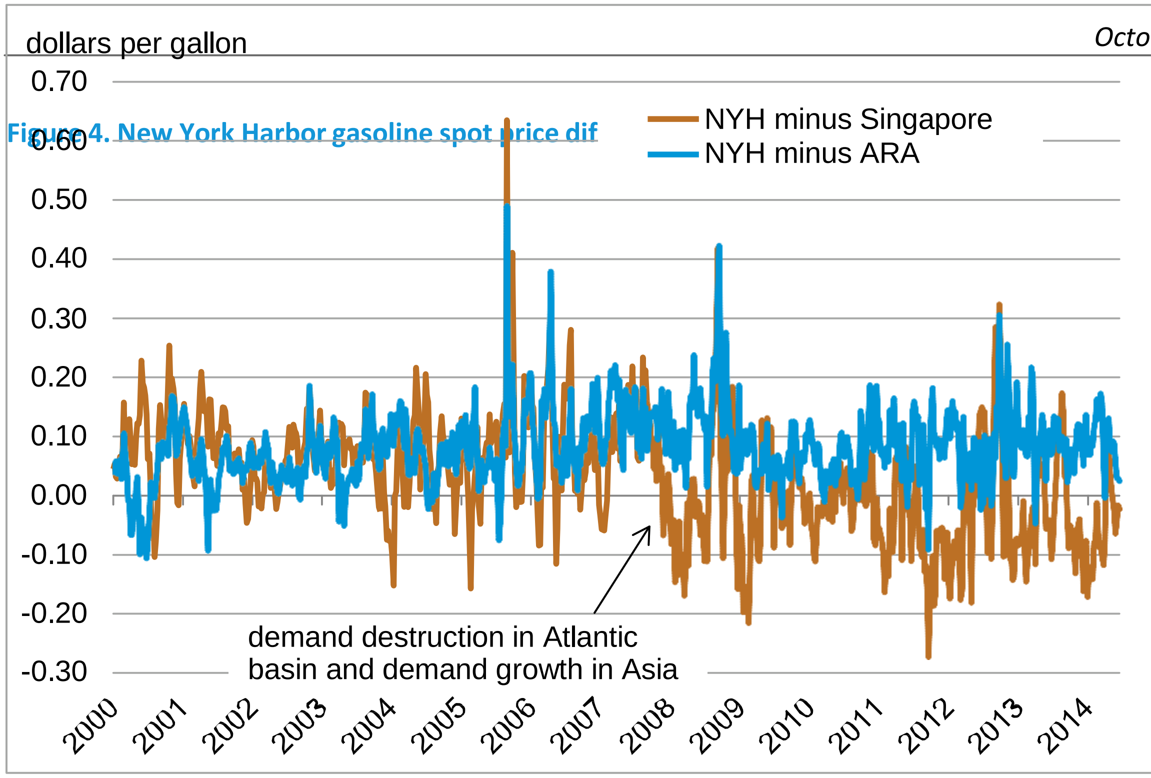
Source: Bloomberg LP and Thomson Reuters.

Changing global gasoline price relationships

Spot gasoline prices in NYH, ARA, and Singapore can be broadly thought of as being representative of the western Atlantic basin, the eastern Atlantic Basin, and the Pacific Basin, respectively. Prior to 2008, the United States, in particular the U.S. East Coast, was a large and growing gasoline market that needed to import large amounts of gasoline from the international market to meet demand. To attract gasoline supply to the U.S. East Coast from Europe, and at times from the Pacific Basin, NYH gasoline prices typically traded at a premium to prices in ARA and Singapore.

Around 2008, economic recession, efficiency policies, and U.S. ethanol mandates began eroding gasoline demand in the Atlantic Basin, while gasoline demand in Asia continued growing, led by major consuming countries China, India, and Indonesia. This shift in demand growth contributed to an increase in Singapore gasoline prices relative to prices in NYH and ARA. Since 2008, the price of gasoline in Singapore has typically been the highest price among the three major trading hubs, reflecting the need for gasoline supply to flow into the Pacific Basin (Figure 4). Despite the erosion in Atlantic Basin gasoline demand and the increase in demand in Asia, the relationship between gasoline prices in the ARA and NYH has remained relatively unchanged from the period before 2008. The stability of the ARA-NYH price relationship reflects the continuing need for the East Coast to import gasoline, much of which has been and continues to be supplied from northwest Europe.

Figure 4. New York Harbor gasoline spot price dif



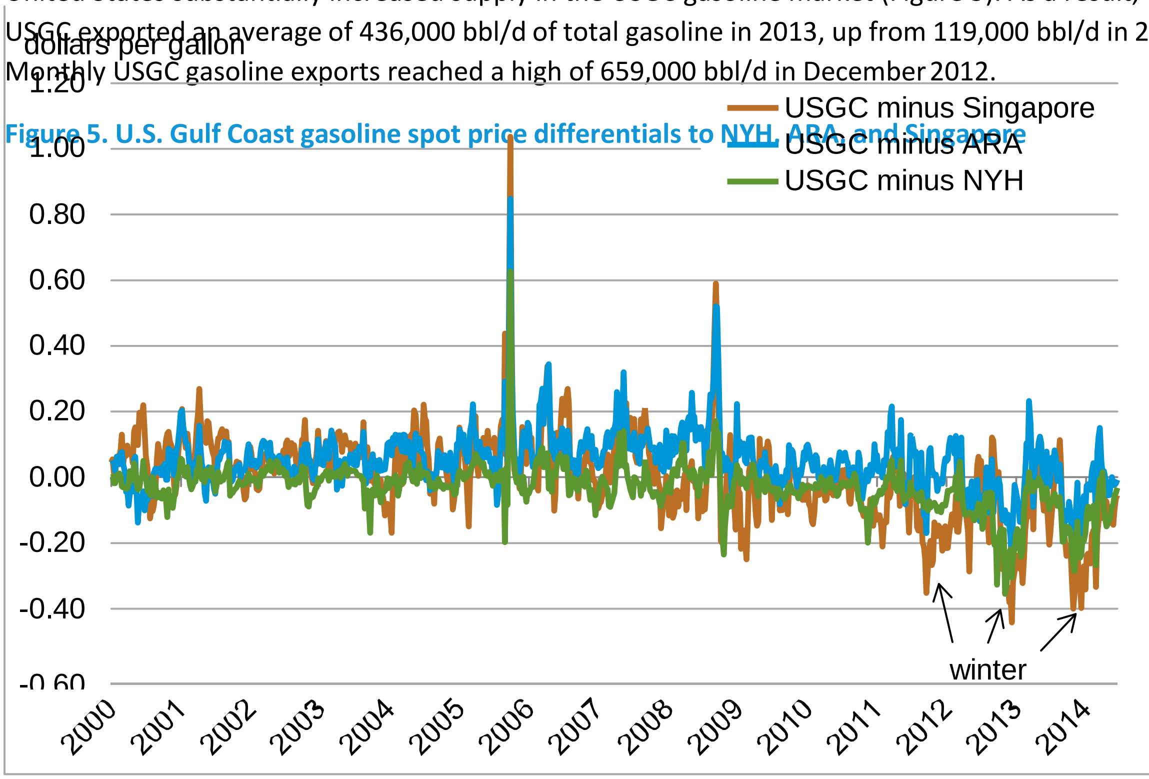
Source: Bloomberg LP and Thomson Reuters.

Both NYH and the USGC are submarkets in the western Atlantic Basin. The USGC, which is home to half of U.S. refining capacity and about 10% of total global refining capacity, has long been a major supplier of gasoline and other refined products to other regions of the United States. More recently, the USGC has become a major supplier to the rest of the world. The combination of increasing USGC production of refined products and stagnating Atlantic Basin demand has had a major impact on global gasoline markets.

Historically, USGC spot gasoline priced in a tight range with other Atlantic Basin and U.S. gasoline prices. From 2000 through 2010, USGC spot gasoline prices averaged a $0.07-per-gallon premium to ARA, reflecting the United States' status as a major gasoline importer. During the 2000-2010 period, USGC gasoline prices were slightly lower on average than NYH and Chicago, reflecting the region's position as a supplier to those markets. As was the case in other Atlantic Basin markets, in 2008, USGC prices shifted from typically being at a premium to Singapore to typically being at a discount, reflecting the easing supply-demand balances in the Atlantic Basin and the tightening balances in the Pacific Basin. Beginning in 2011, USGC gasoline prices began to price at a discount to prices at all other major market hubs for much of the calendar year, and the volatility of the spread between USGC gasoline prices and other global gasoline prices increased. USGC gasoline prices fell to a discount to ARA, NYH, and Singapore prices of $0.01, $0.10, and $0.13 per gallon, respectively, on average from January 2011 through June 2014. Additionally, USGC gasoline price discounts to other locations reached particularly wide levels during the past three winters when seasonally lower demand and record refinery runs in the

United States substantially increased supply in the USGC gasoline market (Figure 5). As a result, the USGC exported an average of 436,000 bbl/d of total gasoline in 2013, up from 119,000 bbl/d in 2008. Monthly USGC gasoline exports reached a high of 659,000 bbl/d in December 2012.

Figure 5. U.S. Gulf Coast gasoline spot price differentials to NYH, ARA, and Singapore

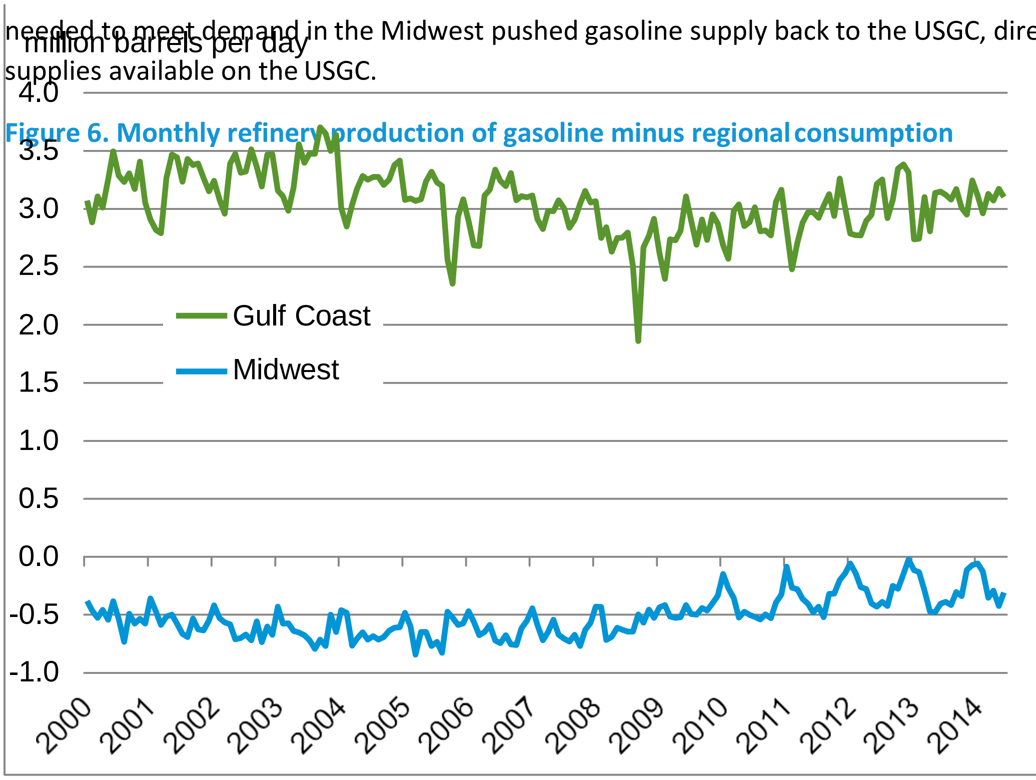


Source: Bloomberg LP and Thomson Reuters.

Changing U.S.gasoline supply patterns

Changes in regional supply-demand balances in both the USGC and the Midwest have contributed to changes in gasoline price relationships and supply flows. From 2008 through 2013, USGC petroleum-based (non-ethanol) gasoline consumption increased only modestly, and in the Midwest, consumption decreased by 100,000 bbl/d, largely due to increased ethanol blending and fleet efficiency gains as a result of corporate average fuel economy (CAFE) standards. Over the same period, access to price-advantaged crude oil and natural gas feedstock increased the relative competitiveness of U.S. refineries in the global market, as did refinery investment in upgrading capacity and capacity expansions. Since 2008, when USGC refinery production of gasoline bottomed out at 4.0 million bbl/d, refineries increased gasoline production to an average of almost 4.4 million bbl/d during 2013. Over the same period, Midwest refineries increased gasoline production from 1.8 million bbl/d to almost 2.0 million bbl/d. On an average annual basis, the USGC's surplus of gasoline production over consumption increased from 2.7 million bbl/d in 2008 to 3.0 million bbl/d in 2013. In the Midwest, the supply shortfall decreased by half, dropping from 0.6 million bbl/d in 2008 to just 0.3 million bbl/d in 2013 (Figure 6). Because the Midwest's shortfall of gasoline is supplied from the USGC, the reduction in the amount of gasoline needed to meet demand in the Midwest pushed gasoline supply back to the USGC, directly adding to supplies available on the USGC.

Figure 6. Monthly refinery production of gasoline minus regional consumption



Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*.

Because most incremental supply in the Midwest comes from the USGC, the reduction in USGC-produced gasoline needed to supply the Midwest, along with the increasing production on the USGC itself, combined to increase the annual average USGC supply relative to consumption by almost 0.6 million bbl/d since 2008.

USGC gasoline oversupply is particularly high during the winter months when gasoline demand in the United States is at a seasonal low. Again, the Midwest is a key driver of this dynamic. While Midwest gasoline production was 390,000 bbl/d below consumption on average from March–October 2013, the shortfall was just 90,000 bbl/d on average during the winter months of November 2013–February 2014. However, the dramatic narrowing of the gasoline production gap in the Midwest during the winter is a recent development. As recently as the winter months of November 2010–January 2011, the Midwest production shortfall averaged 270,000 bbl/d.

A combination of declines in demand and increases in refinery crude runs in the late autumn and early winter have increased gasoline oversupply in the USGC. From November 2013 to January 2014, USGC refinery gross inputs to distillation units were 8.3 million bbl/d, up almost 0.5 million from the same period in 2010-11. Much of this increase was the result of increased capacity rather than higher utilization of existing capacity. Utilization for USGC refineries remained unchanged at 91% over those periods. In the Midwest, gross inputs increased 0.2 million bbl/d from November 2010–January 2011 to average 3.5 million bbl/d from November 2013 to January 2014.

Although a lower call on USGC gasoline by the Midwest and more surplus gasoline production in the USGC have made more gasoline available on the USGC, pipeline infrastructure and marine shipping constraints limit how much USGC-produced gasoline can be economically transferred to other U.S. regions, particularly the U.S. East Coast, which produces less gasoline than it consumes. As a result, USGC refinery utilization is now very much a function of export demand, and USGC spot gasoline prices reflect the shift.

Changing global gasoline trade flows

As noted above, the differences between product prices at different market hubs reflect transportation costs between the regions, differences in gasoline quality, and regional supply-demand balances. As the USGC produces increasingly more gasoline than it consumes, the spot gasoline prices in the USGC have shifted to export parity, declining versus gasoline prices in Europe, Singapore, NYH, and the rest of the world, and encouraging the export of gasoline to the marginal market for USGC production. Spot gasoline prices in the USGC are now typically the lowest in the world for at least some part of the year.

Tables 1 and 2 below provide percentage data by month on the number of weeks the gasoline price in a particular market hub was the lowest among the identified group of major hubs. As gasoline typically flows from regions of lower price where there is excess supply to regions of higher price where supply is needed, these data can be used as a proxy for global gasoline balances and trade flows. Data on individual and aggregated global refined product balances and flows are difficult to accurately develop because of differences in the availability of country-level and regional data and concerns about data integrity. Table 1 covers the period 2000-2010 and the Table 2 the period 2011-14. These two time periods were chosen for consistency with the analysis of the relationship between U.S. gasoline prices and crude oil prices. The gasoline-crude analysis takes into account the observed January 2011 break point between the relationship of gasoline and crude oil prices that resulted from the decline in U.S. crude prices relative to global crude prices. The decline in U.S. crude oil prices, combined with access to low-cost natural gas, created incentives for U.S. refineries to increase crude runs leading to higher gasoline production. The combination of higher gasoline production and stagnating Atlantic basin gasoline demand resulted in changes in global gasoline price relationships.

Table 1. Percentage of weeks with lowest average weekly gasoline spot price 2000-10

Month	NYH	USGC	Chi	LA	Europe	Sing
January	0%	0%	8%	0%	84%	8%
February	0%	0%	7%	0%	91%	2%
March	0%	0%	4%	0%	82%	14%
April	0%	0%	2%	0%	64%	34%
May	0%	0%	0%	0%	48%	52%
June	0%	0%	0%	0%	46%	54%
July	0%	8%	4%	0%	33%	54%
August	0%	6%	6%	0%	53%	35%
September	0%	0%	0%	0%	70%	30%
October	0%	6%	0%	0%	65%	29%
November	0%	4%	9%	0%	74%	13%
December	0%	0%	8%	0%	84%	8%

Source: Bloomberg LP and Thomson Reuters.

Table 2. Percentage of weeks with lowest average weekly gasoline spot price 2011-14

	NYH	USGC	Chi	LA	Europe	Sing
January	0%	0%	81%	0%	19%	0%
February	0%	25%	25%	0%	50%	0%
March	0%	6%	6%	0%	89%	0%
April	0%	12%	18%	0%	71%	0%
May	0%	28%	0%	0%	72%	0%
June	0%	38%	6%	0%	38%	19%
July	0%	15%	8%	8%	62%	8%
August	0%	14%	0%	7%	43%	36%
September	0%	77%	0%	0%	8%	15%
October	0%	33%	25%	0%	33%	8%
November	0%	57%	29%	0%	14%	0%
December	0%	15%	62%	0%	23%	0%

Source: Bloomberg LP and Thomson Reuters.

As the data in Table 1 indicate, during the period 2000-2010, the lowest gasoline spot prices were most often in Europe and Singapore. The Singapore price was lowest particularly during the summer, although mostly prior to 2008. The price was less-frequently lowest at a U.S. market hub, and only in the USGC or Chicago. NYH and Los Angeles never had the lowest price.

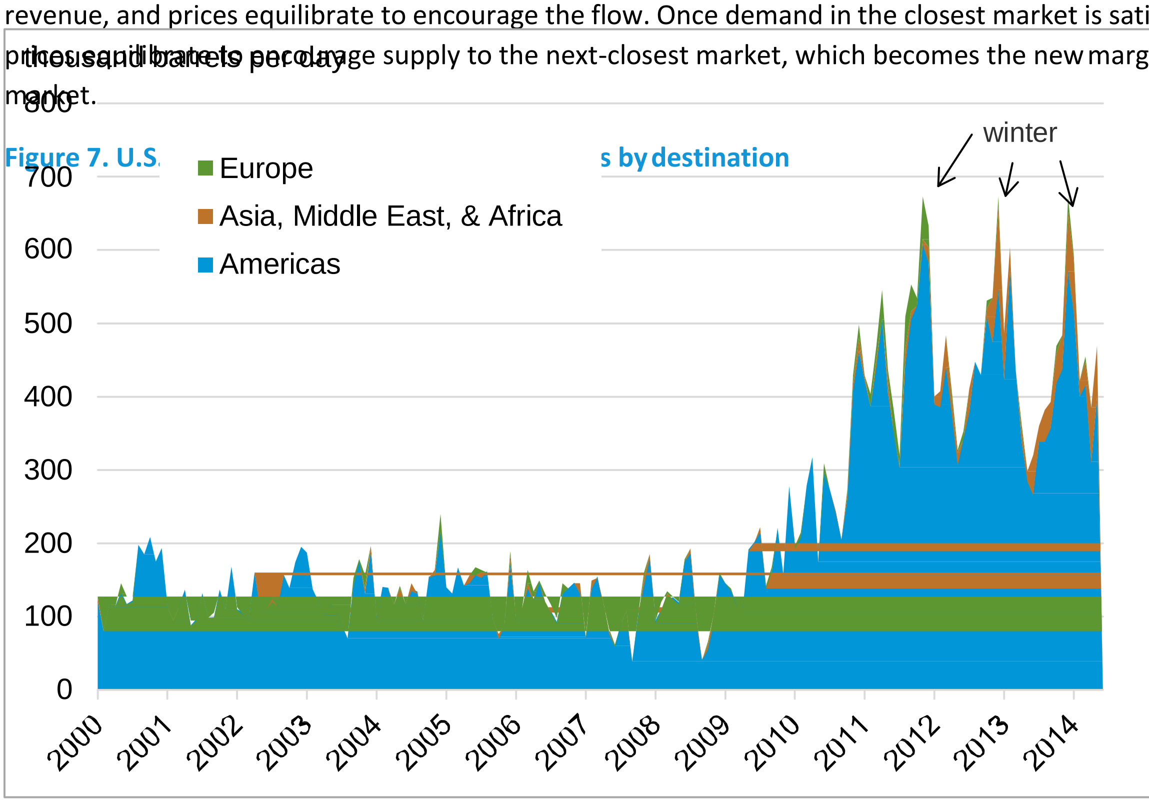
In 2011, as the USGC gasoline supply surplus began to increase, the relationship between global gasoline prices began to change. As the data in Table 2 show, during the winter months of the 2011-through-

June-2014 period, the price of gasoline in the USGC or Chicago was most often the lowest, while the gasoline price in Europe was typically lowest during the spring and in July. Over the 2011–June 2014 period, the price of gasoline in Singapore was lowest less frequently and only during the June through October period. NYH was never the lowest price gasoline market because the region depends on imports of gasoline.

Lower prices on the USGC are now needed to clear the larger gasoline surplus in that market. Lower prices make it economic to export gasoline to more distant markets, thus redefining the incremental market for USGC gasoline. Prior to 2011, USGC gasoline rarely moved to markets beyond the Americas (Figure 7). However, as the gasoline surplus in the USGC has increased, relatively lower USGC prices have been needed to make it economic to move gasoline to more distant markets. In the winter months, when U.S. gasoline demand is seasonally lowest and the surplus in the USGC peaks, USGC gasoline prices are at their lowest compared with other market hubs.

It is useful to think of the various market hubs as "*faucets*" and "*sinks*." The faucet hubs are long on product, meaning that the region produces more gasoline than can be locally consumed. The sink hubs are short product, meaning that the region consumes more gasoline than it produces. Faucet markets typically supply product to the closest sink market, minimizing transportation costs and maximizing revenue, and prices equilibrate to encourage the flow. Once demand in the closest market is satisfied, prices equilibrate to encourage supply to the next-closest market, which becomes the new marginal market.

Figure 7. U.S. s by destination

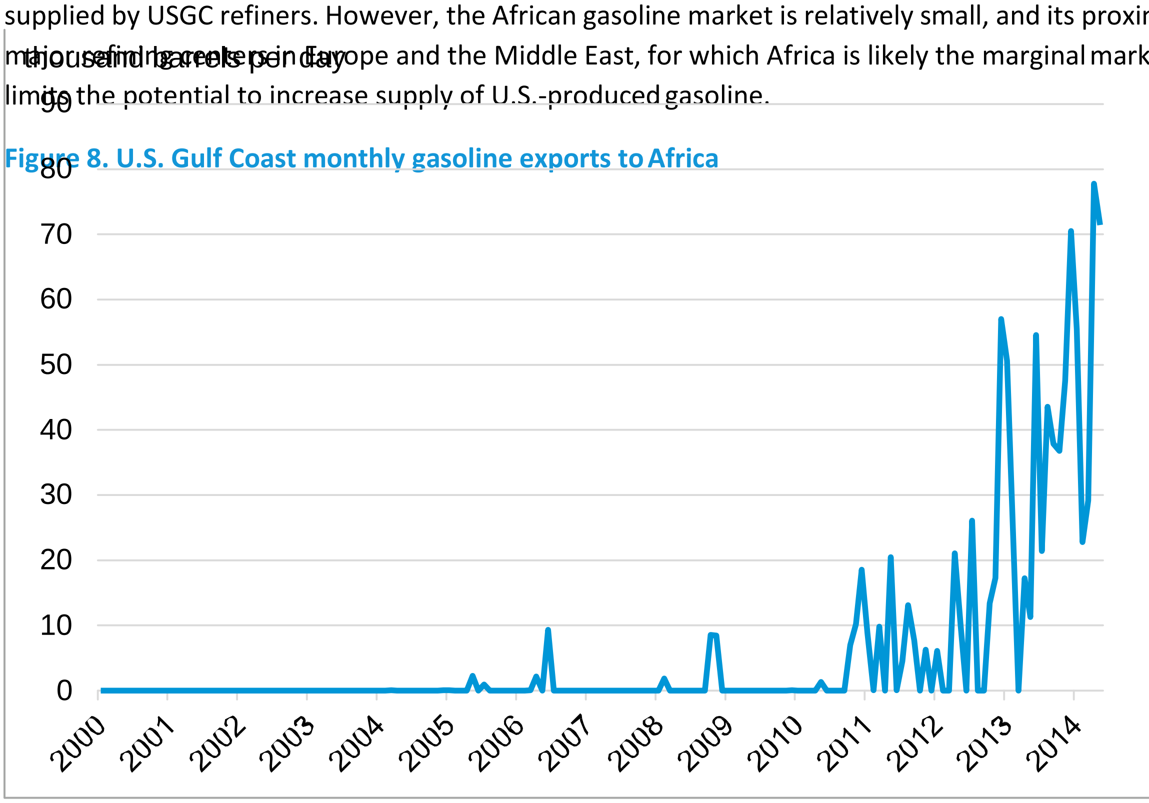


Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*.

Most USGC exports of gasoline continue to supply the Americas, primarily Mexico, as it is the closest export market to the USGC. More recently, USGC exports have started to reach markets outside the Americas. The still small but growing share of exports to these markets indicates that USGC refineries have likely captured as much of the Americas gasoline market as is currently possible. As Figure 7 illustrates, demand for USGC gasoline in the Americas has been declining slowly since 2011.

With limited opportunity to increase exports to the Americas, USGC gasoline exports are moving to Africa, a market historically supplied by European refineries. In the past year, exports of gasoline from the USGC to Africa, which were historically unusual, have averaged at least 20,000 bbl/d (Figure 8). This consistent level of exports suggests that African gasoline demand is now part of the base market supplied by USGC refiners. However, the African gasoline market is relatively small, and its proximity to major refining centers in Europe and the Middle East, for which Africa is likely the marginal market, limits the potential to increase supply of U.S.-produced gasoline.

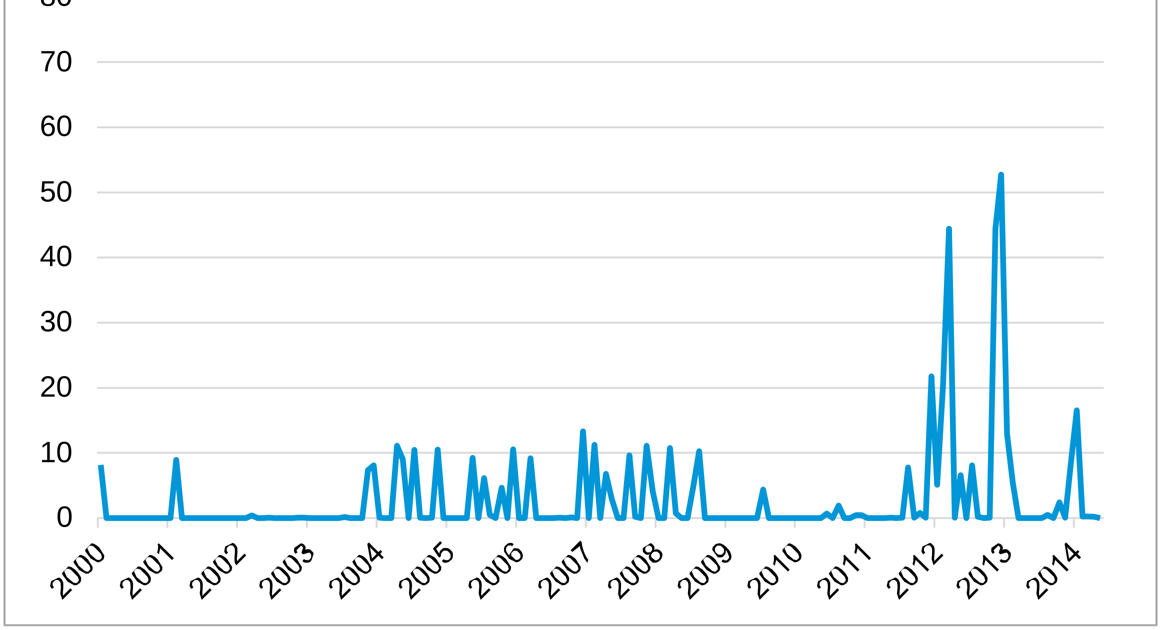
Figure 8. U.S. Gulf Coast monthly gasoline exports to Africa



Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*.

As noted earlier, USGC gasoline prices are at their lowest compared with other trading hubs during the winter months, between November and February. This deeper discount of USGC gasoline to prices in the rest of the world is needed to support sales to regions beyond the Americas and Africa. During the winter months of the past three years, the USGC has exported increasing volumes of gasoline to Asia (Figure 9), including Japan, South Korea, China, and Singapore. Exports to Asia are not economic during the U.S. summer when U.S. demand is seasonally higher and the price of gasoline in the USGC is not so steeply discounted versus prices in the rest of the world. Thus, evidence suggests that Asia is now the marginal market for USGC gasoline supplies during the winter months of November–February, while Africa is the marginal market during the balance of the year.

Figure 9. U.S. Gulf Coast monthly gasoline exports to Asia and the Middle East

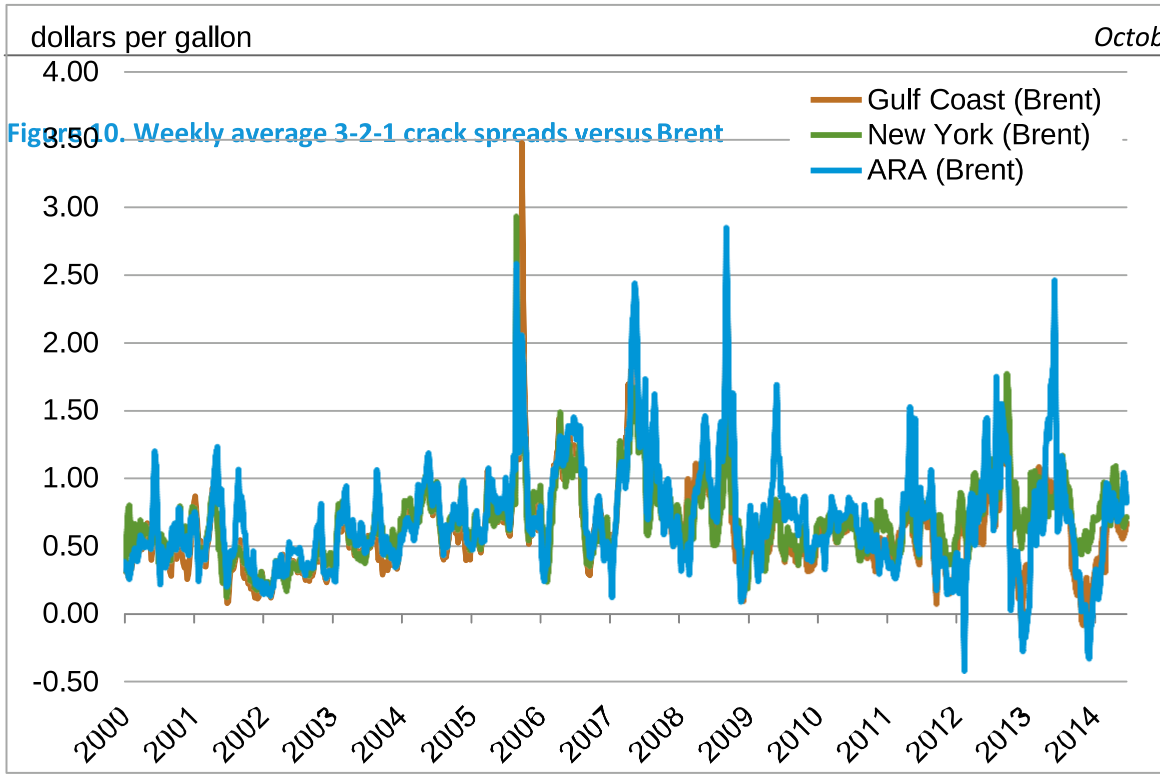


Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*.

Gasoline-distillate market interactions

The foregoing analysis of the gasoline market focuses on gasoline supply and demand and does not explore how distillate supply-demand, including both diesel fuel and heating oil, affects gasoline market dynamics. Strong diesel fuel demand growth in recent years has caused diesel to price at a premium to other refined petroleum products for most of the year. The behavior of the 3-2-1 crack spread, which approximates the margin a refinery would realize from processing (cracking) three barrels of crude oil to produce two barrels of gasoline and one barrel of distillate, during the winter months when gasoline demand around the world is lowest, suggests that refineries are running the last barrel of crude oil to capture distillate margins (Figures 10 and 11). During the late autumn and early winter, gasoline margins in recent years have been very small or even negative, while distillate margins, buoyed by winter distillate demand for space heating fuel, have been strong. Without distillate demand and the contribution of distillate to refining margins, refineries might opt to reduce crude oil inputs during this time of the year, a move which would reduce the supply of gasoline in the global market and change absolute and relative gasoline prices around the world.

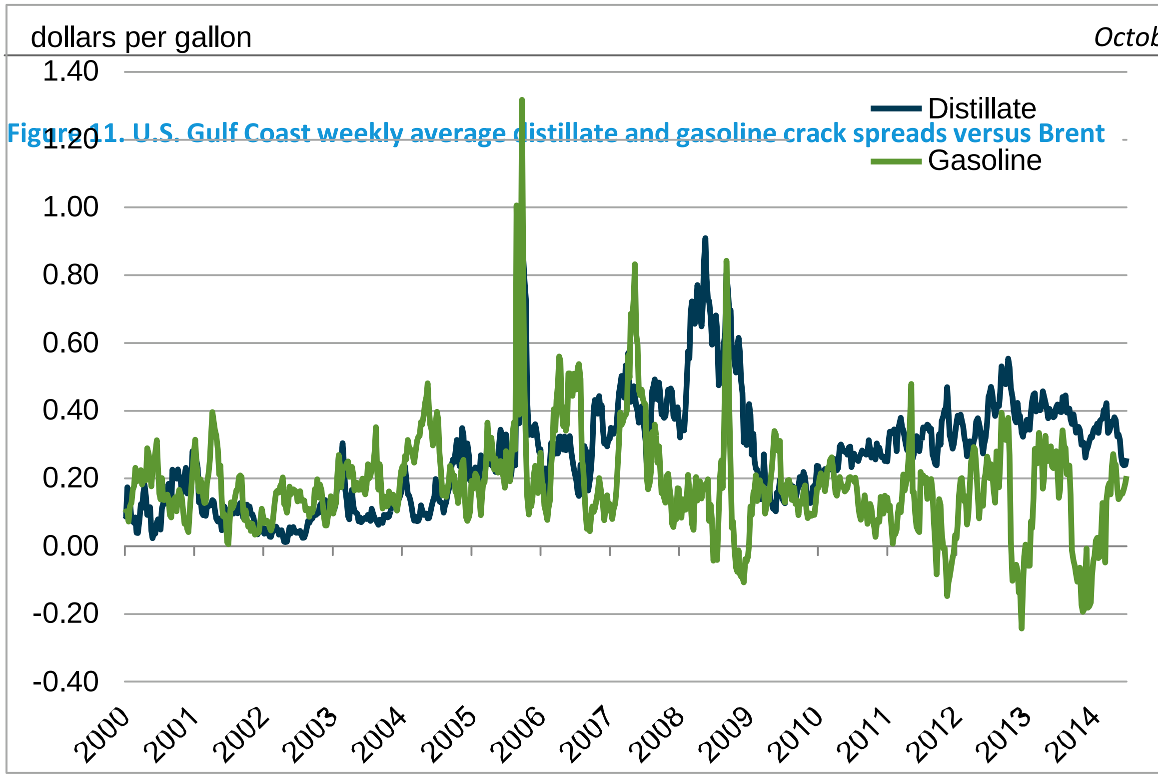
Figure 10. Weekly average 3-2-1 crack spreads versus Brent



Source: Bloomberg LP.

Source: Distillate price used to calculate crack spread is heating oil.

Figure 11. U.S. Gulf Coast weekly average distillate and gasoline crack spreads versus Brent



Source: Bloomberg LP.

Source: Distillate price used to calculate crack spread is heating oil.

Appendix: Statistical Methodology for Relationships between Gasoline and Crude Oil Price

Econometric analysis

The purpose of this analysis is to determine which benchmark light sweet crude oil (Brent or WTI) better explains (i.e., is more statistically significant in determining) gasoline spot price behavior in the various Petroleum Administration for Defense Districts (PADD) of the United States, and whether gasoline-crude oil price relationships have changed over time. To do this, EIA created models that analyze changes in gasoline spot prices as a function of changes in crude oil prices, regional inventories and crude oil price spreads. The time period chosen for the study is January 2000–June 2014. January 2011, when WTI prices first moved to a significant discount to Brent prices, offers a useful breakpoint for testing crude oil-gasoline price relationships. EIA confirmed the statistical validity of using January 2011 as a breakpoint for the data series by employing a Chow Breakpoint test. The estimated model examined the change in weekly average WTI price as a function of the change in Brent price and an error correction term (lagged WTI and lagged Brent price level). The test involved an examination of the Brent-WTI price relationship using a single model (the restricted model) for the whole time period, along with individual models (the unrestricted model) for each of the two sub-time periods (2000-10 and), and using an F-test to compare the Sum of Squared Errors (SSE) of the restricted model with the SSE of the unrestricted model. The null hypothesis of no statistically significant change in the SSE's of the restricted and unrestricted models was rejected, indicating that January 2011 is a breakpoint in the Brent-WTI price relationship. As a result, EIA broke the data into two periods. Period 1 runs from January 2000 through December 2010, while Period 2 runs from January 2011 through June 2014.

The data analyzed consisted of Brent and WTI crude oil spot prices, regional gasoline spot prices, and regional gasoline inventories. Daily gasoline and crude oil spot prices were obtained from Bloomberg LP. The daily prices were averaged to a weekly frequency for each of the crude oils and each of the four regions with viable gasoline spot market prices: U.S. East Coast, U.S. Gulf Coast (USGC), Midwest and West Coast. These markets are represented by gasoline spot price series in: New York Harbor (NYH), USGC, Chicago (CHI), and Los Angeles (LA), respectively. To account for the effects of seasonal behavior, the regional inventories were adjusted to be deviations from the previous five-year averages.[6] The regional gasoline price series were adjusted to account for a very small number of extraordinary one-time events (e.g., Hurricane Katrina).[7]

Energy market spot price series are well known to be non-stationary in the long term, although they may demonstrate stationary behavior during short time periods.[8] To investigate the behavior of the series, EIA used autocorrelograms and augmented Dickey-Fuller (DF) tests; the results of these tests, for

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[6] Energy Information Administration; Form EIA-800 "Weekly Refinery and Fractionator Report," Form EIA-801 "Weekly Bulk Terminal Report," Form EIA-802 "Weekly Product Pipeline Report," http://www.eia.gov/dnav/pet/pet_stoc_wstk_a_epm0_sae_mbbl_w.htm.

[7] Modified data points include Hurricane Katrina 9/2/05 (all regions); Hurricanes Gustav and Ike 9/12/08 and 9/26/08 (NYH, CHI, and USGC); Summer 2012 Chicago price spike 8/3/12 (CHI only); and 2012 California price spike 10/5/12 (LA only).

[8] A stationary series reverts to a constant, long-term mean and has a constant variance independent of time. A non-stationary series does not display these characteristics and is considered a "random walk."

the three time periods considered, are shown in Table 3. Unlike spot prices, all four of the regional gasoline inventory series demonstrate stationary behavior in both sub-time periods. The gasoline and crude oil price series are clearly non-stationary in Period 1. In Period 2, some of the test results indicate that both gasoline and crude oil prices demonstrate some stationary behavior. The time series properties of data series can be affected by the presence of major market events (e.g., the 2008 crude oil price spike) and transitory outliers principally due to weather events (especially in the gasoline price series), which make correct interpretation of the low power DF test results difficult; however, this does not appear to be the case in Period 2.

Table 3. Dickey-Fuller test and autocorrelogram results

	DF test[1]			Autocorrelogram		
		Period			**Period**	
	Full	**1**	**2**	**Full**	**1**	**2**
Inventory Deviation from 5-year avg	reject H_0	accept H_1	reject H_0	stationary	stationary	stationary
Crude Oil Prices	weak accept H_0	accept H_0	reject H_0	random walk	random walk	stationary
Gasoline Prices	reject H_0	weak[2] accept H_0	reject H_0	random walk	random walk	stationary

[1]Note: "accept" means "not reject."

[2]Note: New York Harbor is "reject" in Period 1.

Because market spot price series are known to be non-stationary in the long term, EIA assumed non-stationary price series for this study. As the various combinations of crude oil and gasoline price series were found to be cointegrated by the Johansen method, EIA used error correction models (ECM) as the basis for this analytical work. Additionally, all the error correction terms in the estimated equations are significantly different from zero and are of the correct (negative) sign.

The Error Correction Term was created from the residuals (ε_t) of the following equation:

Equation 1: $y_t = \beta x_t + \text{seasonal dummy variables} + \varepsilon_t,$

where

- y_t is gasoline spot price (NYH, CHI, USGC, or LA) at time t;
- x_t is crude oil spot price (WTI or Brent) at time t.

The weekly seasonal dummy variables were defined as all weeks in a particular month. Gasoline prices demonstrate regular seasonal fluctuations; the significance test for the seasonal dummy variables shows them to be jointly different from zero.

The basic model used to investigate the regional gasoline spot price behavior was as follows:

Equation 2: $\Delta y_t = C + \mathbf{\Delta x'\beta} + \mathbf{\Delta w'}\,\boldsymbol{\tau} + \gamma^*\text{BWspread}_t + \lambda * \text{ECT}_{t-1} + \varepsilon_t + \text{AR(1) correction}$

where

- Δ**x** is a vector of current (and lagged) change in crude oil price (WTI or Brent);
- Δ**w** is a vector of current and/or lagged change deviations from normal regional inventory;
- BWspread is the change in the Brent-WTI price differential;
- Bolded items indicate vectors.

Since the Breusch-Pagan-Godfrey test and White's test indicated the presence of residual heteroskedasticity in all of the equations, the Newey-West HAC estimator was used to calculate the covariance matrix. The expected sign of the estimated coefficient on inventory variables is negative, the expected sign on the estimated coefficient on change in crude oil price is positive with the sum equal to approximately 0.0238. The sign of the estimated coefficient on the error correction term is negative. Because gasoline prices demonstrate regular seasonal fluctuations, the significance test for the seasonal dummy variables confirmed them to be jointly different from zero.

For each of the four gasoline (mogas) spot prices considered, EIA created two different sets of equations:

1. Equation Set 1
   a. $\Delta(\text{mogas})_t = \beta_1\Delta(\text{Brent})_t + \beta_2\Delta(\text{regional inv})_t$ + other terms
   b. $\Delta(\text{mogas})_t = \beta_1\Delta(\text{WTI})_t + \beta_2\Delta(\text{regional inv})_t$ + other terms
2. Equation Set 2
   a. $\Delta(\text{mogas})_t = \beta_1\Delta(\text{Brent})_t + \beta_2\Delta(\text{regional inv})_t + \beta_3\Delta(\text{Brent-WTI})_t$ + other terms
   b. $\Delta(\text{mogas})_t = \beta_1\Delta(\text{WTI})_t + \beta_2\Delta(\text{regional inv})_t + \beta_3\Delta(\text{Brent-WTI})_t$ +other terms

where

- Δ(Brent) and Δ(WTI) = weekly change in Brent and WTI spot price, including lags in some cases
- Δ(regional inv) = weekly change in the deviation of in-region gasoline inventories from the previous 5-year average, including lags in some cases
- Δ(Brent-WTI) = weekly change in crude oil spot price differential
- Other terms include the error correction term and an AR (1) variable

These four equations were estimated for two periods:

- Period 1: January 2000–December 2010: period of narrow Brent – WTI price differentials
- Period 2: January 2011–June 2014: period of wide and variable Brent – WTI price differentials

Equation Set 1 shows changes in each of the regional gasoline spot prices as a function of the change in the respective benchmark crude oil. Comparing the results of Equations 1a and 1b will indicate whether Brent or WTI price change had more explanatory power in determining U.S. gasoline spot prices. Additionally, comparing the results of Equations 1a and 1b in Periods 1 and 2 will show whether each crude oil's explanatory power went up or down after WTI began selling at a significant discount to Brent in January 2011.

Equation Set 2 introduces the change in the Brent-WTI spread to Equation Set 1. Adding this variable allows evaluation of whether adding Brent prices to an equation that has WTI prices as an independent variable, or vice-versa, adds statistically significant explanatory power to the equation. The reasoning is as follows: if Brent is the crude oil price that explains gasoline price changes, then introducing WTI (in the form of WTI-Brent spread to reduce multicollinearity) into the gasoline/Brent estimation should add no explanatory power (i.e., result in an insignificant coefficient). However, under the same hypothesis, introducing Brent into the gasoline/WTI equation should add explanatory power (i.e., result in a statistically significant coefficient). As shown in the following section, this hypothesis is confirmed.

Results of the regression analysis

Tables 4 and 5 summarize (i.e., with the "other terms" not shown) results of the regression analysis. Tables 6 and 7 show the detailed estimation results.

Table 4. Summary regression results for Equation Set 1

Equation 1a: Δ(mogas) = $\beta_1\Delta$(Brent) + $\beta_2\Delta$(regional inv)

Period 1: 2000-10	Δ(Brent)		Δ(inv)[1,2]		Adj
	β	lags	β	lags	R-sq
New York Harbor	0.023	0	-12.0	1	0.63
U.S. Gulf Coast	0.024	0	-15.6	2	0.60
Chicago	0.023	0	-15.9	2	0.43
Los Angeles	0.024	0	-36.9	2	0.44

Equation 1a: Δ(mogas) = $\beta_1\Delta$(Brent) + $\beta_2\Delta$(regional inv)

Period 2: 2011-14	Δ(Brent)		Δ(inv)[1,2]		Adj
	β	lags	β	lags	R-sq
New York Harbor	0.023	0	-27.2	2	0.59
U.S. Gulf Coast	0.024	0	-13.0	1	0.54
Chicago	0.021	0	-20.6	1	0.37
Los Angeles	0.028	0	-41.7	2	0.44

Equation 1b: Δ(mogas) = $\beta_1\Delta$(WTI) + $\beta_2\Delta$(regional inv)

Period 1: 2000-10	Δ(WTI)[1]		Δ(inv)[1,2]		Adj
	β	lags	β	lags	R-sq
New York Harbor	0.021	0	-11.7	1	0.58
U.S. Gulf Coast	0.021	0	-14.1	2	0.55
Chicago	0.024	1	-16.3	2	0.39
Los Angeles	0.022	0	-38.2	2	0.41

Equation 1b: Δ(mogas) = $\beta_1\Delta$(WTI) + $\beta_2\Delta$(regional inv)					
Period 2: 2011-14	Δ(WTI)[1]		Δ(inv)[1,2]		Adj
	β	lags	β	lags	R-sq
New York Harbor	0.019	0	-20.7	1	0.42
U.S. Gulf Coast	0.020	0	-16.8	1	0.41
Chicago	0.015	0	-25.6	1	0.30
Los Angeles	0.027	1	-49.1	2	0.36

[1]Note: Where lags have been included in the equation, the reported coefficients are the sums of the lagged and present period coefficients.
[2]Note: All inventory coefficients are x10^6.

Comparing the results of Equations 1a and 1b (shown in Table 4) for both sub-time periods indicates that changes in Brent prices are more important than changes in WTI prices for all regions in explaining changes in gasoline price, as evidenced by higher R-squared values for Equation 1a for each respective gasoline spot price. Additionally, from Period 1 to Period 2 the R-squared values in Equation 1a decreased only slightly, between 0.00 and 0.06, showing the explanatory power of changes in Brent price stayed relatively unchanged. However, for WTI the R-squared values decreased between 0.05 and 1.16 from Period 1 to Period 2, showing the explanatory power of changes in WTI price went down. The lower R-squared values for both crudes in Period 2 are likely the result of changes in the U.S. gasoline market in Period 2 that reflect increasing refinery runs and declining domestic demand, which have changed historical levels and variation of U.S. gasoline-crude differentials. However, the changing nature of the U.S. gasoline market is a topic for further study.

The coefficient for change in crude oil price is expected to be approximately 0.0238 (i.e., a $1 per barrel change in the price of crude oil leads to 2.38 cents per gallon change in the price of gasoline, or 1/42). This coefficient represents full price pass-through from crude oil prices to gasoline prices. Coefficients for Brent in Period 1 are consistent with those expectations. Those coefficients change somewhat in Period 2 for Chicago and Los Angeles, likely because of differences in the nature of U.S. gasoline markets. This is responsible for the lower R-squared values described above for those hubs. For WTI, the coefficients are largely in line with expectations for Period 1, but to a lesser extent than Brent. However, in Period 2 for WTI, the coefficients deviate from the expected 0.0238 level. In both periods, the *p*-values indicate that the coefficients of both changes in Brent and WTI prices are significant at the 99% confidence level. While equations with Brent as the independent variable have higher R-squared values than those with WTI, week-to-week changes in WTI price are still very highly correlated with the week-to-week changes in Brent price, and thus with gasoline prices, even in Period 2. Additionally, the current period and lagged inventory variables are generally significant at least at the 90% confidence level across the board. (See Table 6 and 7 for details.)

For both periods and sets of equations, the R-squared values (reported in Tables 4 and 5) for New York Harbor and the USGC are higher than for Chicago and Los Angeles. This is because the Chicago and Los Angeles markets have more volatile gasoline-crude oil margins, which reflect those markets' relative isolation. Unlike New York Harbor and the USGC, they cannot directly pull supply from the actively traded Atlantic Basin, causing differentials in these markets to widen further in times of tight supply to encourage resupply from other more distant markets. As a result, more of the variation in gasoline price in these markets is related to price changes in the gasoline market itself, rather than changes in the price of crude oil. The inventory variable is included to capture changes in gasoline market conditions, but it is imperfect in that function. This is particularly true in markets such as Los Angeles and Chicago. For example, New York Harbor gasoline inventories comprise a significant amount of total PADD 1B (Central Atlantic) gasoline inventories, likely better reflecting supply-demand conditions in that market. However, changes in total PADD 5 (West Coast) gasoline inventory levels could vary significantly from changes in inventories in Los Angeles, as PADD 5 has several other large markets, including San Francisco, Seattle, and Portland. Thus, PADD 5 inventories might not accurately reflect gasoline market conditions in Los Angeles.

Table 5 shows regression results for Equations 2a and 2b, which include the Brent-WTI price differential as an independent variable. As discussed above, the results support the hypothesis that changes in the Brent price, rather than in the WTI price, explain changes in gasoline prices.

Table 5. Summary regression results for Equation Set 2

Equation 2a: $\Delta(\text{mogas}) = \beta_1\Delta(\text{Brent}) + \beta_2\Delta(\text{regional inv}) + \beta_3\Delta(\text{Brent-WTI})$

Period 1: 2000-10	Δ(Brent)		Δ(inv)[1,2]		Δ(Brent-WTI)		Adj
	β	lags	β	lags	β	p-value	R-sq
New York Harbor	0.023	0	-11.8	1	-0.004	0.133	0.63
U.S. Gulf Coast	0.024	0	-15.2	2	-0.004	0.236	0.60
Chicago	0.023	0	-15.9	2	0.002	0.640	0.43
Los Angeles	0.024	0	-36.9	2	-0.004	0.410	0.44

Equation 2a: $\Delta(\text{mogas}) = \beta_1\Delta(\text{Brent}) + \beta_2\Delta(\text{regional inv}) + \beta_3\Delta(\text{Brent-WTI})$

Period 2: 2011-14	Δ(Brent)		Δ(inv)[1,2]		Δ(Brent-WTI)		Adj
	β	lags	β	lags	β	p-value	R-sq
New York Harbor	0.024	0	-27.2	2	0.000	0.955	0.59
U.S. Gulf Coast	0.025	0	-13.6	1	-0.005	0.124	0.55
Chicago	0.021	0	-20.6	1	-0.001	0.883	0.37
Los Angeles	0.030	0	-44.7	2	-0.008	0.096	0.45

Equation 2b: $\Delta(\text{mogas}) = \beta_1\Delta(\text{WTI}) + \beta_2\Delta(\text{regional inv}) + \beta_3\Delta(\text{Brent-WTI})$

Period 1: 2000-10	Δ(WTI)		Δ(inv)[1,2]		Δ(Brent-WTI)		Adj
	β	lags	β	lags	β	p-value	R-sq
New York Harbor	0.023	0	-12.0	1	0.017	0.000	0.63
U.S. Gulf Coast	0.024	0	-15.1	2	0.018	0.000	0.60
Chicago	0.023	0	-15.0	2	0.022	0.000	0.43
Los Angeles	0.024	0	-17.5	2	0.019	0.000	0.44

Equation 2b: $\Delta(\text{mogas}) = \beta_1\Delta(\text{WTI}) + \beta_2\Delta(\text{regional inv}) + \beta_3\Delta(\text{Brent-WTI})$

Period 2: 2011-14	Δ(WTI)		Δ(inv)[1,2]		Δ(Brent-WTI)		Adj
	β	lags	β	Lags	β	p-value	R-sq
New York Harbor	0.023	0	-14.6	1	0.020	0.000	0.54
U.S. Gulf Coast	0.023	0	-15.6	1	0.017	0.000	0.50
Chicago	0.018	0	-23.0	1	0.016	0.000	0.33
Los Angeles	0.028	0	-37.3	1	0.020	0.000	0.41

[1]Note: Where lags have been included in the equations, the reported coefficients are sums of the lagged and present period coefficients.

[2]Note: All inventory coefficients are $x10^6$.

For Equation 2a, the coefficients on the Brent and inventory variables are largely unchanged, for the different markets and time periods, from Equation 1a. Importantly, the addition of the change in the price differential between Brent and WTI does not add explanatory power to the Brent equations. The coefficients of the Brent-WTI spread in Equation 2a are insignificant with the exception of Los Angeles in Period 2, which is barely significant at the 90% level. In this case, the coefficient is likely picking up other trends in the data, as the Los Angeles gasoline market is not meaningfully connected to the WTI market. Additionally, the R-squared values for Equation 2a are generally unchanged from Equation 1a. This indicates that including the spread between Brent and WTI prices adds no explanatory power to the change in gasoline price when Brent is already an independent variable. However, the addition of the price spread between Brent and WTI prices does add explanatory power to the WTI equations (Equation 2b in Table 5). The coefficients of the Brent-WTI spread in Equation 2b are all significant at the 99% confidence level. Furthermore, the R-squared values for Equation 2b all exceed those for Equation 1b. That Brent adds explanatory power to the WTI equations, but not vice-versa, is a particularly important result. This evidence supports the conclusion that the price of Brent, rather than the price of WTI, is the more important crude oil in determining U.S. gasoline prices.

Tables 6 and 7 present a detailed version of the regression results.

Table 6. Detailed regression results for Equation Set 1

New York Harbor	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_ny		Δ mg_ny		Δ mg_ny		Δ mg_ny	
equation	1a		1b		1a		1b	
constant	0.000		0.001		0.000		0.002	
Δ brent	0.023	***			0.023	***		
Δ wti			0.021	***			0.019	***
Δ dsa_stock	-4.3E-06	**	-4.6E-06	**	-6.5E-06		-1.0E-05	**
Δ dsa_stock(-1)	-7.7E-06	***	-7.1E-06	***	-1.1E-05	***	-1.1E-05	**
Δ dsa_stock(-2)					-1.0E-05	**		
ECT(-1)	-0.152	***	-0.126	***	-0.395	***	-0.144	***
AR(1)	0.171	**	0.136	**	0.368	**	0.184	*
no. obs.	571		571		178		178	
adj. R^2	0.627		0.576		0.593		0.417	
S.E. regression	0.046		0.049		0.058		0.069	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Gulf Coast	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_gc		Δ mg_gc		Δ mg_gc		Δ mg_gc	
equation	1a		1b		1a		1b	
constant	0.001		0.001		-0.001		-0.000	
Δ brent	0.024	***			0.024	***		
Δ wti			0.021	***			0.020	***
Δ dsa_stock	-6.5E-06	***	-5.3E-06	**	-6.4E-06	*	-9.0E-06	**
Δ dsa_stock(-1)	-4.2E-06	***	-3.4E-06	**	-6.6E-06	**	-7.8E-06	**
Δ dsa_stock(-2)	-4.9E-06	***	-5.34E-06	***				
ECT(-1)	-0.148	***	-0.137	***	-0.386	***	-0.182	***
AR(1)	0.161	**	0.141	**	0.256	**	0.223	*
no. obs.	570		570		178		178	
adj. R^2	0.602		0.553		0.543		0.414	
S.E. regression	0.050		0.053		0.063		0.072	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Chicago	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_chi		Δ mg_chi		Δ mg_chi		Δ mg_chi	
equation	1a		1b		1a		1b	
constant	0.000		0.000		0.001		0.003	
Δ brent	0.023	***			0.021	***		
Δ wti			0.0193	***			0.015	***
Δ wti(-1)			0.0044	***				
Δ dsa_stock	-4.4E-06	*	-4.2E-06	*				
Δ dsa_stock(-1)	-7.3E-06	***	-7.0E-06	**	-2.1E-05	***	-2.6E-05	***
Δ dsa_stock(-2)	-4.2E-06	*	-5.2E-06	**				
ECT(-1)	-0.185	***	-0.1615	***	-0.572	***	-0.460	***
AR(1)	0.143	**	0.1041	*	0.359	***	0.340	**
no. obs.	570		570		179		179	
adj. R^2	0.426		0.385		0.375		0.300	
S.E. regression	0.072		0.074		0.107		0.113	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Los Angeles	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_la		Δ mg_la		Δ mg_la		Δ mg_la	
equation	1a		1b		1a		1b	
constant	0.000		0.000		0.000		0.001	
Δ brent	0.024	***			0.028	***		
Δ wti			0.022	***			0.023	***
Δ wti(-1)							0.004	
Δ dsa_stock	-9.8E-06	**	-9.7E-06	**	-1.3E-05		-1.2E-05	
Δ dsa_stock(-1)	-1.6E-05	***	-1.8E-05	***	-1.6E-05		-2.3E-05	**
Δ dsa_stock(-2)	-1.1E-05	***	-1.1E-05	***	-1.3E-05		-1.4E-05	
ECT(-1)	-0.176	***	-0.174	***	-0.361	***	-0.254	***
AR(1)	0.195	***	0.203	***	0.146		0.158	
no. obs.	565		565		178		178	
adj. R^2	0.441		0.409		0.445		0.361	
S.E. regression	0.075		0.077		0.095		0.102	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Table 7. Detailed regression results for Equation Set 2

New York Harbor	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_ny		Δ mg_ny		Δ mg_ny		Δ mg_ny	
equation	2a		2b		2a		2b	
constant	0.000		0.000		0.002		0.001	***
Δ brent	0.023	***			0.024	***		
Δ wti			0.023	***			0.023	***
Δ dsa_stock	-4.2E-06	**	-4.2E-06	**	0.000		-7.4E-06	*
Δ dsa_stock(-1)	-7.6E-06	***	-7.3E-06	***	-1.1E-05	***	-7.3E-06	*
Δ dsa_stock(-2)					-1.0E-05	*		
Δ brent-wti	-0.004		0.017	***	-0.000		0.020	***
ECT(-1)	-0.147	***	-0.123	***	-0.393	***	-0.126	**
AR(1)	0.163	**	0.154	**	0.366	**	0.190	*
no. obs.	571		571		178		178	
adj. R^2	0.630		0.625		0.590		0.542	
S.E. regression	0.046		0.046		0.058		0.061	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Gulf Coast	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_gc		Δ mg_gc		Δ mg_gc		Δ mg_gc	
equation	2a		2b		2a		2b	
constant	0.001		0.001		-0.001		-0.001	
Δ brent	0.024	***			0.025	***		
Δ wti			0.024	***			0.023	***
Δ dsa_stock	-6.3E-06	***	-6.4E-06	***	-6.8E-06	*	-8.3E-06	**
Δ dsa_stock(-1)	-4.0E-06	***	-3.9E-06	***	-6.9E-06	**	-7.3E-06	**
Δ dsa_stock(-2)	-4.9E-06	***	-4.8E-06	***				
Δ brent-wti	-0.004		0.018	***	-0.005		0.017	***
ECT(-1)	-0.144	***	-0.132	***	-0.382	***	-0.140	**
AR(1)	0.154	**	0.149	**	0.260	**	0.149	
no. obs.	570		570		178		178	
adj. R^2	0.604		0.602		0.547		0.333	
S.E. regression	0.050		0.050		0.063		0.110	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Chicago	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_chi		Δ mg_chi		Δ mg_chi		Δ mg_chi	
equation	2a		2b		2a		2b	
constant	0.000		0.000		0.001		0.003	
Δ brent	0.023	***			0.021	***		
Δ wti			0.023	***			0.018	***
Δ wti(-1)			0.003	**				
Δ dsa_stock	-4.5E-06	*	-4.4E-06	*				
Δ dsa_stock(-1)	-7.3E-06	***	-7.0E-06	**	-2.1E-05	***	-2.3E-05	***
Δ dsa_stock(-2)	-4.1E-06	*	0.000					
Δ brent-wti	0.002		0.022	***	-0.001		0.016	***
ECT(-1)	-0.189	***	-0.172	***	-0.570	***	-0.515	***
AR(1)	0.152	**	0.152	**	0.357	***	0.417	***
no. obs.	570		570		179		179	
adj. R^2	0.426		0.432		0.371		0.333	
S.E. regression	0.072		0.071		0.107		0.110	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Los Angeles	Period 1 (Jan 2000 - Dec 2010)				Period 2 (Jan 2011 - Jun 2014)			
dependent var	Δ mg_la		Δ mg_la		Δ mg_la		Δ mg_la	
equation	2a		2b		2a		2b	
constant	0.000		0.000		0.000		0.000	
Δ brent	0.024	***			0.030	***		
Δ wti			0.024	***			0.028	***
Δ wti(-1)								
Δ dsa_stock	-9.8E-06	**	-1.0E-05	***	0.000		-1.8E-05	*
Δ dsa_stock(-1)	-1.7E-05	***	-1.7E-05	***	-1.8E-05	*	-1.9E-05	*
Δ dsa_stock(-2)	-1.1E-05	***	-1.1E-05	***	0.000			
Δ brent-wti	-0.004		0.019	***	-0.008	*	0.020	***
ECT(-1)	-0.176	***	-0.164	***	-0.290	***	-0.170	***
AR(1)	0.197	***	0.191	***				
no. obs.	565		565		179		179	
adj. R^2	0.442		0.441		0.447		0.413	
S.E. regression	0.075		0.075		0.095		0.098	

Note: Significance level indicators are * at the 10%, ** at the 5%, and *** at the 1% level.

Dynamic linear modeling

Further evidence of the importance of Brent in determining U.S. gasoline prices is found by investigating parameter behavior over time using Dynamic Linear Modeling (DLM). Previous analysis found that market conditions changed due to major exogenous changes to the crude oil and/or gasoline distribution structure; this occurred on or about January 2011. This exercise determines whether or not the model coefficients significantly changed during the analysis period. A simplified model was employed using only current variables analyzing spot gasoline price as a function of crude oil price, PADD level gasoline inventory (adjusted for seasonal patterns), and the Brent/WTI spread.

The models (for NYH spot gasoline price) were

Brent:

$$mga\_ny_t = \alpha + \beta_t(Brent_t) + \delta_t(P1B\_Inv_t) + \omega_t(BWspread_t) + \varepsilon_t$$

$$\beta_{t+1} = \beta_t + \nu_t$$

$$\omega_{t+1} = \omega_t + \eta_t$$

WTI:

$$mga\_ny_t = \alpha + \beta_t(WTI_t) + \delta_t(P1B\_Inv_t) + \omega_t(BWspread_t) + \varepsilon_t$$

$$\beta_{t+1} = \beta_t + \nu_t$$

$$\omega_{t+1} = \omega_t + \eta_t$$

where

- mga_ny_t = NYH spot gasoline price at time t;
- (Brent) and (WTI) = Brent and WTI spot prices at time t;
- (P1B_Inv) = deviation of in-region gasoline inventories from 5-year average at time t;
- (BWspread) = crude oil spot price differential (Brent – WTI) at time t; and
- ε_t, ν_t, and η_t are normally distributed random error series.

In this study, the behavior of inventories was not of interest and was not dynamically analyzed.

The results of the New York Harbor model estimation are shown as graphs of smoothed state estimates for the coefficient on crude oil (Figures 12 and 13) and for the coefficient on the Brent/WTI spread

(Figure 14 for Brent and Figure 15 for WTI). The figures also show confidence bands of $\pm$ 2 RMSE, where RMSE is the root mean squared error.

As expected, the crude oil coefficients (SV1 state variable) for both models are very similar, and vary by a value of about 0.25 over the entire time period. However, what is noticeable is that the state estimated standard errors for the period beginning in January 2011 are much larger than for the earlier period. These results show that the relationship between crude oil price changes and gasoline price changes fluctuates over the analysis period (coefficient range is 0.19 to 0.34) and that the gasoline price change is similar for both crude oils. The latter result is not surprising, given that the correlation between the two crude oil prices is 0.98.

Figures 14 and 15 show the changing relationship (SV3 state variable) over time between gasoline prices and the WTI/Brent crude oil price spread. Both state estimates show a significant decrease during the analysis time period (from 0.015 to 0.003 for the Brent model and -0.010 to -0.020 for the WTI model). The estimated coefficient reached its largest value at the time that the crude oil market began its recovery after the dramatic collapse late in 2008. The important thing to note is that in the Brent model, the coefficient is statistically different from zero from January 2000 to the middle of 2006, and is insignificant thereafter. In contrast, the coefficient in the WTI model is statistically less than zero for the entire time period, with the coefficient becoming larger in absolute value over time. These results seem to imply that while Brent was the crude oil determining gasoline price in the recent period, both (or other) crudes impacted gasoline prices in the earlier period.

Figure 12 (appendix). Brent model, crude oil coefficient

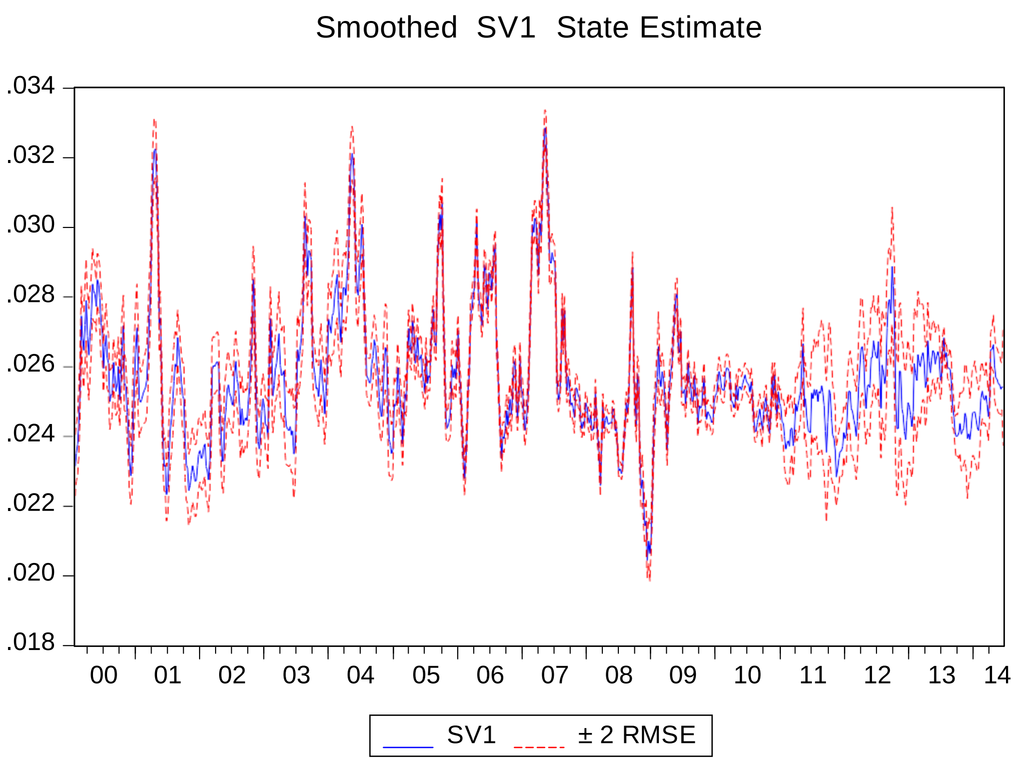


Figure 13 (appendix). WTI model, crude oil coefficient

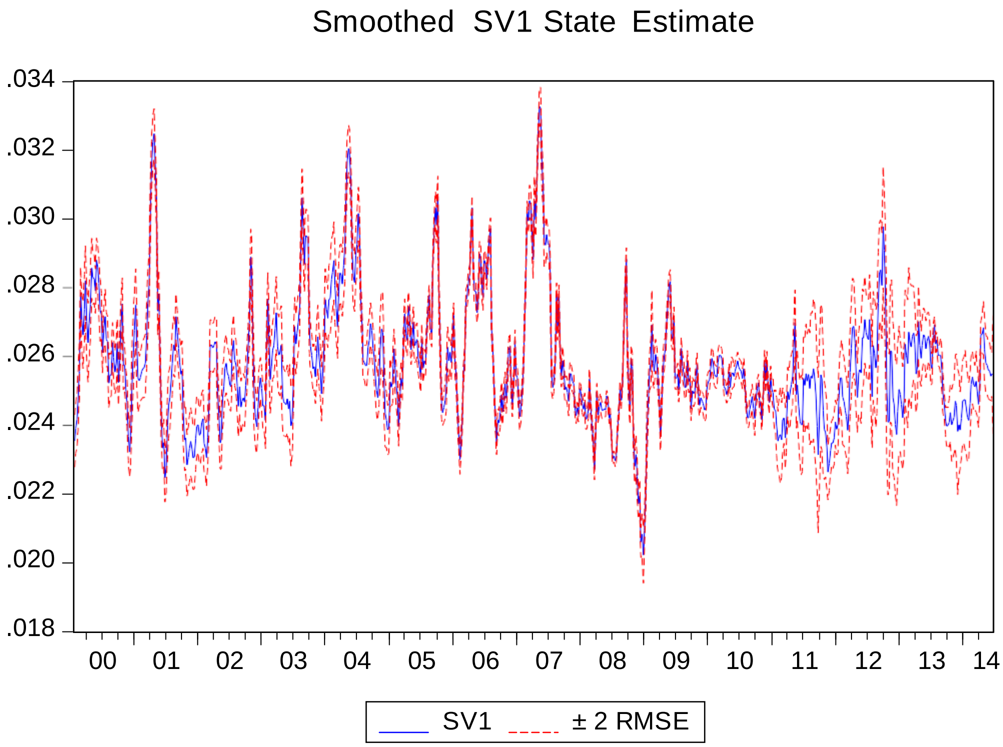


Figure 14 (appendix). PADD 1B (NYH): Brent model, spread coefficient

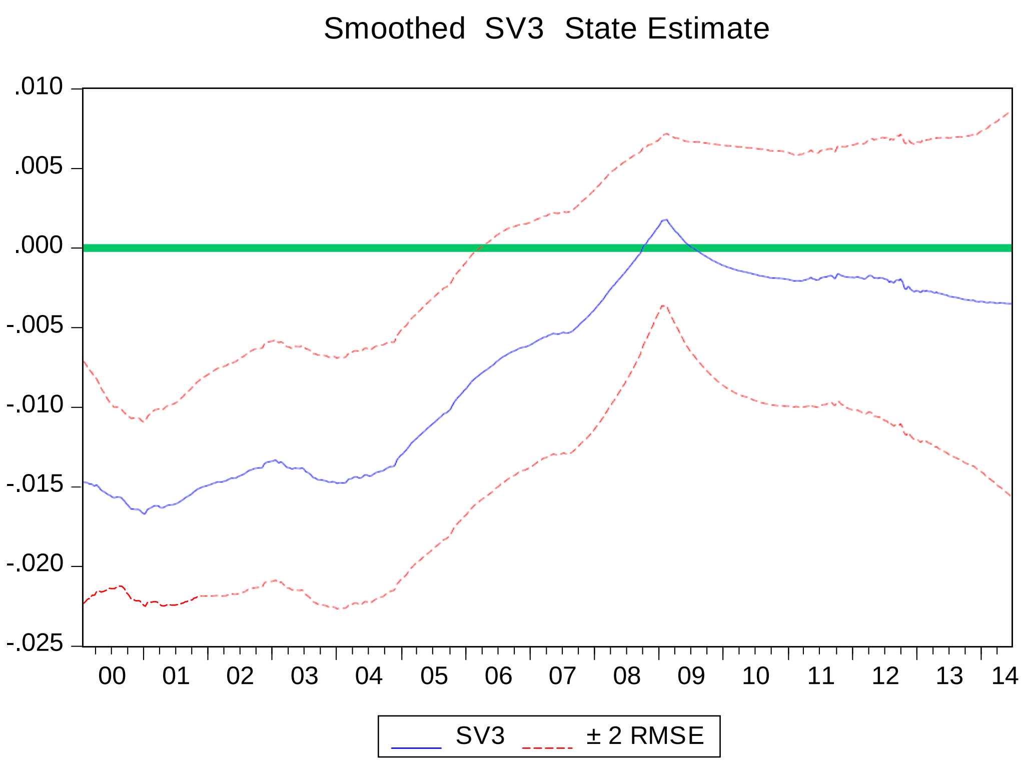
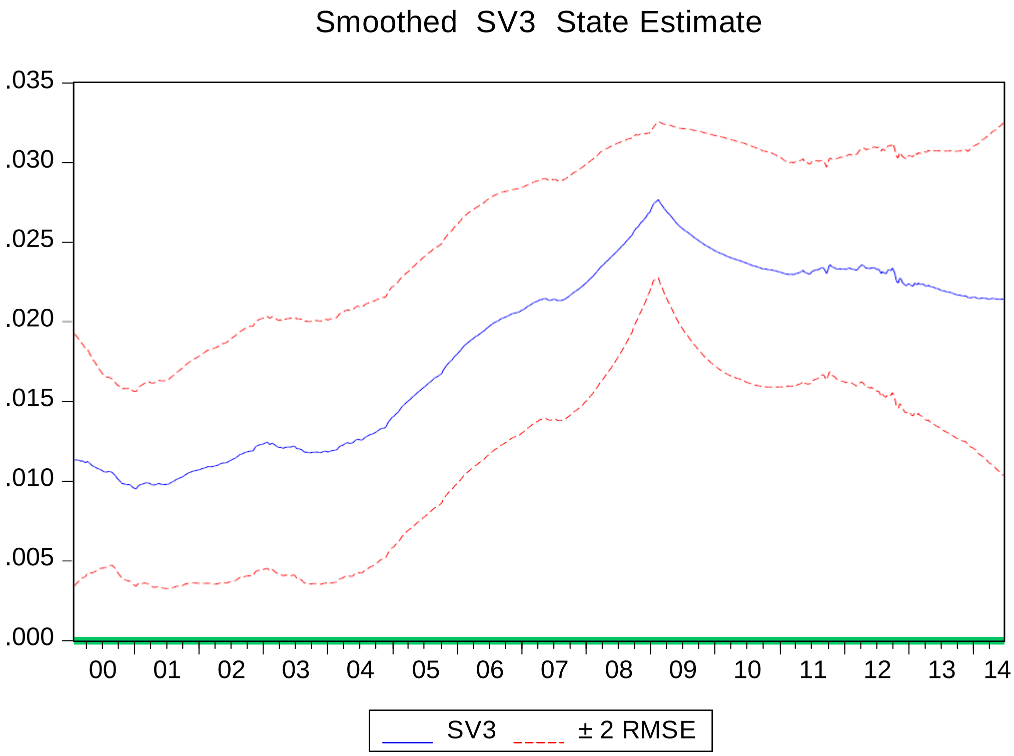


Figure 15 (appendix). PADD 1B (NYH): WTI model, spread coefficient



The estimation results for the other regions show similar results (Figures 16-18). The shift of the crude oil coefficients (SV1 coefficient) around 2008 is similar to the coefficient shift in PADD 1B. Additionally, in PADD 2 (Midwest), the spread coefficient (SV3) is insignificant in the Brent model for most of the analysis period. PADD 3 (Gulf Coast) and PADD 5 (West Coast) differ from the other regions in that the spread coefficient (SV3) is not significantly different from zero for most of the first half of the sample period.

Figure 16 (appendix). PADD 2: Chicago spot

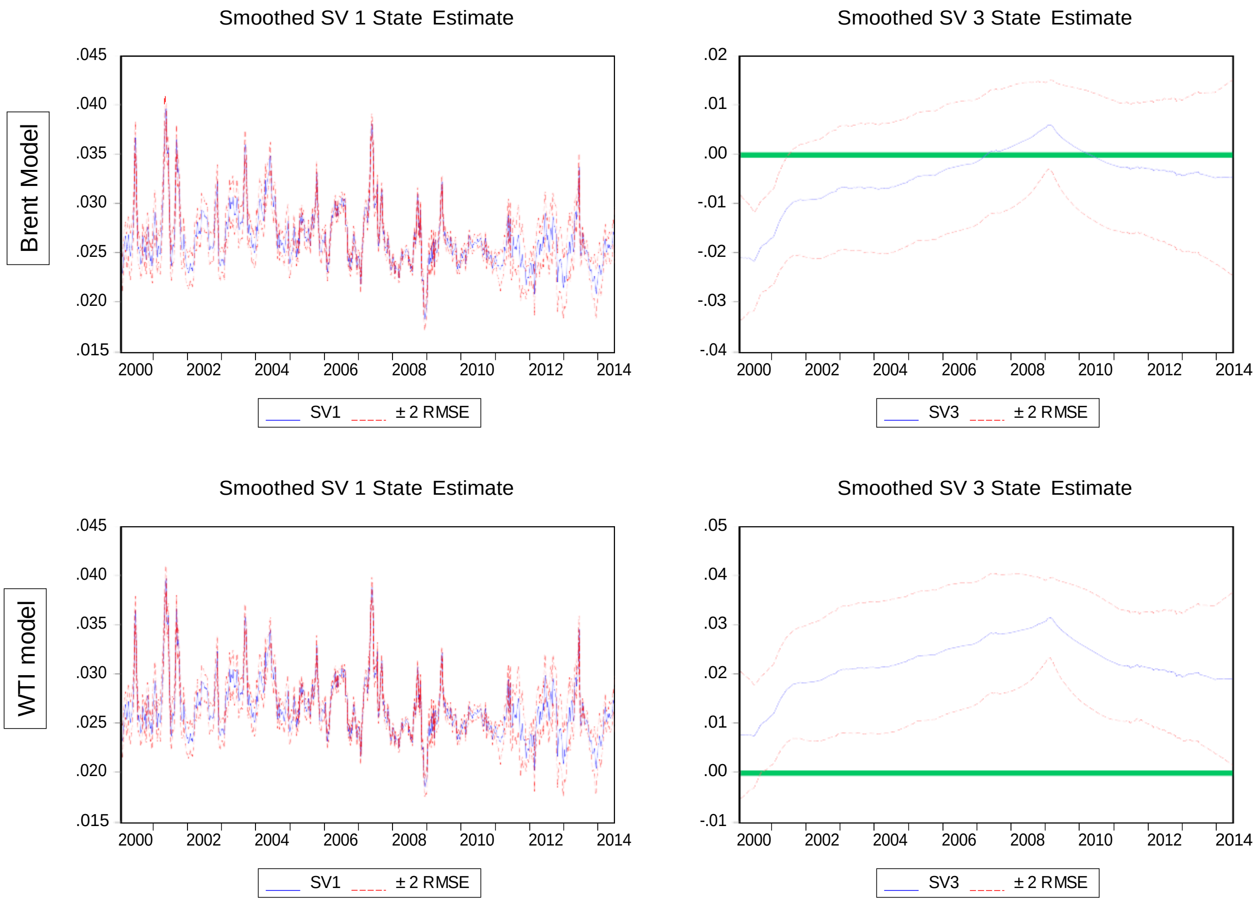


Figure 17 (appendix). PADD 3: Gulf Coast spot

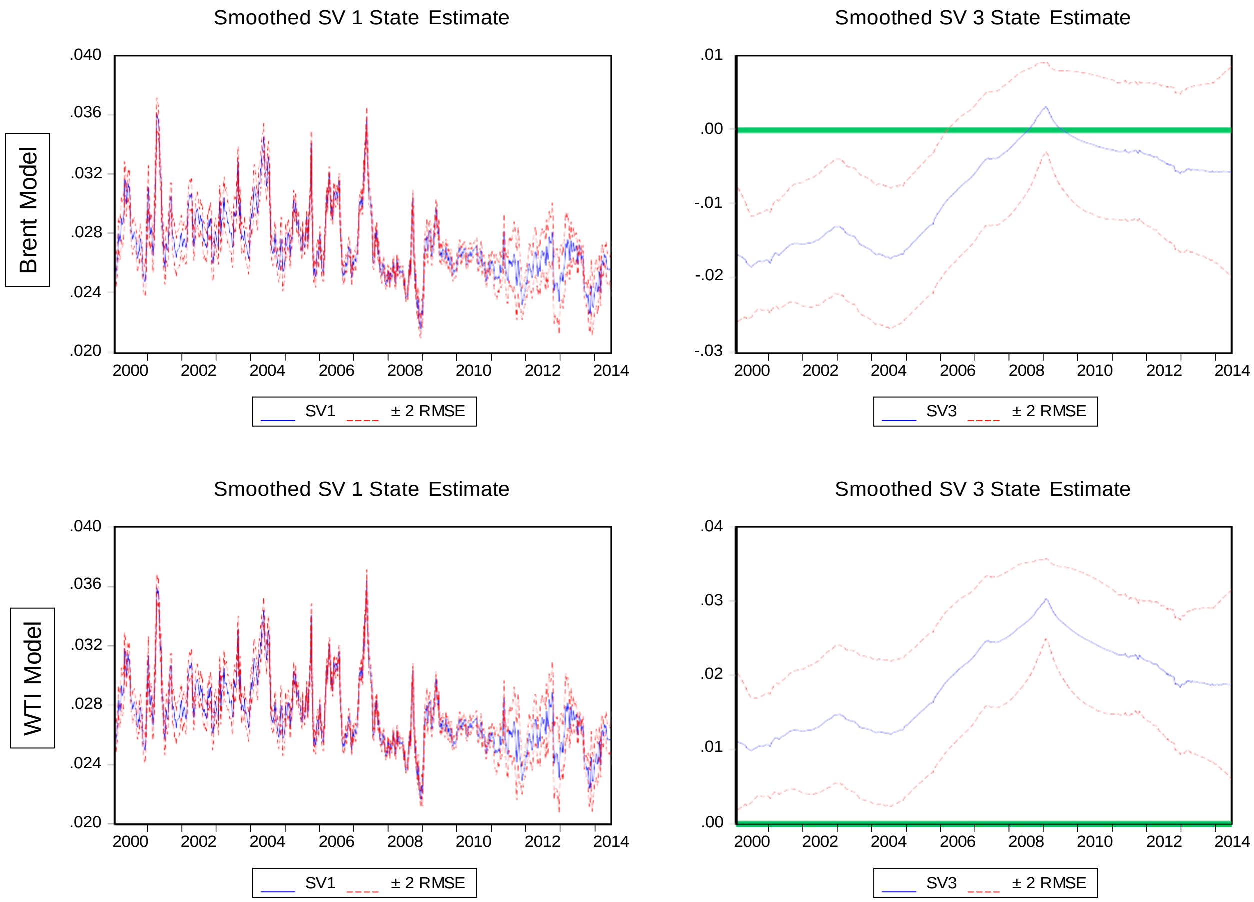
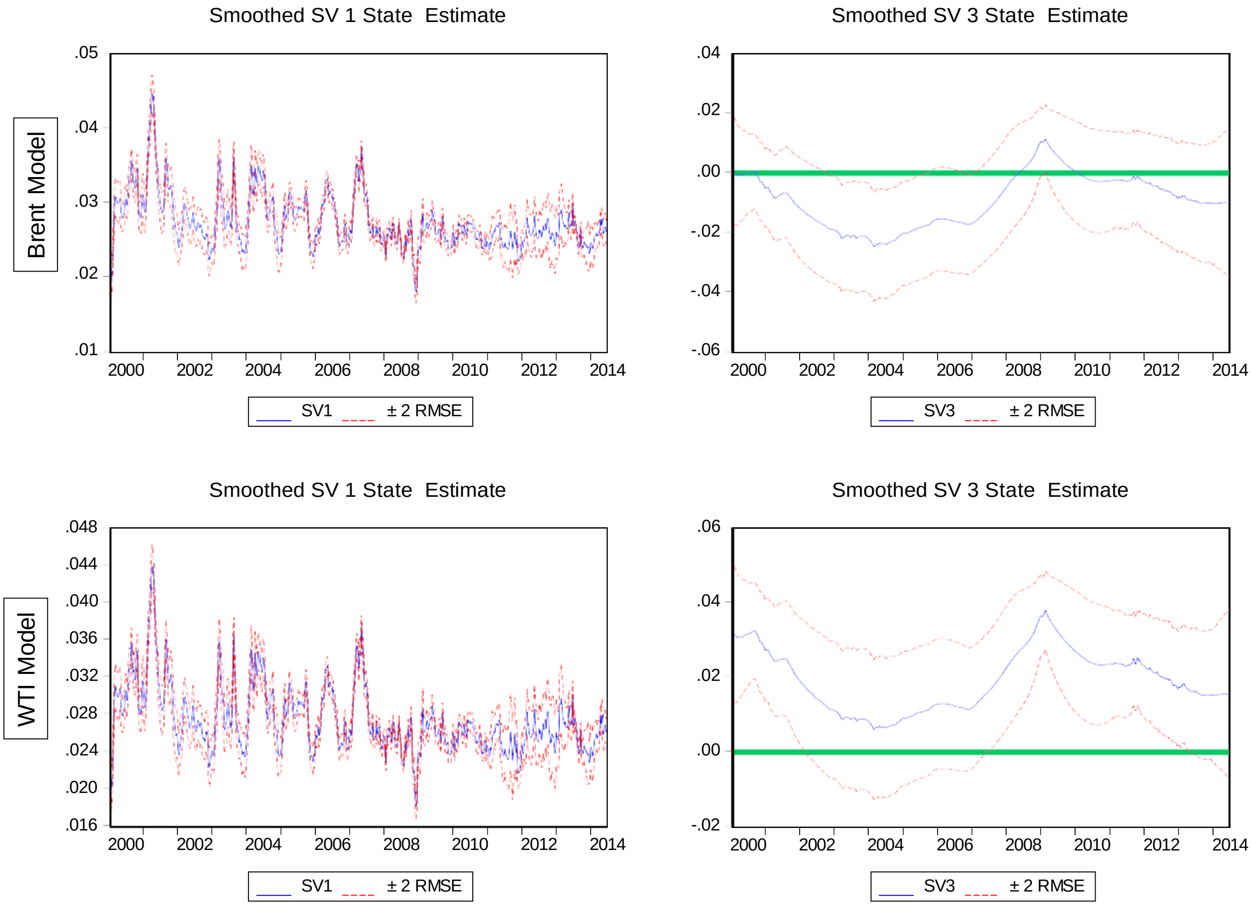


Figure 18 (appendix). PADD 5: Los Angeles spot



LIFTING THE CRUDE OIL EXPORT BAN:
THE IMPACT ON U.S. MANUFACTURING

By Thomas J. Duesterberg, Donald A. Norman and Jeffrey F. Werling

October 2014

THE ASPEN INSTITUTE MANUFACTURING AND SOCIETY IN THE 21ST CENTURY

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Lifting the Crude Oil Export Ban: The Impact on U.S. Manufacturing

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EXECUTIVE SUMMARY

The manufacturing sector is an important source of strength in the U.S. economic recovery. The surging oil and gas production sector, in turn, is a major reason behind the manufacturing sector's robust performance since 2010. This paper employs the Inforum LIFT economic forecasting model to analyze how removing the ban on crude oil exports could add to growth in manufacturing by stimulating higher levels of oil production in the United States. Two scenarios are presented and contrasted with a baseline derived from EIA's base economic projections, a low export case (up to 2 million barrels per day [b/d] at peak year in additional oil production) and a high export case (which would average 2 million b/d and reach a peak of 3.25 million b/d). Higher levels of oil production require higher investment expenditures for capital equipment and construction, which in turn boost overall demand for goods. This stimulates the manufacturing sector and its supply and distribution chains. The resulting improvement in income and employment boosts the economy significantly. Consider several figures from the high export scenario. In that alternative, we have the following highlights:

Macroeconomic Benefits

- GDP is higher by 0.93 percent or about $165 billion in 2019-2021, and levels off around 0.74 percent higher or $141 billion in 2025.
- 630,000 jobs added at peak in 2019.
- Real Household Income higher by $2,000 to $3,000 per household in 2025, an increase of 2.2 percent, and reaches peak of 2.5 percent on a per household basis in 2019.

Industrial Sector Gains

- Production of Durable Goods and materials gains 1.4 percent ($8 billion) by 2017.
- Machinery production gains 3.3 percent ($12.4 billion) in 2017.
- Agriculture, Mining, and Construction Equipment gains 6 percent ($6.1 billion) in 2017.
- Jobs in Mining (including oil and gas) up by average 43,000 per year through 2025.
- New Construction jobs peak at 216,000 in 2017.
- All Manufacturing jobs see average gain of 37,000 per year through 2025.
- Related Professional Services jobs increase by average 148,000 per year through 2025.
- Capital Investment for Machinery—exploration and development—up by $7 billion in 2020 and for construction and mining machinery by $3.6 billion.

In contrast, the refinery sector, because of slightly higher prices for light crude oil, sees its capital investment slip by almost $1 billion in 2020 from the baseline. Some manufacturing exports are also marginally reduced from the baseline by the effects of higher wages, inflation, and the real value of the dollar. Increased employment, especially good paying semi-skilled production jobs and related engineering and professional services jobs, higher capital investment, and increased production of oil and associated natural gas all combine to strengthen U.S. manufacturing if the crude oil ban is lifted. And strong manufacturing is one key to quickening the pace of economic growth in the United States.

INTRODUCTION

Despite the fact that the U.S. economy is well into its fifth year of recovery from the Great Recession, many indicators of strength in the economy are lackluster. The current recovery is the weakest on record dating back to the 1930s. Expansion of employment, investment, wages, labor participation rates, productivity, and

consumer confidence are all substandard in relation to historical patterns. Public opinion polls reflect profound uneasiness with the state of the economy and prospects for the future, especially among young people just entering labor markets.

One of the economic bright spots in the United States since 2010 has been, surprisingly to many analysts, the manufacturing sector. While U.S. manufacturing has been repeatedly challenged by more competition—Japan, the Asian Tigers, the BRICS (Brazil, Russia, India, China)—it has found ways to survive and prosper. Strong productivity growth, keeping costs under control, and retaining a technological edge have helped the sector recoup lost ground and, in the last four years, start to increase employment, export competitiveness, and leadership in such technology-dependent industries as electronics, aerospace, and heavy machinery. A recent study by The Boston Consulting Group, *The Shifting Economics of Global Manufacturing: How Cost Competitiveness Is Changing Worldwide*, identifies the reasons for the resurgence and calls the United States a "rising global star" in manufacturing.[1] Manufacturing production in the United States grew at a 4 percent annual rate in the first half of 2014, while the overall economy advanced only 1.0 percent. Productivity growth in manufacturing far outpaces that in the overall business sector. Projections for 2014-2016 by the MAPI Foundation indicate that this above-average growth will continue to power the rest of the economy.[2] Manufacturing lost 2.3 million jobs in the 2008-2009 recession. Since February 2010, 705,000 jobs or 31 percent of jobs lost have been recovered. Further, these jobs carry above-average wages and benefits.

One of the most important drivers of a robust domestic manufacturing sector is the U.S. oil and gas production boom of the last five years.[3] U.S. industry is a huge consumer of energy—up to one-third of all energy used in the United States goes into the sector. It also is a leader in the infrastructure equipment—drilling rigs, turbines, pumps, pipes, construction equipment, etc.—needed for exploration, production, transportation, and processing of oil and natural gas. Natural gas production has led the energy resurgence, and this resource is especially important as an input to sectors such as chemicals, metals, glass, and cement. The cost advantage from natural gas has already brought massive new investments to the United States in these industries and has helped the overall manufacturing sector enhance its cost advantage over competing countries, especially in Europe and Asia which must import most of their natural gas and oil.[4]

Less well understood is the importance of oil production to manufacturing. Although of course widely used in transportation and refining, it is only in the last few years that U.S. crude oil production has expanded to a point where its importance to manufacturing is worth a reassessment. Because of constraints in domestic refining (explained below), much of the potential growth in crude oil production will not be realized unless global markets can be accessed. According to many studies, we are fast approaching a tipping point where growth in U.S. crude oil production will be economically challenged, unless the long-standing ban on exports of crude is lifted.[5] The boom in oil production has been a boon to manufacturing due not only to its impact on the growth of GDP but also because U.S. industry is highly competitive in producing the capital equipment used to develop shale resources. In addition, the United States has a dominant competitive position on the technical expertise required for extracting oil from shale formations. Also, much of the new natural gas being produced in recent years comes from oil drilling (natural gas prices are too low to spur much new drilling for this resource alone) so increasing the production of oil is currently very important if we are to maintain an abundant and stable supply of natural gas.

This study assesses the importance of increased oil production on manufacturing, and especially the potential impact of spurring even more production by opening global markets to U.S. crude oil. We will argue that the combination of increased oil and gas production likely to be spurred by lifting the export ban, and the associated increase in manufacturing can provide a substantial boost to U.S. economic growth over the next few years.

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[1] Sirkin, *et al*., *The Shifting Economics of Global Manufacturing: How Cost Competitiveness Is Changing Worldwide*, The Boston Consulting Group, August 2014. See also the August 2013 BCG report by the same authors, *The U.S. as One of the Developed World's Lowest-Cost Manufacturers: Behind the American Export Surge*.
[2] Daniel J. Meckstroth, "U.S. Industrial Outlook: Growth Mode," MAPI Foundation, September 9, 2014.
[3] Sirkin, *op. cit.*, and see also Thomas J. Duesterberg, *The Manufacturing Resurgence: What It Could Mean for the U.S. Economy*, The Aspen Institute, March 2013.
[4] The American Chemistry Council notes that in the United States over 204 separate projects, representing cumulative capital investment of $126 billion have been announced in recent years. Sixty-four percent of these projects involve foreign direct investment. See American Chemistry Council and "Economic Trends," September 26, 2014.
[5] See Charles K. Ebinger and Heather Greenley, *Changing Markets: Economic Opportunities from Lifting the U.S. Ban on Crude Oil Exports* (Washington, DC: Brookings Institution, 2014) Policy Brief 14-02, pp. 23-28.

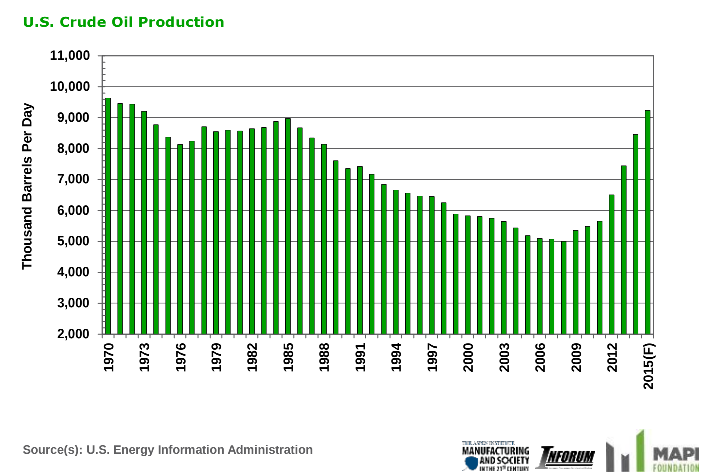
BRIEF HISTORY

In the wake of the 1973 Arab oil embargo, Congress enacted a ban on the export of crude oil. The ban on oil exports was largely academic in that the United States was becoming increasingly reliant on crude oil imports. In 1973, the United States imported an average of 3.2 million barrels of crude oil per day (million b/d) and 3.0 million b/d of petroleum products. By 2005, crude oil imports had more than tripled to 10.1 million b/d while petroleum product imports had risen to 3.6 million b/d. Reliance on oil and product imports as a percent of total petroleum consumption increased from 36 percent in 1973 to 66 percent in 2005.

Thanks to the hydraulic fracturing-directional drilling revolution, by August 2014 oil production was 3.5 million b/d above its January 2008 level. On the demand side, total petroleum use through the first seven months of 2014 was 1.8 million b/d lower than in 2007, the year prior to the start of the Great Recession. As a result of increased production and falling consumption, crude oil imports during the first seven months of 2014 were 4.2 million b/d lower than their average level for all of 2007. Total petroleum imports during the first seven months of 2014 were equivalent to 49 percent of consumption, down from 66 percent in 2005. Petroleum imports net of exports of refined products and very small quantities of crude oil (mainly to Canada where exports of Alaskan crude are permitted) were equal to just 28 percent of domestic consumption for the first eight months of 2014.

The U.S. Energy Information Administration's (EIA) 2014 baseline *Annual Energy Outlook* projects that in 2020 crude oil production will reach 9.6 million b/d (Figure 1). Domestic consumption will total 19.5 million b/d in 2020 and then decline thereafter through 2040. Under higher growth scenarios (see the section on methodology on page 6), production could reach 30 percent or more than is now projected. A major incentive to increase domestic crude oil production would of course be opening sales to global markets by removing the ban on exports. Many opposed to ending the ban are concerned that doing so would result in higher prices for petroleum products—especially gasoline. We will show why this argument lacks merit. Moreover, ending the ban would generate considerable benefits for the overall U.S. economy as well as the manufacturing sector.

Figure 1: Downward Trend in U.S. Oil Production Turned Up Sharply After 2008



Source(s): U.S. Energy Information Administration

WHY EXPORT CRUDE OIL?

Given that U.S. crude oil imports currently total 7.4 million b/d, one might ask why there is a push to export any oil. That is, why don't we simply use new production of crude in U.S. refineries and thereby further reduce our reliance on crude oil imports?

The reason for allowing exports is primarily that not all oil is the same. Most of the increased production in recent years has been in the form of lighter ("sweet") crude oil. Unfortunately, this type of oil is not well-suited for U.S. refineries. U.S. refiners have invested over $85 billion in the last 25 years to reconfigure their plants so that they can efficiently process heavier crude oil slates because this oil sells at a discount and has been increasingly available to U.S. refineries. Much of this heavy oil originates in Canada, Mexico, and Venezuela. These refineries can process lighter slates of crude oil, but given the way they have been configured, their efficiency, in terms of the yields of petroleum products like kerosene, light diesel oil, heating oil, and heavy diesel oil would fall.[6]

---

[6] For a thorough discussion of U.S. refining capacity, including the types of oil used in domestic refineries, see IHS Global Insight, *U.S. Crude Oil Export Decision Assessing the Impact of the Export Ban and Free Trade on the U.S. Economy* (Houston: IHS Global Insight, 2014), especially Chapter III.

Refiners eventually will have to make new investments to upgrade existing refineries and when they do they have the option of reconfiguring them so that they can process lighter slates of crude oil. But the required investments to do this are very sizable. Further, given that many refiners have already made investments that enable them to process heavier slates of crude oil that sells at a discount, it will take years before overall U.S. refining capacity changes significantly so that the growing production of domestic light oil coming from shale formations can be efficiently processed.

Economically, then, it makes more sense to export light crude oil to Europe and Asia where more refineries are configured to handle light oil. Light oil sells at premium compared to heavier oil in world markets. In the United States, however, the refinery mismatch means that light oil sells as a significant discount relative to heavier, imported oil. The current price for light oil in the United States makes the development of some shale plays less economic. Once producers are free to export crude oil to markets abroad where it is more highly valued, the incentive to further develop these resources will be significantly increased.

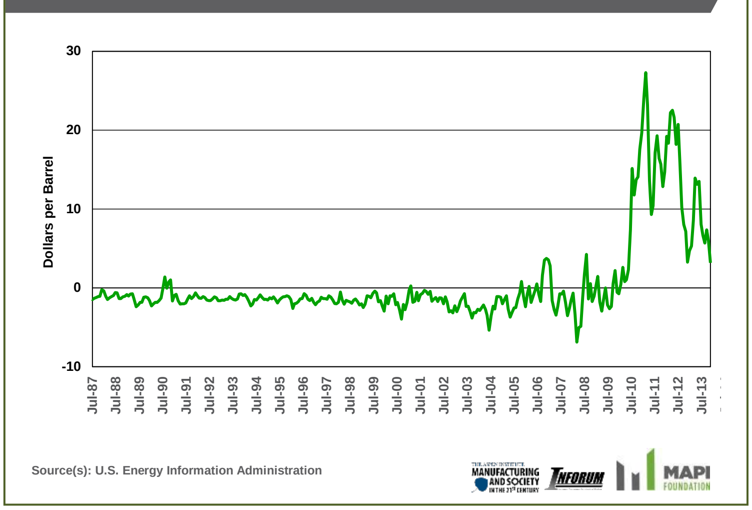
There are three other compelling reasons to consider exporting crude oil. First, the United States has been, since the Bretton Woods Accord after World War II, a leader in promoting the unfettered global exchange of goods and services. The post-war free trade era has been one of consistent and strong economic growth, which has extended prosperity to an ever-widening share of the global population. The oil export ban is a serious flaw in the U.S. record of support for the Bretton Woods system. Second, in the current climate in which many of our best allies are dependent on Russian supplies of oil and gas, increasing U.S.-sourced resources in the global marketplace will be of great benefit in reducing such dependence. And, finally, as we will show in the paper, lifting the ban on U.S. exports will spur production of oil (and affiliated gas) and will strengthen the U.S. manufacturing economy. In summary, as Harvard economist Lawrence Summers recently argued: "The merits [of lifting the outright ban on crude oil exports] are as clear as the merits with respect to any significant public policy issue that I have ever encountered."[7]

INCREASED OIL PRODUCTION AND THE SPOT PRICE OF OIL

The price of crude oil is determined by supply and demand. On a day-to-day basis, various factors including weather, inventory reports, changes in the value of the dollar, economic reports signaling an upturn or downturn in the economy, a terrorist action that halts production, and changes in the amount of excess worldwide production capacity, can cause the price of oil to fluctuate around its long-term trend.

Daily spot oil prices reflect the confluence of all these factors. Light crude oil currently is selling in the United States at spot prices that are below the world price of oil. As shown in Figure 2, the Brent spot price has exceeded the West Texas Intermediate (WTI) spot price since November 2010. The Brent spot price is a better indicator of the cost of incremental (imported) oil supplies. In addition, domestic gasoline prices track the Brent spot more closely than they do the WTI spot price.[8]

Figure 2: Brent Spot Price Minus WTI Spot Price



This was not always the case. From May 1987 through the end of 2010, the long-term difference between these two spot prices averaged $1.37 per barrel and, during this period, it was the WTI price that was at a premium compared to the Brent price. The gap between these two prices expanded after 2010, reaching as high as $27.31 per barrel in September 2011. Even with the decline in the difference in recent months, the gap between these two prices averaged $13.64 from January 2011 through July 2014.

There are two reasons why the WTI spot price is currently so far below the Brent spot price. First, due to the surge in oil production,

[7] "Larry Summers Argues Case for Lifting the Crude Oil Export Ban," Fred Dews, *Brookings Now*, September 9, 2014.

[8] Donald A. Norman, "Shedding the Light: Should the United States Export Crude and Petroleum Products?" MAPI, *Issues in Brief*, March 5, 2014.

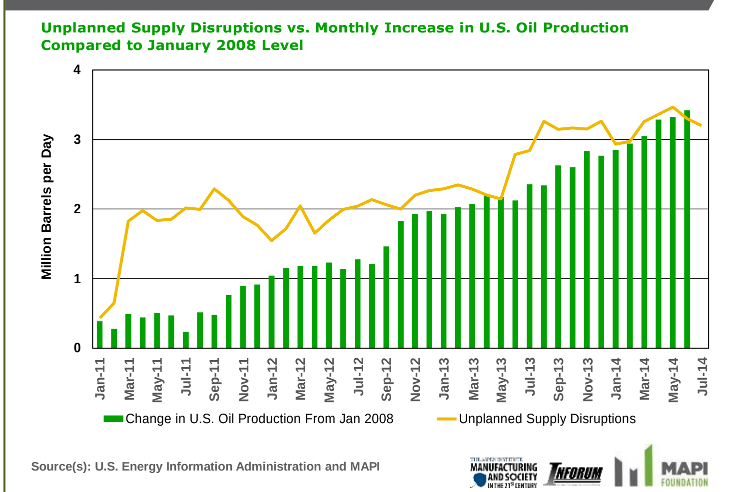
especially from new oil shale plays in the Northern Great Plains and the Utica and Marcellus formations in the East and Midwest, the ability to ship oil coming down to major refining locations in the Midwest and the Gulf Coast from the newer places is hindered by the lack of pipeline capacity. As a result, much of this oil must be shipped by rail which is more expensive than shipping through a pipeline. To compete, the oil coming south from North Dakota must sell at a discount. With new pipelines, however, it is becoming easier to ship oil out to the Midwest. As a result, the gap between the WTI spot price and the Brent spot price is narrowing.

The second reason is that, as mentioned earlier, refiners are not willing to pay a premium for lighter oil because their facilities are largely configured to process heavy oil and cannot process lighter grades as efficiently. To compete, the lighter oil that is being produced in places like North Dakota must be priced competitively with less expensive, heavier crude oil.

THE EFFECTS OF CRUDE OIL EXPORTS ON THE PRICE OF CRUDE OIL

Critics of oil exports argue that exports would raise the domestic price of oil and therefore the cost of petroleum products like gasoline and diesel fuel. In reality, the prices of crude oil are determined in the world oil market, not by how much oil is exported from the United States. There is a touch of irony in the argument that allowing oil exports would raise the price of oil because some complain that the significant increase in U.S. oil production in recent years has not reduced the price of oil and gasoline. But in fact, increased U.S. oil production has affected the world price of oil. The 3.5 million b/d increase in production since January 2008 has offset the loss of oil production due to unplanned disruptions in countries like Libya, Nigeria, and Angola and the sanctions imposed on Iran (Figure 3).

Figure 3: Increased U.S. Oil Production Has Offset Unplanned Global Supply Disruptions



Had U.S. production not increased—had it continued its long-term downward trend—the world price of oil would be much higher today. Many likewise believe that gasoline prices will rise if the ban is lifted. On the surface, this seems to make sense: if we export oil, we have less of it here and therefore the price of all petroleum products must rise. Given the public's sensitivity to changes in the price of gasoline, many in Congress are reluctant to support eliminating the ban on crude oil exports.[9]

The oil market, however, is worldwide and prices of various grades of oil are set in world markets. Producing more oil domestically will put additional downward pressure on the world price of oil. If we export oil and then have to import more of it to offset exports, it might seem a wash and the price of oil would not change. In reality, however, the price of gasoline would likely fall a bit. The reason is that the price of light oil is artificially depressed in the United States. By allowing light oil to be exported, the price received by producers would rise, thereby spurring additional development and thus leading to an increase in production over and above what would be forthcoming were exports banned. Moreover, we note that the United States is already a net exporter of refined products such as gasoline and diesel (an average of 3.6 million b/d to date in 2014) and this has not caused domestic prices to deviate from global crude prices. That is, gasoline and diesel prices continue to move in tandem closely with the world price of crude oil despite the increase in product exports.

Arguing that the market for crude oil is not free also resonates with many, but the fact is that the price of oil is determined by the forces of global supply and demand and moves over time in a way consistent with these market forces. As mentioned above, the daily spot price of oil is impacted by a number of factors, thereby resulting in price volatility on a day-to-day basis around the longer-term trend in the price of oil. This simply reflects the rational response by market participants to events that impact the oil market. If a hurricane, for

[9] For additional analysis of the impact on gasoline prices, see Stephen P.A. Brown, et al., "Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States," Resources for the Future, Issue Brief 14-03-REV, March 2014.

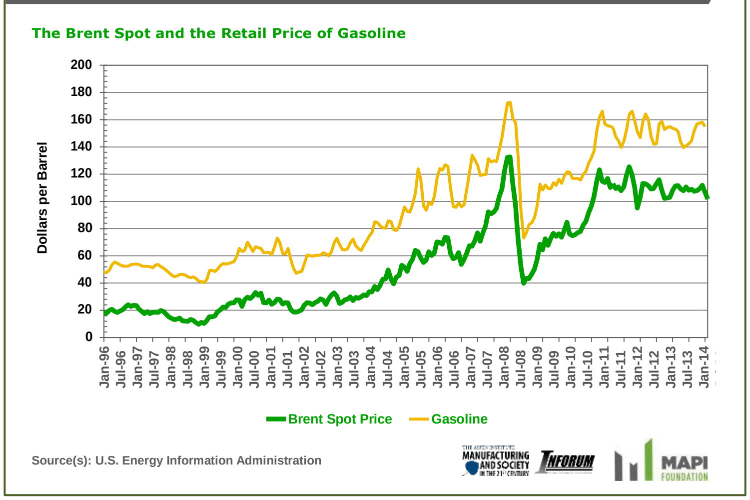
example, knocks out refineries and drilling rigs along the Gulf Coast as two did in 2005, the price of petroleum products will rise, thereby signaling consumers that, temporarily, petroleum products in some markets have become scarcer. The function of higher prices is to allocate existing supplies among consumers.

OPEC can impact the price of oil, but its ability to determine the price of oil in the long-term is limited. OPEC countries rely on the revenue generated from oil sales. If OPEC countries cut back on production, their spare production capacity will grow. The fall in revenue is very detrimental to the budgets of these countries, especially when they realize that the marginal cost of producing oil when they have spare production capacity is low.[10] Eventually, growing excess capacity causes any cartel discipline to fall apart, just as it did in the mid-1980s. Added to OPEC's problem in trying to control the price of oil are the rise in production from non-OPEC countries (including, now, the phenomenal increase in U.S. oil production) and the slowing growth in consumption in Europe and the United States.

Oil is obviously important for consumers, but so too is corn and wheat. If the U.S. imposed a ban on exports of corn and wheat, the prices of corn and wheat would fall temporarily simply because the available supply would exceed demand. Further, we are not dependent on imports of corn and wheat as is the case for oil. If we maintain a ban on oil exports, we would import less, but continue to consume the same amount of oil. Therefore, there would be no excess supply of oil in the aggregate. But if the goal is to reduce the price of essential commodities, then why not impose a ban on corn and wheat exports? One reason is that lower prices would reduce the amount of corn and wheat produced by farmers. In little time, supply would fall until the price of corn rose sufficiently to bring supply and demand into balance.

In short, as shown in the Figure 4, the price of gasoline in the United States moves almost in lockstep with the price of crude oil which is set in world markets. Regression analysis further indicates just how closely gasoline prices are linked to the world price of oil. Because petroleum products like gasoline are more closely linked to the world price of oil, the price of imported and domestically refined gasoline is expected to fall slightly. As a consequence of a slightly lower price for petroleum products and having to pay more for domestic production of light oil, refiners could see their margins reduced slightly even though they would pay less for imports of heavier oils.

Figure 4: Gasoline Prices Closely Track the Spot Brent Price



Methodology

Baseline

The following analysis used the Inforum's Long-Term Interindustry Forecasting Tool (or LIFT) to illustrate the macroeconomic and industry effects of removing the crude oil export ban. It is a dynamic equilibrium model which combines an interindustry input-output formulation with extensive use of regression analysis to create a "bottom-up" approach to macroeconomic modeling. Various versions of the LIFT model have been used over the past 45 years to describe how changes in the economic conditions or economic policy affect the economy.

We calibrated LIFT for a base economic projection which generally follows EIA's *Annual Energy Outlook* (AEO) 2014 reference case, especially in terms of crude petroleum demand, production, imports, and prices. An overview of key variables behind this projection is shown in Table 1. Growth is very similar to the AEO from 2015 through 2017. The economy begins to recover strongly in this baseline, with growth approaching 3 percent from 2015 through 2017. Therefore, much of the excess capacity and cyclical unemployment still lingering in the economy is eliminated. In other words, we do not assume secular stagnation.

[10] See, for example, "Overhead," *The Wall Street Journal*, September 25, 2014, which discusses the impact of the recent slide in prices on various OPEC members.

Table 1: Baseline Projection (Annual Percentage Change)	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
REAL GDP by FINAL DEMAND CATEGORY (Annual Percentage change)										
Real Gross Domestic Product	3.3	2.8	2.8	2.7	2.6	2.5	2.5	2.5	2.4	2.5
Manufacturing Gross Output	3.4	2.3	2.5	2.4	2.1	2.5	2.6	2.6	2.4	2.4
Personal Consump. Expenditures	2.7	2.8	2.6	2.5	2.4	2.4	2.3	2.3	2.3	2.3
Nonresidential Structures	11.3	6.8	5.7	5.4	5.1	2.4	2.5	2.7	2.6	2.8
Equipment Investment	7.6	4.2	3.5	3.4	3.2	3.1	3.3	3.4	3.2	3.3
Exports	5.3	5.5	5.4	5.2	5.0	5.0	5.0	5.0	5.0	4.9
Manufactured Exports	5.9	6.1	6.0	5.6	5.4	5.3	5.4	5.4	5.3	5.2
Imports	4.1	4.5	3.9	3.8	3.7	3.3	3.2	3.1	3.3	3.3
Manufactured Imports	5.3	5.2	4.4	4.2	4.2	3.6	3.5	3.4	3.6	3.6
PRICE INDICATORS (Annual percentage change)										
GDP Deflator	1.9	2.0	2.1	2.3	2.5	2.4	2.1	2.0	2.0	1.9
POPULATION, LABOR FORCE, WAGES and PRODUCTIVITY (Annual Percentage Change)										
Population	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Civilian Labor Force	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8
Total Employment	0.9	0.6	0.6	0.7	0.8	0.6	0.7	0.8	0.8	0.9
Manufacturing Employment	-0.2	-0.5	-0.6	-0.3	-0.2	-0.1	0.1	0.2	0.1	0.1
Unemployment Rate (%)	5.6	5.7	5.7	5.6	5.5	5.5	5.4	5.5	5.5	5.4
Average wage ($/hr)	4.2	3.6	3.8	4.0	4.0	3.9	3.7	3.5	3.4	3.3
Average real wage (05$/hr)	1.9	1.4	1.6	1.6	1.5	1.5	1.4	1.3	1.4	1.4
Total Lab Productivity (05$/hr)	2.0	1.9	2.0	1.9	1.6	1.7	1.6	1.6	1.5	1.4
PERSONAL INCOME										
Personal Income, bil$	5.7	5.3	5.7	5.4	5.5	5.2	4.9	4.6	4.5	4.4
Real Disp Income, bil 05$	3.0	2.9	3.2	2.6	2.4	2.3	2.4	2.2	2.1	2.2

Source: Inforum LIFT Model

Over 2018-2023 we are a bit higher on GDP growth (by 0.3–0.4 percent per year) compared to the AEO. In our baseline, total crude oil demand and supply are higher relative to the AEO not only because of faster growth, but also because the oil intensity of the economy falls more slowly than in the AEO projections.

We think that this is a reasonable view of the economy for 2016-2025. It represents only a partial return to normality in capital and labor markets, however. In the baseline, interest and inflation rates are still very low and the demand multipliers on capital investment are still quite large, in the range of 1.7 to 2.0.

Oil Export Scenarios

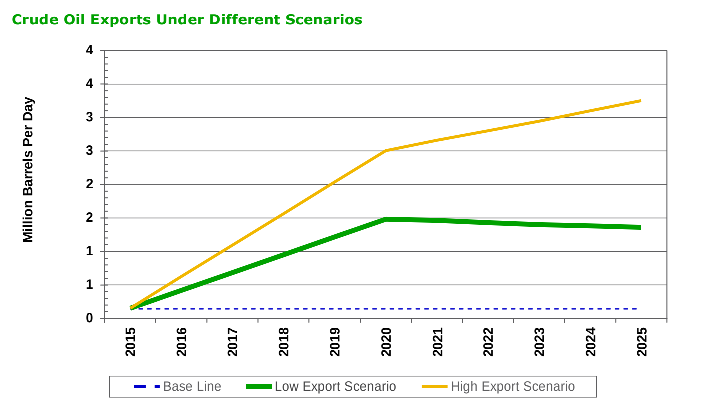
We developed two scenarios to compare to the baseline projection: (1) a low export case; and (2) a high export case. Each of the scenarios assumes a different level of exogenous crude oil exports, production, imports, oil industry capital expenditures, and oil prices. These assumptions are displayed in Table 2. We borrowed heavily from the IHS study for guidance on how removing the ban would affect crude oil export and production potentials, domestic and world oil prices, and capital expenditures for the oil and gas industries.

The baseline includes only trivial exports of crude oil of 0.13-0.15 million b/d throughout the projection horizon.[11] In the low oil exports alternative case, crude oil exports increase by 1.3 million b/d by 2020 compared to the baseline. This increment levels out to about 1.2 million b/d by 2025. For the high exports scenario, crude exports increase by 2.35 million b/d by 2020, rising to 3.12 million b/d by 2025. The projections on crude oil exports are shown in Figure 5.

The impact of oil exports on oil production under our two scenarios also is shown in Table 2 and Figure 6. The AEO projection of oil production shows production rising to 9.8 million b/d in 2019 and peaking at 9.96 million b/d in 2024-2025. In our low export scenario, production reaches 10.96 million b/d in 2019 and 12.13

[11] The AEO baseline for crude exports is almost certainly understated because it was made prior to the policy change announced earlier this year to allow exports of lease condensate. The actual exports experience this year range from 220,000 to 401,000 (July) barrel p/d, compared to 150,000 barrels p/d in the baseline. We consider the increase as part of the overall policy change suggested, that is, to remove the general ban on exports.

Figure 5: Crude Export Scenarios



Source(s): U.S. Energy Information Administration, MAPI, and Inforum

million b/d in 2025. In the high export scenario, oil production rises to 11.53 million b/d in 2019 and 13.21 million b/d in 2025—an increase of 3.25 million b/d above the base case level of production.

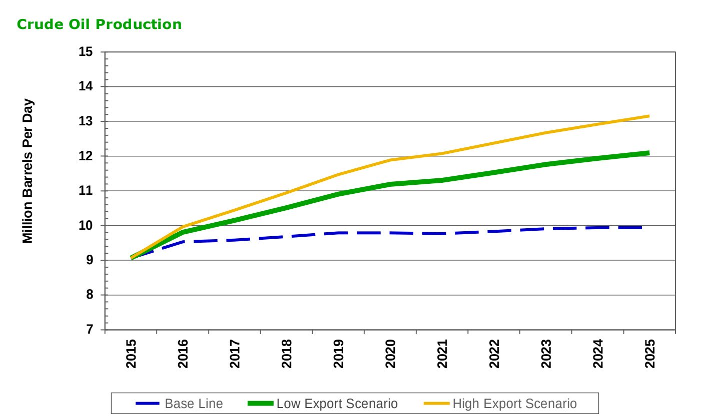
It is worth noting that the EIA has steadily increased its long-term oil production forecast in recent years. There are two reasons for these revisions: (1) technological improvements are enabling producers to produce more from existing shale formations;[12] and (2) estimates of shale resources are being revised upward. In our low and high export scenarios, production will rise even more because eliminating the ban on exports allows producers of light oil to sell their oil at the world price rather than a discounted price.

To increase crude oil production, the industry will have to make substantial investments in exploration, production, and the transportation of crude oil. To include this important development in our scenarios, we use the capital expenditure figures very similar to the IHS study, which are shown in Table 2. According to IHS, lifting the ban will encourage immediate and large increases in capital spending in the crude oil industry. The largest increment in spending occurs in the first three years, peaking in 2017 at $61.8 billion in the low exports scenario and $78.8 billion in the high exports scenario. By 2025, the total increment to capital spending, relative to the baseline, is $43.7 billion and $62.1 billion, in each scenario, respectively. These are relatively large numbers, reaching between 0.3 and 0.4 percent in GDP in 2017 and continuing at 0.15 to 0.21 percent of GDP in 2025.

This exogenous boost to investment is divided among exploration, production, pipelines, and refining. Moreover, according to the IHS study, investment in the refining sector is actually a bit lower in the alternative scenarios since fewer refineries will require retrofitting.

Also shown in Table 2 are projections of oil prices and the price of gasoline. The oil price paths are based on the IHS study which shows the prospective margin between domestic WTI and imports in the low and high export scenarios. The price of gasoline is based on the imported price of crude oil, a benchmark for the world price of oil. In both scenarios, the price of gasoline is lower than the price of gasoline in the baseline scenario.

Figure 6: Allowing Crude Exports Would Raise U.S. Oil Production From Current EIA Baseline Projections



Source(s): U.S. Energy Information Administration, MAPI, and Inforum

[12] Mark J. Perry, "Shale revolution deniers face an inconvenient truth," *Investor's Business Daily*, September 23, 2014. In the Marcellus shale for instance, gas wells are producing 700 percent more per well when compared to 2009. In the Bakker oil field production per well is up 400 percent since 2007. See also, Robert Kleinberg, "Technology on the Horizon & Over the Horizon," Presentation made at the 2014 EIA Energy Conference in the session on Tight Oil Production Trends.

Table 2: Basic Assumptions on Petroleum Sector											
First line is Baseline level as indicated. Second line is Low Exports, differences from the baseline as indicated. Second line is High Exports case, differences from the baseline as indicated.											
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Crude Petroleum (Million barrels per day)											
Domestic production	9.06	9.56	9.59	9.69	9.80	9.80	9.79	9.85	9.93	9.96	9.96
Low Oil Exports (diff in MBD)	0.00	0.26	0.60	0.87	1.15	1.43	1.56	1.71	1.86	2.02	2.17
High Oil Exports (dif in MBD)	0.00	0.43	0.89	1.30	1.72	2.14	2.34	2.57	2.80	3.02	3.25
Exports	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.14	0.13	0.13	0.13
Low Oil Exports (diff in MBD)	0.00	0.27	0.53	0.80	1.06	1.33	1.31	1.29	1.27	1.25	1.23
High Oil Exports (dif in MBD)	0.00	0.47	0.94	1.41	1.88	2.35	2.51	2.66	2.81	2.97	3.12
Oil Industry Investment											
Capital Expenditures (bil$)	231.6	234.7	239.4	244.1	249.2	255.2	261.0	266.1	271.0	276.0	281.1
Low Exports (diff in bil$)		59.6	61.8	50.4	38.1	39.4	45.6	45.1	44.6	44.2	43.7
(% of baseline GDP)		0.32	0.31	0.24	0.17	0.17	0.19	0.18	0.17	0.16	0.15
High Exports (diff in bil$)		73.1	78.8	63.7	47.5	50.5	65.6	64.7	63.9	63.0	62.1
(% of baseline GDP)		0.39	0.40	0.30	0.21	0.22	0.27	0.25	0.24	0.22	0.21
Oil Prices (Current Dollars per Barrel)											
Domestic Crude Price (WTI)	88.6	69.9	75.9	83.5	92.9	101.0	108.6	113.9	119.3	124.7	129.9
Low Oil Exports ($/bbl)		24.9	20.1	16.2	11.0	7.9	5.8	5.9	6.0	6.1	6.3
High Oil Exports ($/bbl)		23.9	19.0	15.1	9.9	6.8	4.6	4.7	4.8	4.9	5.0
Imported Crude Price (RAC)	97.9	96.1	96.3	98.9	103.1	108.0	113.4	118.8	124.3	129.8	135.0
Low Oil Exports ($/bbl)		-2.1	-2.1	-2.1	-2.2	-2.2	-2.3	-2.3	-2.4	-2.4	-2.5
High Oil Exports ($/bbl)		-3.1	-3.1	-3.2	-3.3	-3.3	-3.5	-3.5	-3.6	-3.7	-3.7
Regular MV Fuel ($ per gallon)	3.5	3.5	3.6	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3
Low Oil Exports ($/gal)		-0.03	-0.06	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08
High Oil Exports ($/gal)		-0.05	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09

Source: Inforum LIFT Model

MACROECONOMIC IMPACTS FROM REMOVING THE BAN ON CRUDE OIL EXPORTS

A number of studies have found that lifting the ban on crude oil exports would have a positive impact on GDP growth, employment and income.[13] Our results reinforce the findings in these previous studies. Lifting the ban on crude oil exports has significant positive and durable effects on GDP, aggregate employment and income. Compared to the baseline, most of the initial boost to economic activity comes about through the assumed required increases in capital spending for exploration, production and pipelines. The boost to real GDP reaches a peak of 0.68 percent, or about $105 billion, in 2017 in the low export case (Table 3 below). Though the positive boost is smaller after 2017, GDP is still 0.44 percent higher ($70 billion) than in the baseline case by

[13] See Trevor Houser and Shashank Mohan, *Fueling Up: The Economic Implications of America's Oil and Gas Boom*, Peterson Institute for International Economics, 2014; *America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy, Volume 1: A Manufacturing Renaissance—Main Report,* An IHS Global Report, September 2013; *America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy, Volume 3: A Manufacturing Renaissance—Main Report,* An IHS Global Report, September 2013; Susan Lund et al., *Game Changers: Five Opportunities for US Growth and Renewal*, McKinsey Global Institute, July 2013; *Oil and Natural Gas Transportation & Storage Infrastructure: Status, Trends, & Economic Benefits*, Report for the American Petroleum Institute submitted by IHS Global Inc. December 2013; *Shale Gas, Competitiveness, and New US Chemical Industry Investment: An Analysis Based on Announced Projects*, American Chemistry Council, May 2013; *Shale Gas: A Renaissance in US Manufacturing?* PwC, December 2011; Energy Policy at a Crossroads: An Assessment of the Impacts of Increased Access versus Higher Taxes on U.S. Oil and Natural Gas Production, Government Revenue, and Employment, Slide Presentation, Wood Mackenzie; Stephen P.A. Brown, et al., *Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States*, *op.cit.*; and *The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs.* ICF International, May 2014.

2025. In the high export scenario, the increment to GDP growth peaks at 0.93 percent in 2019-2021 (or $165 billion in 2021) and then subsides to 0.74 percent ($141 billion) in 2025.

The reason the increase in GDP growth attributable to the removal of crude oil export ban tapers off after 2017 is that the stimulus from incremental capital expenditures falls after 2017. Nevertheless, increases in crude oil production and exports throughout the period provide a continuing boost to GDP growth. Additions to employment are also significant, reaching a peak of 495,000 in 2017 in the low exports scenario and a peak of 630,000 in 2019 in the high exports scenario. As was the case with GDP, the boost to employment falls through time as the capital expenditure boom subsides and various other industries react to higher wages by investing in increased productivity.

The increase in employment has a positive effect on real wages and thus personal income. In 2020, the average real wage in the high export scenario is 1.19 percent higher than in the base case. The positive impact continues so that by 2025, real wages in the high export scenario are 1.48 percent higher. Even in the low export scenario, real wages are raised by 0.94 percent by 2025. As shown in Table 3, wage gains on a percentage basis are higher than projected GDP gains. Real disposable personal income per household peaks at a 2.5 percent increase in 2019 and remains well above 2 percent for the forecast period after 2017.

Table 3: Crude Oil Export Simulations

For each variable:
Line #1 is in levels as indicated.
Line #2 is deviation in LOW OIL EXPORT case in percent or as indicated.
Line #3 is deviation in HIGH OIL EXPORT case in percent or as indicated.

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
REAL GDP by FINAL DEMAND CATEGORY (Billions of chained 2005 dollars)											
Real Gross Domestic Product (bil 05$)	14600	15086	15514	15961	16405	16832	17260	17704	18158	18607	19071
Low Exports (% difference)	0.00	0.30	0.68	0.64	0.61	0.59	0.57	0.53	0.50	0.48	0.44
High Exports (% difference)	0.00	0.40	0.83	0.86	0.93	0.93	0.93	0.88	0.80	0.77	0.74
Real GDP growth	3.2	3.3	2.8	2.9	2.8	2.6	2.5	2.6	2.6	2.5	2.5
Low Exports (% growth)	3.2	3.6	3.2	2.8	2.8	2.6	2.5	2.5	2.5	2.5	2.5
High Exports (% growth)	3.2	3.8	3.3	2.9	2.9	2.6	2.5	2.5	2.5	2.4	2.5
Total Employment (millions of jobs)	153.92	155.25	156.23	157.24	158.31	159.54	160.54	161.68	162.93	164.23	165.64
Low Exports (% difference)	0	0.29	0.77	0.75	0.65	0.57	0.51	0.44	0.38	0.32	0.25
High Exports (% difference)	0	0.38	0.91	0.97	1.00	0.94	0.89	0.81	0.66	0.58	0.50
Low Exports (millions)	0.000	0.189	0.495	0.475	0.413	0.357	0.317	0.275	0.230	0.197	0.154
High Exports (millions)	0.000	0.247	0.584	0.615	0.630	0.589	0.557	0.501	0.406	0.353	0.300
Manufacturing employment	12366	12339	12282	12214	12182	12162	12145	12159	12180	12196	12205
Low Exports (thousands)	0	62.2	103.4	67.7	32.7	13.3	3.8	-6.5	-16.9	-25.6	-35.1
High Exports (thousands)	0	79.8	129.7	96.3	64.0	40.8	31.6	14.7	-8.8	-25.9	-40.9
Average real wage (05$/hr)	30.6	31.2	31.6	32.2	32.7	33.2	33.7	34.2	34.6	35.1	35.6
Low Exports (% difference)	0	-0.05	0.49	0.77	0.87	0.86	0.88	0.89	0.91	0.93	0.94
High Exports (% difference)	0	0.05	0.67	0.99	1.16	1.19	1.26	1.32	1.37	1.43	1.48
Real Disposable Income (bil 05$)	11039	11381	11711	12093	12415	12712	13002	13323	13615	13904	14216
Low Exports (% difference)	0	0.6	1.7	2.0	2.0	1.8	1.7	1.5	1.4	1.4	1.3
High Exports (% difference)	0	0.7	1.9	2.4	2.6	2.6	2.5	2.4	2.2	2.2	2.2
Real Disposable Income per Household (thousands of 05$)	87.70	89.72	91.62	93.89	95.66	97.21	98.68	100.37	101.81	103.22	104.78
Low Exports (thousands of 05$)	0	0.51	1.53	1.88	1.92	1.76	1.63	1.53	1.42	1.46	1.40
High Exports (thousands of 05$)	0	0.61	1.75	2.27	2.53	2.49	2.46	2.39	2.25	2.32	2.27

Source: Inforum LIFT Model

Wage gains are significant in our export enhanced scenarios because most of the new jobs are in relatively high paying sectors. Median wages in the mining sector (including oil and gas extraction) are almost $44 per hour, compared to all private sector jobs which pay $21.78 per hour. Manufacturing jobs pay a median hourly wage of $23, although jobs specifically in the petroleum products sector are higher at almost $30 per hour. Construction jobs are also boosted by the growth in oil exports, and median wages are nearly $24 per hour. It is worth noting too that manufacturing workers benefit from greater levels of health care and pension coverage than those in non-manufacturing occupations. Total compensation in all manufacturing jobs is 9 percent higher than in the non-manufacturing sector, and even higher in the oil and gas production, development, and equipment industries.

General prices and wages rise slightly compared to the baseline scenario. By 2020, the GDP deflator is 1.34 percent and 1.61 percent higher than the baseline in the low exports and high exports scenarios respectively. By 2025, these increments reach 1.76 and 2.47 percent.

The biggest gainers from lifting the ban on crude oil exports are American households. Table 3 also shows that in the low exports scenario household incomes would rise by an average between $1,000 and $2,000 per household (in 2005 prices). In the high exports case, the enhancements to household income are raised by $2,000–$3,000 per household.

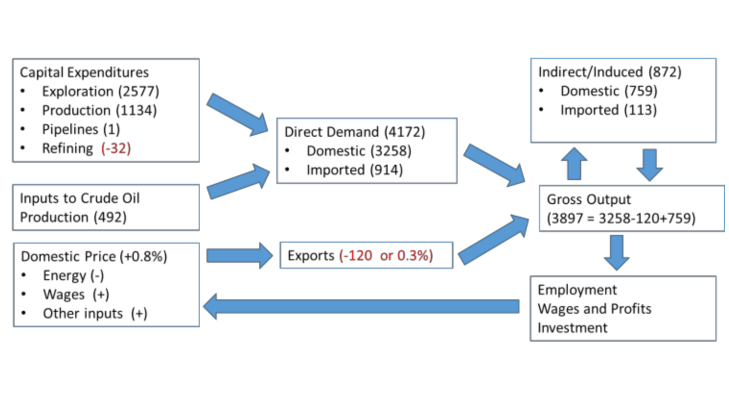
ECONOMIC IMPACT ON THE MANUFACTURING SECTOR

Ending the ban on crude oil exports would benefit the manufacturing sector in several ways. First, oil producers will increase expenditures for exploration, production, and transportation of crude oil. These activities involve long and complex supply chains which include manufactured products such as drilling pipes, pumps, drilling rigs, earth moving equipment, and motor vehicles. Purchases from manufacturers will be direct, as when a driller buys pipe or pumps and compressors. Much indirect activity also will be stimulated, such as the production of coal, ore, and limestone used to produce the steel that makes up the pipe. Second, because increased production of oil would contribute to a moderation in the world price of oil, manufacturers, especially those that consume a lot of energy, would benefit from lower prices for petroleum products. In addition, associated natural gas, which is akin to a by-product of much of the oil production from shale formations, would put additional downward pressure on the price of natural gas, an important feedstock for many manufacturers. In 2012 (the last year for which comprehensive data is available) almost 17 percent of all gas production, around 5 trillion cubic feet, came from oil wells and this number has likely increased in the last several years as most drilling is now directed at oil.

Third, the general improvement in economic growth and employment will provide manufacturers new "induced" demand for products seemingly far from the oil field supply chain. For instance, securely employed steel and oil workers earning higher salaries will be better able to afford a long-delayed new vehicle purchase. In addition to automakers, food producers, apparel providers, and appliance manufacturers would all enjoy enhanced business.

An example of how the impact on manufacturing flows through the economy is illustrated in Figure 7. The diagram shows the difference in demand and supply for the high export case compared to the baseline case for agriculture, construction, and mining equipment (ACME which is NAICS 3331) for a single year, in this case 2020. All the figures are in millions of 2005 dollars.

Figure 7: Agricultural, Construction and Mining Equipment (Sector 35)
Net Change to Gross Output 2020, High Export Case
(millions of 2005 dollars)



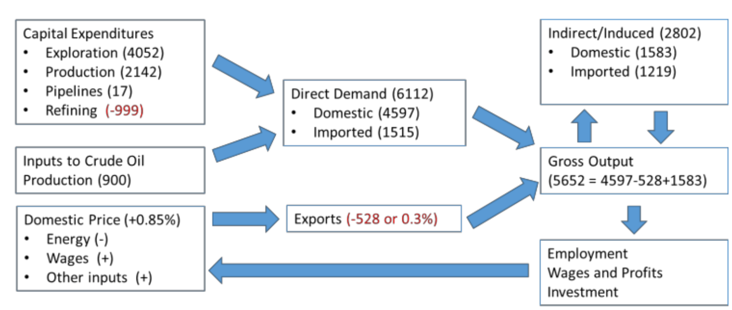
Source(s): Inforum LIFT Model

In total, the domestic output of the ACME sector is $3,897 million greater in this scenario relative to the baseline projection assuming a continued oil export ban, a figure derived from several different processes acting within the LIFT model. First, compared to the baseline, direct demand from new capital expenditures increases by $2,577 million for exploration, $1,134 million for production, and $12 million for pipelines. Demand for equipment from the refining sector falls by $32 million. Also, new exploration and higher production of crude boost intermediate demand for spare parts and other non-capital expenditures by $492. In total, the new direct demand of $4,172 million is split between domestic production ($3,258 million) and imports ($914 million). Thus, 78 percent of new demand is met by domestic manufacturers, who have a competitive advantage in this sector.

There is more to the story. As explained above, higher economic activity and employment push up general wages and input costs for industries, thus raising production prices. In the ACME case, prices are boosted compared to the baseline by 0.8 percent in 2020. These higher prices lead to a decrease in equipment exports of $120 million, or 0.3 percent, in 2020. Finally, expansion across the economy leads to increased demand for products from the ACME sector both indirectly through oil supply chains and through induced growth in other sectors of the economy. The increment of indirect and induced demand totals $872 million, split between $759 million of domestic production and $113 million in imports. The net increase in production ($3,897 million) is therefore defined by the domestic production for new direct demand ($3,258 million), minus the loss of exports ($120 million), plus the domestic production for new indirect and induced demand ($759 million).

Figure 8 provides a similar figure for the Machinery sector as a whole (NAICS 333) which includes ACME and several other industrial and service machinery sectors. The demand and supply patterns are similar, but the proportional loss of business from lower refining investment and exports is a bit larger.

Figure 8: Machinery (Sectors 35-41)
Net Change to Gross Output 2020, High Export Case
(millions of 2005 dollars)



Source(s): Inforum LIFT Model

Table 4 shows the output results across mining, construction and the major manufacturing sectors. Consistent with the assumptions discussed in Table 2 (page 9), petroleum extraction increases steadily throughout the period. Mining services and construction benefit from large direct new spends on exploration and development which peak in 2017 and 2018.

An end to the ban on oil exports clearly benefits most of the manufacturing subsectors, though the impact varies according to the extent to which they are connected with oil development and production activities. Industries that supply durable materials such as steel and concrete, construction and mining equipment (ACME), and transport machinery such as ships and boats all experience healthy increases in output relative to the baseline. For example, in the high export scenario, in 2017 the total output of the entire machinery sector is 3.1 percent higher (or $12.4 million) than in the export ban baseline. This figure still registers 0.5 percent by 2025. For the ACME industry we examined above, the 2017 peak increase in output is 6 percent. The impact declines thereafter, but remains 2.8 percent above the base line projection in 2025.

On the other hand, electronics and electrical products and miscellaneous manufacturing see small net production decreases compared to the export ban baseline. In these cases, export losses and lower demand for their products from the non-oil economy outweighs any demand expansion from a more buoyant oil sector.

Table 5 shows the effects on industrial employment. As expected, mining and construction employment are substantially higher for the 2016–2025 period. Mining employment is up 294.7 thousand job years (one single job for a single year) in the case of low exports and up by 426.1 thousand in the case of high exports. Significantly, compared to the baseline, new construction employment peaks in 2017 at 181 thousand job years in the low export case and almost 216 thousand job years in the high export case. Other big gainers include the big services sector, such as finance and retail trade, parts of which are linked to the industrial sector. There, the number of job years is up between 939.2 thousand and 1.48 million job years for the low and high export scenarios, respectively. Given relatively low labor productivity in these sectors, any increments to overall demand normally means large absolute gains for employment. Durable manufacturing jobs growth peaks at 114.7 million job years in 2017, and declines after that as new production and associated equipment level off. Total accumulated gains for durables through 2025 total 371.6 thousand job years. The transportation sector also sees accumulative gain of 313.7 thousand job years over the projection period.

Table 4: Output by Producing Sector (Billions of 2005$) Deviations displayed a percent difference from the baseline						
	2016	**2017**	**2018**	**2020**	**2022**	**2025**
Crude oil extraction (bil of 2005$)	167.6	168.1	169.9	171.8	172.7	174.5
Low Export	2.8	6.3	9.0	14.6	17.4	21.8
High Export	4.5	9.3	13.4	21.8	26.1	32.6
Mining support activities	**171.8**	**181.6**	**191.7**	**211.0**	**222.6**	**239.4**
Low Export	2.3	4.5	3.6	2.4	1.9	1.3
High Export	3.1	5.4	4.5	3.6	3.2	1.7
Construction	1074.8	1121.1	1168.9	1260.3	1321.7	1409.5
Low Export	0.7	2.2	1.8	1.2	0.9	0.4
High Export	0.9	2.6	2.3	1.9	1.5	0.5
Manufacturing						
Nondurable Consumer Products	796.4	810.9	827.3	855.3	886.6	930.0
Low Export	0.0	0.2	0.1	0.0	-0.1	-0.2
High Export	0.0	0.2	0.2	0.1	0.0	-0.2
Nondurable Materials and Products	1678.6	1713.3	1752.0	1824.0	1913.3	2053.1
Low Export	0.2	0.4	0.2	0.1	0.2	0.2
High Export	0.3	0.6	0.4	0.3	0.4	0.5
Durable Materials and Products	569.5	580.8	596.4	624.5	659.7	712.5
Low Export	1.0	1.1	0.4	0.0	-0.2	-0.4
High Export	1.3	1.4	0.7	0.3	0.0	-0.6
Machinery	365.3	374.9	386.8	406.4	431.1	471.4
Low Export	2.5	2.6	1.8	0.9	0.7	0.3
High Export	3.1	3.3	2.4	1.4	1.2	0.5
Electronic, electrical products	578.5	599.2	623.1	666.4	718.0	805.0
Low Export	0.6	0.3	-0.3	-1.0	-1.1	-1.3
High Export	0.7	0.5	-0.2	-1.0	-1.3	-1.8
Transport Machinery	787.1	804.3	822.1	855.9	897.7	956.1
Low Export	0.8	1.2	0.8	0.5	0.4	0.2
High Export	1.0	1.5	1.1	0.9	0.7	0.3
Furniture, Health, Other Mfg	237.6	243.5	250.1	261.0	273.6	293.0
Low Export	0.2	0.4	0.0	-0.4	-0.6	-0.9
High Export	0.2	0.4	0.1	-0.3	-0.6	-1.1
Services						
Professional, business services	3603.8	1313.8	3860.2	4113.1	4374.8	4787.4
Low Export	0.4	0.7	0.6	0.5	0.4	0.3
High Export	0.5	0.9	0.9	0.8	0.7	0.5

Source: Inforum LIFT Model

Table 5: Impact on Employment-Selected Sectors of the Economy (Thousands of Job Years)											
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Mining	909.7	939.6	943.8	946.1	949.7	951.2	946.6	944.3	942.3	940.4	940.6
Low Exports–difference		15.8	31.9	31.0	30.7	31.1	31.0	30.8	30.4	31.1	30.9
High Exports–difference		21.7	41.0	41.5	44.3	46.5	48.0	47.9	44.8	45.3	45.2
Construction	8175.8	8539.0	8738.0	8893.4	9051.1	9188.8	9246.3	9306.5	9365.7	9428.2	9506.0
Low Exports–difference		52.1	180.9	165.5	144.0	115.3	96.7	80.2	62.7	56.8	41.0
High Exports–difference		73.4	215.8	204.3	203.7	179.8	164.5	142.9	88.8	72.2	50.1
Durable manufacturing	7760.4	7730.1	7655.7	7570.5	7519.0	7473.2	7440.4	7429.8	7425.5	7418.3	7408.1
Low Exports–difference		57.6	91.3	61.1	30.3	14.4	7.6	-0.2	-7.9	-13.9	-20.7
High Exports–difference		73.4	114.7	84.5	54.7	36.0	30.1	17.1	-1.0	-13.5	-24.4
Transportation	5076.0	5123.3	5146.0	5156.3	5165.5	5184.2	5208.5	5241.3	5278.9	5322.6	5369.3
Low Exports–difference		13.7	33.1	29.8	25.7	22.5	20.4	17.9	15.3	13.2	10.6
High Exports–difference		18.0	39.3	39.8	40.1	36.6	35.0	31.8	27.1	24.4	21.6
Professional, business services	21.398	21.658	21.870	22.050	22.254	22.491	22.663	22.855	23.064	23.269	23.486
Low Exports–difference		66.1	139.1	130.2	112.7	101.3	94.8	86.8	77.4	70.1	60.8
High Exports–difference		87.4	172.1	177.3	177.2	169.2	167.6	156.6	136.9	124.8	114.0

Source: Inforum LIFT Model

Winners and Losers

Any policy decision (even a decision to do nothing) creates winners and losers. A decision to maintain the ban on crude oil exports provides benefits to some while imposing costs on others. Our analysis shows that a decision to eliminate the ban provides significant benefits for the overall economy in terms of greater economic growth, higher employment, and greater personal income, as well as to the overall manufacturing sector which would benefit from a higher level of output and employment. Further, ending the ban would not raise the price of petroleum products like gasoline but would actually put some, if modest, downward pressure on these prices. This latter result of course benefits consumers but would cut into the gross margins of refineries in the United States. Total refinery output, however, would grow in our export enhanced scenarios. Growing exports of crude oil and products would lower the U.S. trade deficit by about 1 percent but would lead to strengthening the dollar and slightly lower total manufacturing exports by the end of our projection period.

Concluding Comments

There is an excellent case on policy grounds to end the long-standing prohibition on exports of U.S. crude oil. The economic case for such an action is even more compelling. We have provided data and analysis to support this by focusing on the manufacturing sector. This sector has led the, tepid, U.S. economic recovery since 2009 and an end to the ban on oil exports could strengthen this recovery in a material sense. Manufacturing is a source of good jobs, which is increasingly important, especially to the category of what used to be called blue collar workers whose status and income levels have been eroded in the past few decades. Increasing oil (and associated gas production) will create good paying jobs and add thousands of dollars to average household incomes. U.S. manufacturing is leading the world in the development and construction of the infrastructure equipment important to the boom in energy production. Manufacturing is still the source of much of the research and development behind innovation in the modern economy. Lifting the ban on oil exports, which arguably could be done by executive action,[14] is a simple and effective way to support high economic growth, better jobs for a beleaguered segment of the working population and for skilled workers and engineers, and energy self-sufficiency for the United States and its allies.

[14] Alan M. Dunn, "U.S. Export Restraints on Crude Oil Violate International Agreements And Are Vulnerable To Challenge," Stewart and Stewart, June 25, 2015.

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United States
International Trade Commission

Shifts in U.S. Merchandise Trade 2013

October 2014
Publication Number: 4493
Investigation Number: 332-345

United States International Trade Commission

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Part I
U.S. Merchandise Trade and Overall Economic Performance

This section of the report provides an overview of the economic performance of the United States during 2013. It also summarizes overall U.S. merchandise trade performance in broad industry categories in 2013 and compares it with that of previous years.

Overall Economic Performance

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The U.S. economy grew at a rate of 1.9 percent in 2013. This growth rate was lower than the 2.8 percent increase in 2012, but similar to the 2011 growth rate. [1] Various factors slowed economic growth in 2013, including the U.S. federal government shutdown in early October and a decrease in private investment. U.S. gross domestic product (GDP) growth in 2013 was driven by private domestic investment and increased production. [2]

Total industrial production in the United States rose by 2.6 percent during 2013. Although industrial production increased in almost all sectors, it grew most strongly in the natural gas distribution and mining sectors, falling only in the textiles, paper, printing, and primary metal sectors. [3] Unemployment in the United States decreased from 7.9 percent of the labor force in January 2013 to 6.7 percent in December 2013. [4]

U.S. trade flows were affected by the relative strength of the U.S. dollar. The nominal trade-weighted value of the dollar appreciated by 1.3 percent between 2012 and 2013 relative to the currencies of the Broad dollar index, [5] generally lowering the cost of imported inputs and making U.S. exports more expensive in foreign markets.

One key determinant of the demand for U.S. exports is the performance of other economies. Overall, other advanced economies grew at a slower rate than the United States. The average GDP growth rate for advanced economies in 2013 was 1.3 percent (table US.1). [6] While Canada, the United States' largest export market, matched its previous year's growth at 1.7 percent, the United States' second-largest export market, the European Union, experienced a slow growth rate of only 0.2 percent. (The European Union accounts for 23 percent of world GDP). [7] In contrast, growth in emerging markets and developing economies in 2013 was stronger than

[1] USDOC, BEA, "Gross Domestic Product: Fourth Quarter and Annual," February 28, 2014.
[2] Ibid.
[3] Federal Reserve System, Board of Governors, G.17 Industrial Production and Capacity Utilization (accessed April 11, 2014).
[4] USDOL, BLS, Current Population Survey (CPS) database (accessed April 11, 2014).
[5] The broad index is a weighted average of the foreign exchange values of the U.S. dollar against the currencies of a large group of major U.S. trading partners. Federal Reserve System, Foreign Exchange Rates—H.10 (accessed March 20, 2014).
[6] IMF, *Is the Tide Rising?* January 2014. This document is the source for the rest of this paragraph.
[7] World Bank, World Development Indicators database (accessed April 11, 2014).

Table US.1 Real gross domestic product, change from previous year, (%)

Region	2012	2013
World output	3.1	3.0
United States	2.8	1.9
Mexico	3.9	1.1
Japan	1.5	1.5
Latin America and the Caribbean	3.1	2.7

Source: International Monetary Fund (IMF), World Economic Outlook database (accessed May 2, 2014).

U.S. growth. China's economy grew by 7.7 percent, and China is the fourth-largest export destination for U.S. goods. The Developing Asia [8] region grew by 6.5 percent on average.

The countries of Latin America and the Caribbean [9] also grew faster than the United States, at 2.7 percent on average, although Mexico's growth was below the mean at 1.1 percent. Mexico is the United States' third-largest export market. Countries in the Central and Eastern European region also performed relatively well, with average GDP growth of 2.7 percent in 2013.

[8] IMF country grouping, composed of 27 countries: Afghanistan, Bangladesh, Bhutan, Brunei Darussalam (Brunei), Cambodia, China, Fiji, India, Indonesia, Kiribati, Laos, Malaysia, the Maldives, Burma, Nepal, Pakistan, Papua New Guinea, the Philippines, Samoa, the Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu, and Vietnam.

[9] IMF country grouping, composed of 32 countries: Antigua and Barbuda, Argentina, The Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

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U.S. Trade by Industry, Sector, and Selected Trading Partners

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U.S. Trade Balance[10]

In 2013, 9 of the 10 U.S. merchandise sectors addressed in this report—all except the agricultural sector—registered trade deficits. Additionally, 8 of the 10 sectors experienced greater trade deficits or declines in trade surpluses. The chemicals and related products and the energy-related products sectors were the exceptions. In fact, the energy-related products sector experienced a substantial decline in its trade deficit, lowering the deficit in this sector by $55.9 billion (22 percent) (table US.2). The change in this sector was a major factor in the $30.1 billion (3 percent) decline in the overall U.S. trade deficit to $867.7 billion in 2013 (figure US.1). All of the sectoral deficits expanded by less than $6 billion, and none grew by more than 8 percent. Although the agricultural products sector recorded a trade surplus in 2013, its trade surplus declined by $430 million (2 percent) to $26.5 billion.

The energy-related products sector continued to perform well in 2013, as U.S. production of crude petroleum reached levels not seen since the 1990s and refineries produced at levels last reached in 2000. This increased production, combined with the continued gradual decline in U.S. consumption of these products, supported more exports and reduced the need for imports.

[10] Throughout this report, unless specifically noted otherwise, export data consist of data on U.S. domestic exports and import data consist of data on U.S. imports for consumption, both as reported by Census. The merchandise trade balance derived on this basis may differ from another measure of the merchandise trade balance, defined as total exports minus general imports, which is generally reported by Census and other federal agencies (see definitions of trade terms at http://www.census.gov/foreign-trade/reference/definitions). Note that imports for consumption may include re-exports—goods that are imported into the United States and then exported without any substantial alteration—while domestic exports do not. As a result, when trade deficits with certain partners are calculated as U.S. domestic exports minus U.S. imports for consumption, they may be larger than the deficits calculated using total exports minus general imports. This difference is most notable in bilateral trade with Canada and Mexico.

Table US.2 U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by major industry/commodity sectors, 2009–13

Item	Million $						
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. exports of domestic merchandise							
Agricultural products	103,184	121,473	145,724	149,293	152,162	2,869	1.9
Forest products	30,489	36,381	39,274	38,309	39,244	935	2.4
Chemicals and related products	165,948	197,026	213,983	217,452	218,078	626	0.3
Energy-related products	59,827	85,468	134,088	142,294	152,652	10,358	7.3
Textiles and apparel	14,653	17,350	19,433	19,211	19,754	543	2.8
Footwear	620	728	832	824	789	-36	-4.3
Minerals and metals	84,351	109,910	140,640	140,516	133,749	-6,767	-4.8
Machinery	85,427	104,379	115,193	122,404	122,269	-135	-0.1
Transportation equipment	194,082	222,403	257,589	285,772	293,023	7,251	2.5
Electronic products	142,938	159,833	164,537	167,003	166,976	-27	([a])
Miscellaneous manufactures	24,765	25,542	26,759	27,914	29,843	1,929	6.9
Special provisions	30,460	41,638	41,123	42,218	43,501	1,283	3.0
Total	936,745	1,122,131	1,299,176	1,353,211	1,372,039	18,827	1.4
U.S. imports for consumption							
Agricultural products	87,301	97,572	115,585	122,400	125,699	3,299	2.7
Forest products	31,511	35,749	36,271	37,116	39,966	2,850	7.7
Chemicals and related products	182,515	218,020	254,229	252,153	250,484	-1,669	-0.7
Energy-related products	260,878	338,184	430,796	398,441	352,853	-45,588	-11.4
Textiles and apparel	90,581	104,199	113,611	113,507	117,225	3,718	3.3
Footwear	17,666	20,710	22,559	23,745	24,612	868	3.7
Minerals and metals	117,025	156,199	192,550	194,712	190,474	-4,238	-2.2
Machinery	110,061	130,469	154,948	166,237	169,113	2,876	1.7
Transportation equipment	199,808	266,946	306,579	358,409	371,548	13,138	3.7
Electronic products	311,420	377,617	400,592	413,767	417,226	3,459	0.8
Miscellaneous manufactures	84,437	97,346	99,415	104,443	109,412	4,970	4.8
Special provisions	55,960	55,600	59,815	66,105	71,137	5,032	7.6
Total	1,549,163	1,898,610	2,186,951	2,251,035	2,239,750	-11,285	-0.5

See footnote(s) at end of table.

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance							
Agricultural products	15,883	23,901	30,139	26,893	26,464	-430	-1.6
Forest products	-1,022	632	3,003	1,193	-723	-1,915	([b])
Chemicals and related products	-16,567	-20,994	-40,246	-34,701	-32,406	2,294	6.6
Energy-related products	-201,051	-252,716	-296,708	-256,147	-200,201	55,946	21.8
Textiles and apparel	-75,928	-86,849	-94,178	-94,297	-97,472	-3,175	-3.4
Footwear	-17,046	-19,982	-21,728	-22,920	-23,824	-903	-3.9
Minerals and metals	-32,674	-46,288	-51,910	-54,196	-56,725	-2,529	-4.7
Machinery	-24,634	-26,090	-39,755	-43,833	-46,844	-3,011	-6.9
Transportation equipment	-5,726	-44,543	-48,989	-72,637	-78,525	-5,888	-8.1
Electronic products	-168,483	-217,784	-236,055	-246,764	-250,250	-3,486	-1.4
Miscellaneous manufactures	-59,672	-71,804	-72,656	-76,529	-79,570	-3,041	-4.0
Special provisions	-25,500	-13,962	-18,692	-23,887	-27,635	-3,749	-15.7
Total	-612,419	-776,479	-887,775	-897,824	-867,712	30,112	3.4

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. Sectors are ordered by the level of processing of the products classified therein.

[a]Less than 0.05 percent.

[b]Not meaningful for purposes of comparison.

Figure US.1 U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, 2009–13

Source: Compiled from official statistics of the U.S. Department of Commerce.

U.S. Exports

In 2013, U.S. exports increased by $18.8 billion (1 percent) to $1,372.0 billion, as exports in 6 of the 10 sectors reviewed in this report increased. The energy-related products sector recorded the greatest increase in both absolute ($10.4 billion) and percentage (7 percent) terms. In addition to the changes in domestic production and consumption of energy-related products noted above, continued strong global demand for distillate fuel oils also contributed to increased U.S. exports in this sector.

U.S. exports of transportation equipment and minerals and metals experienced the next-largest shifts in 2013. Exports of aircraft equipment and motor vehicles increased by $13.6 billion, driving the transportation equipment sector's overall $7.3 billion rise in exports (table US.3).

Increased domestic consumption of natural and synthetic stones and decreased interest in holding precious metals led to a decline in U.S. minerals and metals exports (down $6.7 billion, or 5 percent). In anticipation of greater U.S. demand for jewelry, the U.S. industry exported fewer stones for cutting and processing overseas.

U.S. Imports

In 2013, the value of total U.S. imports fell 0.5 percent to $2,239.8 billion, with the largest absolute shifts occurring in energy-related products (down $45.6 billion to $352.9 billion), transportation equipment (up $13.1 billion to $371.5 billion), and minerals and metals (down $4.2 billion to $190.5 billion). Significant reductions in imports of energy-related products (down $45.6 billion, or 11 percent) drove the contraction in the value of overall U.S. imports. Lower domestic consumption of crude petroleum and higher U.S. production of this commodity contributed to these reductions.

Mexican suppliers accounted for most of the growth in U.S. imports of transportation equipment in 2013. Benefiting from proximity to the United States, lower labor costs than the United States, and duty-free access under the North American Free Trade Agreement (NAFTA), Mexico’s exports to the United States increased by $7.2 billion (9 percent) even as exports to the U.S. market from Canada and Japan declined.

Table US.3 All merchandise sectors: Leading changes in U.S. exports and imports, 2009–13

Item	Million $						
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. EXPORTS							
Increases							
Transportation equipment	77,700	73,949	82,028	95,210	104,881	9,671	10.2
Aircraft, spacecraft, and related equipment (TE013)							
Motor vehicles (TE009)	35,963	48,940	59,454	65,669	69,557	3,888	5.9
Energy-related products	42,048	61,131	100,425	111,355	119,700	8,345	7.5
Petroleum products (EP005)							
Natural gas and components (EP006)	5,270	7,805	10,394	9,225	13,039	3,814	41.3
Crude petroleum (EP004)	1,620	1,384	1,460	2,184	4,818	2,635	120.6
Animal feeds (AG013)	8,498	9,677	10,103	12,476	14,525	2,050	16.4
Decreases							
Construction and mining equipment (TE004)	19,777	22,010	27,971	29,959	23,729	-6,230	-20.8
Coal, coke, and related chemical products (EP003)	8,079	12,612	19,471	17,779	13,665	-4,115	-23.1
Precious metals and non-numismatic coins (MM020)	20,699	28,033	42,230	42,762	38,868	-3,893	-9.1
Oilseeds (AG032)	16,780	18,936	17,875	25,040	21,794	-3,245	-13.0
All other	700,312	837,653	927,765	941,554	947,462	5,908	0.6
Total	936,745	1,122,131	1,299,176	1,353,211	1,372,039	18,827	1.4
U.S. IMPORTS							
Increases							
Transportation equipment	94,348	132,471	144,426	171,556	180,005	8,449	4.9
Motor vehicles (TE009)							
Aircraft, spacecraft, and related equipment (TE013)	18,339	18,931	21,546	24,107	29,080	4,973	20.6
Certain motor-vehicle parts (TE010)	35,296	51,903	59,875	69,605	71,969	2,364	3.4
Telecommunications equipment (EL002)	60,299	74,065	79,771	83,831	89,161	5,330	6.4
Natural and synthetic gemstones (MM019)	13,608	19,730	23,625	21,597	24,733	3,136	14.5
Apparel (TX005)	69,457	78,501	85,668	84,962	87,658	2,696	3.2
Decreases:							
Energy-related products	150,809	196,862	246,894	228,944	195,487	-33,457	-14.6
Crude petroleum (EP004)							
Petroleum products (EP005)	72,581	97,889	135,170	129,773	118,136	-11,638	-9.0
Steel mill products (MM025)	16,995	22,928	30,765	34,303	29,065	-5,238	-15.3
Consumer electronics (EL003)	47,186	51,031	46,343	47,714	42,936	-4,779	-10.0
Medicinal chemicals (CH019)	82,417	86,603	92,732	88,771	85,477	-3,294	-3.7
Construction and mining equipment (TE004)	6,345	8,213	12,935	16,302	13,727	-2,576	-15.8
All other	881,484	1,059,482	1,207,200	1,249,571	1,272,318	22,747	1.8
Total	1,549,163	1,898,610	2,186,951	2,251,035	2,239,750	-11,285	-0.5

Source: Compiled from official statistics of the U.S. Department of Commerce.

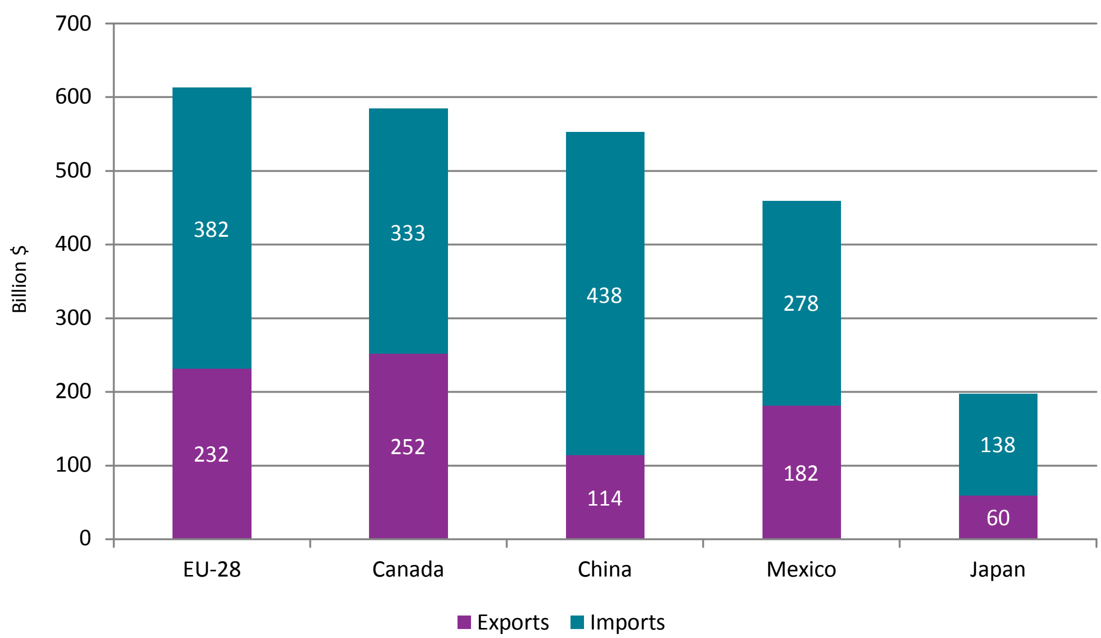
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. In 2009, 60 export commodity classification (schedule B) codes covering all civilian aircraft, engines, equipment, and parts were consolidated into a single code by the U.S. Census Bureau. This reclassification may have accounted for some of the shifts in exports in the transportation equipment sector.

Shifts in U.S. Bilateral/Multilateral Trade Among Leading Trading Partners

In 2013, the United States' top five trading partners continued to be the 28 members of the European Union (EU-28), Canada, China, Mexico, and Japan (figure US.2). U.S. trade deficits increased with the EU-28 (up $11.3 billion to $149.9 billion), China (up $2.5 billion to $323.8 billion), and Canada (up $1.5 billion to $81.2 billion), but fell with Japan (down $1.7 billion to $78.3 billion) and Mexico (down $5.3 billion to $96.0 billion) (table US.4). Together, these trading partners accounted for 67 percent of total U.S. trade with the world. The U.S. trade deficit with these countries was equivalent to 84 percent of the total U.S. trade deficit.

The largest trade balance shift in 2013 occurred with the members of the Organization of Petroleum Exporting Countries (OPEC):[11] the collective U.S. trade deficit with this group fell by $31.5 billion (33 percent) to $63.4 billion. The United States reduced its imports of energy-related products from several individual OPEC members by $5–$7 billion each. The combined effect on U.S. trade with OPEC and on the overall U.S. trade balance was substantial.

Figure US.2 Total trade between the United States and its five largest trading partners, 2013



Source: Compiled from official statistics of the U.S. Department of Commerce.

[11] There are currently 12 OPEC member countries: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

Table US.4 All merchandise sectors: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. exports of domestic merchandise							
Canada	171,695	205,956	233,774	244,199	251,685	7,486	3.1
China	65,124	85,746	96,898	103,508	114,313	10,806	10.4
Mexico	105,718	131,602	159,910	175,159	181,690	6,531	3.7
Japan	47,074	55,727	61,409	64,599	59,689	-4,910	-7.6
Germany	40,229	44,391	44,240	43,676	42,372	-1,304	-3.0
Korea	27,074	36,836	41,311	40,004	39,008	-996	-2.5
United Kingdom	41,990	44,005	49,984	48,293	41,228	-7,065	-14.6
France	24,367	24,421	25,361	27,491	28,351	859	3.1
Brazil	22,135	30,157	37,275	37,252	37,627	375	1.0
Saudi Arabia	10,235	10,712	12,823	16,935	17,656	721	4.3
All other	381,104	452,578	536,192	552,096	558,419	6,324	1.1
Total	936,745	1,122,131	1,299,176	1,353,211	1,372,039	18,827	1.4
EU-28	202,581	217,629	241,587	235,916	231,676	-4,240	-1.8
OPEC	46,750	50,050	59,461	75,855	77,801	1,946	2.6
Latin America	205,299	256,600	312,562	340,366	346,893	6,527	1.9
Asia	238,447	307,077	345,014	349,499	360,224	10,725	3.1
Sub-Saharan Africa	14,638	16,437	20,298	21,573	22,969	1,396	6.5
U.S. imports for consumption							
Canada	224,584	275,536	316,397	323,925	332,887	8,962	2.8
China	295,545	364,047	398,467	424,874	438,147	13,273	3.1
Mexico	176,309	228,824	262,671	276,408	277,664	1,255	0.5
Japan	96,002	119,938	127,901	144,538	137,954	-6,584	-4.6
Germany	69,790	80,886	96,539	105,084	112,233	7,149	6.8
Korea	38,770	47,914	56,006	57,874	61,979	4,105	7.1
United Kingdom	47,019	49,293	51,045	54,497	52,165	-2,332	-4.3
France	33,961	38,241	39,596	41,099	44,697	3,598	8.8
Brazil	19,612	23,402	30,368	31,720	26,861	-4,860	-15.3
Saudi Arabia	21,366	30,911	45,130	52,306	46,576	-5,730	-11.0
All other	526,207	639,620	762,832	738,710	708,589	-30,121	-4.1
Total	1,549,163	1,898,610	2,186,951	2,251,035	2,239,750	-11,285	-0.5
EU-28	278,355	315,213	362,856	374,570	381,591	7,021	1.9
OPEC	109,883	147,136	184,730	170,756	141,246	-29,510	-17.3
Latin America	283,049	358,048	429,290	443,139	429,634	-13,505	-3.0
Asia	583,910	718,322	792,540	844,754	860,554	15,800	1.9
Sub-Saharan Africa	47,159	64,351	74,019	49,591	39,419	-10,173	-20.5

See footnote(s) at end of table.

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. merchandise trade balance							
Canada	-52,889	-69,580	-82,623	-79,726	-81,202	-1,476	-1.9
China	-230,421	-278,301	-301,569	-321,367	-323,834	-2,467	-0.8
Mexico	-70,591	-97,222	-102,761	-101,249	-95,973	5,276	5.2
Japan	-48,928	-64,211	-66,492	-79,939	-78,265	1,674	2.1
Germany	-29,561	-36,495	-52,299	-61,408	-69,861	-8,452	-13.8
Korea	-11,696	-11,077	-14,695	-17,870	-22,971	-5,100	-28.5
United Kingdom	-5,030	-5,288	-1,060	-6,204	-10,937	-4,733	-76.3
France	-9,593	-13,819	-14,236	-13,608	-16,346	-2,739	-20.1
Brazil	2,523	6,755	6,907	5,532	10,767	5,235	94.6
Saudi Arabia	-11,131	-20,199	-32,307	-35,371	-28,920	6,451	18.2
All other	-145,103	-187,042	-226,640	-186,614	-150,169	36,445	19.5
Total	-612,419	-776,479	-887,775	-897,824	-867,712	30,112	3.4
EU-28	-75,774	-97,584	-121,269	-138,654	-149,915	-11,260	-8.1
OPEC	-63,133	-97,086	-125,268	-94,901	-63,445	31,455	33.1
Latin America	-77,750	-101,448	-116,729	-102,772	-82,741	20,031	19.5
Asia	-345,463	-411,246	-447,526	-495,255	-500,330	-5,075	-1.0
Sub-Saharan Africa	-32,521	-47,915	-53,721	-28,019	-16,450	11,569	41.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

The U.S. trade deficit with China—the largest source of U.S. imports by value—grew by $2.5 billion (0.8 percent) to $323.8 billion in 2013. Electronic products, comprising computers, peripherals, and telecommunications equipment, continued to account for 40 percent of U.S. merchandise imports from China.

Overall trade with Japan—the fourth-largest source of U.S. imports by value—contracted by over 5 percent in 2013. Declines occurred in both exports (down by $4.9 billion, or 8 percent) and imports (down by $6.6 billion, or 5 percent) and were distributed across many sectors. The U.S. trade deficit with Japan fell by 2 percent in 2013.

Part II
Bilateral Trade

This section of the report analyzes U.S. merchandise trade with three selected trading partners—Brazil, China, and Vietnam. U.S. merchandise trade with all three of these countries changed significantly from 2012 to 2013. The section also examines bilateral U.S. trade with the Organization of Petroleum Exporting Countries (OPEC), a group of 12 countries that accounted for 41 percent of world total crude petroleum production in 2013.

Brazil

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Change in 2013 from 2012:

U.S. trade surplus: Increased by $5.2 billion (95 percent) to $10.8 billion
U.S. exports: Increased by $375 million (1 percent) to $37.6 billion
U.S. imports: Decreased by $4.9 billion (15 percent) to $26.9 billion

The U.S. trade surplus with Brazil increased by $5.2 billion in 2013 (95 percent), owing almost entirely to a $4.9 billion reduction in the value of U.S. imports (table BR.1 and figure BR.1). While four of the U.S. industry sectors reviewed in this report recorded a trade deficit with Brazil in 2013, [12] substantial trade surpluses in chemicals and related products and energy-related products largely accounted for the overall increase in the United States' trade surplus with Brazil. The main contributors to the growth in the trade surplus were the significant decline in the value of U.S. imports of energy-related products from Brazil coupled with the increase in U.S. exports of agricultural products to Brazil.

Brazil's gross domestic product (GDP) rose 2.5 percent in 2013. The Brazilian economy is relatively stable, and changes in the U.S. trade balance with Brazil were not a result of movements in the Brazilian economy. Rather, the change was largely the result of falling global prices for energy-related products, which caused the value of U.S. imports from Brazil to drop significantly.

U.S. Exports

The value of U.S. exports to Brazil increased by just 1 percent (about $375 million) to $37.6 billion in 2013, with increased exports of agricultural products driving the growth. Agricultural product exports grew by $1.3 billion, fueled mostly by increases in cereals exports (table BR.2).

U.S. exports of cereals to Brazil grew by $1.2 billion (over 7,000 percent) in 2013. This sharp increase was driven by a surge in U.S. wheat exports. The United States exported almost 3.5 million metric tons (mmt) in 2013, the largest amount in 30 years, fueled by a spike in Brazilian demand and a record U.S. wheat crop. [13] While Brazil, a large net wheat importer,

[12] These sectors include agricultural products; forest products; footwear; and minerals and metals.
[13] USDA, FAS, U.S. Wheat Exports to Brazil Highest in 30 Years, February 19, 2014, 1–2.

Table BR.1 Brazil: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by major industry/commodity sectors, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. exports of domestic merchandise							
Agricultural products	349	564	1,892	695	1,952	1,257	180.8
Forest products	359	445	481	418	388	-30	-7.2
Chemicals and related products	5,714	7,815	8,875	8,987	9,818	831	9.2
Energy-related products	2,022	4,368	6,501	7,382	6,712	-669	-9.1
Textiles and apparel	188	246	271	284	254	-30	-10.4
Footwear	1	2	4	2	2	-1	-30.1
Minerals and metals	784	1,140	1,177	1,257	1,330	73	5.8
Machinery	2,144	3,061	3,516	3,794	3,961	166	4.4
Transportation equipment	6,407	7,205	9,140	8,997	8,132	-865	-9.6
Electronic products	3,474	4,325	4,320	4,382	4,079	-304	-6.9
Miscellaneous manufactures	184	218	291	263	227	-36	-13.7
Special provisions	510	768	807	790	773	-17	-2.2
Total	22,135	30,157	37,275	37,252	37,627	375	1.0
U.S. imports for consumption							
Agricultural products	2,632	3,201	4,643	4,924	4,675	-249	-5.1
Forest products	1,300	1,790	1,793	1,802	2,159	357	19.8
Chemicals and related products	1,883	2,705	3,191	3,157	2,514	-643	-20.4
Energy-related products	6,118	7,000	8,918	8,631	4,869	-3,762	-43.6
Textiles and apparel	259	238	117	111	117	6	5.1
Footwear	382	360	253	210	200	-10	-4.8
Minerals and metals	2,458	3,346	5,554	5,603	5,214	-389	-6.9
Machinery	969	1,062	1,231	1,279	1,081	-198	-15.5
Transportation equipment	2,066	2,221	2,949	3,325	3,325	([a])	([b])
Electronic products	321	305	288	323	254	-68	-21.2
Miscellaneous manufactures	387	376	381	418	454	36	8.6
Special provisions	836	798	1,049	1,937	1,999	62	3.2
Total	19,612	23,402	30,368	31,720	26,861	-4,860	-15.3

See footnotes at end of table.

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. merchandise trade balance							
Agricultural products	-2,284	-2,637	-2,751	-4,229	-2,723	1,506	35.6
Forest products	-941	-1,345	-1,311	-1,384	-1,771	-387	-28.0
Chemicals and related products	3,831	5,110	5,684	5,830	7,303	1,474	25.3
Energy-related products	-4,096	-2,633	-2,417	-1,250	1,843	3,093	([c])
Textiles and apparel	-71	8	154	173	137	-35	-20.5
Footwear	-381	-358	-249	-207	-198	9	4.5
Minerals and metals	-1,673	-2,206	-4,377	-4,345	-3,883	462	10.6
Machinery	1,174	1,999	2,285	2,516	2,880	365	14.5
Transportation equipment	4,341	4,985	6,190	5,672	4,808	-865	-15.2
Electronic products	3,153	4,020	4,033	4,060	3,824	-236	-5.8
Miscellaneous manufactures	-203	-158	-90	-155	-227	-72	-46.2
Special provisions	-326	-30	-242	-1,147	-1,226	-79	-6.9
Total	2,523	6,755	6,907	5,532	10,767	5,235	94.6

Source: Compiled from official statistics of the U.S. Department of Commerce.

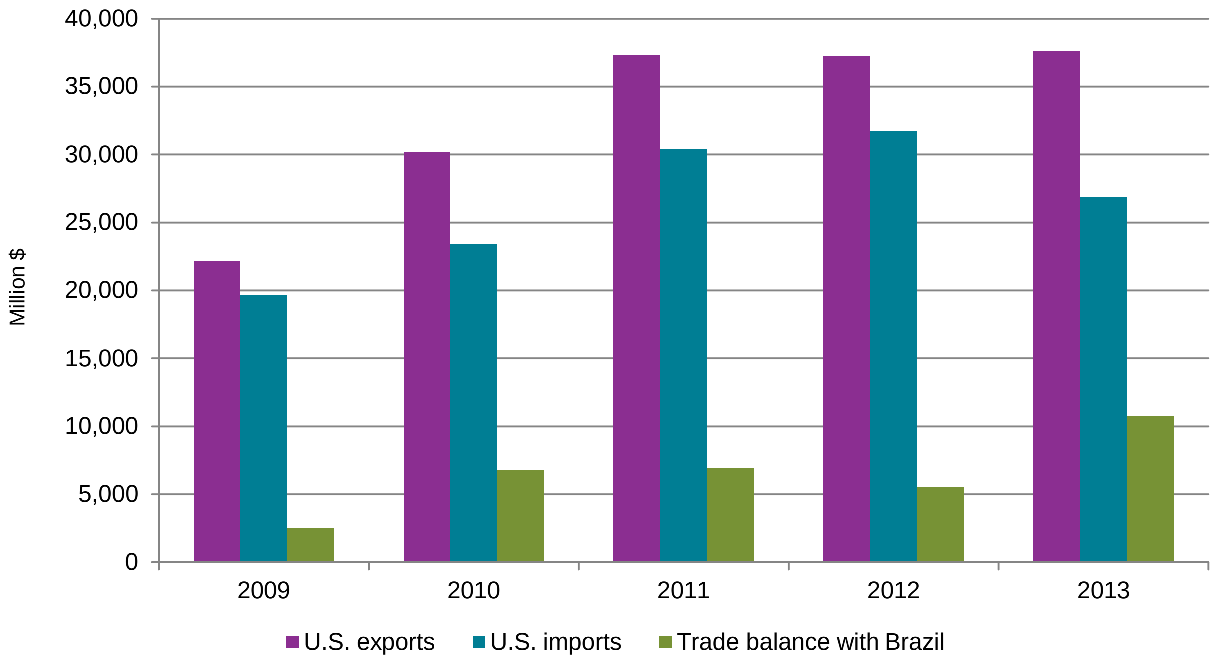
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. Sectors are ordered by the level of processing of the products classified therein.

[a]Less than $500,000.

[b]Less than 0.05 percent.

[c]Not meaningful for purposes of comparison.

Figure BR.1 U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, 2009–13



Source: Compiled from official statistics of the U.S. Department of Commerce.

Table BR.2 Brazil: Leading changes in U.S. exports and imports, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. EXPORTS							
Increases							
Cereals (AG030)	41	128	31	15	1,248	1,232	7,975.2
Decreases							
Petroleum products (EP005)	1,026	2,778	4,315	5,684	4,972	-711	-12.5
All other	21,068	27,250	32,928	31,553	31,408	-145	-0.5
Total	22,135	30,157	37,275	37,252	37,627	375	1.0
U.S. IMPORTS							
Increases							
Aircraft, spacecraft, and related equipment (TE013)	722	697	872	985	1,742	757	76.8
Oilseeds (AG032)	1	([a])	([a])	([a])	184	183	42,525.7
Decreases							
Energy-related products	4,661	5,188	6,498	5,374	2,659	-2,715	-50.5
Crude petroleum (EP004)							
Petroleum products (EP005)	1,150	1,367	1,783	2,633	1,918	-715	-27.2
All other	13,079	16,149	21,214	22,728	20,358	-2,370	-10.4
Total	19,612	23,402	30,368	31,720	26,861	-4,860	-15.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. In 2009, 60 export commodity classification (schedule B) codes covering all civilian aircraft, engines, equipment, and parts were consolidated into a single code by the U.S. Census Bureau. This reclassification may have accounted for some of the shifts in exports in the transportation equipment sector.

[a]Less than $500,000.

generally purchases its wheat from neighboring Argentina, shortages in Argentine production drove up its wheat prices. [14] The Argentine government imposed an export ban on wheat, leaving Brazilian consumers to find alternate sources of supply. [15] While U.S. wheat is usually subject to a 10 percent import duty in Brazil, [16] this common external tariff (CET) was waived through the summer of 2013 in order to lower the cost of imported wheat for Brazilian customers. [17] Although Argentina's export restriction on wheat is not permanent, the U.S. wheat industry views it as an opportunity for further export growth to Brazil in the future. [18]

The increase in agricultural exports to Brazil was largely offset by export declines in several other sectors, including exports of energy-related products and transportation equipment, which fell by over $0.5 billion each (although these represented decreases of less than 10 percent from the previous year). In 2013, the quantity of U.S. exports of petroleum products to Brazil increased by 6 percent, from 60.7 million barrels in 2012 to 64.5 million barrels. However, the value of such exports decreased by 13 percent compared with 2012. This rise in volume but decline in value was caused by a drop in world prices of crude petroleum, the feedstock for the production of petroleum products. Average world prices for crude petroleum decreased by about 3 percent to $108 per barrel in 2013. Brazil's 13 refineries have a capacity of 1.9 million barrels per day of crude petroleum and are currently operating at full capacity. The refining industry in Brazil is not able to fully process the nation's production of heavy crudes and, because of this capacity constraint, Brazil must import petroleum products to meet domestic demand. [19] Brazil accounts for only about 5 percent of total U.S. petroleum product exports, with Argentina being Brazil's primary source of these imports.

U.S. Imports

The value of U.S. imports from Brazil fell by $4.9 billion (15 percent) to $26.9 billion in 2013. This decline was driven by a large decrease (almost $3.8 billion) in both the value and the quantity of U.S. imports from Brazil of energy-related products.

U.S. imports of crude petroleum from Brazil decreased by 50 percent in value and by about 33 percent in terms of quantity. Although the United States is Brazil's primary market for crude petroleum, Brazil is not a major supplier to the U.S. market, accounting for less than 2 percent of total U.S. crude petroleum imports. Most of Brazil's crude production is heavy crude, which

[14] Sjerven, "Brazil Emerges as Major Market for U.S. Wheat," August 28, 2013.
[15] In addition to a drought in Argentina, which depressed wheat output during the 2012–13 season, the Argentinian government's June announcement that it would not authorize wheat shipments likely lowered wheat production further, as growers switched to other crops. Southern states in Argentina plant wheat later in July and August, and the knowledge that the export market was limited by the government caused some producers to plant barley in lieu of wheat. Sjerven, "Brazil Emerges as Major Market for U.S. Wheat," August 28, 2013.
[16] The 10 percent duty is applied to all countries outside the Mercado Común del Sur (Common Market of the South) exporting wheat to Brazil. Sjerven, "Brazil Emerges as Major Market for U.S. Wheat," August 28, 2013.
[17] Brazil previously lifted a CET on wheat in 2008. This action, though temporary, also led to a surge of U.S wheat exports to this market. U.S. Wheat Associates, "Wheat Exports Grow As Brazil Waives Tariff," April 11, 2013.
[18] U.S. Wheat Associates, "Wheat Exports Grow As Brazil Waives Tariff," April 11, 2013.
[19] USDOE, EIA, "Country Analysis: Brazil," October 2013.

yields fewer of the higher-valued petroleum products than light crudes do. During 2013, U.S. production of crude petroleum increased, while consumption decreased as a result of economic conditions.

U.S. imports of petroleum products from Brazil dropped by about 28 percent in terms of value and by about 3 percent in terms of quantity. The United States is not a major importer of petroleum products, as the U.S. domestic industry refines lighter crudes to satisfy most U.S. demand for petroleum products. Brazil supplied only about 1 percent of total U.S. imports of petroleum products in 2013.

Though energy-related products drove the overall decrease in U.S. imports from Brazil, U.S. imports of several product categories notably increased. U.S. imports of aircraft, spacecraft, and related equipment from Brazil increased by over $750 billion (77 percent) to about $1.7 billion. This growth reflected U.S. airlines' and business jet operators' investments in new regional jets and single-aisle aircraft produced by Embraer in Brazil. [20] Embraer also increased production of its small Phenom jet at its facility in Melbourne, Florida, which uses many parts produced in Brazil. [21]

Additionally, the United States imported oilseeds valued at $184 million from Brazil in 2013, compared to less than $0.5 million worth in 2012. U.S. imports of soybeans constituted most of this increase. The United States usually imports only a small amount of soybeans and was a large net exporter to the world in 2013. However, in 2012, the Midwestern states experienced a drought, while global demand for soybeans remained high. The United States and Brazil are generally able to satisfy global demand for soybeans, but delays and problems at Brazilian ports limited Brazil's ability to export soybeans, and as a result the United States exported for a longer time period than usual. U.S. soybean processors still needed to maintain their crush rate (the share of soybeans that are crushed) in order to provide soy oil and meal to consumers, and U.S. domestic stocks were getting smaller and more expensive. By the summer of 2013, the price difference between domestically produced soybeans and imported soybeans from Brazil was so low that many U.S. processors chose to import the oilseed from Brazil. [22]

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[20] Reuters, "Embraer Seeks to Maintain Profit Margin," February 26, 2014.

[21] Trimble, "Embraer Announces Melbourne Expansion," October 29, 2013; Thalji, "Aircraft Parts Have Port of Tampa Flying High," February 9, 2013.

[22] Government representative, email message to USITC staff, February 28, 2014; industry representative, email message to USITC staff, February 28, 2014.

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China

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $2.5 billion (1 percent) to $323.8 billion
U.S. exports: Increased by $10.8 billion (10 percent) to $114.3 billion
U.S. imports: Increased by $13.3 billion (3 percent) to $438.1 billion

The U.S. trade deficit with China increased by $2.5 billion (1 percent) in 2013, as U.S. exports to China rose by $10.8 billion and U.S. imports rose by $13.3 billion (figure CN.1 and table CN.1). The increasing trade deficit resulted from rising deficits with China in machinery (up by $2.7 billion), electronic products (up by $2.3 billion), chemicals and related products (up by $1.5 billion), and textiles and apparel (up by $1.1 billion). Growth in the U.S. trade deficit with China was limited by a higher U.S. trade surplus in transportation equipment (up by $6.6 billion). Two other U.S. industry sectors that had trade surpluses with China in 2013 were agricultural products and energy-related products. China's real GDP grew by 7.7 percent in both 2012 and 2013.[23]

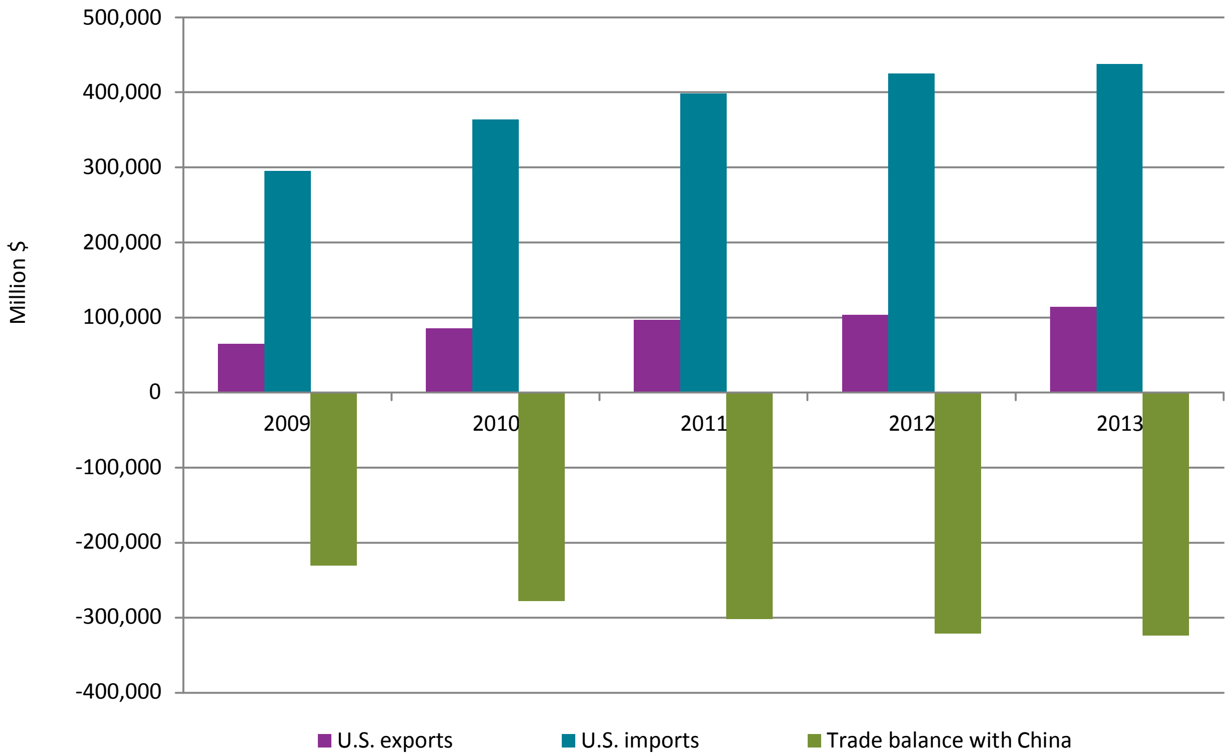
U.S. Exports

U.S. merchandise exports to China increased by $10.8 billion (or 10 percent) to $114.3 billion in 2013. The four sectors that contributed the most to the growth of U.S. merchandise exports to China in 2013 were transportation equipment (up by $7.6 billion), electronic products (up by $1.8 billion), forest products (up by $583 million), and machinery (up by $546 million) (table CN.1).

The transportation equipment sector accounted for the second-largest share (22 percent) of all U.S. merchandise exports to China in 2013, but represented the largest increase in U.S. exports to China (figure CN.2). Sector exports rose because of significant increases in 2013 of U.S. exports of aircraft, spacecraft, and related equipment (up by 53 percent, or $4.2 billion) and motor vehicles (up by 51 percent, or $2.8 billion) (table CN.2).

[23] IMF, *World Economic Outlook*, January 2014.

Figure CN.1 U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, 2009–13



Source: Compiled from official statistics of the U.S. Department of Commerce.

Table CN.1 China: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by major industry/commodity sectors, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. exports of domestic merchandise							
Agricultural products	13,762	18,232	20,089	27,266	27,176	-89	-0.3
Forest products	3,720	5,050	6,722	6,208	6,791	583	9.4
Chemicals and related products	10,643	13,344	15,021	14,205	14,128	-76	-0.5
Energy-related products	708	1,619	2,308	2,785	3,057	272	9.8
Textiles and apparel	846	1,083	1,240	1,243	1,412	169	13.6
Footwear	44	55	56	47	44	-3	-5.7
Minerals and metals	8,703	10,791	13,489	12,099	11,998	-101	-0.8
Machinery	5,424	7,903	8,946	8,539	9,085	546	6.4
Transportation equipment	9,193	12,519	15,827	17,494	25,038	7,544	43.1
Electronic products	11,133	13,493	11,889	12,331	14,123	1,792	14.5
Miscellaneous manufactures	362	354	425	458	508	50	10.9
Special provisions	585	1,301	886	834	954	120	14.3
Total	65,124	85,746	96,898	103,508	114,313	10,806	10.4
U.S. imports for consumption							
Agricultural products	4,850	5,653	6,498	7,043	6,967	-76	-1.1
Forest products	6,281	7,123	7,333	8,080	8,277	197	2.4
Chemicals and related products	17,510	21,319	25,637	27,975	29,445	1,470	5.3
Energy-related products	305	495	620	390	498	108	27.7
Textiles and apparel	35,083	42,095	44,798	44,949	46,239	1,289	2.9
Footwear	13,415	15,727	16,677	17,026	16,876	-151	-0.9
Minerals and metals	19,146	22,208	25,258	26,890	27,616	726	2.7
Machinery	25,995	32,326	36,534	40,730	44,024	3,294	8.1
Transportation equipment	8,553	11,850	15,284	16,866	17,813	947	5.6
Electronic products	110,794	143,716	158,671	171,159	175,212	4,053	2.4
Miscellaneous manufactures	49,892	57,635	57,041	59,339	60,574	1,235	2.1
Special provisions	3,721	3,900	4,116	4,425	4,606	181	4.1
Total	295,545	364,047	398,467	424,874	438,147	13,273	3.1

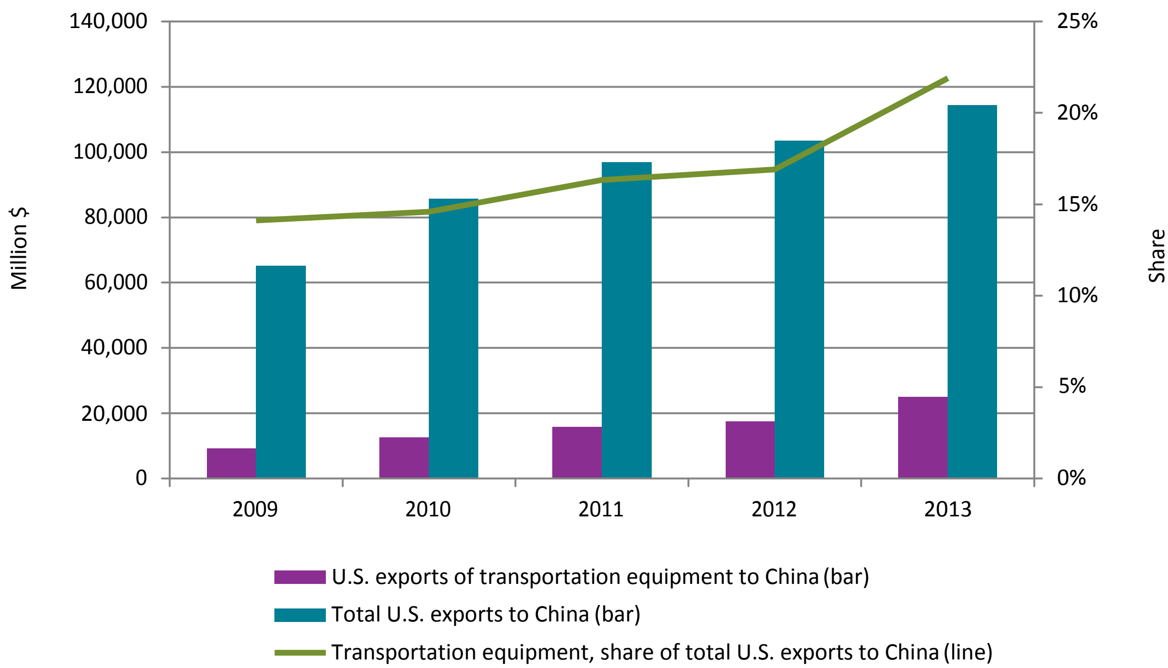
See footnotes at end of table.

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. merchandise trade balance							
Agricultural products	8,913	12,579	13,591	20,223	20,210	-13	-0.1
Forest products	-2,561	-2,073	-612	-1,872	-1,486	386	20.6
Chemicals and related products	-6,867	-7,975	-10,616	-13,771	-15,316	-1,546	-11.2
Energy-related products	403	1,125	1,689	2,395	2,559	164	6.8
Textiles and apparel	-34,237	-41,013	-43,558	-43,707	-44,827	-1,120	-2.6
Footwear	-13,371	-15,671	-16,622	-16,979	-16,831	148	0.9
Minerals and metals	-10,443	-11,416	-11,769	-14,792	-15,619	-827	-5.6
Machinery	-20,571	-24,423	-27,588	-32,191	-34,939	-2,748	-8.5
Transportation equipment	640	669	543	628	7,225	6,597	1,050.5
Electronic products	-99,661	-130,223	-146,782	-158,828	-161,089	-2,260	-1.4
Miscellaneous manufactures	-49,530	-57,281	-56,616	-58,881	-60,067	-1,185	-2.0
Special provisions	-3,136	-2,599	-3,230	-3,592	-3,653	-61	-1.7
Total	-230,421	-278,301	-301,569	-321,367	-323,834	-2,467	-0.8

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. Sectors are ordered by the level of processing of the products classified therein.

Figure CN.2 China: Total U.S. exports, U.S. exports of transportation equipment, and share of total U.S. exports of transportation equipment



Source: Compiled from official statistics of the U.S. Department of Commerce.

Table CN.2 China: Leading changes in U.S. exports and imports, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change 2012–13
	Million $						
U.S. EXPORTS							
Increases							
Aircraft, spacecraft, and related equipment (TE013)							
Motor vehicles (TE009)	951	3,105	5,008	5,479	8,285	2,806	51.2
Animal feeds (AG013)	286	883	731	1,091	2,040	949	86.9
Decreases							
Cotton, not carded or combed (AG049)	824	2,064	2,562	3,422	2,181	-1,240	-36.3
Total	65,124	85,746	96,898	103,508	114,313	10,806	10.4
Increases							
Household appliances, including commercial applications (MT004)	6,858	8,331	8,778	9,671	11,090	1,419	14.7
Electronic products	20,554	21,734	17,892	18,037	16,942	-1,095	-6.1
Consumer electronics (EL003)							
Fabricated structurals (MM027)	428	382	477	615	211	-404	-65.6
Total	295,545	364,047	398,467	424,874	438,147	13,273	3.1

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. In 2009, 60 export commodity classification (schedule B) codes covering all civilian aircraft, engines, equipment, and parts were consolidated into a single code by the U.S. Census Bureau. This reclassification may have accounted for some of the shifts in exports in the transportation equipment sector.

In 2013, China was the largest single-country market for U.S. exports of aircraft, spacecraft, and related equipment, accounting for almost 12 percent of such exports. In 2013, China was a significant market for commercial aircraft. [24] The growth in U.S. exports of these products in 2013 was most likely due to deliveries of commercial aircraft and spare parts for Boeing aircraft. In 2013, Boeing delivered 143 planes to China, and expects to deliver a similar number there in 2014. [25]

Industry foresees significant potential for the business jet market. Although it felt that Chinese airspace regulations prevented the sharp rise in deliveries originally anticipated for 2013, the U.S. industry expects Chinese aviation and other regulatory authorities to expand Chinese airspace to accommodate more business jets in 2014. [26]

Transportation equipment exports to China also rose because of an increase in U.S. exports of motor vehicles to China in 2013 (table CN.2). Comprising passenger automobiles, tractors, trucks, and motorcycles, these exports rose from 167,251 units in 2012 to 247,976 in 2013, or from $5.5 billion to $8.3 billion. [27] In addition, U.S. exports of certain motor-vehicle parts to China rose in value by $623 million to almost $1.4 billion in 2013.

The increase in U.S. motor vehicle exports was driven primarily by exports of passenger automobiles. Since 2010, China has become the largest export market for U.S. passenger automobiles. Although the market is largely served by Chinese production, [28] relatively competitive cost structures have enabled U.S.- and foreign-owned automobile manufacturers to export from their U.S. manufacturing operations. [29]

The second-largest sectoral increase in exports to China was in electronic products. The increase occurred chiefly in exports of semiconductors and integrated circuits (up $902 million to $3.6 billion) that are incorporated into electronic products assembled or manufactured in China. U.S. exports of measuring, testing, and controlling instruments (up $516 million to $3.8 billion)—principally instruments and apparatus for measuring or checking electrical quantities specially designed for telecommunications—also contributed to the rise in these sectoral exports.

U.S. exports of agricultural products, which experienced the largest sector increase from 2011 to 2012, showed a minor decrease in 2013. Nonetheless, agricultural products remained the largest U.S. export sector to China in 2013, valued at $27.2 billion and accounting for almost 24 percent of U.S. exports to China. In 2013, U.S. exports to China of cereals rose $1.1 billion, while exports of animal feeds rose $949 million. Such increases, however, were offset by

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[24] Boeing Co., "Long-Term Market, Current Market Outlook," n.d. (accessed March 24, 2014).
[25] Bloomberg News, "Boeing Expects to Deliver 140 Planes," January 21, 2014.
[26] Fang and Miller, "Small Jet Makers See Big Chance," December 26, 2013.
[27] USITC DataWeb/USDOC (April 17, 2014).
[28] Based on new passenger-car registrations. EIU, "Industry Report: Automotive, China," January 2014, 2.
[29] Arnsdorf, "U.S. Car Revival Boosts Shipping," December 13, 2013. A certain amount of U.S. exports are likely to be gray market exports (i.e., exports and sales outside of automobile manufacturers' normal sales channels) of luxury automobiles. Barris, "$50,000 in the US; $149,000 in China," *ChinaDaily USA,* December 6, 2013.

declines in exports of oilseeds (down $1.6 billion) and cotton, not carded or combed (down $1.2 billion), as shown in table CN.2.

U.S. Imports

In 2013, U.S. imports of merchandise from China increased by $13.2 billion, or 3 percent, over 2012. The increase in U.S. imports from China was principally driven by the electronic products sector, although the machinery and chemicals and related products sectors also registered high import growth (table CN.1).

The electronic products sector accounted for 40 percent of total U.S. imports from China in 2013. Imports in this sector rose by $4.1 billion (2 percent), a much slower rate of increase than during 2011–12 (8 percent). Computers, peripherals, and parts accounted for 43 percent of imports in this sector, followed by telecommunications equipment (31 percent), consumer electronics (10 percent), and other industries, such as medical goods and semiconductors and integrated circuits (16 percent).

The largest increase in imports of electronic products was in the telecommunications equipment group. The majority of these imports were cellphones manufactured in China, U.S. imports of which rose by $3.8 billion to reach $36.6 billion in 2013 (table CN.1). [30] In 2013, China remained the largest supplier of U.S. imports in the telecommunications equipment industry, accounting for almost 61 percent of total U.S. imports from all sources in this industry.

The large increase in imports of telecommunications equipment from China was partially offset by a decline in imports of computers, peripherals, and parts, which fell by $646 million (almost 1 percent) to $75.6 billion in 2013. The decline was due to falling demand from consumers and corporations for personal computers and servers, as consumers shifted towards mobile devices. [31] There was also a decline in imports of consumer electronics [32] from China, which fell by $1.1 billion (6 percent) to $16.9 billion in 2013, as U.S. consumers reduced spending on these consumer electronics, particularly television cameras and camcorders, and radios. [33]

Machinery sector imports from China rose in 2013, principally due to increased imports of household appliances, up $1.4 billion (15 percent) to $11.1 billion in 2013. Within the group of household appliances, imports of washing machines from China rose by $553 million. [34] One possible reason for the increase in U.S. imports of washing machines was a shift in production of these goods to China following issuance of antidumping duty orders on imports of large residential washers from the Republic of Korea (Korea) and Mexico and a countervailing duty

[30] NPD Group, "Apple Leads US Consumer Smartphone Sales," February 20, 2014.
[31] EIU, "Telecoms and Technology Report," May 28, 2013, 1.
[32] The category of consumer electronics EL003 in Table CN.2 includes radios, amplifiers, turntables, television camcorders, and televisions, but not electronic products such as computers, tablets, and cellular telephones.
[33] CEA, "U.S. Consumer Electronics Sales & Forecasts 2009–2014," January 2014, 16.
[34] NPD Group, "The NPD Group Reports Consumers Spent $46B," February 14, 2014.

order on large residential washers from Korea, issued in February 2013. [35] Imports from China of small household appliances, such as food processors and vacuum cleaners, also rose in 2013. Other groups in the machinery sector that had import increases from China in 2013 were the electrical transformers, static converters, and inverters category, as well as nonautomotive insulated electrical wire and related equipment.

The fourth-largest increase in sector imports from China occurred in chemicals and related products. Imports in this sector were up by almost $1.5 billion (5 percent) in 2013. Imports of miscellaneous plastic products, tires and tubes, and organic chemicals registered significant increases in 2013.

The United States imposed trade remedies in 2012 and 2013 on two types of renewable energy products from China. U.S. imports of utility-scale wind towers for wind turbines from China declined by $404 million in 2013. This followed the imposition of U.S. antidumping and countervailing duty orders in February 2013. [36] The U.S. Department of Commerce also issued antidumping and countervailing duty orders in December 2012 on certain crystalline silicon photovoltaic solar panels from China. [37] The Harmonized Tariff Schedule of the United States (HTS) categorizes this type of solar photovoltaic product under the semiconductors and integrated circuits subheading. The trade figures for this subheading show a decline of $342 million in U.S. imports from China in 2013.

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[35] Wolf, "ITC Imposes Duties on Imported Washers," January 23, 2013. See also USITC, *Certain Large Residential Washers from Korea and Mexico, Investigation Nos. 701-TA-488 and 731-TA-1199-1200 (Final)*, Publication 4378, February 2013.

[36] 78 Fed. Reg. 11146 (February 15, 2013) and 78 Fed. Reg. 11152 (February 15, 2013). See also USITC, *Utility Scale Wind Towers from China and Vietnam: Investigation Nos. 701-TA-486 and 731-TA-1195-1196 (Final)*, Publication 4372, February 2013.

[37] 77 Fed. Reg. 73017 (December 7, 2012) and 77 Fed. Reg. 73018 (December 7, 2012).

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Yan, Fang, and Matthew Miller. "Small Jet Makers See Big Chance As China Prepares to Open Skies." Reuters, December 26, 2013. http://www.reuters.com/article/2013/12/26/aviation-china-privatejet-idUSL3N0JZ28C20131226 (accessed March 10, 2014).

Vietnam

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $3.9 billion (25 percent) to $19.7 billion
U.S. exports: Increased by $400 million (8 percent) to $4.7 billion
U.S. imports: Increased by $4.3 billion (21 percent) to $24.4 billion

The U.S. trade deficit with Vietnam increased by $3.9 billion in 2013, as a $4.3 billion increase in U.S. imports was only partially offset by a $400 million increase in U.S. exports (figure VN.1 and table VN.1). This shift principally reflects Vietnam's increasing ability to compete with other U.S. import sources. During 2013, the Vietnamese economy expanded by 5 percent, and exports and foreign direct investment were major factors in this growth. Exports grew by 15 percent, while Vietnam's exports-to-GDP ratio rose to 75 percent in 2013 from 56 percent in 2009. Disbursed foreign direct investment increased 10 percent, and pledged foreign direct investment rose 55 percent.

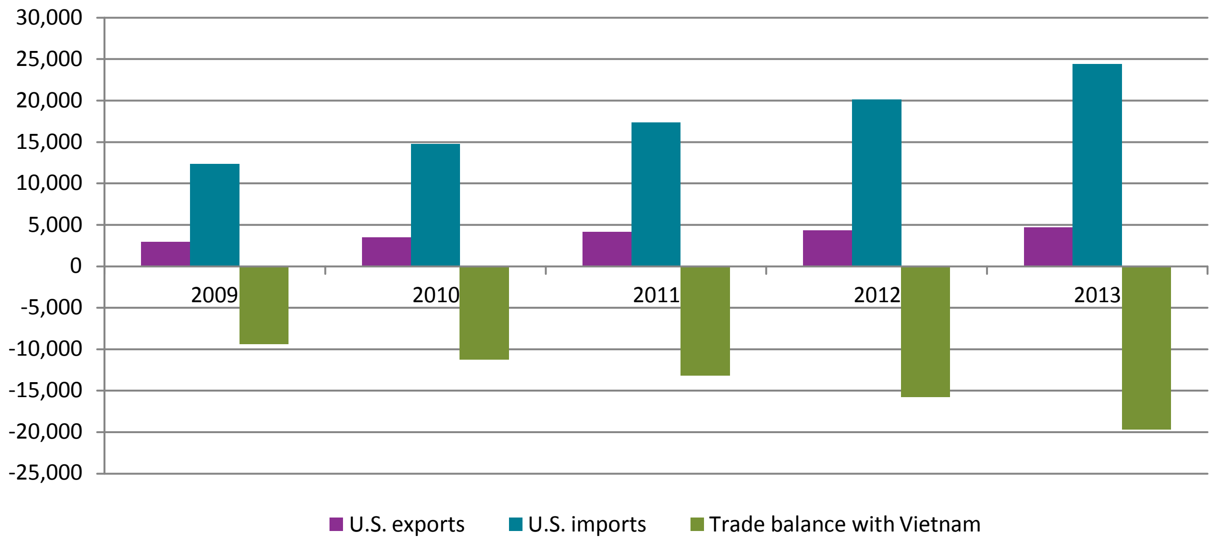
U.S. Exports

U.S. exports to Vietnam increased by $400 million to $4.7 billion in 2013 (up 8 percent from 2012). U.S. exports to Vietnam grew in seven of the sectors shown in table VN.1, with one sector, agricultural products, accounting for most of the overall increase in exports (table VN.2).

U.S. exports of agricultural products increased by $500 million, due to a combination of higher domestic Vietnamese consumption of animal feed and an increase in Vietnamese imports of edible nuts. U.S. exports of animal feed to Vietnam rose by $171 million (74 percent) in 2013. Changes in Vietnamese eating habits, coinciding with recent economic growth, have spurred growth in the domestic livestock sector. Domestic and foreign investment have increased Vietnamese capacity for animal feed production, [38] but this growth was insufficient to meet the rapid rise in feed demand in 2013. [39] As a result, Vietnam increased its imports of U.S. animal feed, including corn, wheat, and soybeans.

[38] USDA, FAS, "Vietnam: Oilseeds and Products Annual, 2013," April 5, 2012, 17–18.
[39] USDA, FAS, "Vietnam: Grain and Feed Annual, 2013," April 3, 2013, 2.

Figure VN.1 U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance with Vietnam, 2009–13



Source: Compiled from official statistics of the U.S. Department of Commerce.

Table VN.1 Vietnam: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by major industry/commodity sectors, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. exports of domestic merchandise							
Agricultural products	968	1,390	1,756	1,746	2,248	502	28.8
Forest products	166	227	236	263	291	27	10.4
Chemicals and related products	356	351	494	483	557	73	15.2
Energy-related products	7	13	12	11	15	4	31.1
Textiles and apparel	37	41	43	67	62	-5	-6.9
Footwear	25	47	54	39	60	21	54.3
Minerals and metals	293	348	283	292	316	24	8.3
Machinery	199	240	312	275	268	-7	-2.5
Transportation equipment	632	490	501	312	215	-97	-31.1
Electronic products	221	313	404	800	626	-174	-21.8
Miscellaneous manufactures	21	18	22	22	19	-3	-13.0
Special provisions	42	62	35	34	37	2	6.2
Total	2,967	3,540	4,153	4,345	4,714	369	8.5
U.S. imports for consumption							
Agricultural products	1,377	1,779	2,270	2,418	2,760	342	14.2
Forest products	125	163	162	191	228	37	19.3
Chemicals and related products	371	437	500	523	524	2	0.3
Energy-related products	596	334	341	305	471	166	54.6
Textiles and apparel	5,290	6,177	7,081	7,499	8,564	1,065	14.2
Footwear	1,323	1,616	2,019	2,388	2,898	510	21.4
Minerals and metals	326	396	634	850	799	-51	-6.0
Machinery	130	213	316	496	506	10	2.0
Transportation equipment	175	259	347	610	699	90	14.7
Electronic products	879	1,102	1,219	1,666	3,191	1,525	91.5
Miscellaneous manufactures	1,694	2,251	2,402	3,083	3,621	539	17.5
Special provisions	79	57	73	76	132	57	74.5
Total	12,367	14,784	17,364	20,105	24,397	4,292	21.3

See footnotes at end of table.

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance							
Agricultural products	-409	-389	-514	-672	-512	160	23.8
Forest products	41	64	75	72	62	-9	-13.2
Chemicals and related products	-15	-86	-5	-40	32	72	([a])
Energy-related products	-589	-321	-330	-294	-456	-163	-55.5
Textiles and apparel	-5,254	-6,136	-7,038	-7,432	-8,502	-1,070	-14.4
Footwear	-1,298	-1,569	-1,965	-2,349	-2,838	-489	-20.8
Minerals and metals	-33	-48	-351	-558	-483	75	13.5
Machinery	69	26	-4	-221	-238	-17	-7.6
Transportation equipment	457	231	154	-298	-484	-187	-62.7
Electronic products	-659	-790	-815	-866	-2,565	-1,699	-196.2
Miscellaneous manufactures	-1,674	-2,234	-2,381	-3,061	-3,602	-541	-17.7
Special provisions	-37	5	-38	-41	-96	-54	-131.3
Total	-9,400	-11,245	-13,211	-15,760	-19,683	-3,923	-24.9

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. Sectors are ordered by the level of processing of the products classified therein.
[a]Not meaningful for purposes of comparison.

In 2013, U.S. exports to Vietnam of edible nuts rose by $173 million (106 percent). Much of this increase was in peanuts, with exports increasing by $97 million (an over 80-fold rise). In part, this reflects global trends in the peanut market: the U.S. had its largest crop ever, [40] while two other leading exporters, India and Argentina, had smaller crops than in 2012. [41] China also supplied fewer peanuts to the global market in 2013, owing to increased domestic demand for peanuts (used to produce peanut oil). [42] In fact, U.S. exports to Vietnam included purchases in Vietnam to supply the Chinese market. [43] This practice was reportedly halted in April by Chinese authorities, [44] but likely contributed to the increase in U.S. exports to Vietnam for 2013.

U.S. exports of cotton, not carded or combed, increased $153 million (62 percent). During 2013, Vietnamese imports of cotton increased as demand rose, driven by an increase in yarn production capacity. India, typically a major cotton exporter, produced less cotton than expected in 2012, opening opportunities for U.S. cotton exporters in Vietnam. Yarn produced in Vietnam is both exported directly and consumed domestically by the export-oriented textile and apparel industries. [45]

U.S. Imports

U.S. imports from Vietnam rose by $4.29 billion (21 percent) to $24.4 billion in 2013. Three sectors—electronic products, textiles and apparel, and footwear—accounted for $2.6 billion of this increase. A common set of competitive factors, including low labor costs, a large labor pool, and proximity to existing supply chains, enabled Vietnam to increase its share of U.S. imports compared to other sources. [46] Specifically, multiyear increases in labor costs in China, which is the largest U.S. import source in these sectors, provided an incentive for foreign investors to also locate some production facilities in other nearby countries. [47] Vietnam was a primary beneficiary of this trend. [48]

U.S. imports of electronic products from Vietnam increased by $1.53 billion (92 percent) to $3.2 billion, while U.S. imports of electronic products from all sources rose by 0.8 percent. Much of the increase in imports from Vietnam resulted from investment in production facilities

[40] U.S. peanut exports to all countries increased by 109 percent in 2013.
[41] Floyd, "Chinese Market Softer for U.S. Grown Peanuts," June 5, 2013; Archer, "U.S. Export Market Developments," July 27, 2013.
[42] Archer, "U.S. Export Market Developments," July 27, 2013.
[43] Floyd, "Chinese Market Softer for U.S. Grown Peanuts," June 5, 2013.
[44] Archer, "U.S. Export Market Developments," July 27, 2013.
[45] Cleveland, "Strong U.S. Exports Bolster Cotton Market," February 7, 2014.
[46] *Taipei Times*, "Samsung Moves Factories from China to Vietnam," December 13, 2013; Leong, "Vietnam's High-Tech Boom," February 24, 2014; Textile World, "Vietnam: A Small Tiger Is Growing Up," September/October 2012; Kenneally, "Vietnam Continues to Dominate TPP Debate," October 8, 2013.
[47] Bloomberg, "China Wages Seen Jumping in 2014," January 6, 2014. Accenture, "Wage Increases in China," 2011.
[48] Bloomberg, "China Wages Seen Jumping in 2014," January 6, 2014.

Table VN.2 Vietnam: Leading changes in U.S. exports and imports, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. EXPORTS							
Increases							
Agricultural products	34	43	88	163	336	173	105.6
Edible nuts (AG020)							
Animal feeds (AG013)	178	291	217	231	402	171	73.9
Cotton, not carded or combed (AG049)	171	253	369	248	401	153	61.8
All other	2,583	2,954	3,479	3,703	3,575	-128	-3.5
Total	2,967	3,540	4,153	4,345	4,714	369	8.5
U.S. IMPORTS:							
Increases							
Apparel (TX005)	5,121	5,910	6,726	7,183	8,226	1,043	14.5
Computers, peripherals, and parts (EL017)	328	514	535	808	1,821	1,013	125.3
Footwear (FW001)	1,323	1,616	2,019	2,388	2,898	510	21.4
All other	5,595	6,745	8,084	9,726	11,452	1,726	17.7
Total	12,367	14,784	17,364	20,105	24,397	4,292	21.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

by multinational companies. The importance of foreign direct investment is demonstrated in mobile phones, where Samsung accounted for 98 percent of Vietnam's 2013 exports.[49]

U.S. imports of textiles and apparel from all sources increased by 3 percent in 2013. U.S. imports of textiles and apparel from Vietnam, however, increased by 14 percent ($1.1 billion) to $8.6 billion, and Vietnam's share of total U.S. imports in this sector increased from 6.6 percent to 7.3 percent. Vietnam's textile and apparel industry benefits from low labor costs relative to other exporting countries.[50]

U.S. imports of footwear from Vietnam increased by $510 million (21 percent) to $2.9 billion. U.S. imports of footwear from all sources increased 4 percent, while Vietnam's share of U.S. imports increased from 10 percent to 12 percent. As with textiles and apparel, the Vietnamese footwear industry benefits from comparatively low labor costs.[51] Vietnamese operations associated with foreign direct investment accounted for an estimated 76 percent of Vietnam's total exports in the footwear sector.[52]

[49] *Taipei Times*, "Samsung Moves Factories from China to Vietnam," December 13, 2013.
[50] AmCham Vietnam, "Vietnam-U.S. Trade Status 2013," December 1, 2013.
[51] Xinhua, "Vietnam's Footwear Export Hits Record High in 2013," January 7, 2014.
[52] *Viet Nam News*, "Footwear Industry Heads for Record Year," November 7, 2013.

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Organization of Petroleum Exporting Countries (OPEC)

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Change in 2013 from 2012:

U.S. trade deficit: Decreased by $31.4 billion (33 percent) to $63.4 billion
U.S. exports: Increased by $1.9 billion (3 percent) to $77.8 billion
U.S. imports: Decreased by $29.5 billion (17 percent) to $141.2 billion

The OPEC [53] countries collectively accounted for 7 percent of the total U.S. trade deficit in 2013 (table OP.1). Energy-related products accounted for 85 percent of U.S. imports from OPEC member countries in 2013. Crude petroleum imports from OPEC countries declined from $88.3 billion in 2012 to $65.2 billion in 2013, due principally to flat U.S. consumption and increasing U.S. production.

OPEC member countries coordinate and unify their petroleum policies with a view to ensuring the stability of prices in international oil markets. [54] OPEC collectively accounted for 73 percent of the world's reserves of crude petroleum and 41 percent of the world's total production in 2013. [55] Saudi Arabia supplied 31 percent of OPEC's crude production in 2013, followed by Venezuela (8 percent) and Nigeria (6 percent).

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[53] There are currently 12 OPEC member countries: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.
OPEC was founded in September 1930 by five countries: Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. They were later joined by Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), Gabon (1975) and Angola (2007). From December 1992 until October 2007, Ecuador suspended its membership. Gabon terminated its membership in 1995. Indonesia suspended its membership effective January 2009.

[54] The stated mission of OPEC is to "coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry." http://www.opec.org/opec_web/en/about_us/23.htm (accessed March 5, 2014).

[55] *Oil and Gas Journal,* "Forecast and Review," January 6, 2014.

Table OP.1 U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by major industry/commodity sectors, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. exports of domestic merchandise							
Agricultural products	4,301	5,092	6,908	6,690	6,947	257	3.8
Forest products	685	883	1,009	918	940	22	2.4
Chemicals and related products	4,130	5,175	6,272	6,685	6,720	35	0.5
Energy-related products	2,652	3,585	4,500	7,665	9,273	1,608	21.0
Textiles and apparel	331	377	450	483	469	-14	-3.0
Footwear	32	37	53	50	41	-9	-18.0
Minerals and metals	2,222	2,172	3,077	3,670	4,452	782	21.3
Machinery	6,487	7,055	7,224	8,869	8,786	-84	-0.9
Transportation equipment	18,164	17,730	20,677	29,266	27,735	-1,531	-5.2
Electronic products	5,460	5,269	6,103	7,614	7,750	136	1.8
Miscellaneous manufactures	1,237	1,394	1,855	2,416	3,030	613	25.4
Special provisions	1,049	1,282	1,332	1,528	1,657	129	8.4
Total	46,750	50,050	59,461	75,855	77,801	1,946	2.6
U.S. imports for consumption							
Agricultural products	1,679	1,692	2,031	1,972	2,074	102	5.2
Forest products	68	80	77	78	76	-2	-2.7
Chemicals and related products	8,071	12,136	15,120	16,087	15,558	-530	-3.3
Energy-related products	98,097	130,793	163,728	148,520	119,390	-29,131	-19.6
Textiles and apparel	173	220	147	152	146	-6	-3.7
Footwear	1	1	1	([a])	([a])	([a])	-23.7
Minerals and metals	707	1,261	2,286	2,461	2,131	-330	-13.4
Machinery	73	95	120	146	146	([a])	0.1
Transportation equipment	25	35	48	60	182	122	202.6
Electronic products	25	27	40	45	73	29	63.5
Miscellaneous manufactures	40	35	40	57	58	1	2.4
Special provisions	924	761	1,093	1,177	1,412	235	20.0
Total	109,883	147,136	184,730	170,756	141,246	-29,510	-17.3

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance							
Agricultural products	2,623	3,400	4,878	4,718	4,874	155	3.3
Forest products	617	803	933	840	864	24	2.9
Chemicals and related products	-3,941	-6,960	-8,848	-9,403	-8,838	565	6.0
Energy-related products	-95,445	-127,208	-159,228	-140,855	-110,117	30,738	21.8
Textiles and apparel	157	156	303	331	323	-9	-2.6
Footwear	32	36	52	49	40	-9	-18.0
Minerals and metals	1,515	911	792	1,209	2,321	1,112	92.0
Machinery	6,414	6,959	7,104	8,724	8,640	-84	-1.0
Transportation equipment	18,139	17,695	20,629	29,206	27,553	-1,652	-5.7
Electronic products	5,435	5,242	6,063	7,569	7,677	108	1.4
Miscellaneous manufactures	1,198	1,359	1,815	2,360	2,972	612	25.9
Special provisions	125	520	239	351	245	-106	-30.2
Total	-63,133	-97,086	-125,268	-94,901	-63,445	31,455	33.1

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. Sectors are ordered by the level of processing of the products classified within a sector.

[a]Less than $500,000.

U.S. Exports

In 2013, U.S. exports of goods to the OPEC member countries accounted for only 6 percent of total U.S. exports. The primary products exported included transportation equipment, energy-related products, and certain drilling equipment.

There was a major shift in U.S. exports of energy-related products to OPEC countries, which rose by 21 percent in 2013 (table OP.2). The increase is accounted for by rising prices of petroleum products, primarily jet fuels to Nigeria and distillate and residual fuel oils to Ecuador, Venezuela, and Nigeria. Although Nigeria has four refineries, their capacity utilization rates hover around 16–18 percent due to operational failures, fires, and sabotage (mainly of pipelines leading from the wellhead to the refineries). As a result, the four refineries do not meet domestic demand. [56] Ecuador is a net importer of petroleum products, and its three refineries, which are small and operate well below capacity, likewise do not meet domestic demand. [57] Most of Venezuela's crude petroleum is refined outside of the country; 40 percent is refined along the U.S. Gulf Coast and is dedicated to the U.S. market. During 2013, Venezuela was unable to meet its domestic demand for distillate and residual oils because its domestic refineries were operating at about 50 percent capacity, and much of that capacity was slated for export to neighboring countries under long-term contracts. As a result, Venezuela imported distillate and residual fuel oils from U.S. refineries. [58]

Transportation equipment was the largest U.S. export to the OPEC countries in 2013, accounting for 36 percent of the total. U.S. exports of ships, tugs, and pleasure boats increased by nearly 183 percent to $113 million in 2013, while exports of construction and mining equipment more than doubled, reaching $14.2 million. The United Arab Emirates is a major market for U.S. exports of these products and acts as a regional entry point for U.S. firms seeking access to the Middle East's markets. In addition, the country is rapidly adding to its stock of civil aircraft and undertaking significant infrastructure projects, which boosted import demand for construction equipment in 2013. [59]

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[56] USDOE, EIA, "Country Analysis Brief: Nigeria," December 30, 2013.
[57] USDOE, EIA, "Country Analysis: Ecuador," January 16, 2014; *Oil and Gas Journal,* "Western Europe Leads Global Refining Contraction," December 2, 2013.
[58] USDOE, EIA, "Country Analysis Brief: Venezuela," October 3, 2012; *Oil and Gas Journal,* "Western Europe Leads Global Refining Contraction," December 2, 2013.
[59] USDOC, "Export Countries of Interest for North Carolina" (accessed March 12, 2014).

Table OP.2 OPEC: Leading changes in U.S. exports and imports, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. EXPORTS							
Increases							
Petroleum products (EP005)	2,386	3,233	4,228	7,273	8,738	1,465	20.1
Precious metals and non-numismatic coins (MM020)	30	163	548	880	1,555	675	76.7
Navigational instruments and remote control apparatus (EL005)	104	105	144	448	1,060	613	136.9
Aircraft, spacecraft, and related equipment (TE013)	6,495	5,193	6,681	11,198	11,374	176	1.6
Decreases							
Electric motors, generators, and related equipment (MT023)	812	1,561	1,069	1,614	1,034	-580	-35.9
Transportation equipment	4,649	6,543	7,625	10,740	10,246	-494	-4.6
Motor vehicles (TE009)							
Construction and mining equipment (TE004)	2,730	2,131	2,231	2,544	2,124	-420	-16.5
Aircraft engines and gas turbines (TE001)	2,065	1,652	1,634	1,700	1,377	-323	-19.0
Certain motor-vehicle parts (TE010)	868	855	988	1,170	876	-293	-25.1
All other	26,611	28,614	34,314	38,289	39,416	1,127	2.9
Total	46,750	50,050	59,461	75,855	77,801	1,946	2.6
U.S. IMPORTS							
Increases							
Chemicals and related products	1,816	2,457	3,546	3,889	4,040	151	3.9
Fertilizers (CH010)							
Certain organic chemicals (CH006)	295	546	787	739	784	45	6.0
Precious metals and non-numismatic coins (MM020)	33	87	56	492	627	134	27.3
Coal, coke, and related chemical products (EP003)	1,598	2,034	3,007	2,869	2,973	103	3.6
Shellfish (AG009)	388	462	583	604	706	102	16.9
Decreases							
Energy-related product	65,832	86,188	103,226	88,291	65,195	-23,095	-26.2
Crude petroleum (EP004)							
Petroleum products (EP005)	22,937	32,655	44,961	44,100	38,777	-5,323	-12.1
Natural gas and components (EP006)	7,730	9,916	12,533	13,261	12,445	-816	-6.2
Major primary olefins (CH001)	4,266	6,727	7,509	7,541	6,952	-589	-7.8
All other	4,988	6,063	8,520	8,971	8,749	-222	-2.5
Total	109,883	147,136	184,730	170,756	141,246	-29,510	-17.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. In 2009, 60 export commodity classification (schedule B) codes covering all civilian aircraft, engines, equipment, and parts were consolidated into a single code by the U.S. Census Bureau. This reclassification may have accounted for some of the shifts in exports in the transportation equipment sector.

U.S. Imports

U.S. imports of energy-related products from OPEC countries decreased by 20 percent to $119.4 billion between 2012 and 2013, with Saudi Arabia, Venezuela, and Nigeria being the principal OPEC sources. Energy-related products accounted for nearly the entire shift in U.S. imports from OPEC countries in 2013 and accounted for 85 percent of total U.S. imports from these countries. Crude petroleum was the largest import category in 2013, accounting for about 46 percent of the total value of U.S. imports from OPEC, followed by petroleum products (27 percent). The United States imports very little natural gas and coal from OPEC countries.

The quantity of U.S. imports of crude petroleum from OPEC declined by 14 percent to 1.4 billion barrels in 2013. The drop in imports of crude resulted from increased U.S. production, stagnant U.S. demand, and supply disruptions in both Venezuela and Nigeria.

U.S. imports of crude petroleum from Saudi Arabia declined by 3 percent to 484.8 million barrels in 2013, while imports from Venezuela declined by 17 percent to 291.0 million barrels. While Venezuela has been decreasing its exports to the United States in recent years in an effort to diversify its markets, the United States remains Venezuela's primary market. Venezuela exports heavy crude, which can be refined into petroleum products in refineries on the U.S. Gulf Coast that were specifically designed for this type of crude. Other markets for Venezuela's crude include China, the Caribbean, and the European Union.

The quantity and the share of U.S. imports from Nigeria have fallen substantially during the past few years. Such imports declined by 37 percent in 2013 to a new low of 102.6 million barrels. Some of this decline can be attributed to the growth in U.S. crude petroleum production from the Bakken and Eagle Ford formations, both of which are of similar quality and as a result partially displaced Nigeria's crude. [60] Also, Nigerian crude as a share of U.S. imports has fallen as a result of the idling of two U.S. East Coast refineries in late 2011 and early 2012 that were significant purchasers of Nigerian crude; the two refineries reopened in 2013, but are primarily refining domestically produced crude. [61]

U.S. imports of petroleum products from OPEC also declined in 2013, by $5.3 billion (12 percent) to $38.8 billion. In terms of quantity, these imports declined from 87.8 million barrels to 79.3 million barrels (or by 10 percent). The decline is largely attributed to lower U.S. demand for these products. Also, U.S. refineries, which generally satisfy over 90 percent of domestic consumption, increased their capacity utilization rates in 2013 and thereby domestic production, [62] further reducing demand for imports. OPEC accounted for 10 percent of total U.S. imports of petroleum products in 2013, with Algeria (4 percent), Venezuela (2 percent), and Saudi Arabia (less than 1 percent) being the leading OPEC sources.

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[60] The Bakken and Eagle Ford formations are "shale plays." These are areas with "'fine grained, organic rich, sedimentary rocks. The shales are both the source of and the reservoir for natural gas' and oil." When the rock is fractured or "fracked," the trapped natural gas and oil are released and can be extracted from the ground. The Bakken formation is in North Dakota; the Eagle Ford formation is in Texas. USDOE, EIA, *Review of Emerging Resources*, July 2011, vii.

[61] USDOE, EIA, "U.S. Imports of Nigerian Crude Oil," April 10, 2012.

[62] USDOE, EIA, "Short-Term Energy Outlook," February 11, 2014.

The primary petroleum products imported from Algeria include distillate and residual fuel oils shipped to the U.S. northeastern states. Algeria's three coastal refineries produce a surplus of petroleum products, and the United States is the market for about 50 percent of this surplus.[63] U.S. imports of petroleum products from Venezuela continued to decline from the low levels witnessed in 2012. The drop in 2012 was due to the massive gas explosion that occurred at the Paraguaná refinery in August of that year, which resulted in its total closure; the refinery is still not fully operational.[64] U.S. imports of petroleum products from Saudi Arabia tend to be specialty naphthas, which have a high unit value. These imports fluctuate, entering the U.S. market in response to refinery maintenance needs.[65]

[63] USDOE, EIA, "Country Analysis Brief: Algeria," May 20, 2013.
[64] *Oil and Gas Journal,* "Western Europe Leads Global Refining Contraction," December 2, 2013.
[65] USDOE, EIA, "Country Analysis Brief: Saudi Arabia," February 26, 2014.

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Part III
Commodities

This part of the report examines shifts in trade for 10 merchandise sectors: agricultural products; chemicals and related products; electronic products; energy-related products; footwear; forest products; minerals and metals; machinery; textiles and apparel; and transportation equipment.

Agricultural Products

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Change in 2013 from 2012:

U.S. trade surplus: Decreased by $430 million (2 percent) to $26.5 billion
U.S. exports: Increased by $2.9 billion (2 percent) to $152.2 billion
U.S. imports: Increased by $3.3 billion (3 percent) to $125.7 billion

The U.S. trade surplus in agricultural products fell by 2 percent to $26.5 billion in 2013, as an increase in U.S. agricultural exports was offset by somewhat higher growth in imports (table AG.1). Three commodity groups led the growth in U.S. exports—animal feed, dairy products, and edible nuts, all of which had annual export increases in excess of $1 billion. Income growth in developing countries drove the increased demand for these products. [66] However, these gains were partially offset by decreased exports in other commodities, especially the $3.3 billion dollar decline in oilseed exports.

The picture was similarly mixed in terms of U.S. imports. In particular, a 13 percent increase in the value of shellfish imports, driven by higher shrimp prices, was a major contributor to the growth in the value of U.S. agricultural imports. This growth was somewhat offset by declines, due to lower prices, in the value of imports in two commodity groups—miscellaneous vegetable substances (e.g., guar gum, pectins, and seaweed) and coffee and tea.

Leading export markets for U.S. agricultural products in 2013 were the same as in 2012—China, Canada, Mexico, and Japan. Exports to China were flat, while exports to Canada increased slightly (4 percent). Exports to Mexico and Japan declined by 4 percent and 10 percent, respectively. In 2013, the United States was a net importer from both Canada and Mexico, historically its leading suppliers of imported agricultural products. U.S. imports from both countries increased by more than 7 percent in 2013, reflecting in part increased imports of wheat from Canada and sugar from Mexico.

[66] Trostle and Seely, "Developing Countries Dominate World Demand," August 5, 2013.

Table AG. 1 Agricultural products: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. exports of domestic merchandise:							
Canada	16,571	17,996	20,637	22,285	23,087	802	3.6
Mexico	12,911	14,594	18,425	18,981	18,258	-723	-3.8
China	13,762	18,232	20,089	27,266	27,176	-89	-0.3
Japan	12,249	12,934	15,277	14,585	13,174	-1,411	-9.7
Brazil	349	564	1,892	695	1,952	1,257	180.8
Korea	4,199	5,626	7,366	6,516	5,686	-830	-12.7
Indonesia	1,784	2,215	2,805	2,483	2,808	325	13.1
Italy	869	936	1,144	996	1,361	366	36.7
India	673	799	732	865	873	9	1.0
Chile	243	421	572	698	899	201	28.8
All other	39,574	47,157	56,784	53,924	56,887	2,962	5.5
Total	103,184	121,473	145,724	149,293	152,162	2,869	1.9
EU-28	8,593	10,387	12,066	12,019	13,554	1,535	12.8
OPEC	4,301	5,092	6,908	6,690	6,947	257	3.8
Latin America	22,009	25,002	32,094	31,817	32,805	989	3.1
Asia	43,002	52,249	61,571	66,438	65,954	-484	-0.7
Sub-Saharan Africa	1,956	2,304	3,043	2,670	2,640	-30	-1.1
U.S. imports for consumption:							
Canada	17,136	18,999	21,893	23,203	24,913	1,710	7.4
Mexico	12,460	14,690	17,122	17,732	19,066	1,334	7.5
China	4,850	5,653	6,498	7,043	6,967	-76	-1.1
Japan	687	716	759	780	766	-14	-1.8
Brazil	2,632	3,201	4,643	4,924	4,675	-249	-5.1
Korea	393	450	510	558	636	78	13.9
Indonesia	1,967	2,149	2,494	2,507	2,793	286	11.4
Italy	3,197	3,291	3,759	3,904	4,192	287	7.4
India	1,314	1,806	3,105	5,790	4,444	-1,346	-23.2
Chile	2,887	2,909	3,289	3,509	4,281	772	22.0
All other	39,778	43,709	51,513	52,449	52,966	517	1.0
Total	87,301	97,572	115,585	122,400	125,699	3,299	2.7
EU-28	15,550	16,724	18,917	19,926	20,833	906	4.5
OPEC	1,679	1,692	2,031	1,972	2,074	102	5.2
Latin America	28,912	32,571	40,012	41,463	43,041	1,578	3.8
Asia	16,926	19,893	24,669	27,204	25,693	-1,511	-5.6
Sub-Saharan Africa	1,459	1,846	2,102	1,921	1,958	37	1.9

See footnote(s) at the end of table.

Item	Million $						
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. merchandise trade balance:							
Canada	-565	-1,003	-1,255	-918	-1,826	-908	-98.9
Mexico	452	-96	1,303	1,249	-808	-2,057	([a])
China	8,913	12,579	13,591	20,223	20,210	-13	-0.1
Japan	11,562	12,218	14,519	13,805	12,408	-1,397	-10.1
Brazil	-2,284	-2,637	-2,751	-4,229	-2,723	1,506	35.6
Korea	3,806	5,175	6,856	5,958	5,050	-907	-15.2
Indonesia	-182	66	311	-24	15	39	([a])
Italy	-2,328	-2,355	-2,616	-2,909	-2,830	79	2.7
India	-641	-1,007	-2,372	-4,925	-3,571	1,354	27.5
Chile	-2,644	-2,488	-2,717	-2,811	-3,382	-571	-20.3
All other	-204	3,448	5,271	1,476	3,921	2,445	165.7
Total	15,883	23,901	30,139	26,893	26,464	-430	-1.6
EU-28	-6,957	-6,337	-6,851	-7,907	-7,279	628	7.9
OPEC	2,623	3,400	4,878	4,718	4,874	155	3.3
Latin America	-6,904	-7,569	-7,918	-9,646	-10,236	-590	-6.1
Asia	26,076	32,356	36,903	39,234	40,261	1,027	2.6
Sub-Saharan Africa	497	459	941	749	682	-66	-8.9

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a]Not meaningful for purposes of comparison.

U.S. Exports

Increases in U.S. agricultural exports in 2013 were led by animal feed, dairy products, and edible nuts (table AG.2). Animal feed exports increased by 16 percent to $14.5 billion. This commodity group covers a wide range of products, but the two largest for U.S. producers were "soybean oilcake and other solids" and "brewing/distilling dregs and waste." These two products together accounted for almost 50 percent of all animal feed exports in 2013 and were major contributors to the increase in exports in this group. [67] Most of the growth in exports was driven by increasing demand for animal feed in China, Vietnam, and Turkey. [68] As incomes rise in these developing countries, consumer demand grows for animal protein, which in turn increases demand for animal feed.

U.S. dairy exports have also increased significantly in recent years. Nearly 80 percent of the year-over-year $1.6 billion increase in U.S. dairy exports came from four products—skim milk powder (also known as nonfat dry milk), cheese, whey and whey products, and butter. The fastest-growing export markets for U.S. dairy products are in Asia and North Africa. Rising global demand, especially in rapidly developing economies, increased both export prices and volumes for U.S. dairy products in 2013.

U.S. exports of edible nuts rose by 22 percent to $8.3 billion in 2013. [69] The 28 members of the European Union (EU-28) and Hong Kong are the biggest markets for U.S. exports; in-shell almonds and in-shell pistachios account for the largest share of exports to these partners. [70] The biggest absolute growth in U.S. exports of nuts came from shelled almonds (up $708 million) and was largely caused by higher prices. [71] Prices of these tree nuts have generally risen along with global demand because supply is constrained. Nut trees are limited to specific climate zones and often require many years to reach their full production capacity. [72] Many factors contribute to the growth of demand (manifested in consumer willingness to pay higher prices) for tree nuts, including consumer perception that nuts are a healthy snack, rising demand in

[67] Exports of soybean oilcake and other solids (HTS 2304.00.00) increased $551 million (16 percent); of brewing/distilling dregs (HTS 2303.30.00), $856 million (41 percent). Prices and export volumes for both products increased during 2013. USITC DataWeb/USDOC (accessed February 12, 2014).
[68] USITC DataWeb/USDOC (accessed February 26, 2013).
[69] Edible nuts cover a variety of products, including almonds, pistachios, walnuts, and peanuts.
[70] In 2013, the EU accounted for 30 percent of exports (by value); Hong Kong accounted for 14 percent, although some were likely reexported to other markets. USITC DataWeb/DOC (accessed February 26, 2014); USDA, FAS, *Hong Kong: Product Brief—Tree Nuts*, August 23, 2013, 3.
[71] USITC Dataweb/USDOC (accessed February 12, 2014). Between 2012 and 2013, shelled almond exports grew about 1 percent by quantity: average unit export value grew 27 percent.
[72] Depending on the type of nut, full bearing is reached sometime between 5 to 20 years after planting.

Table AG.2 Agricultural products: Leading changes in U.S. exports and imports, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
[illegible]							
Increases:							
Dairy products (AG010)	2,020	3,441	4,490	4,810	6,382	1,572	32.7
Infant formulas, malt extracts, and other edible preparations (AG036)	3,786	4,174	4,815	5,415	6,065	650	12.0
Oilseeds (AG032)	16,780	18,936	17,875	25,040	21,794	-3,245	-13.0
All other	64,721	76,005	98,032	90,250	91,460	1,210	1.3
U.S. IMPORTS:							
Shellfish (AG009)	6,587	7,469	8,704	8,055	9,140	1,085	13.5
Decreases:							
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Coffee and tea (AG028)	4,509	5,469	8,666	7,618	6,441	-1,177	-15.4
All other	68,878	75,277	86,509	92,821	97,648	4,827	5.2

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

developing countries, and nuts' status as a gift or special snack for holidays in some Asian markets.[73]

By contrast, U.S. oilseed exports fell by $3.2 billion, the largest absolute decline of any U.S. agricultural product in 2013. Soybean exports, which make up about three-quarters of U.S. oilseed exports, fell 13 percent by value and 8 percent by quantity.[74] When U.S. prices reached near-record highs in the summer of 2013, importing countries switched to Brazil, which had a large supply of soybeans due to a bountiful harvest.[75] U.S. oilseed exports declined in almost every market. Exports to China showed the largest decline in absolute terms, falling $1.6 billion (11 percent) from 2012.[76]

In 2013, U.S. agricultural exports to Brazil rose sharply, increasing 181 percent to almost $2.0 billion, about two-thirds of which was wheat. The value of wheat exports increased from $13 million in 2012 to $1.2 billion in 2013, a 30-year high.[77] Brazil's traditional supplier, Argentina, experienced its worst wheat harvest in a century and was unable to meet Brazilian demand due to a ban on wheat exports imposed by the Argentine government. As a result, Brazil lowered its tariff on U.S. wheat from 10 percent to zero during April–December 2013, which made it less costly to import U.S. product. These circumstances created an opportunity for U.S. exporters, who benefited from record U.S. wheat production in 2013.[78]

In 2013, U.S. agricultural exports to Japan fell more in absolute terms ($1.4 billion) than those to any other market. This was driven by a $1.2 billion (41 percent) fall in corn exports, primarily because of a 38 percent decline in feed corn volumes. Japan's global feed corn imports fell about 15 percent by value and 10 percent by volume as it substituted some corn with lower-priced sorghum and wheat in animal feed. In addition, since late 2012, Brazilian feed corn has had a price advantage over U.S. feed corn; in 2013, average Japanese import values for this commodity from Brazil were $309 per metric ton, compared to $341 from the United States.[79] As a result of this price discrepancy, Japan's imports from the United States fell more sharply than the average, and Brazil replaced the United States as Japan's largest feed corn supplier.

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[73] USDA, FAS, *Hong Kong: Product Brief—Tree Nuts*, August 23, 2013, 1, 5; USDA, FAS, *EU-28: Tree Nuts Annual*, September 13, 2013; International Nut and Dried Fruit Council, News and Media (accessed February 27, 2014) http://www.nutfruit.org/en/news_7119; industry officials, farm tours, California, August 3–9, 2013.
[74] Based on HTS 120190. U.S. oilseed exports fell by $3.2 billion and 4.4 million metric tons. USITC DataWeb/DOC (accessed February 25, 2014).
[75] O'Brien, "Soybean Market Outlook in September 2013," September 20, 2013; Thiesse, "September 2013 USDA Crop Production Summary," September 17, 2013; U.S. government official, email to USITC staff, February 28, 2014.
[76] USITC DataWeb/USDOC (accessed February 26, 2014).
[77] Ibid.
[78] USDA, FAS, *Brazil: U.S. Wheat Exports to Brazil*, February 19, 2014, 1–2.
[79] Japan's imports from the United States fell by about 59 percent in both volume and value between 2012 and 2013. GTIS, GTA (accessed February 26, 2014); USDA, FAS, *Japan: Grain and Feed Update*, July 26, 2013.

U.S. Imports

Shellfish led the increase in the value of U.S. agricultural imports in 2013, accounting for about one-third of the total increase in value. In 2013, U.S. imports of shellfish grew by 14 percent to $9.1 billion. Two-thirds of this growth can be attributed to a 26 percent increase in the value of imports of certain shrimp and prawns. [80] Prices rose as shrimp production fell in major producing regions of East and Southeast Asia, a result of an outbreak of early mortality syndrome (EMS) disease starting in late 2012. [81]

The United States has large agricultural trade flows (imports and exports) with its North American Free Trade Agreement (NAFTA) partners, Canada and Mexico, but was a net importer in this category from these two countries in 2013. U.S. imports from both Canada and Mexico reached their highest levels ever in 2013, at $24.9 billion and $19.1 billion, respectively. Mexico and Canada benefit from their proximity to the United States, which gives them logistical advantages over other U.S. import suppliers, and from preferential trade access under NAFTA.

In 2013, the largest absolute increase in U.S. agricultural imports from Canada were of live cattle (not for breeding), which grew 22 percent to $1.3 billion, and wheat (non-durum), which grew 37 percent to $779 million. Both increases were driven by higher import quantities, although prices also increased. [82] A major factor contributing to increased U.S. imports of Canadian cattle was the closure of a beef slaughter plant in Quebec, resulting in higher volumes of Canadian cattle delivered for slaughter in the United States. In addition, low prices in late 2012 caused some U.S. producers to wait until 2013 to deliver cattle for slaughter, and a slaughter plant in Alberta closed for a week, causing a temporary increase in cattle shipments to the United States. [83] The United States imported more Canadian wheat in 2013 because some U.S.-produced wheat was diverted to Brazil (see above). Canada was able to make up the shortfall in the U.S. market because of a good harvest and limited competition from other producing regions like Australia, which had lower production levels in 2013 than the year before. [84]

The U.S. agricultural imports from Mexico with the largest absolute increases in 2013 from 2012 levels were raw cane sugar and avocados. The value of U.S. imports of raw cane sugar rose by $314 million to $415 million; the import quantity increased sevenfold. [85] U.S. refiners can import Mexican sugar duty free and quota free under NAFTA. [86] U.S. imports of Mexican avocados grew by $230 million to $992 million in 2013 because of both higher prices and increased quantities shipped. [87] Rising demand (both globally and within the United States) and

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[80] Import volumes declined slightly (less than 1 percent). USITC DataWeb/USDOC (accessed February 24, 2014).
[81] FAO, "GlobeFish: Shrimp," August 2013; FAO, "GlobeFish: Shrimp," September 2013.
[82] USITC DataWeb/USDOC (accessed March 4, 2014).
[83] USDA, FAS, Canada: Livestock and Products Annual, September 1, 2013, 5.
[84] USDA, FAS, *Canada: Grain and Feed Update*, July 26, 2013, 2.
[85] USITC DataWeb/USDOC (accessed March 4, 2014).
[86] USDA, FAS, *Mexico: Sugar Semi-annual*, September 24, 2013; USDA, ERS, *Sugar and Sweeteners Outlook* , August 16, 2013.
[87] USITC DataWeb/USDOC (accessed March 4, 2014).

the timing of Mexico's shipments, which led to tighter supplies in the U.S. market late in the year compared to 2012, forced U.S. import prices for avocados higher in 2013. [88] In addition, U.S. per capita consumption of avocados more than doubled between 2010–13 because of multiple factors, including a promotional campaign by the U.S. industry and avocados' wider availability at restaurants. [89]

U.S. imports of miscellaneous vegetable substances in 2013 fell by $1.6 billion (32 percent) from 2012. [90] About half of these were mucilages and thickeners derived from guar seeds, also known as guar gum. Imports of guar gum fell by $1.8 billion (52 percent), largely because of lower prices rather than lower imported volumes. [91] Guar gum is used in oil and shale gas exploration, and as a thickener in certain processed foods. The vast majority of guar gum is imported from India (97 percent in 2013). [92] In 2012, guar gum prices were high because fears of production shortages in India, which accounts for about 80 percent of global guar gum production, drove a speculative bubble. [93] In 2013, prices fell because (1) the Indian government, which had banned guar gum futures trading between March 2012 and May 14, 2013, issued guidelines aimed at reducing speculation on guar gum, and (2) guar gum production in India increased as farmers devoted more acreage to guar seed. [94]

The value of U.S. imports of coffee and tea fell by 15 percent to $6.4 billion. This decline was primarily the result of lower prices for certain Arabica coffee imports, which fell 23 percent ($956 million) by value in spite of a 5 percent (40,379 metric tons) rise in quantity. [95] Lower prices drove down the value of U.S. imports of Arabica coffee from almost every supplier, and five suppliers had declines of over $100 million each—Brazil ($209 million), Guatemala ($146 million), Indonesia ($124 million), Honduras ($117 million), and Mexico ($106 million). [96]

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[88] USDA, FAS, *Mexico: Avocado Annual*, December 19, 2013; Boyd, "After Rocky Start, Mexican Avocado Season Stabilizes," November 4, 2013.
[89] Karst, "Avocado Consumption: Still on the Rise?" June 24, 2012; Polis, "Mexican Hass Avocado Industry," June 19, 2012.
[90] Mucilages and thickeners are used in food and manufacturing to thicken, bind, and enhance volume.
[91] Import quantity fell about 34,015 metric tons (12 percent) compared to 2012. USITC DataWeb/USDOC (accessed February 12, 2014).
[92] Mukherjee, "Is Guar Gum's Dream Run Nearing Its End?" November 4, 2013; Ghosal, "Foreign Guar Gum Buyers Return," November 7, 2013.
[93] Guar gum prices were 900 percent higher in 2012 than in 2011. USITC, *Shifts in U.S. Merchandise Trade 2012*, 2013, AG-7.
[94] Sharma, "India to Raise 2013 Output of Fracking Ingredient," May 29, 2013; Ghosal, "Foreign Guar Gum Buyers Return," November 7, 2013; Mukherjee, "Is Guar Gum's Dream Run Nearing Its End?" November 4, 2013.
[95] Based on HTS 0901.11.0025. USITC DataWeb/USDOC (accessed February 12, 2014, and March 3, 2014).
[96] Lower prices were the main reason import values fell for almost every supplier. The volume of U.S. imports from some suppliers also fell, but less sharply than the values. USITC DataWeb/USDOC (accessed March 12, 2014).

Arabica coffee prices fell because of a large harvest in Brazil for the second year in a row, as well as higher production in Colombia after a successful replanting program beginning in 2010.[97]

[97] McFarlane, "Coffee Drinkers Treated to More Arabica," October 30, 2013; Agrimoney.com, "Arabica Coffee Prices," December 31, 2013; USDA, FAS, *Coffee: World Markets and Trade*, December 2013; USDA, FAS, *Colombia: Coffee Semi-annual*, November 15, 2010, 1; Tepper, "As Coffee Rust Devastates Latin America," March 25, 2013; USDA, FAS, *Colombia: Coffee Annual*, May 24, 2011. Colombia has struggled with coffee rust disease and coffee cherry borer (broca) infestations since 2010.

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Chemicals and Related Products

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Change in 2013 from 2012:

U.S. trade deficit: Decreased by $2.3 billion (6.6 percent) to $32.4 billion
U.S. exports: Increased by $626 million (0.3 percent) to $218.1 billion
U.S. imports: Decreased by $1.7 billion (1 percent) to $250.5 billion

The U.S. trade deficit in chemicals and related products decreased by $2.3 billion (6.6 percent) to $32.4 billion in 2013. U.S. exports remained relatively flat compared to 2012, increasing by only $626 million (0.3 percent) in 2013, while U.S. imports decreased by $1.7 billion (0.7 percent). Medicinal chemicals accounted for the largest share of trade in this sector, with $85.5 billion in U.S. imports and $48.2 billion in U.S. exports in 2013. The largest change in value for U.S. exports in this sector was for miscellaneous plastic products, for which U.S. exports increased by $813 million. Medicinal chemicals recorded the largest change in U.S. imports, decreasing by $3.9 billion.

The EU-28 and Canada are the largest trading partners for the United States in the chemicals sector (table CH.1). In 2013, U.S. exports of chemicals and related products to the EU-28 and Canada totaled $54 billion and $36 billion respectively. U.S. trade with both trading partners remained relatively unchanged compared to 2012. U.S. exports to the EU-28 decreased by $76 million (0.1 percent) but increased to Canada by $16 million (less than 0.1 percent). U.S. imports from the EU-28 totaled $86 billion in 2013, a decrease of $292 million (0.3 percent) from 2012. U.S. imports from Canada totaled $34 billion in 2013, a decrease of $399 million (1 percent) from 2012.

Table CH.1 Chemicals and related products: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. exports of domestic merchandise:							
Canada	26,743	31,281	35,319	36,027	36,043	16	([a])
China	10,643	13,344	15,021	14,205	14,128	-76	-0.5
Mexico	20,313	23,869	27,670	30,652	31,736	1,085	3.5
Germany	10,580	10,830	7,806	7,500	7,140	-360	-4.8
Ireland	1,732	2,147	1,987	2,194	2,480	286	13.0
Japan	7,958	10,741	11,609	12,201	10,745	-1,456	-11.9
Belgium	8,568	10,431	11,715	12,281	13,050	769	6.3
United Kingdom	7,488	8,116	8,756	8,449	6,886	-1,563	-18.5
Switzerland	2,804	2,849	2,927	2,349	2,651	302	12.8
Brazil	5,714	7,815	8,875	8,987	9,818	831	9.2
All other	63,405	75,602	82,297	82,607	83,399	792	1.0
Total	165,948	197,026	213,983	217,452	218,078	626	0.3
EU-28	51,138	55,332	53,679	54,470	54,394	-76	-0.1
OPEC	4,130	5,175	6,272	6,685	6,720	35	0.5
Latin America	37,042	45,653	53,373	56,985	58,906	1,921	3.4
Asia	37,564	49,179	54,955	53,034	51,351	-1,682	-3.2
Sub-Saharan Africa	1,459	1,596	1,916	2,048	2,050	1	0.1
U.S. imports for consumption:							
Canada	25,021	30,037	34,515	34,161	33,762	-399	-1.2
China	17,510	21,319	25,637	27,975	29,445	1,470	5.3
Mexico	5,767	7,059	8,374	9,101	9,686	586	6.4
Germany	14,922	15,368	17,885	19,992	21,639	1,647	8.2
Ireland	19,953	25,260	30,795	24,715	22,235	-2,481	-10.0
Japan	9,985	12,013	12,269	12,433	12,138	-295	-2.4
Belgium	5,209	5,160	4,752	3,886	5,018	1,132	29.1
United Kingdom	15,004	12,655	11,170	10,022	8,658	-1,364	-13.6
Switzerland	5,892	7,497	9,158	10,123	11,133	1,011	10.0
Brazil	1,883	2,705	3,191	3,157	2,514	-643	-20.4
All other	61,368	78,946	96,482	96,589	94,256	-2,332	-2.4
Total	182,515	218,020	254,229	252,153	250,484	-1,669	-0.7
EU-28	77,653	83,783	91,738	86,566	86,274	-292	-0.3
OPEC	8,071	12,136	15,120	16,087	15,558	-530	-3.3
Latin America	12,927	16,974	22,187	22,739	23,138	399	1.8
Asia	45,795	56,492	67,964	71,499	70,953	-546	-0.8
Sub-Saharan Africa	988	2,081	2,349	1,540	1,326	-214	-13.9

See footnote(s) at the end of table.

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance:							
Canada	1,722	1,244	804	1,866	2,281	415	22.2
China	-6,867	-7,975	-10,616	-13,771	-15,316	-1,546	-11.2
Mexico	14,546	16,810	19,296	21,551	22,050	499	2.3
Germany	-4,342	-4,538	-10,079	-12,492	-14,498	-2,007	-16.1
Ireland	-18,221	-23,114	-28,808	-22,521	-19,754	2,767	12.3
Japan	-2,028	-1,272	-660	-232	-1,393	-1,161	-500.4
Belgium	3,359	5,272	6,963	8,396	8,032	-363	-4.3
United Kingdom	-7,516	-4,539	-2,414	-1,572	-1,772	-199	-12.7
Switzerland	-3,088	-4,648	-6,231	-7,773	-8,482	-709	-9.1
Brazil	3,831	5,110	5,684	5,830	7,303	1,474	25.3
All other	2,037	-3,344	-14,185	-13,982	-10,857	3,125	22.3
Total	-16,567	-20,994	-40,246	-34,701	-32,406	2,294	6.6
EU-28	-26,515	-28,451	-38,059	-32,096	-31,880	216	0.7
OPEC	-3,941	-6,960	-8,848	-9,403	-8,838	565	6.0
Latin America	24,115	28,679	31,186	34,246	35,768	1,522	4.4
Asia	-8,232	-7,313	-13,009	-18,466	-19,602	-1,136	-6.2
Sub-Saharan Africa	472	-485	-432	508	723	215	42.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a] Less than 0.05 percent.

U.S. Exports

U.S. exports of chemicals and related products remained relatively level, growing by only $626 million (0.3 percent) in 2013. The largest increases in U.S. exports were of miscellaneous plastic products and commodity organic chemicals. U.S. exports of miscellaneous plastic products rose by $0.8 billion (3 percent), owing to increased exports of plastic boxes, cases, crates, and similar articles and plastic articles not elsewhere specified or included (table CH.2). Among commodity organic chemicals, U.S. exports of styrene showed the highest growth, fueled by rising demand in Latin America as well as by global production problems, including an unplanned shutdown of Shell's styrene monomer plant in Alberta, Canada.[98]

U.S. exports of synthetic rubber decreased by $661 million in 2013. The decline in the value of synthetic rubber exports was largely the result of high stocks and low prices of natural rubber, a substitute for synthetic rubber used in the production of vehicle tires and other products.[99] Additionally, new synthetic rubber production facilities began operations in China in 2013, further reducing demand for U.S. exports of synthetic rubber.[100]

U.S. exports of fertilizers decreased by $511 million in 2013. U.S. fertilizer exports dropped, in part, due to lower exports of certain phosphate fertilizers to India. India started 2013 with high stocks of these fertilizers and consumed less throughout the year because of decreased and delayed subsidy payments to farmers, as well as a weaker rupee that made U.S fertilizers more expensive.[101]

[98] Balboa, "US Styrene to Remain Tight in 2014," January 13, 2014.
[99] Liu and Richardson, "China Butadiene and Synthetic Rubber in Crisis," July 1, 2013.
[100] Liu and Richardson, "China Butadiene and Synthetic Rubber in Crisis," July 1, 2013.
[101] *Chemical Week,* "India Cuts Phosphate and Potash Subsidies," May 13, 2013, 8; PotashCorp., *Q4 2013 Market Analysis Report*, December 10, 2013, 16.

Table CH.2 Chemicals and related products: Leading changes in U.S. exports and imports, 2009–13

Item	Million $						
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. EXPORTS:							
Increases:							
Miscellaneous plastic products (CH033)	17,719	21,235	23,108	23,755	24,568	813	3.4
Organic commodity chemicals (CH004)	3,633	5,073	6,047	6,499	7,134	636	9.8
Decreases:							
Synthetic rubber (CH031)	2,697	3,734	4,792	4,637	3,976	-661	-14.3
Fertilizers (CH010)	3,684	3,941	5,429	4,984	4,473	-511	-10.3
Medicinal chemicals (CH019)	46,359	47,304	45,928	48,673	48,232	-441	-0.9
All other	91,856	115,739	128,680	128,904	129,694	791	0.6
Total	165,948	197,026	213,983	217,452	218,078	626	0.3
U.S. IMPORTS:							
Increases:							
Miscellaneous plastic products (CH033)	19,328	22,956	25,279	27,344	28,821	1,477	5.4
Miscellaneous chemicals and specialties (CH023)	3,507	4,310	5,202	4,997	6,154	1,157	23.2
Decreases:							
Medicinal chemicals (CH019)	82,417	86,603	92,732	88,771	85,477	-3,294	-3.7
Major primary olefins (CH001)	5,931	10,496	13,079	11,148	9,258	-1,889	-16.9
All other	71,332	93,654	117,937	119,893	120,774	881	0.7
Total	182,515	218,020	254,229	252,153	250,484	-1,669	-0.7

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

U.S. Imports

U.S. imports decreased by $1.7 billion in 2013, largely because of declines in imports of pharmaceuticals and primary olefins. The value of pharmaceuticals imported in 2013 fell by $3.3 billion compared to 2012. The decrease in value of pharmaceutical imports likely stemmed from the replacement of high-cost brand-name medicines by cheaper generic medicines, as patent terms expired for blockbuster drugs such as atorvastatin (brand name Lipitor) and clopidogrel (brand name Plavix). U.S. imports of primary olefins decreased by $1.9 billion because of increases in domestic production of olefins such as ethylene and propylene.

U.S. imports of miscellaneous plastic products and miscellaneous chemicals and specialties increased in 2013. U.S. imports of miscellaneous plastic products grew by $1.5 billion, in part because of increased imports of plastic floor tiles and plastic tubes, which are used in new-home construction. U.S. imports of miscellaneous chemicals and specialties increased by $1.2 billion, primarily the result of increased imports of biodiesel from Argentina and Indonesia. Argentine and Indonesian exporters of biodiesel were seeking new markets after the EU-28 imposed antidumping duties on biodiesel from these countries in 2013. [102] At the same time, the United States government reinstated the $1 per gallon tax credit for biodiesel through the end of 2013, increasing demand for biodiesel in the U.S. market. [103]

[102] European Commission, "EU to Impose Definitive Anti-Dumping Duties," November 21, 2013.
[103] Reuters, "U.S. Biodiesel Tax Credit Revived through 2013 by Congress," January 2, 2013.

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Electronic Products

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $3.5 billion (1 percent) to $250.3 billion
U.S. exports: Decreased by $27 million (less than 0.1 percent) to $167.0 billion
U.S. imports: Increased by $3.5 billion (1 percent) to $417.2 billion

The U.S. trade deficit in electronic products rose by $3.5 billion to $250.3 billion in 2013 (1 percent). The slight increase was driven by growing deficits in telecommunications equipment as well as circuit apparatus assemblies. U.S. exports of electronic products declined marginally, by less than 0.1 percent, while imports increased by 0.8 percent.

China continued to be the largest contributor to the U.S. deficit in electronic products trade; China's share of the deficit was $161.1 billion in 2013 (table EL.1). China is a leading producer of semiconductors and computers (the former being an input for the latter) as well as peripheral products. [104] Along with the emerging economies of Malaysia and Thailand, China has benefited from the shift of production capacity away from countries with high manufacturing costs, such as the United States and Japan. [105]

[104] The World Trade Organization's *International Trade Statistics 2011* reports that in 2010, China established itself as the largest manufacturer of computer hardware products in the world, accounting for over one-third of world trade in these goods.
[105] IBISWorld, *Global Computer Hardware Manufacturing,* March 2013, 14; Standard & Poor's, "Industry Surveys: Semiconductors," April 2013, 9.

Table EL.1 Electronic products: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. exports of domestic merchandise:							
China	11,133	13,493	11,889	12,331	14,123	1,792	14.5
Mexico	14,901	16,537	16,733	18,945	20,737	1,792	9.5
Japan	8,521	9,661	10,631	11,264	10,419	-844	-7.5
Canada	15,217	16,692	18,207	18,455	17,731	-724	-3.9
Malaysia	4,889	6,451	5,807	4,709	4,533	-176	-3.7
Korea	5,437	6,378	7,158	7,172	6,714	-458	-6.4
Germany	7,639	8,183	8,203	7,954	7,964	10	0.1
Taiwan	3,732	4,659	4,929	3,735	3,520	-215	-5.8
Thailand	1,855	2,496	2,294	2,152	2,226	75	3.5
Singapore	4,709	6,131	5,716	4,836	4,647	-189	-3.9
All other	64,905	69,150	72,971	75,450	74,360	-1,090	-1.4
Total	142,938	159,833	164,537	167,003	166,976	-27	([a])
EU-28	35,484	36,546	36,630	35,134	34,836	-298	-0.8
OPEC	5,460	5,269	6,103	7,614	7,750	136	1.8
Latin America	29,098	31,812	32,908	35,908	37,482	1,574	4.4
Asia	50,161	61,228	61,588	59,538	58,747	-791	-1.3
Sub-Saharan Africa	1,285	1,205	1,217	1,351	1,347	-4	-0.3
U.S. imports for consumption:							
China	110,794	143,716	158,671	171,159	175,212	4,053	2.4
Mexico	50,325	62,049	61,996	65,344	63,627	-1,716	-2.6
Japan	22,917	26,757	26,697	26,213	24,216	-1,997	-7.6
Canada	9,626	9,449	9,758	9,513	9,074	-439	-4.6
Malaysia	17,142	17,892	16,602	17,100	19,165	2,065	12.1
Korea	15,662	18,011	17,953	14,543	16,560	2,017	13.9
Germany	9,717	11,227	13,399	13,512	13,532	20	0.1
Taiwan	14,221	17,977	20,990	17,214	16,130	-1,084	-6.3
Thailand	7,900	9,514	9,556	10,983	11,558	575	5.2
Singapore	6,788	8,060	8,039	7,879	6,387	-1,492	-18.9
All other	46,330	52,964	56,930	60,308	61,766	1,458	2.4
Total	311,420	377,617	400,592	413,767	417,226	3,459	0.8
EU-28	32,519	37,113	40,863	41,589	42,091	502	1.2
OPEC	25	27	40	45	73	29	63.5
Latin America	55,269	69,861	70,940	76,083	74,300	-1,783	-2.3
Asia	203,564	251,509	268,258	275,697	280,774	5,077	1.8
Sub-Saharan Africa	81	87	108	98	98	([b])	-0.4

See footnote(s) at the end of table.

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. merchandise trade balance:							
China	-99,661	-130,223	-146,782	-158,828	-161,089	-2,260	-1.4
Mexico	-35,424	-45,511	-45,263	-46,398	-42,890	3,508	7.6
Japan	-14,395	-17,095	-16,066	-14,949	-13,797	1,152	7.7
Canada	5,591	7,243	8,448	8,942	8,657	-285	-3.2
Malaysia	-12,253	-11,441	-10,795	-12,391	-14,632	-2,241	-18.1
Korea	-10,225	-11,633	-10,795	-7,371	-9,845	-2,474	-33.6
Germany	-2,078	-3,044	-5,196	-5,558	-5,568	-10	-0.2
Taiwan	-10,489	-13,318	-16,061	-13,478	-12,610	868	6.4
Thailand	-6,045	-7,019	-7,262	-8,831	-9,332	-501	-5.7
Singapore	-2,079	-1,929	-2,323	-3,043	-1,740	1,304	42.8
All other	18,575	16,187	16,041	15,143	12,595	-2,548	-16.8
Total	-168,483	-217,784	-236,055	-246,764	-250,250	-3,486	-1.4
EU-28	2,965	-568	-4,233	-6,455	-7,255	-800	-12.4
OPEC	5,435	5,242	6,063	7,569	7,677	108	1.4
Latin America	-26,171	-38,050	-38,032	-40,175	-36,818	3,356	8.4
Asia	-153,403	-190,281	-206,670	-216,159	-222,028	-5,868	-2.7
Sub-Saharan Africa	1,204	1,117	1,109	1,253	1,250	-4	-0.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a]Less than 0.05 percent.

[b]Less than $500,000.

U.S. Exports

U.S. exports of electronic products decreased by $27 million (less than 0.1 percent) in 2013, against the backdrop of a sluggish global economy. [106] Despite this overall decline, U.S. exports increased in a number of subsectors, namely telecommunications equipment, navigational instruments and remote control apparatus, and circuit apparatus assemblies. The leading destinations for U.S. exports of electronic products were the United States' NAFTA partners, Mexico ($20.7 billion) and Canada ($17.7 billion). Together, Mexico and Canada accounted for 23 percent of sector exports. They were followed by China ($14.1 billion) and Japan ($10.4 billion), which together accounted for 15 percent of U.S. exports in this sector. In 2013, exports increased to 4 of the United States' top 10 export destinations but declined to the remaining six.

In 2013, the major markets for U.S. telecommunications equipment exports, which totaled $16.3 billion, were Mexico, Canada, and Hong Kong. U.S. exports of telecommunications equipment rose by $1.1 million (7 percent) in 2013 (table EL.2). This increase was driven by a number of factors, including growing reliance worldwide on communications networks, expanding 4G/LTE networks, increasing mobile broadband access in developing countries, and the continuing

[106] Standard & Poor's, "Industry Surveys: Semiconductors," April 2013, 1.

Table EL.2 Electronic products: Leading changes in U.S. exports and imports, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. EXPORTS:							
Increases:							
Telecommunications equipment (EL002)	13,421	13,605	14,619	15,156	16,260	1,105	7.3
Navigational instruments and remote control apparatus (EL005)	2,558	2,768	3,317	3,356	3,830	474	14.1
Circuit apparatus assemblies (EL012)	2,206	2,427	2,788	3,338	3,798	460	13.8
Decreases:							
Computers, peripherals, and parts (EL017)	19,837	20,592	20,332	21,086	20,111	-975	-4.6
Semiconductors and integrated circuits (EL015)	25,058	31,267	29,188	26,436	26,075	-361	-1.4
Blank and prerecorded media (EL004)	3,567	3,560	3,371	3,464	3,215	-248	-7.2
Consumer electronics (EL003)	3,965	4,785	5,092	4,794	4,553	-242	-5.0
All other	72,325	80,829	85,831	89,374	89,133	-241	-0.3
Total	142,938	159,833	164,537	167,003	166,976	-27	([a])
U.S. IMPORTS:							
Increases:							
Telecommunications equipment (EL002)	60,299	74,065	79,771	83,831	89,161	5,330	6.4
Medical goods (EL022)	25,928	29,219	31,796	32,639	34,131	1,492	4.6
Circuit apparatus assemblies (EL012)	4,228	5,446	6,216	7,471	8,589	1,118	15.0
Semiconductors and integrated circuits (EL015)	21,190	29,134	37,624	37,358	38,025	667	1.8
Decreases:							
Consumer electronics (EL003)	47,186	51,031	46,343	47,714	42,936	-4,779	-10.0
All other	152,590	188,721	198,842	204,753	204,385	-369	-0.2
Total	311,420	377,617	400,592	413,767	417,226	3,459	0.8

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a]Less than 0.05 percent.

attempt by operators to capture revenue from services and content delivered over their own networks. [107] U.S. exports of navigational instruments and remote control devices continued their steady rise, growing from $3.4 billion in 2012 to $3.8 billion (14 percent) in 2013. As the economy has gradually improved, increases in research and development budgets have led to advances in both navigational instruments and remote control devices. [108] The new products (e.g., electricity measuring and testing instruments and medical and bioscience diagnostic equipment) have enabled the U.S. industry to remain competitive amid rising foreign competition and changing demand in downstream markets. Additionally, growth in customer industries such as aircraft manufacturing, shipbuilding, and construction has provided strong demand for various instruments and devices. [109] The leading markets for U.S. exports of various related instruments and devices were the United Arab Emirates (accounting for 24 percent of U.S. exports), Japan (11 percent), and Canada (10 percent).

Exports of circuit apparatus assemblies [110] have increased in each of the past five years, growing from $2.2 billion in 2009 to $3.8 billion in 2013, and by $460 million (14 percent) from 2012 to 2013. The rise reflects continuing growth in global demand for downstream products, such as telecommunications equipment and measuring, testing, and controlling instruments. Growing demand for telecommunications equipment was driven by the continuing expansion of 4G/LTE: the number of commercial networks increased from 49 in 29 countries in January 2012 to 260 in 93 countries by the end of 2013. [111] Global demand for measuring, testing, and controlling instruments rose due to requirements for higher-precision instruments with stricter quality, safety, and environmental standards. The Canadian Environmental Assessment Act of 2012, for example, strengthens assessments related to nuclear safety, energy, and the environment. [112] The leading markets for U.S. exports of circuit apparatus assemblies were Canada (23 percent), Mexico (15 percent), and China (9 percent).

U.S. exports of computers, peripherals, and parts as well as semiconductors declined in 2013. The $975 million (5 percent) decrease in computers, peripherals, and parts exports was caused by the slow economic recovery in foreign markets. [113] Exports of semiconductors and integrated circuits decreased $361 million (1 percent), marking the third consecutive year of declines. Semiconductor fabrication operations continued to expand in Asia, where 9 of the top 10

[107] EIU, "Telecoms and Technology Report," May 28, 2013, 2.
[108] IBISWorld, Navigational Instrument Manufacturing in the U.S., February 2014, 9.
[109] IBISWorld, Navigational Instrument Manufacturing in the U.S., February 2014, 8. More robust export growth has been limited by the appreciating dollar, as industry products become more expensive on the world market; exchange rates can be found on the Federal Reserve website.
[110] Circuit apparatus assemblies include products like control panels, switch assemblies, and remote controls.
[111] EIU, "Telecoms and Technology Report," May 28, 2013, 5.
[112] Canadian Environmental Assessment Agency website, http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=CE87904C-1#ws96301A7E (accessed March 11, 2014).
[113] Standard & Poor's, "Industry Surveys: Semiconductors," April 2013, 1.

semiconductor production foundries are located. Likewise, the Pacific Rim trading partners, especially Taiwan, have seen their chip foundry [114] businesses grow steadily. [115]

U.S. exports of blank and prerecorded media also decreased in 2013, from $3.5 billion to $3.2 billion (7 percent), largely as an indirect result of cloud computing. The popularity of readily accessible and cost-effective online operating and application services (software-as-a-service) is increasingly leading companies and individuals to forego purchasing compact discs. Instead, they are accessing software online. In addition, exports of consumer electronics [116] fell $242 million (5 percent) in 2013, while exports of television receivers and monitors fell $160 million (11.6 percent). The declines—a continuation of a trend for both types of products that commenced in 2010—reflect the evolving role of mobile devices and personal computers in accessing music, television programming, and other media content for global consumers. [117] Mobile devices, which were initially restricted to telephony and short text messaging, are increasingly powerful. Although they remain slower than computers in connecting to and transmitting information over the Internet, "apps" [118] enable such devices to access a wide range of movies, television shows, music, games, and sports. [119]

U.S. Imports

U.S. imports of electronic products increased marginally by $3.5 billion (1 percent) to reach a record $417.2 billion in 2013. As has been the case since 2009, the leading supplying countries were China and Mexico. U.S. imports from China reached $175.2 billion, and were more than double the value of imports of the next largest supplier, Mexico ($63.6 billion). The largest increases in U.S. imports came from Korea (up 14 percent) and Malaysia (up 12 percent). Korea had the largest gains in printing and related machinery, while Malaysia had the largest gains in computers, peripherals, and parts; and electrical sound and visual signaling apparatus.

U.S. imports of telecommunications equipment and medical goods registered the largest increases by value in 2013. U.S. imports of telecommunications equipment rose from $83.8 billion to $89.2 billion (6 percent), with China and Korea posting the greatest increases of 9 percent and 8 percent, respectively. This growth was driven by the introduction of new products with increased functionality, very few of which are produced in the United States. [120] For example, increasingly sophisticated mobile devices are replacing stereos, televisions, and

[114] A chip foundry manufactures chips for other companies.

[115] Standard & Poor's, "Industry Surveys: Semiconductors," April 2013, 9.

[116] The definition of "consumer electronics" increasingly varies as new products are developed and existing ones converge. Before the introduction of home computers, "consumer electronics" generally referred to audio and video products, such as radios, television receivers, record players, and tape recorders.

[117] Marketwired, "Vuclip Releases a Sequel," March 19, 2014.

[118] "App" is an abbreviation for a software application that can run on the Internet, a computer, a phone, or another electronic device.

[119] Marketwired, "Vuclip Releases a Sequel," March 19, 2014. One industry source reports that 38 percent of smartphone owners regularly watch videos on their devices, and 10 percent watch full-length television programs on them. EIU, "Telecommunications World Industry Outlook," November 2013, 8.

[120] EIU, "Telecoms and Technology Report," May 28, 2013, 1. According to this report, the United States has outspent the rest of the world in telecommunications equipment each of the past five years, and is forecast to continue doing so through 2017.

other entertainment electronics, resulting in increased imports of computers and telecommunications equipment and decreased imports of consumer electronics. The personal computer, in particular, is becoming a hub for a wide array of consumer electronic devices, ranging from mobile phones and digital music players to cameras and smartphones.[121]

U.S. imports of medical goods in 2013 increased from $32.6 billion to $34.1 billion (5 percent). The aging Baby Boom population, with an increasing need for medical goods, drove this increase, along with the introduction of new cardiovascular and neurological devices.[122] The largest increases occurred with respect to imports from Ireland and China (up by 9 percent from each country); these countries remained the United States' second- and fourth-largest suppliers of medical devices in 2013. Ireland is a global leader in the production of various cardiac devices, and growing U.S. demand for these goods reflects the high rate of U.S. heart-related afflictions.[123] Imports from China were mostly hospital supplies, instruments, and other low-value-added, low-cost devices.[124]

[121] EIU, "Telecoms and Technology Report," May 28, 2013, 1.
[122] *Today's Medical Developments,* "Entering the Medical-Manufacturing Crossroads," February 2013.
[123] CDC, "Heart Disease Facts," February 19, 2014.
[124] See table CH.1 in part 1.

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Energy-Related Products

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Change in 2013 from 2012:

U.S. trade deficit: Decreased by $55.9 billion (22 percent) to $200.2 billion
U.S. exports: Increased by $10.4 billion (7 percent) to $152.7 billion
U.S. imports: Decreased by $45.6 billion (11 percent) to $352.9 billion

The U.S. trade deficit in the energy-related products sector [125] fell by 22 percent (table EP.1) in 2013, continuing the 13 percent decline experienced in 2012. Crude petroleum is the primary energy product in this sector, accounting for 95 percent of the total U.S. trade deficit in energy-related products in 2013. However, the trade deficit in crude petroleum decreased in 2013 (by 16 percent), reaching its lowest level since 2009. This decrease was due to falling U.S. imports resulting from higher domestic production coupled with reduced U.S. consumption. Also, U.S. exports of petroleum products (particularly distillate and residual fuel oils) and natural gas (primarily from oil shale deposits in the Bakken formation) continued to increase in 2013, more than offsetting a drop in U.S. exports of coal (figure EP.1 and table EP.2).

In addition to changes in U.S. supply and demand for energy products, global price changes also impacted U.S. trade, albeit to a much smaller extent. During 2012–13, prices for most energy-related products followed the trends in crude petroleum prices, increasing by an average of 4 percent except for coal, which declined slightly by 2 percent (figure EP.2). The world benchmark price for a barrel of crude petroleum increased slightly in 2013 in response to rising global consumption (particularly in China) and supply disruptions in certain members of the Organization of Petroleum Exporting Countries (OPEC). U.S. natural gas prices increased in 2013 as production from less profitable wells decreased. [126] Global coal prices declined in 2013 as electric utilities (which have been the primary consumers of coal) continued switching to cleaner-burning natural gas.

[125] The quantity and price data presented in this chapter are derived primarily from official statistics of the U.S. Department of Energy.
[126] U.S. Department of Energy, Energy Information Administration, *Short-Term Energy Outlook,"* February 11, 2014.

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Table EP.1 Energy-related products: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. exports of domestic merchandise:							
Canada	10,127	12,436	17,437	18,204	24,720	6,516	35.8
Mexico	7,948	14,471	23,652	24,152	23,386	-766	-3.2
Saudi Arabia	70	70	153	135	182	46	34.2
Venezuela	797	654	768	3,653	2,902	-751	-20.6
Colombia	1,244	2,311	2,791	3,601	5,582	1,980	55.0
Russia	103	187	135	104	141	36	34.6
Netherlands	5,304	5,926	11,632	11,532	11,814	282	2.4
Nigeria	325	617	631	1,005	2,125	1,120	111.5
Ecuador	1,028	2,077	2,371	2,604	3,159	555	21.3
Brazil	2,022	4,368	6,501	7,382	6,712	-669	-9.1
All other	30,858	42,351	68,017	69,923	71,931	2,008	2.9
Total	59,827	85,468	134,088	142,294	152,652	10,358	7.3
EU-28	12,636	14,371	26,597	25,703	26,437	734	2.9
OPEC	2,652	3,585	4,500	7,665	9,273	1,608	21.0
Latin America	23,444	39,593	60,883	69,932	70,962	1,030	1.5
Asia	8,146	12,229	16,760	16,492	16,544	52	0.3
Sub-Saharan Africa	1,166	1,493	1,959	2,107	3,601	1,493	70.9
U.S. imports for consumption:							
Canada	64,367	82,587	103,749	103,042	109,739	6,697	6.5
Mexico	24,214	33,102	44,475	39,375	34,126	-5,248	-13.3
Saudi Arabia	18,916	26,278	38,738	45,245	39,583	-5,663	-12.5
Venezuela	25,044	28,901	35,326	30,237	22,754	-7,483	-24.7
Colombia	6,490	10,337	14,826	17,396	14,937	-2,459	-14.1
Russia	12,768	18,248	24,757	21,617	19,329	-2,288	-10.6
Netherlands	3,458	3,750	5,296	5,437	3,965	-1,472	-27.1
Nigeria	19,136	29,148	33,310	18,838	11,774	-7,064	-37.5
Ecuador	3,436	5,538	7,316	6,937	8,570	1,633	23.5
Brazil	6,118	7,000	8,918	8,631	4,869	-3,762	-43.6
All other	76,930	93,295	114,086	101,687	83,206	-18,480	-18.2
Total	260,878	338,184	430,796	398,441	352,853	-45,588	-11.4
EU-28	18,970	22,157	26,706	27,033	24,012	-3,021	-11.2
OPEC	98,097	130,793	163,728	148,520	119,390	-29,131	-19.6
Latin America	73,035	92,230	122,221	110,576	90,498	-20,078	-18.2
Asia	4,223	7,214	8,805	8,137	9,996	1,860	22.9
Sub-Saharan Africa	37,674	51,266	58,816	36,467	26,393	-10,074	-27.6

See footnote(s) at the end of table.

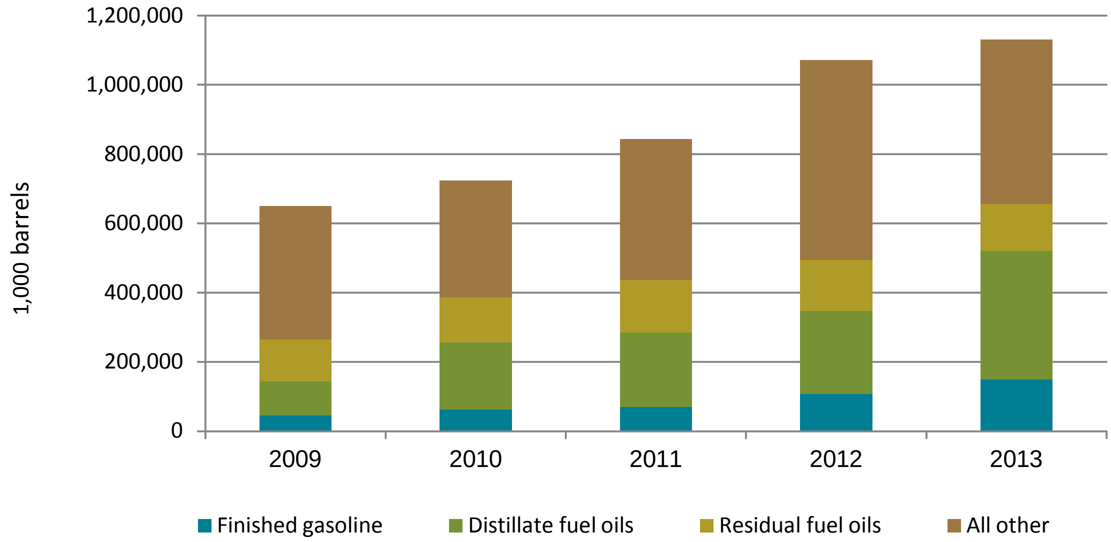
Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance:							
Canada	-54,239	-70,151	-86,312	-84,837	-85,019	-182	-0.2
Mexico	-16,267	-18,631	-20,823	-15,223	-10,740	4,483	29.4
Saudi Arabia	-18,846	-26,208	-38,585	-45,110	-39,401	5,709	12.7
Venezuela	-24,248	-28,247	-34,558	-26,585	-19,852	6,732	25.3
Colombia	-5,247	-8,026	-12,034	-13,795	-9,356	4,439	32.2
Russia	-12,664	-18,061	-24,622	-21,513	-19,189	2,324	10.8
Netherlands	1,847	2,177	6,336	6,094	7,848	1,754	28.8
Nigeria	-18,811	-28,531	-32,678	-17,833	-9,649	8,184	45.9
Ecuador	-2,408	-3,462	-4,944	-4,333	-5,411	-1,078	-24.9
Brazil	-4,096	-2,633	-2,417	-1,250	1,843	3,093	([a])
All other	-46,072	-50,944	-46,070	-31,764	-11,275	20,489	64.5
Total	-201,051	-252,716	-296,708	-256,147	-200,201	55,946	21.8
EU-28	-6,333	-7,786	-108	-1,330	2,426	3,756	([a])
OPEC	-95,445	-127,208	-159,228	-140,855	-110,117	30,738	21.8
Latin America	-49,591	-52,637	-61,337	-40,644	-19,535	21,108	51.9
Asia	3,923	5,015	7,955	8,355	6,547	-1,808	-21.6
Sub-Saharan Africa	-36,508	-49,773	-56,857	-34,360	-22,792	11,567	33.7

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a]Not meaningful for purposes of comparison.

Figure EP.1 U.S. exports of petroleum products have increased four years in a row



Source: Derived from official statistics of the U.S. Department of Energy.

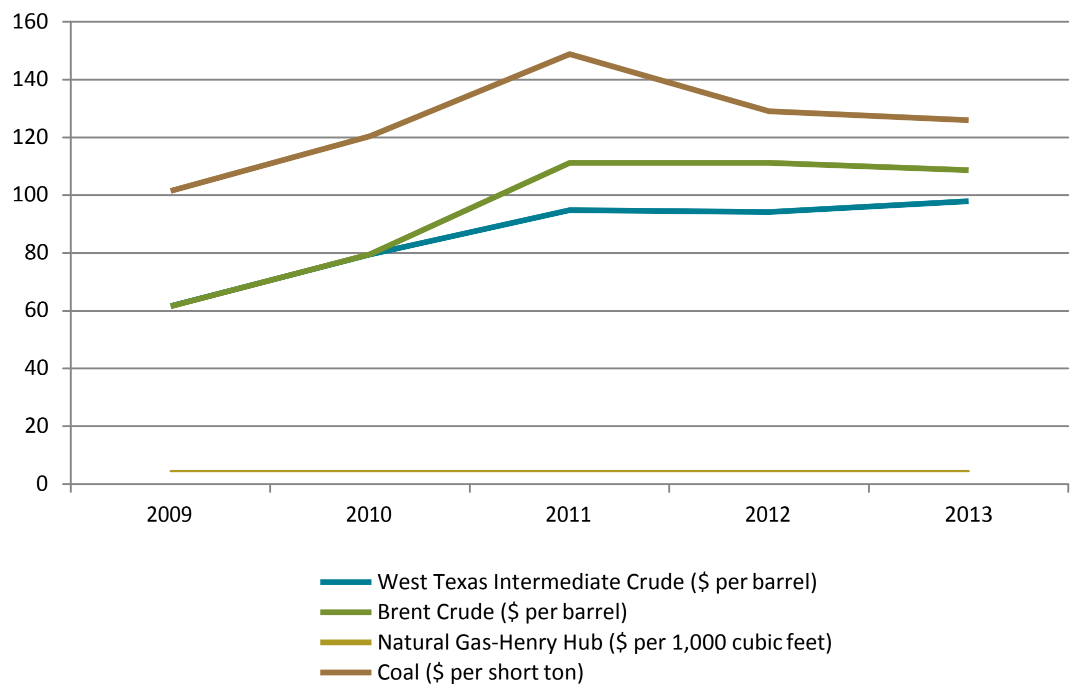
Table EP.2 Energy-related products: Leading changes in U.S. exports and imports, 2009–13

	Million $						
Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. EXPORTS:							
Increases:							
Petroleum products (EP005)	42,048	61,131	100,425	111,355	119,700	8,345	7.5
Crude petroleum (EP004)	1,620	1,384	1,460	2,184	4,818	2,635	120.6
Decreases:							
Coal, coke, and related chemical products (EP003)	8,079	12,612	19,471	17,779	13,665	-4,115	-23.1
Nuclear materials (EP002)	2,235	1,886	1,948	1,518	1,103	-416	-27.4
Electrical energy (EP001)	575	648	391	233	327	94	40.5
Natural gas and components (EP006)	5,270	7,805	10,394	9,225	13,039	3,814	41.3
Total	59,827	85,468	134,088	142,294	152,652	10,358	7.3
U.S. IMPORTS:							
Decreases:							
Crude petroleum (EP004)	150,809	196,862	246,894	228,944	195,487	-33,457	-14.6
Petroleum products (EP005)	72,581	97,889	135,170	129,773	118,136	-11,638	-9.0
Coal, coke, and related chemical products (EP003)	4,123	5,335	7,076	5,447	4,796	-650	-11.9
Nuclear materials (EP002)	4,454	5,025	4,943	4,171	3,845	-325	-7.8
Natural gas and components (EP006)	26,840	31,001	34,616	28,193	28,296	103	0.4
Electrical energy (EP001)	2,071	2,071	2,096	1,914	2,293	380	19.8
Total	260,878	338,184	430,796	398,441	352,853	-45,588	-11.4

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

Figure EP.2 Trends in energy prices



Source: Derived from official statistics of the U.S. Department of Energy.

U.S. Exports

U.S. exports of energy-related products increased by 7 percent to $152.7 billion in 2013, with the largest growth seen in exports to Canada, Colombia, and Nigeria. The dominant energy-related goods exported from the United States in 2013 continued to be petroleum products. Natural gas, coal, and crude petroleum were also exported, but with much smaller values.[127]

Petroleum Products

The value of U.S. exports of petroleum products increased by 7.5 percent ($8.3 billion) to $119.7 billion in 2013 as exports continued to surge. In 2012, for the first time in over 60 years, the United States exported a larger volume of petroleum products than it imported. In 2013, export volumes rose again, increasing by about 9 percent over 2012 levels to 1.3 billion barrels.

[127] U.S. exports of crude petroleum have been prohibited since 1973, except as approved by the U.S. government. Canada has been the only consistent market for these exports, which are part of a commercial exchange agreement between U.S. and Canadian refiners that has been approved by the secretary of the Department of Energy. In May 1996, the President determined that allowing export of Alaskan North Slope (ANS) crude was in the national interest, thus ending the 23-year ban on ANS crude exports. However, the President can impose new export restrictions if severe crude petroleum supply shortages occur.

While distillate and residual fuels continued to be the leading petroleum exports (with the EU-28 being the primary market), the product mix changed from the previous year, as it normally does.[128] Most of the increase in the quantity of U.S. exports of petroleum products is attributed to the following factors: (1) reduced domestic demand for motor fuels, due in part to a still-lagging economy and more fuel-efficient cars; (2) increased U.S. production of crude petroleum (the feedstock for petroleum products), particularly increased supplies of crude petroleum from North Dakota's Bakken formation; and (3) high demand for distillate and residual fuel oils on the world market.

Particularly strong increases were seen in U.S. exports of petroleum products to France, Colombia, and Nigeria. U.S. exports to France increased by 47 percent to $4.8 billion in 2013This increase was due to the multiweek shutdown of all three of Total's[129] refineries (caused by a workers' strike that began in early 2013), along with maintenance problems. The shutdown resulted in the removal of about 1.2 million barrels per day of distillation capacity during the third quarter of 2013, and much of the fourth quarter as well.[130] U.S. exports to Colombia increased by 56 percent to $5.6 billion because of refining declines at the largest Colombian oil refiner, Cartagena Oil Refinery, caused by worker strikes, which began in September 2012 and lasted through most of 2013.[131] Exports to Nigeria experienced the largest increase, as U.S. exports of fuel oils increased to meet demand. Although Nigeria has four refineries, their capacity utilization rates hover around 16–18 percent due to operational failures, fires, and sabotage, mainly on pipelines leading from the wellhead to the refineries. As a result, the four refineries cannot meet domestic demand.[132]

Coal, Coke, and Other Carbonaceous Materials

In 2013, U.S. exports of coal, coke, and other related products decreased in value by 23 percent to $13.7 billion and in quantity by 6 percent to 117.7 million short tons. The decline in U.S. exports is attributed to the continued economic downturn in the EU-28, the largest regional importer of U.S. coal; decreased Asian demand; and increased coal production in other coal-exporting countries (primarily Australia, which has now fully recovered mining operations following the Queensland floods of 2011–12). In addition, there has been a growing international interest in moving away from coal in favor of cleaner-burning energy sources such as natural gas and certain renewable fuels.[133]

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[128] Refineries do not produce only one product from a barrel of crude petroleum; they produce a variety of products, such as gasoline, heating oils, and diesel and bunker fuels. Ultimately, there is a market for all of these products, whether domestic or foreign. Petroleum products are traded globally, and the United States has a long history of exporting certain petroleum products and importing others to balance refinery output and global demand. *Oil and Gas Journal*, "Refining Report," April 15, 2013.

[129] Total is a multinational energy company headquartered in France.

[130] *Oil and Gas Journal,* "Western Europe Leads Global Refining Contraction," December 2, 2013.

[131] Ibid.

[132] U.S. Department of Energy, Energy Information Administration, *Country Analysis Brief—Nigeria*, December 30, 2013.

[133] USDOE, EIA, *Short-Term Energy Outlook,* February 11, 2014.

Natural Gas and Components

The quantity of U.S. natural gas exports (in gaseous form) decreased by 10 percent to 1.5 trillion cubic feet in 2013, but the value increased by 34 percent to $5.8 billion owing to the rise in natural gas prices. [134] U.S. exports of natural gas in gaseous form are transported via pipeline, and the United States' NAFTA partners, Canada and Mexico, are the only U.S. markets. Trade generally fluctuates from year to year based on market size along the pipeline. The price of U.S. exports of pipeline natural gas increased from $2.79 per thousand cubic feet in 2012 to $3.94 per thousand cubic feet in 2013, a 41 percent rise.

The volume of U.S. exports of liquefied natural gas (LNG) continued to decrease, dropping from 28.3 billion cubic feet in 2012 to about 7.3 billion cubic feet in 2013 primarily as a result of increased consumption of natural gas in the United States and decreased exports to Japan. U.S. exports of LNG to Japan fell from 14.0 billion cubic feet in 2012 to 4.3 billion cubic feet in 2013. [135] The decline occurred primarily because Japanese power plants that use natural gas as their fuel source were still operating well below capacity, if at all, due to damage from the March 2011 earthquake and tsunami. Also, during 2013, there was a limited U.S. supply of natural gas from the mature North Cook Inlet gas field, which is liquefied in Kenai, Alaska, solely for export to Japan.

In 2012, for the first time, the United States became a net exporter of liquefied petroleum gases (LPGs) [136], and these exports further increased by 69 percent to 121 million barrels in 2013. In terms of value, U.S. exports of LPGs rose by 78 percent to $4.9 billion, with the strongest export growth to the Netherlands, Brazil, and Japan. This increase was the result of increased production from shale deposits in the Marcellus formation and other areas producing shale gas and tight crude [137]. The U.S. supply of propane and other LPGs is expected to increase as pipeline infrastructure from these shale areas to refineries and natural gas processing plants is built. [138]

U.S. Imports

In 2013, U.S. imports of energy-related products decreased by 11 percent to $352.9 billion. Canada remained the leading source of U.S. imports of energy-related products, with Saudi

[134] Unlike petroleum prices, which are largely set on the world market, U.S. domestic natural gas prices are based on supply and demand in the NAFTA countries, which are connected via pipelines. For the last several years, these prices have ranged below those in Asia and Europe. The difference between domestic and international prices is in part explained by transportation costs, as liquefying and shipping natural gas involves significant costs. Constraints on the industry's capacity to handle liquefied natural gas is another factor driving up international prices.
[135] USDOE, EIA, *Short-Term Energy Outlook,* February 11, 2014.
[136] LPG are a group of hydrocarbon gases or hydrocarbon gas liquids, primarily propane, normal butane, and isobutane, derived from crude petroleum refining or natural gas processing. These gases may be marketed individually or mixed. They can be liquefied through pressurization (without requiring cryogenic refrigeration) for convenience of transportation or storage. These products are primarily used for heating and cooking, as well as chemical conversion.
[137] Tight crude is crude oil extracted from rock formations with low permeability deep below the earth's surface.
[138] USDOE, EIA, "U.S. Exports of Liquefied Petroleum Gases," May 2, 2013.

Arabia, Mexico, Venezuela, Russia, and Nigeria being the other major U.S. import suppliers. However, there were significant shifts in importance among the suppliers; in particular, imports of crude petroleum from Nigeria, Venezuela, Mexico, and Saudi Arabia registered large declines, while Canada was the only supplier to see increased imports. Crude petroleum continued to be the primary energy product the United States imported in 2013, accounting for 55 percent of the total value of sector imports; petroleum products accounted for 33 percent, and natural gas for 8 percent. However, U.S. imports of crude petroleum and petroleum products saw significant declines, while imports of natural gas remained essentially unchanged.

Crude Petroleum

The United States is the second-largest world importer of crude petroleum, being outpaced only by China in 2013. However, the value of U.S. imports of crude petroleum declined by 15 percent to $195.5 billion in 2013, and the quantity declined by 10 percent to 2.8 billion barrels as U.S. production increased by 15 percent to its highest level since 1990. At the same time, U.S. consumption remained at about 2012 levels.

Canada has been the leading U.S. import source of crude petroleum for decades and continued to be so in 2013. U.S. crude imports from Canada increased to 887.7 million barrels valued at $74 billion in 2013, or by 6.5 percent for both quantity and value. Large multinational energy companies operate in both countries and exchange crude and petroleum products across the border. An integrated system of shared pipelines crossing the U.S.-Canada border makes it easy and cost efficient to transport crude petroleum from the wellhead to refineries.

U.S. imports of crude petroleum from all other major sources declined in 2013. Crude petroleum from OPEC, which accounted for 46 percent of the total quantity (33 percent of the value) of crude petroleum imported, declined in 2013 as the share of the U.S. market accounted for by Saudi Arabia, Venezuela, and Nigeria fell. U.S. imports from OPEC declined by 13 percent in quantity to 1.3 billion barrels in 2013. The decreases in imports of crude are due to increased U.S. production, stagnant U.S. demand, and supply disruptions in both Venezuela and Nigeria.

With respect to Nigeria, U.S. imports of crude declined by 37 percent in 2013 to a recent low of 102.6 million barrels. Some of this decline can be attributed to the growth in U.S. crude petroleum production from the Bakken and Eagle Ford shale formations, both of which produce crude similar in quality to Nigeria's crude.[139] U.S. imports of Nigeria crude as a share of U.S. imports have also fallen as a result of the idling of two U.S. East Coast refineries in late 2011 and early 2012 that were significant purchasers of Nigerian crude; the two refineries reopened in 2013, but are primarily refining domestically produced crude petroleum.[140]

Petroleum Products

The value of U.S. petroleum product imports fell by 9 percent in 2013, while the quantity fell by about 1 percent to 753.0 million barrels. This decrease was due primarily to a small reduction in demand for residual fuel oils, which are used to generate electricity for large industrial complexes; many of these consumers have switched to natural gas, as it is a cleaner-burning and less expensive fuel.[141] Additionally, U.S. refineries, which generally satisfy over 90 percent of domestic consumption, increased their capacity utilization rates in 2013,[142] further reducing demand for imports.

Non-OPEC import sources continue to be the primary suppliers of petroleum products to the United States, accounting for 90 percent of total U.S. imports in 2013. Canada remained the primary source of U.S. imports of petroleum products; imports from Canada increased by 6 percent to 203.1 million barrels in 2013 and accounted for 50 percent of total U.S. imports of these products.[143] Imports from Mexico increased by 13 percent and accounted for 8 percent of total U.S. imports. Imports from most other sources declined, including those from OPEC, which declined 10 percent. Among OPEC countries, imports from Venezuela continued to decline from the low levels witnessed in 2012 because of the massive gas explosion that occurred in August 2012 at the Paraguaná refinery, which resulted in its total closure; the refinery is still not fully operational.[144] Also, U.S. imports of petroleum products from Brazil decreased by about 28 percent in terms of value and by about 3 percent in terms of quantity. Brazil's refineries are already operating at full capacity and cannot meet their own domestic demand; as a result, Brazil nearly ceased all exports of petroleum products in 2013.[145]

Natural Gas and Components

The value of U.S. imports of natural gas increased by 0.4 percent to $28.3 billion in 2013, while the volume of imports fell by 10 percent to 2.6 trillion cubic feet. The increased value of natural

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[139] The Bakken and Eagle Ford formations are "shale plays." These are areas with "'fine grained, organic rich, sedimentary rocks. The shales are both the source of and the reservoir for natural gas' and oil." When the rock is fractured or "fracked," the trapped natural gas and oil are released and can be extracted from the ground. The Bakken formation is in North Dakota; the Eagle Ford formation is in Texas. USDOE, EIA, *Review of Emerging Resources*, July 2011, vii.
[140] USDOE, EIA, "U.S. Imports of Nigerian Crude Oil," April 10, 2012.
[141] USDOE, EIA, *Short-Term Energy Outlook,* February 11, 2014.
[142] Ibid.
[143] U.S. imports of refined petroleum products from Canada are mostly distillate and residual fuel oils and gasoline (including stocks for blending motor fuel).
[144] *Oil and Gas Journal,* "Western Europe Leads Global Refining Contraction," December 2, 2013.
[145] Ibid.

gas imports resulted from higher prices for both pipeline natural gas and LNG. Canada remains the primary U.S. supplier, accounting for 99 percent of pipeline natural gas imports, which decreased by 6 percent to 2.8 trillion cubic feet in 2013. This quantity decrease is due to two main factors: (1) a 4 percent increase in U.S. natural gas production, and (2) normal trade fluctuations that occur regularly between the United States and Canada based on changes in market supply and demand along the pipelines.

The quantity of U.S. imports of LNG also declined in 2013, falling by 45 percent to 96.9 million cubic feet, largely due to reduced imports of LNG from Trinidad and Tobago. One reason for the decline was that the price of LNG from Trinidad and Tobago was more than double the price of natural gas imported via pipeline from Canada or produced in the United States. Trinidad and Tobago also diversified export markets for LNG, including entering into long-term contracts with certain Latin American and Caribbean countries. [146] In 2013, the United States fell from being the primary market for LNG from Trinidad and Tobago to ranking as the fourth-largest market behind Spain, Chile, and Argentina.

[146] *Oil and Gas Journal*, "Trinidad and Tobago Energy Minister," October 29, 2012.

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Footwear

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $903 million (4 percent) to $23.8 billion
U.S. exports: Decreased by $36 million (4 percent) to $789 million
U.S. imports: Increased by $868 million (4 percent) to $24.6 billion

In 2013, the U.S. trade deficit in footwear (a category that also includes footwear parts) grew by $903 million (4 percent) as U.S. imports rose by $868 million and U.S. exports fell by $36 million (table FW.1. U.S. exports declined for a second consecutive year from a five-year peak of $832 million in 2011. Although U.S. exports to most leading export destinations fell in 2013, U.S. exports to Vietnam (primarily footwear parts) rose $21 million (up by 54 percent), while those to Canada rose $9 million (8 percent).

Imports supplied over 98 percent of domestic demand in 2013. [147] China remained by far the largest supplier of footwear to the United States, accounting for 69 percent of all U.S. footwear imports. China's share was down from 72 percent in 2012 as other Asian producers, particularly Vietnam and Indonesia, increased their respective shares of the U.S. market at China's expense.

[147] U.S. industry representative, email message to USITC staff, March 24, 2014.

Table FW.1 Footwear: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. exports of domestic merchandise:							
China	44	55	56	47	44	-3	-5.7
Vietnam	25	47	54	39	60	21	54.3
Italy	6	4	6	4	4	([a])	-11.0
Indonesia	6	7	12	12	9	-3	-25.5
Mexico	63	79	65	57	44	-13	-23.2
India	5	4	4	4	3	-1	-20.8
Dominican Rep	22	23	26	26	20	-5	-20.4
Brazil	1	2	4	2	2	-1	-30.1
Spain	2	3	4	2	2	-1	-32.0
Canada	83	87	94	116	125	9	7.7
All other	363	417	507	514	476	-39	-7.5
Total	620	728	832	824	789	-36	-4.3
EU-28	54	57	56	56	60	4	7.2
OPEC	32	37	53	50	41	-9	-18.0
Latin America	176	218	230	216	194	-22	-10.1
Asia	229	287	347	336	321	-15	-4.4
Sub-Saharan Africa	34	29	35	27	24	-4	-13.5
U.S. imports for consumption:							
China	13,415	15,727	16,677	17,026	16,876	-151	-0.9
Vietnam	1,323	1,616	2,019	2,388	2,898	510	21.4
Italy	771	896	1,113	1,198	1,323	125	10.4
Indonesia	446	593	764	940	1,158	219	23.3
Mexico	254	319	371	492	548	56	11.3
India	164	180	196	264	290	26	9.7
Dominican Rep	121	167	207	244	269	25	10.2
Brazil	382	360	253	210	200	-10	-4.8
Spain	106	115	142	164	186	22	13.3
Canada	66	66	55	49	47	-1	-2.8
All other	617	671	762	771	818	48	6.2
Total	17,666	20,710	22,559	23,745	24,612	868	3.7
EU-28	1,093	1,283	1,568	1,683	1,860	177	10.5
OPEC	1	1	1	([a])	([a])	([a])	-23.7
Latin America	780	871	878	1,003	1,062	59	5.8
Asia	15,658	18,414	19,979	20,921	21,546	625	3.0
Sub-Saharan Africa	1	1	2	9	21	12	126.9

See footnote(s) at the end of table.

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance:							
China	-13,371	-15,671	-16,622	-16,979	-16,831	148	0.9
Vietnam	-1,298	-1,569	-1,965	-2,349	-2,838	-489	-20.8
Italy	-765	-892	-1,107	-1,194	-1,320	-125	-10.5
Indonesia	-440	-586	-752	-927	-1,149	-222	-23.9
Mexico	-191	-239	-307	-435	-504	-69	-15.9
India	-159	-176	-192	-260	-286	-26	-10.1
Dominican Rep	-99	-144	-180	-219	-249	-30	-13.8
Brazil	-381	-358	-249	-207	-198	9	4.5
Spain	-104	-113	-138	-161	-184	-23	-14.0
Canada	18	21	39	68	78	10	15.3
All other	-254	-254	-255	-256	-343	-87	-33.8
Total	-17,046	-19,982	-21,728	-22,920	-23,824	-903	-3.9
EU-28	-1,040	-1,227	-1,512	-1,627	-1,800	-173	-10.7
OPEC	32	36	52	49	40	-9	-18.0
Latin America	-604	-653	-648	-787	-868	-80	-10.2
Asia	-15,429	-18,127	-19,632	-20,585	-21,225	-639	-3.1
Sub-Saharan Africa	33	27	33	18	2	-16	-86.4

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a]Less than $500,000.

U.S. consumer spending on footwear rose by 2 percent between 2012 and 2013,[148] and sales at U.S. shoe stores increased 1.3 percent during the same period, down from 5 percent growth between 2011 and 2012.[149] Industry sources report that expenditures on fashion footwear categories—namely outdoor and men's casual shoes—experienced the largest growth, at 10 percent and 7 percent, respectively.[150] The boost in sales of casual shoes reflects an apparent style trend "from business and dress attire to an 'anything goes' look with work attire."[151]

U.S. Exports

Canada, Korea, and Vietnam were the top three export markets for U.S. producers; these countries accounted for 16 percent, 11 percent, and 8 percent, respectively, of U.S. exports of footwear by value in 2013. U.S. exports of footwear to Vietnam rose by the largest percentage and amount, up by $21.1 million (54 percent) to $60.1 million. However, virtually all of the U.S. footwear exported to Vietnam consisted of footwear parts used to assemble footwear for the U.S. market.[152] U.S. exports of footwear to Canada grew by $9 million (8 percent) to $125 million, whereas U.S. exports to Korea fell for the first time since 2009, down sharply by $17.6 million (17 percent) to $83.7 million. Other significant markets for U.S. footwear exports in 2013 were Japan, China, and Mexico. U.S. exports to all three of these markets fell in 2013.[153]

Exports account for a significant source of revenue for domestic footwear manufacturers, totaling an estimated 32 percent of industry revenues in 2013.[154] U.S. production of footwear is concentrated in niche markets—rubber/fabric footwear, men's work shoes, and plastic/protective footwear.[155] In addition, U.S. footwear manufacturers compete on the basis of non-price factors such as specialized types of footwear (e.g., hard-to-find sizes/widths and hand-sewn items), quality, design, exclusive channels of distribution, new product introductions, and brand differentiation. American-made shoes have developed a reputation for high quality and value (high-end athletic shoes, for example) that in recent years has enabled them to make inroads into Asian markets such as Korea.[156] In contrast, footwear parts, including removable insoles, heel cushions, and gaiters, which made up just slightly over one fourth of U.S. exports in 2013, are generally used in low-cost countries (such as China and Vietnam) to assemble final goods that are imported back into the United States.

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[148] USDOL, BEA, *Personal Consumption Expenditures,* January 2014, table 4.5U.
[149] USDOC, Census, Monthly Retail Trade and Food Services: Shoe Stores, February 2014, table 4482.
[150] NPD Group, "Sales Growth of Men's Fashion Footwear," February 12, 2014.
[151] Ibid.
[152] Vietnam has become a leading source of footwear manufacturing for U.S. footwear firms such as NIKE, Inc. Nike, "Form 10-K," July 19, 2013. (Nike's fiscal year 2013 ended on May 31, 2013.)
[153] Compiled from official statistics of the U.S. Department of Commerce. These countries do not appear in table FW.1 because the table was generated based on U.S. imports, which far exceed U.S. exports.
[154] IBISWorld, *Shoe and Footwear Manufacturing,* September 2013, 9.
[155] AAFA, "ShoeStats 2013," December 2013, 12.
[156] IBISWorld, *Shoe and Footwear Manufacturing,* September 2013, 11, 15, 16.

U.S. Imports

U.S. imports of footwear increased by $868 million (4 percent) to $24.6 billion in 2013 as the U.S. economy continued to strengthen. [157] Demand growth was filled primarily by low-cost imports from Asia, which increased by $625 million between 2012 and 2013. U.S. imports of footwear also grew from Italy (up $125 million) and Mexico (up $56 million).

Most of the growth in Asian imports in 2013 came from Vietnam and Indonesia. Imports from these suppliers rose by $510 million (21 percent) and $219 million (23 percent), respectively, with a small portion of that increase perhaps reflected in a $151 million (0.9 percent) decrease in U.S. imports from China in 2013. Vietnam's General Statistics Office and the Vietnam Leather, Footwear, and Handbag Association reported that Vietnam's total footwear exports reached a record high in 2013, which likely can be attributed to Vietnam's relatively low labor costs compared to other footwear exporters and to the expansion of footwear production by foreign investors in anticipation of expected benefits from the TPP. [158]

Although China remains the largest supplier of footwear imports to the United States, U.S. imports of footwear from China fell by $151 million (1 percent) in 2013. U.S. footwear firms continued to move to a "China plus one" sourcing strategy to diversify away from China and offset rising costs. [159]

Because footwear production is highly labor intensive, U.S. producers have moved much of their production and sourcing of footwear to low-cost suppliers abroad, focusing on branding and design in the United States. [160] For example, Nike manufactured 98 percent of its footwear overseas using independent contract manufacturers in Vietnam, China, and Indonesia. [161] As U.S. producers have increasingly relied on foreign sources for footwear, the U.S. industry has continued to shrink. Between 2008 and 2013, the number of domestic footwear manufacturing establishments fell from 302 to 276 and the workforce decreased from 14,222 to 13,948. [162]

Whereas Asian producers largely supply inexpensive shoes, manufacturers in Italy specialize in making high-quality, high-value leather designer footwear. [163] Italy remains an important supplier to the high-end U.S. market and was the third-largest supplier of footwear to the United States in 2013. Mexico has also expanded as a supplier of footwear to the U.S. market in

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[157] U.S. industry representative, email message to USITC staff, March 24, 2014.
[158] *Global Times,* "Vietnam's Footwear Export Hits Record High," January 7, 2014; Yen, "Vietnam Investment Review: Foreign Footwear Companies," December 17, 2013.
[159] AAFA, "ShoeStats 2013," December 2013, 5.
[160] IBISWorld, *Shoe and Footwear Manufacturing,* September 2013, 4. New Balance is the only remaining U.S. producer of athletic footwear that manufactures a portion (25 percent) of its products domestically.
[161] Nike, "Form 10-K," July 31, 2013 (Nike's fiscal year 2013 ended May 31, 2013).
[162] The 2013 data are based on preliminary statistics from the U.S. Department of Labor. USDOL, BLS, "Quarterly Census of Employment and Wages" (accessed February 25, 2014).
[163] IBISWorld, *Shoe and Footwear Manufacturing,* September 2013, 12; Igedo Company, "Shoe Industry Comparisons in Western European Countries," n.d. (accessed May 21, 2013); Italian Trade Commission, "Footwear 2011," (accessed May 21, 2013).

recent years, garnering a reputation for innovative designer shoes. [164] U.S. imports of footwear from Mexico rose by $56 million (11 percent) in 2013 from 2012.

[164] World Footwear, "Mexico Will Host the 5th World Footwear Congress," September 30, 2013; RNCOS Business Consultancy Service, "Mexican Designer Footwear Gaining Traction," November 27, 2013.

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Forest Products

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Change in 2013 from 2012:

U.S. trade balance: Decreased by $1.9 billion to a deficit of $0.7 billion
U.S. exports: Increased by $0.9 billion (2 percent) to $39.2 billion
U.S. imports: Increased by $2.9 billion (8 percent) to $40.0 billion

After three consecutive years of trade surpluses in the forest products sector, the United States swung into a trade deficit in 2013 as a small increase in exports was more than offset by a significant increase in imports. Continued recovery in the U.S. housing market during 2013 drove an increase in demand for imports of wood products such as lumber, wood veneer and wood panels, and moldings, millwork, and joinery. Strengthening construction markets in China led to greater demand for U.S. exports of wood building products.

With an abundance of forest resources, proximity to the United States, and a long-established forest products industry, Canada has traditionally been the largest trading partner of the United States in forest products. In 2013, Canada accounted for 26 percent of the value of U.S. forest products exports and 45 percent of the value of U.S. imports (table FP.1). The U.S. trade deficit with Canada in forest products increased irregularly between 2009 and 2013, from $5.6 billion to $7.8 billion. China is the second-largest trading partner of the United States in this sector and in 2013 accounted for 17 percent of the value of U.S. forest products exports and 21 percent of the value of U.S. imports. The U.S. trade deficit with China in forest products, while fluctuating, has decreased overall from $2.6 billion in 2009 to $1.5 billion in 2013. Other large trading partners of the United States in forest products include Mexico, Japan, and Brazil.

Table FP.1 Forest products: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. exports of domestic merchandise:							
Canada	9,142	10,150	10,249	10,236	10,257	21	0.2
China	3,720	5,050	6,722	6,208	6,791	583	9.4
Mexico	4,162	4,891	5,067	5,239	5,391	152	2.9
Japan	1,712	1,992	2,209	2,156	2,218	62	2.9
Brazil	359	445	481	418	388	-30	-7.2
United Kingdom	1,117	1,214	1,277	1,453	1,520	66	4.6
Germany	762	846	794	782	736	-47	-6.0
Korea	765	938	962	845	856	11	1.3
Italy	727	921	928	762	802	39	5.2
Chile	149	225	226	234	239	5	2.3
All other	7,874	9,709	10,359	9,976	10,047	71	0.7
Total	30,489	36,381	39,274	38,309	39,244	935	2.4
EU-28	4,477	5,140	5,244	5,111	5,071	-40	-0.8
OPEC	685	883	1,009	918	940	22	2.4
Latin America	6,647	8,028	8,288	8,363	8,584	221	2.6
Asia	8,284	10,652	12,844	12,000	12,780	780	6.5
Sub-Saharan Africa	206	267	317	284	274	-10	-3.4
U.S. imports for consumption:							
Canada	14,781	16,544	16,521	16,464	18,088	1,624	9.9
China	6,281	7,123	7,333	8,080	8,277	197	2.4
Mexico	1,201	1,369	1,490	1,525	1,651	126	8.3
Japan	482	554	517	531	474	-57	-10.8
Brazil	1,300	1,790	1,793	1,802	2,159	357	19.8
United Kingdom	478	518	545	552	555	3	0.5
Germany	1,055	1,132	1,146	1,158	1,110	-48	-4.1
Korea	373	493	523	516	539	23	4.5
Italy	307	319	349	354	365	11	3.0
Chile	542	558	624	618	764	146	23.6
All other	4,712	5,349	5,429	5,516	5,985	469	8.5
Total	31,511	35,749	36,271	37,116	39,966	2,850	7.7
EU-28	3,975	4,341	4,560	4,528	4,742	214	4.7
OPEC	68	80	77	78	76	-2	-2.7
Latin America	3,384	4,068	4,235	4,271	4,912	641	15.0
Asia	8,693	9,982	10,134	10,981	11,256	274	2.5
Sub-Saharan Africa	79	87	109	122	135	13	10.7

See footnote(s) at the end of table.

Item	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. merchandise trade balance:							
Canada	-5,639	-6,394	-6,272	-6,228	-7,831	-1,603	-25.7
China	-2,561	-2,073	-612	-1,872	-1,486	386	20.6
Mexico	2,961	3,522	3,577	3,714	3,740	26	0.7
Japan	1,230	1,438	1,692	1,625	1,745	119	7.4
Brazil	-941	-1,345	-1,311	-1,384	-1,771	-387	-28.0
United Kingdom	639	696	732	901	965	64	7.1
Germany	-293	-286	-352	-376	-375	1	0.3
Korea	392	445	439	329	317	-12	-3.7
Italy	421	602	579	408	437	29	7.0
Chile	-393	-333	-398	-385	-525	-140	-36.5
All other	3,162	4,360	4,930	4,459	4,062	-398	-8.9
Total	-1,022	632	3,003	1,193	-723	-1,915	([a])
EU-28	502	800	684	583	330	-254	-43.5
OPEC	617	803	933	840	864	24	2.9
Latin America	3,264	3,960	4,054	4,092	3,672	-420	-10.3
Asia	-410	670	2,710	1,018	1,524	506	49.7
Sub-Saharan Africa	127	181	208	162	140	-23	-14.0

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a]Not meaningful for purposes of comparison.

U.S. Exports

U.S. exports of forest products rose by 2 percent between 2012 and 2013, from $38.3 billion to $39.2 billion. Most of this increase was accounted for by growth in U.S. exports of logs and rough wood products and lumber, primarily to China (table FP.2). U.S. exports of logs and rough wood products to China rose from $819 million in 2012 to $1.2 billion in 2013, and U.S. exports of lumber to China grew from $743 million in 2012 to $1.0 billion in 2013. Strong construction markets in China increased both demand and prices in these two product categories. [165] Export prices for two commodity grades of U.S. logs increased by 11 percent and 16 percent in 2013 over 2012 levels. [166] The average unit value of U.S. lumber exports to China rose by 3 percent between 2012 and 2013.

U.S. Imports

U.S. imports of forest products grew by 8 percent, from $37.1 billion in 2012 to $40.0 billion in 2013. U.S. imports of lumber, wood veneer and wood panels, and moldings, millwork, and joinery accounted for most of this increase, and within these three product categories, imports from Canada accounted for most of the growth. Imports from Brazil of wood veneer and wood panels and moldings, millwork, and joinery accounted for a smaller portion of this growth. During 2013, the continued recovery in the U.S. housing market strengthened demand and prices for these products. Canadian and Brazilian suppliers participated in this recovery, as did Chinese and Mexican suppliers, to a lesser extent.

U.S. imports of lumber increased by more than $1 billion (27 percent) in 2013 compared to 2012, largely because of demand for single-family housing units. U.S. housing starts increased by 18 percent between 2012 and 2013, from 781,000 starts to 923,000 starts. U.S. housing starts in 2013 were 67 percent higher than during the 2009 trough, when housing starts bottomed out as a result of the financial crisis and subsequent recession. [167] In 2013, U.S. housing starts reached their highest level since 2008. The largest category within U.S. housing starts, single-family starts, experienced a 15 percent gain between 2012 and 2013. [168] Single-family starts consume a higher proportion of lumber to total building materials than multi-family starts. [169] Strong U.S. demand in 2013 pushed up prices for commodity grades of lumber by more than 10 percent over 2012. [170]

[165] IBIS World, *Building Construction in China,* September 2013, 37.
[166] Weyerhaeuser, "Form 10-K," February 28, 2014, 7, 8, 36.
[167] USDOC, Census, New Residential Construction (accessed February 18, 2014).
[168] U.S. housing starts are categorized as 1 unit, 2 to 4 units, and 5 units or more.
[169] Canfor Corporation, "Management's Discussion and Analysis 2013," 2013, 5.
[170] West Fraser, "2013 Management's Discussion and Analysis," 2013, 5.

Table FP.2 Forest products: Leading changes in U.S. exports and imports, 2009–13

Item	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. EXPORTS:							
Increases:							
Logs and rough wood products (FP001)	1,716	2,236	2,624	2,545	3,117	573	22.5
Lumber (FP002)	1,593	2,256	2,607	2,681	3,130	449	16.7
Decreases:							
Wood pulp and recovered paper (FP009)	6,751	8,788	9,816	9,006	8,768	-239	-2.7
Printed matter (FP016)	5,162	5,405	5,371	5,313	5,094	-219	-4.1
All other	15,267	17,695	18,856	18,764	19,135	371	2.0
Total	30,489	36,381	39,274	38,309	39,244	935	2.4
U.S. IMPORTS:							
Increases:							
Lumber (FP002)	2,639	3,391	3,366	3,961	5,036	1,075	27.1
Wood veneer and wood panels (FP004)	2,961	3,413	3,263	3,931	4,605	673	17.1
Moldings, millwork, and joinery (FP003)	2,125	2,316	2,229	2,478	2,853	375	15.2
Decreases:							
Printed matter (FP016)	3,952	4,282	4,174	4,237	4,181	-56	-1.3
Newsprint (FP012)	1,442	1,377	1,464	1,344	1,290	-54	-4.0
All other	18,392	20,969	21,775	21,164	22,001	836	4.0
Total	31,511	35,749	36,271	37,116	39,966	2,850	7.7

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

Demand for Canadian and Brazilian wood veneer and wood panels and moldings, millwork, and joinery also increased because of U.S. housing starts. Prices for many of these products increased, too. For example, prices for a commodity grade of medium-density fiberboard rose by 7 percent in 2013 over 2012. [171]

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[171] West Fraser, "2013 Management's Discussion and Analysis," 2014, 7.

Machinery

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $3.0 billion (7 percent) to $46.8 billion
U.S. exports: Decreased by $0.1 billion (0.1 percent) to $122.3 billion
U.S. imports: Increased by $2.9 billion (2 percent) to $169.1 billion

In 2013, the U.S. merchandise trade deficit for machinery rose by $3.0 billion to $46.8 billion, a 7 percent increase. Higher U.S. imports of machinery were attributable in part to increased residential and commercial construction in the United States, which boosted demand for several machinery product groups (see figure MT.1).

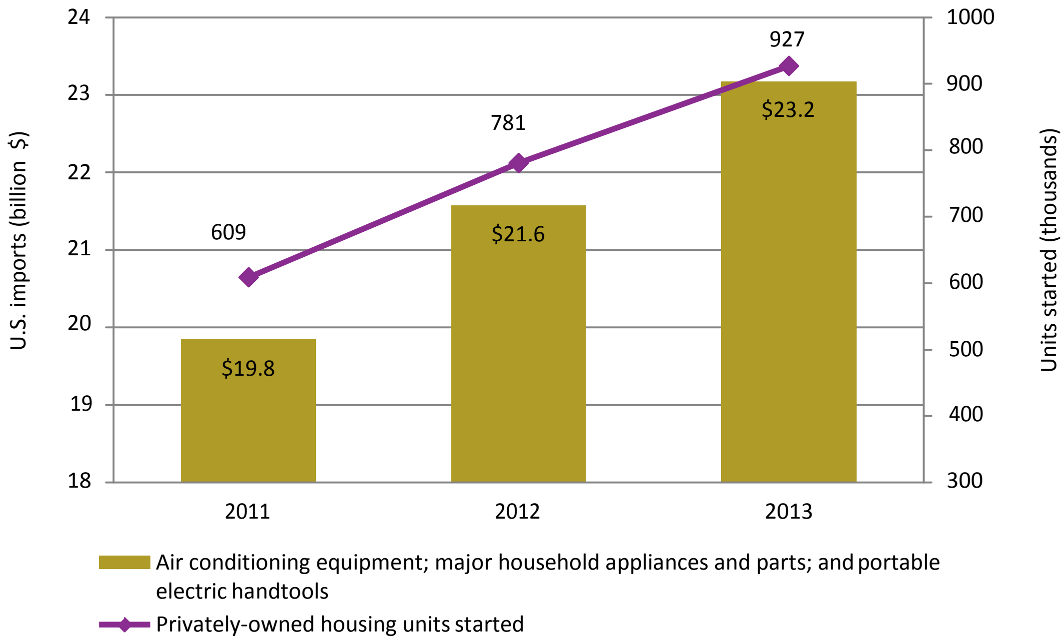
The United States maintained trade deficits for machinery with most major trading partners except for Canada, Taiwan, and Brazil (table MT.1). In 2013, the machinery trade deficit with China increased by $2.7 billion (9 percent) to $34.9 billion, while the deficit with Japan decreased by $1.8 billion (10 percent) to $15.6 billion.

U.S. Exports

U.S. exports of machinery decreased slightly, falling by $135 million (0.1 percent) to $122.3 billion in 2013. Major shifts occurred in taps, cocks, valves, and similar devices; farm and garden machinery and equipment; electric motors and generators; and metal rolling mills (table MT.2). By destination, Mexico, China, and Japan accounted for the largest increases in the value of U.S. exports of machinery (table MT.1). The largest decline in U.S. exports was to Canada.

The largest absolute increase in machinery exports occurred in exports of taps, cocks, valves, and similar devices, which increased by $1.2 billion (13 percent) to $10.2 billion in 2013. Global demand for this product group—which is often used in oil and gas applications—has expanded steadily since 2010, as the petroleum refining and pipeline industries have rebounded following the economic recession.[172] Increased exports to Korea, China, Mexico, and Singapore accounted for 55 percent of the total increase in U.S. exports in 2013.

Figure MT.1 U.S. residential construction and imports of certain machinery product groups



Source: USITC DataWeb/USDOC (accessed March 10, 2014); USDOC, Census, "New Privately Owned Housing Units Started," n.d. (accessed March 10, 2014).

[172] IBISWorld, *Valve Manufacturing,* November 2013, 8.

Table MT.1 Machinery: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. exports of domestic merchandise							
China	5,424	7,903	8,946	8,539	9,085	546	6.4
Mexico	10,442	11,655	13,450	15,508	16,491	983	6.3
Canada	17,437	20,324	23,025	24,938	24,658	-280	-1.1
Japan	2,588	2,992	3,467	3,068	3,409	340	11.1
Germany	2,869	3,734	4,213	4,029	3,996	-33	-0.8
Korea	3,454	5,659	5,499	5,632	5,584	-48	-0.9
Taiwan	3,276	5,856	4,529	4,602	4,691	89	1.9
Italy	918	977	1,066	1,012	1,091	79	7.8
United Kingdom	2,426	2,756	2,893	2,971	3,043	72	2.4
France	1,699	1,754	1,898	1,965	1,982	17	0.9
All other	34,893	40,769	46,207	50,140	48,240	-1,900	-3.8
Total	85,427	104,379	115,193	122,404	122,269	-135	-0.1
EU-28	13,568	15,539	17,249	16,939	17,344	404	2.4
OPEC	6,487	7,055	7,224	8,869	8,786	-84	-0.9
Latin America	19,467	23,545	26,475	29,814	29,917	103	0.3
Asia	22,218	31,970	32,827	32,444	32,731	287	0.9
Sub-Saharan Africa	1,834	1,990	2,108	2,396	2,425	30	1.2
U.S. imports for consumption							
China	25,995	32,326	36,534	40,730	44,024	3,294	8.1
Mexico	16,584	20,548	23,144	25,280	26,292	1,011	4.0
Canada	10,352	10,899	12,511	13,350	13,521	171	1.3
Japan	11,633	15,202	19,014	20,461	18,986	-1,475	-7.2
Germany	11,063	12,286	15,302	15,767	16,542	775	4.9
Korea	4,786	5,675	6,379	6,824	6,572	-252	-3.7
Taiwan	2,324	2,810	3,487	3,908	3,942	34	0.9
Italy	4,492	4,369	5,872	6,045	6,258	213	3.5
United Kingdom	2,818	2,953	3,651	3,877	3,932	55	1.4
France	1,966	2,282	2,790	3,095	3,390	295	9.5
All other	18,047	21,118	26,265	26,899	25,654	-1,245	-4.6
Total	110,061	130,469	154,948	166,237	169,113	2,876	1.7
EU-28	29,338	31,803	40,246	41,167	41,564	397	1.0
OPEC	73	95	120	146	146	([a])	0.1
Latin America	17,885	21,966	24,913	27,145	27,835	690	2.5
Asia	48,807	61,488	72,020	79,232	80,673	1,441	1.8
Sub-Saharan Africa	226	319	362	361	344	-17	-4.6

See footnote(s) at the end of table.

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance							
China	-20,571	-24,423	-27,588	-32,191	-34,939	-2,748	-8.5
Mexico	-6,142	-8,893	-9,695	-9,773	-9,801	-28	-0.3
Canada	7,085	9,425	10,514	11,588	11,137	-451	-3.9
Japan	-9,045	-12,209	-15,546	-17,393	-15,577	1,816	10.4
Germany	-8,193	-8,552	-11,089	-11,738	-12,547	-809	-6.9
Korea	-1,331	-17	-880	-1,192	-988	203	17.1
Taiwan	952	3,045	1,042	694	749	55	8.0
Italy	-3,574	-3,392	-4,806	-5,033	-5,167	-134	-2.7
United Kingdom	-392	-198	-757	-906	-889	17	1.8
France	-268	-528	-892	-1,130	-1,408	-278	-24.6
All other	16,845	19,651	19,943	23,241	22,586	-655	-2.8
Total	-24,634	-26,090	-39,755	-43,833	-46,844	-3,011	-6.9
EU-28	-15,770	-16,264	-22,998	-24,228	-24,220	8	([b])
OPEC	6,414	6,959	7,104	8,724	8,640	-84	-1.0
Latin America	1,581	1,578	1,562	2,668	2,082	-586	-22.0
Asia	-26,589	-29,518	-39,193	-46,787	-47,941	-1,154	-2.5
Sub-Saharan Africa	1,608	1,671	1,746	2,035	2,081	46	2.3

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a] Less than $500,000.

[b] Less than 0.05 percent.

Table MT.2 Machinery: Leading changes in U.S. exports and imports, 2009–13

Item	Million $						
	2009	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. EXPORTS:							
Increases:							
Taps, cocks, valves, and similar devices (MT020)	5,929	7,071	8,421	9,077	10,248	1,171	12.9
Decreases:							
Farm and garden machinery and equipment (MT009)	7,667	8,653	11,234	13,147	11,645	-1,501	-11.4
Electric motors, generators, and related equipment (MT023)	6,743	7,584	7,897	9,321	8,297	-1,024	-11.0
Metal rolling mills (MT014)	486	524	442	430	347	-83	-19.3
Non-metalworking machine tools (MT018)	582	730	704	688	615	-73	-10.5
All other	64,020	79,815	86,496	89,742	91,117	1,374	1.5
Total	85,427	104,379	115,193	122,404	122,269	-135	-0.1
U.S. IMPORTS:							
Increases:							
Household appliances, including commercial applications (MT004)	16,608	19,731	20,524	21,542	22,763	1,221	5.7
Air-conditioning equipment and parts (MT002)	8,576	10,695	12,810	14,045	14,977	932	6.6
Portable electric handtools (MT025)	2,140	2,431	2,648	2,787	3,081	293	10.5
Boilers, turbines, and related machinery (MT022)	1,899	1,614	1,464	1,299	1,480	181	13.9
Metal rolling mills (MT014)	523	382	425	373	489	117	31.3
Decreases:							
Semiconductor manufacturing equipment and robotics (MT019)	5,914	9,335	13,791	12,711	11,502	-1,209	-9.5
Electric motors, generators, and related equipment (MT023)	10,075	10,338	12,055	13,189	12,103	-1,085	-8.2
Metal cutting machine tools (MT015)	2,173	2,529	4,509	5,822	5,106	-716	-12.3
Pulp, paper, and paperboard machinery (MT011)	830	950	1,033	1,260	981	-278	-22.1
All other	61,323	72,464	85,688	93,209	96,630	3,421	3.7
Total	110,061	130,469	154,948	166,237	169,113	2,876	1.7

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

The largest absolute decrease in machinery exports was in farm and garden machinery, exports of which decreased by $1.5 billion (11 percent) to $11.6 billion. Following a surge in exports in 2011 and 2012 resulting from strong farm incomes, high food prices, and a weak U.S. dollar, exports decreased in 2013 to all major markets except Canada. [173] Slower economic growth, falling food prices, and a stronger U.S. dollar contributed to export declines to several leading markets, such as Brazil, Russia, and South Africa. [174] The export decline to Australia may be attributable to Australian farmers' struggles with serious drought and a strong Australian dollar, which hurt demand for Australian farm exports. [175] The largest decrease in this product group occurred in track-laying tractors, exports of which fell by 54 percent to $805 million in 2013. U.S. exports of this product group to Canada, on the other hand, increased by $330 million (9 percent) to $4.2 billion in 2013. North American farmers were reportedly in a financial position that allowed them to upgrade their equipment. [176]

U.S. exports of motors, generators, and related equipment fell by $1.0 billion (11 percent) to $8.3 billion in 2013. This primarily reflects an $811 million (35 percent) decline in exports of other generating sets, with the largest decline in exports to Venezuela and Australia. There are significant annual fluctuations in U.S. exports of these products, with export volumes and destinations often correlated with orders for individual power plants. [177]

U.S. exports of metal rolling mills declined by $83 million (19 percent) to $347 million in 2013. Exports to China of this product group decreased by $41 million (29 percent) to $101 million in 2013, the lowest level of such exports in recent years. Most of the decline was in exports of parts for rolling mills. The decrease may have been due to improved capabilities of the Chinese industry to manufacture its own rolling mills and parts.

U.S. Imports

In 2013, U.S. imports of machinery increased by $2.9 billion (2 percent) to $169.1 billion. Major shifts occurred in household appliances; air conditioning equipment and parts; portable electric hand tools; boilers, turbines, and related machinery; metal rolling mills; semiconductor manufacturing equipment; electric motors, generators, and related equipment; metal cutting machine tools; and pulp, paper, and paperboard machinery. By origin, China, Mexico, and Germany accounted for the largest increases, while Japan accounted for the largest decrease in the value of U.S. machinery imports.

[173] Deere & Co, "Form 10-K," December 17, 2012, 23.
[174] IMF, "Table 3," March 6, 2014; BBC News, "Brazil's Economy Shrinks 0.5%," December 3, 2013; Zaks, "Russia Economy Chief Says Dire 2013 Was 'Low Point,'" January 31, 2014.
[175] Tcktcktck, "Australian Farmers Suffer through Drought," May 1, 2013.
[176] Kanicki, "Dealers View 2014 with 'Tempered' Confidence," October 2013; Canada's Farm Progress Show, "Canada's Farm Show Rolls Out Red Carpet," March 18, 2013.
[177] For an example of the extent to which demand for these products can fluctuate annually and by region, see *Diesel and Gas Turbine Worldwide,* "37th Power Generation Order Survey," May 2013, 3–4, and *Diesel and Gas Turbine Worldwide,* "36th Power Generation Order Survey," May 2012, 3–4.

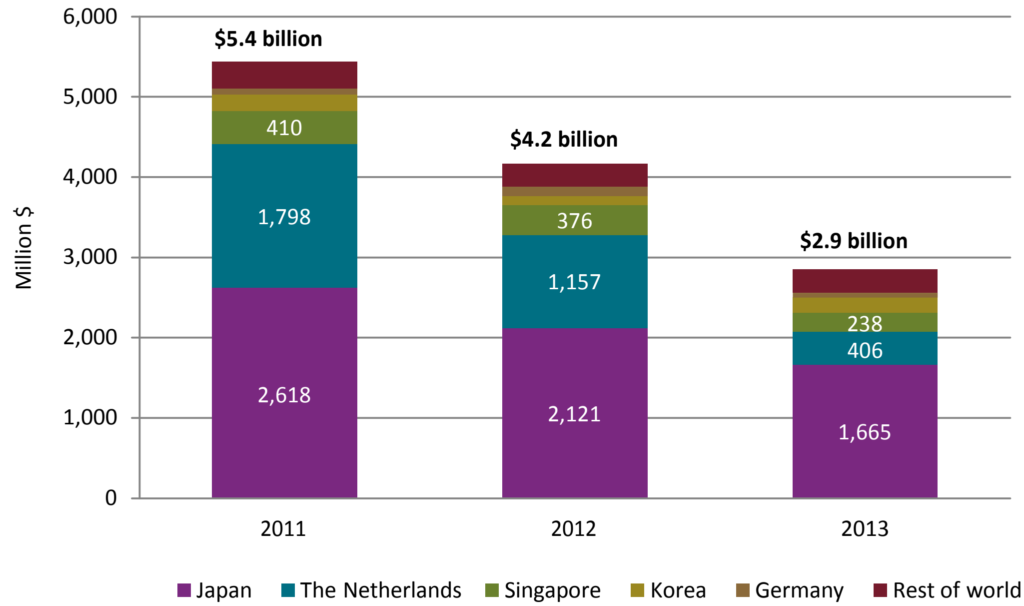
The largest absolute increase in machinery imports in 2013 came from imports of household appliances, which increased $1.2 billion (6 percent) to $22.8 billion. The increase was largely composed of greater imports of combined refrigerator-freezers from China and Mexico (up by $399 million), along with food processors (up by $200 million) and other motorized appliances. The increase in imports is attributable to growth in residential construction, which is one of the largest drivers of demand for household appliances. [178] Imports of household appliances from China rose by $1.4 billion in 2013; such imports have grown every year since 2010, as more companies have located their overseas facilities in China to access low labor costs. [179]

The second-largest absolute increase involved imports of air-conditioning equipment and parts, which increased by $932 million (7 percent) to $15.0 billion. The import growth largely came from Mexico (up by $618 million), China ($183 million), and Korea ($105 million). Growth in residential and commercial construction and home improvements spurred demand for this product group, [180] which is increasingly produced overseas. The increase in imports is part of a trend since 2010, as manufacturers moved some of their facilities for this product group to Mexico, China, and other markets during the economic recession. [181]

The largest absolute decrease in U.S. imports came in semiconductor manufacturing equipment and robotics, which fell by $1.2 billion (10 percent) to $11.5 billion in 2013. The decrease in 2013 followed a $1.1 billion decrease in 2012. The decline was driven primarily by a $1.3 billion decline in U.S. imports of machines and apparatus for the manufacture of semiconductor devices or electronic integrated circuits. Imports from the top five U.S. partners for these products—Japan, the Netherlands, Singapore, Korea, and Germany—fell by $1.3 billion in 2013 (see figure MT.2). The decrease in 2013 likely indicates a shift away from demand for larger, high-capital machinery investments, as the construction of a number of large new semiconductor wafer fabrication facilities concluded in the United States. However, despite the fall in import values, U.S. import quantities of semiconductor manufacturing equipment more than doubled in 2013, indicating an increase in imports of lower-value parts, components, and machinery. Import values for semiconductor manufacturing equipment have fluctuated frequently over the past decade due to changes in the capacity needs of the domestic semiconductor manufacturing industry. [182]

[178] IBISWorld, Major Household Appliance Manufacturing, December 2013, 5.
[179] Ibid., 10.
[180] IBISWorld, Heating and Air Conditioning Equipment Manufacturing, October 2013, 17.
[181] Ibid., 20.
[182] Lineback et al., *The McClean Report,* 2013.

Figure MT.2 Imports of certain semiconductor machinery



Source: USITC DataWeb/USDOC (accessed March 10, 2013).

U.S. imports of electric motors, generators, and related equipment fell $1.1 billion (8 percent) to $12.1 billion in 2013. The decline was likely due to decreased wind turbine demand linked to the expected expiration of a long-standing production tax credit (PTC)—the main tax credit for the wind sector—at the end of 2012. While the PTC was ultimately renewed, the late timing of the renewal motivated managers to schedule project activities for 2012 that might otherwise have been left for 2013; the uncertainty also limited project development activity going into 2013.[183] As a result, U.S. wind turbine installations declined from 13,131 megawatts (MW) in 2012 to 1,084 MW in 2013.[184] This led to a $952 million decline in U.S. imports of wind-powered generating sets,[185] a $159 million decline in imports of generators for wind turbines, and a $95 million decline in imports of parts of wind turbine generators.

Imports of metal-cutting machine tools decreased by $716 million (12 percent) to $5.1 billion in 2013. Much of the decline came in the form of reduced imports of machining centers and lathes, which are widely used in the motor vehicle, aerospace, and medical devices industries. U.S. consumers of machine tools tend to purchase these large capital machines every three to five years. The decrease in 2013 thus reflects typical industry trends, as imports of this product

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[183] USITC, Renewable Energy and Related Services, August 2013, 4-8 to 4-9.
[184] AWEA, "AWEA U.S. Wind Industry Fourth Quarter," January 30, 2014, 3.
[185] Wind-powered generating sets include nacelles and any items imported with the nacelle, such as the blades or hub. If these components are imported or exported separately from the nacelle, they are included in different Harmonized System subheadings.

group increased by $3.3 billion from 2010 to 2012. By market, imports from Japan fell by $362 million (15 percent) in 2013, followed by those from Taiwan ($129 million, or 25 percent), Germany ($119 million, or 12 percent), and Korea ($115 million, or 25 percent). The drop in imports from Japan was due to Japanese companies increasing their U.S.-based production beginning in late 2012: one producer opened a new U.S factory in 2013, and another expanded its existing U.S. operations. [186]

[186] *Metalworking Production and Purchasing,* "Mazak Rolls Out 30,000th Kentucky-Built Machine," September 10, 2013; DMG Mori Seiki Manufacturing, "About Us," http://www.dmgmoriseikimfgusa.com/about-us (accessed March 10, 2014).

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Minerals and Metals

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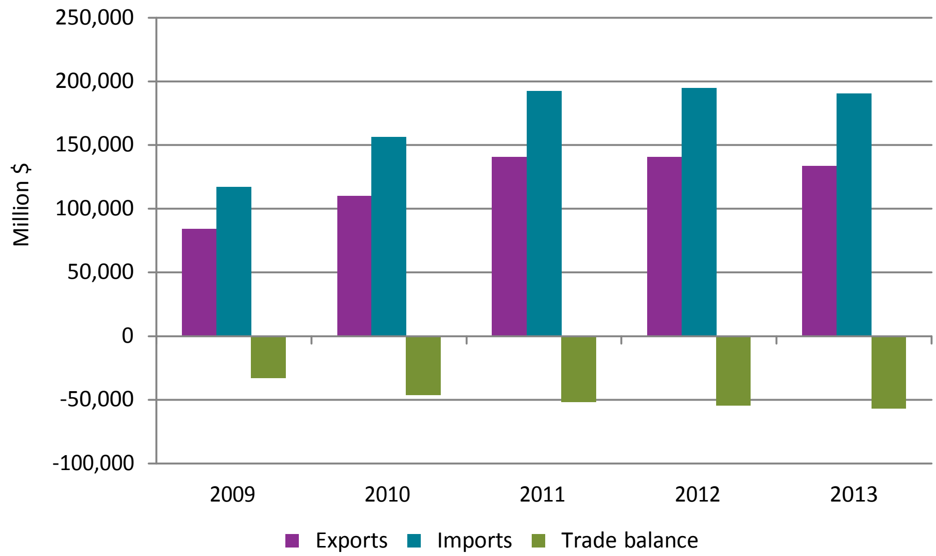
Change in 2013 from 2012:

U.S. trade deficit: Increased by $2.5 billion (4.7 percent) to $56.7 billion
U.S. exports: Decreased by $6.8 billion (4.8 percent) to $133.7 billion
U.S. imports: Decreased by $4.2 billion (2.2 percent) to $190.5 billion

In 2013, both U.S. exports and U.S. imports of minerals and metals decreased, and since the decline in exports exceeded the decline in imports, the U.S. trade deficit in this category continued to widen. The United States has maintained a trade deficit in minerals and metals in each successive year since 2009 (figure MM.1). During this five-year period, the U.S. trade deficit widened the most with China (by $5.2 billion), followed by India ($4.7 billion), Israel ($3.3 billion), and Canada ($2.2 billion) (table MM.1). Leading shifts among U.S. imports and exports of minerals and metals over 2009—13 (table MM.2) reflected the economic performance of the major downstream consuming industries. Of particular importance were recovering construction activity, [187] varying growth rates among individual durable-goods manufacturing industries, [188] and continued rising energy production. [189] Such shifts also resulted from shortfalls in domestic mine resources for many critical raw materials and generally lower commodity prices. [190]

[187] USDOC, Census, "December 2013 Construction at $930.5 Billion Annual Rate," February 3, 2014, table 1, "Value of Construction Put in Place in the Place in the United States, Not Seasonally Adjusted," 1 and 3.
[188] USDOC, Census, "Full Report on Manufacturers' Shipments," February 4, 2014, table 1, "Value of Manufacturers' Shipments for Industry Groups," 2.
[189] USDOE, EIA, "Crude Oil and Natural Gas Resource Development," February 25, 2014, 75–80.
[190] USDOI, USGS, "Significant Events, Trends, and Issues," January 2013, 7.

Figure MM.1 Minerals and metals: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, for minerals and metals, 2009–13



Source: Compiled from official statistic of the U.S. Department of Commerce.

Table MM.1 Minerals and metals: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. exports of domestic merchandise:							
Canada	18,907	24,978	28,710	28,691	27,585	-1,106	-3.9
China	8,703	10,791	13,489	12,099	11,998	-101	-0.8
Mexico	9,603	12,450	15,764	17,766	18,918	1,152	6.5
Switzerland	7,035	10,196	13,227	14,622	13,413	-1,209	-8.3
India	2,176	3,159	2,835	4,645	2,640	-2,004	-43.2
Hong Kong	1,347	2,536	7,848	8,855	11,770	2,915	32.9
Germany	2,371	3,710	4,338	3,903	4,047	143	3.7
Japan	2,043	3,026	3,670	3,088	3,213	125	4.0
Israel	737	700	1,156	1,903	857	-1,045	-54.9
Korea	2,658	3,176	4,170	3,829	3,674	-155	-4.1
All other	28,771	35,188	45,433	41,116	35,633	-5,483	-13.3
Total	84,351	109,910	140,640	140,516	133,749	-6,767	-4.8
EU-28	17,343	21,354	26,493	23,126	16,737	-6,389	-27.6
OPEC	2,222	2,172	3,077	3,670	4,452	782	21.3
Latin America	13,399	17,199	21,300	23,641	24,707	1,066	4.5
Asia	21,194	28,616	40,118	39,286	40,241	955	2.4
Sub-Saharan Africa	789	1,136	1,407	1,520	1,922	402	26.5
U.S. imports for consumption:							
Canada	22,533	31,382	35,358	32,529	33,380	851	2.6
China	19,146	22,208	25,258	26,890	27,616	726	2.7
Mexico	12,142	16,236	21,944	21,997	19,257	-2,740	-12.5
Switzerland	1,102	1,259	1,667	1,642	1,364	-278	-16.9
India	5,136	7,714	9,149	8,668	10,286	1,618	18.7
Hong Kong	304	384	457	544	579	35	6.5
Germany	4,496	6,221	7,722	7,726	7,540	-187	-2.4
Japan	4,468	5,752	6,971	8,024	7,362	-662	-8.3
Israel	5,966	8,242	9,741	8,817	9,375	559	6.3
Korea	2,387	3,466	5,038	5,878	5,539	-340	-5.8
All other	39,347	53,334	69,244	71,997	68,175	-3,822	-5.3
Total	117,025	156,199	192,550	194,712	190,474	-4,238	-2.2
EU-28	18,316	23,555	29,028	30,107	29,061	-1,046	-3.5
OPEC	707	1,261	2,286	2,461	2,131	-330	-13.4
Latin America	22,469	29,944	41,802	44,226	40,534	-3,692	-8.3
Asia	36,410	46,351	55,319	59,271	60,477	1,206	2.0
Sub-Saharan Africa	3,813	5,702	6,519	5,523	5,334	-189	-3.4

See footnote(s) at the end of table.

Item	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. merchandise trade balance:							
Canada	-3,625	-6,404	-6,649	-3,838	-5,795	-1,957	-51.0
China	-10,443	-11,416	-11,769	-14,792	-15,619	-827	-5.6
Mexico	-2,540	-3,786	-6,180	-4,230	-339	3,892	92.0
Switzerland	5,933	8,937	11,560	12,980	12,049	-931	-7.2
India	-2,959	-4,555	-6,314	-4,023	-7,646	-3,622	-90.0
Hong Kong	1,043	2,152	7,392	8,311	11,191	2,880	34.7
Germany	-2,125	-2,511	-3,384	-3,823	-3,493	330	8.6
Japan	-2,425	-2,726	-3,301	-4,936	-4,149	787	16.0
Israel	-5,229	-7,542	-8,585	-6,914	-8,518	-1,604	-23.2
Korea	272	-290	-868	-2,049	-1,865	185	9.0
All other	-10,576	-18,146	-23,812	-30,881	-32,542	-1,661	-5.4
Total	-32,674	-46,288	-51,910	-54,196	-56,725	-2,529	-4.7
EU-28	-973	-2,201	-2,534	-6,981	-12,324	-5,344	-76.5
OPEC	1,515	911	792	1,209	2,321	1,112	92.0
Latin America	-9,070	-12,745	-20,502	-20,585	-15,827	4,758	23.1
Asia	-15,216	-17,735	-15,201	-19,986	-20,236	-250	-1.3
Sub-Saharan Africa	-3,024	-4,565	-5,113	-4,003	-3,411	592	14.8

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

Table MM.2 Minerals and metals: Leading changes in U.S. exports and imports, 2009–13

Item	Million $						
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. EXPORTS:							
Increases:							
Miscellaneous products of base metal (MM031)	5,997	7,087	8,066	8,817	9,318	502	5.7
Pipes and tubes of carbon and alloy steels (MM025L)	2,565	3,042	3,204	3,895	4,179	284	7.3
Industrial fasteners of base metal (MM032)	1,962	2,446	2,854	3,133	3,380	247	7.9
Cement, stone, and related products (MM009)	2,069	2,703	3,070	3,245	3,442	197	6.1
Decreases:							
Precious metals and non-numismatic coins (MM020)	20,699	28,033	42,230	42,762	38,868	-3,893	-9.1
Iron and steel waste and scrap (MM023)	7,125	8,399	11,398	9,449	7,595	-1,854	-19.6
Natural and synthetic gemstones (MM019)	2,447	3,303	3,684	3,623	2,356	-1,267	-35.0
Plates, sheets, and strips of carbon and alloy steels (MM025B)	3,940	5,137	5,976	5,744	5,320	-424	-7.4
Bars, rods, and light shapes of carbon and alloy steels (MM025C)	989	1,536	1,860	1,826	1,483	-343	-18.8
Unrefined and refined copper (MM036A)	452	579	243	754	508	-247	-32.7
Metal construction components (MM028)	1,147	1,227	1,428	1,802	1,562	-240	-13.3
Ingots, blooms, billets, and slabs of carbon and alloy steels (MM025A)	459	474	818	632	409	-223	-35.3
Unwrought aluminum (MM037)	2,673	3,930	4,977	4,418	4,200	-218	-4.9
Angles, shapes, and sections of carbon and alloy steels (MM025D)	459	659	1,007	1,112	922	-190	-17.1
All other	31,369	41,357	49,825	49,305	50,206	902	1.8
Total	84,351	109,910	140,640	140,516	133,749	-6,767	-4.8
U.S. IMPORTS:							
Increases:							
Natural and synthetic gemstones (MM019)	13,608	19,730	23,625	21,597	24,733	3,136	14.5
Cement, stone, and related products (MM009)	4,536	5,066	5,498	5,840	6,482	643	11.0
Unrefined and refined copper (MM036A)	3,403	4,489	5,840	4,938	5,453	515	10.4
Primary and secondary aluminum (MM037A)	5,021	6,163	7,471	6,839	7,249	410	6.0
Certain builders' hardware (MM045)	3,119	3,646	3,848	4,026	4,379	353	8.8
Refined lead (MM039A)	213	258	299	344	692	347	100.9
Miscellaneous products of base metal (MM031)	9,686	11,889	13,630	14,938	15,209	271	1.8
Nonpowered handtools (MM042)	3,628	4,786	5,445	6,088	6,344	256	4.2
Cooking and kitchen ware (MM033)	2,180	2,683	2,676	2,781	3,023	243	8.7
Ceramic floor and wall tiles (MM012)	964	1,025	1,078	1,184	1,412	228	19.3
Unwrought zinc (MM040A)	1,076	1,449	1,605	1,318	1,543	225	17.0

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
Decreases:							
Pipes and tubes of carbon and alloy steels (MM025L)	6,718	6,798	8,952	11,324	8,919	-2,405	-21.2
Precious metals and non-numismatic coins (MM020)	16,287	23,701	33,423	32,257	30,181	-2,075	-6.4
Certain base metals and chemical elements (MM041)	3,822	6,106	7,563	6,744	5,830	-914	-13.6
Fabricated structurals (MM027)	1,366	1,215	1,211	1,893	1,025	-868	-45.8
Plates, sheets, and strips of carbon and alloy steels (MM025B)	4,480	6,133	7,934	8,726	7,896	-830	-9.5
Ingots, blooms, billets, and slabs of carbon and alloy steels (MM025A)	891	2,535	4,192	4,109	3,397	-712	-17.3
Ferroalloys (MM022)	1,062	2,668	2,930	2,899	2,380	-519	-17.9
Primary iron products (MM021)	1,184	2,149	2,916	2,925	2,474	-452	-15.4
Plates, sheets, and strips of stainless steels (MM025G)	670	1,423	1,830	1,771	1,354	-417	-23.6
Bars, rods, and light shapes of carbon and alloy steels (MM025C)	1,472	2,362	3,110	3,466	3,111	-355	-10.2
Iron ores and concentrates (MM003)	375	703	841	757	426	-331	-43.7
Industrial ceramics (MM010)	712	1,241	1,815	1,700	1,464	-237	-13.9
All other	30,553	37,980	44,816	46,249	45,497	-752	-1.6
Total	117,025	156,199	192,550	194,712	190,474	-4,238	-2.2

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

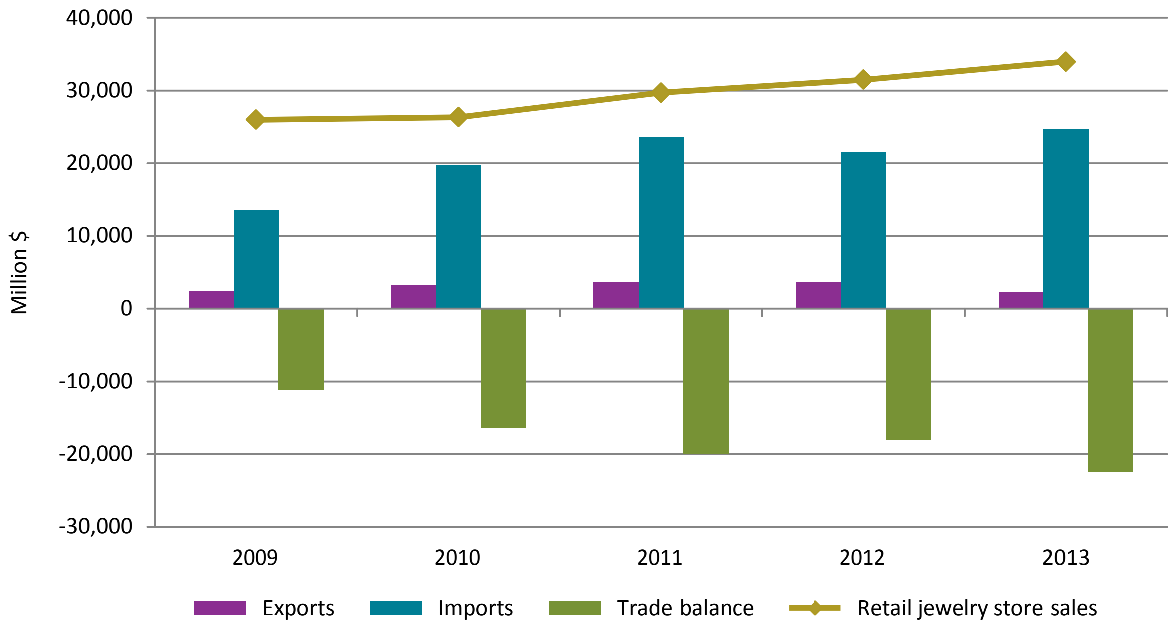
Among the leading changes for U.S. trade in minerals and metals in 2012–13 were significant shifts in both U.S. exports and U.S. imports of natural and artificial gemstones and precious metals and non-numismatic coins (table MM.2). U.S. trade in natural and artificial gemstones significantly contributed to widening the U.S. trade deficit for minerals and metals between 2012 and 2013; the deficit grew by $4.4 billion (24 percent) to $22.4 billion (figure MM.2). On the one hand, U.S. exports of natural and artificial gemstones decreased by $1.3 billion (35 percent) to $2.4 billion in 2013, with the largest decreases recorded to Israel, followed by India. On the other hand, U.S. imports of these goods increased by $3.1 billion (15 percent) to $24.7 billion, with the largest increases recorded from India, followed by Israel and Belgium. India is one of the world's largest centers for the processing (cutting and polishing) of diamond and colored gemstones and for the making of precious jewelry, and Israel and Belgium are both major diamond processing and trading centers.

Nonindustrial (gem-quality) diamonds—worked, but not mounted or set—accounted for most of the U.S. trade shifts for gemstones. The decrease of $1.2 billion in the value of exports reflected lower quantities shipped, while the increase of $3.0 billion in the value of imports reflected higher imports of higher-priced, larger diamonds (weighing more than 0.5 carat each) rather than lower-priced, smaller ones (not more than 0.5 carat each).[191]

Industry observers' anticipation in first quarter 2013 that U.S. retail sales of precious jewelry and watches would continue growing from 2012 levels[192] was fulfilled by reports of robust year-end holiday sales.[193] Lacking domestic mined-diamond resources, the United States was almost totally dependent upon imports to meet increased downstream consumption needs of precious jewelry manufacturers.[194]

[191] USITC DataWeb/USDOC (accessed March 10, 2014).
[192] Munn, *U.S. Retail Jewelry Industry Update 2013*, n.d. (accessed March 11, 2014).
[193] Bates, "Jewelry Will Be among Holiday Season's Top-Selling Categories," December 3, 2013; Ford, "Report: U.S. Jewelry and Watch Sales," December 24, 2013; Cavale, "Discounts, Promotions Spur Sales," December 26, 2013. U.S. consumer demand for gold, in the form of precious jewelry, increased by 14 metric tons (13 percent) to 123 metric tons in 2013. WGC, "Gold Demand Trends Full Year 2013," February 18, 2014, 21, table 11, "Consumer Demand in Selected Countries: Four-Quarter Totals (Tonnes)."
[194] Hence, U.S. diamond exports are reexports of recut stones or recovered stones (e.g., from disposal of precious jewelry). Olson, "Gemstones," February 2014, 62.

Figure MM.2 U.S. trade flows of natural and synthetic gemstones and retail jewelry store sales, 2009–13



Source: Compiled from official statistics of the U.S. Department of Commerce; USDOC, Census, *Monthly Retail Trade and Food Services*, Jewelry Stores (accessed March 26, 2014).
Note: Retail jewelry stores (NAICS 44831) sell any combination of precious (fine) jewelry, sterling ware, and watches. Inclusion of department stores sales of these items would more than double these values.

U.S. Exports

Although U.S. exports of minerals and metals decreased by $6.8 billion (4.8 percent) to $133.7 billion in 2013, certain products recorded increased exports (table MM.2). The leading U.S. export was miscellaneous products of base metal, which increased by $502 million (6 percent) to $9.3 billion. The United States' NAFTA partners (Canada and Mexico) were the leading U.S. destination markets for these products in 2013, with Mexico recording the largest increase in exports, up $205 million (8 percent) to $2.7 billion. U.S. exports to NAFTA partners reflect the extensive integration of the North American manufacturing industry through production-sharing arrangements and cross-border ties. Specific products in this category that recorded the largest export increases included miscellaneous iron or steel articles (up by $246 million); miscellaneous aluminum articles (up by $147 million); and base-metal hinges, castors, mountings, and fittings (up by $135 million). U.S. exports of miscellaneous base-metal products increased concurrently with the growth in shipment values reported by durable-goods manufacturers, either of finished base-metal products or of downstream products that contain intermediate base-metal products.[195]

Precious metals and non-numismatic coins recorded the leading U.S. export decrease by value, down $3.9 billion (9 percent) to $38.9 billion. The largest decreases in exports were to the United Kingdom and Switzerland—major global centers for refining, fabricating, and trading of all precious metals—and India, a major precious-jewelry fabricating and consuming market. Gold accounted for most of this export decline, as exports of unwrought gold (as unrefined doré and refined bullion) decreased by $1.8 billion, while gold waste and scrap exports decreased by $1.4 billion.

In addition to the smaller quantity of gold exported in 2013,[196] the price for gold also decreased in 2013,[197] further reducing the value of gold exports. Some financial-market observers attributed the decrease in gold prices to the fact that investors were less concerned about potential inflation.[198]

As the world's largest and most highly industrialized economy, with a well-established, nationwide scrap recovery infrastructure, the United States is the world's leading generator of ferrous (iron and steel) scrap, with production levels far exceeding domestic consumption needs.[199] However, the value of U.S. exports of iron and steel waste and scrap decreased by $1.9 billion (20 percent) to $7.6 billion. This decline reflected both lower quantities exported[200] and weaker prices.[201] The lower export quantities were attributed by industry observers to competition with scrap production in foreign markets; the weaker prices, to overcapacity among domestic scrap generation and processing operations.[202] Turkey, followed by Taiwan, India, Korea, China, and Malaysia, accounted for the largest decreases in U.S. exports (in excess of $100 million each). All six trading partners have large steel industries,[203] and each is highly

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[195] U.S. manufacturers of durable goods reported a 3.4 percent increase of their shipments in 2013 compared to the previous year. USDOC, Census, "Full Report on Manufacturers' Shipments, Inventories and Orders, December 2013," February 4, 2014, table 1, "Value of Manufacturers' Shipments for Industry Groups," 2.
[196] U.S. exports of the gold contained in doré, bullion, and waste and scrap decreased by 135 metric tons (14 percent) to 812 metric tons. USITC DataWeb/USDOC, March 10 and 12, 2014.
[197] The London Bullion Market Association's "p.m. gold fix" (the world price for gold announced each afternoon in London) averaged $1,411.23 per troy ounce in 2013, which was $257.75 (15 percent) below the 2012 annual average price. LBMA, "Historic Statistics, Gold Fixings, Daily Prices," March 5, 2014.
[198] Berthelsen, Wessel, and Zuckerman, "Gold Plunges As Fears over Inflation Fade," April 16, 2013.
[199] In 2012 (the most recent year for which information was available), the United States exported 21 million metric tons (21 percent) of the 103 million metric tons of ferrous waste and scrap exported worldwide. WSD, "Table 49: Exports of Scrap," *Steel Statistical Yearbook 2013*, November 15, 2013, 102–3.
[200] The United States exported 19 million metric tons of ferrous waste and scrap in 2013, nearly 3 million metric tons (14 percent) less than the amount in the previous year. USITC DataWeb/USDOC, March 6, 2014.
[201] Average annual U.S. ferrous scrap prices declined by $23.95 per long ton (6 percent) to $375.17 per long ton in 2013. Calculated from the annual averages of weekly prices for no. 1 bushelings, no. 1 heavy melting steel, and shredded automobile scrap. AMM, "AMM's Pricing Section," February 6, 2014.
[202] Fenton, "Iron and Steel Scrap," February 2014, 81.
[203] WSD, "The Largest Steel Producing Countries," January 22, 2014.

dependent upon foreign sources of ferrous scrap for their steelmaking industries.[204] However, all six trading partners imported less ferrous scrap from the world in 2013 than in the previous year,[205] although their reasons varied: crude-steel output decreased in Turkey and Korea, but crude-steel producers in Taiwan, India, China, and Malaysia shifted to other types of ferrous raw materials[206] for their increased output.[207]

U.S. Imports

Overall, U.S. imports of minerals and metals declined by $4.2 billion (2.2 percent) to $190.5 billion in 2013. Contributing significantly to this decline were imports of pipes and tubes of carbon and alloy steels (table MM.2), which decreased by $2.4 billion (21 percent) to $8.9 billion. Japan, followed by Germany, Canada, the UK, India, Russia, and China, accounted for the largest decreases in U.S. imports (in excess of $100 million each) in 2013. This decrease reflected both weaker prices and lower import quantities[208] during a period when U.S. domestic consumption of steel pipe and tube also decreased.[209] Lower activity levels in the leading end-use markets were cited by some industry observers as dampening domestic demand for line

The value of U.S. imports of precious metals and non-numismatic coins fell by $2.1 billion (6 percent) to $30.2 billion, with the largest decreases recorded from Mexico, followed by Colombia, Bolivia, and South Africa—all major precious-metal mining countries. Gold accounted for most of this decline, with the value of imports of unwrought gold down by $1.8 billion and that of imports of gold waste and scrap down by $354 million. As the quantity of gold imports actually increased in 2013, the decreased value of U.S. imports was caused solely by significantly lower gold prices.[210] The lower prices, combined with improved consumer sentiment, spurred increased U.S. consumer demand in 2013 for precious jewelry and investment items (in the forms of bullion bars and non-numismatic coins), the largest end-use sectors for gold consumption.[211]

[204] For information about quantities of ferrous scrap imported by these steelmakers in 2012, see WSD, "Table 50: Imports of Scrap," *Steel Statistical Yearbook 2013*, November 15, 2013, 104–5.
[205] Import quantities of HS 7204: ferrous waste and scrap; remelting scrap ingots of iron or steel. GTIS, Global Trade Atlas, March 10, 2014.
[206] Other ferrous raw materials for steelmaking can include iron ore, directly reduced iron, domestically generated ferrous scrap, inventoried ferrous scrap of domestic and foreign origin, etc.
[207] WSD, "The Largest Steel Producing Countries," January 22, 2014.
[208] U.S. imports of pipes and tubes of carbon and alloy steels fell by 816,700 metric tons (11 percent) to less than 7 million metric tons in 2013. USITC DataWeb/USDOC, March 8, 2014.
[209] U.S. domestic consumption of pipes and tubes of carbon and alloy steel decreased by 525,700 short tons (3 percent) to 18 million short tons in 2013. Preston, "All Pipe and Tube Market Analysis," February 2014, 27, 62; Preston, "All Pipe and Tube Market Analysis," February 2013, 60.
[210] U.S. imports of the gold contained in these forms increased by 157 metric tons (35 percent) to 599 metric tons. USITC DataWeb/USDOC, March 10 and 12, 2014.
[211] U.S. consumer demand for gold, in the forms of precious jewelry, bullion bars, and non-numismatic coins, increased by 28 metric tons (18 percent) to 190 metric tons in 2013. WGC, "Gold Demand Trends Full Year 2013," February 18, 2014, 21, table 11, "Consumer Demand in Selected Countries: Four-Quarter Totals (Tonnes)."

U.S. imports of certain base metals and chemical elements (minor metals) decreased by $914 million (14 percent) to $5.8 billion. Nickel accounted for the largest import decrease (down by $505 million), with the largest decline from major mined-nickel producer Russia, followed by Australia.[212] Import declines in 2013 reflected both lower quantities[213] (owing to reduced domestic consumption[214]) and weaker global prices, the result of reduced Chinese demand for ferronickel, European manufacturing cutbacks, and record accumulations of nickel in commodity exchange warehouses.[215] Titanium accounted for the second-largest decrease (down by $182 million), with the largest decline from major unwrought (sponge) titanium producer Japan, followed by Kazakhstan and China.[216] The value of U.S. titanium sponge imports declined, despite higher global sponge prices,[217] because of lower import quantities[218] caused by declining domestic demand for sponge as firms increasingly sought titanium scrap as a substitute.[219]

[212] Kuck, "Nickel," February 2014, 109.
[213] U.S. import quantities of nickel and articles thereof in various forms decreased by 12,600 metric tons (8 percent) to 157,600 metric tons in 2013. USITC DataWeb/USDOC, March 10, 2014.
[214] Despite increased production of nickel-bearing stainless steels, reported domestic consumption of nickel by all downstream consuming sectors decreased by 14,000 metric tons (6 percent) to 202,000 metric tons in 2013. Kuck, "Nickel," February 2014, 108.
[215] Kuck, "Nickel," February 2014, 109.
[216] Bedinger, "Titanium and Titanium Dioxide," February 2014, 171.
[217] Ibid., 170.
[218] U.S. import quantities of titanium and articles thereof in various forms fell by nearly 7,800 metric tons (16 percent) to 40,100 metric tons in 2013. USITC DataWeb/USDOC, March 10, 2014.
[219] Reported domestic consumption of titanium sponge declined by 10,500 metric tons (30 percent) to 24,600 metric tons in 2013. Recycling of titanium metal scrap increased by 10,000 metric tons (29 percent) to 45,000 metric tons. Bedinger, "Titanium and Titanium Dioxide," February 2014, 170; Bedinger, "Titanium and Titanium Dioxide," January 2013, 172.

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Textiles and Apparel

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $3.2 billion (3 percent) to $97.5 billion
U.S. exports: Increased by $543 million (3 percent) to $19.8 billion
U.S. imports: Increased by $3.7 billion (3 percent) to $117.2 billion

In 2013, the U.S. trade deficit in textiles and apparel rose to $97.5 billion, the result of a substantial ($3.7 billion) increase in U.S. imports that outweighed the small increase in U.S. exports (table TX.1). Imports supplied about 98 percent of U.S. consumer demand for textiles and apparel in 2013. [220] Compared to the small decline in U.S. imports in 2012, the significant growth in U.S. imports in 2013 reflected the strengthening U.S. economy. [221] Imports in four categories—shirts and blouses, home furnishings, women's and girls' trousers, and men's and boys' trousers—together accounted for 48 percent of U.S. imports of textiles and apparel in 2013 (table TX.2). U.S. exports of fabrics continued to lead sector exports, rising 3 percent to $6.5 billion. These exports were followed by U.S. exports of fibers and yarns (excluding raw cotton and raw wool), which also rose 3 percent to $5.2 billion. [222]

[220] AAFA, "ApparelStats 2013," December 2013, 4.
[221] U.S. apparel industry representatives, email message to USITC staff, March 4, 2014.
[222] USITC DataWeb/USDOC (accessed February 24, 2014).

Table TX.1 Textiles and apparel: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. exports of domestic merchandise:							
China	846	1,083	1,240	1,243	1,412	169	13.6
Mexico	3,109	3,680	4,075	4,162	4,419	258	6.2
Vietnam	37	41	43	67	62	-5	-6.9
India	114	141	162	168	166	-1	-0.8
Canada	3,063	3,386	3,675	3,873	3,849	-24	-0.6
Indonesia	132	113	131	142	180	37	26.3
Bangladesh	20	8	20	28	22	-6	-20.2
Honduras	1,073	1,469	1,848	1,464	1,408	-56	-3.8
Pakistan	55	55	40	32	40	8	26.1
Cambodia	5	6	6	7	8	1	14.8
All other	6,199	7,369	8,192	8,026	8,187	161	2.0
Total	14,653	17,350	19,433	19,211	19,754	543	2.8
EU-28	1,666	1,987	2,140	2,073	2,125	51	2.5
OPEC	331	377	450	483	469	-14	-3.0
Latin America	6,409	7,769	9,034	8,600	8,761	161	1.9
Asia	2,517	3,035	3,327	3,352	3,606	254	7.6
Sub-Saharan Africa	199	236	261	278	281	3	1.1
U.S. imports for consumption:							
China	35,083	42,095	44,798	44,949	46,239	1,289	2.9
Mexico	5,177	5,537	5,881	5,782	5,826	43	0.8
Vietnam	5,290	6,177	7,081	7,499	8,564	1,065	14.2
India	4,991	5,833	6,447	6,397	6,865	468	7.3
Canada	1,972	2,225	2,320	2,413	2,323	-91	-3.8
Indonesia	4,214	4,858	5,562	5,416	5,457	41	0.8
Bangladesh	3,557	4,104	4,719	4,639	5,112	473	10.2
Honduras	2,133	2,499	2,726	2,696	2,562	-134	-5.0
Pakistan	2,861	3,166	3,487	3,143	3,201	58	1.8
Cambodia	1,888	2,234	2,627	2,560	2,588	28	1.1
All other	23,416	25,472	27,962	28,013	28,489	476	1.7
Total	90,581	104,199	113,611	113,507	117,225	3,718	3.3
EU-28	3,983	4,513	5,259	5,376	5,640	264	4.9
OPEC	173	220	147	152	146	-6	-3.7
Latin America	13,321	14,673	15,996	15,777	15,808	32	0.2
Asia	66,826	77,998	84,873	84,703	88,088	3,385	4.0
Sub-Saharan Africa	943	814	929	891	965	74	8.3

Item	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
U.S. merchandise trade balance:							
China	-34,237	-41,013	-43,558	-43,707	-44,827	-1,120	-2.6
Mexico	-2,068	-1,857	-1,806	-1,621	-1,406	214	13.2
Vietnam	-5,254	-6,136	-7,038	-7,432	-8,502	-1,070	-14.4
India	-4,877	-5,692	-6,285	-6,230	-6,699	-469	-7.5
Canada	1,091	1,161	1,355	1,460	1,526	67	4.6
Indonesia	-4,082	-4,745	-5,431	-5,274	-5,278	-4	-0.1
Bangladesh	-3,537	-4,096	-4,699	-4,611	-5,090	-479	-10.4
Honduras	-1,060	-1,030	-878	-1,232	-1,154	78	6.3
Pakistan	-2,806	-3,111	-3,447	-3,111	-3,160	-50	-1.6
Cambodia	-1,882	-2,227	-2,621	-2,553	-2,580	-27	-1.1
All other	-17,217	-18,103	-19,770	-19,987	-20,302	-315	-1.6
Total	-75,928	-86,849	-94,178	-94,297	-97,472	-3,175	-3.4
EU-28	-2,316	-2,526	-3,119	-3,302	-3,515	-213	-6.5
OPEC	157	156	303	331	323	-9	-2.6
Latin America	-6,912	-6,904	-6,962	-7,177	-7,048	129	1.8
Asia	-64,309	-74,963	-81,546	-81,351	-84,482	-3,131	-3.8
Sub-Saharan Africa	-744	-577	-667	-614	-685	-71	-11.5

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

Table TX.2 Textiles and apparel: Leading changes in U.S. exports and imports, 2009–13

	Million $						
Item	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
U.S. EXPORTS:							
Increases:							
Miscellaneous textile products (TX006)	2,134	2,474	2,740	2,798	3,010	212	7.6
Fabrics (TX002)	4,917	5,878	6,285	6,346	6,548	202	3.2
Fibers and yarns, except raw cotton and raw wool (TX001)	3,496	4,444	5,610	5,059	5,201	143	2.8
Decreases:							
Other wearing apparel (TX005S)	370	415	458	476	457	-20	-4.1
Hosiery (TX005J)	291	315	284	275	258	-17	-6.3
All other	3,446	3,824	4,056	4,257	4,279	23	0.5
Total	14,653	17,350	19,433	19,211	19,754	543	2.8
U.S. IMPORTS:							
Increases:							
Shirts and blouses (TX005E)	21,962	24,728	26,728	26,030	27,254	1,224	4.7
Home furnishings (TX004)	7,553	9,058	9,208	9,253	10,037	784	8.5
Women's and girls' trousers (TX005D)	8,043	8,663	8,965	9,082	9,736	653	7.2
Men's and boys' trousers (TX005C)	6,805	7,496	8,277	8,267	8,640	373	4.5
Decreases:							
Women's and girls' suits, skirts, and coats (TX005G)	4,739	5,121	5,465	5,125	4,896	-229	-4.5
Gloves, including gloves for sports (TX005M)	3,234	3,874	4,517	4,709	4,577	-132	-2.8
Men's and boys' coats and jackets (TX005B)	2,299	2,636	3,183	2,970	2,839	-131	-4.4
All other	35,946	42,622	47,268	48,072	49,248	1,176	2.4
Total	90,581	104,199	113,611	113,507	117,225	3,718	3.3

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

The United States continued to register a trade deficit in textiles and apparel with several of its top trading partners. The largest trade deficit increases were with China ($1.1 billion), Vietnam ($1.1 billion), and India ($480 million). Continuing a trend that began in 2009, the U.S. trade deficit with Mexico shrank in 2013, falling by $214 million (13 percent) to $1.4 billion as the $258 million increase in U.S. exports to Mexico outpaced the $43 million increase in U.S. imports from that country. China remained the largest supplier of U.S. imports of textiles and apparel in 2013, accounting for almost 40 percent of U.S. imports of these products.

U.S. Exports

U.S. exports of textiles and apparel rose by $543 million (3 percent) to $19.8 billion in 2013. U.S. exports in this sector are largely composed of textile articles, which accounted for 83 percent of all U.S. exports of textiles and apparel in 2013. [223] Of these textile articles, fibers and yarns (excluding raw cotton and raw wool) were the second-largest export group (table TX.2). Exports of these products are used primarily as intermediate inputs for finished products manufactured abroad, which are then imported back into the United States. In 2013, the top U.S. export markets for textile inputs continued to be Mexico and Canada—partner countries in NAFTA—and Honduras, a partner country in the Dominican Republic-Central America-United States Free Trade Agreement (CAFTA-DR). These countries collectively accounted for almost half (48 percent) of U.S. exports of textile inputs in 2013.

U.S. Imports

U.S. imports of textiles and apparel rebounded from a modest decline in 2012, rising by $3.7 billion (3 percent) in 2013. The recovery in U.S. sector imports likely reflects a strengthening of the U.S. economy and a rise in U.S. consumers' confidence in the economy in 2013. [224] Although consumers reportedly were more frugal in purchasing clothing relative to expenditures on other goods or services in 2013, [225] the value of U.S. apparel retail sales grew by almost 3 percent, [226] reflecting growth of $6.9 billion in consumer spending on garments. [227]

U.S. imports of textiles and apparel are principally composed of apparel, which represented slightly more than three-fourths of all U.S. sector imports by value in 2013. By quantity, total U.S. apparel imports rose by 5 percent between 2012 and 2013. This increase was largely driven by a 5 percent growth in U.S. imports of manmade-fiber apparel, which outpaced the 2 percent growth in U.S. imports of cotton apparel. [228] The continued rise in demand for products made of manmade fibers reflects consumers' growing preference for the functional and performance

[223] USITC DataWeb/USDOC (accessed February 24, 2014).
[224] Barclays, "2013: A Year of 'Cautious Confidence,'" December 10, 2013.
[225] Barclays, "2013: A Year of 'Cautious Confidence,'" December 10, 2013; Moore, "U.S. Economic Indicators Improve in 2013," January 4, 2014.
[226] USDOC, Census, Monthly Retail Trade and Food Services: Clothing Stores, February 2014, table 4481.
[227] USDOL, BEA, *Personal Consumption Expenditures,* February 2014, table 4.5.U.
[228] USDOC, ITA, OTEXA, "Major Shippers Report," March 6, 2013.

properties (i.e., moisture management, wearing comfort, elasticity, and recovery) that manmade fibers offer that natural fibers do not.[229]

U.S. imports from Asia, the largest regional supplier—accounting for three-quarters of all sector imports—rose by $3.4 billion (4 percent) to $88.1 billion. A significant share of the increase in U.S. imports of textiles and apparel in 2013 was accounted for by a $1.3 billion increase in imports from China, by far the leading supplier of textiles and apparel to the United States. Almost as substantial was the $1.1 billion growth (14 percent) in imports from Vietnam, the second-leading supplier of these products to the United States.

Despite stated efforts in recent years by U.S. retailers to diversify their supply chains, China still dominates as a supplier of textiles and apparel to the United States and is expected to remain the leading sourcing country.[230] Although China's textile and apparel production costs have been rising,[231] industry sources report such costs have been offset by gains in productivity.[232] China maintains significant advantages over other suppliers in economies of scale, infrastructure, efficiency, expertise, and stability.[233] China's share of U.S. imports of textiles and apparel by quantity grew to 48 percent of the total in 2013, up from 47 percent in 2012.[234] This exceeded by more than seven times the volume of imports from India, the next leading supplier of textiles and apparel to the United States.

In 2013, U.S. imports of textiles and apparel from Vietnam grew by 14 percent to $8.6 billion. Led by cotton and manmade-fiber knit shirts/blouses and slacks/pants, these imports have grown rapidly in recent years. Reasons for this trend include the country's relatively low labor costs; the industry's focus on specialization, modernization, and increasing added value; and the government of Vietnam's incentives to attract foreign investment for development.[235] In 2013, several new textile and garment plants began production in Vietnam. In addition, the anticipation of the proposed Trans-Pacific Partnership (TPP) reportedly prompted the implementation of numerous fiber and textile projects to prepare for the possibility of greater market access.[236] Also in 2013, significant investments were made to build several new textile and apparel facilities, including a $40 million factory to produce cotton yarn in Vietnam's southern province of Binh Doung, a new spandex production facility in the province of Dong Nai, and a $100 million denim plant in the northeastern province of Quang Nkinh.[237]

U.S. imports from South Asian suppliers Bangladesh and India also experienced significant growth, rising by $473 million (10 percent) and $468 million (7 percent), respectively, in 2013. Despite political uncertainty, factory safety problems, and labor disturbances in 2013, U.S.

[229] Donaldson, "Demand for Man-made Fibers Up and Growing," December 29, 2013.
[230] Beron, "Opportunities and Challenges in Asia's Apparel," February 12, 2014.
[231] Donaldson, "Rising Chinese Apparel Production Costs," December 3, 2013.
[232] Barrie, "US Apparel Imports from China," February 12, 2014.
[233] Beron, "Opportunities and Challenges in Asia's Apparel," February 12, 2014.
[234] USDOC, ITA, OTEXA, "Major Shippers Report," February 18, 2014.
[235] Textiles Intelligence, "Vietnam Aims to Become One of the Top Five," January 2, 2013.
[236] Barrie, "Vietnam: Textile and Garment Exports Soared," January 9, 2014.
[237] Fibre2Fashion, "Vietnamese Textile Sector Attracts Investment in 2013," January 16, 2014.

imports from Bangladesh continued to grow because the country's low labor costs help it to meet the global market's demand for competitively priced apparel. As a result, the Bangladesh textiles and apparel sector has been attracting business from international apparel brands and retailers such as Wal-Mart, JC Penney, the Gap, and others. [238] The growth in U.S. sector imports from India likely reflects the industry in India's efforts to upgrade its technology, focus on innovation in product and design, and improve training. [239]

[238] Islam, "Bangladesh: Apparel Exports Soars 20% in H1," January 14, 2014.
[239] Smith, "India: Garment Exports Continued to Rise," December 12, 2013.

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Transportation Equipment

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Change in 2013 from 2012:

U.S. trade deficit: Increased by $5.9 billion (8 percent) to $78.5 billion
U.S. exports: Increased by $7.3 billion (3 percent) to $293.0 billion
U.S. imports: Increased by $13.1 billion (4 percent) to $371.5 billion

In 2013 the U.S. trade deficit in transportation equipment increased for the fifth straight year, as import growth exceeded export growth by $5.9 billion (table TE.1). The expansion of the sectoral deficit was principally fueled by increased imports of motor vehicles and of aircraft, spacecraft, and related equipment (aircraft and related equipment), coupled with a $6.2 billion drop in exports of construction and mining equipment.

The United States maintained a trade deficit within the transportation equipment sector with four of its top five trading partners, including Canada, Mexico, Japan, and Germany; China was the lone exception. In 2013, the U.S. bilateral trade surplus with China for transportation equipment increased by $6.6 billion (more than 1,000 percent) to $7.2 billion, reflecting China's rapidly growing demand for aircraft and related equipment and, to a lesser extent, motor vehicles.

Table TE.1 Transportation equipment: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 2009–13

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. exports of domestic merchandise:							
Canada	44,447	57,243	63,354	67,427	68,452	1,025	1.5
Mexico	16,804	22,528	27,130	31,213	33,695	2,482	8.0
Japan	7,095	7,535	7,748	11,463	10,046	-1,417	-12.4
Germany	11,659	11,312	13,118	13,507	12,589	-917	-6.8
China	9,193	12,519	15,827	17,494	25,038	7,544	43.1
Korea	3,238	4,704	4,807	5,578	6,180	602	10.8
United Kingdom	8,208	8,818	9,933	9,574	10,932	1,358	14.2
France	9,161	7,677	7,828	8,261	8,524	263	3.2
Brazil	6,407	7,205	9,140	8,997	8,132	-865	-9.6
United Arab Em	5,487	4,136	6,245	10,647	9,298	-1,349	-12.7
All other	72,384	78,726	92,459	101,611	100,136	-1,475	-1.5
Total	194,082	222,403	257,589	285,772	293,023	7,251	2.5
EU-28	44,387	41,935	48,299	48,020	47,955	-65	-0.1
OPEC	18,164	17,730	20,677	29,266	27,735	-1,531	-5.2
Latin America	34,594	41,802	50,207	56,535	55,601	-934	-1.7
Asia	35,712	42,824	48,467	55,032	65,581	10,549	19.2
Sub-Saharan Africa	4,969	5,330	7,043	7,926	7,406	-520	-6.6
U.S. imports for consumption:							
Canada	43,301	58,922	64,420	73,230	71,358	-1,873	-2.6
Mexico	37,697	57,439	67,167	77,547	84,769	7,222	9.3
Japan	40,241	52,674	55,569	69,277	67,368	-1,909	-2.8
Germany	20,809	27,458	32,826	38,113	41,855	3,742	9.8
China	8,553	11,850	15,284	16,866	17,813	947	5.6
Korea	9,059	11,397	15,542	18,899	21,368	2,469	13.1
United Kingdom	7,690	9,367	10,859	12,667	12,943	276	2.2
France	9,478	10,588	10,638	11,494	12,618	1,123	9.8
Brazil	2,066	2,221	2,949	3,325	3,325	([a])	([b])
United Arab Em	7	13	29	37	159	122	328.5
All other	20,908	25,017	31,295	36,954	37,973	1,019	2.8
Total	199,808	266,946	306,579	358,409	371,548	13,138	3.7
EU-28	48,053	59,853	71,357	82,400	88,148	5,748	7.0
OPEC	25	35	48	60	182	122	202.6
Latin America	40,391	60,576	71,230	82,097	89,466	7,369	9.0
Asia	63,267	82,566	93,389	113,831	114,874	1,043	0.9
Sub-Saharan Africa	1,549	1,713	2,318	2,167	2,318	151	7.0

See footnote(s) at end of table.

Item	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
U.S. merchandise trade balance:							
Canada	1,146	-1,679	-1,065	-5,804	-2,906	2,898	49.9
Mexico	-20,892	-34,912	-40,037	-46,334	-51,074	-4,740	-10.2
Japan	-33,146	-45,138	-47,821	-57,814	-57,322	492	0.9
Germany	-9,150	-16,146	-19,707	-24,606	-29,265	-4,659	-18.9
China	640	669	543	628	7,225	6,597	1,050.5
Korea	-5,821	-6,694	-10,735	-13,321	-15,188	-1,867	-14.0
United Kingdom	518	-549	-926	-3,093	-2,011	1,081	35.0
France	-317	-2,911	-2,811	-3,233	-4,094	-861	-26.6
Brazil	4,341	4,985	6,190	5,672	4,808	-865	-15.2
United Arab Em	5,479	4,123	6,216	10,610	9,139	-1,471	-13.9
All other	51,476	53,709	61,164	64,657	62,164	-2,493	-3.9
Total	-5,726	-44,543	-48,989	-72,637	-78,525	-5,888	-8.1
EU-28	-3,665	-17,918	-23,058	-34,380	-40,193	-5,813	-16.9
OPEC	18,139	17,695	20,629	29,206	27,553	-1,652	-5.7
Latin America	-5,797	-18,774	-21,023	-25,562	-33,864	-8,303	-32.5
Asia	-27,555	-39,742	-44,923	-58,799	-49,293	9,507	16.2
Sub-Saharan Africa	3,420	3,618	4,725	5,759	5,088	-672	-11.7

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. The countries shown are those with the largest total U.S. trade (U.S. imports plus U.S. exports) in these products in the current year.

[a] Less than $500,000.

[b] Less than 0.05 percent.

Table TE.2 Transportation equipment: Leading changes in U.S. exports and imports, 2009–13

Item	Million $						
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
U.S. EXPORTS:							
Increases:							
Aircraft, spacecraft, and related equipment (TE013)	77,700	73,949	82,028	95,210	104,881	9,671	10.2
Motor vehicles (TE009)	35,963	48,940	59,454	65,669	69,557	3,888	5.9
Decreases:							
Construction and mining equipment (TE004)	19,777	22,010	27,971	29,959	23,729	-6,230	-20.8
Ships, tugs, pleasure boats, and similar vessels (TE014)	1,946	2,525	2,420	3,387	2,591	-796	-23.5
All other	58,697	74,979	85,716	91,548	92,265	717	0.8
Total	194,082	222,403	257,589	285,772	293,023	7,251	2.5
U.S. IMPORTS:							
Increases:							
Motor vehicles (TE009)	94,348	132,471	144,426	171,556	180,005	8,449	4.9
Aircraft, spacecraft, and related equipment (TE013)	18,339	18,931	21,546	24,107	29,080	4,973	20.6
Decreases:							
Construction and mining equipment (TE004)	6,345	8,213	12,935	16,302	13,727	-2,576	-15.8
Motors and engines, except internal combustion, aircraft, or electric (TE015)	2,240	2,431	3,358	4,466	3,629	-837	-18.7
All other	78,536	104,900	124,314	141,978	145,107	3,129	2.2
Total	199,808	266,946	306,579	358,409	371,548	13,138	3.7

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data. In 2009, 60 export commodity classification (schedule B) codes covering all civilian aircraft, engines, equipment, and parts were consolidated into a single code by the U.S. Census Bureau. This reclassification may have accounted for some of the shifts in exports in the transportation equipment sector.

U.S. Exports

The $7.3 billion (3 percent) increase in U.S. transportation equipment exports in 2013 to $293.0 billion was driven by a $9.7 billion increase in aircraft and related equipment, along with a $3.9 billion increase in motor vehicles (table TE.2). Exports of aircraft and related equipment, which represented more than one-third of total sectoral exports, primarily reflected U.S.-based Boeing's near-record global deliveries of jets and civil aircraft in 2013. The company delivered 648 jets in 2013, eclipsing its previous record of 620 from 1999. [240] The aircraft delivered in 2013 had been ordered by airlines and leasing companies in previous years, as the production time and waitlist for large civil aircraft can stretch from many months to several years. (While companies account for the sales differently, the trade value is registered only when the plane is delivered.) Airlines have been ordering more aircraft because of increasing traffic, as measured by revenue passenger miles. [241] Carriers have also taken advantage of lower borrowing costs to replace existing fleets with more fuel-efficient planes; Boeing is one of the world's leading manufacturers of these aircraft. [242]

China remained the largest export market for U.S. aircraft equipment in 2013. It registered both the largest absolute growth in aircraft equipment imports from the United States ($12.1 billion) and the largest percentage increase (53 percent). The country is already the world's second-largest aircraft market, and growing travel demand from within the country, along with an increase in air cargo, is translating into rapid growth in demand for aircraft. About half of China's new aircraft are supplied by Boeing. [243]

The growth in U.S. exports of motor vehicles principally resulted from increased demand for passenger vehicles in China, which has the world's largest passenger vehicle market. The $2.8 billion (51 percent) increase in U.S. exports of passenger vehicles to China during 2012–13 was the largest value gain recorded during the five-year period 2009–13 (see part II, "China," figure CN.2). In quantity, the United States exported 80,597 more passenger vehicles in 2013 than in 2012—a 49 percent increase–to reach 246,915 vehicles exported to China. China registered 17,929,000 passenger vehicles in 2013 (figure TE.1), so U.S. imports accounted for just over 1 percent of the Chinese market. Passenger car registrations in China increased 16 percent from the previous year and 74 percent over the 2009–13 period, as shown in figure TE.1, reflecting the country's increased wealth, better roads, and greater access to financing options. [244] Albeit from a small base, sales of U.S. vehicles in China increased by nearly 50 percent in 2013, as Chinese consumers began to choose U.S.-made vehicles over Japanese ones; sales of Japanese vehicles in China have declined since 2012, owing to an ongoing dispute over territory in the East China Sea. [245] Exports of motor vehicles to regional partners Canada

[240] Gates, "Boeing's 2013 Deliveries," January 6, 2014.

[241] IATA, "Passenger Demand Maintains Historic Growth Rates," February 6, 2014. "Revenue passenger miles" are calculated by multiplying the number of paying passengers by the length of the trip for each flight.

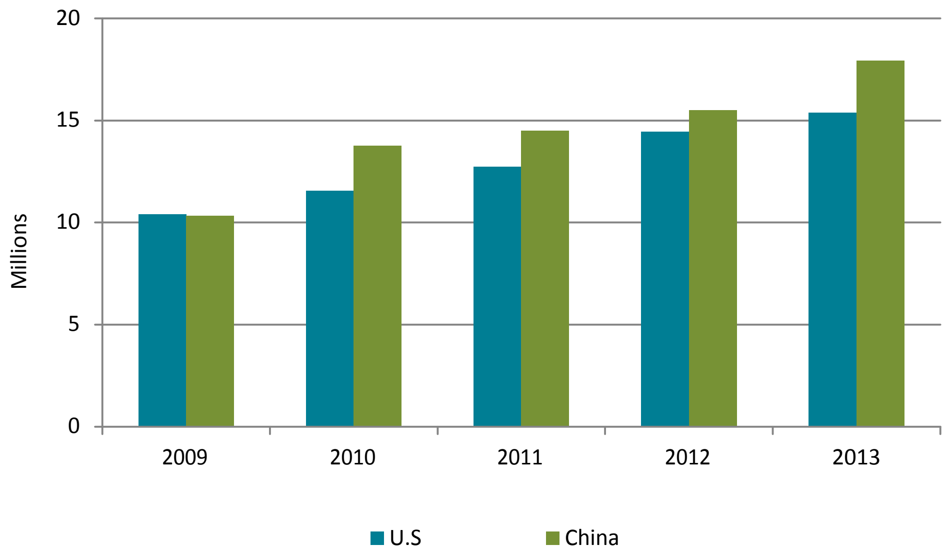
[242] IATA, "Passenger Demand Maintains Historic Growth Rates," February 6, 2014.

[243] Foley, "Boeing Turns," September 7, 2013.

[244] EIU, "Industry Report: Automotive, China," January 2014.

[245] Ibid.

Figure TE.1 Million of passenger car registrations: China overtook the U.S. to become the world's largest passenger car market during 2009–13



Source: EIU, "China: Automotive Report," January, 2014.

and Mexico also increased slightly, although these increases totaled only a combined $1.7 billion and remained consistent with growth during the previous five years. These markets remained significant destinations for U.S. motor vehicles, owing to the integration of the motor vehicle industry in North America stemming from NAFTA.

Strong export growth in the aircraft and motor vehicles sectors was tempered by a $6.2 billion (21 percent) reduction in U.S. exports of construction and mining equipment. These exports dropped to $23.7 billion in 2013, as exports to four of the United States' five leading markets fell by a combined $4.4 billion; more than two-thirds of this decline occurred in Australia and Canada. Reasons for the decrease varied, but included difficulties in securing skilled labor in these two markets in particular, along with rising input costs and a focus on completing projects delayed by the recent global economic recession.[246]

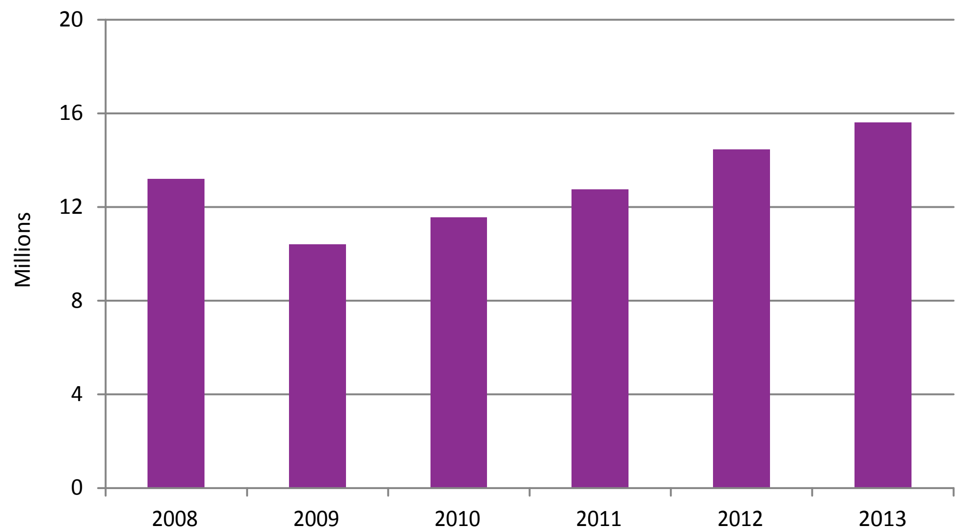
U.S. Imports

The largest contributors to the growth in U.S. imports of transportation equipment in 2013, in terms of absolute value, were the motor vehicle and aircraft equipment industries. Imports of the former rose by $8.4 billion (5 percent) to $180.0 billion, while imports of the latter grew by $5.0 billion (21 percent) to $29.0 billion. Relatively strong U.S. motor vehicle imports resulted,

[246] KPMG, *Global Construction Survey 2013*, 2013; ACA, AI, "Construction Outlook," October 2013.

in part, from wider access to credit; increased consumer confidence, stemming from the ongoing economic recovery; and improved household wealth, owing to declining unemployment rates and stock market gains. [247] In particular, sales of light motor vehicles in the United States increased by 8 percent to 15.6 million units during 2013, the highest level recorded since the economic recession [248] (figure TE.2).

Figure TE.2 New passenger vehicle registrations reached a four-year high in 2013



Source: EIU, "United States of America: Automotive Report," January, 2014.

Imported motor vehicles from Mexico and Germany, the United States' second- and fourth-leading suppliers of these goods in 2013, increased by 14 and 10 percent, respectively. Mexico has emerged as one of the leading destinations for motor vehicle production, due in large part to the country's relatively low labor costs and proximity to the large U.S. market, which imports these goods duty-free under NAFTA. Many of the world's largest manufacturers have recently established manufacturing facilities within the country, including Nissan, Mazda, and Honda. [249] German-based manufacturers enjoyed success in the United States during 2013 due to increased marketing campaigns and greater investments in new dealerships. These efforts may have translated into the nearly threefold increase seen in purchases of these vehicles—especially Volkswagens. [250]

[247] Isidore, "Car Sales," January 3, 2014.
[248] EIU, "Industry Report: Automotive, United States of America," January 2014.
[249] *Economist*, "Steaming Hot," November 15, 2013.
[250] EIU, "Industry Report: Automotive, United States of America," January, 2014.

Increased U.S. imports of aircraft and related equipment resulted from domestic carriers replacing their fleets with more fuel-efficient aircraft types. Many of these aircraft were produced by Airbus in Europe and Embraer in Brazil, and then exported to the United States.[251]

[251] Schlangenstein, "JetBlue Defers," October 29, 2013.

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Part IV
Special Topic Chapter

The use of value added offers researchers an innovative method for analyzing trade flows. This section gives an overview of the concept of value added as a measurement of trade, as well as relevant data sources. It also discusses how this information can help business officials, government representatives, and others gain new insights into the economics of global production as well as the sources and destinations of value in trade.

Value Added as a Measurement of Trade

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Most trade statistics, including those found earlier in this report, represent trade between countries on a "gross" basis. Under this approach, both the exporting country and the importing country simply record the total value of a good that has been traded. Statistics produced using this method are both the easiest to find and the easiest to understand, and they do accurately reflect total imports and exports between nations for many purposes.

However, such statistics do not fully account for global supply chains—in particular, for the way slices of value—goods or services—are added at each step of increasingly international manufacturing processes. These inputs, also known as "intermediates," may be anything from a circuit board added to a product, to the further processing of a half-assembled car, to the work of a testing service ensuring that a food ingredient meets national standards. It is not uncommon for one intermediate to be added in Country A, a second in Country B, and a third in Country C.

Because goods often cross multiple borders, intermediates may be counted several times when the gross method is used to calculate global trade flows. Analysts have recognized that attributing the entire export value to the last exporting country does not provide people with information on the source of value in global trade. In contrast, "value-added" international trade statistics reflect the value added at each step of the supply chain across national borders. The use of value-added statistics has become more routine for analyzing trade flows, although challenges remain—including a lack of data broken out at an intermediate input level by industry or country, as well as difficulties getting timely data. A brief introduction to the concept and its uses is presented below.

Definition of Value Added and Findings from Its Use in Trade Data

"Value added" can be defined at both the microeconomic and the macroeconomic levels. At the microeconomic level, it is defined as "the amount by which the value of a good . . . increases at a specific step in a production process." At the macroeconomic level, in the context of measuring exports, it is defined as "the value of national work performed (i.e., the contribution of all national factors of production) in a country's exports." [252] Export values calculated using the value-added method differ from official reported export values, which do not distinguish between "national" (domestic) inputs into a product and foreign inputs into that

[252] Sposi and Koech. "Value-Added Data Recast the U.S.-China Trade Deficit," July 2013; Benedetto, "Implications and Interpretations," July 2012. See also Maurer, "Trade in Value Added," April 14, 2011.

product.[253] For example, one microeconomic analysis attempted to calculate the percentage of contributions from Japan, the United States, and the Republic of Korea (Korea) contained in an Apple iPod music player sold in the United States after being assembled in China. The analysis estimated that at least 82 percent of the factory cost originated in Japan, the United States, and Korea, with China's contribution estimated at only 4 percent of the value. This breakdown would be reflected in trade statistics that are based on value-added calculations. Gross trade statistics, however, show 100 percent of the iPod's import value originating in China.[254]

One breakdown of the (macroeconomic) elements that make up a country's gross exports identifies three types of value added: (1) domestic (national) value added that will never reenter the domestic market, (2) domestic (national) value added that will eventually reenter in the form of imports, and (3) foreign value added that is incorporated into domestic exports. In contrast, a country's value-added export figures capture only the domestic value added that does not reenter the domestic market.[255] Under this definition, value-added imports are only the part of a country's imports that is foreign value added. The difference between gross and value-added measures of trade is that only the latter can reflect the actual supply chain processes in which goods cross national boundaries several times during a multinational production process.

Measuring trade in terms of value added leads to several discoveries. First, it reveals export values for some countries, including China, to be smaller than reported, because the value of imported inputs, which is included in official export figures, is now excluded.[256] In addition, it shows which countries account for the final demand for the production of each country (for use in consumption, investment, and government expenditures), because the value of production is traced through various stages across countries to its ultimate destination.[257] (It is often useful to distinguish such "final destination" countries from countries that import a good only to incorporate it into a product which they will then export.) Finally, the value-added approach provides more information on the contribution of various sectors to production for export.[258]

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[253] OECD and WTO, "Trade in Value-Added: Concepts, Methodologies and Challenges." See also Maurer, "Trade in Value Added," April 14, 2011.

[254] Dedrick, Kraemer, and Linden, "Who Profits From Innovation?" May 2008. See also Varian, "An iPod Has Global Value," June 28. 2007, and Dedrick, "Who Profits from Innovation?" March 21, 2012. Even the iPod packaging may have originated in the United States in the form of paper waste exported to China for reprocessing; McCormack, "U.S. Continues to Import," September 28, 2012.

There have been some critiques of the assumptions underlying the manufacturing locations of the iPod components examined in the study. See McMillion, "China Trade Apologists Know a 'Reality,'" October 21, 2011; Benedetto, "Implications and Interpretations of Value-Added Trade Balances," July 2012.

[255] Benedetto, "Implications and Interpretations of Value-Added Trade Balances," July 2012. See also Koopman et al., "Give Credit Where Credit Is Due," September 2010.

[256] CBO, "How Changes in the Value of the Chinese Currency," July 17, 2008.

[257] See Jones, Powers, and Ubee, "Making Global Value Chain Research More Accessible," October 2013.

[258] USITC, *The Economic Effects of Significant U.S. Import Restraints: Seventh Update*, 2011. See also Fujii-Gambero and Cervantes-Martínez, "Indirect Value Added in Mexico's Manufacturing Exports," March 2013.

Data and Data Sources for Value Added

A primary source for value-added trade data is the Trade in Value Added (TiVA) database, the product of a joint initiative of the Organisation for Economic Co-operation and Development (OECD) and the World Trade Organization (WTO).[259] As of May 2013, it had gathered data on more than 57 countries and economic entities and zones, such as the European Union (EU) and the Association of Southeast Asian Nations, and on 18 economic activities, such as mining and electrical equipment. TiVA takes its underlying data from highly aggregated input-output tables issued by the participating countries and economic entities; these tables reflect how much of the value of the industry's output is represented by inputs purchased from another industry.[260] The World Input-Output Database (WIOD) is another project that publishes global and national input-output tables using a set format.[261] Studies of high-visibility bilateral trade relationships have also benefited from using input-output tables made available by individual markets, including the United States,[262] China,[263] Japan,[264] and the EU and certain EU members.[265]

The Need for Value-Added Data and Challenges in its Use

Measuring trade on a value-added basis provides valuable insights to the sometimes intricate workings of global supply chains. This approach makes it easier to describe and analyze the various inputs and factors that result in products generated by the contemporary global supply chain. However, it is important to understand the limits on the underlying trade data when applying a value-added analysis. For example, while the TiVA database contains the most recently available data, most country's data are from 2011, thus yielding a lag of several years in the timeliness of the raw data and a still longer lag in the timeliness of data analysis. The gap widens further if analysis involves national input-output tables from countries with an even longer data lag. As a result, conclusions drawn from the data, and even ways in which the data can be analyzed, can be dated by anywhere from 3 to10 years, depending on the framework

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[259] Lewis, "Trade in Value-Added," December 3, 2013. See OECD, "OECD-WTO Database on Trade in Value-Added," n.d. (accessed various dates).

[260] CBO, "How Changes in the Value of the Chinese Currency," July 17, 2008. The OECD defines input-output tables as describing "the sale and purchase relationships between producers and consumers within an economy." OECD, "Measuring Trade in Value Added" (accessed various dates).

[261] Timmer, "The World Input-Output Database (WIOD)," April 2012. See http://www.wiod.org/new_site/database/wiots.htm.

[262] For input-output tables through 2012 produced by the Bureau of Economic Analysis in the U.S. Department of Commerce and the Bureau of Labor Statistics in the U.S. Department of Labor, see www.bea.gov/industry/index.htm and http://www.bls.gov/emp/ep_data_input_output_matrix.htm.

[263] For data through 2007, see http://www.purpleculture.net/china-inputoutput-tables-2007-p-4346/. See also Koopman, Wang, and Wei, "How Much of Chinese Exports," March 2008.

[264] For data through 2005, see http://www.stat.go.jp/english/data/io/index.htm.

[265] For data through 2011, see http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/database. See also Cappariello, "Domestic Value Added Content of Exports," February 2012.

and the purpose of the analysis.[266] For goods with dynamic supply chains, such a lag may result in analytic conclusions that no longer reflect current trade trends or policy initiatives.

In addition, difficulties exist in gathering value-added statistics. These include the reluctance of certain sources to release data that may be commercially sensitive; the lack of a common statistical framework; data assumptions that may understate the effects of international engagement on a domestic economy; and challenges in distinguishing between inputs and final goods.[267] A recent paper proposes a framework for addressing some of the data issues systematically, but considerable work remains to be done.[268]

Nevertheless, even analysis of the data currently available yields benefits in terms of a clearer understanding of bilateral trade. For example, a country's *global* trade balance is the same whether it is considered in light of gross trade statistics or value-added ones.[269] Measures of *bilateral* trade balances, though, can differ greatly, depending on the method used to calculate them. For example, the U.S. bilateral trade deficit with China is smaller when measured in trade in value added than when measured in gross trade, because China buys so many of the inputs for its exports from other countries.[270] However, U.S. bilateral trade deficits with many of those other countries are larger (or U.S. trade surpluses with them are smaller) when measured in trade in value added, since many U.S. imports from China incorporate the value of inputs originating in these countries.[271] Given the attention routinely accorded the U.S.-China trade deficit, a more detailed understanding of that deficit would enhance any analysis involving it.

Applying the value-added approach to trade in services might also suggest different levels of trade flows for goods and services trade than traditional measures show. An analysis using the TiVA database finds that trade in a particular good may have a sizable component of trade in related services affecting the data. Measuring trade in manufactured goods using the value-added method, the U.S. trade deficit in manufactured goods is significantly lower than the gross measure, although the overall U.S. trade deficit (in goods and services together) remains

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[266] *Economist*, "Value-Added Trade," January 19, 2013.

[267] Derviş, Meltzer, and Foda, "Value-Added Trade and Its Implications," April 2, 2013; Powers, "The Value of Value Added," November 2012. Some analysis has taken place that uses certain firm-level transaction data, such as that from the Annual Surveys of Industrial Firms conducted by China's National Bureau of Statistics, which covers all Chinese state-owned enterprises and non-state-owned companies that have sales of more than ¥5 million [$775,000] in a given year. See Kee and Tang, "Domestic Value Added in Chinese Exports," September 2012.

[268] Koopman, Wang, and Wei, "Tracing Value-Added and Double Counting," February 2014, 459–94.

[269] Benedetto, "Implications and Interpretations of Value-Added Trade Balances," July 2012.

[270] See Ma, Wang, and Zhu, "Domestic Value Added in China's Exports," May 2013.

[271] Derviş, Meltzer, and Foda, "Value-Added Trade and Its Implications," April 2, 2013. For examples of inputs to Chinese production, see Horowitz and Riker, "Measuring Shifts in Brazil's Trade," 2014; Wang, Powers, and Wei, "Value Chains in East Asian Production Networks," October 2009. See also Benedetto, "Implications and Interpretations of Value-Added Trade Balances," July 2012 (noting that the U.S. trade deficit with China would not greatly shrink if calculated using value added).

unchanged. [272] The lower calculated trade deficit in value added for manufactured goods results from foreign services that contribute to trade in manufactured goods, such as transportation, distribution, and finance services, which were previously categorized as manufactured imports but are now service sector imports in value-added terms. At the same time, the study found that the value created by services in the United States and incorporated directly or indirectly as inputs represented 27 percent of the total domestic value added in U.S. gross manufactured exports in 2009. For certain industrial classifications, such as wood and paper; food, beverages, and tobacco; and transport equipment, it is estimated that "more than one-third of the domestic value-added in exports comes from the services sector." [273]

Another analysis from a different perspective cautions against the use of value-added trade data when analyzing U.S. trade with China. The analysis contends that those data do not account in a timely fashion for the rapidly increasing domestic content in China's exports and may be affected by China's currency policies. [274]

[272] At the same time, under a value-added calculation, the U.S. surplus in trade in services becomes a deficit. The standard method calculates that in 2009 there was a 61-34 split among U.S. gross exports between the manufacturing sector and the services sector; using the alternative method, this becomes a 42-52 split. The change occurs because of the services used to facilitate and improve the links in the global production chain. Xu, "A Value-Added Perspective on U.S. International Trade," January 9, 2014.
[273] Xu, "A Value-Added Perspective on U.S. International Trade," January 9, 2014, section 3, "The Rising Role of Services in Manufacturing Trade."
[274] Scott, "Value-Added Analysis of Trade with China," June 27, 2013.

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Appendix A
U.S. Trade by Industry Group and Subgroup

Table A.1 Agricultural products: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group		Million $					
	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
AG001 Certain miscellaneous animals and meats							
Exports	2,308	2,500	2,916	2,808	2,990	182	6.5
Imports	1,747	1,738	2,020	2,099	2,234	134	6.4
Trade balance	561	762	896	709	757	48	6.8
AG002 Cattle and beef							
Exports	2,817	3,873	5,222	5,627	6,089	462	8.2
Imports	3,784	4,314	4,457	5,353	5,417	64	1.2
Trade balance	-967	-442	766	273	672	399	145.9
AG003 Swine and pork							
Exports	3,645	4,003	5,263	5,498	5,116	-381	-6.9
Imports	1,020	1,292	1,367	1,354	1,499	145	10.7
Trade balance	2,625	2,711	3,895	4,144	3,617	-527	-12.7
AG004 Sheep and meat of sheep							
Exports	34	28	27	20	21	1	4.5
Imports	434	512	659	552	568	15	2.8
Trade balance	-400	-484	-632	-532	-546	-14	-2.7
AG005 Poultry							
Exports	4,297	4,298	5,009	5,535	5,594	59	1.1
Imports	263	301	310	373	403	30	8.1
Trade balance	4,034	3,997	4,699	5,162	5,191	29	0.6
AG006 Fresh or frozen fish							
Exports	2,326	2,649	3,343	3,185	3,275	90	2.8
Imports	4,880	5,432	5,981	6,396	6,670	274	4.3
Trade balance	-2,554	-2,783	-2,638	-3,211	-3,395	-185	-5.7
AG007 Canned fish							
Exports	251	234	264	269	279	10	3.8
Imports	1,090	1,215	1,334	1,557	1,548	-9	-0.6
Trade balance	-839	-981	-1,069	-1,287	-1,268	19	1.5
AG008 Cured and other fish							
Exports	194	229	243	273	288	15	5.5
Imports	443	468	518	548	537	-11	-2.0
Trade balance	-249	-239	-275	-274	-248	26	9.5

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
AG009 Shellfish							
Exports	1,035	1,179	1,489	1,501	1,500	-1	[a]
Imports	6,587	7,469	8,704	8,055	9,140	1,085	13.5
Trade balance	-5,552	-6,290	-7,215	-6,555	-7,640	-1,085	-16.6
AG010 Dairy products							
Exports	2,020	3,441	4,490	4,810	6,382	1,572	32.7
Imports	1,977	1,984	2,277	2,503	2,425	-78	-3.1
Trade balance	43	1,457	2,213	2,307	3,957	1,650	71.5
AG011 Eggs							
Exports	347	358	408	483	610	127	26.4
Imports	30	40	42	43	42	-1	-2.8
Trade balance	317	319	366	440	568	128	29.2
AG012 Sugar and other sweeteners							
Exports	687	1,101	1,334	1,484	1,351	-132	-8.9
Imports	1,905	2,744	3,734	3,311	2,707	-604	-18.2
Trade balance	-1,218	-1,643	-2,400	-1,827	-1,356	471	25.8
AG012A Sugar							
Exports	137	231	273	259	270	11	4.2
Imports	1,246	2,046	2,867	2,351	1,678	-673	-28.6
Trade balance	-1,109	-1,815	-2,594	-2,092	-1,408	684	32.7
AG012B High fructose corn sweetener							
Exports	257	511	597	784	616	-167	-21.4
Imports	92	104	108	120	134	13	11.2
Trade balance	165	407	489	664	483	-181	-27.3
AG013 Animal feeds							
Exports	8,498	9,677	10,103	12,476	14,525	2,050	16.4
Imports	1,290	1,472	2,067	2,671	2,910	239	9.0
Trade balance	7,208	8,204	8,036	9,805	11,616	1,811	18.5
AG014 Live plants							
Exports	190	197	208	218	242	24	11.1
Imports	487	524	549	525	552	28	5.2
Trade balance	-297	-327	-341	-307	-310	-3	-1.1
AG015 Seeds							
Exports	1,190	1,292	1,460	1,559	1,644	86	5.5
Imports	792	813	941	1,302	1,542	240	18.4
Trade balance	398	479	519	257	103	-154	-60.0

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
AG015A Grass Seed							
Exports	315	357	454	447	475	28	6.2
Imports	141	124	142	164	184	20	12.2
Trade balance	173	234	312	284	291	8	2.8
AG015B Fruit Seed							
Exports	51	55	66	53	50	-3	-5.7
Imports	41	46	56	66	68	2	3.0
Trade balance	10	8	10	-13	-18	-5	-37.7
AG015C Vegetable Seeds							
Exports	457	490	519	495	473	-23	-4.6
Imports	309	340	409	495	486	-9	-1.9
Trade balance	148	150	110	[b]	-13	-13	[c]
AG015D Grain Seeds							
Exports	255	235	275	343	423	79	23.1
Imports	253	240	262	469	671	202	43.1
Trade balance	1	-5	12	-126	-249	-123	-97.5
AG015E Sugar Beet Seed							
Exports	4	4	5	5	4	-1	-17.2
Imports	[b]	1	5	[b]	[b]	[b]	-8.4
Trade balance	3	4	[b]	5	4	-1	-18.0
AG015F Oilseed Seeds							
Exports	107	148	139	213	218	5	2.4
Imports	46	62	65	106	132	26	24.6
Trade balance	61	86	73	107	86	-21	-19.7
AG015G Tobacco Seeds							
Exports	2	2	2	2	2	[b]	-3.7
Imports	1	[b]	1	2	[b]	-1	-68.7
Trade balance	2	2	1	[b]	1	1	495.4
AG016 Cut flowers							
Exports	39	37	33	26	23	-3	-11.4
Imports	768	847	881	968	1,000	32	3.3
Trade balance	-728	-810	-848	-942	-978	-35	-3.7
AG017 Miscellaneous vegetable substances							
Exports	822	872	902	1,007	915	-92	-9.1
Imports	1,280	1,465	2,349	5,042	3,426	-1,617	-32.1
Trade balance	-458	-593	-1,447	-4,035	-2,510	1,525	37.8

USITC code and industry/commodity group	Million $						Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
AG018 Fresh, chilled, or frozen vegetables							
Exports	2,005	2,179	2,338	2,265	2,471	206	9.1
Imports	4,800	5,846	6,490	6,513	7,366	854	13.1
Trade balance	-2,796	-3,668	-4,151	-4,247	-4,895	-648	-15.3
AG019 Prepared or preserved vegetables, mushrooms, and olives							
Exports	2,446	2,567	2,794	3,197	3,426	229	7.2
Imports	2,736	2,894	3,199	3,430	3,379	-51	-1.5
Trade balance	-290	-327	-405	-233	47	280	[c]
AG020 Edible nuts							
Exports	4,024	4,756	5,679	6,870	8,345	1,475	21.5
Imports	1,275	1,463	1,865	1,998	1,997	-1	[a]
Trade balance	2,749	3,293	3,815	4,872	6,348	1,475	30.3
AG021 Tropical fruit							
Exports	70	101	107	153	174	21	13.6
Imports	3,130	3,301	3,836	3,974	4,376	402	10.1
Trade balance	-3,060	-3,201	-3,729	-3,821	-4,202	-381	-10.0
AG022 Citrus fruit							
Exports	832	998	1,115	1,136	1,146	10	0.8
Imports	683	776	838	862	969	107	12.4
Trade balance	149	222	277	274	177	-97	-35.6
AG023 Deciduous fruit							
Exports	1,396	1,550	1,771	2,040	1,989	-51	-2.5
Imports	372	424	392	373	461	88	23.6
Trade balance	1,024	1,126	1,379	1,667	1,528	-139	-8.3
AG024 Other fresh fruit							
Exports	1,326	1,435	1,640	1,782	1,920	139	7.8
Imports	2,302	2,803	2,659	2,941	3,236	295	10.0
Trade balance	-976	-1,368	-1,019	-1,160	-1,316	-156	-13.4
AG025 Dried fruit other than tropical							
Exports	533	608	710	689	674	-15	-2.2
Imports	180	183	207	218	214	-4	-1.7
Trade balance	353	426	503	471	460	-11	-2.4
AG026 Frozen fruit							
Exports	130	148	191	210	217	7	3.4
Imports	348	393	526	624	631	6	1.0
Trade balance	-218	-244	-335	-414	-413	1	0.2

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
AG027 Prepared or preserved fruit							
Exports	365	412	515	522	582	60	11.4
Imports	1,213	1,320	1,523	1,631	1,779	148	9.1
Trade balance	-848	-909	-1,008	-1,109	-1,197	-88	-7.9
AG028 Coffee and tea							
Exports	819	945	1,206	1,352	1,305	-47	-3.5
Imports	4,509	5,469	8,666	7,618	6,441	-1,177	-15.4
Trade balance	-3,690	-4,524	-7,460	-6,266	-5,137	1,130	18.0
AG029 Spices							
Exports	117	122	131	148	153	5	3.4
Imports	729	872	1,124	1,197	1,275	78	6.5
Trade balance	-612	-750	-992	-1,048	-1,122	-73	-7.0
AG030 Cereals							
Exports	17,240	19,930	28,110	20,347	19,866	-481	-2.4
Imports	1,808	1,610	1,930	2,637	3,437	799	30.3
Trade balance	15,432	18,320	26,180	17,709	16,429	-1,280	-7.2
AG031 Milled grains, malts, and starches							
Exports	824	736	769	817	767	-51	-6.2
Imports	957	982	1,089	1,114	1,271	157	14.1
Trade balance	-132	-246	-319	-297	-504	-208	-70.0
AG032 Oilseeds							
Exports	16,780	18,936	17,875	25,040	21,794	-3,245	-13.0
Imports	668	647	870	843	1,418	576	68.3
Trade balance	16,112	18,289	17,005	24,197	20,376	-3,821	-15.8
AG033 Animal or vegetable fats and oils							
Exports	3,354	4,484	4,729	4,433	3,591	-842	-19.0
Imports	3,779	4,306	6,558	5,965	5,813	-152	-2.5
Trade balance	-425	177	-1,829	-1,532	-2,222	-691	-45.1
AG034 Pasta, cereals, and other bakery goods							
Exports	2,489	2,708	3,024	3,382	3,642	260	7.7
Imports	3,971	4,415	4,888	5,127	5,381	254	5.0
Trade balance	-1,482	-1,706	-1,863	-1,745	-1,739	6	0.4
AG035 Sauces, condiments, and soups							
Exports	1,172	1,285	1,412	1,575	1,740	166	10.5
Imports	964	1,030	1,156	1,229	1,282	52	4.2
Trade balance	208	255	256	345	459	114	32.9

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
AG036 Infant formulas, malt extracts, and other edible preparations							
Exports	3,786	4,174	4,815	5,415	6,065	650	12.0
Imports	1,615	1,930	2,109	2,267	2,464	197	8.7
Trade balance	2,171	2,244	2,706	3,148	3,602	453	14.4
AG037 Cocoa, chocolate, and confectionery							
Exports	1,384	1,530	1,799	1,976	2,174	198	10.0
Imports	4,659	5,599	6,096	5,578	5,717	139	2.5
Trade balance	-3,275	-4,069	-4,296	-3,602	-3,543	59	1.7
AG038 Fruit and vegetable juices							
Exports	990	1,084	1,247	1,212	1,233	20	1.7
Imports	1,357	1,402	1,944	1,844	1,854	10	0.5
Trade balance	-367	-317	-697	-632	-621	11	1.7
AG039 Nonalcoholic beverages, excluding fruit and vegetable juices							
Exports	887	886	1,024	1,169	1,302	133	11.4
Imports	1,626	1,789	2,030	2,406	2,589	183	7.6
Trade balance	-739	-902	-1,006	-1,237	-1,287	-50	-4.0
AG040 Malt beverages							
Exports	306	327	365	446	517	71	15.8
Imports	3,325	3,493	3,551	3,683	3,685	2	0.1
Trade balance	-3,020	-3,166	-3,187	-3,236	-3,168	68	2.1
AG041 Wine and certain other fermented beverages							
Exports	860	1,064	1,293	1,336	1,555	219	16.4
Imports	4,039	4,306	4,901	5,151	5,353	202	3.9
Trade balance	-3,180	-3,242	-3,608	-3,816	-3,799	17	0.4
AG042 Distilled spirits							
Exports	1,051	1,175	1,361	1,501	1,533	32	2.1
Imports	4,810	5,218	5,770	6,067	6,417	350	5.8
Trade balance	-3,759	-4,042	-4,409	-4,566	-4,883	-318	-7.0
AG043 Unmanufactured tobacco							
Exports	1,160	1,167	1,149	1,098	1,141	43	3.9
Imports	900	720	737	885	952	67	7.6
Trade balance	260	447	412	213	189	-24	-11.1
AG044 Cigars and certain other manufactured tobacco							
Exports	76	83	105	166	197	31	19.0
Imports	475	532	590	673	765	92	13.7
Trade balance	-399	-450	-484	-508	-568	-61	-12.0

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
AG045 Cigarettes							
Exports	414	371	383	317	288	-28	-8.9
Imports	156	137	125	137	147	10	7.2
Trade balance	258	234	258	179	141	-38	-21.2
AG046 Hides, skins, and leather							
Exports	1,812	2,827	3,248	3,156	3,662	506	16.0
Imports	450	593	609	674	699	24	3.6
Trade balance	1,362	2,233	2,639	2,482	2,964	482	19.4
AG047 Furskins							
Exports	182	265	397	575	665	90	15.7
Imports	102	142	166	207	265	58	28.2
Trade balance	80	123	230	368	400	32	8.6
AG048 Wool and other animal hair							
Exports	21	24	24	18	24	6	32.3
Imports	20	20	35	34	28	-6	-18.1
Trade balance	2	3	-11	-16	-4	12	74.7
AG049 Cotton, not carded or combed							
Exports	3,384	5,746	8,424	6,246	5,589	-657	-10.5
Imports	[b]	1	16	7	7	[b]	-1.2
Trade balance	3,384	5,744	8,408	6,239	5,582	-657	-10.5
AG050 Ethyl alcohol for nonbeverage purposes							
Exports	245	883	3,260	1,927	1,567	-359	-18.6
Imports	564	326	903	1,839	1,412	-427	-23.2
Trade balance	-318	556	2,357	87	155	68	77.4

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a] Less than 0.05 percent.

[b] Less than $500,000.

[c] Not meaningful for purposes of comparison.

Table A.2 Chemicals and related products: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group		Million $					Percent change, 2012–13
	2009	2010	2011	2012	2013	Absolute change, 2012–13	
CH001 Major primary olefins							
Exports	439	587	887	620	659	39	6.3
Imports	5,931	10,496	13,079	11,148	9,258	-1,889	-16.9
Trade balance	-5,493	-9,909	-12,192	-10,527	-8,599	1,928	18.3
CH002 Other olefins							
Exports	430	623	676	629	535	-93	-14.8
Imports	375	473	630	696	686	-10	-1.4
Trade balance	56	150	47	-67	-150	-83	-124.5
CH003 Primary aromatics							
Exports	531	816	1,161	1,053	738	-315	-29.9
Imports	2,054	2,992	3,951	4,524	4,705	181	4.0
Trade balance	-1,523	-2,176	-2,790	-3,472	-3,968	-496	-14.3
CH004 Organic commodity chemicals							
Exports	3,633	5,073	6,047	6,499	7,134	636	9.8
Imports	2,104	3,139	3,811	3,414	3,858	444	13.0
Trade balance	1,529	1,935	2,236	3,085	3,277	192	6.2
CH005 Organic specialty chemicals							
Exports	6,956	9,739	9,449	9,396	9,421	24	0.3
Imports	7,805	8,580	10,620	11,111	12,019	909	8.2
Trade balance	-849	1,160	-1,171	-1,714	-2,599	-884	-51.6
CH006 Certain organic chemicals							
Exports	13,339	17,679	20,754	20,315	20,302	-14	-0.1
Imports	6,663	9,072	11,261	10,659	10,894	235	2.2
Trade balance	6,675	8,607	9,493	9,656	9,408	-248	-2.6
CH007 Miscellaneous inorganic chemicals							
Exports	9,059	11,379	12,613	12,822	12,458	-365	-2.8
Imports	6,388	8,314	11,000	10,218	9,352	-866	-8.5
Trade balance	2,671	3,066	1,613	2,604	3,106	502	19.3
CH008 Inorganic acids							
Exports	535	657	909	849	891	43	5.0
Imports	496	529	679	735	676	-59	-8.1
Trade balance	38	128	230	113	215	102	90.0

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
CH009 Chlor-alkali chemicals							
Exports	1,601	1,583	2,123	2,393	2,362	-31	-1.3
Imports	453	355	487	405	427	22	5.5
Trade balance	1,149	1,228	1,637	1,988	1,935	-53	-2.7
CH010 Fertilizers							
Exports	3,684	3,941	5,429	4,984	4,473	-511	-10.3
Imports	7,373	11,801	16,763	16,791	15,549	-1,242	-7.4
Trade balance	-3,689	-7,860	-11,334	-11,807	-11,076	731	6.2
CH011 Paints, inks, and related items, and certain components thereof							
Exports	5,195	6,937	8,185	7,542	7,166	-376	-5.0
Imports	2,151	2,744	3,168	3,377	3,491	114	3.4
Trade balance	3,044	4,193	5,017	4,165	3,676	-489	-11.8
CH012 Synthetic organic pigments							
Exports	329	445	425	375	336	-39	-10.5
Imports	330	494	526	530	532	2	0.4
Trade balance	-1	-48	-101	-155	-197	-42	-26.8
CH013 Synthetic dyes and azoic couplers							
Exports	300	379	414	391	452	61	15.6
Imports	260	380	367	390	397	8	2.0
Trade balance	40	-1	47	1	54	53	4,461.8
CH014 Synthetic tanning agents							
Exports	19	24	22	23	24	1	3.3
Imports	6	8	9	9	10	1	13.9
Trade balance	13	16	13	14	14	[a]	-3.2
CH015 Natural tanning and dyeing materials							
Exports	67	78	81	88	83	-5	-5.9
Imports	122	138	146	186	182	-4	-2.0
Trade balance	-55	-60	-65	-98	-99	-1	-1.5
CH016 Photographic chemicals and preparations							
Exports	610	803	693	700	693	-7	-1.0
Imports	343	394	402	359	337	-22	-6.0
Trade balance	267	409	291	341	356	15	4.3
CH017 Pesticide products and formulations							
Exports	3,737	4,507	4,310	4,604	5,212	608	13.2
Imports	2,249	2,169	2,946	3,396	3,830	434	12.8
Trade balance	1,488	2,338	1,364	1,208	1,382	174	14.4

USITC code and industry/commodity group		Million $						Percent change, 2012–13
		2009	2010	2011	2012	2013	Absolute change, 2012–13	
CH018	Adhesives and glues							
	Exports	997	1,257	1,333	1,386	1,402	16	1.2
	Imports	276	315	332	356	385	29	8.3
	Trade balance	721	942	1,002	1,031	1,017	-13	-1.3
CH019	Medicinal chemicals							
	Exports	46,359	47,304	45,928	48,673	48,232	-441	-0.9
	Imports	82,417	86,603	92,732	88,771	85,477	-3,294	-3.7
	Trade balance	-36,057	-39,299	-46,805	-40,098	-37,245	2,853	7.1
CH020	Essential oils and other flavoring materials							
	Exports	1,816	2,055	2,216	2,355	2,459	104	4.4
	Imports	2,940	3,141	3,395	3,376	3,675	299	8.9
	Trade balance	-1,124	-1,085	-1,180	-1,021	-1,216	-195	-19.1
CH021	Perfumes, cosmetics, and toiletries							
	Exports	5,911	6,600	6,892	7,495	7,897	402	5.4
	Imports	4,738	5,492	6,237	6,864	7,574	710	10.3
	Trade balance	1,173	1,108	655	631	324	-308	-48.7
CH022	Soaps, detergents, and surface-active agents							
	Exports	4,409	5,115	5,566	5,809	5,927	118	2.0
	Imports	1,737	2,026	2,269	2,480	2,620	140	5.6
	Trade balance	2,672	3,089	3,298	3,329	3,307	-22	-0.7
CH023	Miscellaneous chemicals and specialties							
	Exports	5,155	5,730	6,777	6,844	7,029	186	2.7
	Imports	3,507	4,310	5,202	4,997	6,154	1,157	23.2
	Trade balance	1,648	1,420	1,575	1,847	875	-971	-52.6
CH024	Explosives, propellant powders, and related items							
	Exports	575	732	720	766	750	-16	-2.1
	Imports	512	608	626	642	644	3	0.4
	Trade balance	63	124	95	125	106	-19	-15.1
CH025	Polyethylene resins in primary forms							
	Exports	6,236	6,959	7,495	7,370	7,736	367	5.0
	Imports	2,454	3,330	4,118	3,812	4,257	445	11.7
	Trade balance	3,781	3,630	3,377	3,557	3,479	-79	-2.2
CH026	Polypropylene resins in primary forms							
	Exports	2,659	3,085	3,442	3,133	3,162	29	0.9
	Imports	162	255	304	360	413	53	14.8
	Trade balance	2,498	2,830	3,137	2,774	2,750	-24	-0.9

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
CH027 Polyvinyl chloride resins in primary forms							
Exports	2,228	3,149	3,500	3,402	3,376	-27	-0.8
Imports	247	368	472	452	432	-20	-4.3
Trade balance	1,981	2,781	3,028	2,950	2,943	-7	-0.2
CH028 Styrene polymers in primary forms							
Exports	1,000	1,307	1,441	1,437	1,413	-24	-1.7
Imports	653	862	989	1,145	1,168	23	2.0
Trade balance	347	446	452	292	245	-47	-16.1
CH029 Saturated polyester resins							
Exports	963	1,346	1,353	1,377	1,419	42	3.1
Imports	873	960	1,351	1,387	1,451	64	4.6
Trade balance	90	387	2	-10	-32	-22	-208.2
CH030 Other plastics in primary forms							
Exports	10,412	14,512	16,134	15,771	16,217	446	2.8
Imports	3,377	4,606	5,030	5,503	5,599	96	1.7
Trade balance	7,034	9,906	11,104	10,268	10,618	350	3.4
CH031 Synthetic rubber							
Exports	2,697	3,734	4,792	4,637	3,976	-661	-14.3
Imports	1,178	1,816	2,507	2,604	2,212	-392	-15.0
Trade balance	1,519	1,918	2,285	2,033	1,764	-269	-13.2
CH032 Tires and tubes							
Exports	3,799	4,385	5,423	5,891	5,465	-426	-7.2
Imports	8,229	10,806	13,411	14,752	14,687	-65	-0.4
Trade balance	-4,429	-6,421	-7,989	-8,861	-9,222	-361	-4.1
CH033 Miscellaneous plastic products							
Exports	17,719	21,235	23,108	23,755	24,568	813	3.4
Imports	19,328	22,956	25,279	27,344	28,821	1,477	5.4
Trade balance	-1,609	-1,721	-2,171	-3,589	-4,253	-664	-18.5
CH034 Miscellaneous rubber products							
Exports	2,442	3,121	3,500	3,880	3,936	56	1.4
Imports	3,331	4,491	5,153	5,713	5,849	135	2.4
Trade balance	-890	-1,370	-1,653	-1,833	-1,913	-80	-4.4
CH035 Gelatin							
Exports	62	65	88	100	109	9	8.9
Imports	179	181	205	265	305	40	15.1
Trade balance	-117	-116	-116	-165	-196	-31	-18.9

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
CH036 Natural rubber							
Exports	45	83	94	87	64	-22	-25.8
Imports	1,274	2,820	4,772	3,382	2,557	-825	-24.4
Trade balance	-1,228	-2,737	-4,678	-3,295	-2,492	803	24.4

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a]Less than $500,000.

Table A.3 Electronic products: U.S. trade for industry/commodity groups and subgroups, 2009–13

	Million $						
USITC code and industry/commodity group	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
EL001 Office machines							
Exports	759	724	675	589	517	-73	-12.3
Imports	1,487	1,564	1,579	1,521	1,492	-30	-2.0
Trade balance	-727	-839	-904	-932	-975	-43	-4.6
EL002 Telecommunications equipment							
Exports	13,421	13,605	14,619	15,156	16,260	1,105	7.3
Imports	60,299	74,065	79,771	83,831	89,161	5,330	6.4
Trade balance	-46,878	-60,460	-65,152	-68,675	-72,900	-4,225	-6.2
EL003 Consumer electronics							
Exports	3,965	4,785	5,092	4,794	4,553	-242	-5.0
Imports	47,186	51,031	46,343	47,714	42,936	-4,779	-10.0
Trade balance	-43,221	-46,246	-41,251	-42,920	-38,383	4,537	10.6
EL003A Television receivers and video monitors							
Exports	1,223	1,540	1,718	1,374	1,214	-160	-11.6
Imports	29,751	31,125	27,552	27,560	24,235	-3,325	-12.1
Trade balance	-28,528	-29,585	-25,834	-26,186	-23,021	3,165	12.1
EL004 Blank and prerecorded media							
Exports	3,567	3,560	3,371	3,464	3,215	-248	-7.2
Imports	3,799	3,814	4,106	4,256	4,665	409	9.6
Trade balance	-232	-254	-736	-792	-1,449	-657	-83.0
EL005 Navigational instruments and remote control apparatus							
Exports	2,558	2,768	3,317	3,356	3,830	474	14.1
Imports	5,501	5,341	5,405	6,390	5,987	-403	-6.3
Trade balance	-2,943	-2,573	-2,088	-3,035	-2,157	877	28.9
EL006 Radio and television broadcasting equipment							
Exports	989	1,090	1,075	961	870	-91	-9.5
Imports	2,279	2,734	2,895	3,337	3,060	-277	-8.3
Trade balance	-1,290	-1,645	-1,820	-2,376	-2,190	186	7.8
EL007 Electric sound and visual signaling apparatus							
Exports	1,243	1,295	1,357	1,379	1,340	-39	-2.8
Imports	2,455	2,821	3,018	2,970	3,109	139	4.7
Trade balance	-1,212	-1,526	-1,662	-1,592	-1,769	-178	-11.2

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
EL008 Electrical capacitors and resistors							
Exports	1,172	1,254	1,204	1,291	1,317	27	2.1
Imports	1,586	2,296	2,323	2,322	2,428	107	4.6
Trade balance	-414	-1,042	-1,119	-1,031	-1,111	-80	-7.7
EL009 Printed circuits							
Exports	1,141	1,325	1,200	1,299	1,303	5	0.4
Imports	1,479	1,841	1,883	1,853	1,862	9	0.5
Trade balance	-338	-516	-683	-554	-559	-4	-0.8
EL010 Circuit apparatus exceeding 1000V							
Exports	576	649	748	785	748	-37	-4.7
Imports	465	523	687	775	708	-67	-8.7
Trade balance	111	126	61	9	40	31	326.6
EL011 Circuit apparatus not exceeding 1000V							
Exports	5,032	5,859	6,106	6,494	6,768	274	4.2
Imports	5,727	7,911	8,430	9,180	9,555	375	4.1
Trade balance	-694	-2,051	-2,324	-2,686	-2,788	-102	-3.8
EL012 Circuit apparatus assemblies							
Exports	2,206	2,427	2,788	3,338	3,798	460	13.8
Imports	4,228	5,446	6,216	7,471	8,589	1,118	15.0
Trade balance	-2,022	-3,019	-3,428	-4,133	-4,791	-658	-15.9
EL013 Parts of circuit apparatus							
Exports	1,864	2,442	2,679	2,851	2,837	-14	-0.5
Imports	1,424	2,037	2,402	2,662	2,767	105	3.9
Trade balance	440	405	276	189	70	-119	-62.8
EL014 Electron tubes							
Exports	262	320	273	242	220	-22	-9.0
Imports	267	294	348	343	309	-34	-9.9
Trade balance	-5	25	-76	-101	-89	12	11.8
EL015 Semiconductors and integrated circuits							
Exports	25,058	31,267	29,188	26,436	26,075	-361	-1.4
Imports	21,190	29,134	37,624	37,358	38,025	667	1.8
Trade balance	3,869	2,133	-8,437	-10,922	-11,950	-1,027	-9.4
EL016 Miscellaneous electrical equipment							
Exports	1,744	2,066	2,329	2,629	2,586	-43	-1.6
Imports	3,638	5,587	6,841	6,105	6,376	271	4.4
Trade balance	-1,894	-3,521	-4,512	-3,476	-3,790	-314	-9.0

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
EL017 Computers, peripherals, and parts							
Exports	19,837	20,592	20,332	21,086	20,111	-975	-4.6
Imports	95,391	118,898	121,300	123,283	121,329	-1,955	-1.6
Trade balance	-75,554	-98,306	-100,968	-102,198	-101,218	980	1.0
EL018 Photographic film and paper							
Exports	2,091	2,034	1,996	1,793	1,801	8	0.4
Imports	1,067	1,056	999	804	756	-48	-5.9
Trade balance	1,023	978	998	990	1,045	55	5.6
EL019 Optical fibers, optical fiber bundles and cables							
Exports	906	982	893	1,165	1,104	-61	-5.2
Imports	481	589	676	776	783	7	1.0
Trade balance	425	392	217	389	321	-68	-17.5
EL020 Optical goods, including ophthalmic goods							
Exports	4,447	5,489	5,636	5,460	5,477	17	0.3
Imports	6,632	8,095	8,805	9,275	9,466	191	2.1
Trade balance	-2,184	-2,606	-3,169	-3,814	-3,989	-174	-4.6
EL021 Photographic cameras and equipment							
Exports	1,301	1,550	1,578	1,511	1,452	-58	-3.9
Imports	842	928	891	873	853	-21	-2.4
Trade balance	459	622	687	638	600	-38	-5.9
EL022 Medical goods							
Exports	28,647	30,604	32,298	33,471	33,440	-31	-0.1
Imports	25,928	29,219	31,796	32,639	34,131	1,492	4.6
Trade balance	2,719	1,384	502	832	-691	-1,523	[a]
EL023 Watches and clocks							
Exports	356	381	453	396	356	-40	-10.1
Imports	3,000	3,592	4,372	4,643	4,833	189	4.1
Trade balance	-2,643	-3,211	-3,919	-4,247	-4,476	-229	-5.4
EL024 Drawing, drafting, and calculating instruments							
Exports	543	605	594	562	427	-134	-23.9
Imports	158	206	242	270	272	2	0.8
Trade balance	385	399	351	291	155	-137	-46.9

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
EL025 Measuring, testing, and controlling instruments							
Exports	19,251	22,161	24,738	26,496	26,569	73	0.3
Imports	14,912	18,592	21,639	23,115	23,777	662	2.9
Trade balance	4,339	3,569	3,099	3,381	2,793	-589	-17.4

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.
[a]Not meaningful for purposes of comparison.

Table A.4 Energy-related products: U.S. trade for industry/commodity groups and subgroups, 2009–13

	Million $						
USITC code and industry/commodity group	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
EP001 Electrical energy							
Exports	575	648	391	233	327	94	40.5
Imports	2,071	2,071	2,096	1,914	2,293	380	19.8
Trade balance	-1,495	-1,423	-1,705	-1,681	-1,966	-285	-17.0
EP002 Nuclear materials							
Exports	2,235	1,886	1,948	1,518	1,103	-416	-27.4
Imports	4,454	5,025	4,943	4,171	3,845	-325	-7.8
Trade balance	-2,219	-3,139	-2,996	-2,652	-2,743	-90	-3.4
EP003 Coal, coke, and related chemical products							
Exports	8,079	12,612	19,471	17,779	13,665	-4,115	-23.1
Imports	4,123	5,335	7,076	5,447	4,796	-650	-11.9
Trade balance	3,956	7,278	12,395	12,333	8,869	-3,464	-28.1
EP004 Crude petroleum							
Exports	1,620	1,384	1,460	2,184	4,818	2,635	120.6
Imports	150,809	196,862	246,894	228,944	195,487	-33,457	-14.6
Trade balance	-149,189	-195,478	-245,435	-226,760	-190,669	36,091	15.9
EP005 Petroleum products							
Exports	42,048	61,131	100,425	111,355	119,700	8,345	7.5
Imports	72,581	97,889	135,170	129,773	118,136	-11,638	-9.0
Trade balance	-30,533	-36,758	-34,745	-18,418	1,564	19,983	[a]
EP006 Natural gas and components							
Exports	5,270	7,805	10,394	9,225	13,039	3,814	41.3
Imports	26,840	31,001	34,616	28,193	28,296	103	0.4
Trade balance	-21,571	-23,196	-24,222	-18,968	-15,256	3,711	19.6

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.
[a]Not meaningful for purposes of comparison.

Table A.5 Forest products: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
FP001 Logs and rough wood products							
Exports	1,716	2,236	2,624	2,545	3,117	573	22.5
Imports	398	423	427	459	483	24	5.3
Trade balance	1,317	1,813	2,197	2,085	2,634	549	26.3
FP002 Lumber							
Exports	1,593	2,256	2,607	2,681	3,130	449	16.7
Imports	2,639	3,391	3,366	3,961	5,036	1,075	27.1
Trade balance	-1,046	-1,135	-759	-1,280	-1,906	-626	-48.9
FP003 Moldings, millwork, and joinery							
Exports	549	648	702	711	736	25	3.5
Imports	2,125	2,316	2,229	2,478	2,853	375	15.2
Trade balance	-1,576	-1,668	-1,527	-1,767	-2,117	-351	-19.9
FP004 Wood veneer and wood panels							
Exports	833	1,065	1,060	1,113	1,140	26	2.4
Imports	2,961	3,413	3,263	3,931	4,605	673	17.1
Trade balance	-2,128	-2,348	-2,203	-2,818	-3,465	-647	-23.0
FP005 Wooden containers							
Exports	253	271	270	276	300	24	8.8
Imports	546	590	619	654	717	64	9.7
Trade balance	-293	-319	-349	-378	-417	-39	-10.5
FP006 Tools and tool handles of wood							
Exports	56	61	41	47	47	[a]	0.2
Imports	156	177	185	200	221	20	10.2
Trade balance	-100	-116	-144	-153	-174	-20	-13.3
FP007 Miscellaneous articles of wood							
Exports	216	221	267	212	204	-9	-4.1
Imports	981	1,068	1,122	1,200	1,301	101	8.4
Trade balance	-765	-847	-854	-988	-1,097	-109	-11.1
FP008 Cork and rattan							
Exports	54	46	43	40	38	-3	-7.0
Imports	561	618	715	741	737	-5	-0.6
Trade balance	-507	-571	-672	-701	-699	2	0.2

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
FP009 Wood pulp and recovered paper							
Exports	6,751	8,788	9,816	9,006	8,768	-239	-2.7
Imports	2,449	3,886	4,043	3,369	3,634	264	7.8
Trade balance	4,302	4,902	5,773	5,637	5,134	-503	-8.9
FP010 Paper boxes and bags							
Exports	1,483	1,669	1,744	1,757	1,836	79	4.5
Imports	1,596	1,796	1,920	1,990	2,085	95	4.8
Trade balance	-113	-127	-176	-233	-249	-17	-7.2
FP011 Industrial papers and paperboards							
Exports	7,265	8,574	9,338	9,085	9,378	293	3.2
Imports	4,621	5,256	5,397	5,301	5,578	277	5.2
Trade balance	2,644	3,318	3,941	3,784	3,799	16	0.4
FP011A Paperboard							
Exports	5,065	6,055	6,739	6,346	6,600	254	4.0
Imports	2,019	2,342	2,394	2,321	2,549	228	9.8
Trade balance	3,045	3,713	4,345	4,025	4,051	25	0.6
FP011B Tissue and tissue products							
Exports	1,589	1,774	1,801	1,944	2,033	89	4.6
Imports	1,946	2,176	2,178	2,130	2,201	72	3.4
Trade balance	-357	-402	-376	-186	-169	17	9.1
FP011C Industrial paper							
Exports	611	745	798	795	745	-50	-6.3
Imports	656	738	825	851	827	-23	-2.7
Trade balance	-44	7	-28	-56	-82	-27	-47.4
FP012 Newsprint							
Exports	317	440	535	454	445	-8	-1.9
Imports	1,442	1,377	1,464	1,344	1,290	-54	-4.0
Trade balance	-1,125	-937	-929	-890	-845	45	5.1
FP013 Printing and writing papers							
Exports	1,105	1,277	1,336	1,533	1,439	-93	-6.1
Imports	4,285	4,044	4,024	3,858	3,870	12	0.3
Trade balance	-3,180	-2,766	-2,688	-2,325	-2,431	-105	-4.5
FP014 Certain specialty papers							
Exports	1,389	1,526	1,476	1,336	1,297	-39	-2.9
Imports	835	905	935	922	943	22	2.3
Trade balance	554	621	540	414	354	-60	-14.6

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
FP015 Miscellaneous paper products							
Exports	1,749	1,898	2,043	2,199	2,276	77	3.5
Imports	1,964	2,207	2,388	2,470	2,432	-38	-1.5
Trade balance	-216	-309	-345	-270	-156	114	42.3
FP016 Printed matter							
Exports	5,162	5,405	5,371	5,313	5,094	-219	-4.1
Imports	3,952	4,282	4,174	4,237	4,181	-56	-1.3
Trade balance	1,210	1,123	1,197	1,075	913	-163	-15.1

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a]Less than $500,000.

Table A.6 Minerals and metals: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MM001 Clays and related mineral products							
Exports	980	1,269	1,284	1,267	1,293	27	2.1
Imports	351	429	447	454	430	-24	-5.3
Trade balance	628	840	837	813	863	50	6.2
MM002 Fluorspar and miscellaneous mineral substances							
Exports	47	107	139	121	123	1	0.9
Imports	184	173	223	242	241	-2	-0.6
Trade balance	-138	-66	-85	-121	-118	3	2.2
MM003 Iron ores and concentrates							
Exports	356	1,092	1,327	1,436	1,483	47	3.3
Imports	375	703	841	757	426	-331	-43.7
Trade balance	-19	388	486	678	1,057	379	55.8
MM004 Copper ores and concentrates							
Exports	930	1,181	2,227	2,396	2,556	160	6.7
Imports	[a]	2	143	30	18	-12	-39.3
Trade balance	929	1,179	2,084	2,366	2,538	172	7.3
MM005 Lead ores, concentrates, and residues							
Exports	382	668	725	594	572	-23	-3.8
Imports	[a]	2	29	29	20	-9	-31.2
Trade balance	381	666	696	565	552	-14	-2.4
MM005A Lead ores and concentrates							
Exports	372	667	724	594	571	-23	-3.9
Imports	[a]	2	29	28	18	-10	-36.5
Trade balance	372	665	696	566	553	-13	-2.3
MM006 Zinc ores, concentrates, and residues							
Exports	674	934	1,062	885	989	103	11.7
Imports	76	63	64	41	22	-18	-45.1
Trade balance	598	871	998	845	966	122	14.4
MM006A Zinc ores and concentrates							
Exports	663	924	1,050	866	963	98	11.3
Imports	68	44	46	14	6	-8	-57.2
Trade balance	595	880	1,004	852	957	105	12.4

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MM007 Certain ores, concentrates, ash, and residues							
Exports	768	1,225	1,609	1,276	1,202	-75	-5.8
Imports	1,696	1,747	2,184	2,336	2,255	-82	-3.5
Trade balance	-928	-522	-576	-1,060	-1,053	7	0.7
MM007A Molybdenum ores and concentrates							
Exports	631	1,055	1,446	1,119	1,032	-86	-7.7
Imports	150	314	460	299	297	-2	-0.7
Trade balance	481	741	986	820	736	-84	-10.3
MM008 Precious metal ores and concentrates							
Exports	204	249	413	321	395	74	22.9
Imports	36	62	156	57	25	-32	-56.4
Trade balance	168	187	257	264	370	106	40.0
MM008A Gold ores and concentrates							
Exports	68	158	299	271	340	68	25.1
Imports	33	58	125	43	18	-25	-57.8
Trade balance	35	100	174	228	321	93	40.7
MM008B Silver ores and concentrates							
Exports	134	81	110	48	41	-7	-14.0
Imports	([a])	([a])	1	8	3	-5	-56.9
Trade balance	134	81	110	40	38	-2	-5.4
MM009 Cement, stone, and related products							
Exports	2,069	2,703	3,070	3,245	3,442	197	6.1
Imports	4,536	5,066	5,498	5,840	6,482	643	11.0
Trade balance	-2,467	-2,364	-2,428	-2,595	-3,040	-446	-17.2
MM009A Cement							
Exports	109	169	190	233	233	([a])	-0.2
Imports	511	501	478	524	541	18	3.4
Trade balance	-402	-331	-288	-290	-308	-18	-6.2
MM010 Industrial ceramics							
Exports	807	1,146	1,292	1,271	1,309	37	2.9
Imports	712	1,241	1,815	1,700	1,464	-237	-13.9
Trade balance	95	-95	-523	-429	-155	274	63.9
MM011 Ceramic bricks and similar articles							
Exports	39	39	56	54	46	-7	-13.7
Imports	43	34	46	44	55	11	24.1
Trade balance	-5	5	10	10	-8	-18	[b]

USITC code and industry/commodity group		Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MM012	Ceramic floor and wall tiles							
	Exports	39	40	42	43	41	-3	-5.8
	Imports	964	1,025	1,078	1,184	1,412	228	19.3
	Trade balance	-926	-985	-1,036	-1,141	-1,372	-231	-20.3
MM013	Ceramic household articles							
	Exports	100	97	99	107	109	3	2.4
	Imports	1,181	1,490	1,487	1,500	1,583	83	5.5
	Trade balance	-1,081	-1,393	-1,388	-1,394	-1,474	-81	-5.8
MM014	Flat glass							
	Exports	1,785	2,310	2,478	2,435	2,600	166	6.8
	Imports	1,474	1,784	1,825	1,822	1,835	13	0.7
	Trade balance	311	526	653	613	765	153	24.9
MM015	Glass containers							
	Exports	298	279	290	295	268	-27	-9.0
	Imports	792	926	1,070	1,127	1,250	122	10.8
	Trade balance	-494	-647	-780	-833	-981	-149	-17.9
MM016	Household glassware							
	Exports	215	247	244	271	264	-7	-2.4
	Imports	632	758	776	855	869	14	1.7
	Trade balance	-417	-512	-533	-584	-605	-21	-3.6
MM017	Miscellaneous glass products							
	Exports	686	877	886	833	897	64	7.6
	Imports	789	954	1,049	1,066	1,116	50	4.7
	Trade balance	-103	-77	-163	-233	-220	13	5.7
MM018	Fiberglass insulation products							
	Exports	205	127	172	187	234	47	25.3
	Imports	73	73	115	139	140	1	0.5
	Trade balance	131	54	56	47	94	47	98.2
MM019	Natural and synthetic gemstones							
	Exports	2,447	3,303	3,684	3,623	2,356	-1,267	-35.0
	Imports	13,608	19,730	23,625	21,597	24,733	3,136	14.5
	Trade balance	-11,161	-16,427	-19,942	-17,974	-22,377	-4,403	-24.5
MM020	Precious metals and non-numismatic coins							
	Exports	20,699	28,033	42,230	42,762	38,868	-3,893	-9.1
	Imports	16,287	23,701	33,423	32,257	30,181	-2,075	-6.4
	Trade balance	4,412	4,332	8,808	10,505	8,687	-1,818	-17.3

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MM020A Unrefined and refined gold							
Exports	11,918	14,698	24,134	33,339	31,585	-1,753	-5.3
Imports	7,928	11,647	14,330	15,912	14,124	-1,788	-11.2
Trade balance	3,990	3,052	9,805	17,426	17,462	35	0.2
MM021 Primary iron products							
Exports	7	18	38	12	7	-5	-40.0
Imports	1,184	2,149	2,916	2,925	2,474	-452	-15.4
Trade balance	-1,176	-2,131	-2,878	-2,913	-2,467	447	15.3
MM022 Ferroalloys							
Exports	128	165	171	143	126	-17	-12.1
Imports	1,062	2,668	2,930	2,899	2,380	-519	-17.9
Trade balance	-935	-2,503	-2,760	-2,756	-2,254	501	18.2
MM023 Iron and steel waste and scrap							
Exports	7,125	8,399	11,398	9,449	7,595	-1,854	-19.6
Imports	817	1,423	1,655	1,605	1,483	-122	-7.6
Trade balance	6,307	6,975	9,743	7,844	6,112	-1,732	-22.1
MM024 Abrasive and ferrous products							
Exports	528	774	855	806	843	37	4.7
Imports	745	1,039	1,218	1,184	1,190	6	0.5
Trade balance	-217	-265	-364	-378	-347	32	8.4
MM024A Abrasive products							
Exports	339	486	544	506	522	16	3.1
Imports	536	683	770	803	818	15	1.9
Trade balance	-197	-197	-226	-297	-296	([a])	0.1
MM025 Steel mill products							
Exports	10,648	14,086	16,647	16,965	16,017	-948	-5.6
Imports	16,995	22,928	30,765	34,303	29,065	-5,238	-15.3
Trade balance	-6,347	-8,842	-14,118	-17,337	-13,048	4,289	24.7
MM025A Ingots, blooms, billets, and slabs of carbon and alloy steels							
Exports	459	474	818	632	409	-223	-35.3
Imports	891	2,535	4,192	4,109	3,397	-712	-17.3
Trade balance	-432	-2,060	-3,375	-3,477	-2,989	489	14.1
MM025B Plates, sheets, and strips of carbon and alloy steels							
Exports	3,940	5,137	5,976	5,744	5,320	-424	-7.4
Imports	4,480	6,133	7,934	8,726	7,896	-830	-9.5
Trade balance	-540	-997	-1,958	-2,982	-2,576	405	13.6

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MM025C Bars, rods, and light shapes of carbon and alloy steels							
Exports	989	1,536	1,860	1,826	1,483	-343	-18.8
Imports	1,472	2,362	3,110	3,466	3,111	-355	-10.2
Trade balance	-483	-825	-1,250	-1,640	-1,629	12	0.7
MM025D Angles, shapes, and sections of carbon and alloy steels							
Exports	459	659	1,007	1,112	922	-190	-17.1
Imports	394	516	631	573	648	75	13.2
Trade balance	65	143	376	539	274	-265	-49.2
MM025E Wire of carbon and alloy steels							
Exports	198	270	287	258	242	-16	-6.1
Imports	493	665	758	807	771	-36	-4.4
Trade balance	-295	-395	-471	-549	-529	20	3.6
MM025F Ingots, blooms, billets, and slabs of stainless steels							
Exports	101	97	159	173	134	-39	-22.6
Imports	204	355	505	513	352	-161	-31.5
Trade balance	-104	-258	-346	-340	-218	122	35.9
MM025G Plates, sheets, and strips of stainless steels							
Exports	841	1,365	1,441	1,282	1,377	95	7.4
Imports	670	1,423	1,830	1,771	1,354	-417	-23.6
Trade balance	171	-58	-389	-489	23	512	[b]
MM025H Bars, rods, and light shapes of stainless steels							
Exports	200	271	398	382	330	-52	-13.7
Imports	362	564	849	800	656	-143	-17.9
Trade balance	-162	-293	-451	-417	-326	91	21.8
MM025I Angles, shapes, and sections of stainless steels							
Exports	11	17	17	22	19	-3	-14.5
Imports	17	31	36	31	32	1	3.1
Trade balance	-6	-14	-19	-9	-13	-4	-45.8
MM025J Wire of stainless steels							
Exports	59	86	109	111	101	-10	-8.6
Imports	126	205	248	239	228	-11	-4.6
Trade balance	-67	-119	-138	-128	-127	1	1.1
MM025K Rails and accessories of carbon and alloy steels							
Exports	209	210	250	327	359	32	9.8
Imports	313	327	396	442	455	13	3.0
Trade balance	-104	-117	-146	-114	-96	19	16.4

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MM025L Pipes and tubes of carbon and alloy steels							
Exports	2,565	3,042	3,204	3,895	4,179	284	7.3
Imports	6,718	6,798	8,952	11,324	8,919	-2,405	-21.2
Trade balance	-4,153	-3,756	-5,748	-7,429	-4,740	2,689	36.2
MM025M Pipes and tubes of stainless steels							
Exports	260	294	406	443	429	-14	-3.1
Imports	693	675	853	1,026	859	-167	-16.3
Trade balance	-433	-381	-447	-583	-430	153	26.3
MM025N Tool steels							
Exports	358	627	714	759	713	-46	-6.0
Imports	161	339	470	477	386	-91	-19.0
Trade balance	197	288	244	282	327	45	16.0
MM026 Steel pipe and tube fittings and certain cast products							
Exports	1,291	1,537	1,692	1,835	1,928	93	5.1
Imports	1,246	1,447	1,992	2,487	2,303	-183	-7.4
Trade balance	45	90	-299	-651	-375	276	42.4
MM027 Fabricated structurals							
Exports	420	500	582	727	799	72	9.9
Imports	1,366	1,215	1,211	1,893	1,025	-868	-45.8
Trade balance	-946	-714	-629	-1,166	-226	940	80.6
MM028 Metal construction components							
Exports	1,147	1,227	1,428	1,802	1,562	-240	-13.3
Imports	1,939	1,618	1,744	2,156	2,315	158	7.3
Trade balance	-792	-391	-317	-354	-753	-398	-112.4
MM029 Metallic containers							
Exports	1,333	1,479	1,592	1,648	1,782	135	8.2
Imports	1,288	1,038	1,193	1,408	1,414	6	0.4
Trade balance	45	441	399	240	368	129	53.7
MM030 Wire products of base metal							
Exports	1,124	1,413	1,629	1,755	1,906	151	8.6
Imports	1,731	2,105	2,499	2,792	2,723	-69	-2.5
Trade balance	-607	-692	-870	-1,037	-817	220	21.2
MM031 Miscellaneous products of base metal							
Exports	5,997	7,087	8,066	8,817	9,318	502	5.7
Imports	9,686	11,889	13,630	14,938	15,209	271	1.8
Trade balance	-3,689	-4,802	-5,564	-6,122	-5,891	231	3.8

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MM032 Industrial fasteners of base metal							
Exports	1,962	2,446	2,854	3,133	3,380	247	7.9
Imports	2,561	3,490	4,234	4,679	4,575	-104	-2.2
Trade balance	-599	-1,044	-1,380	-1,545	-1,194	351	22.7
MM033 Cooking and kitchen ware							
Exports	221	253	256	284	292	9	3.1
Imports	2,180	2,683	2,676	2,781	3,023	243	8.7
Trade balance	-1,960	-2,430	-2,420	-2,497	-2,731	-234	-9.4
MM034 Metal and ceramic sanitary ware							
Exports	193	202	206	190	184	-5	-2.7
Imports	1,030	1,183	1,214	1,331	1,464	133	10.0
Trade balance	-836	-981	-1,008	-1,141	-1,280	-139	-12.2
MM035 Construction castings and other cast-iron articles							
Exports	53	64	85	80	82	3	3.4
Imports	139	168	229	253	231	-22	-8.6
Trade balance	-86	-104	-144	-174	-149	25	14.2
MM036 Copper and related articles							
Exports	4,636	7,189	8,841	8,738	8,303	-435	-5.0
Imports	6,125	8,609	11,158	9,735	10,181	446	4.6
Trade balance	-1,488	-1,420	-2,318	-997	-1,878	-881	-88.4
MM036A Unrefined and refined copper							
Exports	452	579	243	754	508	-247	-32.7
Imports	3,403	4,489	5,840	4,938	5,453	515	10.4
Trade balance	-2,951	-3,909	-5,597	-4,183	-4,946	-762	-18.2
MM036B Copper alloy plate, sheet, and strip							
Exports	193	263	288	275	316	41	15.0
Imports	119	225	255	254	298	43	16.9
Trade balance	73	38	32	20	19	-2	-9.2
MM037 Unwrought aluminum							
Exports	2,673	3,930	4,977	4,418	4,200	-218	-4.9
Imports	5,761	7,180	8,678	8,049	8,428	379	4.7
Trade balance	-3,089	-3,250	-3,701	-3,631	-4,228	-597	-16.4
MM037A Primary and secondary aluminum							
Exports	620	921	1,134	1,056	1,016	-40	-3.8
Imports	5,021	6,163	7,471	6,839	7,249	410	6.0
Trade balance	-4,401	-5,242	-6,337	-5,783	-6,233	-450	-7.8

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MM038 Aluminum mill products							
Exports	3,671	4,235	5,305	5,526	5,705	179	3.2
Imports	3,330	4,397	4,712	4,572	4,493	-78	-1.7
Trade balance	341	-162	594	955	1,212	257	27.0
MM038A Aluminum bars, rods, and profiles							
Exports	431	534	654	736	874	138	18.8
Imports	783	899	531	620	643	24	3.8
Trade balance	-352	-365	124	116	231	115	98.7
MM038B Aluminum wire							
Exports	132	163	187	154	159	5	3.4
Imports	321	387	491	644	583	-61	-9.4
Trade balance	-189	-224	-304	-490	-424	66	13.4
MM038C Aluminum plate, sheet, and strip							
Exports	2,397	2,699	3,426	3,652	3,750	98	2.7
Imports	1,423	2,104	2,544	2,235	2,081	-154	-6.9
Trade balance	974	595	883	1,417	1,669	252	17.8
MM038D Aluminum foil							
Exports	460	538	714	603	513	-90	-14.9
Imports	591	751	867	795	902	107	13.5
Trade balance	-131	-213	-153	-192	-389	-197	-102.8
MM038E Aluminum tubes, pipes, and fittings							
Exports	226	269	296	365	390	25	6.8
Imports	190	210	232	231	238	7	3.1
Trade balance	36	59	64	134	152	17	13.0
MM039 Lead and related articles							
Exports	283	278	293	253	276	23	9.0
Imports	509	708	897	892	1,176	284	31.8
Trade balance	-225	-431	-604	-639	-900	-261	-40.9
MM039A Refined lead							
Exports	61	62	29	33	41	8	23.0
Imports	213	258	299	344	692	347	100.9
Trade balance	-152	-196	-269	-311	-651	-340	-109.3
MM040 Zinc and related articles							
Exports	185	289	315	312	303	-10	-3.2
Imports	1,254	1,703	1,966	1,611	1,806	195	12.1
Trade balance	-1,069	-1,414	-1,651	-1,298	-1,503	-205	-15.8

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MM040A Unwrought zinc							
Exports	3	4	20	15	11	-4	-26.6
Imports	1,076	1,449	1,605	1,318	1,543	225	17.0
Trade balance	-1,073	-1,445	-1,586	-1,303	-1,532	-229	-17.5
MM041 Certain base metals and chemical elements							
Exports	2,735	3,227	4,291	4,361	4,225	-137	-3.1
Imports	3,822	6,106	7,563	6,744	5,830	-914	-13.6
Trade balance	-1,087	-2,879	-3,272	-2,383	-1,606	777	32.6
MM041A Titanium ingot							
Exports	20	10	6	71	87	16	22.8
Imports	13	4	12	9	14	6	66.1
Trade balance	6	6	-6	62	73	10	16.9
MM042 Nonpowered handtools							
Exports	2,734	3,538	4,078	4,101	4,074	-27	-0.7
Imports	3,628	4,786	5,445	6,088	6,344	256	4.2
Trade balance	-894	-1,248	-1,368	-1,987	-2,270	-284	-14.3
MM043 Certain cutlery, sewing implements, and related products							
Exports	562	625	636	603	588	-14	-2.4
Imports	1,253	1,525	1,720	1,763	1,818	56	3.2
Trade balance	-691	-900	-1,084	-1,160	-1,230	-70	-6.0
MM044 Table flatware and related products							
Exports	26	22	28	26	24	-2	-6.6
Imports	444	530	560	523	587	64	12.1
Trade balance	-418	-508	-532	-498	-563	-65	-13.1
MM045 Certain builders' hardware							
Exports	942	1,002	1,053	1,113	1,183	70	6.3
Imports	3,119	3,646	3,848	4,026	4,379	353	8.8
Trade balance	-2,177	-2,644	-2,795	-2,913	-3,196	-283	-9.7

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a]Less than $500,000.

[b]Not meaningful for purposes of comparison.

Table A.7 Miscellaneous manufactures: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MS001 Luggage, handbags, and flat goods							
Exports	449	461	524	539	581	42	7.7
Imports	6,395	7,917	8,893	9,880	10,372	491	5.0
Trade balance	-5,946	-7,456	-8,369	-9,341	-9,790	-450	-4.8
MS001A Luggage							
Exports	286	305	350	362	390	28	7.7
Imports	3,602	4,860	5,461	6,178	6,406	228	3.7
Trade balance	-3,316	-4,556	-5,111	-5,816	-6,016	-200	-3.4
MS001B Handbags							
Exports	117	111	120	111	125	13	12.0
Imports	2,131	2,274	2,519	2,723	2,903	180	6.6
Trade balance	-2,014	-2,163	-2,399	-2,611	-2,778	-167	-6.4
MS001C Flat goods							
Exports	35	32	42	52	54	2	4.0
Imports	621	748	871	947	1,015	68	7.2
Trade balance	-585	-716	-829	-894	-961	-66	-7.4
MS002 Certain other leather goods							
Exports	98	124	131	157	152	-5	-2.9
Imports	391	483	611	570	580	11	1.9
Trade balance	-293	-359	-480	-413	-428	-15	-3.7
MS003 Musical instruments and accessories							
Exports	599	618	713	739	692	-47	-6.4
Imports	1,075	1,204	1,234	1,264	1,251	-14	-1.1
Trade balance	-476	-586	-521	-525	-558	-34	-6.4
MS004 Umbrellas, whips, riding crops, and canes							
Exports	12	15	20	21	20	-1	-5.9
Imports	385	479	498	521	525	4	0.7
Trade balance	-372	-464	-479	-500	-505	-5	-1.0
MS005 Silverware and related articles of precious metal							
Exports	246	351	249	285	264	-21	-7.4
Imports	1,398	1,383	1,496	944	1,148	203	21.5
Trade balance	-1,152	-1,032	-1,246	-660	-884	-224	-34.0

USITC code and industry/commodity group		2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
		Million $						
MS006	Precious jewelry and related articles							
	Exports	3,931	4,327	4,781	4,817	5,178	361	7.5
	Imports	5,755	6,945	7,725	7,443	8,114	671	9.0
	Trade balance	-1,824	-2,618	-2,943	-2,626	-2,936	-310	-11.8
MS007	Costume jewelry and related articles							
	Exports	148	167	179	191	201	9	4.9
	Imports	1,379	1,719	1,799	1,964	1,931	-33	-1.7
	Trade balance	-1,231	-1,551	-1,621	-1,773	-1,730	42	2.4
MS008	Bicycles and certain parts							
	Exports	313	342	349	395	386	-9	-2.4
	Imports	1,404	1,818	1,848	2,136	1,959	-177	-8.3
	Trade balance	-1,092	-1,476	-1,499	-1,741	-1,573	167	9.6
MS009	Furniture							
	Exports	3,392	3,872	4,226	4,766	4,807	41	0.9
	Imports	20,057	24,005	24,659	26,914	28,590	1,675	6.2
	Trade balance	-16,665	-20,132	-20,433	-22,149	-23,783	-1,634	-7.4
MS010	Writing instruments and related articles							
	Exports	130	157	172	164	178	14	8.8
	Imports	1,092	1,277	1,357	1,390	1,395	4	0.3
	Trade balance	-962	-1,120	-1,185	-1,227	-1,217	10	0.8
MS011	Lamps and lighting fittings							
	Exports	916	1,056	1,268	1,327	1,350	23	1.7
	Imports	4,709	5,824	6,443	7,644	8,585	941	12.3
	Trade balance	-3,793	-4,769	-5,175	-6,317	-7,235	-918	-14.5
MS012	Prefabricated buildings							
	Exports	627	875	961	1,075	1,151	76	7.1
	Imports	216	242	227	244	227	-17	-7.0
	Trade balance	410	633	734	831	924	93	11.2
MS013	Toys and games							
	Exports	2,435	2,450	2,462	2,562	2,398	-164	-6.4
	Imports	21,256	22,387	19,974	18,923	18,339	-584	-3.1
	Trade balance	-18,821	-19,936	-17,511	-16,361	-15,941	420	2.6
MS014	Sporting goods							
	Exports	1,550	1,633	1,655	1,700	1,722	22	1.3
	Imports	4,688	5,573	5,725	6,143	6,131	-12	-0.2
	Trade balance	-3,138	-3,940	-4,070	-4,443	-4,409	34	0.8

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MS015 Smokers' articles							
Exports	85	88	112	122	123	2	1.4
Imports	188	229	244	228	275	47	20.8
Trade balance	-103	-141	-132	-106	-152	-46	-43.1
MS016 Brooms, brushes, and hair grooming articles							
Exports	266	290	296	308	316	7	2.4
Imports	1,292	1,473	1,561	1,686	1,734	49	2.9
Trade balance	-1,026	-1,184	-1,265	-1,377	-1,418	-41	-3.0
MS016A Brooms and brushes							
Exports	244	266	268	277	288	10	3.7
Imports	1,060	1,195	1,274	1,400	1,466	67	4.8
Trade balance	-816	-930	-1,006	-1,122	-1,179	-57	-5.0
MS016B Hair grooming articles, non-electric (except brushes)							
Exports	22	24	28	31	28	-3	-9.1
Imports	232	278	287	286	268	-18	-6.3
Trade balance	-211	-254	-260	-255	-240	15	6.0
MS017 Works of art and miscellaneous manufactured goods							
Exports	5,169	3,680	3,854	3,768	4,564	797	21.1
Imports	8,621	10,325	11,513	12,546	13,926	1,380	11.0
Trade balance	-3,452	-6,645	-7,659	-8,778	-9,361	-583	-6.6
MS018 Apparel fasteners							
Exports	109	143	155	125	168	43	34.4
Imports	60	77	82	89	88	-1	-0.7
Trade balance	48	67	73	36	79	44	122.1
MS019 Arms, ammunition, and armored vehicles							
Exports	4,292	4,892	4,652	4,854	5,592	739	15.2
Imports	4,076	3,988	3,526	3,915	4,243	328	8.4
Trade balance	216	905	1,126	939	1,349	410	43.7
MS019A Small arms and ammunition							
Exports	1,115	1,311	1,327	1,261	1,301	40	3.2
Imports	2,304	2,136	2,063	2,544	3,144	600	23.6
Trade balance	-1,189	-824	-736	-1,283	-1,843	-560	-43.6

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

Table A.8 Machinery: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MT001 Pumps for liquids							
Exports	4,238	5,073	6,189	7,085	7,385	300	4.2
Imports	3,746	4,915	6,356	7,216	7,150	-66	-0.9
Trade balance	492	158	-167	-131	235	366	[a]
MT002 Air-conditioning equipment and parts							
Exports	6,911	7,857	8,568	9,198	9,569	370	4.0
Imports	8,576	10,695	12,810	14,045	14,977	932	6.6
Trade balance	-1,665	-2,838	-4,242	-4,847	-5,409	-562	-11.6
MT003 Industrial thermal-processing equipment and furnaces							
Exports	3,489	3,993	4,430	4,634	4,517	-116	-2.5
Imports	3,648	3,365	3,790	4,120	3,961	-160	-3.9
Trade balance	-160	628	640	513	557	43	8.4
MT004 Household appliances, including commercial applications							
Exports	5,576	6,308	6,771	7,184	7,523	339	4.7
Imports	16,608	19,731	20,524	21,542	22,763	1,221	5.7
Trade balance	-11,031	-13,423	-13,753	-14,358	-15,240	-882	-6.1
MT004A Major household appliances and parts							
Exports	1,875	1,977	1,999	2,123	2,037	-86	-4.0
Imports	5,964	7,113	7,037	7,529	8,198	669	8.9
Trade balance	-4,089	-5,136	-5,038	-5,406	-6,161	-755	-14.0
MT005 Centrifuges and filtering and purifying equipment							
Exports	4,703	5,163	5,922	6,297	6,789	492	7.8
Imports	3,886	4,653	5,569	5,794	6,052	259	4.5
Trade balance	817	509	354	503	736	233	46.4
MT006 Wrapping, packaging, and can-sealing machinery							
Exports	722	758	869	832	822	-10	-1.2
Imports	1,625	1,808	2,343	2,241	2,421	180	8.1
Trade balance	-903	-1,050	-1,474	-1,409	-1,600	-191	-13.5
MT007 Scales and weighing machinery							
Exports	194	185	199	212	212	-1	-0.3
Imports	529	663	680	700	690	-10	-1.4
Trade balance	-336	-477	-481	-488	-479	9	1.9

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MT008 Mineral processing machinery							
Exports	1,193	1,405	1,721	1,842	1,666	-176	-9.5
Imports	656	752	1,097	1,232	1,264	33	2.6
Trade balance	537	653	624	610	402	-208	-34.1
MT009 Farm and garden machinery and equipment							
Exports	7,667	8,653	11,234	13,147	11,645	-1,501	-11.4
Imports	4,977	5,887	7,069	8,191	8,943	752	9.2
Trade balance	2,689	2,767	4,165	4,956	2,702	-2,254	-45.5
MT010 Industrial food-processing and related machinery							
Exports	763	877	1,008	1,063	1,073	10	1.0
Imports	741	825	1,027	1,071	1,286	215	20.1
Trade balance	23	52	-19	-8	-213	-205	-2,617.3
MT011 Pulp, paper, and paperboard machinery							
Exports	616	643	713	780	734	-47	-6.0
Imports	830	950	1,033	1,260	981	-278	-22.1
Trade balance	-214	-307	-320	-479	-248	232	48.4
MT012 Printing and related machinery							
Exports	1,431	1,651	1,699	1,587	1,469	-118	-7.5
Imports	1,372	1,251	1,420	1,388	1,388	[b]	[c]
Trade balance	59	400	279	199	81	-119	-59.5
MT013 Textile machinery							
Exports	642	800	741	712	700	-12	-1.7
Imports	843	1,190	1,292	1,221	1,360	139	11.4
Trade balance	-201	-389	-551	-509	-660	-151	-29.7
MT014 Metal rolling mills							
Exports	486	524	442	430	347	-83	-19.3
Imports	523	382	425	373	489	117	31.3
Trade balance	-37	143	17	57	-142	-200	([a])
MT015 Metal cutting machine tools							
Exports	1,524	1,883	2,357	2,438	2,410	-28	-1.2
Imports	2,173	2,529	4,509	5,822	5,106	-716	-12.3
Trade balance	-650	-646	-2,152	-3,384	-2,696	688	20.3
MT016 Machine tool accessories							
Exports	319	401	475	421	438	17	4.0
Imports	438	568	793	923	842	-81	-8.7
Trade balance	-119	-167	-317	-501	-404	97	19.4

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
MT017 Metal forming machine tools							
Exports	938	1,190	1,418	1,399	1,319	-80	-5.7
Imports	816	847	1,177	1,418	1,543	124	8.8
Trade balance	121	343	241	-19	-224	-205	-1,077.6
MT018 Non-metalworking machine tools							
Exports	582	730	704	688	615	-73	-10.5
Imports	1,287	1,090	1,118	1,178	1,350	172	14.6
Trade balance	-705	-359	-415	-490	-735	-245	-49.9
MT019 Semiconductor manufacturing equipment and robotics							
Exports	8,414	16,533	14,694	13,570	13,606	36	0.3
Imports	5,914	9,335	13,791	12,711	11,502	-1,209	-9.5
Trade balance	2,500	7,198	903	859	2,104	1,245	144.9
MT019A Semiconductor manufacturing equipment							
Exports	8,005	16,136	14,200	13,137	13,126	-11	-0.1
Imports	5,510	8,772	13,077	11,998	10,752	-1,247	-10.4
Trade balance	2,495	7,364	1,122	1,138	2,374	1,236	108.6
MT020 Taps, cocks, valves, and similar devices							
Exports	5,929	7,071	8,421	9,077	10,248	1,171	12.9
Imports	7,542	9,661	11,667	12,977	13,538	561	4.3
Trade balance	-1,613	-2,590	-3,246	-3,901	-3,290	611	15.7
MT021 Mechanical power transmission equipment							
Exports	1,713	2,177	2,753	3,058	2,972	-87	-2.8
Imports	3,047	3,672	4,730	5,201	4,747	-455	-8.7
Trade balance	-1,334	-1,494	-1,977	-2,143	-1,775	368	17.2
MT022 Boilers, turbines, and related machinery							
Exports	1,773	1,643	1,930	1,736	1,846	110	6.3
Imports	1,899	1,614	1,464	1,299	1,480	181	13.9
Trade balance	-126	29	466	437	366	-71	-16.2
MT023 Electric motors, generators, and related equipment							
Exports	6,743	7,584	7,897	9,321	8,297	-1,024	-11.0
Imports	10,075	10,338	12,055	13,189	12,103	-1,085	-8.2
Trade balance	-3,332	-2,754	-4,158	-3,868	-3,807	61	1.6
MT024 Electrical transformers, static converters, and inductors							
Exports	2,416	2,759	2,991	3,118	3,303	184	5.9
Imports	7,577	8,999	9,585	10,053	10,582	529	5.3
Trade balance	-5,162	-6,240	-6,594	-6,934	-7,279	-344	-5.0

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
MT025 Portable electric handtools							
Exports	110	141	157	199	198	-1	-0.4
Imports	2,140	2,431	2,648	2,787	3,081	293	10.5
Trade balance	-2,031	-2,290	-2,492	-2,588	-2,882	-294	-11.4
MT026 Nonelectrically powered handtools							
Exports	814	917	927	948	897	-51	-5.4
Imports	1,017	1,404	1,570	1,673	1,742	68	4.1
Trade balance	-203	-487	-643	-725	-844	-119	-16.4
MT027 Electric lamps (bulbs) and portable electric lights							
Exports	668	752	738	715	729	14	1.9
Imports	2,281	2,705	2,809	2,973	3,185	211	7.1
Trade balance	-1,613	-1,953	-2,071	-2,258	-2,456	-198	-8.8
MT028 Welding and soldering equipment							
Exports	816	1,064	1,243	1,219	1,210	-9	-0.7
Imports	742	901	1,243	1,391	1,431	40	2.9
Trade balance	74	163	([b])	-172	-221	-49	-28.2
MT029 Nonautomotive insulated electrical wire and related products							
Exports	3,727	4,790	5,382	6,020	6,207	187	3.1
Imports	4,540	6,025	6,765	7,258	7,552	294	4.1
Trade balance	-813	-1,235	-1,384	-1,238	-1,346	-108	-8.7
MT030 Miscellaneous machinery							
Exports	8,510	9,011	10,535	11,281	11,379	98	0.9
Imports	7,717	8,668	10,503	11,446	11,608	163	1.4
Trade balance	793	343	33	-164	-229	-65	-39.4
MT031 Molds and molding machinery							
Exports	1,801	1,841	2,066	2,191	2,144	-46	-2.1
Imports	2,294	2,617	3,086	3,544	3,995	451	12.7
Trade balance	-494	-775	-1,020	-1,353	-1,850	-497	-36.7

Source: Compiled from official statistics of the U.S. Department of Commerce.
Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a]Not meaningful for purposes of comparison.

[b]Less than $500,000.

[c]Less than 0.05 percent.

Table A.9 Textiles, apparel, and footwear: U.S. trade for industry/commodity groups and subgroups, 2009–13

	Million $						
USITC code and industry/commodity group	**2009**	**2010**	**2011**	**2012**	**2013**	**Absolute change, 2012–13**	**Percent change, 2012–13**
TX001 Fibers and yarns, except raw cotton and raw wool							
Exports	3,496	4,444	5,610	5,059	5,201	143	2.8
Imports	2,638	3,479	3,980	3,830	3,752	-78	-2.0
Trade balance	857	965	1,630	1,229	1,449	220	17.9
TX002 Fabrics							
Exports	4,917	5,878	6,285	6,346	6,548	202	3.2
Imports	4,410	5,444	6,241	6,587	6,733	145	2.2
Trade balance	507	434	44	-241	-184	57	23.7
TX002A Broadwoven fabrics							
Exports	1,261	1,417	1,637	1,565	1,536	-29	-1.8
Imports	1,708	2,114	2,481	2,507	2,486	-21	-0.8
Trade balance	-447	-697	-844	-942	-950	-8	-0.9
TX002B Knit fabrics							
Exports	891	1,036	1,026	991	1,023	32	3.2
Imports	652	727	841	959	948	-11	-1.1
Trade balance	238	309	185	32	74	42	132.7
TX002C Specialty fabrics							
Exports	374	405	383	368	359	-9	-2.5
Imports	380	445	488	518	531	13	2.4
Trade balance	-7	-41	-105	-151	-172	-22	-14.4
TX002D Coated and other fabrics							
Exports	925	1,246	1,312	1,380	1,370	-9	-0.7
Imports	864	1,168	1,356	1,436	1,513	77	5.4
Trade balance	61	78	-44	-57	-143	-86	-152.5
TX002E Glass fiber fabrics							
Exports	219	237	251	271	282	10	3.8
Imports	120	143	170	207	205	-2	-0.9
Trade balance	99	94	81	64	76	12	19.3
TX002F Other fabrics							
Exports	1,248	1,537	1,676	1,772	1,979	207	11.7
Imports	685	847	905	961	1,049	88	9.2
Trade balance	563	691	771	811	930	119	14.6

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
TX003 Carpets and rugs							
Exports	821	959	1,025	1,057	1,070	13	1.3
Imports	1,475	1,732	1,904	2,030	2,154	124	6.1
Trade balance	-654	-773	-880	-974	-1,084	-110	-11.3
TX004 Home furnishings							
Exports	363	398	436	500	512	12	2.4
Imports	7,553	9,058	9,208	9,253	10,037	784	8.5
Trade balance	-7,190	-8,660	-8,772	-8,753	-9,525	-772	-8.8
TX004A Blankets							
Exports	23	20	23	28	28	1	2.9
Imports	616	735	740	751	860	108	14.4
Trade balance	-593	-716	-717	-724	-831	-107	-14.8
TX004B Pillowcases and sheets							
Exports	46	53	65	71	72	1	1.6
Imports	1,938	2,447	2,534	2,547	2,819	272	10.7
Trade balance	-1,893	-2,394	-2,468	-2,477	-2,747	-270	-10.9
TX004C Table/kitchen linens and towels							
Exports	44	51	47	50	49	-1	-2.0
Imports	1,852	2,151	2,196	2,257	2,333	76	3.4
Trade balance	-1,808	-2,099	-2,149	-2,207	-2,284	-77	-3.5
TX004D Curtains							
Exports	78	80	91	110	113	3	3.0
Imports	991	1,101	1,052	989	1,130	141	14.3
Trade balance	-913	-1,021	-961	-879	-1,017	-138	-15.7
TX004E Bedspreads and other furnishing articles							
Exports	54	62	66	80	86	6	7.5
Imports	1,112	1,383	1,509	1,563	1,645	82	5.2
Trade balance	-1,058	-1,321	-1,443	-1,483	-1,558	-76	-5.1
TX004F Pillows, cushions, and sleeping bags							
Exports	118	131	143	160	162	1	0.9
Imports	1,042	1,240	1,175	1,142	1,248	107	9.3
Trade balance	-924	-1,108	-1,032	-982	-1,087	-105	-10.7
TX004G Tapestries and other wall hangings							
Exports	1	1	1	1	1	([a])	17.8
Imports	2	2	3	4	2	-1	-34.0
Trade balance	-1	-2	-2	-3	-1	1	51.5

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
TX005 Apparel							
Exports	2,922	3,197	3,337	3,452	3,412	-39	-1.1
Imports	69,457	78,501	85,668	84,962	87,658	2,696	3.2
Trade balance	-66,534	-75,304	-82,331	-81,510	-84,246	-2,736	-3.4
TX005A Men's and boys' suits and sports coats							
Exports	31	27	20	25	23	-1	-5.8
Imports	949	1,014	1,201	1,304	1,359	54	4.2
Trade balance	-917	-987	-1,181	-1,280	-1,336	-56	-4.4
TX005B Men's and boys' coats and jackets							
Exports	60	73	89	95	103	7	7.6
Imports	2,299	2,636	3,183	2,970	2,839	-131	-4.4
Trade balance	-2,239	-2,563	-3,094	-2,874	-2,736	138	4.8
TX005C Men's and boys' trousers							
Exports	216	234	258	265	259	-5	-2.1
Imports	6,805	7,496	8,277	8,267	8,640	373	4.5
Trade balance	-6,589	-7,262	-8,019	-8,002	-8,380	-378	-4.7
TX005D Women's and girls' trousers							
Exports	239	276	285	297	295	-2	-0.6
Imports	8,043	8,663	8,965	9,082	9,736	653	7.2
Trade balance	-7,803	-8,387	-8,680	-8,785	-9,440	-655	-7.5
TX005E Shirts and blouses							
Exports	525	556	587	671	669	-2	-0.3
Imports	21,962	24,728	26,728	26,030	27,254	1,224	4.7
Trade balance	-21,437	-24,172	-26,141	-25,358	-26,584	-1,226	-4.8
TX005F Sweaters							
Exports	27	33	29	32	38	5	15.9
Imports	2,014	2,275	2,492	2,324	2,364	40	1.7
Trade balance	-1,987	-2,242	-2,463	-2,292	-2,327	-35	-1.5
TX005G Women's and girls' suits, skirts, and coats							
Exports	158	146	145	144	145	2	1.3
Imports	4,739	5,121	5,465	5,125	4,896	-229	-4.5
Trade balance	-4,581	-4,975	-5,320	-4,981	-4,750	231	4.6
TX005H Women's and girls' dresses							
Exports	163	188	235	237	258	20	8.6
Imports	3,098	3,679	4,339	4,619	4,530	-89	-1.9
Trade balance	-2,935	-3,490	-4,104	-4,382	-4,272	110	2.5

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
TX005I Robes, nightwear, and underwear							
Exports	97	127	116	112	125	13	11.8
Imports	4,683	5,464	5,704	5,619	5,763	144	2.6
Trade balance	-4,586	-5,337	-5,588	-5,507	-5,638	-131	-2.4
TX005J Hosiery							
Exports	291	315	284	275	258	-17	-6.3
Imports	1,509	1,831	1,947	2,031	2,163	132	6.5
Trade balance	-1,218	-1,516	-1,663	-1,755	-1,905	-149	-8.5
TX005K Body-supporting garments							
Exports	47	60	74	68	57	-11	-15.9
Imports	1,850	2,247	2,250	2,360	2,525	166	7.0
Trade balance	-1,803	-2,186	-2,176	-2,292	-2,468	-176	-7.7
TX005L Neckwear, handkerchiefs, and scarves							
Exports	20	20	26	28	30	2	7.3
Imports	758	834	968	1,013	1,130	117	11.6
Trade balance	-738	-813	-942	-985	-1,100	-115	-11.7
TX005M Gloves, including gloves for sports							
Exports	126	148	164	162	147	-14	-8.8
Imports	3,234	3,874	4,517	4,709	4,577	-132	-2.8
Trade balance	-3,108	-3,727	-4,352	-4,547	-4,430	118	2.6
TX005N Headwear							
Exports	128	140	162	192	182	-9	-4.9
Imports	1,357	1,652	1,999	1,982	1,928	-54	-2.7
Trade balance	-1,229	-1,512	-1,837	-1,791	-1,746	44	2.5
TX005O Leather apparel and accessories							
Exports	154	145	137	139	146	7	5.3
Imports	841	934	926	954	1,062	108	11.3
Trade balance	-687	-789	-789	-815	-916	-101	-12.4
TX005P Fur apparel and other fur articles							
Exports	19	15	15	19	19	([a])	2.6
Imports	136	158	186	157	157	([a])	([b])
Trade balance	-117	-143	-171	-139	-138	([a])	0.3
TX005Q Rubber, plastic, and coated-fabric apparel							
Exports	173	186	179	148	134	-14	-9.5
Imports	445	603	640	762	829	67	8.9
Trade balance	-272	-417	-462	-614	-695	-81	-13.3

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
TX005R Nonwoven apparel							
Exports	77	93	74	68	66	-1	-1.6
Imports	500	554	591	628	654	25	4.0
Trade balance	-423	-461	-517	-561	-587	-26	-4.7
TX005S Other wearing apparel							
Exports	370	415	458	476	457	-20	-4.1
Imports	4,235	4,739	5,290	5,026	5,254	227	4.5
Trade balance	-3,865	-4,324	-4,832	-4,550	-4,797	-247	-5.4
TX006 Miscellaneous textile products							
Exports	2,134	2,474	2,740	2,798	3,010	212	7.6
Imports	5,047	5,984	6,609	6,844	6,891	47	0.7
Trade balance	-2,914	-3,510	-3,870	-4,047	-3,881	166	4.1
FW001 Footwear							
Exports	620	728	832	824	789	-36	-4.3
Imports	17,666	20,710	22,559	23,745	24,612	868	3.7
Trade balance	-17,046	-19,982	-21,728	-22,920	-23,824	-903	-3.9

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on free along ship value, U.S. port of export. Calculations based on unrounded data.

[a] Less than $500,000.

[b] Less than 0.05 percent.

Table A.10 Transportation equipment: U.S. trade for industry/commodity groups and subgroups, 2009–13

USITC code and industry/commodity group	2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
	Million $						
TE001 Aircraft engines and gas turbines							
Exports	9,457	8,786	9,556	10,181	9,443	-739	-7.3
Imports	14,558	14,807	16,946	19,292	19,631	339	1.8
Trade balance	-5,102	-6,021	-7,389	-9,110	-10,188	-1,078	-11.8
TE002 Internal combustion piston engines, other than for aircraft							
Exports	11,556	16,199	18,117	18,937	18,857	-79	-0.4
Imports	11,866	17,989	22,548	24,522	23,906	-616	-2.5
Trade balance	-310	-1,790	-4,431	-5,586	-5,048	537	9.6
TE003 Forklift trucks and similar industrial vehicles							
Exports	1,576	2,163	2,848	3,046	3,066	19	0.6
Imports	1,182	1,432	2,427	3,110	3,246	135	4.4
Trade balance	394	732	421	-64	-180	-116	-181.2
TE004 Construction and mining equipment							
Exports	19,777	22,010	27,971	29,959	23,729	-6,230	-20.8
Imports	6,345	8,213	12,935	16,302	13,727	-2,576	-15.8
Trade balance	13,432	13,797	15,036	13,656	10,002	-3,654	-26.8
TE005 Ball and rollers bearings							
Exports	1,701	2,212	2,596	2,694	2,658	-37	-1.4
Imports	1,927	2,753	3,553	3,864	3,590	-274	-7.1
Trade balance	-226	-540	-957	-1,170	-932	238	20.3
TE006 Primary cells and batteries and electric							
Exports	2,162	2,712	3,184	3,054	3,522	468	15.3
Imports	2,985	3,701	4,102	4,512	4,681	169	3.8
Trade balance	-823	-989	-918	-1,458	-1,159	299	20.5
TE007 Ignition, starting, lighting, and other electrical equipment							
Exports	1,867	2,426	2,749	3,022	3,125	103	3.4
Imports	4,066	5,588	6,497	7,113	7,690	577	8.1
Trade balance	-2,199	-3,162	-3,748	-4,091	-4,565	-474	-11.6
TE008 Rail locomotive and rolling stock							
Exports	2,140	2,410	3,053	3,659	3,641	-18	-0.5
Imports	1,251	1,405	1,809	1,972	1,602	-371	-18.8
Trade balance	888	1,005	1,244	1,687	2,040	352	20.9
TE009 Motor vehicles							
Exports	35,963	48,940	59,454	65,669	69,557	3,888	5.9
Imports	94,348	132,471	144,426	171,556	180,005	8,449	4.9
Trade balance	-58,386	-83,531	-84,972	-105,887	-110,448	-4,561	-4.3

USITC code and industry/commodity group	Million $ 2009	2010	2011	2012	2013	Absolute change, 2012–13	Percent change, 2012–13
TE010 Certain motor-vehicle parts							
Exports	22,713	31,194	35,714	37,806	38,109	303	0.8
Imports	35,296	51,903	59,875	69,605	71,969	2,364	3.4
Trade balance	-12,584	-20,709	-24,161	-31,799	-33,860	-2,061	-6.5
TE011 Powersport vehicles							
Exports	2,571	2,748	2,985	3,235	3,214	-21	-0.6
Imports	2,988	2,317	3,251	3,866	3,860	-6	-0.2
Trade balance	-417	431	-266	-631	-646	-15	-2.4
TE011A Motorcycles and mopeds							
Exports	1,357	1,373	1,476	1,526	1,641	115	7.5
Imports	2,341	1,618	2,420	2,873	2,813	-60	-2.1
Trade balance	-984	-246	-944	-1,347	-1,172	175	13.0
TE012 Trailers, semi-trailers, and parts							
Exports	1,772	2,486	3,038	3,493	3,821	328	9.4
Imports	906	1,202	1,911	2,117	2,144	27	1.3
Trade balance	866	1,284	1,126	1,376	1,677	301	21.9
TE013 Aircraft, spacecraft, and related equipment							
Exports	77,700	73,949	82,028	95,210	104,881	9,671	10.2
Imports	18,339	18,931	21,546	24,107	29,080	4,973	20.6
Trade balance	59,361	55,019	60,482	71,103	75,801	4,698	6.6
TE014 Ships, tugs, pleasure boats, and similar vessels							
Exports	1,946	2,525	2,420	3,387	2,591	-796	-23.5
Imports	1,510	1,804	1,395	2,005	2,789	784	39.1
Trade balance	436	720	1,026	1,382	-198	-1,580	[a]
TE015 Motors and engines, except internal combustion, aircraft, or electric							
Exports	1,183	1,641	1,875	2,420	2,809	389	16.1
Imports	2,240	2,431	3,358	4,466	3,629	-837	-18.7
Trade balance	-1,057	-789	-1,483	-2,047	-820	1,226	59.9

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note: The codes shown above are used by the U.S. International Trade Commission to identify major groupings and subgroupings of imported and exported products for trade monitoring purposes. Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export. Calculations based on unrounded data. In 2009, 60 export commodity classification (schedule B) codes covering all civilian aircraft, engines, equipment, and parts were consolidated into a single code by the U.S. Census Bureau. This reclassification may have accounted for some of the shifts in exports in the aircraft, spacecraft, and related equipment industry/commodity group and the engines and gas turbines industry/commodity group.

[a]Not meaningful for purposes of comparison

Energy Security Initiative
at BROOKINGS

Changing Markets

Economic Opportunities from Lifting the U.S. Ban on Crude Oil Exports

Charles Ebinger
Heather L. Greenley

September 2014
Policy Brief 14-02

About the Brookings Energy Security Initiative

The Energy Security Initiative (ESI) is a cross-program effort by the Brookings Institution designed to foster multidisciplinary research and dialogue on all aspects of energy security. ESI recognizes that public and private choices related to energy production and use will shape the global, economic, environ- mental, and strategic landscape in profound ways and that achieving a more secure future will therefore require a determined effort to understand the likely consequences of these choices and their implications for sound policymaking. The ESI Policy Brief Series is intended to showcase serious and focused scholar- ship on topical issues in one or more of these broad research areas, with an emphasis on targeted policy recommendations.

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List of Acronyms And Abbreviations

AEO 2014	Energy Information Administration's Annual Energy Outlook 2014
ANS	Alaskan North Slope crude oil
API	American Petroleum Institute
b/d	Barrels per day
bbl	One barrel. Unit of measurement equaling 42 gallons or approximately 159 liters
BIS	Bureau of Industry and Security, U.S. Department of Commerce
BLM	Bureau of Land Management, U.S. Department of Interior
BRICS	Brazil, Russia, India, China, and South Africa
BSD	Barrels per stream day
CAFE	Corporate Average Fuel Economy
CDF	Condensate distillation facility
CRS	Congressional Research Service
DOE	United States Department of Energy
EAA	Export Administration Act of 1979
EIA	Energy Information Administration
EPCA	Energy Policy and Conservation Act
EU	European Union
FTA	Free trade agreement
GATT	General Agreement on Tariffs and Trade
GHG	Greenhouse gas
GDP	Gross domestic product
IEEPA	International Emergency Economic Powers Act
IEO	Energy Information Administration's International Energy Outlook
LLS	Louisiana Light Sweet crude oil
LNG	Liquefied natural gas
LR2000	A searchable database constructed by BLM to record all rights of way granted over federal land
LTO	Light tight oil
mbd[1]	Million barrels per day
MLA	Mineral Leasing Act of 1920
MOIP	Mandatory Oil Import Program (1959-1973)
NAFTA	North American Free Trade Agreement

[1] For the purpose of this report, we have used mbd to refer to million barrels per day in order to maintain consistency with NERA's units.

NATO	North Atlantic Treaty Organization
NERA	National Economic Research Associates
NGL	Natural gas liquids
NPRPA	Naval Petroleum Reserves Production Act
NYMEX	New York Mercantile Exchange
OAPEC	Organization of Arab Petroleum Exporting Countries
OCSLA	Outer Continental Shelf Lands Act
OECD	Organization for Economic Co-operation and Development
OPECFix	OPEC maintains crude oil exports
PADDs	Petroleum Administration for Defense Districts
RFF	Resources for the Future
SNAP-R	Simplified Network Application Process – Redesign
SPR	Strategic Petroleum Reserve
TAPS	Trans-Alaska Pipeline System
TPP	Trans-Pacific Partnership
TTIP	Transatlantic Trade and Investment Partnership
VOIP	Voluntary Oil Import Program (1957-1959)
WTI	West Texas Intermediate crude oil
WTO	World Trade Organization

GPM	Global Petroleum Model
HOGR	High Oil and Gas Resource
NoBan	U.S. allows exports of all crude oil types starting in 2015
NoBanCond	U.S. allows exports of condensate only starting in 2015
NoBanDelay	U.S. allows exports of all crude oil starting in 2020
OPECCut	OPEC cuts crude oil exports to maintain crude oil price
OPECFix	OPEC maintains crude oil exports
REF	U.S. Reference Case
ROW	Rest of World

Preface

In 2014, the Brookings Institution's Energy Secu- rity Initiative (ESI) convened the Crude Oil Task Force, a group of energy and legal experts drawn from academia, major energy consultancies, gov- ernment, think tanks, research institutions, law firms, financial analysts, and industry to exam- ine the history and efficacy of U.S. crude oil ex- port policy. Charles Ebinger, director of ESI, and David Goldwyn, ESI nonresident senior fellow, served as co-chairmen of the task force to address the following issues:

- How and why the current laws in place were enacted;
- How the oil market has changed;
- Whether the 1975 laws in place are relevant to today's market; and
- Whether a new approach will enhance U.S. energy security, national and international prosperity and U.S. foreign policy interests.

One of the task force meetings centered on bring- ing together some of the lead analysts on other re- ports addressing the crude oil export issue to look at the methodologies each report employed, to bet- ter assess how each study reached its conclusions.

The policy issues were difficult to examine be- cause they involve interactions between U.S. oil production and the global oil market, the U.S. and global refining systems, and the impact of U.S. policies on the global economy. Uncertain- ties include how much light tight oil (LTO) the existing refining system and other market out- lets can absorb, how the U.S. refining system might adapt to LTO supplies in the future, how the Organization of Petroleum Exporting Coun- tries (OPEC) and other producers will react to rising U.S. production and the possibility of exports, and how global oil prices impact U.S. production and vice versa. Questions policymak- ers may ask in determining whether to support lifting the ban include: How will prices be affected in both the domestic and the international econo- my, and what will the impact will be on U.S. gross domestic product (GDP), unemployment, and foreign policy?

In addition, many policymakers will want to take a hard look at the environmental impacts of lift- ing the ban on crude oil exports, especially vis-à- vis rising emissions of greenhouse gases (GHGs). Clearly if lifting the ban leads (as we believe it will) to higher U.S. oil production and this oil is then burned either domestically or processed in foreign refineries, there will be larger GHG emis- sions than if the oil had remained in the ground. There will also be enhanced emissions from the production of the oil equipment that goes into the wells and the additional transportation net- works (pipelines, barges, trucks) to move the oil to market. Furthermore, in areas where the oil is produced, there will be larger local emissions. Many policymakers will certainly be taking en- vironmental concerns into consideration. While these concerns are not within the scope of this report, we do not underestimate their importance. We do believe that it is difficult to quantify them unless we know where the oil will be processed (either domestically or internationally) and the particular configuration of each refinery in terms of its emissions profile. The environmental con- sequences are highly complex and while cur- rently the data is unavailable, we do agree these issues need to be recognized, though the impact on global emissions (in comparison to U.S. coal exports) is likely to be negligible.

To address these economic questions, Brookings se- cured the modeling support of National Economic Research Associates (NERA),[2] a major internation- al economics consulting firm, to better understand the interplay of markets and various interactions between the domestic and international economy. This interplay can be assessed credibly only with computable general equilibrium models of the U.S. economy and models of the global oil market and global refining market. In addition, our policy experts examined the market anomalies caused by the North American unconventional crude oil boom, and the distortions occurring in the pricing of various crude oils in North America due to the lack of infrastructure to move these crude oils to market. Refining experts advised our task force on the challenges refiners, especially those on the U.S. Gulf Coast, face in utilizing ultra-light oil while maintaining their current product slates.

We drew on the expertise of legal advisers to un- derstand the laws and regulations applicable to trade of crude oil and petroleum products, as well as the policy motivations behind them. We exam- ined what steps the U.S. government will need to take if it chooses to change or modify its current policies and investigated in depth the economic impact of lifting the ban under different policy scenarios. As part of this process, we looked at a number of other studies that have been con- ducted on the issue and in the body of this report we compare and contrast our findings with those of other top analysts.[3] Finally, before making our recommendations, we looked at the foreign pol- icy implications of lifting the ban, since putting potentially large volumes of crude on the inter- national market will have a differential impact on various nations, including some of America's major trading partners, allies, and neighbors in the Western Hemisphere.

nera methodology

This report is supported by the empirical analysis performed by NERA. The Brookings Institution asked NERA to perform this task based on its pre- vious analysis for the U.S. Department of Energy (DOE) on the macroeconomic impact of export- ing liquefied natural gas (LNG). Brookings asked NERA to run macroeconomic modeling scenarios to understand the impacts on the U.S. if the ban on crude oil exports and/or condensates were to be lifted. In carrying out the assignment, NERA focused on the following four major issues:

1. U.S. crude oil production potential based on EIA's Annual Energy Outlook 2014 (AEO 2014) reference and high oil and gas resource case (HOGR) scenarios;
2. Options for modifying/lifting the ban: al- lowing condensate exports only, lifting the ban entirely in 2015, and delaying lifting the ban until 2020;
3. Global energy market interferences: using the reference case[4] for low crude oil prices, and lower demand for refined crude oil products in the Asia-Pacific region; and

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[2] NERA was retained by the Department of Energy to do the economic modeling on the impact of allowing liquefied natural gas exports on the U.S. economy.
[3] NERA used a computable general equilibrium model for the U.S. economy.
[4] Modeled from the AEO 2014 and IEO 2013 reference cases.

4. OPEC's reaction to crude oil exports: either cutting exports to maintain prices, or continuing to keep export levels steady resulting in declining crude oil prices.

NERA utilized its Global Petroleum Model (GPM) and NewERA models to perform this analysis. According to NERA, "GPM is a partial equilibrium model of the petroleum industry and was used in this study to determine the impact of lifting the crude oil export ban on energy mar- kets both in the U.S. and abroad. NewERA is a computable general equilibrium model of the U.S. economy. It determines how changes in the global energy market will ripple through the U.S. economy."[5] To present a clear explanation of the economic impact on the previously outlined four factors, NERA set about quantifying these im- pacts on the U.S. oil market. Lifting the ban on U.S. crude oil exports will most certainly have a ripple effect through the U.S. economy. NERA accounted for these economic impacts by measur- ing them in terms of standard metrics of welfare and GDP for the United States; and changes in income, unemployment, and industry.

NERA's study focuses on the economic benefits of international trade. NERA's work outlines the data projections from 2015 to 2035 and illustrates the impacts under various scenarios on the econ- omy, consumers, and crude oil and refined prod- uct markets. For further explanation and detailed analysis of the economic impacts of lifting the bans, refer to NERA's report, *Economic Benefits of Lifting the Crude Oil Export Ban.* For our analysis on NERA's findings of the economic impact on lifting the ban on crude oil for the United States, see Chapter 5.

definitions and assumptions from the nera report:[6]

- **Tight oil** is a form of light sweet crude oil contained in low permeability shale or tight sandstone. It will not flow naturally into an oil well, and prior to new technological developments could not be produced profitably.
- The broadest measure of net economic benefits to U.S. residents is the measure of economic **welfare** known as the "equiva- lent variation." The equivalent variation is defined as the amount of money that would have to be given to U.S. households to make them indifferent between receiving the money and experiencing the changes in prices and income associated with lifting the ban.[7]
- The components of **GDP**: wage income, capital income, resource and sector-specific capital, and indirect tax revenues.
- **Unemployment** in the U.S. is projected by analysts to persist until 2018. NERA's data therefore only estimates reductions in un- employment during 2015-2020.
- In this report, we refer to crudes from shale formations with **API gravities**[8] from 40 to 49 as light tight crude oil. Crudes with API gravity greater than 49 are referred to as condensates (see Exhibit A in Annex).
- All **baseline cases** assume that the U.S. re- tains its ban on crude oil exports while the scenario cases assume the ban is lifted in dif- ferent ways.

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[5] See NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*, prepared for the Brookings Institution, September 2014, for a more detailed and comprehensive explanation of the GPM and the NewERA models.

[6] NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban.*

[7] Hal R. Varian and Jack Repcheck, *Intermediate Microeconomics: A Modern Approach*, 7th Edition. (New York: W.W. Norton & Company, 2010), 255-256.

[8] API gravity is a scale used to measure the density of liquid petroleum products. See EIA, "Definitions, Sources and Explanatory Notes," www.eia.gov/dnav/pet/tbldefs/pet_pri_wco_tbldef2.asp.

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Summary for Policymakers

The skyrocketing growth of unconventional oil and natural gas production in the United States has ignited an intense debate on the impact of energy exports on U.S. energy and economic security and its foreign policy. Today, rising U.S. crude oil production, combined with declining demand for petroleum products, has led to falling oil imports and increased product exports (which are not prohibited). The absence of logistics sys- tems for many of these new crude oil sources has forced domestic producers to discount prices in order to get them to refineries, while at the same time having to endure higher-cost rail, barge, and truck transportation networks. The market is dis- torted further by the fact that a large volume of these new crude oil supplies are light sweet crudes which are ill-suited for many existing refineries designed to process heavy crude oil, in the ab- sence of large-scale capital investments. There is intense analytical debate on when the capacity of the U.S. refining system to process the entire volume of light tight oil available will end, the so- called "day of reckoning." Few market observers, including the authors of this report, doubt that the day is coming. If this happens, there will be a mix of pressures on prices: downward pressure on domestic oil prices; slowing domestic produc- tion; rising unemployment; and declining tax and royalty revenues for federal, state, and local governments. The market harbinger that a glut is emerging will be widening spreads in the price of Louisiana Light Sweet crude (LLS, the Gulf Coast price marker) against Brent prices (the interna- tional marker for the same quality of crude). When that day comes, there will be pressure on the Unit- ed States to act, to avoid the self-inflicted harm of artificially constraining crude oil exports.

The market distortions arising from this situation have raised a debate on the utility of lifting the decades-old ban on U.S. crude oil exports. The is- sue has gained great political and economic po- tency because given current trends, it appears that the crude surplus will continue to grow in coming years. All of these issues together have fostered the need to examine the legitimacy of a set of laws in place for nearly 40 years, long before the un- conventional revolution in the United States.

In our 2012 *Liquid Markets* report on U.S. LNG exports, we concluded that the U.S. should neither constrain nor promote LNG exports, but should instead let the market determine the viability of projects and the levels of exports.[9] We concluded that allowing natural gas exports would not ma- terially impact U.S. natural gas prices, but would contribute to energy security by diversifying global LNG markets while sustaining U.S. natural gas production and providing more competitive gas pricing.

[9] Charles Ebinger, Kevin Massy, and Govinda Avasarala, *Assessing the Case for Liquefied Natural Gas Exports from the United States*, ESI Policy Brief, The Brookings Institution, May 2012, www.brookings.edu/research/reports/2012/05/02-lng-exports-ebinger.

Unlike the market for natural gas where the U.S. has become self-sufficient, the U.S. is still a ma- jor importer of heavy crude oil and will remain so for many years. Likewise, while natural gas shortages and price volatility have occurred in the past, these disruptions have been induced either by short-sighted regulatory policy or the absence of adequate pipeline capacity—not by searing politically-motivated interruptions as have been experienced in the oil market.

Our legal analysis shows that the President has the power to act at any time to lift the ban, by declar- ing exports to be in the national interest under the provisions of the Energy Policy and Conservation Act of 1975 (EPCA). Barring presidential action, Congress could act to lift the ban by amending the EPCA. The current presidential administra- tion seems to believe that if a crude surplus does emerge, it will not happen imminently so there is little reason to propose any significant policy changes until after the 2014 midterm elections.

As in the case of LNG exports, we find that the United States should avoid selective easing of the ban, for example: to allow exports only to nations that are members of the North Atlantic Treaty Or- ganization (NATO), or those who cooperate with U.S. policy in regards to Iran, or are members of the World Trade Organization (WTO). Likewise, we do not support as good policy only lifting the ban on condensates or limiting the volume of ex- ports to some predetermined level. These selec- tive discriminations will lead to market distor- tions and may violate U.S. trade commitments.

Based on our team's robust macroeconomic mod- eling of the U.S. economy, global oil markets, and global refining capabilities, we believe that the U.S. should allow the market to determine where crude oil will go and move immediately to lift the ban on all crude oil exports. Our analysis shows categorically that the crude oil export ban does not, and for some time has not, advanced U.S. en- ergy security. To the contrary, our analysis shows that lifting the ban will increase U.S. oil produc- tion, diversify global supply, reduce U.S. gasoline prices, and provide net benefits to the U.S. econo- my. An export option is indispensable to sustain- ing domestic production; absent the price support that exposure to international markets provides, U.S. production will not reach its full potential.

Below, we highlight the key findings of this re- port. As a leader in world trade circles, where the U.S. is a consistent advocate for open markets and transparency, continued restrictions on crude oil exports have the potential to tarnish U.S. global standing while hindering its pursuit of energy security. Allowing crude oil exports is in the na- tional interest. Our analysis shows a direct corre- lation between increased U.S. oil production, net benefits to society, and lower gasoline prices. As a result, we find the ban an anachronism that has long outlived its utility and now threatens to im- pair, rather than protect, U.S. energy, economic, and national security.

key findings

The modeled effects of lifting the ban on crude oil exports from the United States are measured against a baseline projection that assumes the ban continues. The "reference case" is a projection of business-as-usual conditions calibrated to the best estimates of the U.S. Energy Information Admin- istration. The study also examined alternative sce- narios in which supplies of economically-recover- able oil turn out to be higher or lower than in the baseline scenario.

NERA's analysis makes several clear findings:

1. **Lifting the ban on crude oil exports from the United States will boost U.S. economic growth, wages, employment, trade, and overall welfare. For example, the present discounted value of GDP in the high resource case increases through 2039 is between $600 billion and $1.8 trillion, depending on how soon and how completely the ban is lifted.**

2. **Benefits are greatest if the U.S. lifts the ban in 2015 for all types of crude. Delaying or allowing only condensate exports lowers benefits by 60 percent relative to a complete and immediate removal of the ban. If oil and gas supplies are more abundant than expected, allowing only condensate exports lowers the benefits by 75 percent relative to completely lifting the ban. The chief reason for this is that the greatest increase in LTO production comes in 2015. Therefore a delay would forego significant benefits. In addition, according to the EIA data, the volume of condensate is smaller than LTO and it is discounted less comparatively so exempting it entirely adds fewer benefits than all crude oil entirely.**

3. **The welfare benefits to U.S. households derive from higher real incomes (from higher wages) and lower gasoline prices. In the reference case, the decrease in gasoline price is estimated to be $0.09/gallon, but only for about five years. If oil supplies are more abundant than currently expected, the decline in gasoline prices will be larger ($0.07 to $0.12 per gallon) and more enduring.**

4. **The benefits of lifting the ban depend on assumptions of energy market conditions and how other oil suppliers, especially OPEC, respond. For example: If the ban is lifted, will OPEC continue to produce at current levels to defend market share, even if this leads to lower prices? Or will it cut production to keep prices up effectively nullifying or limiting the impact of U.S. crude oil exports?**

What is most important is our finding that in all these modeling scenarios, there are positive gains for U.S. households.

One might have guessed that keeping crude oil in the U.S. would make oil and gasoline cheaper here, and thus make Americans better off. So why does lifting the export ban on crude oil prove so beneficial? The answer hinges on how the ban on crude exports affects incentives to invest in do- mestic oil production and where the crude oil can generate the greatest net value for the resource and the global nature of the oil market:

- Without the ban on exports, U.S. oil produc- ers can sell their product more profitably because they are not forced to sell it to U.S. refiners who discount their kind of crude, which is generally less well-suited to existing refining facilities than imported crude.
- With greater profits, producers invest in producing more oil in the United States, about 1.3 million to 2.9 million barrels per

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day more in 2020 than under the ban, assuming the ban is lifted in 2015.

- The increase in U.S. oil production makes world oil prices fall. Accordingly, so do U.S. gasoline and diesel prices, at least temporarily. This lowers the costs of production for all kinds of businesses and makes households better off.
- Moreover, U.S. refiners do not spend money on modifying their facilities to accept U.S.-produced LTO.

Thus, allowing U.S. crude oil to go to the refineries that can process it most efficiently, whether at home or abroad, is in the broad national economic interest. Lifting the ban on exports of crude oil also has important foreign policy benefits. U.S. allies in Europe and Asia will be able to diversify their crude oil supply sources away from dependency on Russia (in the case of Europe) and away from seaborne routes in the South China Sea increasingly claimed by China (in the case of Japan and South Korea).

After 40 years of perceived oil scarcity, the United States is in a position to help maximize its own energy and economic security by applying the same principles to free trade in energy that it applies to other goods. By lifting the ban on crude oil exports, the United States also will help mitigate oil price volatility while alleviating the negative impacts of future global oil supply disruptions.

1. Introduction

In a recent statement, U.S. Senator Lisa Murkowski stated, "The United States is the only member of the OECD and IEA [Interna- tional Energy Agency] that has effectively banned the export of crude oil produced domestically."[10] While other countries have adapted to changes in the international petroleum market brought about by new technological advancements and changing global oil supply-and-demand market dynamics, the United States seems to be the only nation of its peers that continues to operate under a now arcane complex of rules designed for an- other age.

Throughout history, the United States has under- gone significant energy market shifts. In earlier de- cades, the U.S. public had a national sense of enti- tlement to low energy prices borne from an era of energy abundance. Commencing in the 1950s and continuing to 1970, it was an axiom of the era that energy in the post-war period was, in the words of Daniel Yergin, "almost a free good," with land and resources, abundance and self-sufficiency guaranteed by access to cheap oil, gas, and coal.[11]

This myth of energy "abundance" was shattered in 1973-1974 when crude oil and, even more importantly, gasoline prices quadrupled in the af- termath of the 1973-1974 Organization of Arab Petroleum Exporting Countries (OAPEC) oil em- bargo, even with price controls in effect. Ameri- can consumers were jolted again in 1979 following the fall of the Shah of Iran, and the outbreak of the Iran-Iraq War in 1980. New supply disrup- tions combined with unsuccessful policy choices hit world markets, causing prices to skyrocket to highs never seen before. With price controls still in effect from the Nixon administration, U.S. leg- islation meant to protect domestic oil producers failed to adjust to the new realities of the global marketplace. By suppressing domestic prices, price and allocation controls limited the domestic price response, creating artificial shortages. Unlike the situation today, at that time the U.S. not only used oil for transportation fuel but also for elec- tricity generation, making the U.S. economy heav- ily dependent on any fluctuations in the world price of oil. In the aftermath of the shortages pro- duced by the 1973 OAPEC oil embargo (as well as

[10] Lisa Murkowski, "A Ban for One: The Outdated Prohibition on U.S. Oil Exports in Global Context Prepared by Minority Staff for Ranking Member Lisa Murkowski," U.S. Senate Committee on Energy and Natural Resources, U.S. Senate, 26 June 2014, www.energy.senate.gov/public/index.cfm/files/serve?File_id=8749ae25-8446-4d5e-bab2-d68f02f293df.

[11] Daniel Yergin, "America in the Strait of Stringency," in *Global Insecurity: A Strategy for Energy and Economic Renewal*, Daniel Yergin and Martin Hillenbrand, eds., (Boston: Houghton Mifflin Company, 1982), 97.

the oil price and allocation controls in effect since 1971).[12] Legislative efforts were launched to curb energy demand and to promote alternative sourc- es of supply. These early efforts were successful over time in advancing major structural changes in the power and industrial sectors as consum- ers worldwide flocked to alternative fuels such as coal, nuclear power, natural gas, wind, and solar. In addition, consumers wherever possible made their operations more fuel efficient.

Despite these profound changes in the market- place, the myth of energy abundance remained. In 1980, when Ronald Reagan predicted that following his phased decontrol of oil prices, the country would be self-sufficient within five years, few pundits challenged him.[13] However, despite the President's bravado, most Americans had learned that the era of energy abundance had passed and that an era of scarcity and higher pric- es was here to stay. Even though markets began to stabilize and prices fell, culminating in an oil price crash in 1986, the mindset of energy scar- city remained fixed in the minds of most of the public. Then during the 1990s, a period of low prices, research and development successes, and a resurgent OPEC led to transformations in energy markets both domestically and internationally.

In response to low prices and OPEC's failure to curtail production even after Iraq returned to the market, global demand (albeit slowly) began to pick up by the early 2000s. Demand for oil sky- rocketed as the newly emerging economies of Brazil, India, China, Russia, and South Africa (BRICS) took off, surprising analysts around the world. China was particularly important because while most oil analysts focused on China's bur- geoning industrial and transportation demand, the demand from the power sector rose by nearly 1 mbd, catching many "oil market" analysts by surprise.[14] With global oil demand soaring, prices rose as OPEC's spare capacity disappeared. At the same time, mounting prices for conventional gas, and the perception that the U.S. was running out of gas and would within a decade need to import as much as 40 percent of its overall gas demand, led to renewed interest in unconventional gas, leading to the surplus situation we have today.

One of the most important factors sparking the unconventional oil revolution was the price of oil hitting an all-time high of $147/bbl in 2008.[15] High prices resulted not only from Chinese de- mand rising to 9-10 mbd but also owing to rising demand elsewhere in the emerging market world. Price rises also occurred because about 3-4 mbd was shut in as a result of civil conflict in a num- ber of oil-producing countries. With the advent of the U.S. economic and global recession, demand fell, causing prices in 2009 to drop to below $60/ bbl.[16] By 2010, however, U.S. GDP grew and con- sequently, tight oil and NGL production were able to flourish. West Texas Intermediate (WTI) prices bounced back to $80/bbl and then to nearly $100/ bbl in 2011, creating an anomaly where, "more than at any time in its history, the U.S. oil econo- my was one of staggering abundance and simulta- neous scarcity."[17] With a strong demand for crude in the international market, U.S. oil production grew at a faster pace than anywhere else in the world. However, like all previous oil booms, the pace of development self-corrected as the huge volumes of ultra-light products (including eth-

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[12] Daniel Yergin, *The Prize: The Epic Quest for Oil, Money & Power*, (New York: Simon and Schuster, 2011), 659.

[13] Yergin, "America in the Strait of Stringency," 102.

[14] International Energy Agency, "World Energy Outlook 2005," www.worldenergyoutlook.org/media/weowebsite/2008-1994/weo2005.pdf, p. 82.

[15] Madlen Read, "Oil sets new trading record above $147 a barrel," *Associated Press*, 11 July 2008, http://usatoday30.usatoday.com/money/economy/2008-07-11-3815204975_x.htm.

[16] Catherine Contiguglia and Matthew Saltmarsh, "Oil Prices Fall Below $60 a Barrel," *New York Times*, 10 July 2009, www.nytimes.com/2009/07/11/business/energy-environment/11oil.html?_r=0.

[17] Blake C. Clayton, *Market Madness: A Century of Panics, Crises, and Crashes* (Oxford, UK: Oxford University Press, 2015).

ane, butane, and propane) soon overwhelmed the existing storage and transportation capacity to move these volumes to the U.S. Gulf Coast where they could be refined and exported. This created a profound change in the market where, while WTI had traditionally been priced at a premium of several dollars to Brent (the basis for most other crude oil futures contracts outside North Ameri- ca), WTI soon commenced selling at a discount, a classic market response to oversupply. The light crude oversupply became so huge that the differ- ential widened to nearly $30/bbl at one point.

These changing market dynamics, combined with progress in reducing gasoline demand through higher Corporate Average Fuel Economy (CAFE) standards, have now put the United States in the position to export crude oil: a development many never thought would become a reality. The accel- eration in U.S. production is having a profound impact on the market, with imports of light sweet crude oil having fallen precipitously.[18] However, because much of this new oil comprises light tight oils (LTO) and condensates with very high API gravities (for NERA's oil type classification, see Exhibit A in Annex), they have significantly different product yields than conventional crudes. This causes technical challenges for U.S. refiners who do not have the capacity to process them.[19] The large volumes of light sweet crude produced domestically have had a dramatic market impact with price discounts for these crudes reaching as much as $30/bbl compared to their Brent equiva- lents, a clear signal of excess supply especially during the periods when refineries cut back de- mand as they change from winter (heating oil) to summer (gasoline) blends of products (or vice versa) known as "market turnarounds."

Even as policymakers and oil market analysts de- bated the implications of these profound market changes and their impact on a new "geopolitics of energy," what most analysts failed to see was that one of the major policy issues that would emerge was whether or not the nation should lift the ban on crude oil exports.

[18] Marianne Kah, "The Need for U.S. Crude Exports." Presentation at Brookings ESI Workshop on U.S. Crude Exports, Brookings Institution, Washington, D.C., 25 April 2014.

[19] Ibid.

2. U.S. Crude Oil Production Debate from Abundance to Scarcity to Abundance: The Evolution of Policy

Throughout its history, the United States has attempted to ensure energy security (defined for the public primarily as gasoline price moderation) by regulating the price of oil, controlling the imports of oil, and by restricting the exports of oil. In each case, powerful market forces, rising or falling demand, or discontinuities between U.S. and international prices have overwhelmed the policy of the day. Despite these policies (not be- cause of them), the U.S. has swung from an abun- dance of oil supply, to scarcity, and today back to abundance.

a brief history of united states crude oil policy

From 1910 to around 1950, the major force in global petroleum supply was the Texas Railroad Commission, which set petroleum prices and made decisions on the allocation of supply. In 1929, roughly a third of total global oil demand was met by U.S. exports. During World War II, 6 million of the 7 million barrels of oil used by the Allies were provided by the United States.[20] After the end of the war, oil demand in the rest of the world exploded, spurred on by the global economic recovery of the late 1950s and 1960s.

Between 1950 and 1970, as a result of its ready availability, the non-communist world increased its consumption of oil from 9 mbd to 30 mbd, an average annual compound rate of over 7 percent. While the U.S. attempted to protect its domes- tic production against competition from cheap overseas oil by regulating the volume of imports through both a Voluntary Oil Import Program (VOIP, 1957-1959) and a Mandatory Oil Import Program (MOIP, 1959-1973), owing to a number of regulatory loopholes on the eve of the 1973 OAPEC oil embargo, the U.S. was 28 percent de- pendent on oil imports.

The 1960 formation of OPEC and its growing bargaining power over its first decade had cre- ated a situation where the U.S. was no longer able to produce reserves large enough to serve as a buffer for Western Europe in the aftermath of the 1967 Arab-Israeli war. As a result, the oil-consuming world became vulnerable to supply shocks.[21] At this time, the Texas Railroad Com- mission was still restricting production and im- ports to keep U.S. crude oil prices high in order to protect the industry and to make it profitable. The result of this policy was that U.S. crude oil prices were about \$3/bbl in comparison to prices

[20] Yergin, "America in the Strait of Stringency," 98.

[21] Charles K. Ebinger, Wayne Berman, Richard Kessler and Eugenie Maechling, *The Critical Link: Energy and National Security in the 1980s*, (Cambridge, Massachusetts: Ballinger Publishing Company, 1982), 2.

of around $1.80 in the Persian Gulf. Although the U.S. might have been able to produce more, U.S. industry costs were too high to sell in the global marketplace. This artificial support of the U.S. industry angered OPEC, which believed that if allowed, it could sell more oil; OPEC also believed that the price it was receiving for its oil was too low, especially in comparison to U.S. prices. In re- sponse, Libya and Iran, followed by other OPEC members commencing in the late 1960s and early 1970s, demanded higher prices and greater shares of their production. In a new phenomenon known as "price leapfrogging," no sooner had one OPEC nation renegotiated oil prices or produc- tion sharing terms, another OPEC member used this agreement on the next negotiation. When the international oil companies balked at a change in terms, OPEC used is bargaining power to up the ante on certain companies and, in the case of Ven- ezuela and Libya, led to outright nationalizations. In hindsight, U.S. protectionist measures (VOIP and MOIP) backfired badly. While the intent was to restrict crude oil imports to protect higher cost domestic producers, the policies created scarcity rather than market stability.

In response to the flood of imported oil and concerns about inflation, President Richard Nixon in 1971 imposed broad wage, price, and alloca- tion controls, including on the energy sector. De- signed to curb inflation, price controls did not bring price stability but created greater scarcity since there were few economic incentives to look for oil and gas in a price-controlled environment. In addition, despite attempts to limit oil imports, between 1970 and 1973 imports rose dramatically as U.S. petroleum consumption was growing due to the rapid growth of the transportation sector with the continued expansion of the Interstate Highway System.

the oapec oil embargo

In 1973, the Arab members of OPEC (OAPEC) announced an oil embargo in retaliation to the U.S. support of Israel during the Arab-Israeli War.[22] In response to the 1973-1974 OAPEC oil embargo and the resulting rise in oil prices that devastated the United States and other world economies, Congress gave the President broad statutory authority under the Energy Policy and Conservation Act of 1975 (EPCA) to restrict or permit energy exports.[23] EPCA vests the Presi- dent with the authority to restrict the export of crude oil, natural gas, petroleum products, petro- chemical feedstocks, and coal. Today, only crude oil exports remain banned.

The period between 1975 and 1981 was a conten- tious period in U.S. energy policy. While President Jimmy Carter began the phased deregulation of crude oil prices in 1978,[24] it was not completed until the Reagan presidency in 1981. During the loosen- ing process, allocation controls continued to exist under the Powerplant and Industrial Fuel Use Act of 1978, which would not allow natural gas or pe- troleum to be burned in industrial boilers or new power plants as a primary fuel, leading to a surge in coal combustion.[25] During this six-year period, fuel economy standards were broadened, oil allocations were terminated, the International Energy Agency (IEA) and Strategic Petroleum Reserve (SPR) were created, global and domestic spot markets emerged, and oil increasingly became a globally-traded com- modity with prices varying only by quality and transportation-cost differentials to select markets.

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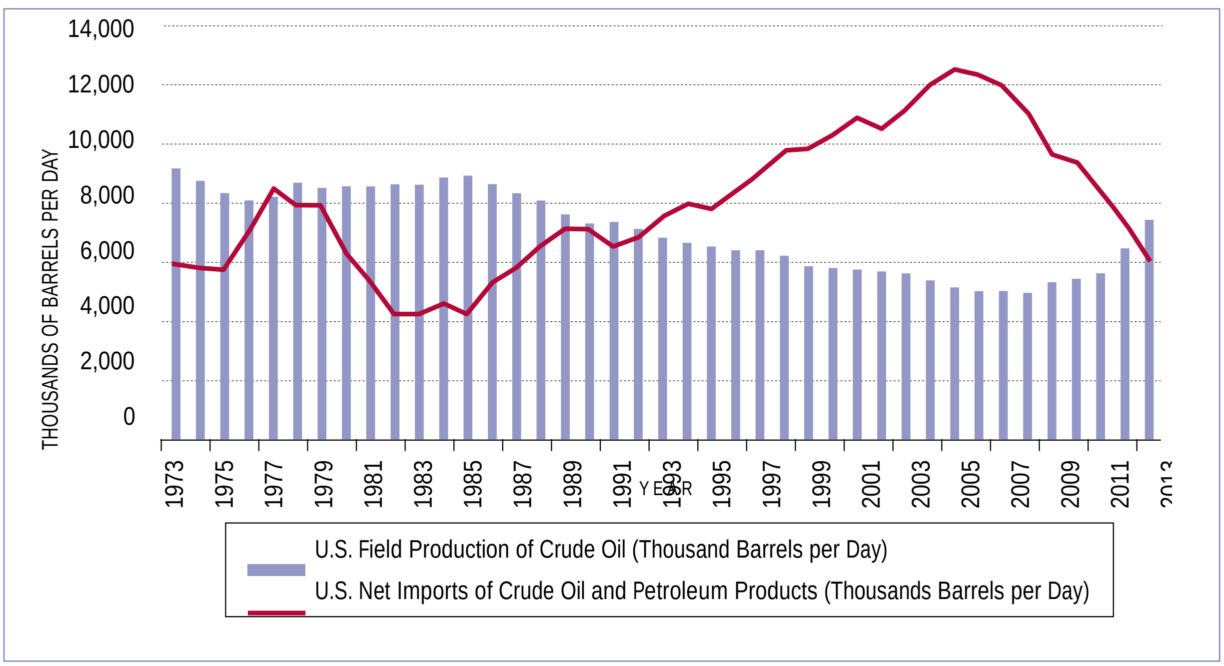
[22] EIA, "Petroleum Chronology of Events: Arab Oil Embargo of 1973," U.S. Government, www.eia.gov/pub/oil_gas/petroleum/analysis_publications/chronology/petroleumchronology2000.htm.
[23] For an in depth explanation of the EPCA, refer to Chapter 2 – Legal Framework.
[24] Yergin, *The Prize: The Epic Quest for Oil, Money & Power*, 663-664.
[25] EIA, "Petroleum Chronology of Events."

Still, the ban on crude oil exports remained until President Reagan in 1981 abandoned the phased decontrol of oil prices and lifted the ban on petroleum products.[26]

Contrary to expectations, the EPCA failed to con- trol prices, which nearly doubled in 2013 dollars from $49.93/bbl in 1975 to $92.08/bbl in 1981,[27] largely as a result of turmoil in the Middle East following the overthrow of the Shah of Iran and the outbreak of the Iran-Iraq War. Escalating pe- troleum prices stimulated fuel switching in the electric power sector from oil to other types of electricity. High prices led to major fuel switch- ing, nearly eliminating oil demand in the electric power sector. Overall, the growth of alternative energy resources and innovations in fuel-effi- cient plants and new energy technology led to a reduction in consumption. These structural changes led to a collapse in oil prices in 1986 and fears that the U.S. as a high-cost oil producer would see its production collapse. These events led to calls for oil import fees to protect the U.S. from a flood of cheap imported oil, especially from the Arabian Gulf.

Throughout the 1980s and 1990s and well into the 2000s, U.S. oil production continued to fall while imports of crude oil and petroleum prod- ucts rose (see Figure 1) as OPEC nations contin- ued to produce at high volumes, not realizing the profound shifts that had occurred in the demand for oil as a result of high prices. As the change in market dynamics became manifest and prices fell to low levels in 1986, domestic producers began to curtail new production and scrambled to stay

Figure 1: U.S. Oil Production to Imports, 1973-2013



Source: U.S. Energy Information Administration, "Petroleum and Other Liquids"

[26] The ban on petroleum product exports, including gasoline, was lifted in 1981. See Daniel Yergin and Kurt Barrow, "Why the U.S. needs to lift the ban on oil exports," *The Wall Street Journal*, 18 June 2014, http://online.wsj.com/articles/why-the-u-s-needs-to-lift-the-ban-on-oil- exports-1403133535.

[27] BP, "Statistical Data Workbook," June 2014, www.bp.com/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-ener- gy/statistical-review-downloads.html.

in business. For those producers that survived, the lesson learned was clear: if prices rise, U.S. oil production will rise; and if they drop, U.S. pro- duction will drop.

World oil prices recovered in the early 1990s, only to tumble again in 1998 as new fuel econ- omy standards, enhanced energy efficiency, re- newables, coal, and nuclear again took a toll on OPEC's efforts to maintain prices. Downwards price pressure also was affected by OPEC's deci- sion not to cut back production despite Iraq's re- entry into the export market, the Asian financial crisis which severely curtailed demand, and near panic about the spread of bird flu which severely cut back on aviation fuel demand.

However, by the early 2000s the emergence of the BRICS and their skyrocketing economic growth rates caught the market off guard. Without the availability of an excess in capacity or large in- ventories, this surge in demand led to the re- emergence of OPEC as a dynamic force in world markets as price became the only tool to control the market. This surge in prices generated concern about the staggering size of the U.S. oil import bill and the impact that high oil prices were having on the global economy. This turnaround in the mar- ket led to renewed interest in unconventional oil and natural gas, which some independents had been talking about for years. From 2008 to 2013, oil production rose by nearly 2.5 mbd with the ma- jority of gains being in unconventional resources such as tight oil plays.[28] In 2012 alone, crude pro- duction rose 0.835 mbd, and then in 2013 rose 0.954 mbd.[29] EIA's 2014 reference case projects unconventional production to jump to 4.8 mbd by 2019 and then peak.[30] Almost the entire growth in tight oil production is projected to come from the Eagle Ford field and the Permian Basin in Texas and the Bakken reservoir in North Dakota.[31] Some analysts believe that other areas, such as the Utica Basin, may see significant production gains.

reflections on the era of 'scarcity'

After nearly 40 years of global economic and fi- nancial instability, including oil price shocks oc- curring multiple times from 1973 through 2008, political volatility in the Middle East and other major oil producing countries, the Iranian hos- tage crisis, the rise of global terrorism, and three major wars involving threats to global oil sup- plies, a "scarcity mindset" has become ingrained in American consumers and many members of Congress. In reality, the U.S. did not experience a physical scarcity of oil after 1973; rather, the shortages were the result of price and allocation controls that created a false and self-inflicted sense of vulnerability. The economic threat the U.S. has faced over and over again is oil price volatility, and the pain of trying to adapt to rap- idly escalating prices. Yet politicians and pundits have misunderstood the price threat as one of "scarcity" and thus have channelled policy in the wrong direction: to mitigate high gasoline prices by husbanding domestic supply while protecting the industry from foreign competition through a variety of mechanisms (oil import fees, volumet- ric quotas on imports, etc.)

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[28] EIA, "Crude Oil Production," U.S. Government, www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbblpd_a.htm.

[29] Ibid.

[30] EIA, "Lower 48 onshore tight oil development spurs increase in U.S. crude oil production," EIA Annual Energy Outlook 2014, U.S. Govern- ment, December 2014, www.eia.gov/forecasts/aeo/MT_liquidfuels.cfm.

[31] Some independent consultants believe that EIA's estimates are often too low from what actually is occurring in the market and that the EIA may be incorrect and that U.S. production may soar to even higher levels than in EIA's reference forecast. For example, there are analysts such as Ponderosa who believe that condensate reserves in the Utica basin which are listed by the EIA as zero may be larger than all the condensate in the referenced above basins. EIA's mandate does not correct for any policy changes. In addition, many other forecasters are not necessarily more accurate. The reason many production estimates are so far apart is that drilling in these areas on a large scale only recently commenced. Consequently, we are only now starting to learn about the longer term production rates of wells.

energy independence vs. energy security

Since the 1973-1974 oil embargo, U.S. policymak- ers often have confused energy dependence and the vulnerability posed to U.S. energy security by America's large dependence on oil imports. How- ever, there is a substantial difference between de- pendence and vulnerability. It is the high concen- tration of cheap petroleum reserves in unstable regions of the world which impose risks to the U.S. and global economy. Production in these re- gions can and has been disrupted, spiking world oil prices while imposing large costs to the U.S. and international economy. As pointed out in this report, rising U.S. production does not protect the U.S. economy completely from supply disruptions in the world market, but it does reduce wealth transfers from the U.S. to foreign sellers and adds resiliency to the U.S. and allied economies from the threat or the reality of periodic disruptions. Hence, U.S. production provides a higher level of energy security. More importantly, restricting U.S. exports does not reduce the costs of disrup- tions to the U.S. economy and to the extent that limiting U.S. exports reduces U.S. crude oil pro- duction, it both increases dependency while at the same time increasing vulnerability. Even in the case where dependency (as measured by gross imports) declines, if domestic production also de- clines, vulnerability increases.

return of the era of abundance

As noted, from 2008 and 2013 U.S. oil production rose nearly 2.5 mbd, transforming U.S. oil import dependency.[32] It also helped to offset the loss of other global production shut in, as noted, from political turmoil in a number of countries while keeping global crude prices from skyrocketing. At the same time, the nature of oil production changed in the United States as light crude oil ac- counted for nearly all this new production mak- ing it difficult for many refineries in the United States, built to process heavy crude oils, to process this oil. This situation is complicated by a lack of pipeline infrastructure to transport this new oil production from its new locales. Much of the light crude oil is being produced in locations far from the existing pipeline networks, and only the steep price discount has allowed a massive invest- ment in railroad, barge, and truck infrastructure to move it to market. To this day, pipeline infra- structure is lacking, a situation highlighted by the absence of final decisions on the Keystone XL pipeline and other pending pipeline infrastruc- ture approvals.[33]

The impact of this change has been transforma- tive for various parts of the country. In Petroleum Administration for Defense Districts[34] (PADDs) 2 and 3, domestic production has replaced al- most all non-Canadian light crude imports, while PADD 1 dependence on imported light sweet crudes has fallen in spite of significant infrastruc- ture constraints (see Figure 2 for 2012 PADD refinery capacity). PADD 5 has also seen major reductions in oil imports. Another market change has been the rise in light crude exports to Eastern Canada (allowed under the EPCA and the Export Administration Act of 1979 [EAA]). The resur- gence of American crude oil and NGL production has the potential to restore the United States as a "global powerhouse" in liquids production.[35]

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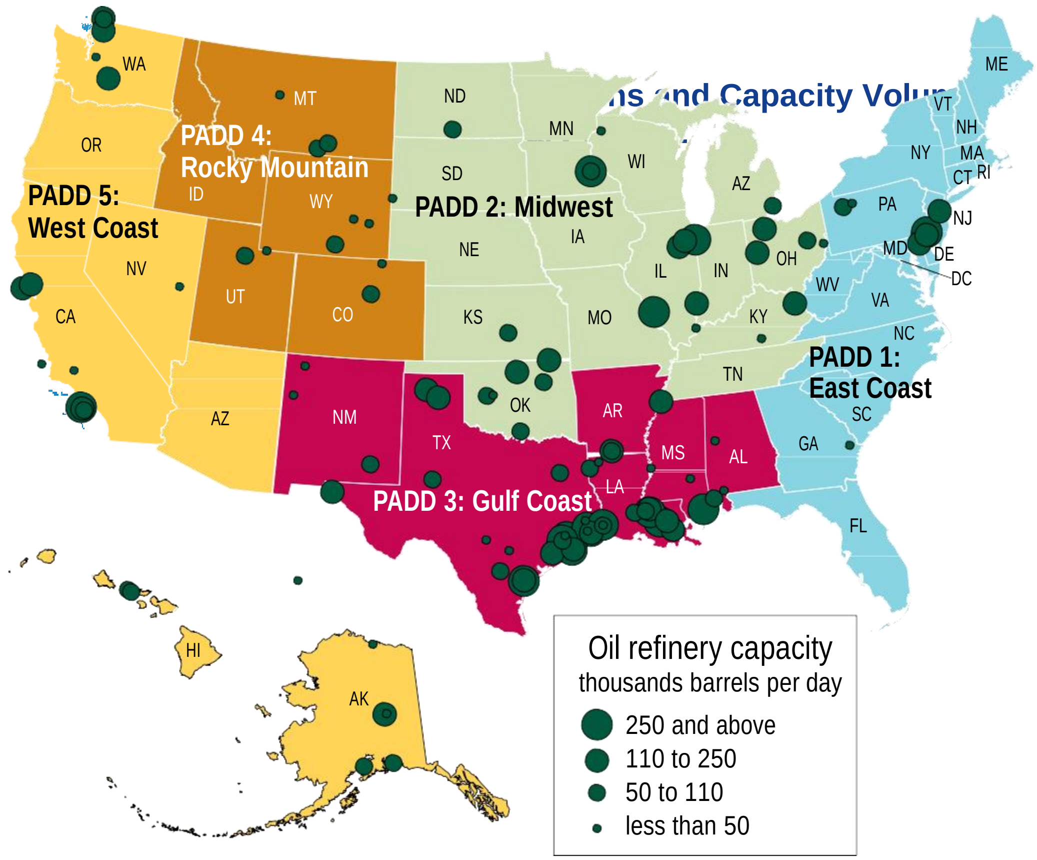
[32] EIA, "Crude Oil Production," U.S. Government, www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbblpd_a.htm.

[33] Roger Diwan, "The Unbearable Lightness of U.S. Crudes: When Will the Levee Break?" PFC Presentation at the Center for Strategic and International Studies, Washington, D.C., February 2014, p.13, http://csis.org/files/attachments/120210_Diwan.pdf.

[34] Petroleum Administration for Defense Districts (PADDs) are regions of the 50 states and the District of Columbia categorized into five districts. PADDs help illustrate data patterns of crude oil and petroleum product movements throughout the United States. See EIA, "PADD regions enable regional analysis of petroleum product supply and movements," U.S. Government, www.eia.gov/todayinenergy/detail.cfm?id= 4890.

[35] Kah, "The Need for U.S. Crude Exports."



Source: EIA Today in Energy, "Much of the country's refinery capacity is concentrated along the Gulf Coast," EIA, U.S. Government, 19 July 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=7170.

Despite these trends and the restoration of America's role in the global energy economy, storm clouds linger on the horizon, especially in PADD 3 and, to a lesser extent, PADD 2. The crux of the problem is the growing surplus of light sweet crudes for which there is inadequate refinery infrastructure. Given projections of further substantial growth in U.S. oil production, the inability of existing U.S. refinery capacity to process the growing production of light sweet crude oil forms the cornerstone of the policy debate over the ban on crude oil exports.[36]

As noted, since 2008 U.S. oil production has risen dramatically and is scheduled to rise further before it peaks in 2019, according to EIA's Annual Energy Outlook 2014.[37] However, despite the likelihood of these projections actually coming to pass or being surpassed, most members of Congress and much of the American populace simply either are unaware of these facts or are skeptical of oil industry assertions that a glut will emerge. Consequently, trying to point out that the United States actually has an abundance of oil and gas and that restrictions on crude oil exports are no

[36] Hax, "The Need for U.S. Crude Exports."

[37] EIA, "Annual Energy Outlook 2014," U.S. Government, 7 May 2014, www.eia.gov/forecasts/aeo/

longer needed is extremely politically conten- tious. The notion that the market will function efficiently is simply not believed by many people and is mistrusted by others, including members of the political establishment. Americans strongly believe that dependence on imported oil threat- ens national security, poses grave threats to both the domestic and international economy, and that moving towards "energy independence" is essen- tial to the success and prosperity of the United States.[38] With such a mindset, which has been in- grained over 40 years, it is exceedingly difficult for the public to grasp the possibility that the United States can export crude oil without endangering national security or economic prosperity.

In the subsequent chapters, we state why we be- lieve that lifting the ban on crude oil exports will in fact bring strong benefits to the U.S. economy and national security while opening up new opportu- nities for U.S. foreign policy. We also hope that critics of lifting the ban will look at past attempts to "protect" the domestic industry, such as the Voluntary Oil Import Program (1957-1959) and Mandatory Oil Import Program (1959-1973), the price and allocation controls of the 1970s which extended into the mid-1980s, calls for oil import fees and so on, and will realize that in every case, (rather than protecting the American consumer) such policies facilitated scarcity, whereas today the United States has crude oil abundance.

[38] John Pappas, "Texas A&M poll shows American support renewable energy—but don't want to pay for it at the pump," Dwight Look College of Engineering, Texas A&M University, 9 November 2012, http://engineering.tamu.edu/news/2012/11/09/texas-am-poll-shows-americans- support-renewable-energy-%E2%80%94-but-dont-want-to-pay-for-it-at-the-pump.

3. Legal Framework

The laws and regulations governing the U.S. export of energy have evolved in response to changing market conditions, perceived threats to U.S. national security, and concerns regarding the health of the domestic oil industry. During this evolution, they have become more complex and laden, with a host of exceptions and restrictions on whether and how particular hydrocarbons can be moved at all. The President retains the power to allow exports of all energy forms and the power to restrict exports of energy currently allowed, if the President finds that national circumstances necessitate. In this chapter, we review these laws and regulations to explain how we got to where we are today. We examine how changing market conditions have led to the relaxation of previous restrictions, and discuss how exports may be li- censed today, even when a broad legislative ban on crude oil exports persists.

The Energy Policy and Conservation Act of 1975

As stated in Chapter 1, the EPCA was passed in reaction to the oil embargo of 1973 in an attempt to counter the drastic spike in oil prices and to ensure that U.S. consumers had adequate sup- plies of petroleum products. This act instilled the President with the authority to restrict the export of, "coal, petroleum products, and natural gas or petrochemical feedstocks,"[39] as well as crude oil if he or she determines such action to be in the national interest.[40] The EPCA vests the Secre- tary of Commerce and the Department of Com- merce's Bureau of Industry and Security (BIS) with the responsibility to implement any rules stipulated in the legislation, but mandates that both the President and the Secretary of Commerce shall, when imposing restrictions, ensure that the national interest is left "uninterrupted or unim- paired." Past administrations have allowed crude exports, determining that the national interest is protected through exchanges in similar quantities and quality either for convenience or enhanced transportation efficiencies with persons or the government of a foreign state; and/or temporary exports for convenience or increased transporta- tion efficiency across parts of an adjacent foreign state which exports re-enter the United States and the historical trading relations of the United States with Canada and Mexico.[41] The BIS has also allowed:

[39] Energy Policy and Conservation Act of 1975, P.L. 94-163, 89 Stat.871, U.S. Government, 22 December 1975; for similar provisions in the Export Administration Act of 1979 see 50 USCS Appx 2401 et seq.
[40] Ibid., Section 6212 (b)(1).
[41] Ibid., Section 6212 (d).

- exports from Alaska's Cook Inlet;
- exports to Canada for consumption therein;
- exports in conjunction with refining or for exchanges of oil in the Strategic Petroleum Reserve;
- exports of heavy California crude not in excess of 25,000 b/d;
- exports provided for in certain international agreements;
- exports consistent with presidential findings under certain legal statutes;[42] and
- exports of foreign oil (predominantly Canadian) where the exporter can prove that the crude is not of U.S. origin or has not been co-mingled with U.S. crude.[43]

These allowable export categories are codified in the BIS's Short Supply Controls, which are explained later in this chapter.

the export administration act and the international emergency economic powers act

In addition to the EPCA, the Export Administration Act (EAA) grants the President the right to regulate exports for reasons of national security, foreign policy, or short-term supply shortfalls. It authorizes the President to establish licensing mechanisms while placing clear limits on his/her authority.[44] Although the EAA expired in August 2001, its provisions and the regulations pursuant to it, administered by the BIS, remain intact via the International Emergency Economic Powers Act of 1977 (IEEPA) which authorizes the President to, "deal with any unusual and extraordinary threat, which has its source in whole or substantial part outside the United States, to the national security, foreign policy, or economy of the United States, if the President declares a national emergency with respect to such a threat."[45]

secondary legislation regarding export controls

In addition to the EPCA and the EAA, other statutory regimes impose additional limitations on exports. The Mineral Leasing Act of 1920 (MLA) prohibits exports of domestically produced crude oil transported by pipeline over federal rights of way,[46] namely over federal lands, imposing an additional restriction on otherwise qualified export transactions such as swaps. The Outer Continental Shelf Lands Act (OCSLA) prohibits the export of crude oil produced from the Outer Continental Shelf,[47] and the Naval Petroleum Reserves Production Act (NPRPA), disallows the export of petroleum produced from these reserves.[48]

From a policy perspective, these statutes (OCSLA and NPRPA) are designed primarily to facilitate access to federal resources, with the export restrictions viewed as ancillary and embedded in secondary provisions. The main purpose of the MLA is to allow the construction of pipelines and other infrastructure to transport energy resources by granting rights of way over federal land for such pipelines.[49] The OCSLA was enacted to facilitate a regime for the development of deepwater resources, primarily in the Gulf of Mexico.[50]

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[42] For a delineation of these statutes see Phillip Brown, Robert Pirog, Adam Vann, Ian F. Fergusson, Michael Ratner and Jonathan L. Ramseur, *U.S. Crude Oil Export Policy: Background and Considerations*, Congressional Research Service, Washington, D.C., 26 March 2014, www.energy.senate.gov/public/index.cfm/files/serve?File_id=dfe108c9-cef6-43d0-9f01-dc16e6ded6b4.

[43] 15 CFR 754.2-Crude oil (i).

[44] P.L. 96-72.

[45] CRS, *U.S. Crude Oil Export Policy*, p. 6.

[46] 30 U.S.C. § 185(u).

[47] 43 U.S.C. 1354.

[48] 10 U.S.C. 7430(e).

[49] 30 U.S.C. § 185(a).

[50] 43 U.S.C. 1332.

The export restrictions under these laws can be lifted only by presidential executive orders, based on national interest findings; historically such orders have been entered into sparingly and under narrow circumstances (see Exhibit B in the Annex). The "national interest" criteria are extraordinarily broad supporting nearly every basis or justification for presidential action.[51] Such findings are not subject to any procedural requirements or to judicial review.[52]

In reality, these laws have had little impact on the scope of exports allowed by executive order. President Reagan made national interest findings under the EPCA, as well as the MLA, allowing crude oil exports to Canada.[53] On the other hand, in ruling on specific license applications, the BIS lacks the authority to waive the MLA or OCSLA restrictions, even when the export license meets the "national interest" criteria.[54] Although, these laws impose additional layers of prohibition and complexity to U.S. crude oil export restrictions they apply only to domestically produced oil. While these secondary statutes reinforce the President's authority to control crude oil exports, when produced or transported in different ways, they do not apply to the re-export of foreign-origin crude oil facilitating the export of Canadian crude oil from U.S. ports.

presidential authority to allow exports in the national interest

The authority to allow exports under the EPCA based on a national interest determination has been exercised by only three presidents on five different occasions. However, there have been a number of permits granted allowing exports under more narrow circumstances.

In 1985, President Reagan permitted crude exports to Canada. He again allowed crude exports to Canada produced from Alaska's Cook Inlet.[55] In 1988, he permitted the export to Canada of 50,000 b/d of Alaskan North Slope crude oil (ANS) that had been transported over the Trans-Alaska Pipeline.[56] In 1992, President Bush allowed 25,000 b/d of California heavy crude oil to be exported.[57] Lastly, in 1996, President Clinton expanded President Reagan's initial finding regarding ANS crude oil, allowing unlimited amounts of exports of ANS crude oil to any destination, provided certain transport conditions were met.[58] Currently, no ANS crude is exported outside the U.S. and Canada (see Exhibit B: Presidential Allowances for Crude Oil Exports in the Annex for further information). With the exception of ANS exports, all of the above-mentioned categories of exports require a license which BIS has granted on various occasions.[59]

Most of the above presidential actions have involved allowing crude oil exports to Canada, reflecting the unique commercial relationship reinforced by treaties such as the North American Free Trade Agreement (NAFTA).[60] The EPCA does not specifically set out criteria that the President should consider in making a "national interest" determination, which is not unusual. In all cases, however, the export permits were

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[51] 64 Fed. Reg. 73744.

[52] The Administrative Procedure Act (APA) does not apply to executive orders, allowing the President to act without any notice or public input. 5 U.S.C. 706. Moreover, courts are very reluctant to review Presidential actions authorized under a "national interest" or similar criteria.

[53] 50 Fed. Reg. 25189 (18 June 1985).

[54] 15 C.F.R. § 754.2(c).

[55] 50 Fed. Reg. 25189 (18 June 1985); 50 Fed. Reg. 52798 (26 December 1985).

[56] 54 Fed. Reg. 271 (5 January 1989).

[57] Presidential Memorandum of 22 October 1992, *Exports of Domestically Produced Heavy Crude Oil.*

[58] Presidential Memorandum of 26 April 1996, *Exports of Alaskan North Slope (ANS) Crude Oil.*

[59] 15 C.F.R. § 754.2.

[60] 42 U.S.C. 6212(d)(3).

viewed as having only a minimal impact on the U.S. economy.

Despite the fact that there are no restrictions on the export of petroleum products, the President, under the EPCA, has the authority to tighten re- strictions if found to be in the national interest. However, since export controls on refined petro- leum products were lifted in the 1980s, no presi- dent has exercised this power.[61]

regulatory controls on crude oil exports

The BIS export processes and procedures apply not only to crude oil exports, but also to all goods subject to export restrictions. Consequently, BIS regulations do not always address unique issues arising with crude oil export transactions. Soar- ing unconventional oil production has required the BIS to become more familiar with the oil in- dustry and to adapt its procedures to the indus- try's unique commercial environment. This issue has gained saliency over the past two years as the number of license applications has burgeoned. Similarly, the industry has had to become better informed about the BIS's licensing standards and processes in order to advocate effectively for their export applications. As noted, crude oil exports are governed by the Short Supply Controls, which generally require a license for the export of any hydrocarbon commodity falling within the defi- nition of "crude oil."[62]

If a product is governed by BIS regulations, a li- cense application must be filed and, if granted, exporters must abide by the license's terms. This often requires companies to implement signifi- cant compliance programs.

By comparison, a license is not required for petro- leum "products," including gasoline. Unfinished oils and topped crude oil can be exported without a license because they specifically fall outside the scope of the definition of crude oil.[63]

A company seeking reassurance in a close case that its product is not crude oil has the oppor- tunity to seek a classification ruling (in effect, regulatory approval) allowing the product to be exported without a license. The BIS has specific procedures in place for obtaining such rulings.[64]

While BIS export regulations are publicly avail- able, current law mandates that BIS maintain the confidentiality of all license applications, all relevant communications and deliberations, and the license itself.[65] Accordingly, even though the BIS enforces and administers its regulations con- sistently and by the book, without a political or policy-making agenda, the fact that the agency operates in a "black box" creates concerns about a lack of transparency over how its regulations are interpreted and applied. This lack of transpar- ency exists primarily because the BIS relies heav- ily upon the voluntary cooperation of the private sector. There is a long history of the Department

[61] When propane shortages occurred in the Midwest in the winter of 2013/14, stakeholders called on President Obama to restrict the exports of propane. They argued that, while the Midwest was suffering greatly as a result of propane shortages, large quantities were exported to foreign markets. See Julia Edwards and Sabina Zawadzki, "Analysis: Propane freeze squeeze may harden resistance to U.S. oil exports," *Reuters*, 26 January 2014, www.reuters.com/article/2014/01/26/us-energy-propane-usa-analysis-idUSBREA0P0K520140126.

[62] "Crude oil" is defined as "a mixture of hydrocarbons that existed in liquid phase in underground reservoirs and remains liquid at atmo- spheric pressure after passing through surface separating facilities and which has not been processed through a crude oil distillation tower. Included are reconstituted crude petroleum, and lease condensate and liquid hydrocarbons produced from tar sands, gilsonite, and oil shale. Drip gases are also included, but topped crude oil, residual oil, and other finished and unfinished oils are excluded." 15 C.F.R. § 754.2.

[63] 15 C.F.R. § 754.2(a).

[64] 15 C.F.R. 748.3.

[65] 15 C.F.R. § 748.1(c).

of Commerce protecting the commercial data in order to sustain long-term cooperation with the private sector. The BIS therefore protects the information of the private sector that might turn out to harm the competitive positions of U.S. companies across various commercial activities. There is no publication of BIS decisions or precedents on which applicants can rely. While the BIS alleges that it follows its own precedents, with no confirmation of this fact publicly available it appears that license applications are reviewed and granted on a case-by-case basis creating a situation where, often the only way to obtain a license is for each exporter to take its case directly to the BIS, either through a license application or commodity classification.[66]

Depending on the proposed export, the BIS may grant (what, for the purposes of this report, are termed) a "passport" license or a "transaction" license. While the formal regulations do not distinguish between these two types, the passport license holder can conduct any amount of the approved export transactions typically for a period of one year. The license holder does not have to use it. Licenses for exports of U.S.-origin crude oil to Canada are an example of a passport license.

Transaction licenses involve BIS review and approval of one-time transactions. They could be granted for an export transaction swapping the exported domestic crude oil for a corresponding import of crude oil or petroleum products of equal quality or quantity.[67] Generally, an application for a transaction license requires the submission of specific contract documentation that, if the license is granted, it will govern the entire transaction.

Exporters of crude oil apply for export licenses on the BIS Simplified Network Application Process-Redesign (SNAP-R) online application system.[68] The SNAP-R system, however, is not tailored to address specific export transactions, such as those executed in the commodities arena.

the case of condensate

The restrictions on the export of crude oil also apply to "lease condensate," also referred to as "unprocessed," "field," or "straight run," condensate. Condensate can be found as a gas separated from crude oil underground or even dissolved within the crude. This type of crude oil has been under much controversy lately as it has been accused of being mislabeled as a crude oil. Condensate is not identified or viewed in the industry as crude oil. In addition to the fact that it is comprised of lighter hydrocarbons and produced mostly from natural gas wells, lease condensate has distinguishing physical characteristics the most important of which is that lease condensate typically has an API gravity greater than 48 degrees. For example, Eagle Ford shale lease condensate often has an API Gravity of 60-70 degrees and sometimes exceeds 80 degrees.[69] In contrast, industry standards for light crude oil provide for an API gravity of 42 degrees or lower.[70] For reasons unrelated to export controls, the definition used by the Commerce Department is keyed to whether the hydrocarbon mixture has been distilled in any manner. "Lease condensate" thus is a hydrocar-

[66] 15 C.F.R. § 748.
[67] See e.g., 15 C.F.R. § 754.2(b)(2)(i).
[68] 15 C.F.R. § 748.1(d).
[69] Sandy Fielden, "With or Without Splitting? Changing Lease Condensate Export Definitions," RBN Energy LLC, 25 June 2014, http://rbnenergy.com/with-or-without-splitting-changing-lease-condensate-export-definitions.
[70] For example, NYMEX specifications for light crude oil include an API gravity of 37-42 degrees (CME Group, "NYMEX Rulebook – Chapter 200: Light Sweet Crude Oil Futures," New York Mercantile Exchange Inc., 2009, www.cmegroup.com/rulebook/NYMEX/2/200.pdf) and Light Louisiana Sweet specifications according to Capline Pipeline include a API gravity of 34-41 degrees (Capline Pipeline, "Light Louisiana Sweet (LLS) Common Stream Quality Program," 27 June 2007, www.caplinepipeline.com/documents/LLS_Specifications.pdf).

bon mixture included in the definition of "crude oil," as long as it has not been distilled.[71] On the other hand, any distilled hydrocarbon mixture is not "crude oil," but a product not subject to export restrictions.

The BIS recently was reported to have issued rulings to two companies, Pioneer and Enterprise, allowing condensate exports that classify as a "product" condensate processed through a field condensate distillation facility (CDF), also re- ferred to in the industry variably as a "splitter," "stabilizer," or other more technical terms. The product is referred to as "processed condensate." The BIS rulings are based on the fact that the pro- cessed condensate has been "processed though a distillation tower" in the CDF.[72] While there are many different distillation-based equipment and technologies, at its essence a distillation tower involves the use of heat, evaporation, and con- densation to fractionate the lease condensate into separate petroleum products.[73] From a regulatory perspective, these uses support the rulings that the distillation in the CDF produces a product—pro- cessed condensate—which is distinctly different from the lease condensate feedstock. Finally, the BIS apparently based its rulings on the fact that the regulations are designed to restrict the export of crude oil, while allowing freely the export of pe- troleum products. BIS recognized that processed condensate is much like other, readily exportable products, such as natural gasoline, produced in a gas processing plant, and refinery-produced naph- tha. These recent rulings illustrates that there may be incentives for producers to find low cost op- tions to make their condensate a product.

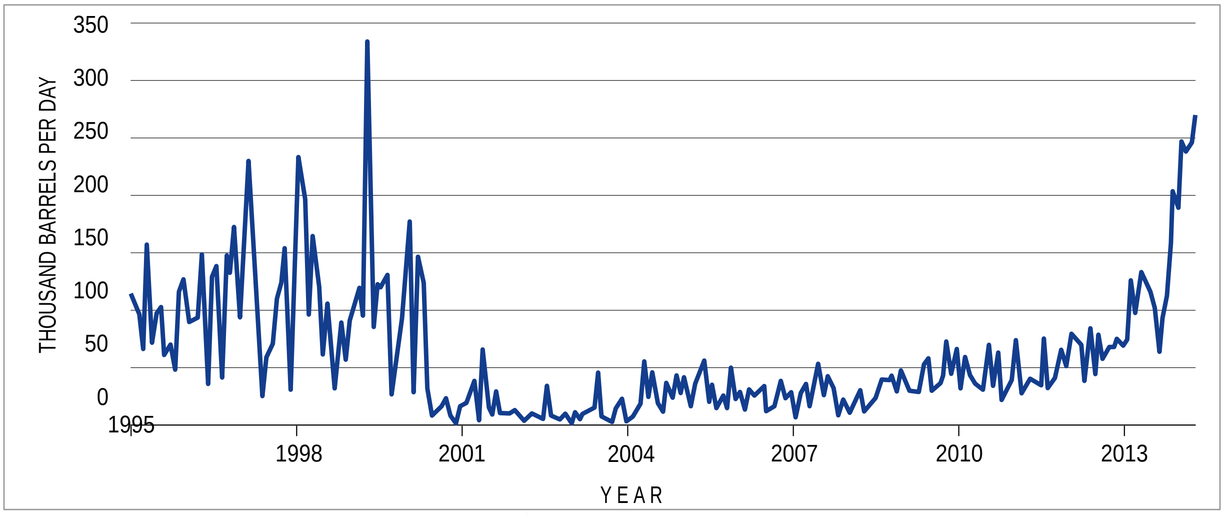
Exports of U.S. Crude Oil to Canada and Canadian Crude Oil

The vast majority of licenses have been granted for domestically-produced crude oil exported to Canada but the U.S. crude oil must be used or consumed in Canada.[74] While U.S.-origin crude cannot be diverted from Canada to third-country destinations, products refined in Canada from
U.S. crude can be sold anywhere. In April 2014, the United States exported the greatest volume (268,000 b/d) of crude oil in the last 15 years (see Figure 3). Most of it was shipped to Canada.[75]

In recent months, the BIS issued licenses for the export of Canadian crude from the United States. Canadian oil can be exported as "foreign" crude if it has not been commingled with any U.S.-origin crude oil. An export condition is that the Cana- dian crude must always remain segregated. An emerging issue with the re-export of Canadian heavy crude oil from U.S. ports has arisen regard- ing the possible blending in of a diluent of U.S.- origin containing "lease condensate," which the BIS defines as "crude oil." Previously, this "lease condensate" has been exported from the United States unblended with other diluent products. There is no issue when the diluent is of Canadi- an origin or when the U.S. diluent is a product that does not fall within the definition of crude oil, such as natural gasoline, naphtha, processed NGLs, or plant condensates. If a small quan- tity (more than a de minimis quantity of lease condensate as compared to the entire batch vol- ume) of U.S. lease condensate does find its way

[71] 15 C.F.R. § 754.2.
[72] Jennifer A. Dlouhy, "US challenges oil export ban with approvals for two Texas companies," *FuelFix*, 24 June 2014, http://fuelfix.com/blog/2014/06/24/feds-open-door-to-condensate-exports/.
[73] EIA Today in Energy, "Crude oil distillation and the definition of refinery capacity," EIA, U.S. Government, 5 July 2012, www.eia.gov/todayinenergy/detail.cfm?id=6970.
[74] 15 C.F.R. 754.2(b)(1)(ii).
[75] EIA Today in Energy, "U.S. crude exports in April rise to highest level in 15 years," EIA, U.S. Government, 16 June 2014, www.eia.gov/todayinenergy/detail.cfm?id=16711.

Figure 3: U.S. Crude Exports, January 1995-April 2014



Source: U.S. Energy Information Administration, "Petroleum Supply Monthly"

into Canadian heavy crude oil as a diluent, it would not qualify for re-export from the United States.[76]

swaps and exchanges

A license option that has not been widely granted is to execute a swap transaction. To obtain such a license, an applicant must meet the requirements outlined in the "Commerce Department's License Requirements to Swap Crude Oil," see textbox.[77] The purpose of these restrictions on swap exports is to ensure that there is no "net" energy leakage from the United States owing to a particular export.

A swap license is difficult to obtain because the licensee must demonstrate that the export is justified for "compelling economic or technologi- cal reasons."[78] Compelling economic reasons can focus on the price discount between the grade of U.S. crude to be exported and the international

Commerce Department's License Requirements to Swap Crude Oil

1. Must demonstrate that the exported crude will be part of an "overall transaction."
2. This "overall transaction" must result *directly* in the importation into the U.S. of an equal or greater quantity and an equal or better quality of crude oil or petroleum products.
3. The applicant must demonstrate that for compelling economic or technological reasons beyond its control, the crude oil cannot reasonably be marketed in the U.S.
4. The transaction takes place only under contracts that may be terminated if the petroleum supplies of the U.S. are interrupted or seriously threatened.

[76] The option to export Canadian crude oil was enhanced this year when the BIS, wh stakeholders with guidance to address issues such as tank bottoms and pipeline in Generally speaking, BIS may deem an export of Canadian crude compliant where there has been very minimal interface in each phase of the transport and storage route with U.S.-origin crudes and where, additionally, such interface is solely incidental to the sequential use of pipelines or tanks. Therefore, while ensuring segregation may prove more challenging for storage in tanks and pipeline infrastructure, it is more readily demonstrable when Canadian crude oil is transported by rail.

[77] 15§ 754.2(b)(2)(i).

[78] 15§ 754.2(b)(2)(i).

price benchmark for a comparable grade (e.g. Brent-WTI). Compelling technological reasons could include the inability of domestic refineries, primarily configured to process heavy oils, to process the crude. Finally, the "overall transaction" requirement obligates the applicant to submit with its application contracts confirming that both the import and the export legs will occur.

It is unclear whether the "compelling reasons" need to apply to the specific exporter's circumstances or if they can be market-based. The latter would appear to be a more sensible approach from a regulatory standpoint, and would help to create market-wide certainty.

One impediment to a swap export transaction is the MLA restriction on the export leg of a swap transaction.[79] As noted, the MLA prohibits the export of domestically produced crude oil that is transported through pipelines crossing federal rights of way.[80] This restriction affects a large number of pipelines, especially in the western United States. In contrast, the MLA restriction is less of an impediment in Texas, where there is little federal land, and the oil is subsequently exported from the Gulf of Mexico, or where the crude oil is transported by rail, which is not governed by the MLA.

Determining whether a pipeline is subject to MLA restrictions is another complicated undertaking. The Department of Interior's Bureau of Land Management (BLM) is the government agency that grants rights of way over federal land for pipeline construction,[81] but there is no comprehensive list of pipelines that cross over federal lands. The BLM maintains records of all rights of way granted over federal land in its searchable database called LR2000.[82] It is difficult, however, to determine whether specific pipelines cross over federal land, because the LR2000 provides the company associated with the granted right-of-way rather than naming the specific pipeline. The safest approach to ascertain whether a pipeline crosses federal rights of way is to contact the pipeline operator, as the pipelines should possess records of all rights of way obtained during construction. Operators are not obliged, however, to share this information, placing a significant burden on the party designing the transaction.

Licenses for crude-for-crude exchange with adjacent countries can be obtained if the transaction promotes "efficiency of transportation" or "convenience."[83] Since licenses for exports to Canada are freely granted, this provision essentially only applies to exchanges with Mexico. "Convenience" is not defined but should likely include quality, price and other benefits. Importantly, unlike swap exports, an exchange with Mexico is exempt from the MLA pipeline restriction.[84]

There is no specific BIS precedent for what constitutes a permissible exchange, but based on BIS regulatory history, other federal regulations involving exchanges, and industry practice, the following factors appear to help create a permissible exchange: a single contract, a similar product—crude-for-crude, reciprocity, two or more

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79 30 U.S.C. § 185(u).
80 30 U.S.C. § 185(u).
81 30 U.S.C. § 185(a).
82 Bureau of Land Management, "Bureau of Land Management's Land & Mineral Legacy Rehost 2000 System - LR2000," U.S. Department of the Interior, www.blm.gov/lr2000/index.htm.
83 15 C.F.R. § 754.2(b)(2)(ii).
84 30 U.S.C. § 185(u).

physical transfers, separate locations, the economics justifying the exchange, and price adjustments for quality as well as other factors.[85]

Similar to Canada, Mexico is a special case for crude exports. The EPCA directs the President and the BIS to, "take into account the national interest as related to . . . the historical trading relations of the United States with Canada and Mexico."[86] Subsequent to the EPCA, Mexico became part of NAFTA. Currently, Mexico may not pose a significant option to reduce the potential emerging oil glut since Mexican crude oil exports have fallen over the last decade, from 2.1 mbd in 2004 to 1.3 mbd in 2012, largely as a result of falling production.[87] Consequently, based on this trend, swaps may not be the ideal route to alleviate the glut of crude oil when it emerges on the Gulf Coast (see Exhibit C: Other Export Transactions in Annex).

As described in depth in the previous chapter, the U.S. is currently undergoing a major energy sector transformation. While the patchwork of legislation and executive decisions described in this chapter were developed in response to the challenges of the time, re-examination of such restrictions and requirements, with an eye towards the challenges of today, is vital for the construction of a coherent energy policy. With a major oil glut in the United States on the horizon, perhaps it is time for policymakers to reassess past legislation, including outright bans on crude oil exports and bring them in line with this new energy era.

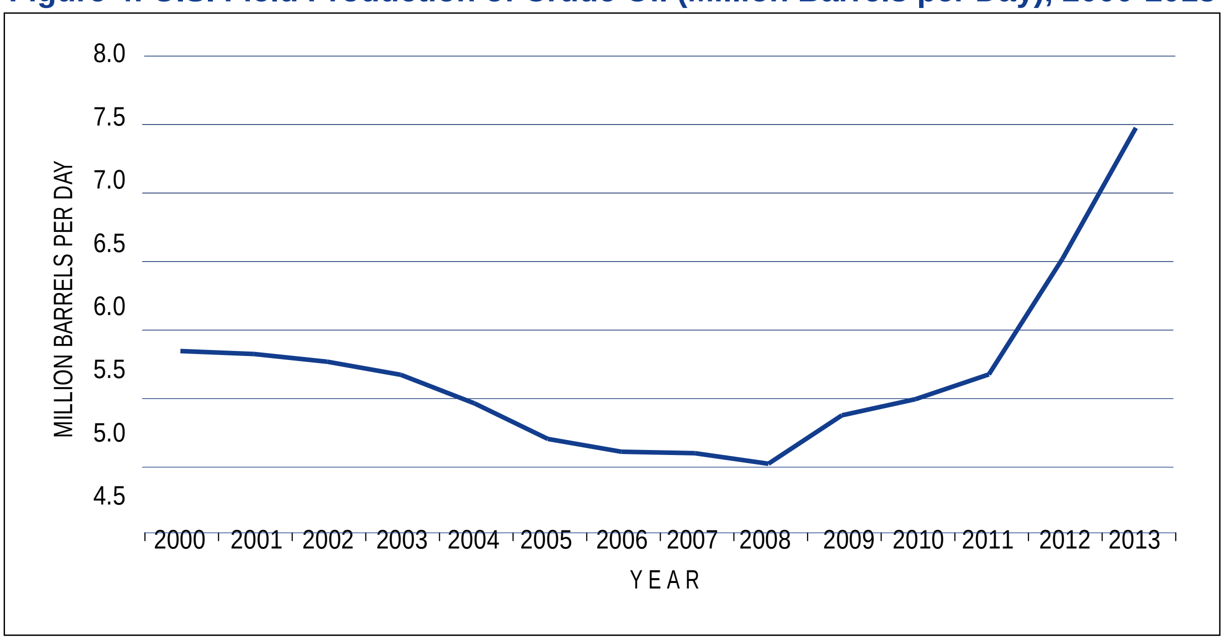
[85] EIA defines a "Petroleum Exchange" as a "type of energy exchange in which quantities of crude oil or any petroleum product(s) are received or given up in return for other crude oil or petroleum products. It includes reciprocal sales and purchases." See EIA, "Glossary," U.S. Government, accessed 17 July 2014, www.eia.gov/tools/glossary/index.cfm?id=E.
[86] 42 U.S.C. § 6212(d)(3).
[87] Murkowski, "A Ban for One."

4. Implications of the Potential Emergence of a Crude Oil Surplus

The pressure to revisit the wisdom of a crude oil export ban has arisen for several reasons. First, the crude oil being produced in ever greater volumes is not the same quality as crude U.S. re- fineries were designed to use. As noted, between 2008 and 2013, U.S. oil production skyrocketed by nearly 4 mbd (see Figure 4).[90] Much of this su- per light tight oil and condensate, however, have very high API gravities producing very different product yields than conventional crudes used by most U.S. refineries.

Second, the crude oil pipeline system was de- signed to move imported oil from the Gulf Coast to inland refineries, not to move oil to the Gulf Coast. These infrastructure discontinuities are

Figure 4: U.S. Field Production of Crude Oil (Million Barrels per Day), 2000-2013



Source: U.S. Energy Information Administration, "Petroleum and Other Liquids"

[88] EIA, "U.S. crude oil production in 2013 reaches highest level since 1989," EIA This Week In Petroleum, U.S. Government, 12 March 2014, www.eia.gov/oog/info/twip/twiparch/2014/140312/twipprint.html.

multifaceted: the new production in the Bakken is geographically dispersed; consequently, pipelines are not yet in place to bring the crude to market. East Coast and West Coast refineries, which use lighter grades of oil and import them from over- seas, are not connected by pipelines to the new producing areas, and the Jones Act requirement that U.S. oil be shipped only by U.S. merchant ma- rine (see box, "Requirements of the Jones Act") makes it impossible or uneconomic to deliver those crudes to East and West Coast refineries by water. Modifications to the Jones Act, including a time-limited waiver on crude oil, would allow a sensible option for U.S. refiners to compete for

U.S. crude in the near term. There is, however, limited but improving capacity to move oil in the midcontinent to Gulf Coast refining centers (see Figure 5).

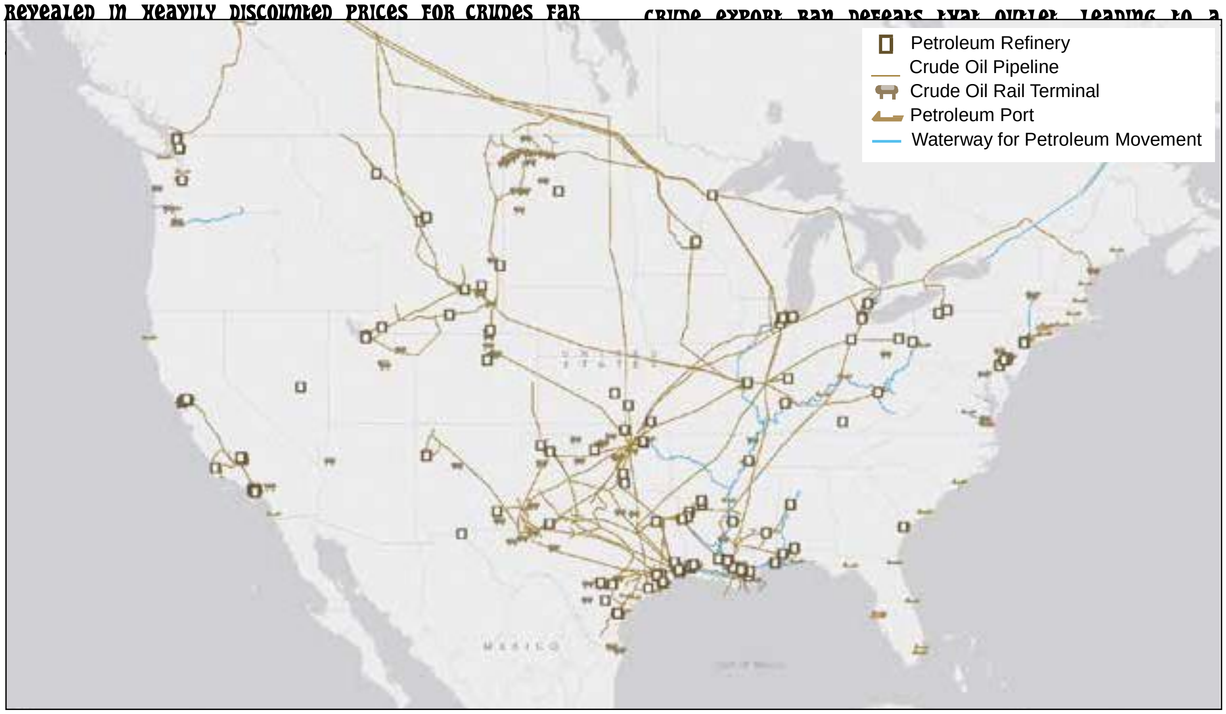
The market manifestation of these discontinuities is revealed in heavily discounted prices for crudes far

Requirements of the Jones Act

All goods transported between U.S. ports must be taken by U.S. ships. These ships must be:

- Manufactured in the U.S.
- U.S. flagged and owned.
- Operated by U.S. citizens and per- manent residents.

differential, between the price of U.S. and Canadi- an crudes and their international benchmark for the same crude quality represents the cost of the current export restrictions. These differentials oc- cur when the market for U.S. supply, in the case of LTO, can no longer process any additional LTO. Once the allowable demand is met, the U.S. price declines. In an open market, the balance would be exported, relieving pressure on international markets. The crude export ban defeats that outlet, leading to a



Source: EIA Energy Mapping System, www.eia.gov/state/maps.cfm

This market impact has been growing as U.S. LTO production grows. The concerns for policymak- ers are: whether the problem will fix itself; if not, what consequences will result from inaction; and whether relaxation of the export ban will result in net benefits for the U.S. economy.

will a surplus emerge?

Absent new investment in upgrading refineries, do- mestic oil prices will decline once existing outlets are subscribed. Investors need a policy signal to know whether to build new refineries, more splitters,[89] or additional pipelines and terminals to export oil. Without that policy signal, investment is more likely to be sub- optimal. It is extremely difficult to project when U.S. refiners will stop being able to process all the LTO coming onto the market and how disrup- tive this may be without knowing how fast U.S. pro- duction will grow. All we can say is that EIA's and other government agencies' projections consistently have underestimated oil production growth, as tech- nology continually outpaces expectations.[90]

can the potential surplus of light sweet crudes be absorbed?

One of the central issues of the crude oil export debate is the degree to which the refinery indus- try will be able, both technically and financially, to absorb the surplus. As noted, three critical ques- tions in the crude oil export debate are: whether the U.S. refining industry will be able with ad- ditional investments to process the surplus, how much can be exported to Canada, and how much can be blended into the existing refinery mix. We believe there are limits to all three options.

Estimates vary as to when the existing system, con- sidering infrastructure improvements already un- der way, will reach capacity. Turner Mason, a lead- ing refinery analysis firm, estimates that production will exceed capacity by 2017; though other analysts, as well as NERA's data indicates this may occur in 2015. Exports to Canada may also reach a limit in 2016. As described in Chapter 2, under current BIS regulations, crude oil exports to Canada are exempt from restrictions. Consequently, eastern Canada has become a major export destination for U.S. crudes moving by rail and tank cars. Currently, eastern Canada imports about 500-700 mbd of light sweet crude, about 200 mbd of which come from the U.S. These volumes are expected to double this year. By late 2014 or early 2015, the advent of new pipeline supplies to eastern Canada from western Canada will begin to back out U.S. exports.[91] To deal with the crude glut, refinery capacity expan- sion plans have mushroomed (Table 1) leading crit- ics of lifting the ban questioning whether the mar- ket might not be taking care of the potential glut. NERA's analysis does not agree with this assess- ment, since it believes that this is an uneconomical way to deal with the potential crude surplus.

Money spent on refinery upgrades could be more productively invested elsewhere in the economy (as explained at the end of this chapter). A third question is whether PADD 3 (Gulf Coast) refiners might substitute imported medium crude blends with light domestic blends, reducing imports and absorbing significant flows of LTO. These medi- um-grade crudes, sourced primarily from the Middle East, will have to be priced competitively with domestic LTO to keep U.S. refiners from modifying their crude slates.[92]

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[89] Splitters or topping units are refineries which can be used for distillation of very light crude oils and condensates into products such as naph- tha, kerosene, diesel, and gas oil which can be freely exported under current law. See Kristen Hays, "Enterprise plans to export condensate soon, others may follow suit," *Reuters*, 25 June 2014, www.reuters.com/article/2014/06/25/us-usa-condensate-enterprise-prodt-idUSKBN- 0F02Z720140625.

[90] Adam Sieminski, "Outlook for Shale Gas and Tight Oil Development in the U.S." Presented at the Deloitte Energy Conference, Washington, D.C., 21 May 2013.

[91] Ibid., 4.

[92] Roger Diwan, "The Unbearable Lightness of U.S. Crudes: When Will the Levee Break?" PFC Presentation at the Center for Strategic and International Studies, Washington, D.C., February 2014, p.13, http://csis.org/files/attachments/120210_Diwan.pdf.

Table 1: Refinery Capacity Expansion Plans

	2014	2015	Total planned increase 2014-2015
North Dakota refinery additions	20	60	80
Refinery expansions	59	204	263
Condensate splitters	88	350	438*
Total refinery capacity	167	614	781*

Source: Edward L. Morse and Eric G. Lee, "Out of America: Aspects of the U.S. Crude Export Debate," Citi presentation in Center for Strategic and International Studies (CSIS), February 2014, 2.

* Total figures do not include 97 MBD of existing condensate splitter

Refinery economics limit the amount of LTO that can be absorbed without negatively impacting the products the refineries produce. The price of LTO will need to be heavily discounted to com- pensate, both to make it cheaper than the price of the current imported medium crude imports and to adjust for the impact on the product output.

U.S. LTO varies in API qualities from 30 degrees API to over 70 degrees API. It may be possible to absorb some of the lower-gravity crudes, but this is probably not the case for higher gravity crudes which are more similar to natural gas than con- ventional crudes. Because many U.S. refineries are designed or have been retrofitted to utilize heavy, sour crudes, they cannot readily process a large volume of LTOs. In the Bakken and Eagle Ford fields, a large volume of heavy oil has to be im- ported to blend in LTO feedstock. The economic merits of refining all these crudes is further com- plicated by the fact that some LTOs are more eas- ily used in petrochemical manufacturing, raising the question in some analysts' minds whether they should be exported as crude or used in higher val- ue domestic applications.[93]

From an economic perspective, one relevant policy question is: What is the most efficient use of the resource, i.e. what use provides the greatest net benefits to the U.S economy? Today, in the absence of a clear policy direction, refinery capacity expansion plans have grown (Table 1). A central conclusion of NERA's analysis is that the most efficient response is to allow excess crude to be used by consumers who will pay the highest value for it, providing the greatest net benefits to the U.S. economy. Building new refinery capacity, not to meet U.S. demand but simply to meet a legal restriction, produces lower income as well as fewer jobs. In addition, to in- crease the use of LTO and condensates in the U.S., refineries require significant investments ranging from $104 million to $390 million (see Table 2) with no certainty that there will be a demand for these products in the U.S. market.

Spending money to export hydrocarbons as prod- uct versus crude is not more beneficial simply be- cause money is spent to convert the crude into a product. The question is which pathway provides a greater net benefit. Put another way, could mon- ey spent on refinery upgrades be more produc- tively invested elsewhere in the economy? NERA's analysis (which we share) is that the net benefits of allowing an export option provides far greater net benefits to the U.S. economy, while still allow- ing the U.S. to be a refiner and product exporter.[94] Clearly the best markets for exports of U.S. LTO are overseas refineries possessing hydroskim- mers. U.S. LTO exports are likely find a market in Europe and in the Asia-Pacific region where hy- droskimming capacity is projected to be 9.1 MBD and 5.6 MBD in 2015 respectively.

93 Deborah Gordon Senior Associate testimony, "Should the U.S. oil export ban be lifted? The need for strategic thinking," Energy and Climate Program Carnegie Endowment for International Peace, 114th Cong., 2 April 2014, http://docs.house.gov/meetings/FA/FA18/20140402/102039/HHRG-113-FA18-Wstate-GordonD-20140402.pdf.

94 NERA, *Economic Benefits of Lifting the Crude Oil Export Ban.*

Table 2: NERA Break Even Calculations for Refinery Investments to Increase Use of LTO and Condensate

Company	Valero	Marathon	Marathon	Calumet & MDU
Refinery Name	Houston Refinery	Canton	Robinson	Dakota Prairie Refinery (new topping refinery)
Refinery Capacity (BSD)	160,000	80,000	212,000	NA
Increase in Light Sweet capacity (BSD)	90,000	25,000	30,000	20,000
Capital Investment ($)	$390,000,000	$104,000,000	$160,000,000	$300,000,000
Refinery Utilization (%)	86%	86%	86%	86%
Payback Period (years)	2.00	2.00	2.00	2.00
Crude Oil discount ($/bbl)	$6.90	$6.63	$8.50	$23.89
Completion Date (year)	2015	NA	NA	late 2014
Type of Refinery	Cracker	Cracker	Coking	Hydroskimmer

Source: NERA, Economic Benefits of Lifting the Crude Oil Export Ban

5. The Impact of the Crude Oil Export Ban on the U.S. Economy

In previous chapters, we examined the implications of the emergence of a possible crude oil surplus in the United States in the context of the existing legislative and regulatory frameworks. Given the likelihood of a surplus in excess of the ability of the U.S. refining system and other out- lets to process it, it is imperative that policymak- ers examine what the impacts would be if there were a change in policy. In this section, we ana- lyze the consequences of lifting the ban on crude oil exports including the key domestic policy is- sues and impacts on key stakeholders.

what volumes may be available for export?

Brookings asked NERA to assess the impacts of lifting the ban on crude oil and condensate ex- ports using EIA's reference case and high and low production forecasts from its AEO 2014 report. NERA was asked to assess the impacts of timing if the ban were lifted on crude and/or just con- densates alone in 2015 or if the lift were delayed. In addition NERA's model horizon covers 2015 (if the ban is lifted in 2015) to 2020, 2025, 2030, and 2035. NERA was also tasked to examine the economic impacts on the U.S. economy, includ- ing product prices, national welfare, and unem- ployment. NERA accounted for a number of sensitivities, including potential reactions by OPEC and scenarios of slow growth in Asia, the region driving global oil demand.

Below we discuss the impact of lifting the ban on crude oil exports and its effect on several sec- tors of the U.S. economy and world markets. We examine the likely impact on domestic gasoline prices, as well as whether lifting the ban will hurt some U.S. refiners currently benefiting from dis- tressed crude prices as a result of cargoes not hav- ing a ready logistics system to get them to market. We examine how lifting the ban is likely to affect domestic oil production. Finally, we assess which crude oil policy (lifting the ban, modifying the ban, or keeping it) will provide the greatest net benefit to the U.S. economy.

Before presenting our findings, it is important to note that currently the U.S. does not ban exports of petroleum products, coal, natural gas, petro- chemicals, and certain raw ultra-light oil com- ponents (such as natural gas liquids or plant con- densates). Over the past eight years (2005-2013), the export of these commodities increased nearly threefold, reaching 3.56 mbd in 2013.[95] The ex- port of these commodities has been a financial boon for the U.S. economy with petroleum prod- uct exports accounting for nearly $150 billion in

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[95] EIA, "Petroleum & other liquids exports," U.S. Government, 27 June 2014, www.eia.gov/dnav/pet/pet_move_exp_dc_NUS-Z00_mbblpd_a.htm.

2013, making the U.S. the largest exporter of petroleum products in the world.[96] The benefits of these exports raise the question of why crude oil should be treated differently from all these other oil-based products including gasoline.

key findings

The volume of oil the U.S. might export, if the crude oil ban is lifted, varies based on the international benchmark prices for matching grades of oil, the refinery demand for specific grades of oil, the grade of oil and what products can be made from it, and whether the U.S. will export condensates as well as crude oil. U.S. oil production levels vary significantly based on the available price of oil for a particular grade. As the ESI May 2012 report found in the case of LNG exports, there will be limits imposed by the market as to the volume of U.S. exports the global market can absorb.[97] The level available for export varies based on the amount of the resource available, domestic demand, the price, transportation costs, the availability of requisite pipelines, and other transportation modes to move the oil to export facilities and domestic refining capacity.

NERA's analysis shows that in the reference case, if the ban were lifted in 2015, U.S. crude exports could increase by 1.7 mbd in 2015 and decline to 1.1 mbd in 2035 (Table 3). In this scenario, the change in U.S. national unemployment would fall on average over 2015-2020 by 200,000 and gasoline prices decline by $0.09 in 2015. Comparatively, in the high oil and gas resource case (HOGR), in 2015 the U.S. could increase exports by as much as 2.5 mbd if the ban were lifted in 2015, rising to an increase of 5.2 mbd by 2035 (see Table 4). Additionally, in the HOGR, lifting the ban entirely in 2015 will lead to a drop in U.S national unemployment of almost 400,000 (double the reference case) on average between 2015 and 2020. Additionally if the ban is lifted in 2015, U.S. gasoline prices decline by $0.12 in 2015 in the HOGR. The more the U.S. exports crude oil, the greater decline in gasoline prices; when U.S. pro-

Table 3: Reference Case: Crude Oil Exports from U.S. (MBD)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	0.7	0.7	0.7	0.6	0.5
Crude Oil Ban Lifted in 2015	1.7	1.9	1.6	1.7	1.1
Asia Pacific Demand is Lower	1.7	1.8	1.6	1.4	1.0

Table 4: HOGR Case: Crude Oil Exports from U.S. (MBD)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	1.0	1.1	1.4	1.4	1.5
Crude Oil Ban Lifted in 2015	2.5	3.6	4.2	4.5	5.2
Asia Pacific Demand is Lower	2.5	3.4	4.1	4.4	5.1

Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

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[96] "Exhibit 9. Exports, Imports, and Balance of Goods, Petroleum and Non-Petroleum End-Use Category totals," U.S. Census Bureau, 6 February 2014, p. 16, www.census.gov/foreign-trade/Press-Release/2013pr/12/ft900.pdf.

[97] Ebinger et al., *Liquid Markets: Assessing the Case for U.S. Exports of Liquefied Natural Gas.*

duction peaks, the gasoline price benefit declines. Lifting the ban on just condensates in 2015 pro- vides less than half of this benefit with exports of 0.7 mbd in 2015 in the reference case and 1.0 mbd in the high case.

According to NERA's analysis, if the demand in the Asia-Pacific market falls (tables 3 and 4) U.S. crude oil exports would be minimally effected. For instance, in the reference case in 2015 and 2025 the amount of exports reflect a minimal difference (table 3). This scenario of a fall in Asia-Pacific de- mand is reflected by the possibility of major Asian nations (China, India, Indonesia, and Vietnam) increasingly shifting from industrial to service sec- tor economies. With this shift, oil demand in the industrial and manufacturing sectors will fall, lead- ing to a weakening in overall Asian crude oil de- mand. This trend will be exacerbated in the power sector, where coal and diesel remain very competi- tive and will back out much of the current demand for oil in power generation.

impacts on gasoline prices

A major public (and political) concern is whether allowing crude oil exports will raise prices for gasoline and other petroleum products. As coun- terintuitive as it may seem, lifting the ban actu- ally lowers gasoline prices by increasing the total amount of crude supply, albeit by only a modest amount. NERA shows that in the reference case, 2015 gasoline prices decline by $0.09/gallon if the ban on crude oil is lifted entirely in 2015 while we see no impact on gasoline prices from 2025 through the model horizon of 2035 (table 5). In the HOGR, prices decrease $0.12/gallon in 2015 and $0.10/gallon in 2025 if the ban is lifted by 2015 (table 6). Lifting the ban on condensates by 2015 reduces gasoline prices by $0.04/gallon in the reference case and $0.06/gallon in the high case in 2015 (tables 5 and 6, respectively).

Gasoline prices decline when the ban is lifted because they are set in the international market. The international price of crude declines as more U.S. oil enters the market, driving down gasoline prices. The lowering in gasoline prices indicated in tables 5 and 6 is based on a national average of gasoline prices, and may not actually reflect the changes on a regional or state level, where state gasoline taxes also will vary. Regardless of loca- tion, however, the data indicates that gasoline prices will fall across the board.

Table 5: Reference Case: Decrease in Gasoline Prices in U.S. ($/Gallon)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	-$0.04	-$0.02	$0.00	$0.00	$0.00
Crude Oil Ban Lifted in 2015	-$0.09	-$0.04	$0.00	$0.00	$0.00

Table 6: HOGR Case: Decrease in Gasoline Prices in U.S. ($/Gallon)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	-$0.06	-$0.04	-$0.03	-$0.04	-$0.04
Crude Oil Ban Lifted in 2015	-$0.12	-$0.10	-$0.10	-$0.07	-$0.08

Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

Table 7: Reference Case: Decrease in Gasoline Prices in ROW ($/Gallon)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	-$0.04	-$0.02	$0.00	$0.00	$0.00
Crude Oil Ban Lifted in 2015	-$0.10	-$0.04	$0.00	$0.00	$0.00

Table 8: HOGR Case: Decrease in Gasoline Prices in ROW ($/Gallon)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	-$0.06	-$0.04	-$0.03	-$0.05	-$0.04
Crude Oil Ban Lifted in 2015	-$0.13	-$0.11	-$0.10	-$0.08	-$0.10

Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

impact on global gasoline prices

As in the U.S., gasoline prices in the world market also decline the reference and the HOGR (tables 7 and 8, respectively). In the rest of the world (ROW), the change in gasoline price is minimal as the U.S. is already a substantial exporter of gaso- line and U.S. demand is projected to fall further as new CAFE standards ripple through the economy, freeing up more gasoline for export. The U.S. is al- ready exporting 2.759 mbd monthly of petroleum products since the export of products is allowed under U.S. law.[98] As a result, the impact of lifting the ban on condensate or crude oil entirely may be that only a relatively small amount of the ex- ports are made into gasoline in overseas markets where diesel rather than gasoline dominate trans- portation fuel markets. According to our analysis, in the reference case, the price of gasoline in the ROW decreases by $0.04/gallon in 2015 with the ban on condensates having been lifted in 2015 and $0.10/gallon if crude oil exports are allowed by 2015 (table 7). These price decreases disappear quickly, for both condensates and crude oil by 2025 in the reference case. In sum, we find there is no empirical foundation for the concern that exporting "our" crude and condensate will have a negative impact on consumer prices for gasoline.

impacts on u.s. refiners

As of 2014, the U.S. has about 18 mbd of operable crude oil distillation refining capacity, of which 51 percent is located on the Gulf Coast, PADD 3. These refineries typically use heavy and medium grades of crude oil[99] with traditionally lower-cost crudes. Over the last decade, significant invest- ments have been spent to modernize them. These heavy crudes constitute the primary form of U.S. crude oil imports. All U.S. refiners can sell their products at world market prices.

If the ban is lifted, prices for crude oil, especially that which is currently heavily discounted owing to shortfalls in logistics capacity to get it to market, will rise and that cost, plus the cost of transporta- tion, will be the refiners' acquisition cost. East and West Coast refineries already buy largely at inter- national prices. East Coast refineries utilizing Bak- ken crude must transport it by rail, costing nearly

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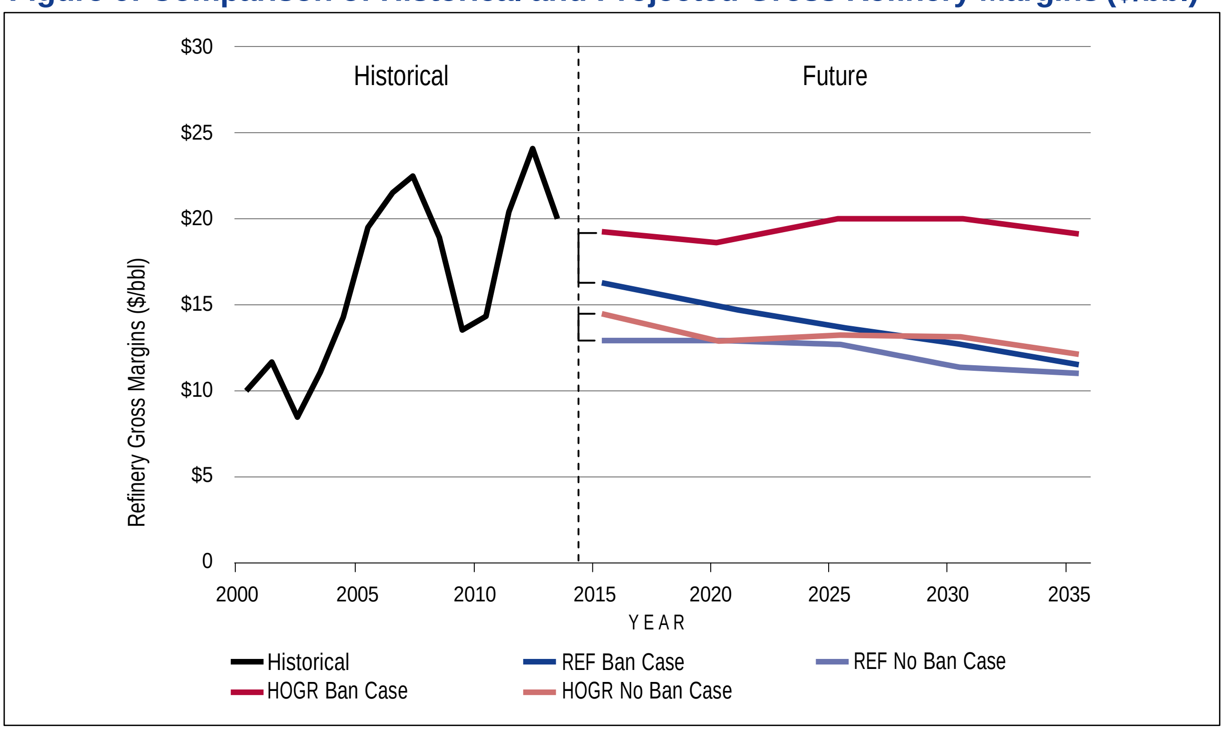
[98] EIA, "U.S. Exports of Crude Oil and Petroleum Products," U.S. Government, http://www.eia.gov/petroleum/data.cfm.

[99] EIA, "Number and Capacity of Petroleum Refineries," U.S. Government, http://www.eia.gov/petroleum/data.cfm.

$10-$15 per barrel.[100] These refineries represent approximately 2 percent of U.S. gasoline production.[101] Some Midwest refiners, which have bought light crudes at depressed prices owing to the lack of infrastructure to move those crudes out of Cushing, Oklahoma, and now off the Gulf Coast, will see higher acquisition costs.

From a policy perspective, two questions arise. One is whether U.S. policy should be based on shielding some industry subsectors from inter- national prices. Another is whether it is a viable business model for any industry to base its profit- ability on a protected market. Clearly, if the ban on crude oil exports is lifted, there will be some short-term dislocations in some sectors of the U.S. economy. In this case, certain regional re- fining processing centers are likely to be harmed by the movement towards free trade in crude oil. These refiners will experience downward pressure on their gross refinery margins merely returning them to their past averages (see Figure 6). These issues are serious for those companies involved and will entail real economic costs which should not be underestimated. These challenges may be particularly acute in the Northeast where some refinery closures may occur. We do believe that there are some short-term remedies which could ease the situation, such as granting a 2-3 year waiver of the Jones Act for the movement of crude oil within the United States. Nonetheless, despite these concerns, we believe based on above analy- sis that allowing goods to flow into the interna- tional market gives buyers access to competitive prices and sellers access to world market prices while enhancing free trade.

Figure 6: Comparison of Historical and Projected Gross Refinery Margins ($/bbl)*



Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*
* Historical data is from calculations using historical U.S. production and prices found on the EIA website.

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[100] Trisha Curtis et al., "Pipelines, Trains, and Trucks: Moving Rising North American Oil Production to Market," EPRINC, 21 October 2013, p. 33, http://eprinc.org/wp-content/uploads/2013/10/EPRINC-PIPELINES-TRAINS-TRUCKS-Oct31.pdf.

[101] EIA, "Refinery Net Production," U.S. Government, www.eia.gov/dnav/pet/pet_pnp_refp2_dc_rec_mbblpd_a.htm.

impacts on production

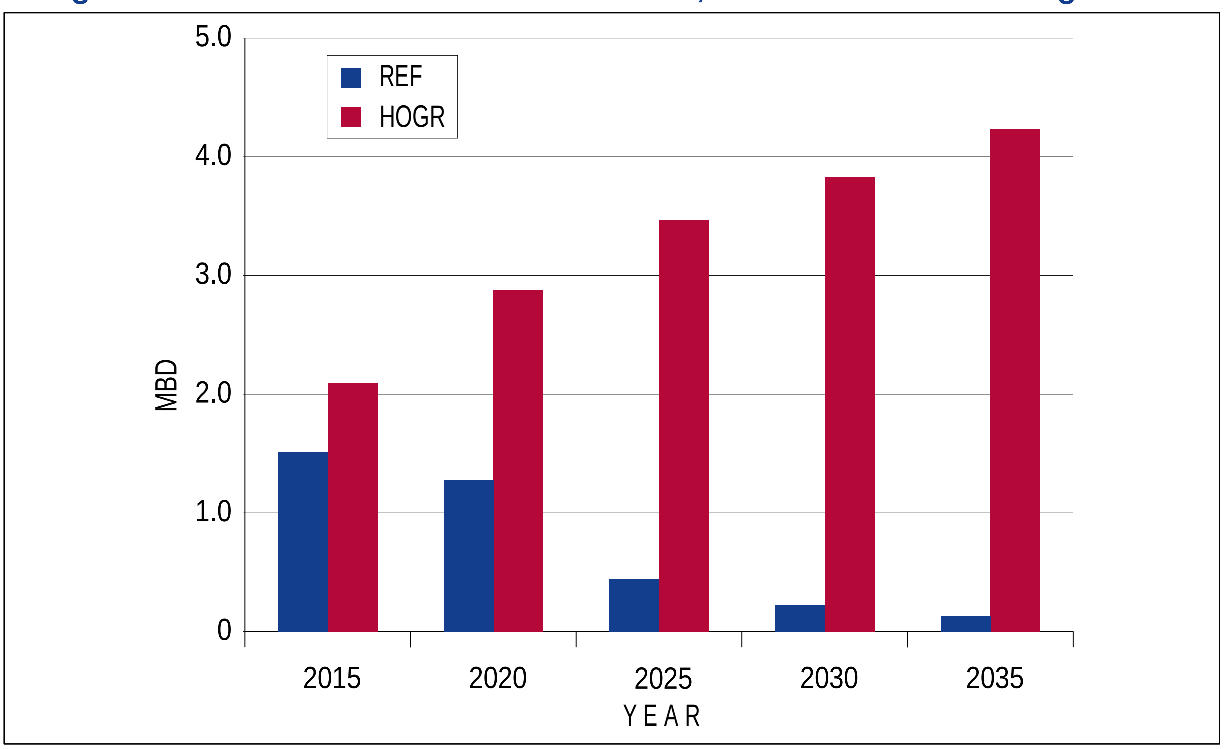
Our analysis shows that exposing U.S. producers to international prices increases U.S. production, sus- tains lower gasoline prices, and reduces unemploy- ment. In both the reference and HOGR scenario lifting the ban entirely by 2015 increases produc- tion. In the reference case that increment declines over time, while in the HOGR case it continues to grow to 4.3 mbd in 2035 (see Figure 7).

A significantly high portion of this growth, roughly 1.1 mbd in the reference case and 1.5 mbd in the high case will occur in PADD 3 (Gulf Coast) in 2015. PADD 2 (Midwest) is the second highest producing area at nearly 0.38 mbd in the reference case and 0.5 mbd in the high case (see Figure 8).

Rising U.S. oil production, primarily light oil pro- duction from the Bakken, Eagle Ford, and more recently the Permian Basin, has (combined with falling demand since 2008) been largely respon- sible for declining crude oil imports.[102] While the U.S. has ceased importing most light oils, a num- ber of producers believe that this trend will not continue if the ban is left in place. This issue is significant since as NERA shows the rise in the price earned by domestic producers after the ex- port ban is lifted leads to increased production, driving greater total oil supply and lower gasoline prices.

If the ban is left in place and price differentials be- tween U.S. and international prices grow to a point where new investment in oil production declines, the positive economic effects of that production

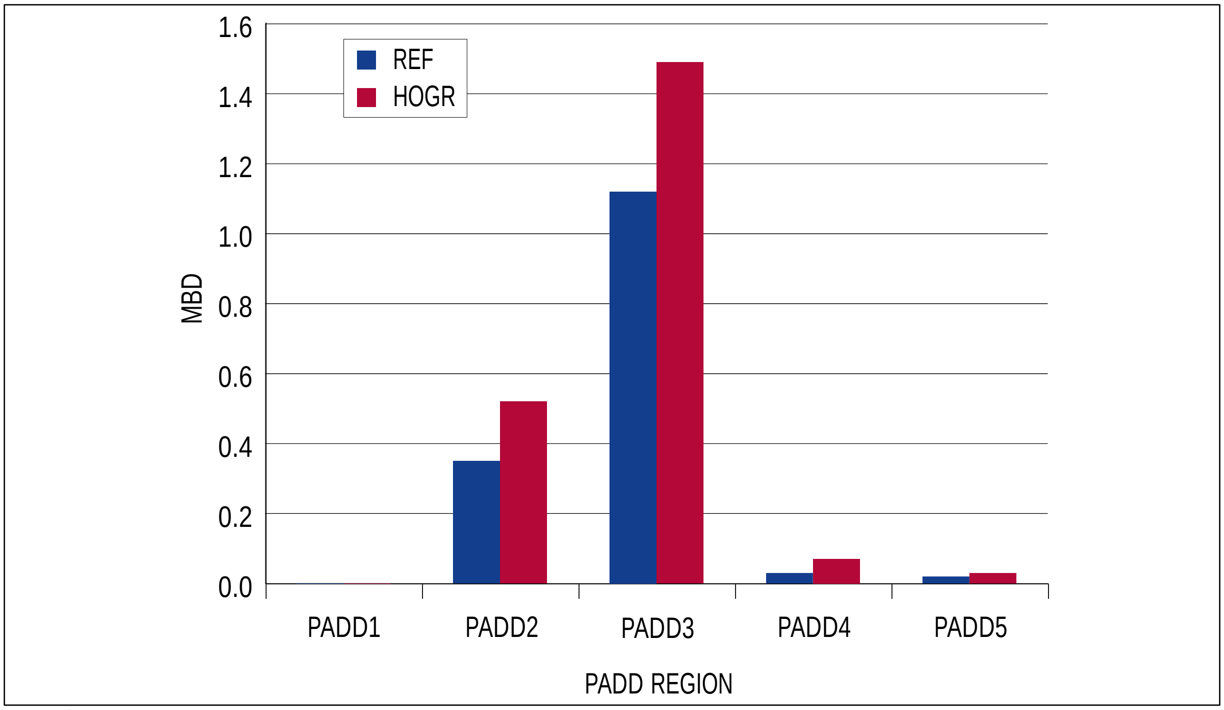
Figure 7: Incremental Crude Oil Production, Both Reference and High Case



Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

[102] EIA, "Market trends: Liquid Fuels," *EIA Annual Energy Outlook 2014*, U.S. Government, 7 May 2014, http://www.eia.gov/forecasts/aeo/.

Figure 8: Distribution of Incremental Production by PADD in 2015



Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

will recede. The current ban combined with the lack of transportation from Cushing, Oklahoma were significant factors leading to the emergence of large price discounting of WTI versus Brent crude. Since the end of 2010, that discount has averaged nearly $15/bbl, a major increase from the $1.41/bbl premium during the previous de- cade.[103] With crude exports constrained, the abil- ity of domestic producers to take advantage of the huge price arbitrage has been limited.[104] As existing outlets for that crude becomes fully sub- scribed, according to NERA, by 2015 the price discount could lead to a slowdown investment with smaller increases in LTO production. While we believe this is the most likely scenario, some market observers believe that if these discounts became large enough they could discourage new production resulting even in some existing un- conventional wells being shut in as uneconomic.

impact on the price of oil

Lifting the crude oil export ban will bring U.S. benchmark prices for crude closer to international prices, although the price of those benchmarks will decline as the result of competition from U.S. crudes. If the ban is lifted by 2015, according to the reference case, U.S. domestic crude prices will raise $2.44/bbl in 2015 and $3.52/bbl in 2020 (see table 9). In the HOGR case, prices will raise $2.17/bbl in 2015 and $4.28 in 2020 (see table 10). Furthermore as U.S. domestic crude prices rise, producers will look for more oil and with the ex- port ban removed will sell more oil on the inter- national market leading to a drop in international prices.

Lifting the ban on condensates does comparative- ly little to alter domestic crude oil prices. As table

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[103] EIA, "Cushing, OK WTI Spot Price FOB," U.S. Government, www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=A.
[104] Ibid., 5.

Table 9: Reference Case: Increase in Average Crude Oil Price in U.S. ($/bbl)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	$0.70	$0.93	$1.55	$0.86	$0.72
Crude Oil Ban Lifted in 2015	$2.44	$3.52	$2.17	$1.30	$0.89

Table 10: HOGR Case: Increase in Average Crude Oil Price in U.S. ($/bbl)

	2015	2020	2025	2030	2035
Condensate Ban Lifted 2015	$0.48	$0.55	$0.46	$1.12	$1.19
Crude Oil Ban Lifted in 2015	$2.17	$4.28	$6.04	$7.51	$8.58

Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

9 shows, in the reference case, lifting the condensate ban alone has a negligible impact on the U.S. domestic price of crude oil since the increase per barrel ranges from as little as $0.70/bbl in 2015 to as high as $1.55/bbl in 2025 before declining to $0.72/ bbl in 2035.[105] In the HOGR case, the U.S. produces more condensate than the global market can absorb, with the result that over time the price of crude increases by $0.48/bbl in 2015 and by 2035 the price increases to $1.19/bbl (see Table 10). If the ban is lifted, U.S. producers will be allowed to compete in the international market, adding to global oil supplies and driving down prices.

impact on the u.s. economy

Lifting the crude oil export ban brings benefits to the U.S. economy in all circumstances. The greater U.S. production is, the larger the economic benefits. The most important policy question surrounding lifting the crude oil export ban is the impact on the economy as a whole. Some of the distributional effects of a change in policy are obvious. Oil producers, especially those closest to existing export infrastructure, will enjoy higher sales prices by selling into the international market at global prices. Refiners, who enjoy protected prices, may see lower margins. Opposition to lifting the ban has been expressed by a few large petrochemical companies and some airlines concerned about the impact on aviation fuel prices if refiners start utilizing more expensive feedstocks.[106] Looking at the wider frame of how the U.S. economy benefits as a whole, the NERA analysis—using a computable general equilibrium model of the entire U.S. economy—presents a very different picture.

NERA finds that lifting the ban on crude oil exports will have a positive impact on GDP and welfare while reducing unemployment (please see NERA Methodology in the Preface for clarification on definitions and assumptions). NERA ran several different scenarios to crystalize projections of economic change in the United States as a result of lifting the ban. In addition, NERA examined how partially lifting the ban, by only allowing condensate exports, would affect the economy. They also looked at the costs and benefits in delaying lifting the ban until 2020 compared with other policy options.

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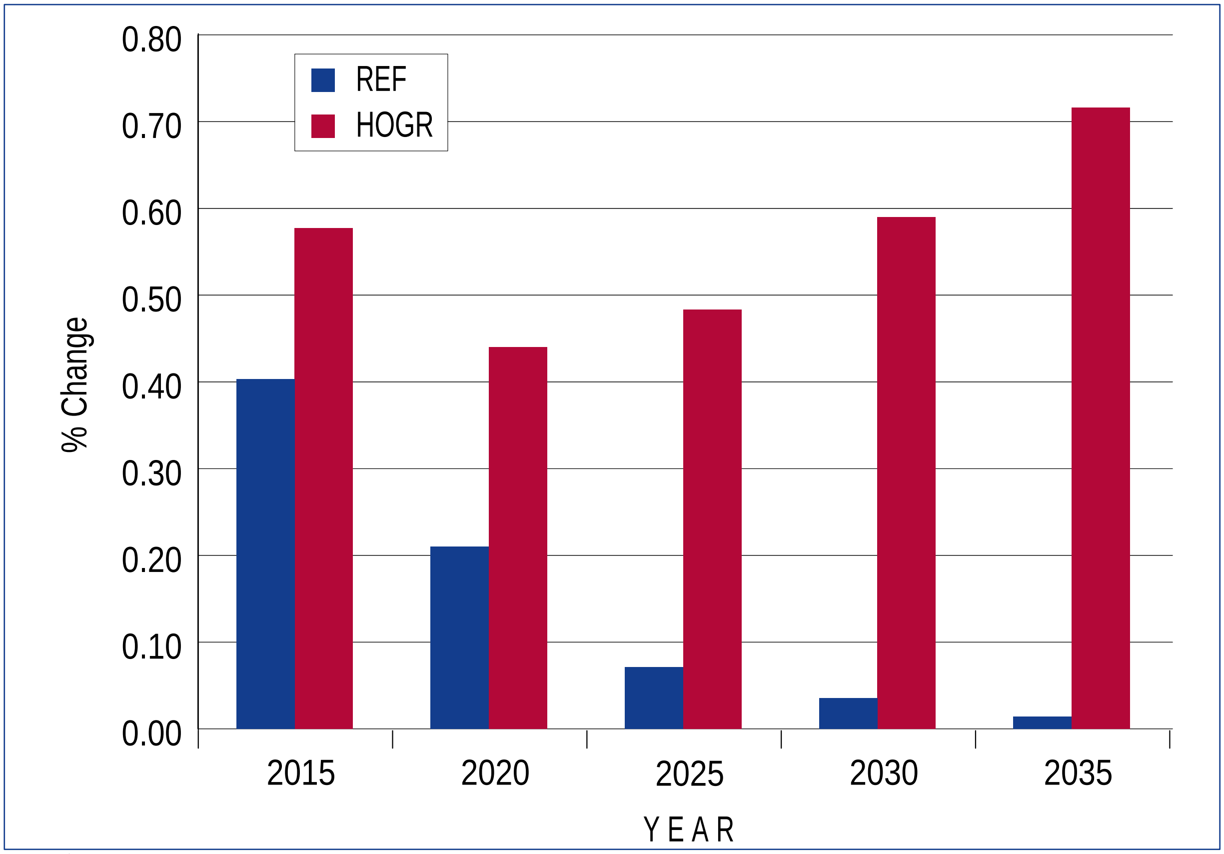
[105] 1 barrel equals 42 gallons.

[106] Graeme Burnett, "Prepared testimony of Graeme Burnett to Senate Energy Committee: Hearing on U.S. crude oil exports: opportunities and challenges," U.S. Senate, 30 January 2014.

Figure 9: Percentage Change in GDP When the Ban Is Lifted Immediately



Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

In regards to the impact on GDP, NERA found in the reference case that lifting the ban entirely by 2015 will result in an increased percentage change of 0.40 percent in 2015 (see Figure 9). While this percentage change may seem miniscule on the sur- face, there are very few actions that the U.S. gov- ernment can take that as a long-term instrument of economic policy would make as measurable a difference in the economy. According to NERA, in all three cases (delaying lifting the ban until 2015, lifting the ban only on condensates, or lifting the ban entirely) there are positive percentage change impacts on GDP. Throughout the model horizon in the reference case, the size of these benefits falls as oil production declines. In the high case, an initial spike in GDP occurs after the ban is lifted and con- tinues all the way to 2035 tracking closely, the high case increase in domestic production (see Figure 9). In short, increases in GDP move in conjunction with rising exports. Throughout 2015-2039, NERA finds that the discounted net present value of GDP in the reference case could be greater than $550 billion, while in the high case it could exceed $1.8 trillion. GDP percentage increases are greatest at the front end of lifting the ban and are in line with LTO production as it drops. In the HOGR case, an increase in the percentage change in GDP is main- tained through 2035, as it tracks closely with the continued increase in exports.

In addition to GDP, NERA examined the im- pact on U.S. welfare. NERA found that lifting the ban completely will have just over a 0.40 percent change in welfare in the HOGR case over the model horizon; however, there is an overall net benefit to welfare inciting a positive change in the

NERA's Definition of Welfare

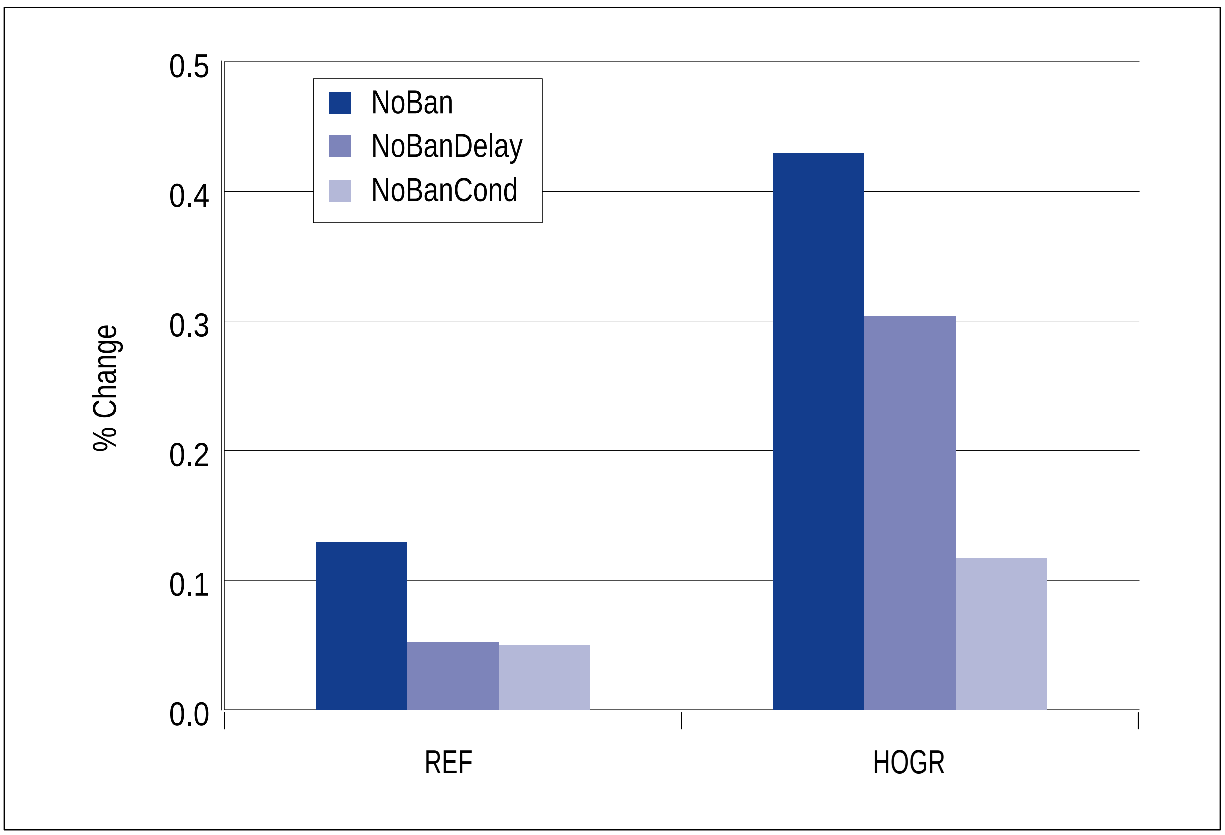
"The broadest measure of net economic benefits to U.S. residents is the measure of economic welfare, known as, 'equivalent variation.' The equivalent variation is defined as the amount of money that would have to be given to U.S. households to make them indifferent between receiving the money and experiencing the changes in prices and income associated with lifting the ban."

See NERA Economic Consulting, *Economic Benefits of Lift- ing the Crude Oil Export Ban*, prepared for the Brookings Institution, September 2014; and also, Hal R. Varian and Jack Repcheck, *Intermediate Macroeconomics: A Modern Approach*, 7th Edition. (New York: W.W. Norton & Company, 2010), 255-256.

U.S. economy across all scenarios. In the reference case (see Figure 10) lifting the ban entirely in 2015 will ignite approximately a 0.14 percent change in welfare while waiting until 2020 will generate only a 0.05 percent change (half of the 2015 lifting sce- nario which is similar to lifting the ban only for condensate). A critical NERA finding in the HOGR scenario (see Figure 10) is the higher production of crude oil leads to higher welfare benefits across all scenarios.

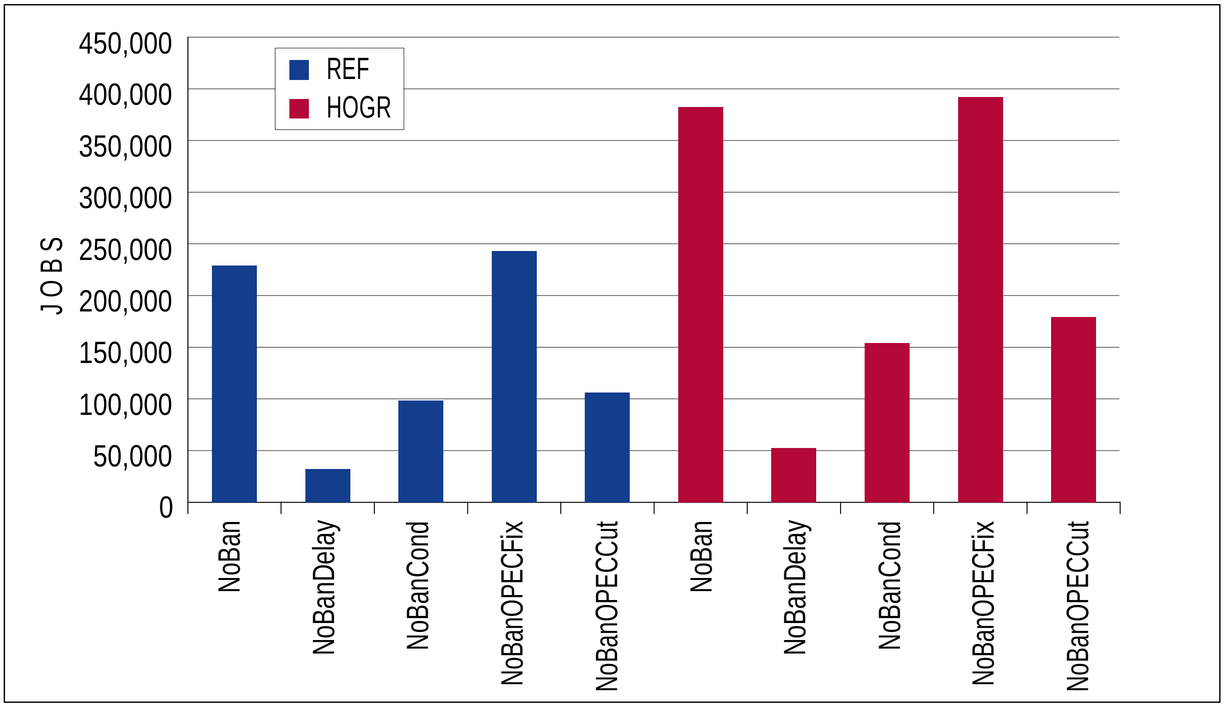
Finally, lifting the ban entirely by 2015 reduces unemployment at an average annual reduction of 200,000 from 2015-2020 (see Figure 11) in the reference case. Employment impacts are economy wide rather than solely oil industry specific or necessarily new jobs. Rather as the welfare ben- efits from lifting the ban ripple through the econ-

Figure 10: Percent Change in Welfare in NoBan, NoBanDelay, and NoBanCond in Reference and HOGR Cases



Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

Figure 11: Average Annual Reduction in Unemployment Across All Scenarios and Both Cases



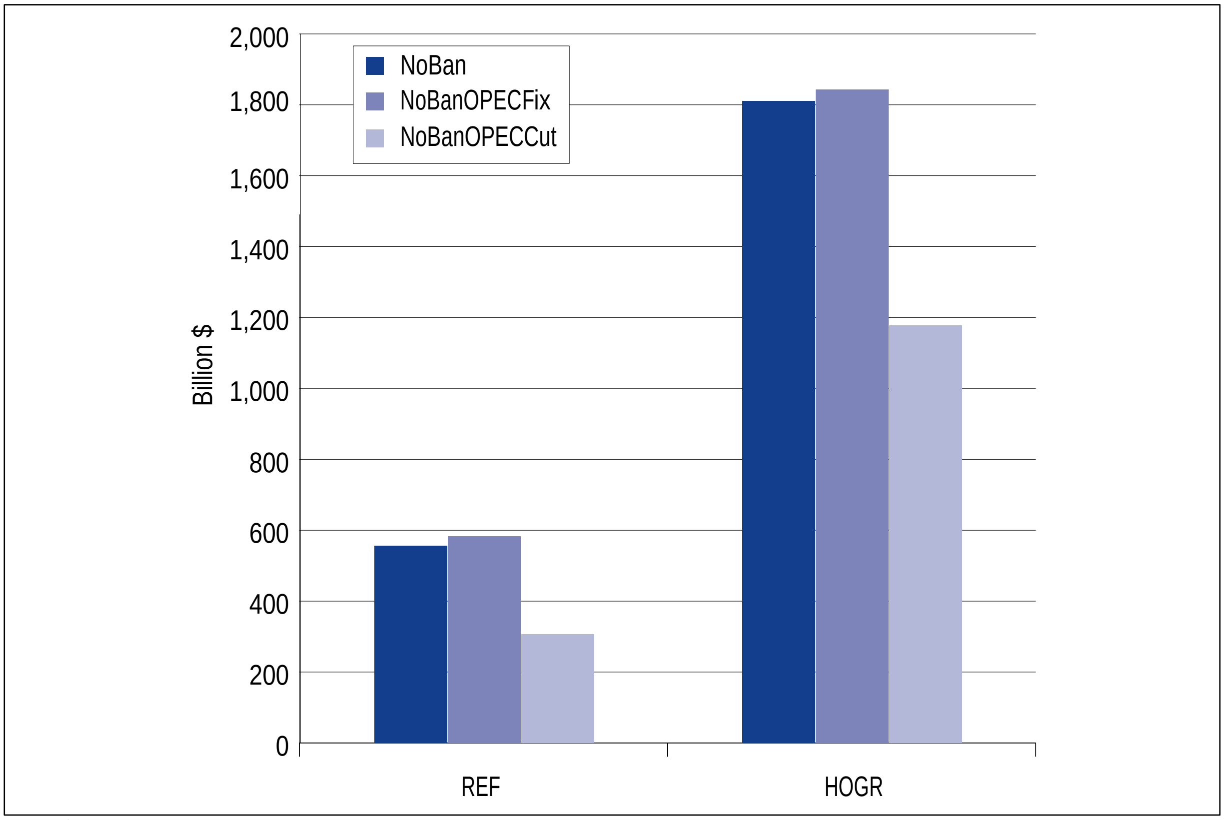
Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

omy there will be a host of people flocking to new employment opportunities. Delays in lifting the ban or partial relief (such as condensate alone) reduce employment benefits significantly. A partial lifting of the ban for condensates decreases the employment gains by nearly half in the reference case. Furthermore, in the reference case, delaying action until 2020 decreases unemployment to less than 50,000 on average from 2015-2020 (see Figure 11). In sharp contrast, in the HOGR case, unemployment on an annual average falls by nearly 400,000 from 2015-2020 if the ban is lifted entirely in 2015 (see Figure 11).

Based on NERA's data, it is clear that lifting the ban on crude oil exports will have a positive outcome for the overall U.S. economy generating lasting long term benefits through decreases in unemployment and benefits to welfare. In both the HOGR and the reference cases oil production scenarios, all data points to positive changes in the economy. NERA also examined several other possible shocks to the market, such as curtailment of production by OPEC in response to a change in U.S. crude oil export policy and a drop in Asian energy demand, currently the locus of most of the increase in global oil demand. In each of these scenarios, the U.S. economy still enjoyed net benefits, albeit at lower levels. We analyzed how OPEC might respond to the increase in U.S. exports that might result from removing restrictions on U.S. crude oil exports (see Figure 12). If OPEC decides to maintain its current level of crude oil exports (OPECFix) the U.S. enjoys the greatest gains measured by the net present value of GDP. If OPEC decides to cut crude oil exports to maintain the current price of crude oil, (OPEC-Cut) then the U.S. enjoys positive, but smaller gains.

The more non-OPEC supply there is available to the market, the more OPEC must compete for market

Figure 12: Change in U.S. Discounted Net Present Value of GDP in NoBan, NoBanOPECFix, and NoBanOPECCut Scenarios in Both Cases



Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

share, and the more free-market dynamics deter- mine price levels rather than cartel politics. If the U.S. chooses not to allow exports of oil, it will (alone among major non-OPEC oil producers) effectively limit market flexibility and market competition among producers on grades of crude oil, in effect elevating prices and limiting global supply. This course of action would increase U.S. self-suffi- ciency for a time (until production fell again), but undermine U.S. energy security. More in-depth analysis of OPEC's response is addressed in the following chapter.

6. Foreign Policy

From a U.S. foreign policy and national se- curity perspective, the threshold question is whether removing crude oil export restrictions will enhance U.S. energy security and strengthen national power. The removal of oil export con- straints enhances America's energy security by increasing self- sufficiency in oil and natural gas, reducing global price volatility, diversifying the global energy supply, and creating a more com- petitive oil market. These measures also enhance U.S. economic security by directionally lowering crude oil (and thereby gasoline) prices while en- abling the U.S. to address oil supply disruptions by producing a supply response that delivers crude oil directly to the global market.

This chapter discusses the possibility that permit- ting the export of crude oil will enhance U.S. na- tional power in several ways: by reinforcing the credibility of U.S. free and open market advocacy, by allowing for the establishment of secure sup- ply relationships between American producers and foreign consumers, by increasing flexibility to export crude to others to address supply dis- ruptions, by empowering another non-OPEC na- tion to meet Asia's and other rapidly developing nations' growing energy demand, by shifting oil rents to the U.S. from less reliable suppliers, and by providing our own hemisphere with a com- petitive source of crude supply. Most importantly, allowing crude oil exports will increase revenues to domestic producers helping to maximize the scope of the production boom, boosting Ameri- can economic power that undergirds U.S. nation- al power and global influence.

U.S. Energy Security

U.S. energy security policy, emanating from both Republican and Democratic administrations, has been developed on the premises of diversification of global oil supply;[107] investment in research and development for technologies (demand and supply side) to reduce dependence on foreign oil; and the creation and upkeep of strategic stocks to buffer the impact of supply disruptions. In the decades since 1973, the U.S. has made great strides in these areas, encouraging secure oil production from the Caspian, West Africa, and other non-OPEC na- tions; building strategic stocks of oil and products; raising fuel efficiency standards; investing in alter- native fuels and engines; and maintaining policies that have encouraged dramatic growth in both deep water and unconventional oil and gas.

[107] See President George W. Bush's National Energy Policy: National Energy Policy Development Group, "National Energy Policy," May 2001, www.wtrg.com/EnergyReport/National-Energy-Policy.pdf; also: President William J. Clinton's National Energy Strategy, "Comprehensive National Energy Strategy," U.S. Department of Energy, April 1998, http://prop1.org/thomas/peacefulenergy/cnesM.pdf.

Less appreciated is the way changes in the oil market itself have enhanced U.S. energy security. For example, the impacts of the 1973 oil embargo were aggravated by the existence of bilateral oil supply contracts that impeded the flow of oil. In the decades since the rise of the futures and for- ward markets have led to greater market transpar- ency and price discovery allowing the market to shift supplies rapidly and efficiently to meet de- mand. These mechanisms, however, only function when markets are open and free and are ill-served when artificial barriers (such as the ban on crude oil exports) exist. In addition, while markets have become more liquid over time, they are still sub- ject to a lack of full transparency on critical issues such as pricing. Nonetheless, the market changes noted above and especially the rapid growth of the international oil products markets have en- hanced U.S. and global energy security.

In the aftermath of the OAPEC oil embargo, the U.S. system of emergency response changed in 1975[108] to one of collective response, rather than oil sharing, in recognition that a release of oil stocks and products by any country will most quickly and efficiently have an impact on global prices, free of the politics of dictating to which country oil will flow. The U.S. has been a primary beneficiary of these liquid markets. The after- maths of both Hurricanes Katrina and Rita, in which gasoline supplies shifted from Europe to the U.S.,[109] demonstrated the effectiveness of this policy. Indeed, assuring a free market in oil trade while resisting mercantile tie-ups of supply that distort flows and prices, have been core tenets of bipartisan U.S. energy security policy through successive administrations.

modern energy security policy

Since 1973, energy security policy has changed to focus more on managing price shocks than secur- ing physical supplies of oil. As the recent oil sup- ply disruptions from the Libyan revolution and the Iran sanctions have demonstrated, it is the global balance of supply and demand that determines U.S. gasoline prices. Furthermore, the avoidance of price shocks is best dealt with by ensuring that the right match of crude supply can get to the category of refiner most impacted by a disruption.[110]

For all the dramatic growth in U.S. oil supply, oil markets remain tight. Global spare capacity is thin, and most of it resides in a single nation: Saudi Arabia. Nearly Nearly 3 mbd of oil supply is disrupted today, much of it light grades of oil from Libya, Iran, and Nigeria. Crude and product prices have not risen as high as they might have because U.S. production has helped back out im- ports of those grades of crude, allowing them to flow to the refineries which process those grades of crude oil. Increased production from Canada, Iraq, and Saudi Arabia contributed in major ways to replace disrupted supply. Taking a broad view of energy security, it is clear that diversity of sup- ply—a world that maximizes the greatest volume of production of oil by the greatest number of countries—remains the primary pillar of U.S. and global energy security. Efficient markets, allowing the free flow of goods including oil, are the circu- latory systems of diversity of supply. Without, it price shocks cannot be effectively ameliorated.

While the U.S. oil boom helps make the U.S. a powerful contributor to global supply, it does not

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[108] William F. Martin and Evan M. Harrje, "The International Energy Agency," in Jan H. Kalicki and David L. Goldwyn, *Energy and Security: Toward a New Foreign Policy Strategy*, (Washington, D.C.: Woodrow Wilson Center Press and Johns Hopkins University Press, 2005).

[109] Amy Myers Jaffe, "Testimony to the Committee on Energy and Natural Resources: Opportunities and Challenges of the U.S. Crude Oil Export Ban," United States Senate, 30 January 2014.

[110] Michelle Billig Patron and David L. Goldwyn, "Managing Strategic Reserves," in Jan H. Kalicki, Michelle Billig Patron and David L. Goldwyn, *Energy & Security: Strategies for a World in Transition*, second ed., (Washington, D.C.: Woodrow Wilson Center Press and Johns Hopkins University Press, 2013).

leave the U.S. immune from price shocks that may come from major disruptions in supply, whether they emerge from the Middle East, West Africa, or the Southern Cone. The only way to mitigate that risk is with a global system of oil trade that maximizes the ability of diverse supplies to meet shifting global demand.

the impact of removing oil export constraints on u.s. energy security

Allowing the free export of oil will enhance U.S. energy security in multiple ways:

- First, allowing the U.S. producers to con- nect to global price signals will sustain U.S. oil production, securing self-sufficiency in light grades of oil.
- Second, by encouraging the production of light grades of oil, even as they remain surplus to U.S. refining needs, the U.S. in- creases global oil supply, directionally low- ering U.S. product prices, which are priced to global benchmarks of crude oil.
- Third, the U.S. reduces the volatility of global crude oil prices by allowing U.S. supply to react to changes in global oil demand.
- Fourth, the U.S. can create a major source of diversification to the global oil supply. Indeed, the rapid growth of U.S. produc- tion has already diversified global supply, impacting global markets by displacement. As noted in Chapter 4, the U.S. is already reaching the limits to which it can displace light oil imports. The U.S. will only connect to the global oil market if it allows exports of surplus grades of oil to flow to those countries that needs those grades.
- Fifth, by allowing exports of U.S. crude oil the U.S. will create a more competitive oil market. For decades, incremental oil demand has been met first by non-OPEC countries that (except for the United States) export all of their production not consumed domestically. The balance is met by OPEC, based on its desired price level. This level is implemented by production quotas and ac- tual production levels. To the extent that in- cremental oil demand is met by non-OPEC production, OPEC must either cut its own production to maintain price levels, or cede market share to non-OPEC countries.

the impact of removing oil export constraints on u.s. foreign policy

In the past, major oil producers have used their ability to supply the oil market to enhance their influence over other nations. For example, it is in- disputable that Russia's supply relationships with Europe; Iran's supply relationships with China, India, South Korea, and Japan; and Venezuela's supply relationships in the Caribbean and the Southern Cone have a remarkable impact on their global political influence and the conduct of their trading partners. Likewise, Norway's commit- ment to free trade in oil and gas, Brazil's growing role as an exporter, and Canada's open investment and export policy have made major contributions to global energy security and set precedents for their neighbors. Likewise, the United States will be judged by the example it sets as a market actor, both in the consistency of its demands for others relative to its own conduct, and by its reliability as a supplier.

u.s. commitment to free trade and open markets

Oil-importing countries are watching to see if the U.S will apply the same standards of open trade in commodities that are not in short supply to its own economy, while it demands these standards from others. America's strategy for economic security has long been anchored by a com- mitment to open markets and free trade, as exemplified by its conduct in the World Trade Organization (WTO) [and its predecessor, the General Agreement on Tariffs and Trade (GATT)], and the International Energy Agency (IEA). The

U.S. has completed successfully free trade agreements with 20 countries, including the North American Free Trade Agreement (NAFTA) with Canada and Mexico. In addition, the U.S. is currently in the midst of negotiations to expand that cadre of nations with pending agreements such as the Transatlantic Trade and Investment Partnership (TTIP) with the EU and the Trans-Pacific Partnership (TPP) with Asia.[111]

While the issues are complex, banning exports of crude oil could be challenged as inconsistent with the "Most Favored Nation" requirement of Article I of the General Agreement on Tariffs and Trade (GATT 1994). This provision could also be utilized to argue that even different or slower licensing criteria for different countries (e.g. FTA versus non-FTA is a violation of the GATT). There is also a question as to whether under XI of GATT 1994 the concept of "national interest determination" without any specified criteria highlighted could be considered a violation of the Agreement.[112]

However, as the Congressional Research Service (CRS) notes, Article XXI may provide the U.S. another defense if challenged since it allows violations of Article I and XI based on "essential security interests." While the U.S. has traditionally considered this exception to be "self-judging" it is possible that some member states of the GATT's Appellate Body could challenge U.S. use of this exception.[113] The U.S. could also utilize Article XX of the GATT, which allows members to take an exception to GATT rules if the action is taken to protect an exhaustible natural resource or to protect human health or the environment. Invocation of such a claim for an exception in this case, however, could run into a problem. When China attempted to use this clause to exempt access to its rare earth minerals, the U.S. opposed the Chinese claim and won.[114] Likewise, while fossil fuels are clearly exhaustible in the long run, advancements in technology that extend the life of or add to reserves and changing pricing conditions could result in such a claim being rejected. In addition, U.S. production would have to be limited in order for the U.S. to make this claim. Finally, Article XIII mandates that if an otherwise inconsistent GATT measure is allowed to remain in force under an Article XX exception; the measure must be administered in a non-discriminatory manner. Many lawyers question whether export restrictions that treat WTO Members differently would meet the nondiscriminatory requirements under Article XIII.[115]

The U.S has launched (and won) WTO claims against China for restricting exports of rare earth materials when these materials are not in short supply in China.[116] Basic politics and economics suggest that the optimal solution would be for the

U.S. to adhere to its own trading requirements—export light tight oil, which is available in surplus, and import the oil that is needed to supply U.S. refineries. For an issue as fundamental as oil security, an issue on which the U.S. has strongly encouraged other nations to open their markets to investment and free trade, it is expected that the U.S. allow the free trade of U.S. oil.

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[111] Office of the United States Trade Representative, "Trans-Pacific Partnership (TPP)," 16 June 2014, www.ustr.gov/tpp.

[112] Adam Vann, Daniel T. Shedd and Brandon J. Murrill, "Federal Permitting and Oversight of Export of Fossil Fuels," Congressional Research Service Report, no. R43231, 17 September 2013, p. 9, http://fas.org/sgp/crs/misc/R43231.pdf.

[113] Ibid., 11.

[114] WTO, "China—Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum," Dispute settlement, 8 April 2014, www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm.

[115] Ibid.

[116] Tom Miles and Krista Hughes, "China loses trade dispute over rare earth exports," *Reuters*, 26 March 2014.

establishment of trading relationships

Nations having national oil companies and for- eign companies establish commodity trade rela- tionships based on the match of a commodity with their needs, price, and reliability. For example, as China grew worried about Middle East stability, it sought supply from West Africa. As supplies of crude oil appeared to be getting heavier, U.S. re- fineries sought supply from Canada and Mexico, while Chinese companies built heavy coking re- fineries and loaned Venezuela $40 billion, which is now being repaid with heavy oil.[117] Countries and companies plan their future investments based on expectations of the quantity, quality, and reliability of future supply.

The question for the U.S. is whether it will permit companies to be the reliable suppliers of compet- itively-priced LTO to the global market. Based on the demand of European and Asian countries for the inclusion of crude oil exports in the TTIP and TPP agreements, it is apparent that there is foreign demand for U.S. crudes. In a world where dis- ruptions are frequent in the Middle East, Africa, and South America, it is more than plausible that Asian and European refiners would benefit from expectations of supply from U.S. producers.

In specific areas, allowing these potential trading relationships to develop will enhance U.S. foreign policy. In addition, creating long-term relation- ships with oil trading partners would strengthen positive relations among some of the most influ- ential nations in the world. The willingness of the U.S. to play this role will enhance its status in glob- al oil markets and its relevance as a trading part- ner to these nations. Allowing these potential ex- ports will also lower the U.S. trade balance for oil, already declining owing to the exponential in- crease in petroleum product exports.[118] In the Western Hemisphere, U.S. exports of petroleum products already have risen as Venezuelan supply has decreased. Many Caribbean nations depen- dent on Venezuelan crudes (medium grades), in- cluding the Dominican Republic and Jamaica,[119] could get fair prices and reliable supply from U.S. producers. If relations were to improve with Cuba, the U.S. could also provide oil resulting in reduc- ing Havana's near total dependence on Venezuela. Likewise, the nations the United States has asked to forego Iranian supply could plan their future supply relations based on U.S. supplies. Adding the potential to supply crude directly to these na- tions, rather than simply press for their coopera- tion in sanctions efforts, will only enhance U.S. persuasiveness.

Finally, it is not inconsequential that to the extent U.S. supply of crude replaces Middle East or Rus- sian supply, the rents from those sales accrue to U.S. citizens rather than, say, Iranian, Russian, or Venezuelan producers. In addition, the U.S. economy has the potential to expand particularly with the growing number of jobs surrounding the crude industry. For example, the surrounding area of the Bakken formation in North Dakota has seen a tremendous increase in their economy and a significant drop in unemployment. Accord- ing to a May 2014 *Bloomberg News* article: "The oil boom has helped send North Dakota's unem- ployment rate to 2.6 percent in April, the lowest in the U.S. according to the Labor Department. That compares with a national jobless rate of 6.3 percent."[120] These jobs are coming from the need for infrastructure to support the new populations in these oil rich areas, for example the building and maintenance of grocery stores, apartment

[117] Peter Wilson, "Venezuela's Oil Heads East," *Bloomberg*, 28 April 2014.
[118] Edward L. Morse, "Welcome to the Revolution: Why Shale is the Next Shale," *Foreign Affairs*, May/June 2014, 7.
[119] EIA, "Country Analysis Brief: Caribbean," U.S. Government, 16 June 2014, www.eia.gov/countries/regions-topics.cfm?fips=cr.
[120] Brian Louis, "Shale boom lures developer for $500M North Dakota project," *Bloomberg News*, 20 May 2014.

complexes, and basic retail, all of which used to be nearly a "two hour" drive away.[121] In terms of the economy, North Dakota's "grew 13 percent in 2012."[122] This growth can be seen as a direct in- fluence of the crude oil expansion as the employ- ment numbers jumped significantly from 5,051 in 2005 (a year before hydraulic fracturing was implemented) to 40,856 in 2011.[123]

enhanced flexibility of the spr

The U.S. can contribute to mitigating serious adverse economic consequences of oil supply disruptions, in part, by releasing or exchanging stocks from the SPR. When the U.S. was a major importer of oil, it released stocks to meet its own refining needs, thereby freeing up global supplies. As the U.S. has a net reduction in its imports and its utilization of light grades of oil, it will be free to sell or exchange SPR crude to other nations to address supply dis- ruptions. The SPR is already a powerful foreign pol- icy tool, serving as a deterrent to nations that may withhold or interrupt global supplies of oil, for vari- ous reasons. This tool could be enhanced by greater flexibility to export this oil to nations in need.

the reaction of opec

One key question is how exports of U.S. crude oil will impact OPEC nations. From an energy security perspective, OPEC's reaction could impact global price levels and the ability of high cost producers to sustain production. From a geopolitical perspective, it is possible that reduced market share or income could produce instability in OPEC member states.

OPEC is no longer, if it ever were, a monolithic institution. Saudi Arabia is the leader of OPEC by virtue of being its largest producer and the largest holder of spare production capacity in the world today. Saudi Arabia has proven multiple times its ability, and frequently its willingness, to miti- gate the impacts of market disruptions by releas- ing spare capacity. So far, Saudi Arabian leaders have publicly downplayed their concerns over the prospects for tight oil production in the U.S.[124] To the extent that global demand for oil is strong, or disruptions persist, there is room for OPEC mem- bers to maximize production and for U.S. supply to gain share without impairing OPEC revenues.

If demand were to weaken, however, or if Iran, Iraq, Libya, Nigeria, or others were to restore dis- rupted production, Saudi Arabia and other OPEC members will be forced to choose whether to ac- cept a smaller share of global oil exports to make room for U.S. and other supplies or to keep their market share at its current level by maintaining production driving down prices. In this scenar- io U.S. exports would rank far lower on OPEC's agenda than a potentially resurgent Iraq or Iran.

Complicating the ability to project how Saudi Ara- bia and OPEC may react are the uncertainties fac- ing OPEC production internally. Since the 1980s, Saudi Arabia has been the undisputed principal oil exporter within OPEC. Given instability and pro- duction problems in other OPEC nations, including Nigeria, Libya, and Angola, there have been fewer major OPEC producers to take into consideration when setting production targets. Looking forward, however, expectations are that production in Iran and/or Iraq could see a major upswing, meaning that internal decisions will have to be made about how best to allocate quotas and production targets. Iran or Iraq or both will seek larger production quotas within OPEC's broader production cap. OPEC countries are highly dependent on oil rev- enues. Their reluctance to reduce their individual production quotas to make room for others and

[121] Brian Louis, "Shale boom lures developer for $500M North Dakota project," *Bloomberg News*, 20 May 2014.
[122] Ibid.
[123] Ibid.
[124] Ed Crooks, "Saudis welcome U.S. shale boom," *Financial Times*, 13 May 2013.

forsake national export revenues has increased in recent years. This is because many states increasingly value these revenues as a means to alleviate public angst in the midst of major unrest in the Arab world. It is certain that OPEC faces a future of internal divisions and disparate goals, and it is unclear whether the organization will continue to function and impact the market as effectively as it has in the past.[125] However given the relatively small volumes of exports projected, at least in the reference case, it is unlikely that U.S. oil exports will be a major calculus in OPEC's behavior.

According to NERA data, if OPEC competes for market share with the lifting of the ban on U.S. crude oil exports and maintains crude export levels, it will have a negligible effect on the U.S. crude oil exports (see tables 11 and 12, the reference and HOGR case respectively). If, however, OPEC decides to maintain the price of oil and cut crude exports, the U.S. will be able to increase exports in the HOGR case by 2.8 mbd in 2015 and by 5.7 mbd in 2035 (see table 12).

Another uncertainty regarding OPEC is how U.S. exports of light sweet crude oil will impact the income levels of member states, particularly nations that have historically provided the market (and the U.S.) with light sweet crude. Nigeria, Angola, and Libya are all traditional producers of light sweet crude oil and important politically and geopolitically to the stability of Africa. Exports of U.S. crude could have a disproportionate impact on them, compared to other OPEC members.

Table 11: Reference Case: Crude Oil Exports from U.S. (MBD)

	2015	2020	2025	2030	2035
Crude Oil Ban Lifted in 2015	1.7	1.9	1.6	1.7	1.1
OPEC Maintains Crude Exports	1.7	1.9	1.5	1.7	1.1
OPEC Cuts Crude Exports to Maintain Crude Price	1.9	2.0	1.6	1.7	1.1

Table 12: HOGR Case: Crude Oil Exports from U.S. (MBD)

	2015	2020	2025	2030	2035
Crude Oil Ban Lifted in 2015	2.5	3.6	4.2	4.5	5.2
OPEC Maintains Crude Exports	2.5	3.6	4.2	4.5	5.2
OPEC Cuts Crude Exports to Maintain Crude Price	2.8	3.9	4.5	5.0	5.7

Source: NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban*

[125] Amy Myers Jaffe and Edward L. Morse, "OPEC: Can the Cartel Survive Another 50 Years," in Jan H. Kalicki and David L. Goldwyn, *Energy & Security: Strategies and Security: Strategies for a World in Transition*, second ed., (Washington, D.C.: Woodrow Wilson Center Press and Johns Hopkins University Press, 2013).

u.s. foreign policy: security, economy, and diplomacy

The policy decisions that face the nation will re- flect broadly on what the U.S. stands for and what example it sets as it interacts with allies and ad- versaries over energy. Over the past few years, numerous energy analysts have cautioned policy- makers and attempted to educate the public about the consequences of choosing isolationist foreign policies because of the misperception that the U.S. will be "energy independent."[126] U.S. leaders re- peatedly say that while growing oil production in the U.S. (and North America more broadly) ben- efits the economy, lowers the need for imported oil, and allows America a greater opportunity to determine its own energy future, this abundance of oil will not sever ties to global oil markets, nor vulnerability to global price fluctuations.

The reality is that nations will judge the United States by its actions. The country faces a choice as to whether or not it will take steps to sustain and expand its contribution to global energy security at a time when insecurity is rampant in nearly ev- ery other region of the world. Economic analy- sis shows that the U.S. will need to remove last century's export restraints to sustain this boom. Diplomatic analysis suggests that the U.S. will be judged by its willingness to share its surpluses with others and practice the tenets of free trade and open markets that have been preached since the end of the Second World War.

The American refusal to do so may be seen as yet another form of isolationism, and one which will leave the U.S. more vulnerable to the fluctua- tions of the global oil market, and less capable of rapid response to alleviate those impacts. Isola- tionism will severely limit the U.S. capability to help allies achieve greater energy security. The
U.S. policy on petroleum exports and decisions about the ban are only one of the foreign policy tools at the nation's disposal, but it can be a very important tool. U.S. exports of crude oil, in addi- tion to the petroleum products and coal already being exported and the LNG in the pipeline, will represent a significant U.S. commitment to global supply security and market stability. In addition to other foreign policies regarding energy secu- rity, including efforts to ensure supply diversity through infrastructure development abroad, the promotion of market reform and indigenous re- source production, research and development fo- cused on alternative fuels and energy efficiency, the U.S. commitment to global energy security will be enhanced. The foreign policy impacts of crude oil exports are weighty, and should not be overlooked in this policy debate.

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[126] Michael Levi: "Rising U.S. oil production will help restrain global prices and provide some limited economic insulation from price spikes. But, contrary to some popular claims, it will fall far short of making the U.S. independent of events overseas. As I argued in *Foreign Policy* magazine last year, U.S. vulnerabilities stem mainly from how much the country spends on oil, not where that money is shipped to. Rising U.S. production won't fundamentally change that" (Michael Levi, "The Experts: How the U.S. Oil Boom Will Change the Markets and Geopolitics," *Wall Street Journal*, 27 March 2013); also David L. Goldwyn: "Suddenly having a great wealth of domestically produced gas and, increasingly, oil, the argument follows, will allow the United States to look inward and take less interest in international affairs, includ- ing those of the politically challenging countries that produce oil and natural gas in the Middle East, Africa and elsewhere. This is unlikely to happen. . . .The most strategic factor in American consumption will remain the price of oil and the effect of disruptions on the U.S. and the global economy, not the source or quantity of U.S. imports," (David L. Goldwyn, "Making an Energy Boom Work for the United States," *International Herald Tribune*, *The New York Times*, 12 November 2012).

7. Conclusions And Recommendations

Fundamental issues that we have addressed in considering the efficacy of the crude oil export ban include how it affects the U.S. economy as a whole and what the impacts will be on U.S. ener- gy security. This report has illustrated how energy policy has evolved over time in response to chang- ing market dynamics and geopolitical events that have sometimes sent the price of petroleum sky- rocketing, and at other times plummeting. The current situation in the United States is not the same as it was 30 years ago or even 10 years ago. Over time U.S. energy policy has attempted to provide price stability for consumers through a variety of policies. Some have been successful, in particular efforts to support research and devel- opment of new technologies, raising CAFE stan- dards, and the creation of strategic stocks to sup- ply the market in the event of disruptions. Others have been impressive failures, notably efforts to manage the market through price and allocation controls or to restrict the size of imports. The re- moval of price controls on natural gas and the re- moval of export controls on petroleum products have incentivized production in those areas as did the phased decontrol of domestic crude oil prices commencing in 1980. We think the key lesson of our economic history in the energy space is that the U.S. economy works better embracing market forces than trying to resist them.

recommendations

The U.S. energy market has changed, and for the better, as technological developments of three- and four-dimensional seismic technology, horizontal drilling and the fracking of unconventional oil and natural gas has allowed dramatic growth in pro- duction. Based on these market realities, we rec- ommend that the U.S. reconsider and modernize its energy policy by lifting the ban on crude oil ex- ports entirely and immediately. It is evident to us, based on our policy deliberations and the extensive macroeconomic modeling of the U.S. economy, and the global oil market research we have com- missioned, that the greater U.S. exports of crude oil, the greater the economic and energy security benefit to the country. In addition to the parochial benefits to the nation, as a leader in world trade circles, where the U.S. is a consistent advocate for open markets and transparency, continued restric- tions on crude oil exports have the potential to tar- nish the U.S. global standing and hinder its pursuit of strengthening energy security.

Lifting the ban significantly enhances U.S. energy security in several ways. Allowing U.S. producers to connect to global price signals will generate ex- pansion of U.S. oil production, securing self-suffi- ciency in light grades of oil. By encouraging this production of light grades of oil, the U.S. increas- es global diversity of oil supply, while reducing the volatility of global crude oil prices. The U.S. has the opportunity to create a source of diversi- fication to the global oil supply and create a more competitive oil market which will not only lower the global price of crude, but also enhances U.S. energy security.

In terms of economic prosperity, lifting the ban will generate significant economic benefits in- cluding declining unemployment, substantial GDP growth, and a lowering of domestic gasoline prices. Keeping the ban in place will forgo these benefits and likely lead to reduced production and by implication less national income, employ- ment and security. It is ironic that the greatest po- litical fear of lifting the ban comes from the ana- lytically unfounded belief that it will raise, rather than lower, gasoline and other petroleum product prices. We appreciate that there will be positive and negative distributional impacts within the U.S. Nevertheless, it would be unwise to base na- tional policy on protecting a small subset of U.S. refiners and questionable how sustainable a busi- ness model based on artificially suppressed input prices can be.

We take seriously the environmental concerns over climate impacts of increased U.S. production. Many environmental groups oppose lifting the ban out of concern that this will stimulate more oil and gas production leading to enhanced consumption of fossil fuels and rising GHG emissions. Another fear is that more production means more frack- ing, and hence a greater threat to water supplies throughout the country. In addition, some oppose lifting the ban because more production means more pipelines, more rail and barge traffic, and po- tentially more accidents. The impacts of lifting the ban on crude oil exports on global climate change are difficult to determine at this point as there is a lack of data available to make any accurate projec- tions. These issues are complex and are not within the capacity of this report to address. The impact will be dependent on whether U.S. production will offset that of others, whether there will be carbon reductions from less transport of oil to the U.S. and whether the U.S. refining system produces fewer emissions relative to others. Further research on the subject is needed in order to make an accu- rate case on the environmental consequences and potential impact on global climate change of lift- ing the ban on crude oil exports. These important considerations are beyond the scope of this report, yet we acknowledge the necessity to address these issues while considering lifting the ban on crude oil exports.

We also consider the utility of taking incremental steps, such as lifting the ban only on condensates, increasing swaps, or even delaying the timetable for lifting the ban. All of these options result in fewer benefits to the U.S. and merely forestall what is good public policy: namely, lifting the ban now. As noted, allowing only exports of conden- sates will have significantly smaller net benefits to the U.S. economy than lifting the crude oil export ban entirely and will have a minimal effect on the global crude market, providing minimal supply diversification.

Allowing the free flow of crude oil exports will increase flexibility in energy trade. For example: in the United States, refineries will be able to maximize their capacity instead of operating be- low it, which will allow for greater efficiency. If the ban on crude oil exports is lifted, producers who currently have to discount their oil will be able to export it, bringing in millions of dollars of revenue. Removal of restrictions on exports will lead to new production creating jobs while bol- stering other important components of the U.S. economy. Free trade allows the U.S. to respond quickly to potential international market disrup- tions. In addition, because the production is still in the U.S., U.S. companies will be able to adjust to increased domestic demand by exporting less (with the guidance of the U.S. government if necessary). Similarly, if world prices fell, the U.S. could in turn export less. Free and open markets are generally self-correcting; the industry can adjust based on the economics instead of being restricted by policy. Therefore, crude oil export restrictions are no longer essential for United States energy security policy.

In summation, increasing crude oil exports in any fashion will have positive affects both in the United States and in the world oil market. At the same time, world energy security will be enhanced by increasing the diversification of oil supply available globally, while also increasing U.S. energy security. As supported with data from reports on the crude oil export issue, conducted by NERA/ Brookings, IHS, Resources for the Future (RFF), and ICF, all of these documents show that lifting the ban leads to a positive outcome for the United States. As U.S. LTO becomes competitive once it is allowed to be marketed on the world market, gasoline prices in U.S. on average fall, and in turn the U.S. is able to take a commodity (currently price discounted) into a vibrant economic resource for the country. Lifting the ban generates paramount foreign policy benefits while increasing U.S. GDP and welfare, and reducing unemployment. It is time the United States commits to its position on free-trade markets as a true member of the OECD and global community and allows U.S. crude oil to flow.

Exhibit A: NERA Model API Gravity Assumptions Crude Oil Types and Products

Type	API Gravity	Refined Petroleum Products
Condensate	50+	Gasoline, distillates, and other refined petroleum products.
Light Tight Oil (LTO)	40-49	
Conventional Light Crude	33-39	
Intermediate Crude	23-32	
Heavy Crude	>22	

Exhibit B: Presidential Allowances for Crude Oil Exports

Exports to Canada, 1985

President Reagan found unlimited exports of U.S. crude oil to Canada to be in the national interest, especially since simultaneously Prime Minis- ter Mulroney removed price and volume controls on crude oil exports to the United States.[127] Internal White House memoranda emphasize that imports of Canadian crude oil replace crude oil imports from unreliable and unstable sources.[128] These memoranda note that lifting restrictions on crude exports is a "logical extension of the special treatment which historically has been accorded Canada under U.S. export controls"[129] and that the United States and Canada's energy markets and needs are interrelated.[130]

[127] 50 Fed. Reg. 25189, 18 June 1985.

[128] William T. Archey and Jan W. Mares, "U.S. Crude Oil Exports," White House Staffing Memorandum to President Reagan, 29 May 1985.

[129] William T. Archey, Acting Assistant Secretary for Trade Administration, Department of Commerce & Jan W. Mares, Assistant Secretary for International Affairs and Energy Emergencies, "U.S. Crude Oil Exports to Canada," Department of Energy, U.S. Government, 2 May 1985.

[130] Ibid.

Exports from Alaska's Cook Inlet, 1985 President Reagan found that unrestricted exports from Cook Inlet would be in the national interest because they would encourage other countries to remove trade barriers to related domestic goods and services. He also found that crude oil from Alaska's Cook Inlet was advantageously located for export trade.[131]

Exports of 50,000 b/d of Alaska North Slope Crude (ANS), 1989

President Reagan saw the allowance of this limited amount of ANS crude oil to be exported to Canada as another means to promote free trade between the United States and Canada even though exports of ANS were still prohibited by the MLA as they were transported over the Trans-Alaskan Pipeline, which crossed over federal rights of way.[132]

Exports of 25,000 b/d of California Heavy, 1992 In 1992, President Bush allowed 25,000b/d of California heavy crude oil to be exported, because, "California independent oil producers [were] suffering financial losses due to the surplus of heavy crude oil in the California market and their lack of alternative marketing options."[133] Additionally, he noted available supply of heavy crude oil ex- ceeded refinery capacity.[134]

While exports of California heavy crude oil were viewed as helping independent oil producers, the effect of t such exports on the domestic maritime industry proved to be a major concern. Under the Jones Act, U.S. flag vessels are the only ones permitted to transport California oil to other U.S. destinations, such as the Gulf Coast, for refining by domestic refiners.[135] Some officials in the Bush Administration feared the U.S. maritime industry would lose business, potentially leading to unemployment, since foreign vessels were then able to transport California heavy crude oil destined for foreign ports.[136]

Exports of Alaska North Slope Crude (ANS), 1996

President Clinton allowed unlimited exports of ANS crude to any destination after an interagen- cy review conducted by the National Economic Council and the Bureau of Export Administra- tion found that such exports would not have a significant impact on the economy or the envi- ronment. The exports, however, were approved subject to very specific requirements; namely, that the crude oil is exported on U.S. registered and crewed vessels and the vessels adhere to specific export routes.[137]

Exhibit C: Other Export Transactions

California Heavy Crude

Pursuant to President Bush's national interest finding, BIS is empowered to grant licenses for exports of California heavy crude oil if the exporter can demonstrate that its crude oil was produced in California, has a gravity of 20 degrees API or lower, and the average volume of such California heavy crude oil exported per day from the United States does not exceed 25,000 barrels.[138]

With respect to the limit of 25,000 barrels, BIS takes a first-come-first-serve approach, in which

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131 50 Fed. Reg. 52798, 26 December 1985.

132 54 Fed. Reg. 271, 5 January 1989.

133 Susan Collins, "EPC Meeting on Oil Exports," 28 November 1989.

134 Ibid.

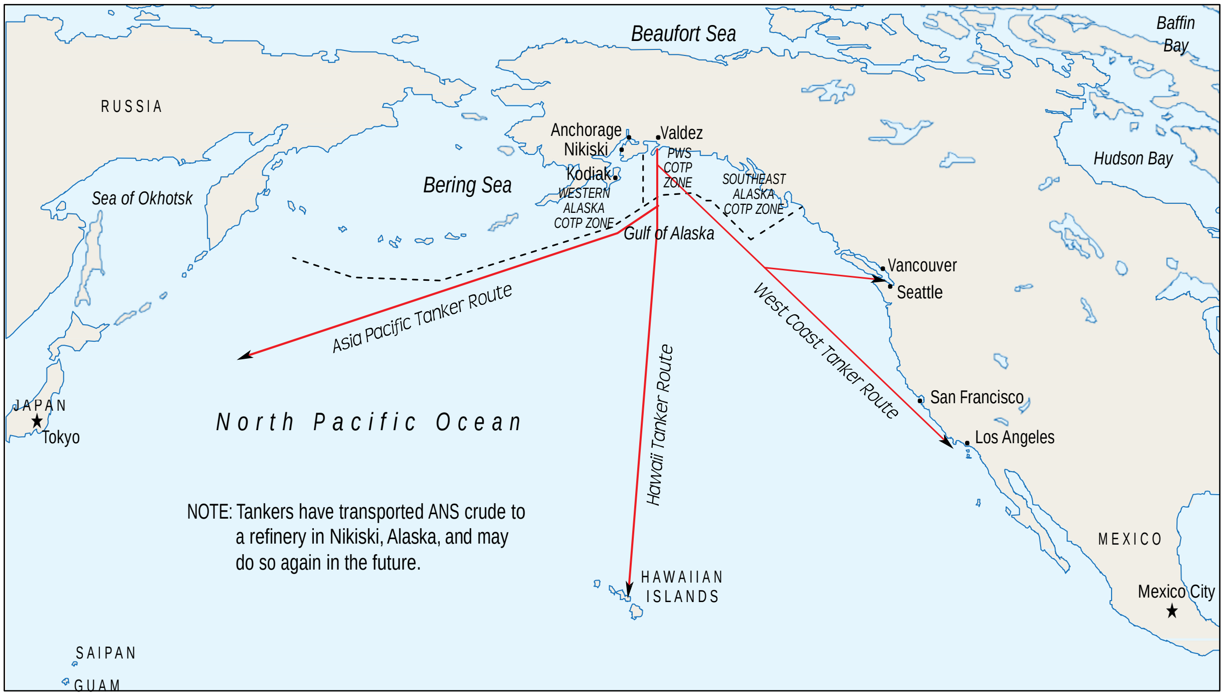
135 The Jones Act, which is formally known as the Merchant Marine Act of 1920, 46 U.S.C. § 55102, among other things, prohibits vessel trans- portation of merchandise from one U.S. port to another U.S. port unless the vessel is a U.S. flag vessel that is owned by a United States citizen and documented under the laws of the United States.

136 Council of Economic Advisers Memorandum from Michael Boskin to Susan Collins (Sutherland FOIA Material) page 1.

137 Presidential Memorandum of 26 April 1996, Exports of Alaskan North Slope (ANS) Crude Oil.

138 15 C.F.R. § 754.2(g).

Figure 13: Tanker Route Map



Source: Trans-Alaska Pipeline System Renewal EIS (TAPSEIS)

It will grant licenses to export California heavy crude oil in the order the license applications are received with the total quantity authorized for any one license not to exceed 25 percent of the annual authorized volume of California heavy crude oil exports.[139]

Exporters receiving license to export California heavy crude oil must export such crude oil within 90 calendar days after the license is issued and, within 30 days of any export; exporters must pro- vide BIS with a certified statement confirming the date and quantity of crude oil exported.

Alaskan ANS Crude

Unlike California heavy crude oil, exports of ANS crude can be exported freely without a license, but such exports must adhere to specific export requirements. First, ANS crude oil must be transported on a vessel documented under the laws of the United States and such vessels must use the same route employed for shipments to Hawaii until they reach a point 300 miles due south of Cape Hinchinbrook Light and then at that point, must remain outside the 200 nautical mile Exclu- sive Economic Zone.[140] Returning vessels from foreign ports to Valdez, Alaska must conform to the same route restrictions.

Additionally, owners and operators of vessels ex- porting ANS must adopt a mandatory program of deep water ballast exchange, ensure their ves- sels are equipped with satellite-based communi- cations systems that will enable the Coast Guard independently to determine the vessel's location, and maintain certain records.

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[139] 15 C.F.R. § 754.2(g)(5).
[140] 15 C.F.R. § 754.2(j).

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United States Government Accountability Office

Report to the Ranking Member, Committee on Energy and Natural Resources, U.S. Senate

September 2014

CHANGING CRUDE OIL MARKETS

Allowing Exports Could Reduce Consumer Fuel Prices, and the Size of the Strategic Reserves Should Be Reexamined

GAO-14-807

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Allowing Exports Could Reduce Consumer Fuel Prices, and the Size of the Strategic Reserves Should Be Reexamined

GAO Highlights

Highlights of GAO-14-807, a report to the Ranking Member, Committee on Energy and Natural Resources, U. S. Senate

Why GAO Did This Study

Almost 4 decades ago, in response to the Arab oil embargo and recession it triggered, Congress passed legislation restricting crude oil exports and establishing the SPR to release oil to the market during supply disruptions and protect the U.S. economy from damage. After decades of generally falling U.S. crude oil production, technological advances have contributed to increasing U.S. production. Meanwhile, net crude oil imports—imports minus exports—have declined from a peak of about 60 percent of consumption in 2005 to 30 percent in the first 5 months of 2014. According to Energy Information Administration forecasts, net imports are expected to remain well below 2005 levels into the future.

GAO was asked to provide information on the implications of removing crude oil export restrictions. This report examines what is known about (1) price implications of removing crude oil export restrictions; (2) other key potential implications; and (3) implications of recent changes in market conditions on the SPR. GAO reviewed four studies on crude oil exports, including two sponsored by industry, and summarized the literature and views of a nonprobability sample of stakeholders including academic, industry, and other experts.

What GAO Recommends

In view of changing market conditions and in tandem with activities to assess other aspects of the SPR, GAO recommends that the Secretary of Energy reexamine the size of the SPR. In commenting on a draft of this report, DOE concurred with GAO's recommendation.

View GAO-14-807. For more information, contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov.

What GAO Found

The studies GAO reviewed and stakeholders interviewed suggest that removing crude oil export restrictions is likely to increase domestic crude oil prices but decrease consumer fuel prices. Prices for some U.S. crude oils are lower than international prices—for example, one benchmark U.S. crude oil averaged $101 per barrel in 2014, while a comparable international crude oil averaged $109. Studies estimate that U.S. crude oil prices would increase by about $2 to $8 per barrel—bringing them closer to international prices. At the same time, studies and some stakeholders suggest that U.S. prices for gasoline, diesel, and other consumer fuels follow international prices, so allowing crude oil exports would increase world supplies of crude oil, which is expected to reduce international prices and, subsequently, lower consumer fuel prices. Some stakeholders told GAO that there could be important regional differences in the price implications of removing crude oil export restrictions. Some stakeholders cautioned that estimates of the implications of removing export restrictions are uncertain due to several factors such as the extent of U.S. crude oil production increases, how readily U.S. refiners are able to absorb such increases, and how the global crude oil market responds to increasing U.S. production.

The studies GAO reviewed and stakeholders interviewed generally suggest that removing crude oil export restrictions may also have the following implications:

- **Crude oil production.** Removing export restrictions would increase domestic production—8 million barrels per day in April 2014—because of increasing domestic crude oil prices. Estimates range from an additional 130,000 to 3.3 million barrels per day on average from 2015 through 2035.
- **Environment.** Additional crude oil production may pose risks to the quality and quantity of surface groundwater sources; increase greenhouse gas and other emissions; and increase the risk of spills from crude oil transportation.
- **The economy.** Removing export restrictions is expected to increase the size of the economy, with implications for employment, investment, public revenue, and trade. For example, removing restrictions is expected to contribute to further declines in net crude oil imports, reducing the U.S. trade deficit.

Changing market conditions have implications for the size, location, and composition of Department of Energy's (DOE) Strategic Petroleum Reserve (SPR). In particular, increased domestic crude oil production and falling net imports may affect the ideal size of the SPR. Removing export restrictions is expected to contribute to additional decreases in net imports in the future. As a member of the International Energy Agency, the United States is required to maintain public and private reserves of at least 90 days of net imports but, as of May 2014, the SPR held reserves of 106 days—worth about $73 billion—and private industry held reserves of 141 days. DOE has taken some steps to assess the implications of changing market conditions on the location and composition of the SPR but has not recently reexamined its size. GAO has found that agencies should reexamine their programs if conditions change. Without such a reexamination, DOE cannot be assured that the SPR is sized appropriately and risks holding excess crude oil that could be sold to fund other national priorities.

Contents

Figures

Abbreviations

API	American Petroleum Institute
BIS	Bureau of Industry and Security
DOE	Department of Energy
EIA	Energy Information Administration
EPCA	Energy Policy and Conservation Act of 1975
IEA	International Energy Agency
OPEC	Organization of the Petroleum Exporting Countries
RFF	Resources for the Future
SPR	Strategic Petroleum Reserve
WTI	West Texas Intermediate

U.S. GOVERNMENT ACCOUNTABILITY OFFICE

441 G St. N.W.
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September 30, 2014

The Honorable Lisa Murkowski
Ranking Member
Committee on Energy and Natural Resources
United States Senate

Dear Senator Murkowski:

Almost 4 decades ago, Congress passed legislation restricting U.S. crude oil exports and establishing the Strategic Petroleum Reserve (SPR) in response to the Arab oil embargo and economic recession it triggered. In recent years, however, crude oil market conditions have changed, reversing decades-long trends in declining domestic crude oil production and increasing crude oil imports. Monthly crude oil production has increased by almost 68 percent from 2008 through April 2014, and increases in production in 2012 and 2013 were the largest annual increases since the beginning of U.S. commercial crude oil production in 1859, according to the Energy Information Administration (EIA).[1] With growing production, net crude oil imports—imports minus exports—have declined from a peak of about 60 percent of consumption in 2005 to about 30 percent in the first 5 months of 2014. In response, some members of Congress proposed legislation to remove crude oil export restrictions, while others argued that restrictions should remain in place and not be modified.[2] Recent congressional hearings stressed the need to understand how changing crude oil export restrictions could affect crude oil prices and the prices of consumer fuels refined from crude oil, such as gasoline and diesel.

At the same time, crude oil market changes may have implications for the SPR, the largest government-held emergency stockpile of crude oil in the world. The SPR holds 691 million barrels of crude oil in underground salt caverns along the Gulf Coast in Louisiana and Texas. In the event of a

[1]EIA is a statistical agency within the Department of Energy that collects, analyzes, and disseminates independent information on energy issues.

[2]Proposed legislation includes H. R. 4349, the Crude Oil Export Act, which was referred to the House Foreign Affairs Committee, Subcommittee on Terrorism, Nonproliferation, and Trade on June 10, 2014.

crude oil supply disruption, the SPR relies on the existing commercial distribution and refining system to transport and process crude oil into usable products for sale to the public. Increasing crude oil production, shrinking crude oil imports, changing crude oil and fuel distribution patterns, and an evolving U.S. refining industry could have important implications for the SPR.

You asked us to provide information on the implications of removing crude oil export restrictions. This report examines what is known about: (1) the potential effect of removing crude oil export restrictions on prices of crude oil and consumer fuels; (2) other potential implications of removing crude oil export restrictions; and (3) implications for the SPR, if any, from recent changes in crude oil market conditions.

To conduct this work, we reviewed information, including studies by federal agencies, consultants, and academics, and summarized the results of interviews from a nonprobability sample of 17 stakeholders. We identified relevant information by conducting a literature search and obtaining suggestions from stakeholders we interviewed.[3] We identified and summarized the results of four recent studies that estimate the potential implications of removing crude oil export restrictions. Two of these studies were sponsored by industry and conducted by consultants, another was sponsored by a research organization and conducted by consultants, and the fourth was conducted at a research organization.[4] To assess the reasonableness of these studies, we conducted a high-level review of the assumptions and methods used, interviewed the studies' authors, and obtained views of other stakeholders. We determined that these studies were reasonable for describing what is known about the range of potential implications but identified several limitations, which we discuss later in this report. We did not identify any other publicly available

[3]Specifically, we searched sources including Proquest, PolicyFile, and Web of Science in April 2014.

[4]The four studies are: Resources for the Future (RFF), *Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States* (Washington, D.C.: Resources for the Future, February 2014, revised March 2014); ICF International and EnSys Energy (ICF International), *The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs* (Washington, D.C.: ICF Resources, March 31, 2014); IHS, *US Crude Oil Export Decision: Assessing the impact of the export ban and free trade on the US economy* (Englewood, CO: IHS, 2014); and NERA Economic Consulting (NERA), *Economic Benefits of Lifting the Crude Oil Export Ban* (Washington, D.C.: NERA Economic Consulting, September 9, 2014).

primary studies of the implications of removing crude oil export restrictions. Stakeholders included representatives of companies and interest groups with a stake in the outcome of decisions regarding crude oil export restrictions, as well as academic, industry, and other experts. We selected stakeholders based on our literature review and recommendations from agency officials and others. We asked the same questions during each interview but also discussed individual stakeholders' perspectives, as appropriate. We summarized their views, noting areas of consensus and disagreement. We may not have identified all stakeholders with a view on this topic, but we sought to balance the group with the range of perspectives. The views of stakeholders we selected are not generalizable to all potential stakeholders, but they provide illustrative examples of the range of views. To assess the implications of recent trends on the SPR, we interviewed Department of Energy (DOE) officials and reviewed agency and other documents. Data in this report are primarily from EIA, the International Energy Agency (IEA), and Bloomberg.[5] To assess the reliability of these data, we reviewed relevant documentation, interviewed EIA and Bloomberg officials, and compared the data with similar data published in other sources. We determined these data to be sufficiently reliable for the purposes of this report. Appendix I provides additional information on the four studies we reviewed, and appendix II lists the stakeholders we interviewed.

We conducted this performance audit from April 2014 to September 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

This section describes crude oil export restrictions, the SPR, and recent trends in U.S. crude oil production and the petroleum refining industry.

[5] Bloomberg is a provider of business and financial news, data, and analytics.

Crude Oil Export Restrictions

The export of domestically produced crude oil has generally been restricted since the 1970s. In particular, the Energy Policy and Conservation Act of 1975 (EPCA) led the Department of Commerce's Bureau of Industry and Security (BIS) to promulgate regulations which require crude oil exporters to obtain a license.[6] These regulations provide that BIS will issue licenses for the following crude oil exports:

- exports from Alaska's Cook Inlet,
- exports to Canada for consumption or use therein,
- exports in connection with refining or exchange of SPR crude oil,
- exports of certain California crude oil up to 25,000 barrels per day,
- exports consistent with certain international energy supply agreements,
- exports consistent with findings made by the President under certain statutes, and
- exports of foreign origin crude oil that has not been commingled with crude oil of U.S. origin.

Other than for these exceptions, BIS considers export license applications for exchanges involving crude oil on a case-by-case basis, and BIS can approve them if it determines that the proposed export is consistent with the national interest and purposes of EPCA.[7] In addition to BIS's export controls, other statutes control the export of domestically produced crude oil depending on where it was produced and how it is transported.[8] In these cases, BIS can approve exports only if the President makes the necessary findings under applicable laws.[9] Some of the authorized exceptions, outlined above, are the result of such Presidential findings.

[6] 15 C.F.R. §754.2(a).

[7] 15 C.F.R. §754.2(b)(2).

[8] For example, the Mineral Leasing Act of 1920 restricts exports of domestically produced crude oil transported by pipeline over certain rights-of-way (30 U.S.C. §185(u)); the Outer Continental Shelf Lands Act restricts exports of crude oil from the outer continental shelf (29 U.S.C. §1354); the Naval Petroleum Reserves Production Act restricts the export of crude oil produced from the Naval Petroleum Reserves (10 U.S.C. §7430) and Section 201 of Pub. L. No. 104-58, "Exports of Alaskan North Slope Oil," provides for exports of domestically produced crude oil transported by pipeline over rights-of-way granted pursuant to section 203 of the Trans-Alaska Pipeline Authorization Act (30 U.S.C. §185(s)).

[9] 15 C.F.R. §754.2(c).

According to NERA, no other major oil producing country currently restricts crude oil exports.[10]

BIS approved about 30 to 40 licenses to export domestic crude oil per year from fiscal years 2008 through 2010. The number of BIS approved licenses increased to 103 in fiscal year 2013. Meanwhile, crude oil exports increased from less than 30 thousand barrels per day in 2008 to 396 thousand barrels per day in June 2014—the highest level of exports since 1957. Nearly all domestic crude oil exports have gone to Canada.

The SPR

To help protect the U.S. economy from damage caused by crude oil supply disruptions, Congress authorized the SPR in 1975. The SPR is owned by the federal government and operated by DOE. The SPR is authorized to hold up to 1 billion barrels of crude oil and has the capacity to store 727 million barrels of crude oil in salt caverns located at sites in Texas and Louisiana. According to DOE, the SPR held crude oil valuded at almost $73 billion dollars as of May, 2014. From fiscal year 2000 through 2013, the federal government spent about $0.5 billion to purchase crude oil, and spent $2.5 billion for operations and maintenance of the reserve.

The United States is a member of the IEA and has agreed, along with 28 other member nations, to maintain reserves of crude oil or petroleum products equaling 90 days of net imports and to release these reserves and reduce demand during oil supply disruptions.[11] The 90-day reserve requirement can be made up of government reserves, such as the SPR, and inventory reserves held by private industry.[12]

Under conditions prescribed by the Energy Policy and Conservation Act, as amended, the President and the Secretary of Energy have discretion to authorize the release of crude oil from the SPR to minimize significant

[10]NERA, *Economic Benefits of Lifting the Crude Oil Export Ban*, p.20.

[11]The 29 member countries of the IEA are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[12]Under the agreement, capacity to switch to nonpetroleum-based fuels and standby crude oil production capacity can also be used to meet the reserve requirement.

supply disruptions.[13] In the event of a crude oil supply disruption, the SPR can supply the market by selling stored crude oil or trading crude oil in exchange for an equal quantity of crude oil plus an additional amount as a premium to be returned to the SPR in the future. When crude oil is released from the SPR, it flows through commercial pipelines or on waterborne vessels to refineries, where it is converted into gasoline and other petroleum products, and then transported to distribution centers for sale to the public.

Trends in U.S. Crude Oil Production and the Petroleum Refining Industry

Reversing a decades-long decline, U.S. crude oil production has increased in recent years. According to EIA data, U.S. production of crude oil reached its highest level in 1970 and generally declined through 2008, reaching a level of almost one-half of its peak. During this time, the United States increasingly relied on imported crude oil to meet growing domestic energy needs. However, recent improvements in technologies have allowed producers to extract crude oil from shale formations that were previously considered to be inaccessible because traditional techniques did not yield sufficient amounts for economically viable production. In particular, the application of horizontal drilling techniques and hydraulic fracturing—a process that injects a combination of water, sand, and chemical additives under high pressure to create and maintain fractures in underground rock formations that allow crude oil and natural gas to flow—have increased U.S. crude oil and natural gas production.[14] Monthly domestic crude oil production has increased from an average of about 5 million barrels per day in 2008 to about 8.4 million barrels per day in April 2014, an increase of almost 68 percent.

As we previously found, the growth in U.S. crude oil production has lowered the cost of some domestic crude oils.[15] For example, prices for West Texas Intermediate (WTI) crude oil—a domestic crude oil used as a

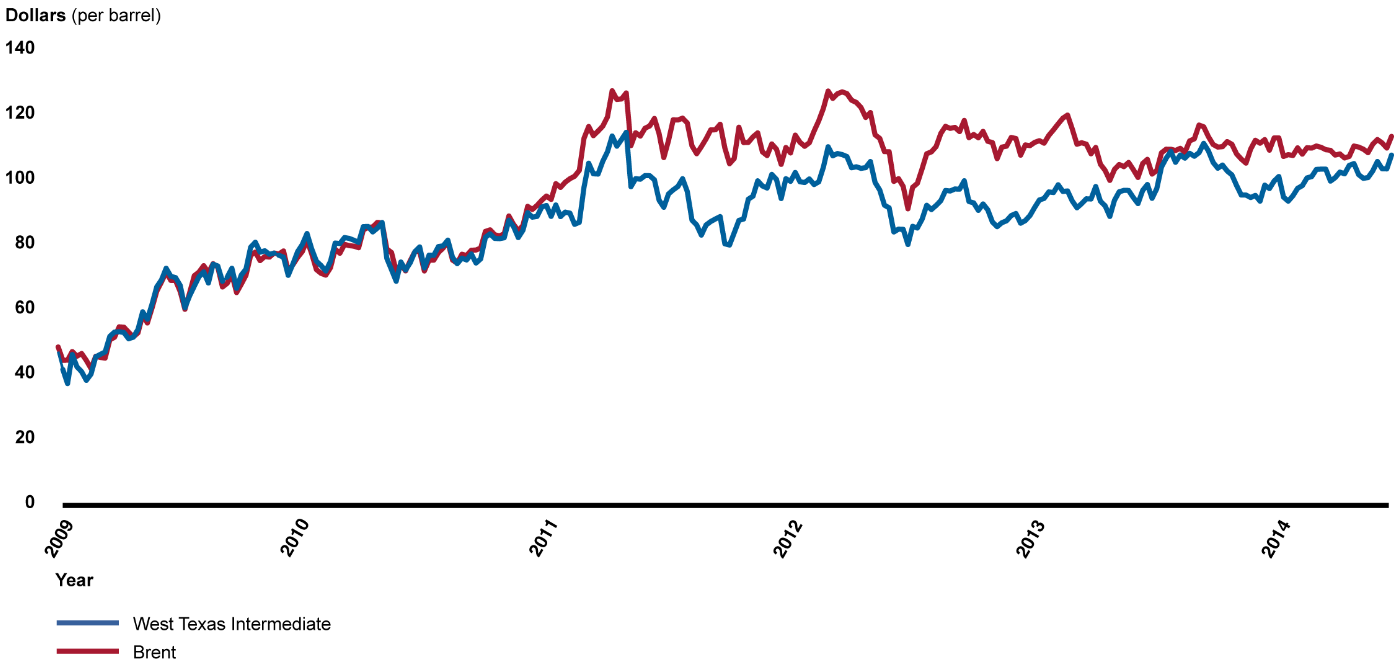
[13]Pub. L. No. 94-163, §161, 89 Stat. 888-889 (1975), codified as amended at 42 U.S.C. §6241. The statute provides for a drawdown of the reserve upon a finding by the President that there is a “severe energy supply interruption” as well as an event that is, or is likely to become, an energy supply shortage “of significant scope or duration” (42 U.S.C. §6241(d), (h)).

[14]For more information on these technologies, see: GAO, *Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks,* GAO-12-732 (Washington, D.C.: Sept. 5, 2012).

[15]GAO, *Petroleum Refining: Industry’s Outlook Depends on Market Changes and Key Environmental Regulations,* GAO-14-249 (Washington, D.C.: Mar. 14, 2014).

benchmark for pricing—was historically about the same price as Brent, an international benchmark crude oil from the North Sea between Great Britain and the European continent.[16] However, from 2011 through June 13, 2014, the price of WTI averaged $14 per barrel lower than Brent (see fig. 1). In 2014, prices for these benchmark crude oils narrowed somewhat, and WTI averaged $101 through June 13, 2014, while Brent averaged $109. The development of U.S. crude oil production has created some challenges for crude oil transportation infrastructure because some production has been in areas with limited linkages to refining centers. According to EIA, these infrastructure constraints have contributed to discounted prices for some domestic crude oils.

Figure 1: Weekly West Texas Intermediate and Brent Crude Oil Prices, 2009-June 2014



Source: GAO analysis of Bloomberg data. | GAO-14-807

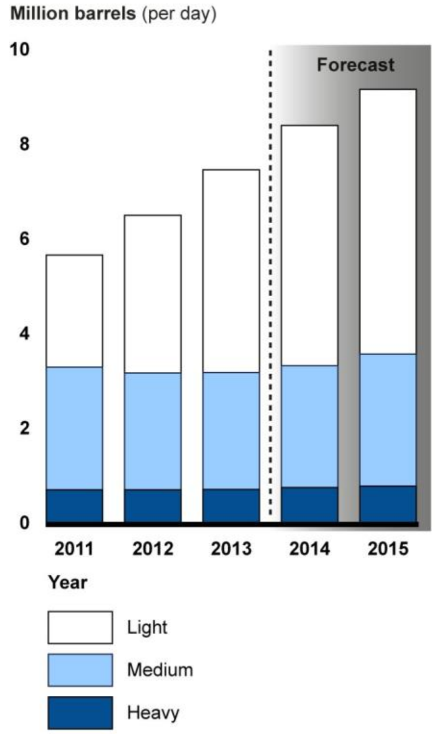
Note: West Texas Intermediate is a domestic crude oil used as a benchmark for pricing, and Brent is an international benchmark from the North Sea between Great Britain and the European continent.

[16]Because of the large number of grades of crude oils, buyers and sellers use benchmark crude oils as a reference in pricing crude oil. A benchmark crude oil is typically an abundantly produced and frequently traded crude oil. For example, crude oils produced in North and South America are typically priced in reference to WTI.

Much of the crude oil currently produced in the United States has characteristics that differ from historic domestic production. Crude oil is generally classified according to two parameters: density and sulfur content. Less dense crude oils are known as “light,” while denser crude oils are known as “heavy.” Crude oils with relatively low sulfur content are known as “sweet,” while crude oils with higher sulfur content are known as “sour.” As shown in figure 1, according to EIA, production of new domestic crude oil has tended to be light oils. Specifically, according to EIA estimates about all of the 1.8 million barrels per day growth in production between 2011 and 2013 consisted of lighter sweet crude oils.[17] EIA also forecasts that lighter crude oils will make up a significant portion of production growth in 2014 and 2015—about 60 percent.

[17]The density, or gravity of a crude oil is specified using the American Petroleum Institute (API) gravity standard, which measures the weight of crude oil in relation to water, which has an API gravity of 10 degrees. For the purposes of this estimate, we considered light oils as those with an API gravity of 35 degrees or above. See: Energy Information Administration, *U.S. Crude Oil Production Forecast-Analysis of Crude Types* (Washington, D.C.: May 29, 2014).

Figure 2: U.S. Crude Oil Production and Energy Information Administration Forecast of Production by Crude Oil Type, 2011-2015



Source: GAO analysis of Energy Information Administration data. | GAO-14-807

Note: The density, or gravity, of a crude oil is specified using the American Petroleum Institute (API) gravity standard, which measures the weight of crude oil in relation to water, which has an API gravity of 10 degrees. Heavy crude oils include those with an API gravity of less than 27; medium includes crude oil with an API from 27 to 35; and light includes crude oil with API gravities of 35 and above.

Light crude oil differs from the crude oil that many U.S. refineries are designed to process. Refineries are configured to produce transportation fuels and other products (e.g., gasoline, diesel, jet fuel, and kerosene) from specific types of crude oil. Refineries use a distillation process that separates crude oil into different fractions, or interim products, based on their boiling points, which can then be further processed into final products. Many refineries in the United States are configured to refine heavier crude oils, and have therefore been able to take advantage of historically lower prices of heavier crude oils.[18] For example, in 2013, the average density of crude oil used at domestic refineries was 30.8 while nearly all of the increase in production in recent years has been lighter crude oil with a density of 35 or above.

According to EIA, additional production of light crude oil over the past several years has been absorbed into the market through several mechanisms, but the capacity of these mechanisms to absorb further increases in light crude oil production may be limited in the future as follows:

- **Reduced imports of similar grade crude oils**: According to EIA, additional production of light oil in the past several years has primarily been absorbed by reducing imports of similar grade crude oils. Light crude oil imports fell from 1.7 million barrels per day in 2011 to 1 million barrels per day in 2013. There may be dwindling amounts of light crude oil imports that can be reduced in the future, according to EIA.
- **Increased crude oil exports**: As discussed above, crude oil exports have increased recently, from less than 30 thousand barrels per day in 2008 to 396 thousand barrels per day in June 2014. Continued increases in crude oil exports will depend, in part, on the extent of any relaxation of current export restrictions, according to EIA.
- **Increased use of light crude oils at domestic refineries**: Domestic refineries have increased the average gravity of crude oils that they refine. The average API gravity of crude oil used in U.S. refineries increased from 30.2 degrees in 2008 to 30.8 degrees in 2013. Continued shifts to use additional lighter crude oils at domestic refineries can be enabled by investments to relieve constraints associated with refining lighter crude oils at refineries that were optimized to refine heavier crude oils.
- **Increased use of domestic refineries**: In recent years, domestic refineries have been run more intensively, allowing the use of more domestic crude oils. Utilization—a measure of how intensively refineries are used that is calculated by dividing total crude oil and other inputs used at refineries by the amount refineries can process under usual operating conditions—increased from 86 percent in 2011

[18] In general, heavier crude oils require more complex and expensive refineries to process the crude oil into usable products, but have been less expensive to purchase than lighter crude oils.

to 88 percent in 2013. There may be limits to further increases in utilization of refineries that are already running at high rates.

Removing Crude Oil Export Restrictions Is Expected to Increase Domestic Crude Oil Prices and Could Decrease Consumer Fuel Prices

The studies we reviewed and stakeholders we interviewed generally suggest some domestic crude oil prices would increase if crude oil export restrictions were removed, while consumer fuel prices could decrease, although the extent of consumer fuel price changes are uncertain and may vary by region.

Some Domestic Crude Oil Prices Are Expected to Increase

Studies we reviewed and most of the stakeholders we interviewed suggest that some domestic crude oil prices would increase if crude oil export restrictions were removed.[19] As discussed above, increasing domestic crude oil production has resulted in lower prices of some domestic crude oils compared with international benchmark crude oils.[20] Three of the studies we reviewed also said that, absent changes in crude oil export restrictions, the expected growth in crude oil production may not be fully absorbed by domestic refineries or through exports (where allowed), contributing to even wider differences in prices between some

[19]Stakeholders we interviewed include representatives of companies and interest groups with a stake in the outcome of decisions regarding crude oil export restrictions, as well as academic, industry, and other experts.

[20]Increasing U.S. crude oil production may also have affected some global oil prices. For example, in 2013 U.S. crude oil production grew more than the combined increase in the rest of the world, which contributed to relatively stable global crude oil prices in 2013, according to EIA. See: EIA, *Today in Energy: U.S. Crude Oil Production Growth Contributes to Global Oil Price Stability in 2013* (Washington, D.C.: Jan. 9, 2014).

domestic and international crude oils.[21] By removing the export restrictions, these domestic crude oils could be sold at prices closer to international prices, reducing the price differential and aligning the price of domestic crude oil with international benchmarks.

While the studies we reviewed and most of the stakeholders we interviewed agree that domestic crude oil prices would increase if crude oil export restrictions were removed, stakeholders highlighted several factors that could affect the extent of price increases. The studies we reviewed made assumptions about these factors, and actual price implications of removing crude oil export restrictions may differ from those estimated in the studies depending on how export restrictions and market conditions evolve. Specifically, stakeholders raised the following three key uncertainties:

- **Extent of future increases in crude oil production**. As we recently found, forecasts anticipate increases in domestic crude oil production in the future, but the projections are uncertain and vary widely.[22] Two of the studies and two stakeholders told us that, in the absence of exports, higher production of domestic light sweet crude oil would tend to increase the mismatch between such crude oils and the refining industry. In turn, one study indicated that a greater increase in production would increase the price effects of removing crude oil export restrictions. On the other hand, lower than anticipated production of such crude oil would lower potential price effects as the additional crude oil could more easily be absorbed domestically.
- **Extent to which crude oil production increases can be absorbed**. The domestic refining industry and exports to Canada have absorbed the increases in domestic crude oil production thus far, and one

[21]We summarize the results of four studies: Resources for the Future (RFF), *Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States* (Washington, D.C.: Resources for the Future, February 2014, revised March 2014); ICF International and EnSys Energy (ICF International), *The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs* (Washington, D.C.: ICF Resources, March 31, 2014); IHS, *US Crude Oil Export Decision: Assessing the impact of the export ban and free trade on the US economy* (Englewood, CO: IHS, 2014); and NERA Economic Consulting (NERA), *Economic Benefits of Lifting the Crude Oil Export Ban* (Washington, D.C.: NERA Economic Consulting, September 9, 2014). For additional information on these studies, see appendix I.

[22]Specifically, we reported on three forecasts, from the International Energy Agency (IEA), IHS Global, and EIA. See, GAO-14-249.

stakeholder told us the domestic refining industry could provide sufficient capacity to absorb additional future crude oil production. This stakeholder said that refineries have the capacity to refine another 400,000 barrels a day of light crude oil, some of which is not being used because of infrastructure or logistics constraints. The industry is planning to develop or is in the process of developing the capacity to process an additional 500,000 barrels a day of light crude oil, according to this stakeholder. The current capacity that is not being utilized plus capacity that is planned or in development would constitute a total capacity to refine 900,000 barrels per day of light crude oil. To the extent that light crude oil production increases by less than this amount, the gap in prices between WTI and Brent could close in the future as increased crude oil supplies are absorbed.[23] This would reduce the extent to which domestic crude oil prices increase if crude oil export restrictions are removed. On the other hand, some stakeholders suggested that the U.S. refining industry will not be able to keep pace with increasing U.S. light crude oil production. For example, IHS stated that refinery investments to process additional light crude oil face significant risks in the form of potentially stranded investments if export restrictions were to change, and this could result in investments not being made as quickly as anticipated.

- **Extent to which export restrictions change.** Aspects of the export restrictions could be further defined or interpreted in ways that could change the pricing dynamics of domestic crude oil markets. Recently, two companies received clarification from the Department of Commerce that condensate—a type of light crude oil[24]—that has been processed through a distillation tower is not considered crude oil and

[23]For example, EIA estimates that light crude oil production may increase by 513,000 barrels per day in 2015. (See: EIA, *U.S. Crude Oil production Forecast-Analysis of Crude Types* (Washington, D.C.: May 29, 2014).

[24]Specifically, the Department of Commerce's definition of crude oil includes condensates, which are light liquid hydrocarbons recovered primarily from natural gas wells.

so not subject to export restrictions.[25] One stakeholder stated that this may lead to more condensate exports than expected.[26]

Within the context of these uncertainties, estimates of potential price effects vary in the four studies we reviewed, as shown in table 1. Specifically, estimates in these studies of the increase in domestic crude oil prices due to removing crude oil export restrictions range from about $2 to $8 per barrel.[27] For comparison, at the beginning of June 2014, WTI was $103 per barrel, and these estimates represent 2 to 8 percent of that price. In addition, NERA found that removing export restrictions would have no measurable effect in a case that assumes a low future international oil price of $70 per barrel in 2015 rising to less than $75 by 2035. According to NERA, current production costs are close to these values, so that removing export restrictions would provide little incentive to produce more light crude oil.

[25]Specifically, companies often process condensate through stabilization units to reduce their volatility and prepare the condensate for transport to markets. Some stabilization units include distillation towers. In March and May 2014, the Department of Commerce issued commodity classifications that determined that condensates processed through a crude oil distillation tower, as described by the two companies requesting clarification, did not meet the definition of crude oil in BIS's regulations and thus were not subject to the export prohibitions applicable to U.S. produced crude oil.

[26]This clarification provided by the Department of Commerce occurred after the publication of the RFF, ICF International, and IHS studies and thus this was not taken into consideration in the studies. NERA also did not consider the potential effect of the clarification in its study.

[27]Unless otherwise noted, dollar estimates in the rest of this report have been converted to 2014 year dollars. These are average price effects over the study time frames, and some cases in some studies project larger price effects in the near term that decline over time.

Table 1: Crude Oil Price Implications of Removing Crude Oil Export Restrictions from Four Studies

	Resources for the Future	ICF International	IHS	NERA
U.S. crude oil price	Midwest refiner acquisition costs increase $6.68 per barrel[a]	WTI prices $2.35 to $4.19 per barrel higher on average from 2015-2035	$7.89 per barrel higher on average from 2016-2030	Prices increase $1.74 per barrel in the reference case and $5.95 per barrel in the high case on average from 2015-2035.[b]

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA studies. | GAO-14-807

Note: Estimates are in 2014 year dollars.

[a]Refiner acquisition costs are the costs of crude oil including transportation and other fees paid by the refiner. Such costs may be closely related to the prices of crude oil discussed in this report.

[b]Implications refer to the difference between the reference case and its baseline with export restrictions in place, and the difference between the high oil and gas recovery case and its corresponding baseline. NERA also found that removing crude oil export restrictions would have no measurable effect in the low world oil price case.

Consumer Fuel Prices Could Decrease, but Effects May Vary by Region

The studies we reviewed and most of the stakeholders we interviewed suggest that consumer fuel prices, such as gasoline, diesel, and jet fuel, could decrease as a result of removing crude oil export restrictions. A decrease in consumer fuel prices could occur because they tend to follow international crude oil prices rather than domestic crude oil prices, according to the studies and most of the stakeholders. If domestic crude oil exports caused international crude oil prices to decrease, consumer fuel prices could decrease as well.[28] Table 2 shows that the estimates of the price effects on consumer fuels vary in the four studies we reviewed. Price estimates range from a decrease of 1.5 to 13 cents per gallon. These estimates represent 0.4 to 3.4 percent of the average U.S. retail gasoline price at the beginning of June 2014. In addition, NERA found that removing export restrictions has no measurable effect on consumer fuel prices in a case that assumes a low future world crude oil price.

[28]RFF also estimates a decrease in consumer fuel prices but this decrease is as a result of increased refinery efficiency (even with an estimated slight increase in the international crude oil price).

Table 2: Consumer Fuel Price Implications of Removing Crude Oil Export Restrictions from Four Studies

	Resources for the Future	ICF International	IHS	NERA[a]
U.S. Consumer Fuel Prices	Gasoline prices decline by 1.8 to 4.6 center per gallon on average	Petroleum product prices decline by 1.5 to 2.4 cents per gallon on average from 2015-2035	Gasoline prices decline by 9 to 13 cents per gallon on average from 2016-2030	Petroleum product prices decline by 3 cents per gallon on average from 2015-2035 in the reference case and 11 cents per gallon in the high case. Gasoline prices decline by 3 cents per gallon in the reference case and 10 cents per gallon in the high case.

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA studies. | GAO-14-807

Note: Dollar estimates are in 2014 year dollars.

[a]Implications refer to the difference between the reference case and its baseline with export restrictions in place, and the difference between the high oil and gas recovery case and its corresponding baseline. NERA also found that removing crude oil export restrictions has no measurable effect in the world crude oil low price case.

Price Effects of Allowing Alaskan North Slope Crude Oil Exports

In 1995, Congress removed the restrictions on the export of Alaskan North Slope crude oil. From the time the restrictions were removed until 2004, about 2.7 percent of Alaskan North Slope crude oil was exported; however, no Alaskan North Slope crude oil has been exported since 2004.The experience of allowing Alaskan North Slope crude oil exports may illustrate some of the potential effects of removing crude oil export restrictions nationally. In 1999, we reviewed the effects of allowing Alaskan North Slope crude oil exports and concluded that:[a]

- lifting the export ban raised the relative prices of Alaskan North Slope and comparable California crude oils by between $0.98 and $1.30 per barrel;[b]
- some refiners' costs increased commensurate with the increase in crude oil prices; and
- consumer fuel prices for gasoline, diesel, and jet fuel did not increase.

The effect of removing the export restrictions for Alaskan North Slope oil is not completely understood due to data limitations and the difficulty of separating the effects of removing the export restrictions from other market changes that occurred at the same time.

Source: GAO. | GAO-14-807

[a]GAO, Alaskan North Slope Oil: Limited Effects of Lifting Export Ban on Oil and Shipping Industries and Consumers, GAO/RCED-99-191 (Washington, D.C., July 1, 1999).

[b]These estimates have not been adjusted for inflation.

The effect of removing crude oil export restrictions on domestic consumer fuel prices depends on several uncertain factors. First, it depends on the extent to which domestic versus international crude oil prices determine the domestic price of consumer fuels. Recent research examining the relationship between domestic crude oil and gasoline prices concluded that low domestic crude oil prices in the Midwest during 2011 did not result in lower gasoline prices in that region.[29] This research supports the assumption made in all of the studies we reviewed that to some extent higher prices of some domestic crude oils as a result of removing crude oil export restrictions would not be passed on to consumer fuel prices. However, some stakeholders told us that this may not always be the case and that more recent or detailed data could show that lower prices for some domestic crude oils have influenced consumer fuel prices.

Second, the extent to which domestic consumer fuel prices could decline also depends on how the global crude oil market responds to the domestic crude oil entering the market. In this regard, stakeholders highlighted several uncertainties. In particular, the response of the Organization of the Petroleum Exporting Countries (OPEC) could have a large influence on any international crude oil price changes. The projections in the RFF, IHS, and ICF International studies assumed that OPEC would not respond by attempting to counterbalance the effect of increased U.S. exports by reducing its countries' exports. However, OPEC could seek to maintain international crude oil prices by pulling crude oil from the global market. In this case, the international crude oil price would not be affected by removing export restrictions, and consumer fuel prices would not decline. On the other hand, OPEC could increase production to maintain its large market share, which would push international crude oil prices and consumer fuel prices downward. NERA examined two alternative OPEC response cases, and found that gasoline prices would not generally be affected if OPEC reduces production, and that consumer fuel prices would decrease further if OPEC maintains its production in the face of lower global crude oil prices. In addition, one stakeholder questioned whether international crude oil prices would be affected by U.S. crude oil exports. Given the size of the global crude oil market, this stakeholder suggested that U.S. exports would have little to no effect on international crude oil prices.

[29]See Severin Borenstein and Ryan Kellogg, "The Incidence of an Oil Glut: Who Benefits from Cheap Crude Oil in the Midwest?" *The Energy Journal 35, no. 1* (2014).

Third, two of the stakeholders we interviewed suggested that there could be important regional differences in consumer fuel price implications, and that prices could increase in some regions—particularly the Midwest and the Northeast—due to changing transportation costs and potential refinery closures. For example, two stakeholders told us that because of requirements to use more expensive U.S.-built, -owned, and -operated ships to move crude oil between U.S. ports, allowing exports could enable some domestic crude oil producers to ship U.S. crude oil for less cost to refineries in foreign countries.[30] Specifically, representatives of one refiner told us that, if exports restrictions were removed, they could ship oil to their refineries in Europe at a lower cost than delivering the same oil to a refinery on the U.S. East Coast. According to another stakeholder, this could negatively affect the ability of some domestic refineries to compete with foreign refineries. Additionally, because refineries are currently benefiting from low domestic crude oil prices, some studies and stakeholders noted that refinery margins could be reduced if removing export restrictions increased domestic crude oil prices. As a result, some refineries could face an increased risk of closure, especially those located in the Northeast. As EIA reported in 2012, refinery closures in the Northeast could be associated with higher consumer fuel prices and possibly higher price volatility.[31] However, according to one stakeholder, domestic refiners still have a significant cost advantage in the form of less expensive natural gas, which is an important energy source for many refineries. For this and other reasons, one stakeholder told us they did not anticipate refinery closures as a result of removing export restrictions.

[30]The Merchant Marine Act of 1920, also known as the Jones Act, in general, requires that any vessel (including barges) operating between two U.S. ports be U.S.-built, -owned, and -operated.

[31]EIA, *Potential Impacts of Reductions in Refinery Activity on Northeast Petroleum Product Markets* (Washington, D.C.: May 11, 2012).

Removing Crude Oil Export Restrictions Is Expected to Increase Domestic Production and Have Other Effects

The studies we reviewed and stakeholders we interviewed generally suggest that removing crude oil export restrictions would increase domestic crude oil production and may affect the environment and the economy.

Removing Export Restrictions Is Expected to Increase Domestic Production, but Projections Vary

Studies we reviewed and stakeholders we interviewed generally agree that removing crude oil export restrictions would increase domestic crude oil production. Monthly domestic crude oil production has increased by almost 68 percent since 2008—from an average of about 5 million barrels per day in 2008 to 8.3 million barrels per day in April 2014. Even with current crude oil export restrictions, given various scenarios, EIA projects that domestic production will continue to increase and could reach 9.6 million barrels per day by 2019.[32] If export restrictions were removed, according to the four studies we reviewed, the increased prices of domestic crude oil are projected to lead to further increases in crude oil production. Projections of this increase varied in the studies we reviewed—from a low of an additional 130,000 barrels per day on average between 2015 and 2035, according to the ICF International study, to a high of an additional 3.3 million barrels per day on average

[32]U.S. crude oil production grows from 2012 through 2019 in EIA's Reference scenario, peaking at more than 9.6 million barrels per day—about 3.1 million barrels per day above the 2012 total and close to the historical high of 9.6 million barrels per day in 1970. However, EIA projects declines in later years. EIA examined several alternative scenarios, including a High Oil and Gas Resource scenario, where growth in oil production continues for a longer period of time than projected in the Reference scenario. Domestic crude oil production increases to nearly 13 million barrels per day before 2035 in this scenario. EIA also examined a Low Oil and Gas Resource scenario reflecting uncertainty about tight oil and shale crude oil and natural gas resources, leading to lower domestic production than in the Reference scenario. In the latter, production reaches 9.1 million barrels per day in 2017 before falling to 6.6 million barrels per day in 2040 (Energy Information Administration. *Annual Energy Outlook 2014*. May 7, 2014. See: http://www.eia.gov/forecasts/aeo/MT_liquidfuels.cfm.)

between 2015 and 2035 in NERA's study.[33] This is equivalent to 1.5 percent to almost 40 percent of production in April 2014.

One stakeholder we spoke with told us that, although domestic demand for crude oil is not expected to change, production will rise as a result of increased international demand, primarily from Asia. For example, according to EIA, India was the fourth-largest consumer of crude oil and petroleum products in the world in 2013, and the country's dependence on imported crude oil continues to grow.[34] Another stakeholder stated that removing export restrictions could lead to increased local and regional opposition to crude oil production if the crude oil was primarily for export, which could affect domestic production.

Removing Export Restrictions Is Expected to Affect the Environment

Two of the studies we reviewed and most stakeholders we spoke with stated that the increased crude oil production that would result from removing the restrictions on crude oil exports may affect the environment. In September 2012, we found that crude oil development may pose certain inherent environmental and public health risks; however, the extent of the risk is unknown, in part, because the severity of adverse effects depend on various location- and process-specific factors, including the location of future shale oil and gas development and the rate at which it occurs, as well as geology, climate, business practices, and regulatory and enforcement activities.[35] The stakeholders who raised concerns identified the following risks related to crude oil production, about which GAO has reported in the past:

- **Water quality and quantity:** Increased crude oil production, particularly from shale, could affect the quality and quantity of surface and groundwater sources, but the magnitude of such effects is

[33]In addition, RFF estimated that oil production in Canada and in the Midwest United States would gradually increase if the restrictions were lifted by about 84,000 barrels per day. RFF estimated production elsewhere in the United States and the rest of the world would increase by 54,000 barrels per day for a total increase in world production of 138,000 additional barrels per day. IHS projected an additional 1.2 to 2.3 million barrels per day of crude oil production from 2016- through 2030. (See app. I for additional information.)

[34]U.S. Department of Energy. Energy Information Administration. Country Report: India. See: http://www.eia.gov/countries/country-data.cfm?fips=IN. June 26, 2014.

[35]GAO-12-732.

unknown. In October 2010, we found that water is needed for a number of oil shale development activities, including constructing facilities, drilling wells, generating electricity for operations, and reclamation of drill sites.[36] In 2012, we found that shale oil and gas development may pose a risk to surface water and groundwater because withdrawing water from streams, lakes, and aquifers for drilling and hydraulic fracturing could adversely affect water resources.[37] For example, we found that groundwater withdrawal could affect the amount of water available for other uses, including public and private water supplies. One of the stakeholders we interviewed suggested that water withdrawal is already an important consideration, particularly for areas experiencing drought. For example, the stakeholder noted that crude oil production and associated water usage already has implications for the Edwards Aquifer, a groundwater system serving the agricultural, industrial, recreational, and domestic needs of almost two million users in south central Texas. In addition, removing export restrictions may affect water quality. Another stakeholder told us that allowing crude oil exports would lead to more water pollution as a result of increased production through horizontal drilling.

- **Air quality:** Increased crude oil production may increase greenhouse gases and other air emissions because the use of consumer fuels would increase, and also because the crude oil production process often involves the direct release of pollutants into the atmosphere (venting) or burning fuels (flaring).[38] Two stakeholders told us that

[36]We found, for example, that water is needed for five distinct groups of activities that occur during the life cycle of oil shale development: (1) extraction and retorting, (2) upgrading of shale oil, (3) reclamation, (4) power generation, and (5) population growth associated with oil shale development. We reviewed a set of studies that indicated that the expected total water needs for the entire life cycle of oil shale production ranged from about 1 barrel (or 42 gallons) to 12 barrels of water per barrel of oil produced from in situ (underground heating) operations, with an average of about 5 barrels, and from about 2 to 4 barrels of water per barrel of oil produced from mining operations with surface heating. See GAO, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development,* GAO-11-35 (Washington, D.C.: Oct. 29, 2010).

[37]GAO-12-732.

[38]Burning natural gas is known as flaring, while releasing natural gas directly into the atmosphere is called venting. In 2004, we found that venting and flaring have adverse environmental effects and result in loss of a significant amount of energy. In areas where the primary purpose of drilling is to produce oil, producers flare or vent because no local market exists for the gas. See GAO, *Natural Gas Flaring and Venting: Opportunities to Improve Data and Reduce Emissions,* GAO-04-809 (Washington, D.C.: July 14, 2004).

venting and flaring has escalated in North Dakota, in part because regulatory oversight and infrastructure have not kept pace with the recent surge in crude oil production in the state. In January 2014, the North Dakota Industrial Commission reported that nearly 30 percent of all natural gas produced in the state is flared. According to a 2013 report from Ceres, flaring in North Dakota in 2012 resulted in greenhouse gas emissions equivalent to adding 1 million cars to the road.[39] Another stakeholder told us that allowing crude oil exports would lead to more air pollution as a result of increased production through horizontal drilling and hydraulic fracturing. RFF estimated the potential environmental effect of removing export restrictions, estimating that increases in crude oil production and consumption would increase carbon dioxide emissions worldwide by almost 22 million metric tons per year.[40] By comparison, U.S. emissions from energy consumption totaled 5,393 million metric tons in 2013 according to EIA. NERA estimated that increased crude oil production and use of fossil fuels would increase greenhouse gas emissions by about 12 million metric tons of carbon dioxide equivalents per year on average from 2015 through 2035.[41]

- **Transportation challenges:** Increased crude oil production could exacerbate transportation challenges. In March 2014, we found that

[39]Ceres, *Flaring Up: North Dakota Natural Gas Flaring More Than Doubles in Two Years* (July 2013). Ceres is a nonprofit organization.

[40]According to the Environmental Protection Agency, carbon dioxide is the primary greenhouse gas emitted through human activities. Further, the main human activity that emits carbon dioxide is the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportation.

[41]Carbon dioxide equivalents provide a common standard for measuring the warming potential of different greenhouse gases and are calculated by multiplying the emissions of the non-carbon dioxide gas by its global warming potential, a factor that measures its heat-trapping ability relative to that of carbon dioxide. The NERA study suggests that maintaining crude oil export restrictions could be a relatively costly means of constraining greenhouse gas emissions. The authors calculated that the cost per ton of avoided emissions using crude oil export restrictions range from about $1,200 to $1,400 per ton of carbon dioxide in one case, and about $900 to $1,000 per ton in another case (in 2013 dollars). The authors stated that these costs are higher than government estimates of the benefits of reducing carbon dioxide emissions—in 2013, an interagency working group estimated the benefits of avoided emissions ranged from $37 to $56 per metric ton of carbon dioxide from 2015 through 2035 (in 2007 dollars at a 3 percent discount rate). See: Interagency Working Group on the Social Cost of Carbon, United States Government, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866* (Washington, D.C.: May 2013, revised November, 2013).

domestic and Canadian crude oil production has created some challenges for U.S. crude oil transportation infrastructure. Some of the growth in crude oil production has been in areas with limited transportation to refining centers.[42] To address this challenge, refiners have relied on rail to transport crude oil. According to data from the Surface Transportation Board, rail moved about 236,000 carloads of crude oil in 2012, which is 24 times more than the roughly 9,700 carloads moved in 2008. As we recently found, as the movement of crude oil by rail has increased incidents such as spills and fires involving crude oil trains have also increased—from 8 incidents in 2008 to 119 incidents in 2013 according to Department of Transportation data.[43] Some stakeholders told us that removing export restrictions would increase the risk for crude oil spills by rail and other modes of transportation such as tankers. On the other hand, one stakeholder suggested that removing export restrictions could reduce the amount of crude oil transported by rail, in some instances, since the most economic way to export crude oil is by pipeline to a tanker. As a result, the number of rail accidents involving crude oil spills could decrease.

Removing Export Restrictions Is Expected to Affect the Economy

The studies we reviewed suggest that removing crude oil export restrictions would increase the size of the economy. Three of the studies project that removing export restrictions would lead to additional investment in crude oil production and increases in employment. This growth in the oil sector would—in turn—have additional positive effects in

[42] GAO-14-249.

[43] Department of Transportation data show that the majority of the 2013 incidents were small; however, two incidents in 2013, in Aliceville, Alabama, and Casselton, North Dakota, resulted in large spills and greater damage. Significant incidents have continued to occur in 2014, including an April derailment and fire in Lynchburg, Virginia. The Department of Transportation Pipeline and Hazardous Materials Safety Administration's incident database can be searched at https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/ (accessed June 12, 2014). GAO, *Oil and Gas Transportation: Department of Transportation Is Taking Actions to Address Rail Safety, but Additional Actions are Needed to Improve Pipeline Safety*, GAO-14-667 (Washington, D.C.: August 21, 2014).

the rest of the economy.[44] For example, NERA projects an average of 230,000 to 380,000 workers would be removed from unemployment through 2020 if export restrictions were eliminated in 2015.[45] These employment benefits largely disappear if export restrictions are not removed until 2020 because by then the economy will have returned to full employment. Potential implications for investment, public revenue, and trade are as follows:

- **Investments:** According to one of the studies we reviewed, removing export restrictions may lead to more investment in crude oil exploration and production, but this investment could be somewhat offset by less investment in the refining industry. As discussed previously, removing export restrictions is expected to increase domestic crude oil production. Private investment in drilling rigs, engineering services, and transportation and logistics facilities, for example, is needed to increase domestic crude oil production. According to IHS, this will directly benefit industries such as machinery, fabricated metals, steel, chemicals, and engineering services. At the same time, removing export restrictions may decrease investment in the refining industry because the industry would not need extensive additional investment to accommodate lighter crude oils. For example, one stakeholder told us that, under current export restrictions, refining additional light crude oils may require capital investment to remove processing constraints at refineries that are designed to process heavier crude oils. Officials from one refining company told us that they had invested a significant amount of capital to refine lighter oils. For example, the refinery installed two new distillation towers to process lighter crude oils at a cost of $800 million. Such investments may not be necessary if export restrictions were removed.

[44] Growth in one sector of the economy can result in economy-wide growth through follow-on effects. For example, researchers at the Federal Reserve Bank of Dallas found that oil development in the Eagle Ford region of South Texas has had profound effects on jobs, income, and spending in the region with effects beyond those in the oil sector alone. See: Gilmer, Robert W., Raúl Hernandez, and Keith Phillips, "Oil Boom in Eagle Ford Shale Brings New Wealth to South Texas," *Southwest Economy* (Federal Reserve Bank of Dallas: Second Quarter, 2012).

[45] According to NERA, because of the increase in economic growth triggered by investment in more production capacity and infrastructure, there will be a corresponding acceleration of the rate at which the economy moves toward full employment.

- **Public revenue:** Two of the studies we reviewed suggest that removing export restrictions would increase government revenues, although the estimates of the increase vary. One study estimated that total government revenue would increase by a combined $1.4 trillion in additional revenue from 2016 through 2030 while another study estimated that U.S. federal, state, and local tax receipts combined with royalties from drilling on federal lands could increase by an annual average of $3.9 to $5.7 billion from 2015 through 2035.
- **Trade:** According to the studies we reviewed, removing export restrictions would contribute to further declines in net petroleum (i.e., crude oil, consumer fuels, and other petroleum products) imports and reduce the U.S. trade deficit. Three of the studies we reviewed estimated the effect of removing export restrictions on net petroleum imports, with ICF projecting a decline in net imports of about 100,000 to 300,000 barrels per day; IHS projecting a decline, but not providing a specific estimate; and NERA projecting a decline of about 0.6 to 3.2 million barrels per day. Further, according to one study, removing export restrictions could also improve the U.S. trade balance because the light sweet crude oils are usually priced higher than heavy, sour crude oils. One study estimated that removing export restrictions could improve the trade balance (narrow the U.S. trade deficit) by $8 to $15 billion per year on average from 2015 through 2035. Another study estimated that removing crude oil export restrictions would improve the trade balance by $72 to $101 billion per year from 2016 through 2030.

Changing Market Conditions Raise Questions about the Size, Location, and Composition of the SPR

Changing market conditions—most importantly the significant increase in domestic production of crude oil from shale—have implications for the role of the SPR, including its appropriate size, location, and composition. DOE has taken some steps to reexamine the location and composition of the SPR in light of these changes, but has not recently reexamined its size.

Changing Crude Oil Market Conditions Affect the SPR

Recent and expected changes in crude oil markets have important implications for the role of the SPR, including its size, location, and composition. DOE has recognized that recent increases in domestic crude oil production and correlating reductions in crude oil imports have changed how crude oil is transported around the United States, and that these changes carry potential implications for the operation and maintenance of the SPR. As discussed above, removing crude oil export restrictions would be expected to increase domestic crude oil production and contribute to further declines in net imports. Our review of DOE documents, prior GAO work, and discussions with stakeholders highlight three primary implications for the SPR.

Size: Increased domestic crude oil production and falling net petroleum imports may affect the ideal size of the SPR—how much the SPR should hold to optimize the benefits of protecting the economy from damage with the costs of holding the reserves. One measure of the economy's vulnerability to oil supply disruptions is to assess net petroleum imports—imports minus exports. Net petroleum imports have declined from a peak of 60 percent of consumption in 2005 to about 30 percent in the first half of 2014. In 2006, net imports were expected to increase in the future, increasing the country's reliance on foreign crude oil. However, imports have declined and, according to EIA's most recent forecast, are expected to remain well below 2005 import levels into the future. (See fig. 3.) As discussed above, removing crude oil export restrictions would be expected to contribute to additional decreases in net petroleum imports in the future.

To the extent that changes in net imports reflect changes in vulnerability, these and other changes in the economy may have reduced the nation's vulnerability to supply disruptions. For example, a recent report by the President's Council of Economic Advisers suggests that decreased domestic petroleum demand, increased domestic crude oil production, more fuel efficient vehicles, and increased use of biofuels, have each contributed to reducing the vulnerability of the nation's economy to international crude oil supply disruptions.[46] Although international crude oil supply and price volatility remains a risk, the report suggests that additional reductions in net petroleum imports could reduce those risks in the future. In addition, the SPR currently holds oil in excess of international obligations. As a member of the IEA, the United States is required to maintain reserves of crude oil or petroleum products equaling at least 90 days of net imports, which it does with a combination of public and private reserves. According to IEA, as of May 2014, the SPR held 106 days of net imports, and private reserves held an additional 141 days of imports for a total of 247 days—well above the 90 days required by the

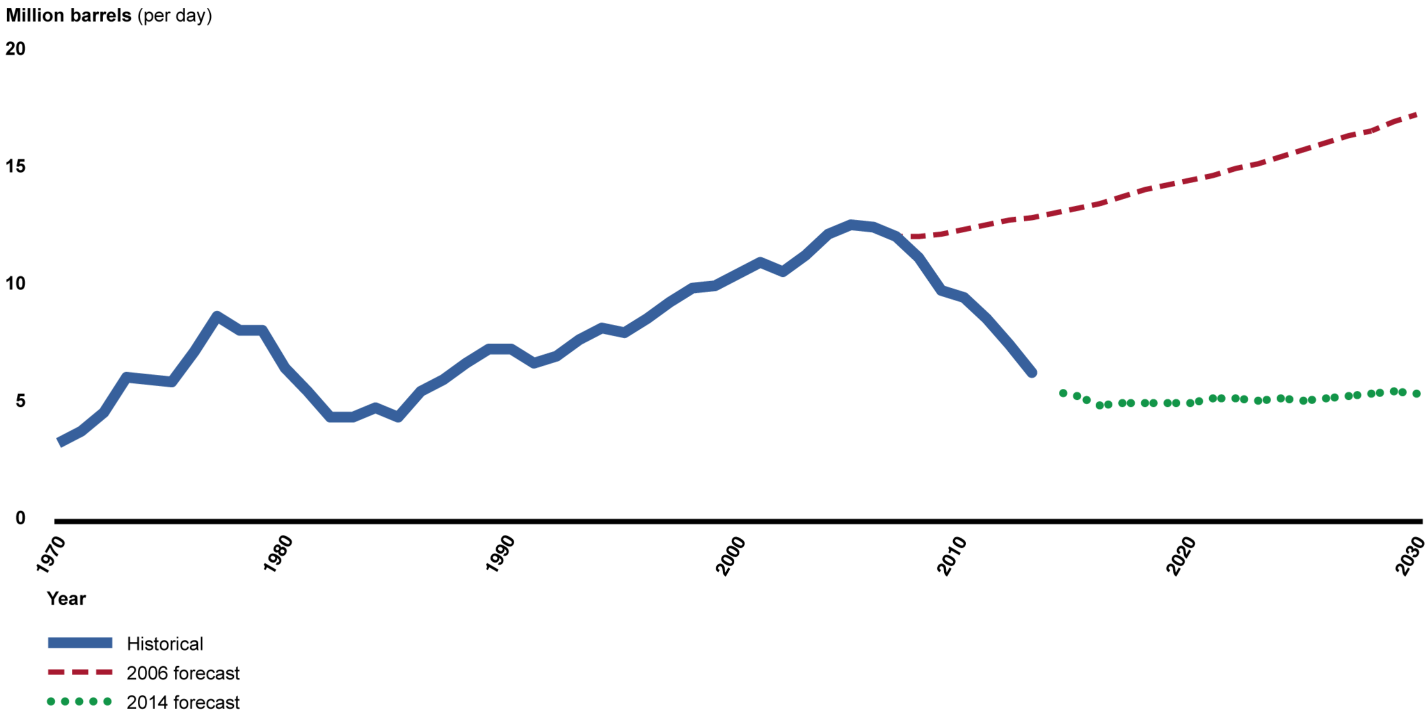
[46]President's Council of Economic Advisers, *The All-of-the-Above Energy Strategy as a Path to Sustainable Economic Growth.* Executive Office of the President. May 2014.

IEA.[47] In light of these factors, some of the stakeholders we interviewed raised questions about whether such a large SPR is needed in the future. For example, one stakeholder indicated that SPR crude oil is surplus and no longer needed to protect the economy. However, other stakeholders highlighted the importance of maintaining the SPR. For example, one stakeholder said that the SPR should be maintained at the current level, and another said that the SPR serves an important "energy insurance" service. DOE officials and one other stakeholder highlighted that, in addition to net imports, there are other factors that may affect the appropriate size of the SPR.[48]

[47]According to IEA, all reserves held by industry count towards meeting a country's IEA reserve commitment. Most member governments require certain companies, such as importers, refiners, product suppliers or wholesalers, to hold a minimum number of days of reserves. However, 9 countries, including the United States, do not place such a requirement on industry. According to DOE officials, commercial entities set their reserves based on the economic principle of inventory minimization and require a large portion of the reserves they hold to keep their logistical systems moving. These reserves may therefore not be available to address a supply disruption in the same way as mandated industry reserves or public reserves.

[48]DOE officials cited several studies to show the diversity of views in this regard, and noted that most of the literature on the effect of supply disruptions on the economy does not focus on net imports, and that this is an area of active research. According to DOE, the literature shows that the United States is still vulnerable to oil price shocks as these can cause dislocations within key economic sectors. As part of this review, we did not assess the validity of the studies. For example, see: J.D. Hamilton, "Causes and Consequences of the Oil Shock of 2007-08," *Brookings Papers on Economic Activity*, Spring 2009: 215-261; L. Kilian, "The Economic Effects of Energy Price Shocks," *Journal of Economic Literature* 46, no.4(2008): 871-909.

Figure 3: U.S. Net Petroleum Imports, Historical (1970-2013) and Energy Information Administration Forecasts



Sources: GAO analysis of Energy Information Administration data and forecasts. | GAO-14-807

Note: Forecast data are the 2006 and 2014 Annual Energy Outlook reference scenarios.

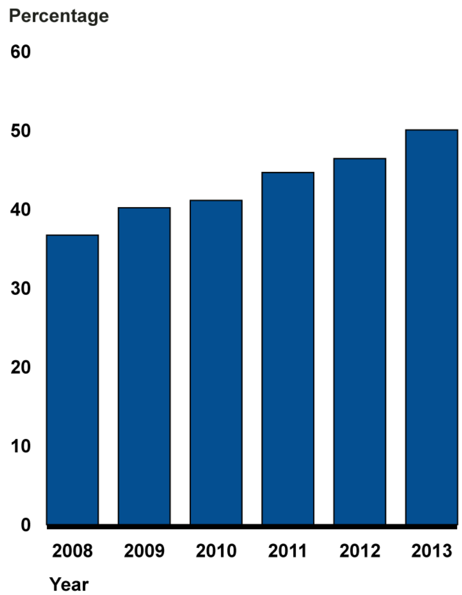
Location: According to DOE, changes in how crude oil is transported throughout the United States and in the existing infrastructure surrounding SPR facilities have implications for the location of the SPR. Crude oil in the SPR is stored along the Gulf Coast, where it can take advantage of being in close proximity to a major refining center, as well as distribution points for tankers, barges, and pipelines that can carry crude oil from the SPR to refineries in other regions of the country. Most of the system of crude oil pipelines in the United States was constructed in the 1950s, 1960s, and 1970s to accommodate the needs of the refining sector and demand centers at the time. According to DOE officials, the existing infrastructure was designed primarily to move crude oil from the southern United States to the North. The SPR has historically been able to rely on this distribution system to reach a large portion of the nation's refining capacity. But, with increases in crude oil production in the Northern U.S. and imports of crude oil from Canada, the distribution system has changed to increase crude oil flows south to the Gulf Coast. Such changes include new pipeline construction and expansions, flow reversals in existing pipelines, and increased utilization of terminals and marine facilities. Such changes may make it more difficult to move crude oil from the SPR to refineries in certain regions of the United States, such as the Midwest, where almost 20 percent of the nation's refining capacity is located, according to EIA data. Some stakeholders raised questions about the location of the SPR. One stakeholder also suggested that holding SPR crude oil in the western United States may better ensure access to crude oil in the case of a disruption, since the West has no pipeline connectivity to the Gulf Coast. According to DOE, recent changes to crude oil distribution in the United States could have significant implications for the operation and maintenance of the SPR.

Composition: In 2006, we reported that the type of crude oil in the SPR was not compatible with all U.S. refineries. We reported that some U.S. refineries processed crude oils heavier than those stored in the SPR. We found that in the event of a disruption in the supply of heavy crude oil, refineries configured to use heavy crude oil would not be able to efficiently refine crude oil from the SPR and would likely reduce production of some petroleum products. As we reported, in such instances, prices for heavy crude oil products could increase, reducing the SPR's effectiveness to limit economic damage.[49] Refinery officials we spoke with noted that the SPR should contain heavier crude oils that domestic refineries could refine in the event of a supply disruption. Since our 2006 report, domestic production of light sweet crude oil has increased. According to EIA, roughly 96 percent of the 1.8 million-barrel per day growth in production from 2011 to 2013 consisted of light sweet grades with API gravity of 40 or above. As a result, imports of light crude oils have declined, and U.S. reliance on imported heavy crude oil has increased from 37 percent of total imports in 2008 to 50 percent of total imports in 2013, as shown in figure 4. However, DOE officials raised concerns about the prospect of storing additional heavy crude oil in the SPR. According to DOE officials and a 2010 report by DOE, storing heavy crude oil in the SPR would limit the SPR's ability to respond to nonheavy crude oil disruptions, such as a loss of Middle East medium sour crude oils. In addition, storing more heavy crude would require infrastructure

[49]GAO, *Strategic Petroleum Reserve: Available Oil Can Provide Significant Benefits, but Many Factors Should Influence Future Decisions about Fill, Use, and Expansion,* GAO-06-872 (Washington, D.C.: Aug. 24, 2006).

improvements.[50] At the same time, DOE officials also stated that, based on recent conversations with refinery officials, no U.S. refineries would have difficulty using SPR crude oils. Another issue raised by some stakeholders we interviewed is that the SPR holds primarily crude oil, and some stakeholders told us that holding additional consumer fuels could be beneficial.[51] Many recent economic risks associated with supply disruptions have originated from the refining and distribution sectors rather than crude oil supplies.

Figure 4: Heavier Crude Oil as a Percentage of Total U.S. Crude Oil Imports, 2008-2013



Source: GAO analysis of Energy Information Administration data. | GAO-14-807

Note: The weight of a crude oil is specified using the American Petroleum Institute (API) gravity standard, which measures the weight of crude oil in relation to water. Data in this figure are imports of crude oils with 25 or lower API gravity as a share of total crude oil imports.

[50]For example, according to DOE, storing heavier crude oil in the SPR would require upgrading the Sun Terminal, a tanker delivery location, to handle the heavier crude oil; building an additional pipeline from one of four storage sites to maintain current drawdown rates; and performing other site improvements. U.S. Department of Energy. Office of the Deputy Assistant Secretary for Petroleum Reserves. *Strategic Petroleum Reserve: Updated Crude Compatibility Study.* April 2010.

[51]DOE also operates the Northeast Home Heating Oil Reserve, which stores 1 million barrels of diesel fuel in Massachusetts and Connecticut.

DOE Has Taken Steps to Reexamine Some Aspects of the SPR but Has Not Recently Reexamined Its Size

DOE has taken some steps to assess the appropriate location and composition of the SPR in view of changing market conditions, but has not recently re-examined its size. We previously found that federal programs should be re-examined if there have been significant changes in the country or the world that relate to the reason for initiating the program.[52] In that report, we identified a set of reexamination criteria that, when taken together, illustrate the issues that can be addressed through a systematic reexamination process. We found that many federal programs and policies were designed decades ago to respond to trends and challenges that existed at the time of their creation. Given fiscal constraints that we are likely to face for years to come, reexamination may be essential to addressing newly emergent needs without unduly burdening future generations of taxpayers. DOE has taken some steps to reexamine how recent changing market conditions could affect the location and composition of the SPR as follows:

- In March 2014, DOE conducted a test sale of SPR crude oil to evaluate the SPR's ability to draw down and distribute SPR crude oil through multiple pipeline and terminal delivery points within one of its distribution systems.[53] DOE officials told us they were reviewing the results of the test sale including data on the movement of crude oil through the system.
- DOE officials also told us they are working to establish a Northeast Regional Refined Petroleum Product Reserve in New York Harbor and New England to store refined consumer fuels. Although the northeast reserve will not store crude oil, it will be considered part of the SPR and hold 1 million barrels of gasoline at a cost of $200 million.
- DOE officials told us that they are conducting a regional fuel resiliency study that will provide insights into whether there is a need for additional regional product reserves and, if so, where these reserves

[52] *21st Century Challenges: Reexamining the Base of the Federal Government,* GAO-05-325SP (Washington, D.C.: Feb. 1, 2005).

[53] According to DOE, the SPR's oil storage facilities are grouped into three geographical distribution systems in the Gulf Coast: Seaway, Texoma, and Capline. Each system has access to one or more major refining centers, interstate crude oil pipelines, and marine terminals for crude oil distribution.

should be located and the capacity.[54] We did not assess this effort because the study was ongoing at the time of our review.

- DOE finalized an assessment in 2010 of the compatibility of crude oil stored in the SPR with the U.S. petroleum refining industry. DOE decided against storing heavy crude oil in the SPR at the time, but committed to revisiting the option of storing heavy crude oil in the future.[55]

However, DOE has not recently reexamined the appropriate size of the SPR. DOE last issued a strategic plan for the SPR in May 2004. The plan outlined the mission, goals, and near-term and long-term objectives for the SPR.[56] In 2006, we recommended that the Secretary of Energy reexamine the appropriate size of the SPR. In 2007, while DOE was planning to expand the SPR to its authorized size of 1 billion barrels, the Administration reevaluated the need for an SPR expansion and decided that the current level was adequate. In responding to our recommendation, DOE stated that its reexamination had taken the form of more "actionable items," including not requesting expansion-funding in its 2011 budget and canceling and redirecting prior year's expansion funding to general operations of the SPR. Officials from DOE's Office of Petroleum Reserves told us that the last time they conducted a comprehensive re-examination of the size of the SPR was in 2005. At that time, DOE's comprehensive study examined the costs and benefits of alternative SPR sizes.[57] Officials told us that they have not conducted a

[54]This study is being undertaken as part of DOE's Quadrennial Energy Review. According to DOE, the Quadrennial Energy Review will provide a multiyear road map that outlines federal energy policy objectives, legislative proposals to Congress, executive actions, and resource requirements. The first installment of the review will focus on transmission, storage, and distribution infrastructure that links energy supplies, including crude oil, to intermediate users.

[55]U.S. Department of Energy. Office of the Deputy Assistant Secretary for Petroleum Reserves. *Strategic Petroleum Reserve: Updated Crude Compatibility Study.* April 2010.

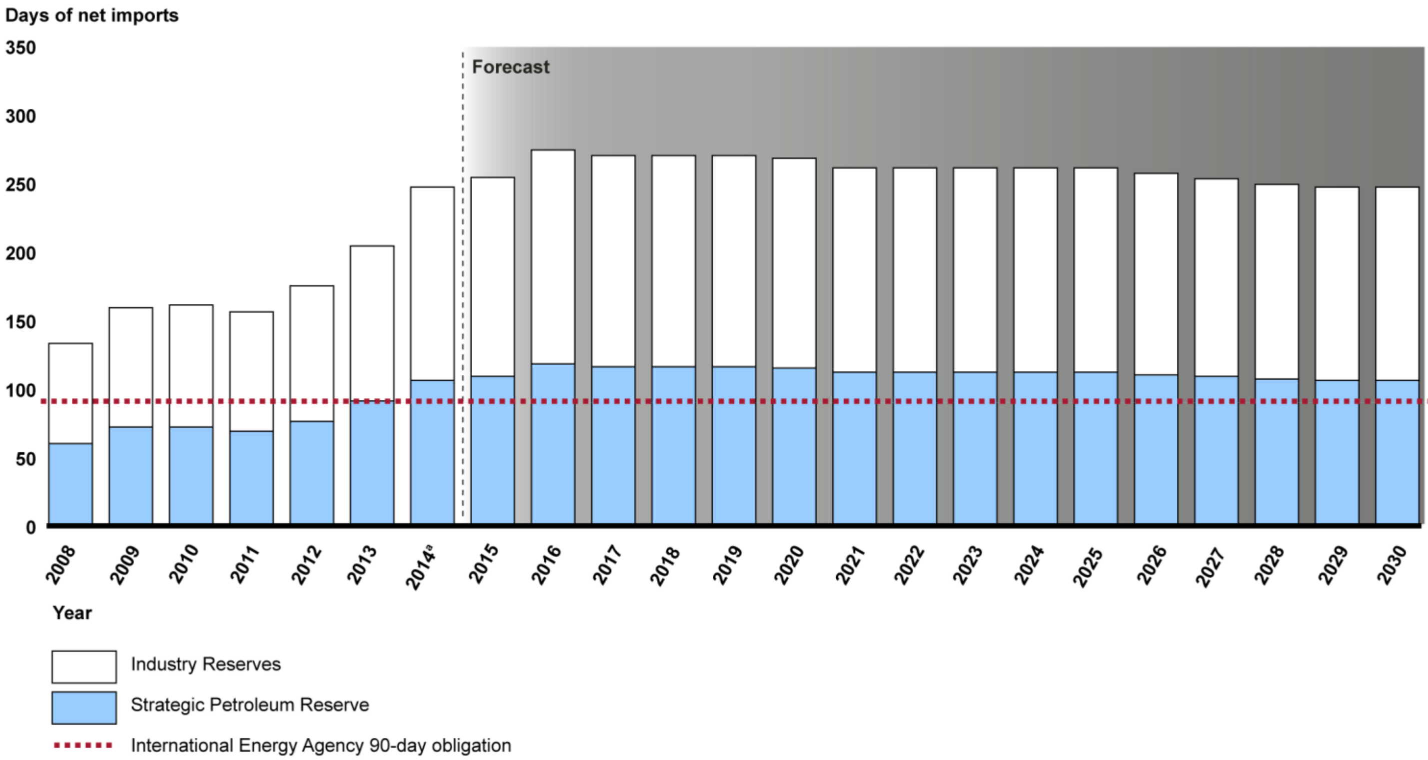
[56]U.S. Department of Energy. Office of Fossil Energy. *Strategic Petroleum Reserve (SPR) Strategic Plan*. May 19, 2004.

[57]The report evaluates the net economic benefits of enhancing the SPR size and drawdown capability. DOE assessed alternative SPR sizes and drawdown capabilities using a numerical simulation model, considering the benefits and costs of oil stockpiling. The evaluation included the SPR's ability to reduce economic losses and oil import costs during oil shocks, and it subtracted the costs of building, filling, and operating the reserve. See: Paul Leiby and David Bowman. *Economic Benefits of Expanded Strategic Petroleum Reserve Size or Drawdown Capability*. Final Report, Oak Ridge National Laboratory. ORNL/TM-2006/5. Dec. 31, 2005.

comprehensive reexamination since 2005 because the SPR only recently met the IEA requirement to maintain 90 days of imports. However, the IEA requirement is for total reserves, including those held by the government and private reserves. As shown in figure 5, such reserves in the United States are currently in excess of the nation's international obligations and, in some scenarios, are expected to be in excess in the future. In July 2014, DOE's Office of Inspector General recommended that the Office of Fossil Energy perform a long-range strategic review of the SPR to ensure it is best configured to respond to the current and future needs of the United States.[58] DOE concurred with the recommendation. DOE stated that it expected to determine the appropriate course of action by August 2014, and according to DOE, it has initiated a process to conduct such a review.

[58]According to DOE officials, this review should take into consideration what the near-term and long-term role of the reserve should be relative to U.S. energy and economic security goals and objectives and International Energy Program requirements; what the optimal configuration and capabilities (e.g., composition, volume, location of petroleum products, infrastructure requirements, distribution capability, and performance criteria) of the Reserve should be; the resources required to attain and maintain the Reserve's long-term sustainability (to ensure alignment with optimal configuration and capabilities); and whether existing legal authorities that govern the policies, configuration, and capabilities of the Reserve are adequate to ensure the Reserve can meet both current and future U.S. energy and economic security goals and objectives. U.S. Department of Energy. Office of Inspector General. Office of Audits and Inspections. *The Strategic Petroleum Reserve's Drawdown Readiness.* DOE/IG-0916. July 2014.

Figure 5: United States' Historic and Estimated Compliance with International Energy Agency Obligation to Hold Reserves



Sources: GAO analysis of International Energy Agency data and Energy Information Administration forecasts. | GAO-14-807

Note: Data for 2015 and later are based on May 2014 reserve levels reported by the International Energy Agency and forecast changes in net imports from the Energy Information Administration's (EIA) reference case forecast. EIA's forecast includes several cases, highlighting uncertainty about future conditions which are not depicted in this figure.

[a]As of May 2014.

The SPR currently holds oil valued at over $73 billion, and without a current reexamination of the SPR's size, DOE cannot be assured that the SPR is sized appropriately. The SPR may therefore be at risk of holding excess crude oil. In addition, DOE officials told us that SPR infrastructure is aging and will need to be replaced soon. Conducting a reexamination of the size of the SPR could also help inform DOE's decisions about how or whether to replace existing infrastructure. If DOE were to assess the appropriate size of the SPR and find that it held excess crude oil, the excess oil could be sold to fund other national priorities. For example, in 1996, SPR crude oil was sold to reduce the federal budget deficit and offset other appropriations. If, for example, DOE found that 90 days of imports was an appropriate size for the SPR, it could sell crude oil worth about $10 billion.[59]

Conclusions

Increasing domestic crude oil production, and declines in consumption and crude oil imports have profoundly affected U.S. crude oil markets over the last decade. These changes can have important implications for national energy policies and programs. The SPR is a significant national asset, and it is important for federal agencies tasked with overseeing such assets to examine how, if at all, changing conditions affect their programs. DOE has recently taken several steps to reexamine various aspects of the SPR in light of these changes, including its location and composition; however, DOE's most recent comprehensive examination of the appropriate size of the SPR was conducted in 2005 when the general expectation was that the country would increasingly rely on foreign crude oil. At about that time, however, it began to become clear that this was not to be the case. Removing export restrictions would be expected to lead to further decreases in net imports that would further affect the role of the SPR. Without a reexamination of the SPR that considers whether a smaller or larger SPR is in the national interest in light of current and expected future changes in market conditions, DOE cannot be assured that the SPR is holding an appropriate amount of crude oil in the SPR, and its ability to make appropriate decisions regarding maintenance of the SPR could be compromised.

Recommendation for Executive Action

In view of recent changes in market conditions and in tandem with DOE's ongoing activities to assess the content, connectivity, and other aspects of the SPR, we recommend that the Secretary of Energy undertake a comprehensive reexamination of the appropriate size of the SPR in light of current and expected future market conditions.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE and Commerce for their review and comment. The agencies provided technical comments, which we incorporated as appropriate. In its written comments, reproduced in

[59]Calculated based on DOE's assessment of the weighted average price of crude oil held in the SPR as of May 28, 2014.

appendix III, DOE concurred in principle with our recommendation. However, DOE stated that conducting a study of only the size of the SPR would be too narrow in scope and would not address other issues relevant to the SPR carrying out its mission of providing energy security to the United States. DOE stated that a broader, long-range review of the SPR is needed. We agree that such a review would be beneficial. We do not recommend that DOE undertake an isolated reexamination of the size of the SPR, but that such a reexamination be conducted in tandem with DOE's other activities to assess the SPR and we clarified our recommendation accordingly.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Secretaries of Energy and Commerce, and other interested parties. In addition, the report will be available at no charge on the GAO website at http://www.gao.gov.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.

Sincerely yours,
Frank Rusco
Director, Natural Resources and Environment

Appendix I: Additional Information on Four Studies of the Implications of Removing Crude Oil Export Restrictions

We identified four studies that examined the price and other implications of removing crude oil export restrictions. These four studies are as follows:

- Resources for the Future (RFF). Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States. Washington, D.C.: Resources for the Future, February 2014, revised March 2014.
- ICF International and EnSys Energy (ICF International). The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs. Washington, D.C.: ICF Resources, March 31, 2014.
- IHS. US Crude Oil Export Decision: Assessing the impact of the export ban and free trade on the US economy. Englewood, Colorado: IHS, 2014.
- NERA Economic Consulting (NERA). *Economic Benefits of Lifting the Crude Oil Export Ban*. Washington, D.C.: NERA Economic Consulting, September 9, 2014.

Table 3 describes these studies and several key assumptions, Table 4 summarizes their findings regarding prices, and Table 5 summarizes their findings regarding other implications of removing crude oil export restrictions.

Table 3: Description of Approach and Key Assumptions in Four Studies on the Implications of Removing Crude Oil Export Restrictions

	Resources for the Future	ICF International	IHS	NERA
Sponsor	Resources for the Future	American Petroleum Institute	Several oil companies.	The Brookings Institution
Description of approach	Using a small static simulation model calibrated to world oil market conditions for 2012, assessed long-run implications of removing export restrictions assuming crude oil prices change to reflect only crude oil qualities.	Used a detailed integrated U.S. and global refining and logistics model together with a detailed assessment of crude oil production and supply and demand changes. Modeled a complete lifting of export restrictions in 2015 and two cases with different assumptions about how hard it will be to accommodate increases in crude oil production.[a]	A bottom up study of crude oil production, refining, and international markets. Examined two outlooks for U.S. crude oil production—a base case based on known production areas and limited technological improvements; and a more optimistic case that includes additional production areas and technological improvements.	Used a partial equilibrium model of the petroleum industry to estimate crude oil production, refining, consumption, and trade effects; and a computable general equilibrium model of the U.S. economy to assess economic effects. Modeled eighteen cases including a reference case and a high oil and gas resources case.[b]
Time period covered in analysis	Modeled long run adjustment, not specific years.	2015-2035	2016-2030	2015-2035
Detailed modeling of crude oil production?	No	Yes	Yes	No
Detailed modeling of refineries?	No	Yes	Yes	Yes
Transportation network model?	No	Yes	Yes	Yes
Crude oil production response from OPEC and other producers	Assumed long run world crude oil supply elasticity of 0.4 based on literature. No significant OPEC response modeled.	Assumed world supply response derived from EIA Annual Energy Outlook sensitivity cases. OPEC production would decline by 50,000 barrels per day from 2015 through 2035 without export restrictions.	We were unable to determine IHS' assumption regarding the crude oil production response of other nations.	Examined three cases of OPEC responses: 1) OPEC competes in the market; 2) OPEC maintains crude oil exports and 3) OPEC cuts crude oil exports to maintain crude oil price.

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA studies | GAO-14-807.

[a]ICF assessed two cases; a low case that assumed relatively rapid accommodation of light crude oil, and a high case that assumed slower adaptations to changing crude oil production than were assumed in the low case. In the high case, the resulting differences in prices between domestic and international crude oils would remain wide for a longer period of time.

[b]NERA's reference case assumes U.S. crude oil production peaks in the early part of the next decade and declines thereafter, while the "high oil and gas resources" case represents a more optimistic and sustained view of future production. NERA examined a total of 18 cases with alternative assumptions about (1) future U.S. crude oil production, (2) the international crude oil market, (3) the status, timing, and scope of export restrictions; and (4) OPEC's response to changes in U.S. export restrictions.

Table 4: Summary of Price Implications of Removing Crude Oil Export Restrictions in Four Studies

	Resources for the Future	ICF International	IHS	NERA[a]
U.S. Crude Oil Price	Midwest refiner acquisition costs increase $6.68 per barrel.	West Texas Intermediate prices increase $2.35 to $4.19 per barrel on average.	$7.89 per barrel increase on average.	Prices increase $1.74 per barrel in the reference case and $5.95 per barrel in the high case, on average.
International Crude Oil Prices	Prices increase outside the Midwest by $0.15 per barrel.	Price of Brent declines by $0.37 to $0.79 per barrel on average.	Brent average price declines by $3.24-5.41.	International average crude oil prices decline by $1.31 per barrel in the reference case and $6.23 per barrel in the high case.
U.S. Consumer Fuel Prices	Gasoline prices decline by 1.8 to 4.6 cents per gallon on average.	Petroleum product prices decline by 1.5 to 2.4 cents per gallon on average.	Gasoline prices decline by 9 to 13 cents per gallon on average.	Petroleum product prices decline by 3 cents per gallon in the reference case and 11 cents per gallon in the high case. Gasoline prices decline by 3 cents per gallon in the reference case and 10 cents per gallon in the high case.

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA studies | GAO-14-807.

Note: Price implications in this table are for the period covered in each study. For Resources for the Future, this is the long run price implication; for ICF International and NERA, it is the average from 2015 through 2035; and for IHS, it is the average from 2016 through 2030. Estimates are in 2014 year dollars.

[a]Results refer to the difference between the reference case and its baseline with export restrictions in place, and the difference between the high oil and gas recovery case and its corresponding baseline. NERA also found that removing crude oil export restrictions has no measurable effect in the world oil low price case.

Table 5: Summary of Other Implications of Removing Crude Oil Export Restrictions in Four Studies

	Resources For the Future	ICF International	IHS	NERA[a]
Domestic Crude Oil Production	Canada and the Midwest: increase by 84,000 barrels per day (bpd). Rest of the World: increase by 54,000 bpd. Total world production will increase by 138,000 bpd.	Increases 130,000 bpd on average in the low scenario (10.6 to 10.7 million bpd) and 300,000 bpd in the high scenario (10.4 to 10.7 million bpd).	Increase of 1.2 million bpd in the low case (9.5 to 10.7 million bpd) to 2.3 million bpd in the high case (11 to 13.3 million bpd).	Increase of 0.7 million bpd, on average, in the reference case and 3.3 million bpd in the high case.
Oil Industry Investments	Not addressed.	Additional $16 to $73 billion in additional crude oil production related investment between 2015 and 2020, and a decline in refining investment of $5 to $7 billion from 2015-2035.	Net cumulative investment increases by $806 billion to $1.1 trillion from 2016-2030.	Increases by $1.08 billion per year on average in the reference case and $26.81 billion per year in the high case from 2015 through 2035.[b]
Environmental Implications	Carbon dioxide emissions would increase by 22 million metric tons per year.	Not addressed.	Not addressed.	Greenhouse gas emissions increase by 12 million metric tons of carbon dioxide equivalents per year.
Trade Implications	Would improve trade balance, though not estimated.	Volumes: Decline in net crude oil imports of 26,000-200,000 bpd and decline in net petroleum product imports of nearly 93,000 bpd. Balance of trade: Increases by $8 to $15 billion.	Volumes: Project a decline in net imports, specific amount not provided. Balance of trade: Increases net petroleum trade by $72-$101 billion per year.	Volumes: Decline in net crude oil and petroleum product imports of 0.63 million bpd in the reference case and 3.15 million bpd in the high case.

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA studies. | GAO-14-807

Notes: Implications in this table are for the period covered in each study. For Resources for the Future, this is in the long run; for ICF International and NERA, it is the average from 2015 through 2035; and for IHS, it is the average from 2016 through 2030. Estimates are in 2014 year dollars.

[a]Results refer to the difference between the reference case and its baseline with export restrictions in place, and the difference between the high oil and gas recovery case and its corresponding baseline. NERA also found that removing crude oil export restrictions has no measurable effect in the world oil low price case.

[b]Includes investment in oil extraction, industrial, and manufacturing sectors.

Appendix II: List of Stakeholders Interviewed

This appendix lists the stakeholders we interviewed. Stakeholders included representatives of companies and interest groups with a stake in the outcome of decisions regarding crude oil export restrictions, as well as academic, industry, and other experts.

1. American Fuel & Petrochemical Manufacturers
2. American Petroleum Institute
3. American Automobile Association
4. Jason Bordoff, Columbia School of International and Public Affairs
5. Severin Borenstein, University of California, Berkeley
6. Stephen Brown, Resources for the Future and University of Nevada-Las Vegas
7. Citigroup
8. Deborah Gordon, Carnegie Endowment for International Peace
9. Hillard Huntington, Stanford University
10. IHS
11. ICF International and EnSys Energy
12. Kenneth Medlock, Rice University
13. NERA Economic Consulting
14. Lorne Stockman, Oil Change International
15. Philip Verleger, PKVerleger LLC
16. Dan Weiss, Center for American Progress
17. Valero Energy Corporation

Appendix III: Comments from the Departmen

Department of Energy
Washington, DC 20585

SEP 17 2014

Mr. Frank W. Rusco
Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Mr. Rusco:

The Department of Energy (DOE) appreciates the opportunity to review and provide comments on the Government Accountability Office's (GAO-14-807) draft report on "*Changing Crude Oil Markets - Allowing Exports Has Price and Other Implications, and the Size of the Strategic Reserves Should Be Re-Examined.*" We offer the following comments, in response to the recommendation provided in the report:

GAO Recommendation for Executive Action:

We are making one recommendation in this report.

"In view of recent changes in market conditions and in tandem with DOE's ongoing activities to assess the content and connectivity of the SPR to markets, we recommend that the Secretary of Energy undertake a comprehensive re-examination of the appropriate size of the SPR in light of current and expected future market conditions."

Agency Comments to GAO Recommendation:

DOE concurs in principle with the GAO recommendation to undertake a comprehensive re-examination of the appropriate size of the Strategic Petroleum Reserve (SPR), in light of current and expected future market conditions. However, DOE believes conducting a size study only is too narrow in scope, and by itself, would fail to investigate and address other issues and factors relevant to the SPR carrying out its mission of providing energy security to the United States, by reducing the impact of disruptions in supplies of petroleum products, and to carry out the obligations of the United States under the International Energy Program.

DOE believes that a broader, long-range strategic review of the SPR needs to be accomplished and has initiated the process to conduct this review. This review will take into consideration what the near-term and long-term role of the SPR should be relative to U.S. energy and economic security goals and objectives, and International Energy Program requirements; what the optimal configuration and capabilities (e.g. composition/volume/location of petroleum products, infrastructure requirements, distribution capability, and performance criteria) of the SPR should be; the financial and management-related resources required to attain and maintain the SPR's long-term sustainability (to ensure alignment with optimal configuration and capabilities); and whether existing legal authorities that govern the policies, configuration, and

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capabilities of the SPR are adequate to ensure the SPR can meet both current and future U.S. energy and economic security goals and objectives.

Sincerely,

Christopher A. Smith
Principal Deputy Assistant Secretary
Office of Fossil Energy

Appendix IV: GAO Contact and Staff Acknowledgments

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Frank Rusco, (202) 512-3841 or ruscof@gao.gov

Staff Acknowledgments:

In addition to the individual named above, Christine Kehr (Assistant Director), Philip Farah, Quindi Franco, Cindy Gilbert, Taylor Kauffman, Celia Rosario Mendive, Alison O’Neill, and Barbara Timmerman made key contributions to this report.

Related GAO Products

Petroleum Refining: Industry's Outlook Depends on Market Changes and Key Environmental Regulations. GAO-14-249. Washington, D.C.: March 14, 2014.

Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks. GAO-12-732. Washington, D.C.: September 5, 2012.

Energy Markets: Estimates of the Effects of Mergers and Market Concentration on Wholesale Gasoline Prices. GAO-09-659. Washington, D.C.: June 12, 2009.

Strategic Petroleum Reserve: Issues Regarding the Inclusion of Refined Petroleum Products as Part of the Strategic Petroleum Reserve. GAO-09-695T. Washington, D.C.: May 12, 2009.

Energy Markets: Refinery Outages Can Impact Petroleum Product Prices, but No Federal Requirements to Report Outages Exist. GAO-09-87. Washington, D.C.: October 7, 2008.

Energy Markets: Increasing Globalization of Petroleum Products Markets, Tightening Refining Demand and Supply Balance, and Other Trends Have Implications for U.S. Energy Supply, Prices, and Price Volatility. GAO-08-14. Washington, D.C.: December 20, 2007.

Strategic Petroleum Reserve: Available Oil Can Provide Significant Benefits, but Many Factors Should Influence Future Decisions about Fill, Use, and Expansion. GAO-06-872. Washington, D.C.: August 24, 2006.

Motor Fuels: Understanding the Factors That Influence the Retail Price of Gasoline. GAO-05-525SP. Washington, D.C.: May 2, 2005.

Alaskan North Slope Oil: Limited Effects of Lifting Export Ban on Oil and Shipping Industries and Consumers. GAO/RCED-99-191. Washington, D.C.: July 1, 1999.

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An IHS Energy / IHS Economics Report

US Crude Oil Export Decision

Assessing the impact of the export ban and free trade on the US economy






Executive summary report

US Crude Oil Export Decision

Assessing the Impact of the Export Ban and Free Trade on the US Economy

Executive Summary

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Study Purpose

Rapidly increasing crude oil production and limited refining capacity for these types of crudes are raising questions about the current US policy of banning crude oil exports. This report assesses the impact of a change in export policy—to free trade—and compares it to the impact of maintaining the current restrictive trade policy. The analysis also examines the historical context in which current export policy was developed in the 1970s and identifies how the world oil market—and the US position in it—has changed significantly since that time.

This report draws on the multidisciplinary expertise of IHS—including upstream, downstream and macroeconomic teams across IHS Energy Insight and IHS Economics. The study has been supported by a group of sponsors. The analysis and conclusions contained in this report are entirely those of IHS Inc., which is solely responsible for the contents herein.

Since the onset of the "Great Revival" in US natural gas and crude oil production, IHS has provided continuing analysis of this development, its prospects both in North American and around the world, and its impact on the US economy and its competitiveness in the world economy. Some of the current studies include:

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See more at: http://press.ihs.com/press-release/economics/us-unconventional-oil-and-gas-revolution-increase-disposable-income-more-270#

GOING GLOBAL: PREDICTING THE NEXT TIGHT OIL REVOLUTION

Going Global: Predicting the Next Tight Oil Revolution examines the widespread geological potential of tight oil globally. The study identifies the 23 highest-potential plays throughout the world and found that the potential technically recoverable resources of just those plays is likely to be 175 billion barrels—out of almost 300 billion for all 148 play areas analyzed for the study. While it is too early to assess the proportion of this that could be commercially recovered, the potential is significant compared to the commercially recoverable resources of tight oil (43 billion barrels) the IHS estimated for North America.

Going Global provides a comprehensive assessment of the potential of tight oil plays outside of North America, where well-level data does not currently exist. (IHS CERA Multi-Client Study)

See more at: http://press.ihs.com/press-release/energy-power/ihs-study-north-americas-tight-oil-phenomena-poised-go-global#

For more information on these and related studies, contact Jamey.Rosenfield@ihs.com

***US Crude Oil Export Decision* Study Sponsors**

The following organizations provided support for this study. The analysis and conclusions in this study are those of IHS, and IHS is solely responsible for the report and its content.

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KEY FINDINGS

- The 1970s-era policy banning oil exports—a remnant of a price controls system that ended in 1981—is creating growing market distortions and needs to be revisited in light of rising US oil production and the expanded domestic resource potential.

- The US oil system is nearing “Gridlock” with the mismatch between the rapid growth of light tight oil and the inability of the US refining system to economically process these growing volumes. The result is a widening discount, which will reduce drilling investment, jeopardizing oil production growth, reducing jobs, and hurting the US economy.

- Lifting the export ban and allowing free trade will, in our base case, increase US production—from 8.2 million B/D currently to 11.2 million B/D—and add investment of nearly $750 billion. The “unconventional” revolution in oil and gas has also been one of the major contributors to the US economic recovery, estimated by IHS to have added nearly 1% to our GDP in each of the past two years.

- By boosting global supplies, the elimination of the ban will result in lower global oil prices. Since US gasoline is priced off global gasoline prices, not domestic crude prices, the reduction will flow back into lower prices at the pump—reducing the gasoline price 8 cents a gallon. The savings for motorists is $265 billion over the 2016-2030 period.

- The higher US oil production resulting from a lifting of the ban will create at its peak 1 million jobs, increase GDP by $135 billion, and increase per household income by $391. The nation’s oil import bill is reduced by $67 billion per year, a 30% reduction from the 2013 level.

- Lifting the ban supports economic activity across all states. A quarter of the additional jobs are in states that essentially produce no crude oil.

Industry and economic results provided in the table below and on the previous page compare the free trade impact—versus the current restricted crude oil trade policy—using the base case production outlook. Presented in the study is also a potential case for US production that results in greater impact from free trade.

Impact of Free Trade (vs. Current Restricted Trade Policy)	
	Base Production Case
Crude Oil Production, average, 2016-2030 (million B/D)	1.2
US Gasoline Price, average, 2016-2030 (cents per gallon, real)	-8
Fuel Cost Savings, cumulative, 2016-2030 ($ billion)	265
Investment	
Peak Annual Investment ($ billion)	66 in 2017
Cumulative Investment, 2016-2030 ($billion)	746
Gross Domestic Product	
Peak Growth (percent)	0.7 in 2018
Peak ($ billion, real)	135
Average, 2016-2030 ($ billion, real)	86
Net Petroleum Trade, average, 2016-2030 ($ billion, real)	67
Employment	
Average, 2016-2030 (thousand)	394
Peak (thousand)	964 in 2018
Disposable Income per Household	
Average, 2016-2030 ($, real)	238
Peak ($, real)	391 in 2018
Cumulative Government Revenue (2016-2030) ($ billion)	1,311

Source: IHS Energy Insight and IHS Economics

EXECUTIVE SUMMARY

This report assesses the impact of a change in crude oil export policy to free trade and compares it to maintaining the current policy, which generally bans crude exports. The analysis also examines the historical context in which current export policy was developed during the 1970s. It identifies how dramatically the world oil market—and the US position in it—has changed since that time and how the rationales from the 1970s have faded away.

IMPORTANCE OF CRUDE OIL EXPORT POLICY

A secure supply of oil—and keeping a lid on gasoline prices—is a fundamental US interest. It is supported across the political spectrum because of its importance to the economy, the daily livelihood of Americans, and energy security. Policy regarding crude oil exports will play a key role in shaping how successfully the US accomplishes these objectives in the years ahead.

Since the 1970s, the United States has effectively banned the export of crude oil. The ban was a reaction to the tumult and crises in the world oil market—the 1973 oil embargo against the United States, the nationalization of oil-producing assets held by Western companies, and the 1978 Iranian Revolution. It was also a response to the conviction that the United States was “running out of oil”.

But closer examination finds that the ban was even more specific to the 1970s and the debates of those years. One purpose was to ensure that new North Slope oil coming through the Alaska pipeline was not shipped to Asia. The other was an essential part of the abstruse system of the 1970s oil price controls—to prevent cheaper “old oil” from earning a higher price on the world market. The oil price control system was completely eliminated in 1981. But the ban on exports, a key element of that system, remains in place 33 years later as the last vestige of a price control system long gone.

The export ban was aimed at ensuring US-produced crude oil would stay in the United States. However, this ban, until recently, was of little practical relevance. US crude oil production was in a long period of decline, falling by half between 1970 and 2008. Shrinking domestic output was readily accommodated by a refining system that was increasingly dependent on oil imported from far-flung sources. But the oil market that prevailed in the 1970s—and even as recently as the early 2000s—no longer exists.

THE GREAT REVIVAL IN US PRODUCTION

The United States currently is at the center of one of the most profound changes in the global oil industry since the 1970s. The decades-long decline in US production has been reversed—and in dramatic fashion. A Great Revival in US production is well under way. US crude oil output increased 64%—3.2 million barrels per day (B/D)—from 2008 through March 2014 and helped reduce global oil prices, even as other global crude supplies have faltered. This increase in US output is the fastest in the nation’s history and has exceeded the combined production gains from the rest of the world.

US domestic production growth has led to a decline in import dependence that not long ago would have seemed unimaginable. Net US dependence on imported oil shrunk from 60% of demand in 2005 to less than 30% in early 2014.

This “unconventional” revolution in oil and shale gas has also been one of the major contributors to the US economic recovery; it is estimated by IHS to have added nearly 1% to our GDP in each of the past two years. Will the growth in US domestic crude oil production continue? Geology and technology point toward further gains—and very large ones. According to the International Energy Agency (IEA), the United States is on the path to regain its prior status as the world’s largest crude oil producer within this decade.[1] The United States could continue to move towards

[1] International Energy Agency, World Energy Outlook 2013.

a further significant reduction in net imports. But none of this is guaranteed. The price of oil on the global market will have a big influence on production trends. So will US crude oil export policy, which is the subject of our study.

- In our Base Case, with the ban on US exports lifted, production will increase from its current level of 8.2 million B/D to 11.2 million B/D in 2022.
- But if the ban is not lifted, output will be 1.2 million B/D lower. The reason is that, if the ban remains in place, domestic oil will sell at an increasing discount, reducing the amount of investment in new production. The discount results from the nature of the US refining system, particularly along the Gulf Coast, where just over half of the nation's total refining capacity is located. Over $85 billion has been spent in the past quarter century to reconfigure these refineries to process heavy oil imported from countries like Venezuela, Mexico and Canada. As a result, there are limits to how much of the new, domestically produced light tight oil (LTO) the refining system can efficiently and effectively process.
- Allowing the export of crude oil would allow LTO to obtain world prices, which in turn would lead to higher investment—nearly $750 billion more investment—and to higher output.
- The economic benefits from the consequences of free trade in exports would flow through to the economy—and to every state—measured in additional GDP ($86 billion annually, on average) and nearly 1 million additional peak annual jobs.

WHY DOES US CRUDE OIL EXPORT POLICY MATTER?

US crude oil export policy will have a major impact in determining whether the United States regains its position as the largest crude oil producer in the world and acts as a force for lower gasoline prices. Today, the United States is the third largest crude oil producer, behind Russia and Saudi Arabia. Oil is also our largest energy source, providing 36% of our daily energy needs.

The existing restrictive trade policy has reduced the price that US producers receive for their crude oil relative to the global market. This is because they cannot sell their output outside the United States except under very limited circumstances.

At first glance, this may seem to be a positive for American consumers. If a US refiner purchases lower-cost domestic crude, wouldn't that translate into lower gasoline prices? This notion may be appealing, but it does not reflect market reality.

Gasoline connects US gasoline prices to the global market—and not to the price of domestically produced US crude oil. This creates a market distortion that disadvantages crude production in the United States relative to global production. Permitting US exports of crude oil would put additional supply onto the world market, lowering international crude prices and international gasoline prices. Lower international gasoline prices flow back into the US gasoline market, resulting in 8 cents per gallon lower prices at the pump for motorists. This creates a savings for consumers of $265 billion between 2016 and 2030.[2]

A big risk of the current restrictive export policy is that it will lead to even lower prices for US-produced crude oil, while gasoline prices will remain high. Discounted prices for US domestic crude oil—at a level and duration that would throttle back output gains—would occur because the US refining system cannot absorb all the potential growth in production. If low prices for US domestic crude endure—and that risk is growing—investment in crude oil production will slow or even decline. Export markets are needed to sustain US crude oil production gains that cannot be absorbed by our refineries without significant and costly changes to the US refining system.

[2] Allowing free trade is estimated to reduce the US real dollar gasoline price by 8 cents per gallon on average for the 2016-2030 period under the Base Production Case.

- The US refining system is the most flexible in the world, but even so is unable to efficiently absorb the quality and quantity of LTO being produced. Specifically, these refiners have too little capacity to process the light part of LTO and too much capacity for the heavy remaining portion of the barrel. As a result, a significant LTO price discount is needed to account for the suboptimal refining of LTO in these heavy crude refineries.
- US refiners' competitive advantage will be maintained under a policy change expanding US crude oil exports. The export of LTO from US shores would provide a competitively priced LTO feedstock (based on offshore market price minus freight cost) that would allow US refiners to economically supply both the domestic and export product markets. While the LTO price under free trade is not severely discounted as in restricted trade, the free trade price provides a competitive advantage relative to imported international crude. In fact, the relative price of LTO under free trade is similar to the price differential that existed from 2011-2013 for US Gulf Coast refiners, a period in which the United States became the largest refined products exporter in the world.
- There is discussion about a policy change that allows the export of condensate—a very light form of oil often derived from natural gas production—instead of a broader crude oil export policy. This would be an important interim step towards relieving the Gridlock and moving towards free trade. However, further changes would be needed to achieve the estimated free trade impacts presented. Moreover, a policy that permanently limits export trade to one type petroleum stream—no matter how carefully defined—could create another market distortion.
- Although not widely recognized, the United States is already a major exporter of refined products, including diesel, gasoline and jet fuel. At almost 4 million B/D, the United States has become the world's largest exporter of products. This is double the level of five years ago. Lifting the ban on exports of crude oil would be consistent with the new realities of US and world oil and would remove one of the last vestiges of the panic-induced policies of the 1970s.

A move to free trade in crude oil would help the United States realize its growth potential for crude oil production. By doing so, US domestic crude oil prices would become linked to the global market and would be a force for lower—not higher—gasoline prices. US crude exports would find ready markets for LTO exports in Europe and Asia. In Europe, it would back out competing crudes from Africa and potentially Russia, which would be reoriented to Asia.

IMPACT OF FREE TRADE VERSUS RESTRICTIVE TRADE

IHS has evaluated the crude export policy decision using two outlooks for US crude oil production. To this point, the impact of lifting the trade policy in the Base Case has been presented above. A more optimistic—but certainly realistic—Potential Case is provided below and throughout our report.

For each of the two production cases—the Base and Potential Cases—two policies were analyzed: free trade, which illustrates the impact of a move to allow exports of US-produced crude oil, and restricted trade, which assumes that the current ban is maintained. The forecast period for this analysis is 2016-2030.

IHS PRODUCTION FORECASTS

The IHS production outlooks integrate our geological and upstream exploration and production databases, the largest in the world, our extensive refining and oil market databases, our deep economic modeling and regional economics capabilities, and our in-depth experience and understanding of oil market dynamics and trends.

- The Base Case is predicated on the IHS central business planning forecast that provides a conservative view based on known defined plays and assumes limited technical improvements from current performance.
- The Potential Case includes additional known but less well defined areas of existing plays and moderate drilling performance & technology improvements in the future.

Free trade is projected to have positive impacts on job growth, trade, government revenues and economic output as shown below.

TABLE ES.1
Impact of Free Trade (vs. Current Restricted Trade Policy)

	Base Production Case	Potential Production Case
Crude Oil Production, average, 2016-2030 (million B/D)	1.2	2.3
US Gasoline Price, average, 2016-2030 (cents per gallon, real)	-8	-12
Fuel Cost Savings, cumulative, 2016-2030 ($ billion)	265	418
Investment		
Peak Annual Investment ($ billion)	66 in 2017	82 in 2017
Cumulative Oil Production-related, 2016-2030, ($ billion)	751	995
Cumulative Refining-related, 2016-2030, ($ billion)	-5	-21
Cumulative Investment, 2016-2030, ($ billion)	746	974
Gross Domestic Product		
Peak Growth (percent)	0.7 in 2018	1.2 in 2018
Peak ($ billion, real)	135	221
Average, 2016-2030 ($ billion, real)	86	170
Net Petroleum Trade, average, 2016-2030 ($ billion, real)	67	93
Employment		
Average, 2016-2030 (thousand)	394	859
Peak (thousand)	964 in 2018	1,537 in 2018
Disposable Income per Household		
Average, 2016-2030 ($, real)	238	466
Peak ($, real)	391 in 2018	733 in 2021
Cumulative Government Revenue (2016-2030) ($ billion)	1,311	2,804

Source: IHS Energy Insight and IHS Economics

Industry and economy benefits from free trade of crude oil include:

- The impact for the US economy of a free trade policy on crude exports is significant. The key driver is the difference between free and restricted trade for US oil production and investment, which increases 1.2 million B/D and $66 billion (peak) in the Base Production Case and 2.3 million B/D and $82 billion (peak) in the Potential Production Case.
- Gross domestic product (GDP) in the Base Production Case with free trade will peak in 2018 at $135 billion, or 0.7%, higher than with the current, restricted trade policy. The peak impact is greater in the Potential Production Case when GDP under free trade will be $221 billion, or 1.2%, higher.
- The impact of free trade and associated higher crude oil production on US petroleum trade is considerable.[3] The 2013 US bill for imported petroleum is calculated at $218 billion. Free trade reduces this bill by $67 billion (Base Production) and $93 billion (Potential Production) over restricted trade per year on average from 2016 through 2030. In overall terms, the oil bill will decline from its 2013 level of $218 billion to $48 billion by 2022 – equivalent to 78 percent of 2013 oil trade deficit.
- Increased economic activity will lead to greater job creation and a lower unemployment rate. Total US jobs increase due to free trade will be, on average, 394,000 in the Base Case and 859,000 in the Potential Case. Peak job creation in 2018 is nearly 1 million in the Base Case and over 1.5 million in the Potential Case. A stronger labor market with free trade relative to restricted trade will increase the average annual household's disposable income by $239 and $465 during 2016-2030 in the Base and Potential Production Cases, respectively.
- Government revenues from corporate, personal and energy-related taxes and royalties are expected to increase under free trade policy. The cumulative addition to revenue is $1.3 trillion from 2016 through 2030 in the Base Production Case and more than double—$2.8 trillion—in the Potential Production Case.
- Benefits from free trade of crude oil are distributed throughout the US. Jobs growth and economic benefits are continent-wide and not just in large oil producing states due to substantial supply chains supporting the field production, capital spending, transportation and refining of crude oil. For example, 24% of the future jobs supporting the oil industry are located in states that essentially produce no crude oil.

OIL MARKET CHANGES POINT TO POLICY CHANGE

Global trade in oil and gas has benefitted the global economy, including the United States. So why is the ban on US crude oil exports, which was a reaction to upheavals during the 1970s in the world oil market, still in place? This oil export ban is indeed one of the last vestiges of an antiquated system in which the federal government once set the price for oil, provided subsidies to refiners that imported crude, and allocated supplies around the country.

But the world and US oil industry have changed dramatically in the past four decades, and the US economy and consumers would benefit from an updated policy that responds to these changes by allowing exports of some of the nation's rising crude oil production. Removing the export ban would enhance energy security by strengthening the energy position of the United States, which would regain its stature as the world's largest producer of crude oil. Further, lifting the export ban would stimulate the economy, create new jobs, and reduce the prices that US consumers pay at the pump for their gasoline.

[3] Petroleum trade defined as the net imports (imports minus exports) of crude oil, refined products and NGLs.

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BACKGROUNDER

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Time to Lift the Ban on Crude Oil Exports

Nicolas Loris

Abstract

Dramatic increases in domestic oil production over the past several yearshaveproducedtremendouseconomicbenefitsfor Americans. The federal government, however, has constrained those benefits by significantly limiting the ability to export crude oil. Heritage Foundation energy policy expert Nicolas Loris explains how removing the ban on crude oil exports would create more opportunities for Americans, increase employment and economic growth, and augment the overall efficiency of global oil markets.

In a time of economic downturn, the sharp rise in crude oil production has been an important and remarkable wealth generator for the United States. as a result of technological advances in extracting and producing "tight oil," also known as shale oil, the United States is now producing 8 million barrels per day, pushing the United States above 10 percent of the world's total crude oil production.[1] While the U.S. will likely remain an important supplier of crude oil long into the future, the long-standing statutory ban on exporting crude oil, in combination with production outpacing refineries' ability to process the crude, will limit america's economic potential and cause a decline of otherwise viable drilling.

Trade freedom is a critical component of overall economic freedom[2] and increased prosperity. Removing the antiquated and unnecessary ban on crude oil will only enhance america's stature in international energy markets, to the benefit of all americans. The federal government can take several paths to allow companies to

Key Points

- Crude oil production in the United States has grown dramatically in the past six years, in large part due to technological advances in hydraulic fracturing and horizontal drilling.
- The enormous quantity of production has companies seeking to export crude oil; but, with limited exceptions, laws prohibit the exportation of crude. Companies must refine crude in the United States before they are allowed to export petroleum products.
- Oil should be no different than any other good or service the U.S. trades around the world. By opening the door to establish more efficient global oil markets, all Americans will reap the benefits of lower prices and a stronger economy.
- Opening markets for both import and export breeds innovation as companies face more competition and face challenges to retain or expand their market share. The result is innovative ideas, higher-quality products at competitive prices, and an improved standard of living.

This paper, in its entirety, can be found at http://report.heritage.org/bg2910

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export crude, but Congress should remove the ban on freely trading oil like other goods and services.

Oil Abundance and Production Growth

Crude oil production in the United States has skyrocketed in the past six years, in large part due to technological advances in hydraulic fracturing, commonly referred to as fracking, and horizontal drilling. as a result of these advanced drilling and extraction techniques, crude oil production has increased by 99.5 percent since 2008, the year when production reached its lowest point since 1943.[3] Over 90 percent of all oil-production growth in the U.S. now results from fracking.[4]

The vast majority of this increase in oil production comes from just six shale resource deposits, the most productive being the Bakken Formation in North Dakota and the Eagle Ford and Permian regions in Texas. These three areas account for 98 percent of production in the major regions, and for over half of all oil production in the U.S.[5]

Production has taken off at such an unexpected rate that the U.S. Energy Information agency (EIa) now estimates that the U.S. will not need to import any oil whatsoever by 2037, a proposition that would have been unheard of only a few years ago.[6] already, in 2012, the amount of oil produced in the U.S. surpassed the amount it imported.[7]

The ability to substantially reduce oil imports should not be misconstrued as a reason for the promotion of energy independence. Energy independence should not be the goal of energy policy. The goal should be to create an energy market that allows producers and consumers to respond to energy prices. Oil is a global commodity. Whether as a net importer or net exporter the U.S. will not be able to insulate americans from price volatility any more than U.S. self-sufficiency in food production will prevent supply problems in other parts of the world from affecting domestic U.S. food prices. More market opportunities for fuel, food, or any other good incentivizes production, generates innovation, and establishes competitive prices. Greater oil supplies on the global market, however, *will* help insulate consumers from price volatility and supply disruptions.

> Trading goods and services freely around the world is largely responsible for lifting hundreds of millions of people out of poverty.

america's current rate of production represents just a fraction of what the U.S. could produce. The U.S. alone has more than five times the amount of recoverable oil than Saudi arabia.[8] Proven reserves continue to add to this known wealth of oil as increased exploration and technological developments make more and more oil viable.

another potentially abundant source is oil shale, which differs from shale oil. Oil shale fields contain kerogen, a naturally occurring chemical compound found in sedimentary rock. Energy companies must heat the rock to extremely high temperatures to convert the kerogen and release the usable hydrocarbons. The Green River formation, located in parts of

1. U.S. Energy Information Administration, "Tight Oil Production Pushes U.S. Crude Supply to Over 10% of World Total," March 26, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=15571 (accessed April 21, 2014).
2. Terry Miller, Anthony B. Kim, and Kim R. Holmes, *2014 Index of Economic Freedom* (Washington, DC: The Heritage Foundation and Dow Jones & Company, Inc., 2014), http://www.heritage.org/index/ranking (accessed April 21, 2014).
3. U.S. Energy Information Administration, "Petroleum & Other Liquids: U.S. Field Production of Crude Oil," March 28, 2014, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS2&f=M (accessed April 21, 2014).
4. U.S. Energy Information Administration, "Petroleum & Other Liquids: Drilling Productivity Report," April 14, 2014, http://www.eia.gov/petroleum/drilling/#tabs-summary-2 (accessed April 21, 2014).
5. Ibid.
6. Dana Van Wagener, "US Tight Oil Production: Alternative Supply Projections and an Overview of EIA's Analysis of Well-Level Data Aggregated to the County Level," U.S. Energy Information Administration, *Annual Energy Outlook 2014*, April 7, 2014, http://www.eia.gov/forecasts/aeo/tight_oil.cfm (accessed April 21, 2014).
7. U.S. Energy Information Administration, *Annual Energy Outlook 2014: Early Release Overview*, December 16, 2013, Table 1, "Comparison of projections in the *AEO2014* and *AEO2013* Reference cases, 2011–2040," http://www.eia.gov/forecasts/aeo/er/pdf/0383er%282014%29.pdf (accessed April 21, 2014).
8. Ibid.

Wyoming, Utah, and Colorado, has more oil than the rest of the world combined. as anu Mittal, director of Natural Resources and Environment at the Government accountability Office, reported to Congress in official testimony in May 2012: "Oil shale deposits in the Green River Formation are estimated to contain up to 3 trillion barrels of oil, half of which may be recoverable, which is about equal to the entire world's proven oil reserves."[9]

While the technology to extract shale oil is still developing and environmental considerations need to be taken into account, the government should not create unnecessary and onerous restrictions—which will stifle the private investment in research and development that could one day make oil shale economically viable and environmentally sound.

as developments in oil production have advanced, the amount of reserves in the U.S. has grown dramatically.[10] The U.S. has an enormous potential for energy wealth and oil production that can be realized by freeing access to both additional resources and additional markets.

The Benefits of Free Trade and Private Property

Free trade is a fundamental component of economic growth by providing consumers with more choice and better products at a lower cost. The ability to buy foreign products that other countries make more efficiently frees up american labor and capital to be more productive, growing the economic pie and increasing prosperity for all. Opening markets for both import and export fosters innovation as companies face more competition and face challenges to retain or expand their market share. The result is innovative ideas, higher-quality products at competitive prices, and an improved standard of living. Trading goods and services freely around the world is largely responsible for lifting hundreds of millions of people out of poverty. Companies in foreign countries that specialize in making a product at a lower cost create opportunities for americans to import it and thus pay less for it. Further, when markets are open to export, opportunities grow, thereby increasing potential for more wealth, investment, and jobs. The increased profitable exchange of goods and services greatly benefits businesses and consumers alike.

as with many other countries around the world, the United States benefits from free trade because of private property rights. When individuals produce something, it is their property and, so long as there is no threat to national security and no violation of the rule of law, they should be able to do whatever they want with their property. Individuals, in large part, have owned and had the ability to produce america's natural resources—which is a primary reason why the U.S is a global energy leader.[11] Individuals extract and sell the energy, and the market should determine where it goes.

Oil No Different, But Treated Differently. Oil should be no different than any other good or service the U.S. trades around the world, yet the law treats it differently. The Mineral Leasing act of 1920 placed some of the first limitations on crude oil exports, but Congress enacted the laws primarily restricting crude exports (the Energy Policy and Conservation act of 1975 and the Export administration act of 1979) in response to the 1973 arab oil embargo.[12]

The Department of Commerce's Bureau of Industry and Security (BIS) outlines the scenarios in which the agency will approve license applications to export crude. Currently, companies have significantly limited opportunities to export crude oil. Under its Short Supply Control regulations, the BIS

9. U.S. Government Accountability Office, "Unconventional Oil and Gas Production: Opportunities and Challenges of Oil Shale Development," statement of Anu K. Mittal, testimony before the Subcommittee on Energy and Environment, Committee on Science, Space, and Technology, U.S. House of Representatives, May 10, 2012, http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/HHRG-112-%20SY20-WState-AMittal-20120510.pdf (accessed April 21, 2014).

10. U.S. Energy Information Administration, "Natural Gas: U.S. Crude Oil and Natural Gas Proved Reserves," April 10, 2014, http://www.eia.gov/naturalgas/crudeoilreserves/index.cfm (accessed April 21, 2014).

11. Resources do exist on federally owned land, but the private sector leases that land and pays for the right to own and sell the resources.

12. Neelesh Nerurkar, "U.S. Oil Imports and Exports," Congressional Research Service, April 4, 2012, http://www.fas.org/sgp/crs/misc/R42465.pdf (accessed April 21, 2014), and U.S. Deaprtment of the Interior, Bureau of Land Management, "Mineral Leasing Act of 1920 as Amended," http://www.blm.gov/pgdata/etc/medialib/blm/ut/vernal_fo/lands minerals.Par.6287.File.dat/MineralLeasingAct1920.pdf (accessed April 21, 2014).

automatically grants export licenses to crude oil produced in alaska's Cook Inlet, crude transported through the Trans-alaska Pipeline, re-exported crude from foreign nations, and small amounts of heavy Californian crude. additionally, companies can export american crude oil to Canada so long as the consumption occurs in Canada. The industry has been taking advantage of this as exports of crude to Canada increased from 29,000 barrels per day in 2008 to 119,000 barrels per day in 2013, which was a 78 percent increase from 2012.[13]

Removing restrictions on crude oil exports could improve national security and geopolitics around the world by reducing any one nation's ability to manipulate energy supplies for political and economic influence.

The BIS, in consultation with the Department of Energy, will also approve crude exports from america's Strategic Petroleum Reserve (SPR) if "such exports will directly result in the importation into the United States of refined petroleum products that are needed in the United States and that otherwise would not be available for importation without the export of the crude oil from the SPR."[14]

Refined petroleum products are not subject to the same restrictions, with the exception of crude oil refined at the Naval Petroleum Reserve.[15] In fact, the U.S. has seen exports of refined petroleum products increase significantly over the past few years. Decreased demand for gasoline as a result of a weaker economy and increased fuel-efficiency mandates, combined with the surge in oil production over the past few years, meant that refiners searched for other markets to sell their product.

U.S. exports of finished petroleum products have increased from 513,000 barrels per day (bpd) in 1985 to 1.3 million bpd in 2007 and 2.8 million bpd in 2013, reaching a high of 3.3 million bpd that December.[16] Some companies have also worked around the crude export ban by building small refineries to process the crude minimally to qualify it for export.[17]

Keep Crude in U.S. and Export Finished Products?

Several special interests[18] who stand to benefit from crude export restrictions have argued that the United States should process the crude oil domestically and export finished, higher-value goods and refined petroleum products, such as gasoline. However, a producer could make that argument regarding just about any good sold in the United States. Should the government restrict the exports of wheat, steel, and gems to sell higher-valued bread, cars, and necklaces? The focus of trade policy should not be to restrict the allocation of goods and services around the world based on the product's final value.

The exports of refined petroleum products are a positive development, but the U.S. should not limit its export capabilities to those products. If the refiners value the crude more than foreign competitors do, they will be willing to pay to refine it and ship it where the market dictates. The free market should determine those decisions, not antiquated laws protecting special interests that restrict companies from making their own decisions.

Goods and services should be allocated to their highest-valued use, and that is determined by who is willing to pay most for them. If opportunities exist for companies to export their goods to a foreign buyer, they should be permitted to do so. The real-

13. U.S. Energy Information Administration, "Petroleum & Other Liquids: U.S. Exports to Canada of Crude Oil," September 27, 2013, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCREXCA2&f=A (accessed April 22, 2014).
14. U.S. Department of Commerce, Bureau of Industry and Security, "Short Supply Controls," January 29, 2014, https://www.bis.doc.gov/index.php/forms-documents/doc_view/425-part-754-short-supply-controls (accessed April 21, 2014).
15. Nerurkar, "U.S. Oil Imports and Exports."
16. U.S. Energy Information Administration, "Petroleum & Other Liquids: U.S. Exports of Finished Petroleum Products," September 27, 2013, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MTPEXUS2&f=A (accessed April 21, 2014).
17. Alex Nussbaum and Bradley Olson, "BP Splitter Refinery Seen Skirting U.S. Oil Export Ban," Bloomberg, March 6, 2014, http://www.bloomberg.com/news/2014-03-06/bp-splitter-refinery-seen-skirting-u-s-oil-export-ban.html (accessed April 21, 2014).
18. Jennifer A. Dlouhy, "Independent Refiners form 'CRUDE' Group to Fight Export Efforts," FuelFix, March 17, 2014, http://fuelfix.com/blog/2014/03/17/independent-refiners-form-crude-group-to-fight-export-efforts/ (accessed April 27, 2014).

ity is that removing restrictions on crude oil exports could improve national security and geopolitics around the world by reducing any one nation's ability to manipulate energy supplies for political and economic influence. Further, the more oil the U.S. is producing, the more oil will be readily available if a national security circumstance necessitates its use.

Misguided Concerns About Gas Prices. One of the primary concerns among skeptics and opponents of lifting the crude export ban is the effect that increased oil exports might have on domestic gas prices. Several studies have projected that lifting the ban would actually decrease gas prices both in the United States and globally by creating a more efficient distribution system for processing oil. To understand how crude exports could cause a price decline, it is important to understand the complexities of the oil market and how, without exports, market saturation could ultimately lead to shutting in production domestically:

- **Understanding oil markets.** Both crude oil and gasoline prices[19] in the United States are tied to the global market price, as oil is a globally traded commodity. The reference price for crude oil trading is set through benchmarks, the three main benchmarks being West Texas Intermediate (WTI), Brent Crude, and Dubai Crude. a large part of the reason why many different benchmarks exist is that different qualities of crude exist in the market. a barrel of oil extracted in Texas is not the same as a barrel extracted in Saudi arabia. Crude can range from very light to very heavy depending on its density,[20] and sweet to sour depending on its sulfur content.[21] Light, sweeter crudes sell at a premium compared to heavy, sour crudes because refiners can process them more cheaply.

  WTI and Brent have historically priced close to one another with the difference mostly stemming from transportation costs, but the spread has grown between the two benchmarks over the past few years. The combination of a Libyan supply disruption affecting the Brent benchmark and the dramatic increase in U.S. production caused a buildup of inventories and a bottleneck in Cushing, Oklahoma, where WTI is priced, that resulted in WTI trading as low as $23 below Brent in February 2013.[22] additional pipeline infrastructure and increased rail deliveries of crude helped relieve that bottleneck and narrow the price differential to around $5 today, but the Energy Information administration expects the discount to remain around $10 for the next two years.[23] Opening exports would allow U.S. companies to compete in the international markets where similar crudes have higher prices. The overall increase in global supply would reduce the price of Brent and decrease the price at the pump.

- **Matching refining capabilities.** The bottleneck in Cushing is not the only constraint facing oil markets in the United States. another critical component to further unleashing america's domestic oil production and improving global market oil efficiencies is matching refining capabilities, which are largely set up for processing heavy crude despite the recent growth in light crude production.

  The shale oil production occurring in the United States produces light sweet crude; in fact, light crude production increased 3 million bpd between 2008 and 2013. This rise has increased the share of light crude from 50 percent to over 70 percent in terms of total oil production.[24] There

19. Spot gasoline prices are linked to the world price, but several factors cause differences, such as refinery configuration and regulations, federal and state taxes, inventories, and weather.
20. The American Petroleum Institute gravity (API gravity) is a formula used to measure petroleum's density to water.
21. U.S. Energy Information Administration, "Today in Energy: Crude Oils Have Different Quality Characteristics," July 16, 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=7110 (accessed April 21, 2014).
22. Ingrid Pan, "Why the WTI-Brent Oil Spread Traded Below $4 Per Barrel," Market Realist, April 15, 2014, http://marketrealist.com/2014/04/wti-brent-oil-spread-traded-4-per-barrel/ (accessed April 21, 2014).
23. U.S. Energy Information Administration, "Short-term Energy and Summer Fuels Outlook," April 8, 2014, http://www.eia.gov/forecasts/steo/ (accessed April 21, 2014).
24. Roger Diwan, "The Unbearable Lightness of US Crudes: When Will the Levee Break?" presentation at "Crude Oil Exports: Market Drivers and Near-Term Implications," event at the Center for Strategic and International Studies, video, February 10, 2014, http://csis.org/multimedia/video-crude-oil-exports (accessed April 21, 2014).

has also been a substantial increase in ultra-light hydrocarbon known as lease condensate. Refiners across the country are equipped to process a range of crudes, which presents challenges with the glut of light crude production. Gulf Coast refineries are set up largely to handle medium and heavy crudes from Venezuela, Mexico, Canada, and the Middle East. For the past 20 years, well before the onslaught of light crude production in the U.S., companies invested $100 billion in refining capabilities to handle heavier crude imports.[25]

Refiners that are already set up to process light crude have almost entirely reduced their imports from West african countries that extract similar grades of oil, and a number of companies have made investments to handle more light crude.[26] Over the past four years, light oil imports decreased by two-thirds.[27] In addition to displacing light crudes, refiners have switched from medium and heavy to light when economical, and have expanded refining capabilities to process more light crudes. However, these shifts have constraints[28] and are unlikely to keep up with american crude production; if the refining market is saturated, oil companies will stall or shut-in production. In some areas of the country, this is already occurring. The discouragement of production brought on by an artificially restricted market will decrease global supplies of oil, and keep prices higher than they otherwise would be. On the other hand, allowing crude oil exports to flow freely to where markets can already process the crude would increase supply and increase overall market efficiency. There will likely always be lags in infrastructure buildup, but reducing artificial constraints will minimize those lags and allow better planning and improved efficiency for mid-stream (transportation) and downstream (processing) activities.

Expanding market opportunities will not just benefit oil companies. By opening the door to establish more efficient global oil markets, all Americans will reap the benefits of lower prices and a stronger economy.

americans will stand to benefit from a more efficient global oil market through lower prices and an increase in economic activity. Two recent studies, one from Resources for the Future (RFF) and a second by ICF International commissioned by the american Petroleum Institute (aPI), found that lifting the crude export ban would lower gasoline prices. RFF projects that market efficiencies would reduce gas prices from 3 cents to 7 cents per gallon, while the aPI study estimates that american consumers would save up to 2.3 cents per gallon on gas, heating oil, and diesel fuels.[29] although the price impact at the pump may seem marginal, the direction is clear that prices will fall, and not only do the savings add up over time, so do the widely expanded economic

25. Jim Efstathiou Jr., "Oil Supply Surge Brings Calls to Ease U.S. Export Ban," Bloomberg, December 17, 2014, http://www.bloomberg.com/news/2013-12-17/oil-supply-surge-brings-calls-to-ease-u-s-export-ban.html (accessed April 21, 2014).
26. Clifford Krauss, "Domestic Crude Oil Drives a Cautious Refining Revival," *The New York Times*, March 3, 2014, http://www.nytimes.com/2014/03/04/business/energy-environment/oil-boom-is-driving-a-revival-in-refining.html?_r=0 (accessed April 21, 2014).
27. ICF International, "The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs," submitted to the American Petroleum Institute, March 31, 2014, http://www.api.org/news-and-media/news/newsitems/2014/mar-2014/~/media/Files/Policy/LNG-Exports/LNG-primer/API-Crude-Exports-Study-by-ICF-3-31-2014.pdf (accessed April 21, 2014), and U.S. Energy Information Administration, "Tight Oil-Driven Production Growth Reduces Need for U.S. Oil Imports," April 7, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=15731 (accessed April 21, 2014).
28. Since many refineries are set up to handle medium and heavy crudes, so long as these crudes are available, refiners will likely stay equipped to handle them. Further, some refineries are co-owned with foreign-owned companies and have destination clauses which will also curtail displacement. See Diwan, "The Unbearable Lightness of US Crudes."
29. ICF International, "The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs," and Stephen P. A. Brown, Charles Mason, Alan Krupnick, and Jan Mares, "Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States," Resources for the Future *Issue Brief*, February 2014, http://www.rff.org/RFF/Documents/RFF-IB-14-03-REV.pdf (accessed April 21, 2014).

benefits. The ICF study concludes that opening markets to crude exports will save american consumers an estimated $5.8 billion over a 20-year period, increase america's gross domestic product by over $38 billion, and add more than 300,000 jobs by 2020.

What Congress and the Administration Can Do

The federal government can lift the ban on crude oil exports in several ways. In a comprehensive review of all U.S. energy export policy, Senator Lisa Murkowski (R–aK) outlined steps that the federal government could take:[30]

- **The Department of Commerce can change the definition for allowable exports**, which it has done in the past,[31] given the technological and economic constraints to use the crude oil in the United States.

- **The President can declare that crude oil exports are in the national interest of the United States.** Given the expansive economic gains from exports and the effect that increased global market supplies would have on geopolitical influence, lifting restrictions on crude oil exports is undeniably in the national interest.

- **Congress can pass legislation to remove the ban.** Regardless whether any decision is made by the Department of Commerce or the President to lift restrictions, Congress should change the law, recognizing the benefits of free trade to american families.

Expanding market opportunities will not just benefit oil companies. By opening the door to establish more efficient global oil markets, all americans will reap the benefits of lower prices and a stronger economy. Free trade is one of the principal drivers of improving standards of living both in the United States and abroad, and removing unnecessary restrictions on oil exports will help power that growth.

—Nicolas D. Loris is Herbert and Joyce Morgan Fellow in the Thomas A. Roe Institute for Economic Policy Studies at The Heritage Foundation.

30. Lisa Murkowski, "A Signal to the World: Renovating the Architecture of U.S. Energy Exports," United States Senate *Energy 20/20 White Paper*, January 7, 2014, http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=546d56f0-05b6-41e6-84c1-b4c4c5efa372 (accessed April 21, 2014).

31. Senate Committee on Energy and Natural Resources Minority Staff, "License to Trade: Commerce Department Authority to Allow Condensate Exports," April 2, 2014, http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=99de41e8-0074-441c-a6f2-e1e91d915314 (accessed April 21, 2014).

The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs

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Key Findings on Economic Impacts of Crude Exports

$5.8b
Estimated reduced consumer fuel costs/yr 2015–2035

- U.S. weighted average petroleum product prices decline as much as 2.3 cents per gallon when U.S. crude exports are allowed. The greatest potential annual decline is up to 3.8 cents per gallon in 2017. These price decreases for gasoline, heating oil, and diesel could save American consumers up to $5.8 billion per year, on average, over the 2015–2035 period.

$70.2b
More investment by 2020

- An expansion of crude exports would result in $15.2–$70.2 billion in additional investment in U.S. exploration, development and production of crude oil between 2015 and 2020.

500,000
Barrels per day increase in domestic crude oil production by 2020

- With crude exports, U.S. oil production is expected to grow faster and could result in incremental U.S. oil production of between 110,000–500,000 barrels per day in 2020.

300,000
Potential job gains in 2020

- The U.S. economy could gain up to 300,000 jobs in 2020 when crude exports are allowed. Consumer products and services and hydrocarbon production sectors would see the largest gains.

$38.1b
Projected GDP gain in 2020

- U.S. GDP is estimated to increase by $38.1 billion in 2020 if expanded crude exports were allowed. GDP increases are led by increases in hydrocarbon production and greater consumer product spending (due to lower retail prices for gasoline and other petroleum products).

$13.5b
Estimated government revenues increase in 2020

- U.S. federal, state, and local tax receipts attributable to GDP increases from expanding crude oil exports could reach $13.5 billion in 2020.

$22.3b
Estimated reduction of trade deficit in 2020

- Lifting crude oil export restrictions contributes to expanded U.S. exports. This could narrow the U.S. trade deficit by $22.3 billion in 2020, assuming all else equal, through increased international trade of U.S. crude oil.

100,000
Barrels per day increase in refinery throughput 2015–2035

- U.S. refinery throughput is expected to average 15.5 MMBPD without crude export restrictions, which is 100,000 barrels per day higher than with the restrictions. Refinery throughput is slightly higher with crude exports because refinery process bottlenecks (caused by mismatched crudes) are more effectively alleviated by the flexibility to exchange crudes in the world market.

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List of Exhibits

Glossary

Abbreviations

AEO	EIA Annual Energy Outlook
ANS	Alaska North Slope
Bcf/day (or Bcfd)	Billion cubic feet of natural gas per day
Btu	British thermal unit, used to measure fuels by their energy content.
CAFÉ	Corporate Average Fuel Economy standards to improve the fuel economy of U.S. vehicles first enacted in 1975 that are periodically updated
CAPP	Canadian Association of Petroleum Producers
DPR	Detailed Production Report, ICF's proprietary play-level natural gas, natural gas liquids (NGL), and oil production model
E&P	Exploration and production of oil and gas resources
EF	Eagle Ford crude oil, a light sweet oil produced in Texas
EIA	U.S. Energy Information Administration, a statistical and analytical agency within the U.S. Department of Energy
FOB	Free on Board
GDP	Gross Domestic Product
IEA	International Energy Agency
IMPLAN	Impact Analysis for Planning (IMPLAN) Model, an input-output economic model
KBPD	Thousand Barrels per Day
Mcf	Thousand cubic feet (volume measurement for natural gas)
MMcf	Million cubic feet (of natural gas)
MMBtu	Million British thermal units. Equivalent to approximately one thousand cubic feet of gas
MMBOE	Million Barrels of Oil Equivalent wherein each barrel contains 5.8 million Btus

MMbbl	Million barrels of oil or liquids
MMBPD	Million Barrels per Day
NAICS Codes	North American Industrial Classification System Codes
NGL	Natural Gas Liquids
OGIP	Original Gas in Place
OOIP	Original Oil in Place
Tcf	Trillion cubic feet of natural gas
WCS	Western Canadian Select crude oil, a heavy, sour crude blend produced in western Canada

Terms Used

Economic Terms

Direct Impacts – represent the immediate impacts (e.g., employment or output changes) in Sector A due to greater demand for and output from Sector A. These are the immediate impacts (e.g., employment or value added changes) in a sector due to an increase in output in that sector.

Indirect Impacts – represent the impacts outside of Sector A in those industries that supply or contribute to the production of intermediate goods and services to Sector A. These are impacts due to the industry inter-linkages caused by the iteration of industries purchasing from other industries, brought about by the changes in direct output.

Induced or "Multiplier Effect" Impacts – represent the cumulative impacts of spending of income earned in the direct and indirect sectors and subsequent spending of income in each successive round. Examples include a restaurant worker who takes a vacation to Florida, or a store owner who sends children to college, based on higher income that arises from the initial activity of crude oil exports. These are impacts on all local and national industries due to consumers' consumption expenditures rising from the new household incomes that are generated by the direct and indirect effects flowing through to the general economy. The term is used in industry-level input-output modeling and is similar to the term Multiplier Effect used in macroeconomics.

Multiplier Effect – describes how an increase in an economic activity produces a cascading effect through the economy by producing "induced" economic activity. The multiplier is applied to the total of direct and indirect impacts to estimate the total impact on the economy. The term is used in macroeconomics and is similar to the term Induced Impacts as used in industry-level input-output modeling.

Oil and Gas Value Chain Terminology

Upstream Oil and Gas Activities – consist of all activities and expenditures relating to oil and gas extraction, including exploration, leasing, permitting, site preparation, drilling, completion, and long-term well operation.

Midstream Oil and Gas Activities – consist of activities and expenditures downstream of the wellhead, including gathering, gas and liquids processing, and pipeline transportation.

Downstream Oil and Gas Activities – activities and expenditures in the areas of refining, distribution, and retailing of oil and natural gas products.

Oil and Gas Resource and Refinery Terminology

Atmospheric Column (also known as Distillation Tower) – the primary process unit in every refinery and the gauge by which refinery capacity is stated. Separates the light, medium, and heavy hydrocarbons present in crude oil into "fractions" or "cuts" by boiling range, which are then generally subjected to "secondary" processing aimed at increasing yields of higher value products and at improving product quality. In the distillation column, the heaviest "residual" petroleum products remain at the lower levels of the tower, while the lighter products (such as diesel, jet fuel, and naphtha/gasoline), which have shorter carbon chains, vaporize and then condense and are withdrawn at stages up the tower. The lightest products (ethane, propane, butane, and the lightest naphtha) exit at the top of the tower in gaseous form and are "condensed" to recover as much as possible as liquids. When the quality of crude input is altered appreciably from that what column was designed for, bottlenecks can result, which force throughput constraints and reductions. For instance, if a new crude is very light, it can contain so much of the light "overhead" streams that bottlenecks result in that part of the distillation unit, and throughput has to be cut.

Bitumen (also known as oil sands) – an extra heavy crude oil type characterized by high viscosity.

Crack spreads – a term used to estimate the refinery profit margin of a barrel of oil by "cracking" crude oil into petroleum products. There are a number of ways to estimate crack spreads, but a common measure is the 3-2-1 crack spread, which subtracts the cost of **three** barrels of crude oil from the wholesale value of **two** barrels of gasoline plus **one** barrel of distillate oil.

Dilbit – bitumen diluted with diluent to facilitate pipeline transportation of the bitumen.

Diluent – a diluting agent used to dilute the viscosity of bitumen to facilitate bitumen pipeline transportation. Typical diluents include lease condensate, pentanes plus from gas processing plants, butane, synthetic crude, and light crudes.

Conventional natural gas and oil resources – generally defined as those associated with higher permeability fields and reservoirs. Typically, such as reservoir is characterized by a water zone below the oil and gas. These resources are discrete accumulations, typified by a well-defined field outline. Permeability in geological terms is the degree to which a rock formation transmits fluids.

Economically recoverable resources – represent that part of technically recoverable resources that are expected to be economic, given a set of assumptions about current or future production technologies, prices, and market conditions.

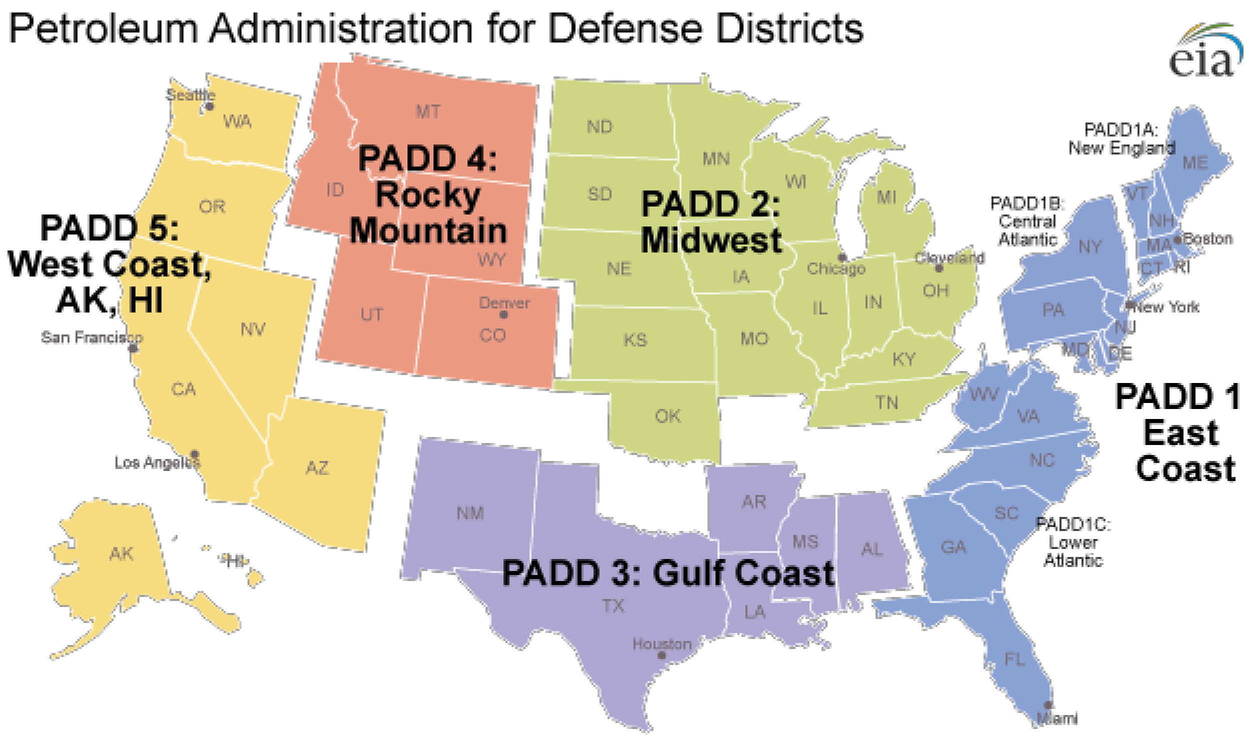
Horizontal Drilling – the practice of drilling a section of a well (the lateral) in a horizontal direction (used primarily in a shale or tight oil well). Laterals are typically thousands of feet in length.

Lease Condensate – a light liquid hydrocarbon produced from non-associated natural gas wells. Lease condensate is typically added to the crude oil stream after extraction from natural gas streams.

Natural Gas Liquids – components of natural gas that are in gaseous form in the reservoir, but can be separated from the natural gas at the wellhead or in a gas processing plant in liquid form. NGLs include ethane, propane, butanes, and pentanes.

Original Oil-in-Place – industry term that specifies the amount of oil in a reservoir (including both recoverable and unrecoverable volumes) before any production takes place.

Petroleum Administration for Defense Districts (PADDs) – five PADDs were created during World War II to allocate fuels across the country. The map below shows the PADD-level divisions. Note that PADD 1 (East Coast) is divided up into three sub-regions.



Source: U.S. Energy Information Administration (EIA). "Today in Energy." EIA, 7 February 2012: Washington, D.C. Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=4890

Pre-Flash Tower – a pre-flash tower is a distillation tower that can be added to an existing refinery to separate out the very light hydrocarbons (petroleum gases and light naphthas) from condensate or light crude oil so that the primary atmospheric distillation tower can process the heavy cuts (i.e., fractions or portions)[1] within the process limitations of the atmospheric tower.

Proven reserves – the quantities of oil and gas that are expected to be recoverable from the developed portions (defined by drilled wells) of known reservoirs under existing economic and operating conditions and with existing technology.

[1] For example, refiners refer to liquids that condense between 200 degree Fahrenheit to 250 degrees Fahrenheit as one "cut."

Railbit – similar to dilbit, diluent is added to bitumen to facilitate rail transportation (generally at a lower concentration than that needed for pipeline transport).

Technically recoverable resources – represent the fraction of gas in place that is expected to be recoverable from oil and gas wells without consideration of economics.

Unconventional gas resources – defined as those low permeability deposits that are more continuous across a broad area. The main categories are coalbed methane, tight gas, and shale gas, although other categories exist, including methane hydrates and coal gasification.

Shale gas and liquids – recoverable volumes of gas, condensate, and crude oil from development of shale plays. Tight oil plays include those shale plays that are dominated by oil and associated gas, such as the Bakken in North Dakota (also see: tight oil).

Coalbed methane (CBM) – recoverable volumes of gas from development of coal seams (also known as coal seam gas, or CSG).

Tight gas – recoverable volumes of gas and condensate from development of very low permeability sandstones.

Tight oil – tight oil is light crude oil or condensate contained in petroleum-bearing formations of low permeability, including shales, carbonates, sandstone and combinations of several lithologies. Economic production of tight oil typically involves the application of the same horizontal well and multi-stage hydraulic fracturing technologies that are used to produce shale gas. Although often produced from shales, tight oil should not be confused with oil shale, which is shale rich in kerogen (fossilized organic matter from which hydrocarbons may be generated under high heat and pressures).

<u>Crude Oil Types</u>

Light crude oil – low-viscosity crude oil that is sometimes defined as having an API gravity above 30 degrees (alternative breakpoints are also used). For exhibits in this report, light crude is defined as 35.1 degrees and higher to correspond with breakpoints of certain DOE/EIA historical data series.

Medium crude oil – medium-viscosity crude oil that is sometimes defined as having an API gravity starting somewhere between 22 degrees and 25 degrees and going up to the lower breakpoint of light crude. For exhibits in this report, medium crude is defined as ranging from 25.1 to 35.0 degrees to correspond with breakpoints of certain DOE/EIA historical data series.

Heavy crude oil – high-viscosity crude oil is defined has having an API gravity below the lower breakpoint of medium crude oil. For exhibits in this report, heavy crude is defined as 25.0 degrees and lower. The term “extra heavy oil” is defined has having API gravity below 10.0 degrees.

Sweet crude oil – crude oil that is defined has having a sulfur content of less than 0.5 percent.

Sour crude oil – crude oil defined as having a sulfur content of 0.5 percent or more.

Conversion Factors

Energy Content of Crude Oil

1 barrel = 5.8 MMBtu = 1 BOE

1 MMBOE = 1 million barrels of crude oil equivalent

Energy Content of Natural Gas (1 Mcf is one thousand cubic feet)

1 Mcf = 1.025 MMBtu

1 Mcf = 0.177 barrels of oil equivalent (BOE)

1 BOE = 5.8 MMBtu = 5.65 Mcf of gas

Volume of Natural Gas

1 Tcf = 1,000 Bcf

1 Bcf = 1,000 MMcf

1 MMcf = 1,000 Mcf

Energy Content of Other Liquids

Condensate

1 barrel = 5.3 MMBtu = 0.91 BOE

Natural Gas Plant Liquids

1 barrel = 4.0 MMBtu = 0.69 BOE (actual value varies based on component proportions)

1 Executive Summary

1.1 Background

API asked ICF International (in cooperation with EnSys Energy) to conduct a study of the economic impacts of changing U.S. government policies that prohibit most export of U.S. crude oils. This study provides an analysis of the impacts of a liberalized crude export policy.

The United States government restricted the export of most domestically produced crude oil starting in 1973, a time when U.S. oil production was in decline.[2] In recent years, the oil and gas industry reversed the downward crude oil production trajectory through a technological revolution. Horizontal well drilling and multi-stage hydraulic fracturing are now utilized to access oil and gas resources that were previously either technically impossible or uneconomic to produce. Between 2009 and 2013, U.S. crude oil production[3] has increased by 2.1 million barrels per day (MMBPD) (39 percent)[4] and is projected to increase another 3.2–3.3 MMBPD through 2020, according to ICF/EnSys estimates. Forecasts of substantial near-term production increases have also been made by the U.S. Energy Information Administration (1.8 MMBPD increase from 2013 to 2020) and other forecasts cited later in this report.[5] This production revolution has fundamentally altered the domestic flow of crude oil, with states such as North Dakota and

Key Points

- ***The U.S. may become the world's leading crude oil producer over the next decade, largely through production of lighter crude oil.***
- ***Current restrictions on the export of crude oil, developed at a time when U.S. oil production was in decline, limit the U.S.' ability to efficiently use crude oil supplies.***
- ***U.S. refineries are mostly designed to accommodate heavy (rather than light) crudes.***
- ***Refineries are expected to continue to make adjustments to accommodate lighter crudes, but may have a difficult time keeping up with growing U.S. light crude and condensate production.***
- ***The U.S. crude oil supply glut is apparent in the discount seen in recent months in U.S. light crude oil prices, relative to international benchmarks.***
- ***Because the U.S. allows import and export of petroleum products, such as gasoline and diesel, U.S. petroleum product prices follow international market dynamics, regardless of the differentials between U.S. and international crude oils.***
- ***Expanding flexibility to export crude oil would allow refiners to operate more efficiently, running heavy crude oil, while export of light crude oil is expected to modestly reduce international oil prices, and, by extension, U.S. gasoline and diesel prices.***
- ***Expanding crude oil exports is expected to increase U.S. crude oil production, leading to net gains in employment, GDP, and government revenues.***

[2] The United States currently allows export of domestic crude oil in a few cases, such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 BPD in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions.

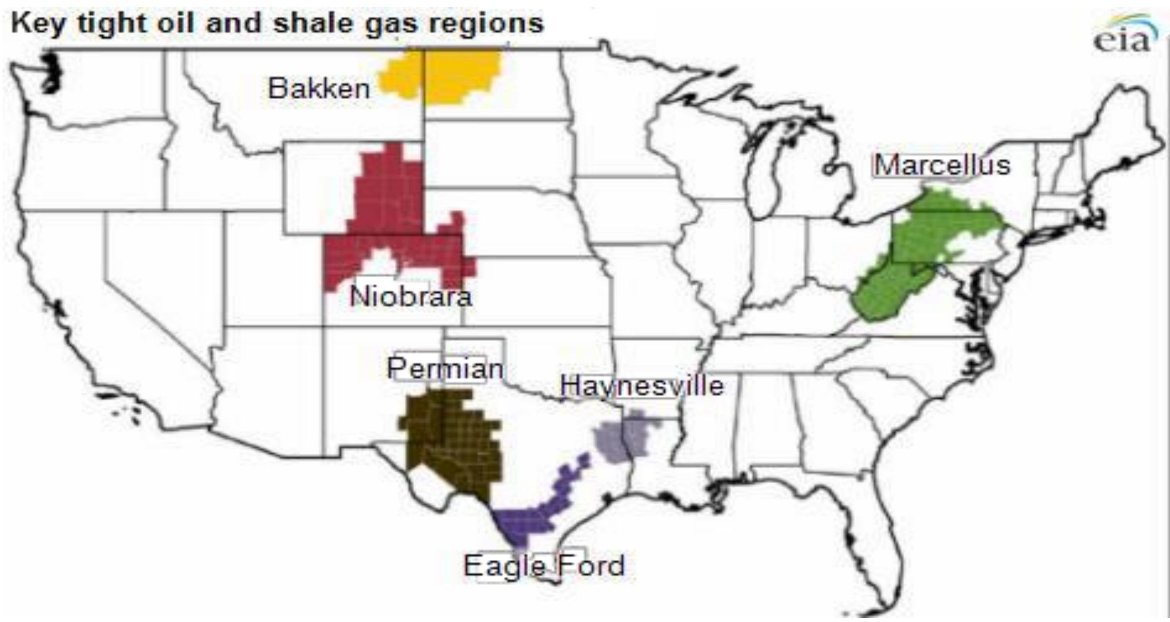
[3] Including lease condensate

[4] U.S. Energy Information Administration (EIA). "Crude Oil Production." EIA, September 2013: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm

[5] U.S. Energy Information Administration (EIA). "Annual Energy Outlook 2014 Early Release." EIA, 16 December 2013. Available at: http://www.eia.gov/forecasts/aeo/er/index.cfm

Texas now producing substantial volumes of tight oil.[6] The new oil supplies, made up primarily of light sweet crude oil and lease condensate, are concentrated in the Bakken (MT, ND), Niobrara (CO, WY), Permian (NM, TX), and Eagle Ford (TX) shale plays, as shown in the exhibit below.[7,8]

Exhibit 1-1: Key Tight Oil and Shale Gas Regions



Source: U.S. Energy Information Administration (EIA). "Today in Energy." EIA, 22 October 2013: Washington, D.C. Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=13471

Construction of new pipeline infrastructure to connect new tight oil plays to traditional demand markets (i.e., refineries) has lagged behind production growth. This has created significant transportation bottlenecks as new supply from sources such as North Dakota could not be shipped to demand areas elsewhere around the country. Over the past several decades, U.S. oil pipeline infrastructure was geared to transport domestic and foreign oil from locations such as the Gulf Coast north to demand markets. However, growing North Dakota tight oil production led to a southward shift in movements of crude to refineries in the midcontinent region. Until very recently, these additional domestic supplies and Canadian crude imports became bottlenecked at Cushing, a large supply hub in Oklahoma, as there was not sufficient pipeline infrastructure to move the crude south from Cushing to the major Gulf Coast refining center.

As shown in the exhibit below, the rapid tight oil production growth coupled with the lack of infrastructure connecting new supply sources to demand markets became apparent in the late

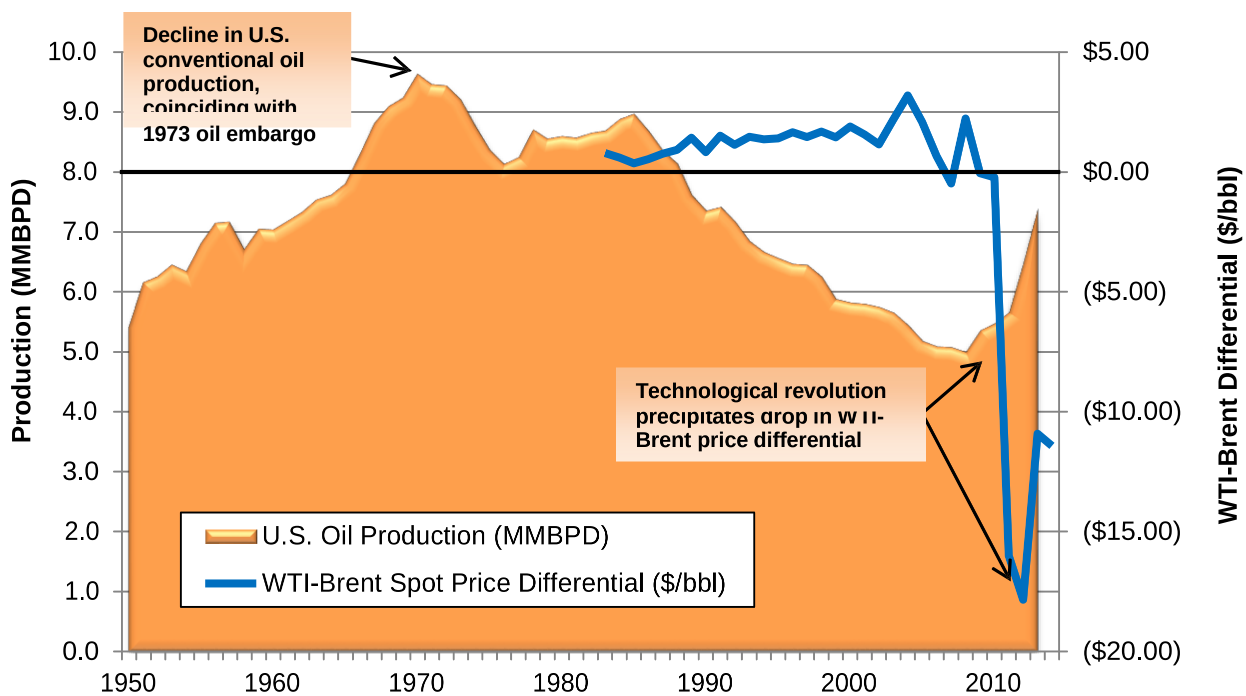
[6] Tight oil is light crude oil or condensate contained in petroleum-bearing formations of low permeability, including shales, carbonates, sandstone and combinations of several lithologies. Economic production of tight oil typically involves the application of the same horizontal well and multi-stage hydraulic fracturing technologies that are used to produce shale gas.

[7] To correspond with breakpoints of certain DOE/EIA historical data series, this study defines light crude as having API gravity of 35.1 degrees and higher, medium crude ranging from 25.1 to 35.0 degrees, and heavy crude as 25.0 degrees and lower.

[8] Sweet crude oil is defined as having a sulfur content of less than 0.5 percent, while sour crude oil is defined as having a sulfur content of 0.5 percent or more.

2000s as evidenced by the drop in U.S. West Texas Intermediate (WTI) Cushing benchmark crude oil price relative to the international comparable benchmark crude. The exhibit shows the historical price spread between WTI—the U.S. oil price benchmark for light sweet crude—and the North Sea Brent price—considered the international oil price benchmark. WTI prices historically were at a slight premium relative to Brent. The WTI-Brent price spread averaged positive $1.30 per barrel between 1983 (the earliest year for which data is available) and 2008. The differential became more volatile starting with the financial crisis and commodity price collapse in 2008, before plunging to a discount of $17.00/bbl in 2011 and 2012 due to the Cushing bottleneck as tight oil production continued to grow.

Exhibit 1-2: Historical U.S. Oil Production and WTI-Brent Spot Price Spreads



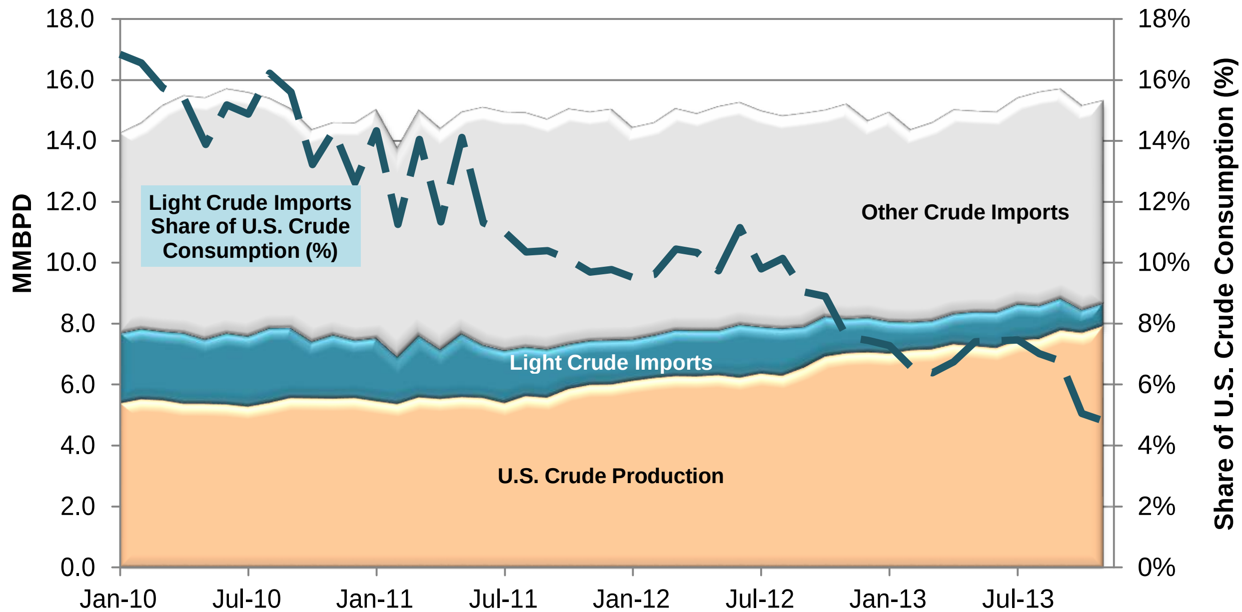
Sources: EIA – oil production; Bloomberg – WTI and Brent spot FOB prices.

Additional pipeline capacity has been added and is under construction to alleviate this bottleneck. Capacity from Cushing to the Gulf Coast, as well as from the Permian region into the Houston refining center has increased. The ongoing development of this infrastructure has opened the pathways for light crude to reach the Gulf Coast, and provided producers higher prices while allowing Gulf Coast refiners access to the discounted light crude. At the same time, East and West Coast refiners do not have access to new tight oil by pipeline, and have been developing rail capabilities to access domestic crudes, such as from the Bakken in North Dakota, allowing them to reduce imports of light sweet, globally-priced crude oils.

Tight oil production, which is characterized as light sweet crude oil and lease condensate, is expected to continue to fuel the bulk of future U.S. oil production growth. As shown below, this production growth is replacing light oil imports, mostly African crude oil, at an increasing clip. Between January 2010 and January 2014, the light oil imports dropped by nearly two-thirds to

790,000 barrels per day (BPD) for the U.S. In the Gulf Coast (PADD 3), light oil imports are currently only about 245,000 BPD, and a portion of these are for lubricant oil manufacturing (requiring a specific crude oil quality).[9]

Exhibit 1-3: Historical U.S. Oil Production and Light Crude Imports



Sources: U.S. Energy Information Administration (EIA). "Crude Oil Production." EIA, 27 February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_m.htm, U.S. Energy Information Administration (EIA). "Refinery Net Input." EIA, 27 February 2014, Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_pnp_inpt2_a_epc0_YIY_mbbl_m.htm

Note: The light crude imports include crude oil imports with API gravity of 35 degrees and above.

There is a fundamental mismatch between U.S. refinery capabilities, configured for heavier oils, and the country's newfound supply, comprised of lighter oils. Although the initial (physical) bottleneck at the Cushing, OK hub that caused the discount of U.S. oil prices has been alleviated for the most part, the prices for U.S. light crudes and condensates have experienced a persistent differential with comparable but higher priced world crude such as Brent since August 2013. Analysts have attributed this differential to U.S. refiners encountering constraints that prevent them from processing all of the growing U.S. light crude and condensate volumes. Refiners are planning investments to increase the ability to process lighter oils, but it is uncertain whether these investments can keep up with growing U.S. light crude and condensate production. There is a high probability that this differential between U.S. and comparable international crudes will persist over the medium term. In addition, given the global nature of petroleum product prices (such as gasoline and diesel), lower crude prices in one region do not necessarily translate to lower product prices.

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[9] Based on the 2013 average for PADD 3 (as PADD for crude processing) crude oil imports with API gravity of 35 degrees and above. U.S. Energy Information Administration (EIA). "Company-level Imports" EIA, 27 February 2014: Washington, D.C. Available at: http://www.eia.gov/petroleum/imports/companylevel/

With U.S. light oil imports at less than 800,000 barrels per day (BPD) and additional growth of production of 3.4 million barrels per day by 2020 anticipated, the “Cushing bottleneck” will soon become a “national” bottleneck. As producers extend pipeline and rail infrastructure, U.S. refiners will gain access to an increasing supply of tight oil crudes and condensates. Refiners will then have to reconfigure to run the new lighter crudes. The Cushing bottleneck foretells a similar outlook for producers as refining capacity becomes the limiting factor on processing the new domestic crude.

This outlook is expected to have ramifications for the U.S. economy as tight oil production grows and options to domestically process the light crudes and condensate become constrained. Historically, many U.S. refineries were adapted to process heavier crude oil. However, the new and growing U.S. production is primarily light crude oil and lease condensate. After backing out all light oil imports, the U.S. is still expected to have a net surplus of light oil production. Due to a combination of flat or declining domestic petroleum product demand, refinery capacity limits to process light oil feedstocks, and continued refinery demand for heavy oils (due to both refinery configuration and long-term import contractual obligations), the U.S. surplus of light oil is

Questions This Study Addressed:

- **How “binding” will the crude export constraint be in the coming years and how much of a price depression will result between U.S. crude prices and prices for comparable global crudes?**
- **How would U.S. production and trade in crudes be affected by lifting the export constraints?**
- **How would refinery throughputs be affected if crude exports were allowed?**
- **What would be the impacts on prices of U.S. and global crudes and U.S. petroleum product prices if crude exports were allowed?**
- **What would be the economic impacts of allowing crude exports in terms of GDP, jobs, and balance of trade?**

1.2 Energy and Pricing Impacts of Crude Oil Exports

This study focused on assessing the impact of lifting the crude oil export restrictions on the U.S. crude oil supply-demand balance and the international supply-demand balance, both in terms of volumetric and pricing changes. The study compared supply-demand trends in a world with continued crude oil export restrictions to a scenario in which the restrictions are lifted. A key focus throughout this report is on differential impacts between the export-restricted and non-restricted cases. Because of the uncertainty in several factors that could affect near- and medium-term crude prices, ICF created two market scenarios within which export policy could be examined:

- A Low WTI-Brent Price Differential Market Scenario (Low-Differential Scenario) – Assumed relatively rapid accommodation of light crudes and condensate, notably that the following would occur by 2015, leading to a narrowing in WTI-Brent differentials:
  - Continued swift buildout and availability of rail capacity to take Bakken and Niobrara crudes out to the U.S. East and West, as well as Gulf coasts.
  - Similar buildup in capacity to ship Eagle Ford crude and condensate via marine terminals at Corpus Christi, enabling expanded movements by sea to refineries in eastern Canada and the U.S. Northeast.
  - No constraints on fully backing out all light sweet crude imports into the Gulf, East and West coasts.
  - Similarly, a degree of flexibility in backing out medium sour crudes imported into the U.S., notably into the Gulf Coast.
  - Announced refinery projects to enable running light crudes all come on-stream by 2015 (but no further adaptations made by then).
- A High WTI-Brent Price Differential Market Scenario (High-Differential Scenario) – Assumed that inertial factors and delays would slow the adaptations to changing crude slate that were assumed in the Low-Differential Scenario, with the result that WTI-Brent differentials would remain wide, at least for several years. While some refiners have invested to process more light crude, others may be reluctant to risk significant capital on higher-cost refinery investments to accommodate lighter crude slates due in part to the uncertainty around crude export policies and the outlook for tight oil production growth. In addition, permitting requirements can adversely affect project timing and delay implementation. These could prevent announced refinery projects from coming on-stream until after 2015. Equally, there could be delays in the implementation of the extensive list of announced projects for crude-by-rail capacity. Crude supply contracts in place and equity ownership stakes in refineries could slow the displacement of imported crudes by domestic grades. These factors would contribute to the wider WTI-Brent price differentials assumed in the High-Differential Scenario, thus prolonging U.S. crude price discounting relative to global prices.

Both the Low-Differential and High-Differential scenarios include two policy cases:

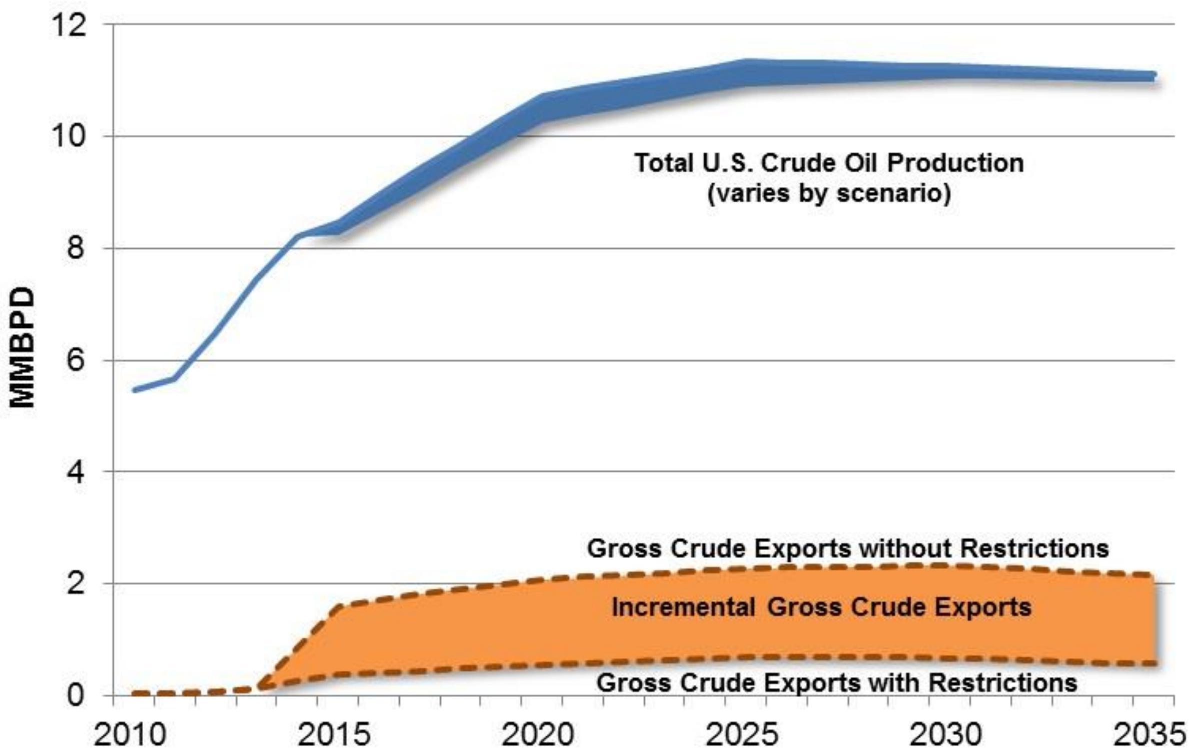
- Base Case (No Exports Policy Case) – Results based on the assumption that existing restrictions on crude exports remains in place.[10]

[10] This case assumed a continuation of current crude export policy in which the United States permits export of crude oil in a few cases such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 BPD in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions.

- With Exports Policy Case – Results based on the assumption that all restrictions on crude exports are lifted.

This study found that the U.S. petroleum industry would, based on global markets and transportation costs, have a strong incentive to export lower priced domestic crude to global markets where prices for similar quality crudes are higher. This “arbitrage” will drive higher exports, as a free market export policy will cause producers to seek higher prices for their domestic crude oil. The study found that based on global markets, a free market export policy would drive an average of 2.1 MMBPD crude oil exports between 2015 and 2035. Under the current export policy, crude oil exports would average about 580,000 BPD and result in lower crude oil production and fewer long-term economic benefits to U.S. consumers.

Exhibit 1-4: Gross Crude Exports and Share of U.S. Crude Production

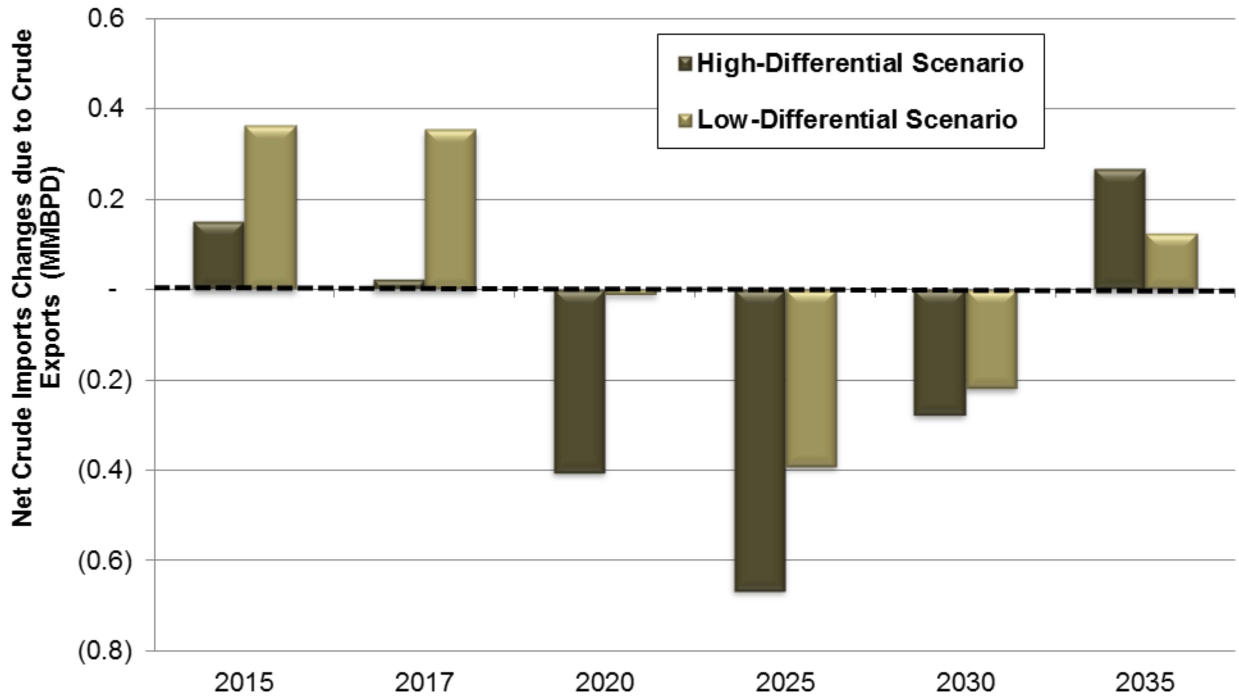


Sources: EIA – historical; ICF International and EnSys Energy –projections

The U.S. is projected to remain a net crude importer through 2035 in the cases examined in this study. Average net imports of crude are approximately equal in all cases with and without exports (within 30,000 BPD on average between 2015 and 2035). As exports of light crude oil are allowed, imports of heavier crudes increase to better align with existing refinery configurations leaving net imports little changed as shown in Exhibit 1-5. Heavier crudes are expected to comprise an increasing share of imports as U.S. tight oil and condensate production back out light imports. For historical reference, net crude imports averaged 9.0 MMBPD in 2000 and dropped to 7.6 MMBPD by 2013. Net crude imports are projected to be between 4.5 and

4.8 MMBPD by 2035 with or without restrictions. The exhibit below shows net crude import changes due to crude exports.

Exhibit 1-5: Net Crude Imports do not Change Considerably due to Crude Exports



Sources: EnSys WORLD Model and ICF analysis

Note: In all cases, crude exports to Canada are allowed.

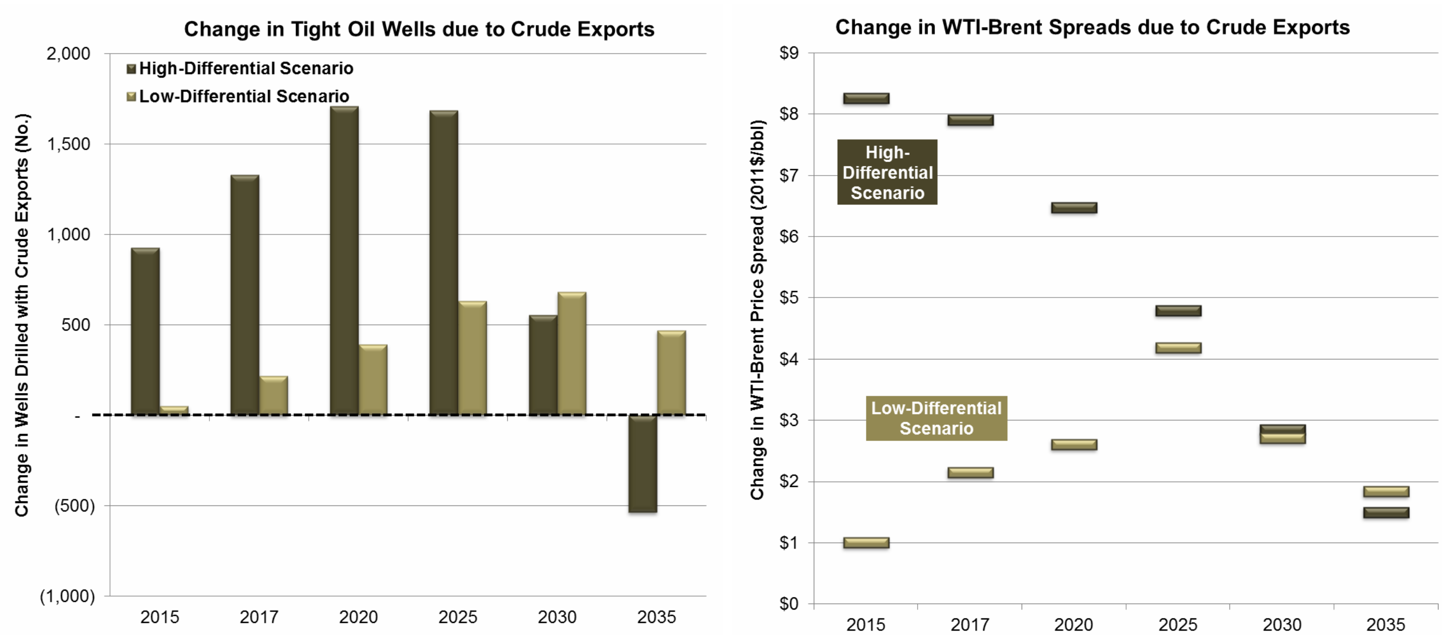
When exports are restricted, U.S. crudes are bottlenecked, which results in their pricing being discounted. With crude exports, U.S. and international crudes are in direct competition, and will move WTI prices closer to comparable global oil prices. In addition, the Brent price drops when U.S. crude exports are allowed, as U.S. incremental crude production increases overall global supply. WTI prices are projected to average $2.25–$4.00/bbl higher over the 2015–2035 period relative to the no export case, depending on the scenario, while global oil prices are approximately $0.35–$0.75/bbl lower over the same time period.[11] WTI-Brent price differentials narrow with crude exports from $7.50/bbl in the Low-Differential Scenario, or $9.60/bbl in the

[11] All projected prices for 2015-2035 in this report are in 2011 dollars, unless otherwise specified.

High-Differential Scenario when exports are constrained, to a differential of $4.85/bbl when export restrictions are relieved in both the Low- and High-Differential Scenario.

The High-Differential Scenario results in much larger drilling activity and production in the early years in comparison to the Low-Differential Scenario. This is because the WTI price adjustment is much larger in the early years in the High-Differential Scenario vs the Low-Differential Scenario when exports are allowed. In the longer term the WTI price adjustments in both study cases converge, and so, the impacts on drilling levels and production are similar.

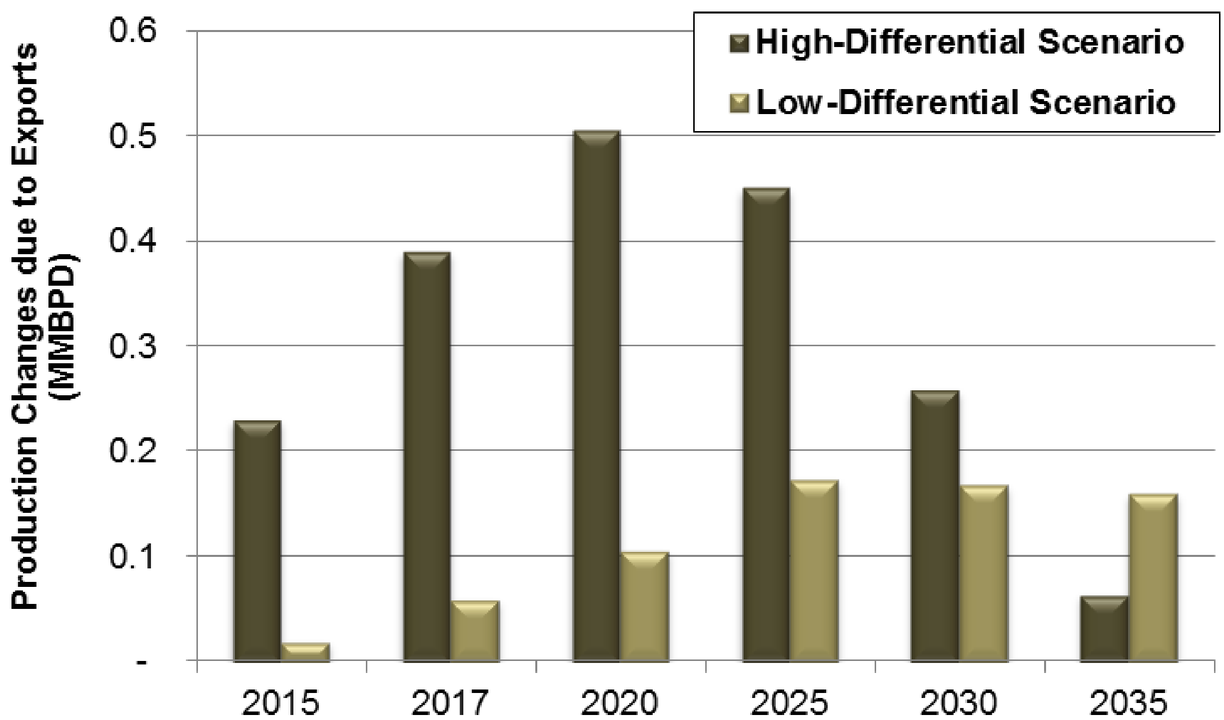
Exhibit 1-6: Allowing Crude Exports Increases Tight Oil Wells Drilled



Sources: EnSys WORLD Model and ICF analysis – projections; EIA pricing forecasts adjusted by EnSys WORLD Model and ICF analysis for case scenarios

Historically, U.S. crude production grew from an annual average of 5.8 MMBPD in 2000 to 7.4 MMBPD in 2013. This study projected that U.S. crude production will average 10.7 MMBPD between 2015 and 2035 with crude exports. Lifting crude export restrictions is projected to increase U.S. crude oil production by approximately 110,000 to 500,000 BPD by 2020, depending on the scenario. This additional crude production would come about through $15.2–$70.2 billion in additional investment between 2015 and 2020.

Exhibit 1-7: U.S. Crude Production Will Be Higher if Exports Are Allowed

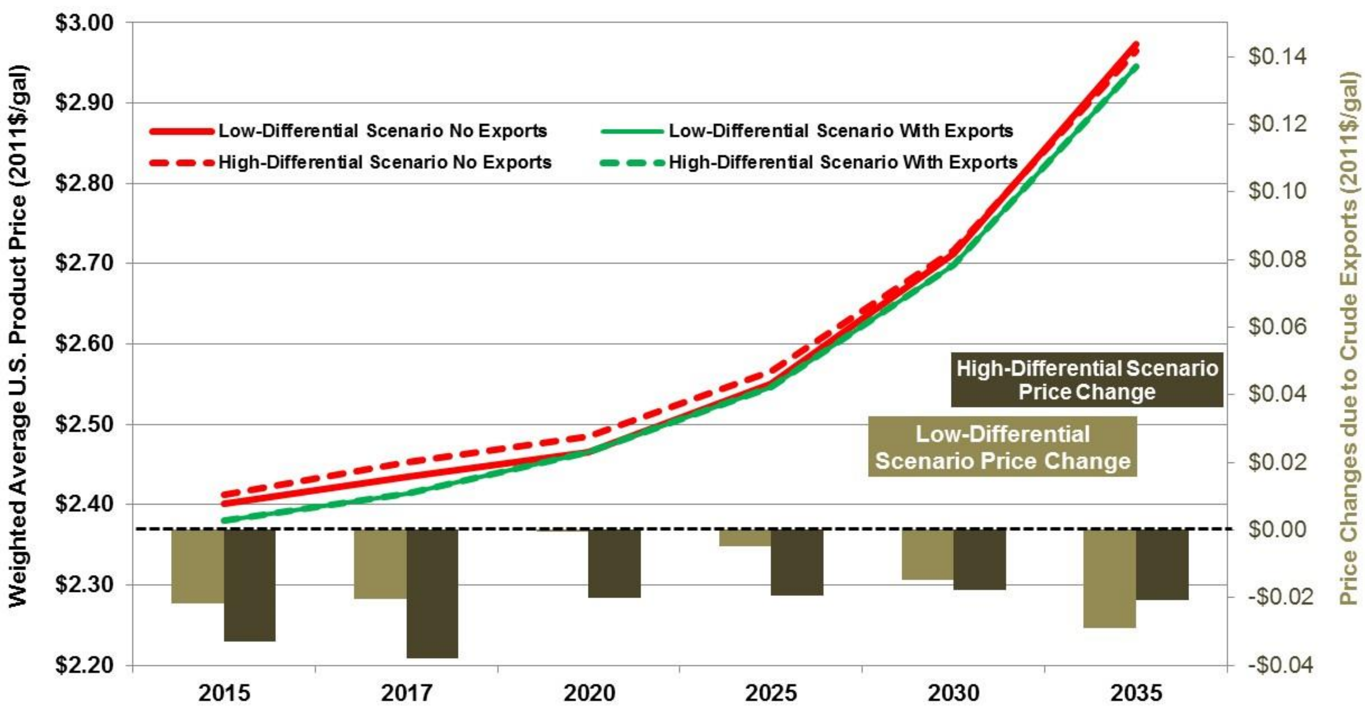


Sources: EnSys WORLD Model and ICF analysis

1.3 Refined Product Pricing Impacts of Crude Oil Exports and Consumer Fuel Savings

This study found that average U.S. wholesale product prices, weighted by product type volumes, decline an average of 1.4–2.3 cents per gallon between 2015 and 2035 due to crude oil exports, with wholesale prices averaging about $2.60 per gallon over 2015 to 2035 with crude exports. This price decline could save American consumers up to $5.8 billion per year, on average, over the 2015–2035 period. Price declines due to crude exports are largest in 2017 in the High-Differential Scenario, with U.S. wholesale product prices dropping 3.8 cents, translating to consumer fuel savings of $9.7 billion. This price decline is similar in magnitude to another study of crude exports and impacts on U.S. pricing.[12]

Exhibit 1-8: Weighted Average U.S. Wholesale Product Price Impacts



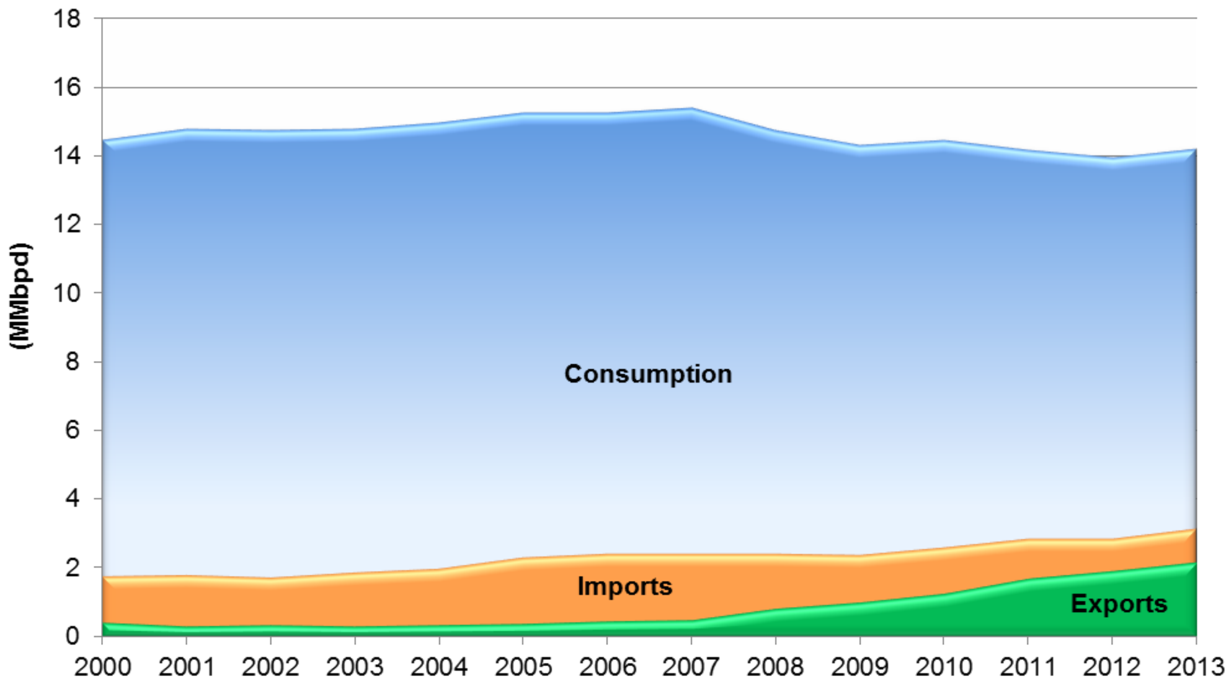
Sources: EnSys WORLD Model and ICF analysis

The United States has long participated in the international trade in refined petroleum products. Between 2000 and 2013, U.S. trade in major refined petroleum products (gasoline, distillates such as diesel and heating oil, jet fuel, kerosene, and propane) increased from 1.8 MMBPD in 2000 to 3.1 MMBPD in 2013, as shown in the exhibit below. Over the period, product imports have trended down slightly, while exports have increased from 0.4 MMBPD to 2.2 MMBPD. Product imports and exports now comprise 22 percent of consumption, up from 12 percent in 2000. This trend illustrates that discretionary U.S. product supply has either been imported into

[12] A recent Resources for the Future (RFF) study found that lifting the U.S. crude oil export restrictions would result in a decrease in the wholesale price of gasoline by 1.7 to 4.5 cents per gallon.

Brown, Stephen P.A.; Charles Mason; Alan Krupnick; and Jan Mares. "Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States." Resources for the Future (RFF), February 2014: Washington, D.C. Available at: http://www.rff.org/RFF/Documents/RFF-IB-14-03-REV.pdf or exported from the global markets. The exhibit below shows U.S. trade in petroleum products has trended upward historically (shown by imports and exports), while exports' share of this trade has risen considerably since 2009.

Exhibit 1-9: Consumption and Trade of Selected U.S. Petroleum Products*



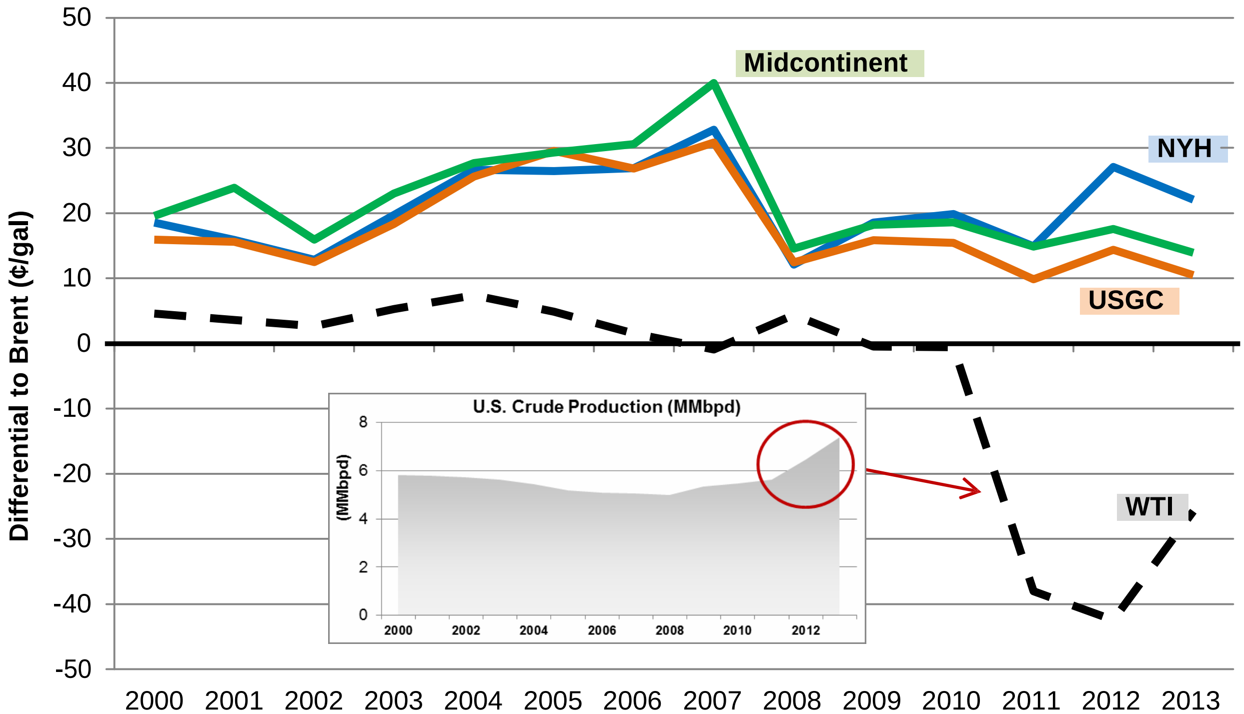
Source: U.S. Energy Information Administration (EIA). "Prime Supplier Sales Volumes." EIA, 25 February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_cons_prim_dcu_nus_m.htm U.S. Energy Information Administration (EIA). "Petroleum and Other Liquids: Exports." EIA, 25 February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_move_exp_dc_nus–z00_mbblpd_m.htm U.S. Energy Information Administration (EIA). "Petroleum and Other Liquids: Imports." EIA, 14 March 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_move_imp_dc_nus–z00_mbblpd_a.htm

* Includes gasoline and gasoline blendstocks, distillates, jet fuel, kerosene, and propane

The cost of delivered crude oil and the value of the primary products from refining influence the operating strategy of the U.S. refining sector. U.S. refiners are competing with global suppliers (traders and foreign refiners) who have the ability to bring product into the U.S. market or purchase product in the U.S. market to export. U.S. refiners supply both domestic and international demand, and also receive product from international sources. Because of these strong market connections, U.S. product prices are set by world prices rather than U.S. crude prices. In recent years U.S. refiners have benefitted from relatively lower domestic crude and natural gas prices to sustain or increase crude runs (despite lower domestic demand) and export gasoline, diesel, and propane to global markets at prices that support processing the crude oil. In addition, as pointed out above, the refinery margins through 2035 are projected to trend somewhat higher from levels seen over the past few years, either with a continuation of current crude export policy or with an expansion of crude exports.

As shown in the exhibit below, the discount in WTI prices after 2010, relative to international benchmarks such as Brent crude, did not translate to lower U.S. refined product prices. This was the case even in the midcontinent, where WTI is physically bought and sold. The midcontinent region is short of refinery capacity to meet its own demands and imports product from the Gulf Coast at Gulf Coast product price levels to balance supply and demand.

Exhibit 1-10: U.S. Petroleum Product Prices Linked to Global Crude Prices



Source: Prices – Bloomberg. Crude production – U.S. Energy Information Administration (EIA). "U.S. Field Production of Crude Oil." EIA, February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS2&f=M

Note: Group 3 refers to Midcontinent 87 octane gasoline prices (Bloomberg ticker: G3OR87PC Index), NYH refers to New York Harbor (NYH) 87 octane gasoline prices(Bloomberg ticker: MOINY87P Index), USGC refers to U.S. Gulf Coast (USGC) 87 octane gasoline prices (Bloomberg ticker: MOINY87P Index). WTI refers to West Texas Intermediate (WTI) crude oil spot price (Bloomberg ticker: U.S.CRWTIC Index). Brent refers to Brent crude oil spot price (Bloomberg ticker: EUCRBRDT Index). Prices on graph show the differential to Brent prices.

The fact that the U.S. refinery sector participates in international product trade means that U.S. refined product prices follow international markets.

The U.S. refining sector comprised roughly 22 percent of global refining throughput processed between 2000 and 2010, with U.S. refined products exports making up an average of six percent of global exports.[13] A differential in refined product cost between U.S. and international markets creates opportunities for arbitrage for both traders and refiners. Much of the gasoline supply for the U.S. Northeast is from imports of gasoline and gasoline blendstocks

[13] U.S. Energy Information Administration (EIA). "International Energy Statistics." EIA, 2014: Washington, D.C. Available at: http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=alltypes&aid=1&cid=ww,US,&syid=2008&eyid=2000&unit=TBPD

from Europe by traders and blenders, while at the same time U.S. refiners are exporting gasoline and diesel from the Gulf Coast to Latin America and other countries. These facts indicate that the U.S. product supply is being optimized in a global market, based on prices in global markets. The larger discounts in domestic crude oil prices due to crude export restrictions improve U.S. refinery margins but do not reduce gasoline or diesel prices, as refiners will have the ability to export these products at global market prices.

This study projects only relatively small differences in U.S. refinery throughputs between cases with and without export restrictions. The model runs show that when export restrictions are lifted, the U.S. exchanges exports of light crudes and condensates for additional imports of medium and heavy crudes, while leaving refinery throughput at similar levels. U.S. refinery throughput was 15.2 MMBPD in 2013. Refinery throughput is expected to increase to a 2015–2035 average of 15.5 MMBPD if the crude export restrictions are lifted, which is 100,000 BPD or 0.6 percent higher than would exist if the restrictions were kept in place. Refinery throughput is slightly higher in the Exports Case because refinery process bottlenecks caused by mismatched crudes are more effectively alleviated by the flexibility to exchange crudes.

U.S. refinery gross margins[14], the difference between the cost of the refinery feedstock (primarily crude) and outputs (such as gasoline and other refined petroleum products) are projected to decline with increased crude oil exports. This is due to a combination of higher domestic U.S. crude prices and slightly lower refined product prices. Per-barrel refinery margins average $12.75/bbl over the period to 2035 when crude exports are allowed, roughly $1.50/bbl lower than when exports are restricted in the Low-Differential Scenario, or $2.85/bbl lower in the High-Differential Scenario with export restrictions. Average gross refinery margins reached as high as $14.23/bbl in 2005, they dropped to an annual average of $6.54/bbl in 2013. Refinery margins are projected to trend higher with or without export restrictions due to global trends toward lighter and higher quality products, such as diesel fuel and jet fuel, at the expense of residual oil products.

Refined petroleum product net exports are roughly the same with and without the crude export restrictions; this is because U.S. refining throughputs and product demand varied little between the Exports and No Exports cases.

1.4 Employment and Economic Impacts of Crude Oil Exports

The study found that lifting the restrictions on crude exports results in economic gains stemming, in large measure, from increasing U.S. crude oil production. This change in production stimulates indirect activities such as the manufacture of drilling equipment, increasing demand for steel pipe, and cement, as well as other materials, equipment, and services. These direct and indirect effects have an upward impact on the economy, which is quantified below. In addition, there are induced or “multiplier effect” impacts, which represent

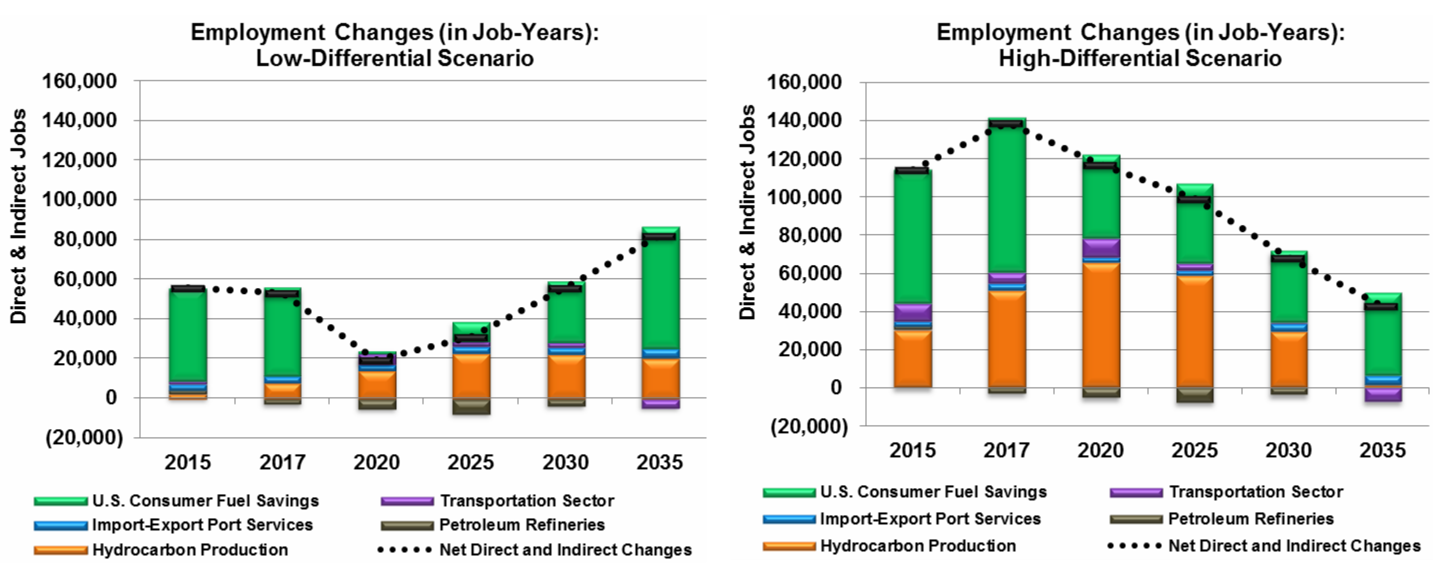
[14] As used in this study, gross refinery margin equals total value of products from refinery (yield times price for each product) minus crude cost (fraction of each crude in feedstock times its price). PADD-level average gross margins were first computed and then weight averaged by PADD-level refinery throughputs to arrive at a national average gross margin.

the additional impacts of income earned by employees in the direct and indirect sectors. Given the uncertainty surrounding multiplier effects, this study applied ranges, which are described in more detail in Section 3.

The impacts of lifting the crude export restrictions on the U.S. economy are larger in the High-Differential Scenario than the Low-Differential Scenario. Refinery and transportation infrastructure investments that are needed to better accommodate lighter domestic crudes are slower in the High-Differential Scenario when crude export restrictions remain in place, thus prolonging the depression in U.S. crude prices relative to international prices.

The ICF methodology calculated direct and indirect employment impacts (relative to the base case trend of no exports) by multiplying the change in production in a given sector (measured in dollars or physical units) times the labor needed per unit of production. Crude exports result in net direct and indirect employment gains in the Low-Differential and High-Differential scenarios, which average between 48,000 and 91,000 jobs annually over the forecast period, respectively. Direct and indirect job gains are concentrated in consumer-related and hydrocarbon production activities. The exhibit below shows the direct and indirect employment changes associated with lifting the crude export restrictions. Employment changes in the Low-Differential Scenario are lower than in the High-Differential Scenario because the High-Differential Scenario has a wider WTI-Brent price spread that results in larger economic impacts when the export constraints are lifted and WTI prices rise to come closer to world crude price levels.

Exhibit 1-11: Direct and Indirect Employment Increases due to Crude Exports



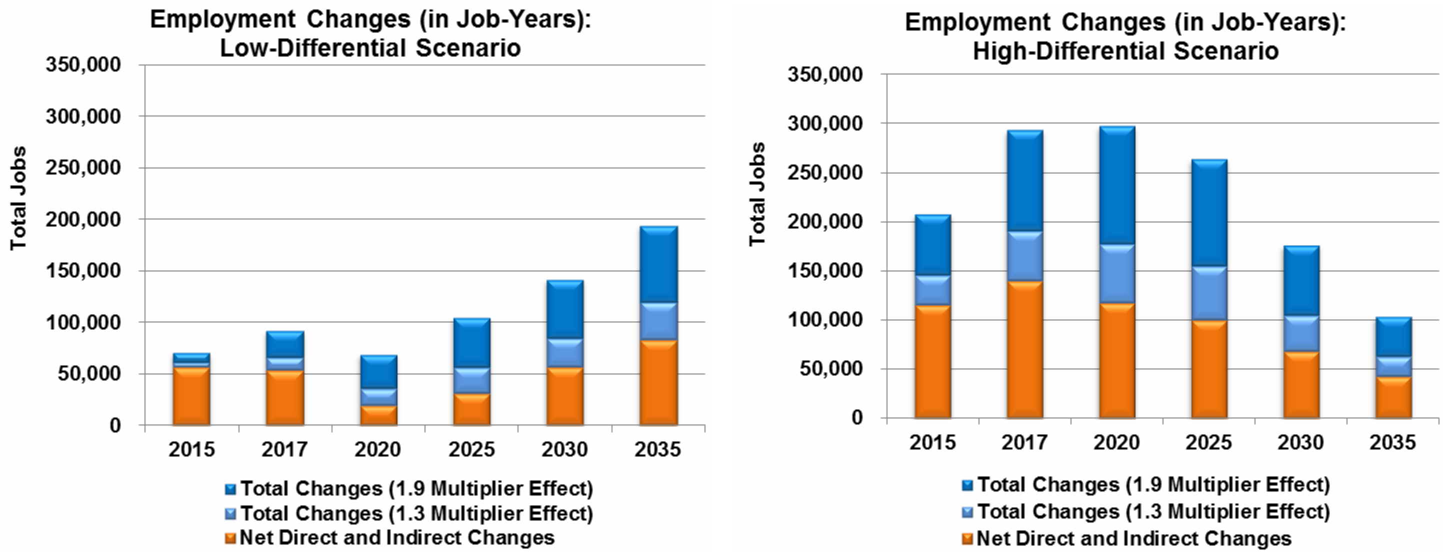
Source: ICF analysis

Note 1: Excludes multiplier effect (or induced) employment impacts.

Note 2: A job-year represents a single job occurring over 12 months or equivalent amounts of employment, such as two jobs occurring for six months each.

The exhibit below shows the total employment changes due to lifting the export restrictions. This includes the direct and indirect jobs, as well as the induced employment generated by the additional consumer spending resulting from the direct and indirect jobs. Lifting the crude export restrictions results in a net employment gain of up to 118,000–220,000 annual jobs over the forecast period.[15] The U.S. economy could gain as many as 300,000 jobs in 2020.[16] As with GDP changes, employment changes between the Low-Differential and High-Differential scenarios are influenced greatly by the WTI-Brent price spread changes.

Exhibit 1-12: Total Employment Goes up when Crude Exports Are Expanded



Source: ICF analysis

Note 1: Multiplier effects can be higher when there is slack in the economy (not at full employment) and less when the economy is running near capacity. Hence, the estimated total employment impacts are shown as a range.

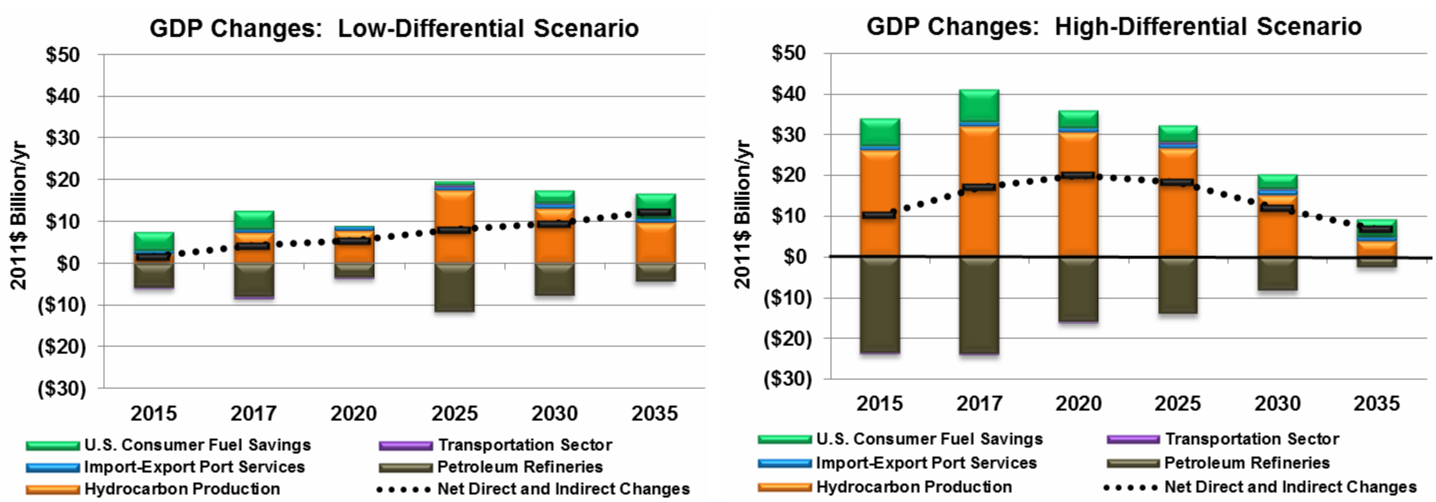
Note 2: A job-year represents a single job occurring over 12 months or equivalent amounts of employment, such as two jobs occurring for six months each.

[15] Based on the 1.9 multiplier effect.

[16] *Ibid.*

Crude exports cause GDP to increase an additional $7.8 billion annually on average over the forecast period in the Low-Differential Scenario (direct and indirect), or $14.3 billion annually in the High-Differential Scenario. The majority of direct and indirect GDP gains are in hydrocarbon production and consumer spending (due to lower domestic gasoline and other petroleum product prices). Included in the hydrocarbon production sector GDP changes are increased benefits to mineral-rights owners. Incremental impacts are due to both a projected increase in volume and a projected relative increase in price. Additional hydrocarbon production royalties average between $2.0 and $4.0 billion annually between 2015 and 2035, depending on scenario.

Exhibit 1-13: Allowing Crude Exports Adds to GDP (Direct and Indirect)



Source: ICF analysis

Note: Excludes multiplier effect (or induced) GDP impacts.

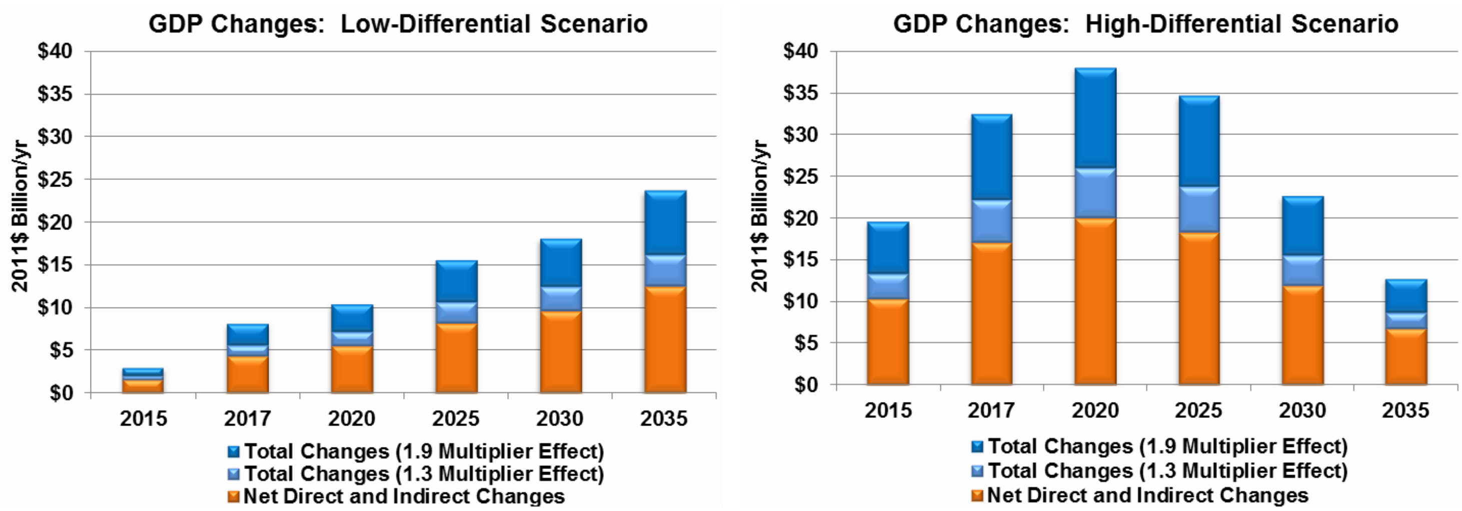
The main GDP offsets stem from the reduction in the calculated contribution to GDP from the petroleum refining sector. Higher domestic crude costs, coupled with slightly lower U.S. and global petroleum product prices result in lower refiner margins. It is important to note that the volume of refined product produced is similar in all cases. Therefore refinery operations, including employment, are not projected to be significantly affected due to crude oil exports. In fact, refinery throughput is projected to increase from current levels in all scenarios, with and without additional crude oil exports.

Total economic impacts include the direct and indirect GDP changes addressed above, as well as the induced impacts through the multiplier effect. The multiplier effect is due to additional consumer spending throughout the economy resulting from extra income from direct and indirect jobs and owners' income. Total (direct, indirect, and induced) GDP changes caused by the change in crude exports average up to $14.8 billion annually in the Low-Differential Scenario and $27.1 billion annually in the High-Differential Scenario over the 2015-2035 forecast period.[17] Annual U.S. GDP is estimated to increase by as much as $38.1 billion in 2020 if expanded

[17] *Ibid.*

crude exports are allowed.[18] As explained above, the High-Differential Scenario has the largest WTI-Brent differentials in the early years when exports are restricted; thus, the GDP impacts of releasing crude exports are highest during the early years. The difference in GDP changes for the Low-Differential and High-Differential scenarios are determined by the WTI-Brent price differentials as discussed earlier.

Exhibit 1-14: Total GDP Increases when Crude Export Restrictions Are Lifted



Source: ICF analysis

Note: Multiplier effects can be higher when there is slack in the economy (not at full employment) and less when the economy is running near capacity. Hence, the estimated total GDP impacts are shown as a range.

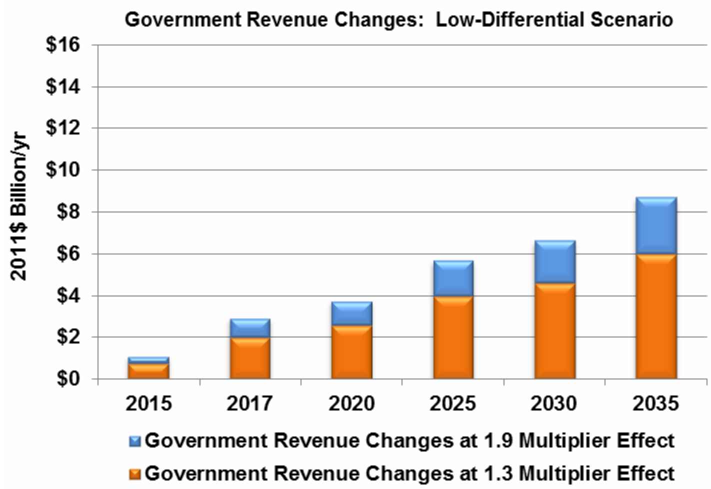
The exhibit below shows total government revenues from an expansion of crude oil exports. Government revenue increases include federal, state, and local tax receipts on the additional GDP generated, as well as from royalties on federal lands for additional crude oil drilling. Government revenue increases could reach $13.5 billion in 2020 in the High-Differential Scenario, or up to $3.7 billion in the Low-Differential Scenario.[19] Government revenue

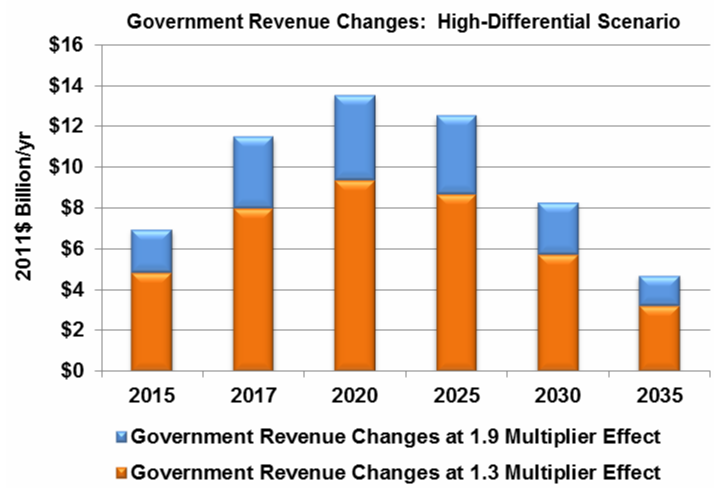
[18] *Ibid.*

[19] Based on the 1.9 multiplier effect.

increases average over $5.4 billion annually over the forecast period in the Low-Differential Scenario, and near $9.7 billion annually in the High-Differential Scenario.[20]

Exhibit 1-15: Total Government Revenues Increase when Crude Export Restrictions Are Lifted





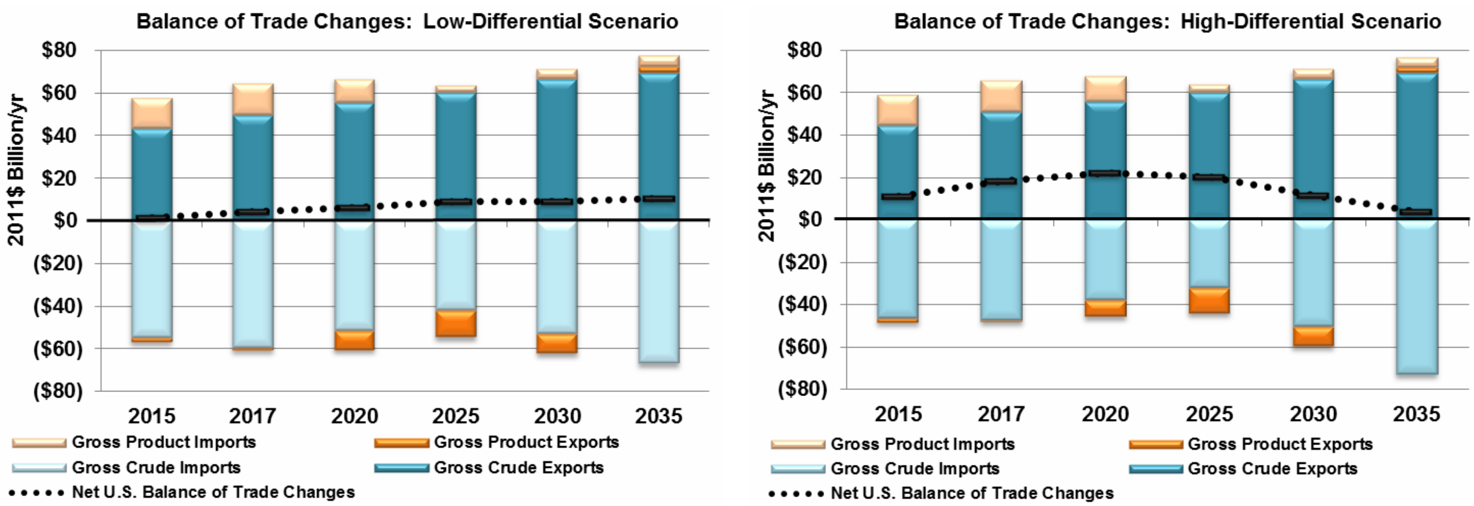
Source: ICF analysis

Note: Multiplier effects can be higher when there is slack in the economy (not at full employment) and less when the economy is running near capacity. Hence, the estimated total employment impacts are shown as a range.

[20] *Ibid.*

Lifting crude oil export restrictions contributes to expanded U.S. exports. Assuming all else equal, this could narrow the U.S. trade deficit by $22.3 billion in 2020 through increased international trade of U.S. crude oil. The change in net exports of crude oil and petroleum products is expected to average $7.6 billion in the Low-Differential Scenario and $14.6 billion in the High-Differential Scenario over the period 2015 to 2035. The contribution to the U.S. trade balance from an expansion of crude exports is led by gross crude exports and an increase in net product exports.

Exhibit 1-16: Balance of Trade Changes due to Lifting Restrictions on Crude Exports



Source: ICF analysis

Note: Increases in gross import values shown as negative values, due to the negative impact on the U.S. balance of trade. This means that an increase in the gross import value (increasing the U.S. international trade deficit) is shown as negative, whereas a decrease in gross import value (decreasing the U.S. international trade deficit) is shown as positive.

1.5 Methodology

The fundamental purpose of this study was to assess the impacts of allowing crude oil exports on the U.S. economy and consumers. A first key step, therefore, was to quantify the volume of crude oil that could be exported economically from the United States if restrictions were lifted. The study simultaneously quantified the pricing impacts on domestic and international crude and petroleum product prices. These oil market projections were then used to assess the economic impacts to the U.S. economy of lifting the export restrictions. Because of the uncertainty in several factors that could affect near- and medium-term crude prices, ICF created a Low WTI-Brent Price Differential Scenario and a High WTI-Brent Price Differential Scenario. The High-Differential Scenario assumed that wider WTI-Brent price differentials are near recent levels for a longer period, relative to that assumed in the Low-Differential Scenario.

All commodity price projections are based on EIA's Annual Energy Outlook 2013 with adjustments due to ICF estimates on changes of supply and demand in each scenario.

In both scenarios, the study assumed that Keystone XL pipeline and the planned Enbridge cross-border expansion would be built, as well as three other major pipelines that export western Canadian crude directly to the Canadian west and east coasts. Other assumptions regarding oil market conditions were primarily based on the 2013 U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) as adjusted by ICF forecasts for higher U.S. tight oil production and Canadian oil sands production. The results from this study were completed before the release of the EIA's AEO 2014 Early Release, although many parts of our forecast are consistent or of similar magnitude to the AEO 2014 Early Release, such as U.S. tight oil production forecast trajectories. In addition, the AEO 2013 High Resource Case is similar to the AEO 2014 Early Release Reference Case in terms of supply outlook.

The primary model used to perform the analysis of refinery operations and international trade in crude oils and petroleum products was the EnSys WORLD refining and logistics model. The WORLD Model projects international pricing across markets (based on an assumed world oil price) and employs freight costs between markets to effectively model global pricing and arbitrages in forecasting refinery operations. The study also employed ICF's proprietary models to estimate North American crude oil production as a function of oil prices and the effect of changes in crude oil production volumes on world crude oil marker prices and consumption of products.

As part of the analysis, ICF developed four cases (two market scenarios times two policy cases) of the global and regional mix of production and consumption of liquid fuels and for the world crude oil marker price (represented in the WORLD Model as Saudi Light crude). ICF used the international and U.S. national tables (Table 11 and 21) from the EIA 2013 Annual Energy Outlook (AEO) as the basis for these scenarios, combined with the conventional and unconventional production outlook from ICF's Detailed Production Report (DPR) model.[21]

The methodology ICF employed to estimate the economic consequences of lifting constraints on U.S. crude oil exports was similar to the methodologies used in our prior work investigating national and state-level economic impacts of liquefied natural gas (LNG) exports and increasing access to federal lands for oil and gas exploration and development. All these studies used an input-output model of the U.S. economy to determine how changes in outputs in certain sectors of the economy ripple through the U.S. economy to affect total GDP and employment.

[21] See Appendix A for an overview of ICF's DPR.

2 Introduction

The U.S. Congress has limited crude oil exports since the mid-1970s.[22] This was done to provide a measure of petroleum supply assurance in the face of declining domestic production, increasing demands for fuel, and growing dependence on foreign crude imports. Through the better part of the next 35 years, this Congressional action aligned with the economics of operating refineries to meet U.S. petroleum product demands and optimize return on refinery investment. U.S. refiners processed domestic crudes and modified refineries to turn cheaper grades of imported crude oil into clean products to meet domestic demand for petroleum products.

In recent years however, this situation has begun to change. U.S. demand for petroleum products stabilized at a lower level since the 2009 recession. Refiners maintained throughput by exporting excess refined product, most notably diesel fuel, to a growing global market. Increased domestic light crude supply in the midcontinent, increasing crude and condensate production in South and West Texas, and higher Canadian production created a crude surplus and depressed crude prices versus global markets particularly in Petroleum Allocation Defense District (PADD) 2[23] from 2011 onward. Imports are increasingly being backed out as more infrastructure is built to move crude and condensate to the Gulf Coast and to the East and West Coasts.

As these factors continue to evolve, the inability to export crude oil and condensate will likely begin to affect both producers' and refiners' ability to optimize their business. The U.S. refining system is geared to process much heavier crude than the rest of the world, and in particular to process heavier crudes than refineries in the markets that are most "reachable" from U.S. ports (e.g., Europe, Latin countries). Allowing crude oil exports may provide the United States the opportunity to export higher-valued light sweet crude oil while continuing to import heavier crude oils, including growing Canadian volumes, to fit the refinery system and at the same time potentially reducing the U.S. trade deficit.

The pace of crude oil and condensate production growth in the U.S. has been remarkable, and is transforming the crude transportation infrastructure and the conditions that impact the investment and operating strategies of producers, refiners, and midstream players. Refiners are doing everything to secure crude oil that is discounted in the market because of logistics constraints, with some refiners in the midcontinent reaping exceptional margins and coastal refiners struggling with rail economics to get some value from the cheaper domestic crude.

Producers are developing new and held-by-production (HBP) tight oil and condensate-rich leases quickly with new hydraulic fracturing techniques. Producers face challenges in delivering

[22] The United States currently allows export of domestic crude oil in a few cases, such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 barrels per day (BPD) in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions.

[23] PADD 2 consists of states mainly in the Central Plains and the Midwest including: Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio, Kentucky, and Tennessee.

the crude to market at an adequate price to generate a return commensurate with needed investments and expenses. Midstream players have been moving to provide services to both producers and refiners. These services include rail facilities to load and unload crude, new terminals and pipelines to get crude to market, and facilities to export more and more products to foreign markets. In addition, the parallel growth in shale gas supply is providing U.S. refiners with an international advantage based on low cost natural gas for fuel and hydrogen feedstocks for refiners.

These changes are transforming the petroleum and petrochemical industries in the U.S., and at the same time, stimulating the economy by driving investments, jobs, and GDP growth at all points along the petroleum supply chain. Coupled with higher Canadian production of oil, domestic oil and condensate production growth have greatly reduced dependence on oil from outside North America.

Despite all these events, development of new tight oil/condensate production and completion of announced pipelines to move crude oil into the Cushing, Oklahoma hub and the U.S. Gulf Coast market increasingly indicate a significant overhang of light crude oil and condensate in the U.S. Gulf Coast region. This situation has a profound impact on both domestic and international markets, but is affected by a number of issues:

1. The pace of production growth in tight oil and condensate in various U.S. and Canadian plays, coupled with the rate of development in western Canadian oil sands. These, in turn, are affected by the resource endowment, technology improvements and exploration and production (E&P) economics. Private forecasters (including ICF) see U.S. crude and condensate production growing from 7.5 million barrels in 2013[24] to near 9 to 12 million barrels of oil per day (MMBPD) circa 2025. The EIA AEO forecast remains below these levels, but an alternative High Oil and Gas Resource Case reaches 10 MMBPD by about 2025 and remains near there through the last forecast year of 2040.[25]
2. The alignment of crude production growth and new pipeline and rail capacity, particularly to coastal markets.
3. The level of refinery margins and possible investment requirements for refiners to process domestic crude oil/condensate and export products.
4. The impact of these changes on light and heavy crude oil spreads and refining optimization drivers.
5. The trends in U.S. demands for petroleum products in the face of Corporate Average Fuel Economy (CAFÉ) standards, Renewable Fuel Standard 2 (RFS2) obligations, and conservation efforts.

[24] U.S. Energy Information Administration (EIA). "Crude Oil Production." EIA, 13 March 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbblpd_m.htm

[25] U.S. Energy Information Administration (EIA). "Annual Energy Outlook (AEO) 2013." EIA, April 2013: Washington, D.C. Available at: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013&subject=0-AEO2013&table=19-AEO2013&region=0-0&cases=ref2013-d102312a

6. The impact of existing joint venture arrangements at Gulf Coast refineries with Mexico, Venezuela, and Saudi Arabia, which coupled with some other "puts" on foreign crude imports (mostly for lube oil production), create a "floor" for foreign imports. This is a critical assumption which may vary over the study period.
7. The sustained penetration of rail movements from various areas due to lack of alternative logistics and/or pipeline project delays, which make rail more viable. However, the rail economics are fluid and rely heavily on significant discounts from WTI and LLS to compete with waterborne light imports or even Eagle Ford movements to the East Coast. Today's rail value to East and West Coast markets is far less than a year ago.
8. Finally, the ability, or continued lack of ability, to legally export any crude oil other than Alaska North Slope or limited amounts of heavy California crudes to markets other than Canada.

The analysis of all of these interrelated factors is complex. However, at the heart of the matter is the management of the volumes of crude that can be produced at various market prices. If world oil prices support continued hydraulic fracturing—and in Canada, continued oil sands development—crude supply possibly may outpace the midstream and refining sector's ability to get it to market and process it. This could drive lower U.S. crude prices (but not lower product prices) and potentially a pull-back in production investment. The ability to export crude would allow producers to market crude to parties in other countries and could lead to higher netbacks for producers.

API has commissioned ICF International (in cooperation with EnSys Energy) to conduct a study of the economic impacts of changing U.S. government policies that prohibit most export of U.S. crude oils. This study provides the framework and sound economic analysis on the impacts of a liberalized crude export policy.

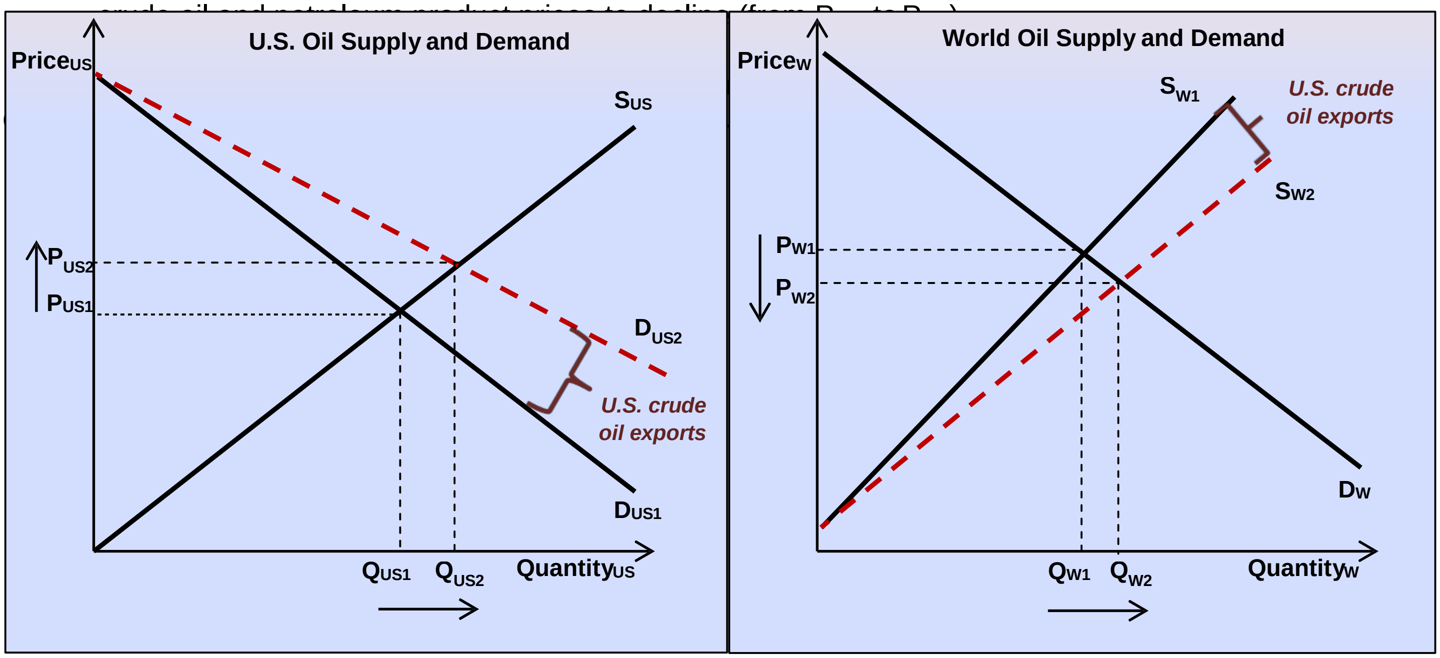
This report is organized into the following sections:

- Section 1: Executive Summary
- Section 2: Introduction
- Section 3: Study Methodology and Assumptions
- Section 4: Energy Impacts of Crude Oil Exports
- Section 5: Economic and Employment Impacts of Crude Oil Exports on the U.S. Economy
- Section 6: Bibliography
- Section 7: Appendices

3 Study Methodology and Assumptions

The fundamental purpose of this study was to assess the impacts on the U.S. economy and consumers of allowing crude oil exports, relative to a continuation of the restrictions on crude oil exports. A first key step was, therefore, to quantify the volume of crude oil that could be exported economically from the United States if restrictions were lifted and to simultaneously quantify the pricing impacts on domestic and international crude and petroleum product prices. These oil market projections were then used to assess the economic impacts to the U.S. economy of lifting the export restrictions.

The exhibit below illustrates the theoretical impact of lifting the crude export restrictions on U.S. crude oil supply and demand volumes and price changes (left-hand chart), as well as U.S. crude exports on global crude oil supply and demand volumes and pricing (right-hand chart). As shown in the left-hand chart, lifting the crude export restrictions increases demand for U.S. crude (i.e., expands demand for U.S. crude oil to include international trade demands). This shift in demand increases the U.S. crude oil price (from P_{US1} to P_{US2}), thus inducing an increase in U.S. crude oil production (from Q_{US1} to Q_{US2}). The right-hand chart illustrates the impact of additional U.S. crude production on the global crude oil market. The additional U.S. crude exports expand global crude oil supplies (from Q_{W1} to Q_{W2}). This supply increase causes global crude oil and petroleum product prices to decline (from P_{W1} to P_{W2}).



3.1 Study Steps

In order to assess the energy, pricing, and economic impacts of expanding crude oil exports from the United States, this study used a number of models and assumptions that are discussed below. This study assessed the impact of lifting the crude oil export restrictions on U.S. crude oil supply-demand balance and the international supply-demand balance, both in terms of volumetric and pricing changes. The study compared supply-demand trends in a world with continued crude oil export restrictions to a policy case in which the restrictions are lifted. Because of the uncertainty in several factors that could affect near- and medium-term crude prices, ICF created two market scenarios:

> **Non-public Information**
>
> - A primary source of non-public data for this study was the WORLD refinery and petroleum logistics model built and maintained by EnSys Energy. WORLD contains proprietary data including information on refinery capacity by process, process performance characteristics, crude oil assays and refinery costs.
> - The U.S. and Canadian oil production forecasts are based on proprietary ICF data for U.S. and Canadian tight oil play geologic descriptions, well performance characteristics and resource economics.
> - Adjustments to AEO projections of world crude prices, demand and supplies were made by ICF to account for North American production volume differences with the AEO and difference among the scenarios presented here. These adjustments were made using proprietary ICF data, algorithms, and models.

- <u>A Low WTI-Brent Price Differential Market Scenario (Low-Differential Scenario)</u> – Assumed relatively rapid accommodation of light crudes and condensate, notably that the following would occur by 2015, leading to a narrowing in WTI-Brent differentials:
  - Continued swift buildout and availability of rail capacity to take Bakken and Niobrara crudes out to the U.S. East and West, as well as Gulf coasts.
  - Similar buildup in capacity to ship Eagle Ford crude and condensate via marine terminals at Corpus Christi, enabling expanded movements by sea to refineries in eastern Canada and the U.S. Northeast.
  - No constraints on fully backing out all light sweet crude imports into the Gulf, East and West coasts.
  - Similarly, a degree of flexibility in backing out medium sour crudes imported into the U.S., notably into the Gulf Coast.
  - Announced refinery projects to enable running light crudes all come on-stream by 2015 (but no further adaptations made by then).
- <u>A High WTI-Brent Price Differential Market Scenario (High-Differential Scenario)</u> – Assumed that inertial factors and delays would slow the adaptations to changing crude slate that were assumed in the Low-Differential Scenario, with the result that WTI-Brent differentials would remain wide, at least for several years. While some refiners have invested to process more light crude, others may be reluctant to risk significant capital on higher-cost refinery investments to accommodate lighter crude slates due in part to the uncertainty around crude export policies and the outlook for tight oil production growth. In addition, permitting requirements can adversely affect project timing and delay

implementation. These could prevent announced refinery projects from coming on-stream until after 2015. Equally, there could be delays in the implementation of the extensive list of announced projects for crude-by-rail capacity. Crude supply contracts in place and equity ownership stakes in refineries could slow the displacement of imported crudes by domestic grades. These factors would contribute to the wider WTI-Brent price differentials assumed in the High-Differential Scenario, thus prolonging U.S. crude price discounting relative to global prices.

Both the Low-Differential and High-Differential scenarios include two policy cases:

- Base Case (No Exports Policy Case) – Results based on the assumption that existing restrictions on crude exports remains in place.[26]
- With Exports Policy Case – Results based on the assumption that all restrictions on crude exports are lifted.

The wider WTI-Brent price differential in the High-Differential Scenario assumes that refiners are slower to reconfigure refineries and change crude supplies to accommodate growing light oil supplies, thus prolonging the U.S. crude pricing discounting to global prices. While some refiners have invested in pre-flash towers[27] to process more light crude, many may be reluctant to risk significant capital on higher-cost refinery investments to accommodate lighter crude slates due in part due to the uncertainty around crude export policies and the outlook for tight oil production growth. In addition, permitting requirements are likely to adversely affect project timing and delay implementation. With crude exports, refiners do not have to make these refinery adjustments, so the Low-Differential and High-Differential with Exports cases are the same. A key focus throughout this report is on differential impacts between the export-restricted and non-restricted cases.

For all cases, this study assumes that the Keystone XL pipeline and the planned Enbridge cross-border expansion are built, as well as three other major pipelines that export western Canadian crude directly to Canadian west and east coasts. Other assumptions regarding oil market conditions are primarily based on the 2013 U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) as adjusted for higher U.S. tight oil production and Canadian oil sands production.

The primary model used to perform the analysis of refinery operations and international trade in crude oils and petroleum products was the EnSys WORLD refining and logistics model. Additional energy market impacts were derived from ICF databases and models used to estimate the U.S. tight oil and shale gas resource base size and economics, future tight oil

[26] This case assumed a continuation of current crude export policy in which the United States permits export of crude oil in a few cases such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 BPD in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions.

[27] A pre-flash tower is a distillation tower that separates out the very light hydrocarbons from condensate or light crude oil so that the primary atmospheric distillation tower can process higher volumes of light oil without impacting condensing limitations.

production levels and North American crude oil logistics. A list of the key energy market and economic impacts estimated are listed in the exhibit below, along with the source or method of estimation.

Exhibit 3-2: Energy Market and Economic Impact Measures to Be Analyzed and Reported

Energy Market and Economic Impact Measures Analyzed and Reported	Source of Information
Base case world crude oil marker price (Brent, $/bbl)	AEO 2013 oil price trajectory as adjusted downward for assumed higher levels of U.S. and Canadian oil production
World crude oil marker price for alternative cases (Brent, $/bbl)	Reduction in world oil prices that is expected from allowing U.S. crude exports. This was estimated using supply-demand elasticity estimates derived from AEO sensitivity cases.
U.S. and Canadian crude oil supply costs (at various geographic points for various qualities, $/bbl)	Product and crude supply costs were solved for within WORLD as differentials off of either base case or alternative marker crude price.
U.S. crude oil and condensate production by location and type	Taken from ICF Detailed Production Report (DPR). ICF has developed detailed crude/condensate resource base and cost estimates for major ongoing and emerging tight oil and liquids-rich gas shale plays. Volume of production will vary among model cases based on WORLD simulation results.
Crude oil and condensate assays	Assays for existing crudes from WORLD assay database.
Canadian oil sands crude oil production	Maximum oil sands production was based on Canadian Association of Petroleum Producers (CAPP) projection. Variation in production among cases due to oil price changes were based on logit-function investment logic whereby the probability of oil sands projects being made is reduced as Alberta bitumen prices fall.
Canadian conventional and tight oil crude oil production	Same as U.S. crude oil. That is, from ICF's DPR as adjusted by crude oil price changes.
Volume and value of U.S. exports of crude and condensate	Solved for within WORLD.
Volume and value of U.S. exports of petroleum products	Solved for within WORLD.
Capacity expansion and dollars investment in U.S. refinery throughput expansion	Solved for within WORLD.
Capacity expansion and dollars investment in U.S. refinery processing (condensate splitters, pre-flash distillation units, light naphtha isomerization units, heavy naphtha reformers, etc.) to accommodate more light crudes and condensates	Solved for within WORLD.
Investment in oil pipelines	Trade between PADDS solved for with WORLD. Canadian crude oil pipelines assumed to be constructed at fixed dates based on current schedules with some delays.
Investment in rail capacity	Based on WORLD results.
Investment in crude export capacity	Volume of exports from each PADD solved for in WORLD.
U.S. gasoline and other product supply costs	Solved for within WORLD. U.S. petroleum product imports and exports are not restricted and so costs are linked to world petroleum product costs.
U.S. petroleum product demand	Base case from EIA AEO 2013. ICF applied price elasticity to vary demand among cases.
World petroleum product demand	Base case from EIA AEO 2013. ICF applied price elasticity to vary demand among cases.
Consumer spending on non-petroleum products	Calculated as a function of product supply cost changes to petroleum products under assumption that money not spent on gasoline, diesel and home heating oil will be spent on other consumer goods and services.
U.S. refinery margin	Based on crude input costs and refined product prices calculated in WORLD.
GDP effects	Based on WORLD results, offline calculations and IMPLAN model. Calculate as value added in U.S. of final products whose output quantity has changed.
Employment effects	Based on IMPLAN model.
Government revenues	Based on IMPLAN model and offline calculations.
Balance of Trade Impacts	Calculated offline using WORLD results and other calculated values.
State-level GDP and employment estimates[28]	Calculated by allocating national-level results to states using allocation factors based on model results, announced plans, or historical activity by sector and state.

[28] State data is to be released as a separate supplement at a later date.

3.2 Overview of WORLD Model and Key Assumptions

The EnSys WORLD Model captures and simulates the total global "liquids" downstream system from crudes and non-crudes supply through refining, transport, and demand, and is used to address a wide range of strategic questions. The WORLD Model marries top down oil price/supply/demand outlooks, such as are developed by the U.S. Energy Information Administration (EIA), International Energy Agency (IEA), EIA, Organization of the Petroleum Exporting Countries (OPEC), and others, with bottom up detail. This detail includes approximately 200 crude oils; breakdown of non-crude supplies (natural gas liquids (NGLs); biofuels; gas-to-liquids and coal-to-liquids (GTLs/CTLs), etc.); data on every refinery worldwide with aggregation into regional or sub-regional groups; refining sector greenhouse gas (GHG) emissions factors; projects and investment costs; multiple product grades and quality specifications; and a detailed transport representation covering marine, pipeline and minor modes.

This formulation is used to model any current or future horizon out to 2035, simulating how the industry is likely to operate and react under any given scenario and capturing the interactions and competition inherent in the global downstream. WORLD is a "deterministic" model. This means that, within any one case, all projected supply and demand volumes are fixed essentially as inputs (except for the marker crude for which generally Saudi Light is used). Based on these and other inputs, WORLD in turn projects as outputs key industry parameters for the horizon being simulated, notably, global refining activities, investments and economics, crude and product pricing/differentials, trade flows, and logistics. Associated projections—such as for crack spreads (refinery margins), producer revenues and product regional supply costs—can readily be calculated. Across any case, the results are internally consistent: supply and demand must balance, crude exports must match imports and so on. The main version of the WORLD Model simulates the world broken into 22 regions with an emphasis on the U.S., which also includes more disaggregated refining groups than in other regions. In this study, the main focus in the WORLD Model cases was on U.S. crude oil exports, U.S. refining activity, and related market economics.

3.2.1 Import Floor Assumptions[29]

The term "import floor" refers to the minimum quantity of imported crude oil that would be expected to take place due to joint venture arrangements, product quality requirement (primarily lubes), investment agreements and other factors that might limit or slow the price responsiveness of import volumes. This is represented in WORLD as minimum import levels that decline over time as these factors are expected to lessen in importance.

[29] All assumptions are based on publicly-available data either from company press releases or company presentations and ICF analysis of historical imports by refinery and volumes.

Exhibit 3-3 shows the decline in Gulf Coast (PADD 3) imports from 2012 through the first half of 2013 (H1). Not surprisingly the greatest decline has been in light crude (-50%) and medium crude (-13%). In comparison, heavy crude imports have declined about 8 percent.

Exhibit 3-3: PADD 3 Import by API Gravity Range

Crude Oil Type	Volume (KBPD)	
	2012	2013 H1
Heavy (< 25)	2,062	1,895
Medium (> 25 & < 35)	1,671	1,462
Light (> 35)	627	300
Total	**4,360**	**3,657**

Source: EIA and ICF analysis

The degree to which the light crude imports can be further reduced has a direct influence on the economic impacts of changing export crude policy. The higher the import floor is estimated to be, the faster and more severe will be the price-depressing effect of crude export restrictions and the greater will be the economic benefit to lifting those restrictions. The assumed crude import floors used in this study are described below.

PADD 1 (East Coast)

No floor was assumed given the degree of foreign light imports and lack of any substantive joint venture (JV) arrangements or crude commitments.

PADD 3 (Gulf Coast)

The confluence of domestic sweet crude into the Gulf Coast via Seaway and TransCanada Keystone (Cushing leg to Houston/Port Arthur), and volumes from Eagle Ford and the Permian via multiple new pipelines are assumed to continue the reductions in foreign imports into PADD 3. Canadian heavy will come into the market via Keystone XL/Enbridge projects based on construction scenario assumptions in the study for Canadian export pipelines. Alternatively, rail movements will take the place of dilbit, railbit, or bitumen (another important assumption).

There are currently several situations that support an argument for a floor on PADD 3 crude imports: 1) JV arrangements; 2) Lube Crude requirements and 3) investment links. The discussion below details all of these possible areas. The availability of light domestic crude and/or heavy Canadian should push the 2013 imports of 3.7 MMBPD lower as North American production growth backs out imports.

By the 2015 period, the production scenarios could drive PADD 3 imports down to a million barrels per day. However, the various issues discussed below could limit how far imports could be driven down. These issues include how Saudi Arabia reacts to U.S. markets, how other JV arrangements push out imports or alter formulas to sustain imports, and how lube demands could be met. The exhibit below shows there already may be some "push out" of JV crudes. (Motiva Port Arthur import declines appear to be due to operational issues rather than price considerations.)

Exhibit 3-4: Import by Joint Venture Refinery

Joint Venture	Volume (KBPD)	
	2012	2013 H1
Motiva (Shell/Saudi JV)	331	301
Shell Deer Park (Pemex JV)	185	139
Citgo (Vz JV)	292	221
Chalmette (Vz JV)	63	42
Total	**871**	**703**

Source: EIA and ICF analysis

A floor of 2 MMBPD in PADD 3 by 2015, and 1 MMBPD by 2020 was assumed. The "buildup" to support these numbers was based on various companies' press releases, investor presentations, and other public sources, along with ICF analysis of import trends from EIA, and is as follows:

- Three refineries have crude supply contracts with PEMEX for heavy crude (Maya) that were used to justify/finance new delayed cokers. It was assumed that these are netback deals wherein the refiner is protected from margin risk on the low side to offset some sort of minimum throughput commitment from the refiner to PEMEX. The three refineries are Valero at Port Arthur and Texas City, and ExxonMobil Baytown. It is assumed that 2013 volumes of PEMEX crude at these refineries will continue to be imported into the future.
- ExxonMobil and Citgo are known from EIA import data to import Mexican crude, primarily Olmeca, to produce solvent refined lubricant base stocks. For the short to medium term, it is assumed that these imports will continue. However, new WTI production from shale formations in the Permian Basin is increasing the volume of MCS- L (Midcontinent Sweet, Lube) components. As Permian Basin production increases, it is expected that the higher valued MCS-L components could be segregated and processed into lubricant basestocks, at the expense of Olmeca processing. The volume of Olmeca imported for lubricants is assumed in the study to decrease versus 2013 volumes by 25 KBPD in 2020 and 50 KBPD in 2025.
- Motiva (Shell/Saudi JV) would have been expected to increase imports of Saudi crude with completion of the Port Arthur expansion project. However, Motiva imports of Saudi crude have actually decreased between 2012 and 2013.
- Chevron Pascagoula has been importing Venezuelan heavy crudes such as Boscan for many years according to EIA data. Although Pascagoula is not directly connected to the

Houston area via pipeline, it is anticipated that barge volumes of dilbit and domestic sweet can substitute for a portion of the current import volume.

- Valero has publicly indicated that it is constructing crude topping units at its Houston and Corpus Christi refineries. This has the potential to decrease imports, especially to the Corpus Christi facility.
- Reversal of the Ho-Ho pipeline to allow crude oil movements from Houston to the Mississippi River refineries in Louisiana is expected to improve the logistics supporting the processing of sweet domestic crude in those refineries. Presumably, dilbit or other Canadian heavy crude oils can also be processed to maximize Coker loadings and gradually push down waterborne imported volumes
- Although Marathon has processed a significant volume of Saudi crude in the expanded Garyville, LA refinery, this plant is expected to be a major beneficiary of the reversed Ho-Ho line. Waterborne imports may have difficulty competing with the economics of a possible sweet domestic and dilbit blend as an alternative.
- Although the dissolution of the Phillips 66/PdVSA joint venture for the Sweeny refinery remains in arbitration, Phillips appears to be in control of the facility and decreasing Venezuelan imports based on EIA data. It is assumed that these volumes will continue to decrease as PdVSA withdraws support, further reducing the import floor.
- There have been no public reports of changes in the Deer Park JV between Shell and PEMEX; therefore, the imports of Mexican crude into Deer Park were assumed to be constant in the study.
- It is expected that Marathon Texas City will continue to decrease imports and rely more on domestic sweet crude.
- Citgo and Chalmette Refining joint ventures are not expected to change from an ownership perspective and therefore the waterborne imports to those plants were assumed to remain constant.
- Houston Refining was an early mover among U.S.G.C. refineries regarding processing Canadian heavy crude. It was assumed that heavy Canadian will continue to back out waterborne heavy crude imports, eventually to zero.

PADD 5 (West Coast)

Declining volumes of Alaska North Slope (ANS) and heavy California will likely require sustained imports. Potential key assumptions were:

- Minimum 200,000 for lubes at Richmond are assumed over the short term as an input in the model.
- Allow movement by rail of domestic (Bakken and WTI) as economic within known capacity investments (Tesoro/Savage, Puget refiners, Plains AA in CA, Valero Benicia, Shell Anacortes) plus limited further expansion.
- Movement of oil sands crude to California could be complicated by local opposition or a low-carbon fuel standard (LCFS) economic penalty and Assembly Bill (AB) 32. For

modeling purposes, we allowed oil sands by rail or marine (from Vancouver, British Columbia, or from Washington State).

3.2.2 Crude Oil Assay Assumptions

The crude oil assay refers to the chemical composition of a specific crude oil. Each type of crude has a specific combination of chemical characteristics that differentiate it from all other crudes. Assay analysis is used by refiners to assess the compatibility of certain crudes with the refinery specifications. Key factors include:

- API gravity – crude oil viscosity (lighter oils are less viscous than heavy oils)
- Sulfur content – sweet crudes have a sulfur content of less than 0.5 percent–1.0 percent, and sour crudes have a sulfur content above this range
- Boiling range fractionation – proportion of the crude oil that boils off at a specific temperature ranges.

Each refinery has a certain capacity for specific refinery products, with each boiling at a certain temperature. U.S. refineries are generally equipped to handle heavier crudes, which have more hydrocarbon chains that condense at higher temperatures (than do lighter oils).

Within an atmospheric column at a refinery, each petroleum product condenses at a certain temperature, with lighter products such as gasoline and diesel condensing at the top of the column, with heavier products such as residual and fuel oil condensing at the bottom. The atmospheric column is designed for a certain assay, with a specific capacity for heavy, medium, and light products. If the column is designed for medium/heavy oil, but light oil is used as the feedstock, there is not enough room at the top of the column for the light petroleum products to condense.

The crude oil slate refers to the proportion of oil that distills/condenses within a certain range. A specific slate will have an average API gravity. The U.S. production increases over the past five years have been primarily light oils, though U.S. refineries are configured to handle heavy oils. This means that the U.S. crude oil slate has become lighter, although refinery capacity to handle this lighter oil is limited. This study assumed that refiners can accommodate using lighter oils by up to one degree of API gravity without making refinery capacity adjustments.

3.2.3 Near-term U.S. Export Flexibility

For cases where exports are allowed in 2015, WORLD Model cases indicate total U.S. crude exports of up to 2 million b/d (MMBPD) may be economic. Exports are forecast to be sourced mainly from the Gulf Coast but also PADD 5 (split between Alaska; the Pacific Northwest; and Los Angeles, California) and PADD 1. Analysis of infrastructure in place and expected by 2015 indicates that these volumes should be logistically feasible. Discussion for each area is below:

PADD 1 (East Coast)

Crude is currently being exported from PADD 1 to Canada (Irving Oil) via railcars to Albany, New York and small tankers (300 MB) to St. John, Newfoundland and Labrador. Exports are roughly 0.1 MMBPD. There are several available sources for PADD 1 exports. Both the Global and Buckeye terminals in Albany receive railcars and outload crude oil—some to Irving but also to the Phillips66 refinery in Linden, New Jersey. Capability exists to increase these movements.

Moreover, Buckeye has purchased the former Chevron refinery site and terminal in Perth Amboy, New Jersey, which may be used to receive crude from Albany and load onto larger tankers for export. The former Yorktown, Virginia refinery is now owned by Plains All-American, and this facility has significant storage to receive railcars of crude and to export. The two operating Philadelphia refineries are expanding crude intake by rail and Enbridge Rail is starting a unit train facility to serve Philadelphia area refineries.

Overall, if the economics are right, PADD 1 has several pathways for crude exports. An export volume of 0.3 MMBPD in 2015 is judged to be reasonable with potential to expand beyond that in 2015 by perhaps another 0.10 MMBPD to 0.40 MMBPD if economically feasible.

PADD 3 (Gulf Coast)

There are several port locations in PADD 3 that are currently shipping crude oil (to U.S. and Canadian ports) or have the ability to do so.

Corpus Christi, Texas has emerged as the primary loading point for Eagle Ford crude oil and condensate onto marine transportation for 1) delivery to other U.S. Gulf Coast (USGC) and U.S. East Coast (USEC) refining centers or 2) export to refineries in eastern Canada. Jones Act vessels are required for domestic destinations whereas foreign flag vessels can be used for export to Canada. Numerous pipelines transport crude oil from the Eagle Ford production area to Corpus Christi for use by local refiners or for loading onto marine transportation. Our survey of publicly available information regarding terminals in Corpus Christi that handle crude oil yields an estimated export capacity of more than 0.8 MMBPD, assuming that domestic deliveries are decreased accordingly. The unfettered crude export scenario postulated by the WORLD Model anticipates roughly 0.8 MMBPD of Eagle Ford exports. (This is logical since Eagle Ford crudes are the lightest of the tight oil crudes and thus the least fitted to Gulf Coast refineries whose average historical crude intake has been close to 30 API.) Note that it is also possible to transport more Eagle Ford to Houston as an alternate location for Eagle Ford exports, so it is not believed that export volumes of 0.8 MMBPD are unreasonable given Corpus/Houston infrastructure.

Due to a flurry of pipeline and terminal construction activity the **Houston/Texas City/Freeport** area should be in a position to support export of significant volumes of crude oil. In addition to receipt of some Eagle Ford volumes, this region now serves as the terminus of the Seaway pipeline system which delivers WTI and other crude oils from Cushing, Oklahoma. When fully expanded, the Seaway system will be capable of delivering over 0.80 MMBPD of crude to two separate dock locations for possible export. In addition, the Gulf Coast Pipeline (southern section of Keystone XL from Cushing) will be able to deliver crude oil to the Oil Tanking facility located on the Houston ship channel. This will require completion of the Houston lateral from the main Gulf Coast Pipeline and a short connector pipeline to the Oil Tanking facility, both of which are currently under construction. The Gulf Coast Pipeline is capable of delivering between 0.6 to 0.8 MMBPD of oil depending on the quality (domestic light versus Canadian heavy if the entire Keystone XL line is completed) via the Port Arthur line and the Houston lateral (in total).

Another prime exporting location is the Sun Logistics terminal in **Nederland, Texas**. This terminal is the terminus of the Keystone Gulf Coast line into Port Arthur. The terminal owner indicates that the facility has capacity to import up to 2.0 MMBPD of crude across five docks and to ship a similar volume of crude by pipeline, vessel or barge.[30] The ability to import 2.0 MMBPD by ship likely does not imply the ability to export a similar amount without some restrictions on import capability. Pipeline crude can be received into the Sun terminal from the TransCanada Gulf Coast pipeline, ExxonMobil's Pegasus pipeline, and the reversed Shell Houston to Houma line. Volumes delivered by Gulf Coast pipeline and Shell Ho-Ho to Sun Nederland may decrease volumes of crude oil available for export at other locations. Therefore, we have limited our estimate of Sun Nederland's current exporting capacity to 0.8 MMBPD.

The **Louisiana** terminals that would be suitable for crude oil exports in 2015 have limited capability due to the limited on-shore pipeline delivery capability to these terminals. Crude oil for export could be provided by the Shell Ho-Ho pipeline, but as with Sun Nederland, it would be at the expense of exports at other Texas locations. Pipelines to supply the Louisiana terminals with crude oil from the Midwest and from western Canada are in the discussion stage, but are not expected to be operational for the 2015 scenario (these could involve a Capline reversal or a Trunkline conversion[31] from gas to oil).

The WORLD Model anticipates a total of about 1.2 MMBPD of exports in 2015 from PADD 3. We believe that there is sufficient capacity and optionality in the PADD 3 pipeline and terminal facilities to support this volume of exports. The capacity ICF/EnSys expects to be in place by 2015 is a combination of facilities currently in use, or under construction with completion dates prior to 1/1/2015.

PADD 5 (West Coast)

Current policy allows export of Alaska North Slope (ANS) crude.[32] In addition to volumes from the North Slope, possible export sources on the West Coast in 2015 include Puget Sound, Port of Vancouver (Washington) and Los Angeles.

[30] Sunoco Logistics. "Nederland Terminal." Sunoco Logistics, 2014: Sinking Spring, PA Available at: http://www.sunocologistics.com/Customers/Business-Lines/Terminal-Facilities/Nederland-Terminal/56/

[31] Thomson Reuters. "Energy Transfer Partners plans Bakken pipeline." Thomson Reuters, 7 March 2014: New York, NY. Available at: http://www.reuters.com/article/2014/03/07/pipeline-projects-energy-transfer-idUSL1N0M41U320140307

[32] The current policy requires the crude to be exported on Jones Act vessels

Analysis of these options, based on information from various public sources, indicates the following:

- Exports from Puget Sound refinery locations are likely not feasible. The Magnuson Amendment would appear to preclude exports from Puget Sound, unless one of the refineries in the area should shut down.
- Tesoro and Savage are developing a project in Vancouver, Washington to receive railcars of domestic crude for transshipment by cargo to West Coast refineries. Assuming permits are granted, the intent is to have the capacity to load 0.36 MMBPD by late 2014. Vessel size may be limited to West Coast-sized vessels (300,000–400,000 barrels) due to draft restrictions and storage limits, but the facility would provide a viable export source if freight costs could be managed.
- Global Partners is currently receiving crude by rail at a former ethanol facility in Clatskanie, Oregon and then loading barges for delivery to West Coast refiners. The dock at this facility is capable of loading ocean going tankers and could be used for crude export if economic conditions warrant. There are also two small terminals in Tacoma, Washington that are currently receiving crude oil by rail for loading onto barges. These facilities also have the capability to load small tankers. The combined export capability for all three of these facilities is roughly 0.1 MMBPD, and the expected cargo sizes would be small.
- Exports from Los Angeles, California would require receipt of crude into Los Angeles via rail from Bakken, Niobrara, or West Texas markets. Plains All American owns a rail facility in the San Joaquin Valley to offload railcars and move crude down its pipelines into LA. This may have some capacity available due to declines in California crude production in recent years. However it is not clear how the crude may get to a vessel given relatively tight infrastructure in the ports of Long Beach and Los Angeles. The California Energy Commission is looking at other possible California obstacles that could impede exports.

In summary, export assumptions from PADD 5 in 2014 should include ANS as economically viable for export, plus an estimated 0.2 MMBPD from Vancouver, British Columbia; Portland, Oregon; and Tacoma, Washington sites that could double by 2025. Infrastructure may be developed in Los Angeles, or other locations such as Gray's Harbor in Washington State.

Overall

Export capacity in 2015—with existing and planned infrastructure for the United States—is estimated at about 3.6 MMBPD as shown in the exhibit below.

Exhibit 3-5: WORLD Forecasts of Exports and Estimated Export Capacity by PADD

Location	Volume (KBPD)		
	2015 Exports (No Exports Case)	2015 Exports (With Exports Case)	Estimated Export Capacity
PADD 1	55	55	400
PADD 3 Corpus Christi	134	862	900
PADD 3 Other	1	293	2,100
PADD 5*	–	200	200
U.S. Total	**190**	**1,410**	**3,600**

Source: EnSys Energy

** Designates that PADD 5 and U.S. totals and capacities do not reflect ANS exports from Valdez.*

Note: The United States currently allows export of domestic crude oil in a few cases, such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 BPD in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions. The "No Exports Case" assumes a continuation of the current crude oil export policy.

Canadian Export via U.S.

The ability to export Canadian crude from U.S. ports requires the crude to be segregated and not commingled with domestic crudes. In addition, the exporter must obtain a license to export. The ability to get a license requires the exporter to demonstrate that the crude has remained segregated. Several Canadian producers have also indicated feasibility of shipping oil sands by rail to the U.S. for export.[33] However, oil transported by the Keystone XL pipeline and other pipelines that ship heavier crude to the U.S. Gulf Coast are not expected to be exported in the near- to mid-term, since that area currently imports heavy and medium crude oil.

3.3 Overview of the AEO Forecast Adjustments Methodology and Key Assumptions

As part of the analysis, ICF has developed four cases of the global and regional mix of production and consumption of liquid fuels and for the world crude marker price (represented in WORLD as Brent crude). These cases were developed through an iterative process in which results for crude price differentials from the WORLD Model were fed into ICF models to estimate U.S. crude production and revised world crude oil price and supply/demand conditions. Those revised price and supply/demand volumes were then put back into WORLD to create a new projection of refinery throughputs, crude oil and petroleum product logistics, crude price differentials, and product prices.

ICF used the international and U.S. national tables (Table 11 and 21) from the EIA 2013 Annual Energy Outlook (AEO) as the basis for these scenarios, combined with the conventional and

[33] Ewart, Stephen. "Canadian producers eye profits through U.S. ports". Calgary Herald, 17 March, 2014: Calgary, AB. Available at: http://www.calgaryherald.com/business/energy-resources/Ewart+Canadian+producers+profits+through+ports/9620681/story.html

unconventional production outlook from ICF's DPR model. First, ICF estimated the demand and supply price elasticities for crude and petroleum products from available U.S. data for the 2013 AEO High Resource and Reference Cases and then used these elasticities to estimate global responses to increasing U.S. production, as in the EIA High Resource Case, in a multi-step process. Next the estimated regional data for the EIA High Resource Case became the basis to derive market forecasts for production levels used in this analysis, which were taken from ICF's Detailed Production Report and the Canadian Association of Petroleum Producers (CAPP).[34] The price of the world crude marker (Brent) each year equilibrated the global markets through an iterative process, while the prices of West Texas Intermediate (WTI), Western Canadian Select (WCS) and Eagle Ford crudes were used in the estimation of U.S. and Canada petroleum production using ICF's proprietary detailed production report (DPR) model.[35]

3.3.1 Regional Liquids Production and Consumption Adjustments

EIA produces a summary regional detail in Table 21 for liquid consumption and production and petroleum production as part of the International Energy Outlook (IEO).[36] ICF used EIA scenario results for the years 2010 to 2035 for the Reference Case and the High Resource Case. These results for the EIA Reference Case include crude prices ($2011/bbl and nominal $/bbl) for Brent and WTI and volumes (MMBPD) including liquid consumption by region, liquid production by region, liquid production by type, and petroleum production by region. For the EIA High Resource Case, the results include crude prices and volumes only for the United States.

First, ICF estimated the missing results for the Table 21 for the EIA High Resource Case along with demand and supply price elasticities using a multi-step process.

1. Used the U.S liquids consumption and Brent prices from the two cases to estimate the demand elasticity of -0.23.
2. Used this elasticity to estimate regional and global liquids production for the High Resource Case.
3. Estimated global liquids production from the Reference Case plus the change in global liquids consumption from the Reference Case to the estimate for the High Resource Case developed above.
4. Estimated global petroleum production assuming that the difference between liquids production and petroleum production stays constant except for the U.S. where we used the Table 11 data.

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[34] Canadian Association of Petroleum Producers (CAPP). "Crude Oil Forecast, Markets, and Transportation." CAPP, 5 June 2013: Calgary, Alberta. Available at: http://www.capp.ca/forecast/Pages/default.aspx

[35] U.S. Energy Information Administration (EIA). "Annual Energy Outlook (AEO) 2013." EIA, April 2013: Washington, D.C. Available at: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013&subject=0-AEO2013&table=19-AEO2013&region=0-0&cases=ref2013-d102312a

[36] U.S. Energy Information Administration (EIA). "International Energy Outlook (IEO) 2013." EIA, July 2013: Washington, D.C. Available at: http://www.eia.gov/forecasts/ieo/

5. Estimated the supply price elasticity of 0.281 using Non-U.S. petroleum production and Brent prices.
6. Estimated regional petroleum and liquids production using the Reference Case petroleum production and difference between liquids production and petroleum production. For the United States, the difference between petroleum production and liquids production comes from the Table 11 data.

The estimated regional data for the EIA High Resource Case became the basis for the alternative price-differential scenario (High-Differential Scenario) and export policy cases. For each of the four cases, ICF calculated the Brent price of crude each year that equilibrated the global markets through an iterative process as follows:

1. Estimated the West Texas Intermediate (WTI), the Western Canadian Select (WCS), and the Eagle Ford (EF) crude prices using the Brent price for each year (see below).
2. Using the Brent price and the liquids demand elasticity, estimated the regional and global demand for liquids.
3. Using the Brent price and the supply elasticity, estimated the regional production for all regions except for the U.S. and Canadian oil sands production.
4. Calculated the production for the Canadian oil sands, which is set to the Canadian Association of Petroleum Producers 2013 forecasts (CAPP13) on production for the With Exports cases, and used the increase in oil sands production from ICF's Oil Sands Production Model and added to the CAPP13 production.[37]
5. Using the change in the WTI price from the With Exports Case, estimated production for U.S. conventional production using the supply elasticity and ICF's DPR Reference Case production estimates.
6. Using the change in the EF price and WTI price for the Reference Case (Low-Differential Scenario), estimated the U.S. tight oil production.
7. Determined the amount that the global supply and demand is out of balance.
8. If the supply/demand balance was within an acceptable range, then the process was stopped; otherwise, ICF adjusted the prices and repeated.

3.3.2 Tight Oil Resource Base Assumptions

In recent years, the tight oil resource base in North America has emerged as a world-scale resource that has the potential to impact world oil markets, while generating thousands of high quality jobs in the United States and Canada. Because of activity in these plays, U.S. oil production is increasing rapidly, greatly reducing the need for imported oil and altering North American oil production and transport patterns and infrastructure development.

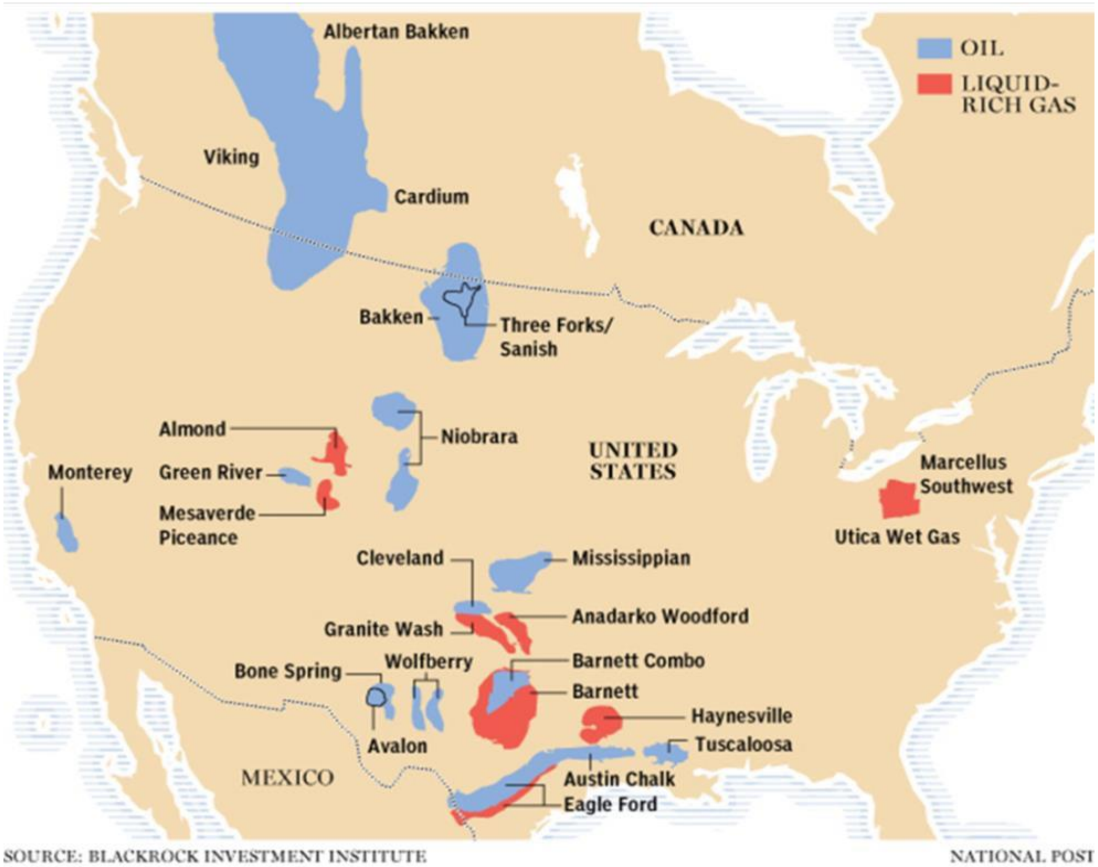
[37] Canadian Association of Petroleum Producers (CAPP). "Crude Oil Forecast, Markets, and Transportation." CAPP, 5 June 2013: Calgary, Alberta. Available at: http://www.capp.ca/forecast/Pages/default.aspx

To date, there has been scarcity of published analytical work assessing the scope and implications of this resource. A large amount of information has been published on individual plays in the areas of geology, drilling activity, well costs, economics, and prospectivity of company acreages. However, there is a need for a much better understanding of the scope and characteristics of future potential at the regional and national level. Such an analysis must consider geologic variability, drilling costs, and economics.

ICF International has developed an assessment of the technically and economically recoverable tight oil resource base of the United States and Canada. That assessment underlies the forecast shown in this report. The assessment is primarily based upon ICF analysis of public domain maps and data, with the information processed through a proprietary tight oil assessment and economics model.

Tight oil production from plays such as the Bakken Shale in the Williston Basin, the Eagle Ford Shale in South Texas, the Niobrara in the Denver Basin, and various plays in the Permian Basin of West Texas and southeastern New Mexico has become a major component of U.S. oil production. A map of the major North America tight oil and wet gas plays is shown in the exhibit below. (On this map, tight oil and wet gas is shown in light blue. Western Canada tight oil is more localized than shown here). The geographic extent of known North America tight oil is vast, extending from the Gulf of Mexico to the northwestern regions of Canada. In the East, a vast area of wet gas is present in the Marcellus and Utica shales, and in California, the Monterey Shale holds large resources.

Exhibit 3-6: Distribution of North America Tight Oil



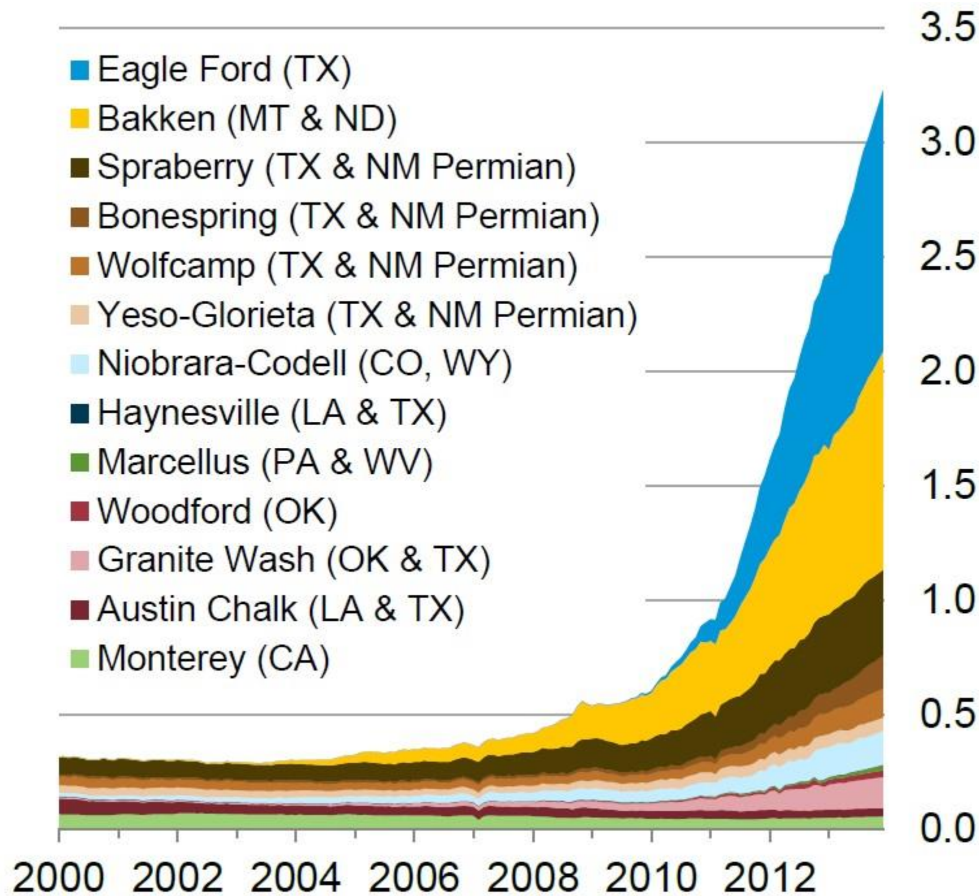
Source: Blackrock Investment Institute

The exhibit below presents the EIA analysis of U.S. tight oil production through 2013. The plays included in the chart produced 3.2 million barrels per day of liquids at year-end 2013. Total annual crude and condensate production in the U.S. in 2012 was 2.37 billion barrels or 6.48 MMBPD, up from 5.65 MMBPD in 2011. Tight oil production represents a large and rapidly growing fraction of U.S. oil production.

U.S. tight oil production is predominantly from two plays: the Williston Bakken and the Texas Gulf Coast Eagle Ford. However, production in West Texas is increasing rapidly as well, and the in-place resources in that region are tremendous due to stacking and thickness of the various oil-bearing geologic formations.

The chart includes both crude and lease condensate production. Other, crude and condensate volumes are not reported separately by state agencies. Lease condensate represents the liquids that separate from the gas stream at the well site. Much of the Eagle Ford Shale liquids production to date has been condensate, because the wet gas portion of the play has been prolific. The crude oil fraction of Eagle Ford liquids is increasing rapidly, however. Almost all of the U.S. tight oil production is considered “light” (relatively high gravity) and “sweet” (low sulfur).

Exhibit 3-7: U.S. Tight Crude and Condensate Production (Unit: MMBPD)



Source: EIA presentation by Adam Sieminski, January 22, 2014

Assessment Approach and Models Used

The objective of the ICF assessment was to evaluate major tight oil plays by using public domain information on geology and well characteristics. ICF completed the analysis of 32 North American shale gas plays using a GIS framework. That work involved the Geographic Information System (GIS) mapping of depth, net thickness, organic carbon content, and thermal maturity of each play. It also included an ICF survey by operator of typical well costs and productivity parameters. These data were imported into ICF models to generate the resource assessment and play economics at a highly granular level.

The GIS shale gas study focused on gas, but in doing so also included the oil portion of plays such as the Eagle Ford, Barnett, and Anadarko Woodford. It did not cover tight oil in the "oil-well" plays such as the Bakken and Permian Basin, nor did it cover some other tight oil plays that include gas wells such as the Denver Niobrara.

ICF typically assesses tight oil plays on the basis of mapped "cells" or sub-plays, typically ranging from 5 to 10 cells per play. For each play, the following information was either obtained from published geologic maps or company data or was estimated.

Parameters for each cell from map or other sources of information:

- Mapped play area
- Average vertical depth
- Average net pay thickness
- Thermal maturity (vitrinite reflectance or R_o)
- Organic carbon content (TOC)
- Porosity (generally estimated)
- Temperature and pressure gradients (often estimated for regional data)
- Well productivity characteristics (from historic production data and company slides)
- Lateral length and hydraulically fracture half length

Estimated factors:

- Thickness of brittle units (sandstone or limestone) within the shale formation
- Conversion efficiency of organic matter (for oil-in-place calculation)
- Risk factor applied to assessment (percent of area ultimately productive). The risk is assumed to be much lower in portions of the play that are productive.

The information for each play was input into the model to develop the estimated oil and gas in place (original oil in place, OOIP; and original gas in place, OGIP) and of technically recoverable resources. The output includes technically recoverable crude and condensate, dry gas, and gas plant liquids on both a risked and unrisked basis. Model output also includes the number of potential wells and average well recovery by cell.

Results of the Analysis of Technical Recovery

The exhibit below presents the results of the assessment and shows which plays are included. A total of 32 North American plays have been evaluated. Twenty-four plays have been assessed using the models and eight plays currently have estimated resources based on generalized factors. Plays with estimates include the Three Forks and Heath in the Williston basin and the Gulf Coast Tuscaloosa shale. These estimates are generally based upon play area, well spacing, and average recovery per well—not mapped geologic parameters. A risking approach is applied to the process to compensate for uncertainty in productivity and resource quality. In general, higher risk is applied to outlying areas of plays that have yet to be developed significantly.

The exhibit below summarizes the current assessment of risked, recoverable resources. The assessment presented in the exhibit represents technically recoverable resources from the initial well spacing only, and assuming current technology. Resources in place and infill potential are discussed below as well.

U.S. primary spacing tight oil potential is assessed at 60.9 billion barrels of liquids and 189.9 trillion cubic feet (Tcf) of associated gas. (Of the 60.9 billion barrels, about 54 billion barrels is from ICF-assessed GIS plays and 7 billion barrels is from plays with estimates). Western Canada tight oil is assessed at 20.3 billion barrels of liquids and 114.4 Tcf of gas. The natural gas portion of the assessment shown here consists of both associated gas in the crude oil portions of plays and gas well gas in the wet gas portions. A large fraction of the total gas resource comes from wet gas areas of plays such as the Eagle Ford, Utica, and Duvernay. The Duvernay is the dominant tight oil/wet gas play in Western Canada in terms of recovery, based upon our mapping and assumptions, and represents the majority of the assessed Canadian gas from tight oil.

Exhibit 3-8: North America Assessment Summary

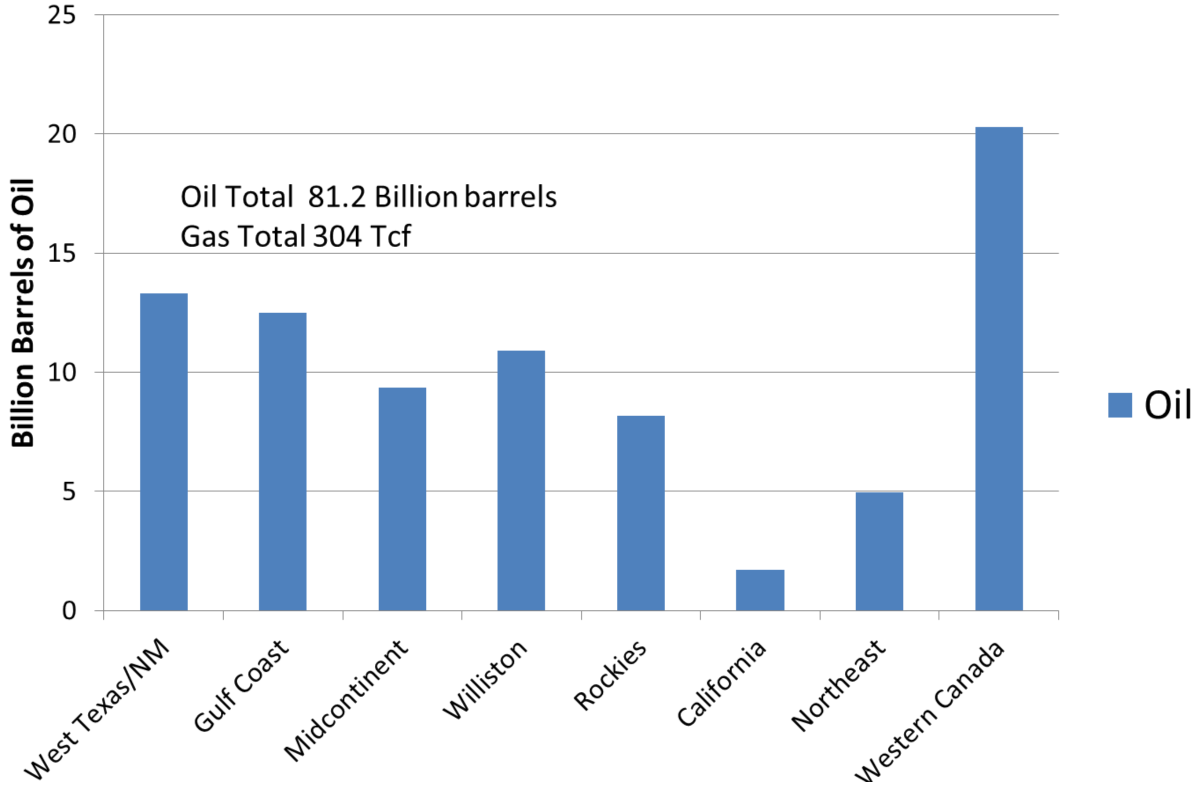
Region	Crude/Cond. Billion Barrels	Dry Gas Tcf
West Texas/NM	13.3	33.0
Avalon		
Bone Spgs.		
Wolfberry		
Cline		
Gulf Coast	12.5	36.7
Eagle Ford		
Austin Chalk		
Tuscaloosa		
Woodbine		
Midcontinent	9.4	25.1
Anadarko Woodford		
Mississippi Lime		
Fort Worth Barnett		
Smackover Brown Dense		
Anadarko Hogshooter		
Williston	10.9	14.9
Bakken (US)		
Three Forks		
Heath		

Region	Crude/Cond. Billion Barrels	Dry Gas Tcf
Rockies	8.2	48.8
Denver Niobrara		
Other Niobrara		
California	1.7	13.8
Monterey		
Kreyenhagen		
Northeast	5.0	17.6
Utica		
WCSB	20.3	114.4
Bakken (Canada)		
Cardium		
Viking		
Duvernay		
Montney		
Minor plays		
US Totals	**60.9**	**189.9**
Canada Totals	**20.3**	**114.4**
North America Totals	**81.2**	**304.3**

* Minor plays are Shaunavon, Ameranth, Pekisko, Exshaw, Slave Point, and Beaverhill Lake

Source: ICF International

Exhibit 3-9: North America Regional Tight Oil Current Technically Recoverable Based on Initial Well Spacing



Source: ICF International

Original Oil-in-Place (OOIP) and Recovery Factors

The ICF tight oil resource assessment relies upon an assessment of original oil-in-place, to which recovery factors and risk factors are applied. Recovery factors (recovery as a percentage of oil-in-place) can be used to check the reasonableness of resource estimates, assuming current technology or advanced technology plus infill potential recoverable resources.

The exhibit below summarizes U.S. original oil-in-place for conventional oil reservoirs and tight oil resources. The oil volumes for conventional oil reservoirs are based upon a study of CO_2 enhanced oil recovery (EOR) potential conducted for the U.S. Department of Energy. [38] The OOIP for tight oil is from the ICF assessment. The exhibit below indicates that U.S. conventional OOIP is 595 billion barrels and tight oil OOIP is 1,936 billion barrels. Thus, conventional OOIP is only 24 percent of total OOIP.

[38] U.S. Department of Energy National Energy Technology Laboratory, 2008, “Storing CO2 with Enhanced Oil Recovery,” http://www.netl.doe.gov/kmd/cds/disk44/D-CO2%20Injection/NETL-402-1312.pdf

The middle portion of the exhibit summarizes what has been discovered and proved through 2011 (the latest year of EIA reserves data). This volume, based upon ICF analysis of historic U.S. production, totals 220 billion barrels of crude oil, of which 194 billion barrels is past production and 26.5 billion barrels of remaining reserves. Assuming none of the 220 billion is tight oil (though a portion of it is – primarily the Bakken and Permian), this would represent a recovery factor of 37 percent of conventional OOIP. The overall perspective from this analysis is the tremendous volume of in-place resources associated with tight oil.

Exhibit 3-10: U.S. Oil-in-Place and Proved Recovery

Category	Source	AK	L-48	Total
		Billion barrels of oil		
Conventional OOIP	DOE study for CO_2 EOR	67	528	595
Cumulative Production and Proved Reserves (Through EOY 2011)				
	Cumulative production	17.3	176.6	193.9
	Proved reserves	3.8	22.7	26.5
	Ultimate recovery	21.1	199.3	220.4
Ultimate Recovery as a Percent of Conventional OOIP		31.5%	37.7%	37.0%
Tight Oil OOIP *	ICF	0	1,936	1,936
Total assessed U.S. OOIP		67	2,464	2,531
Conventional OOIP as percent of total OOIP				24%

* AK tight oil not assessed.

Source: Compiled from various public sources by ICF International

Volume of Tight Oil Developed in Forecast

The tight oil production forecast through 2035 developed for this study is based upon the ICF tight oil recoverable resource base, as well as economic factors and other considerations. It is useful to summarize what is developed in the forecast relative to the total recoverable resource base and tight oil OOIP. This is presented in the exhibit below. The exhibit shows the OOIP, the risked current technology initial spacing resource, the risked current technology infill resource, and the risked advanced technology infill resource. The latter is the resource base used for the long-range forecast. The recovery factor for the risked, advanced technology resource base is 5.4 percent of OOIP (risked recoverable divided by unrisked OOIP). A total of 46 billion barrels of tight oil is developed in the forecast through 2035, representing 44 percent of the assessed recoverable resource.

Exhibit 3-11: ICF Tight Oil Resources and Portion Developed in Forecast

	Billion Barrels *
Original in-place tight oil resource	1,936
Risked current technology recoverable resource - initial spacing	53.9
Risked current technology recoverable resource - with infill	86.2
Risked advanced technology recoverable - with infill + technology advancement	103.8
Risked advanced technology recovery factor	5.4%
Resource developed through 2035	46.0
Percent of recoverable resource developed through 2035	44.3%

* The resources here exclude a number of plays with estimates only, whose resources are included in the ICF total assessed tight oil resource base.

3.4 Economic Impacts of Crude Oil Exports

The methodology ICF employed to estimate the economic consequences of lifting constraints on U.S. crude oil exports was similar to the methodologies used in our prior work investigating national and state-level economic impacts of liquefied natural gas (LNG) exports and increasing access to federal lands for oil and gas exploration and development. All these studies used an input-output model of the U.S. economy to determine how changes in outputs in certain sectors of the economy ripple through the U.S. economy to affect total GDP and employment. The economic impacts methodology consisted of the following six steps.

1. ***Assessed the volumetric and pricing results from the WORLD Model and other adjustments for each of the following cases:***

   <u>Low-Differential Scenario:</u>

   No Crude Oil Exports Case[39]

   With Crude Oil Exports Case

   <u>High-Differential Scenario:</u>

   No Crude Oil Exports Case[40]

   With Crude Oil Exports Case

[39] This case assumed a continuation of current crude export policy in which the United States permits export of crude oil in a few cases such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 BPD in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions.

[40] *Ibid.*

2. Translated energy market results into direct and indirect GDP effects

These effects, which are the immediate or "first round" effects on demand and output of goods and services in the U.S. economy, include economic changes brought on by a change in crude oil export policy, including:

- An increase in hydrocarbon production (including crude oil, lease condensate, natural gas, and natural gas liquids (NGLs)
- Changes in petroleum refinery throughput, margins, revenues
- Changes in consumer fuel expenditures due to changes in petroleum product prices
- Changes in import-export port fees due to changes in crude oil and petroleum product imports and exports
- Changes in the transportation sector due to a change in crude oil flows

In calculating these impacts, ICF first determined the physical unit and dollar value change in demand/output for the final products. The change in GDP was calculated as the value of the final product minus the estimated contribution from imported intermediate goods. Only changes in final products are counted toward changes in GDP to simplify the calculations.

3. Assessed the direct and indirect employment impacts

The direct and indirect value added GDP changes, as well as employment changes, and taxation were calculated using input-output relationships developed with the Impact Analysis for Planning (IMPLAN) Model of the U.S. economy. This input-output (I-O) model is based on a social accounting matrix that incorporates all flows within the U.S. economy. This model is used to assess the aggregate economic impacts associated with changes in an industry's output, such as the impact of crude oil exports on the U.S. economy. For example, additional crude oil exports will require additional crude oil production services, equipment, and materials.

Those direct impacts will be followed by indirect impacts as intermediate inputs such as steel production to make casing and iron mining to make steel, which will also see higher demand. These I-O relationships can be extracted into matrices that show the number of direct and indirect jobs in sector X per million dollars of output in sector Y. This matrix is also defined as the number of direct and indirect jobs in sector X per physical unit of output in sector Y. Similar matrices can be constructed showing the GDP value added in sector X per million dollars or per unit of production in sector Y. With these matrices, ICF estimated the value added and job impacts by sector for the changes in economic and employment impacts attributable to crude oil exports.

4. Assess the induced economic activity

Apply a range of multiplier effects to the direct and indirect GDP changes to estimate the induced economic activity. Induced economic activity is generated as employees in direct and indirect activities, such as oil production or steel manufacturing spend their income. There is a great deal of uncertainty as to the induced economic activity generated. Thus, ICF applied a range of multiplier effects. This estimate of additional GDP is referred to as the "induced GDP effect."

The range in multiplier effects represents uncertainties regarding the possible future "slack" in the economy and how much of a "crowding out" effect there might be in factor[41] markets if the new demands for labor and other factors stemming from crude oil exports cannot be met entirely with new workers and other factors.

The range spans from a lower-bound of 1.3, representing significant crowding out effect, to an upper-bound of 1.9, which is consistent with a very slack economy and/or an elastic supply of labor and other factors of production. This range is based on previous ICF efforts. This range indicates that every $1.00 of direct and indirect economic activity generated leads to additional induced economic activity of $0.30–$0.90.

Estimation of Multiplier Effect

This study employs a range of multiplier effects to estimate the lower-bound and upper-bound for "induced" activities in the U.S. economy, resulting from the spending of personal income generated by the direct and indirect activities. The equation below shows the hypothetical GDP multiplier effect from any incremental increase of purchases (from business investment, exports, government spending, etc.) MPC is marginal propensity to consume, and is estimated at 0.900 using a post-World War II average for the U.S. This means that for every dollar of personal income generated, $0.90 goes toward consumption, and the remaining $0.10 is saved. The MPI is the marginal propensity to import, estimated at 0.162, based on the average for recent years. The effective tax rate is $0.269 per dollar of income/GDP. Inputting the MPC, MPI, and tax rate into the equation below shows that every dollar of income stemming from direct and indirect activity hypothetically could produce a total of $1.984, meaning that $0.984 is "induced" economic activity, or the amount produced as the multiplier effect.

$$\Delta GDP = \Delta Exports * 1 / (1-MPC*(1-TAX) + MPI)$$

Multiplier Effect Input	Value
Marginal Propensity to Consume after Taxes (MPC)	0.900
Marginal Propensity to Import (MPI)	0.162
Tax Rate	0.269
Resulting Multiplier	**1.984**

Because of this uncertainty in the multiplier effect, a range is used in this study. A value of 1.9 is used as the multiplier for the upper-bound limit, and 1.3 [1.6 – (1.9-1.6)] for the lower-bound estimate.

Source: American Clean Skies Foundation (ACSF), based on analysis conducted by ICF International. "Tech Effect: How Innovation in Oil and Gas Exploration is Spurring the U.S. Economy." ACSF, October 2012: Washington, D.C. Available at: http://www.cleanskies.org/wp-content/uploads/2012/11/icfreport_11012012_web.pdf

5. *Assessed the induced employment activity*

The GDP impacts (direct and indirect alone *versus* direct, indirect, and induced) are then converted to employment impacts using input-output relationships, wherein the number of jobs per dollar of value added vary among economic sectors. The net result of crude oil

[41] Factors of production are defined by economists to be inputs such as labor, land, capital, materials, energy, and technical knowhow that are used in producing goods and services.

exports would be an increase in the demand for labor. In theory, this additional demand could be accommodated by the following processes:

i. Reduced unemployment – those in the labor force who are actively searching for employment, but remain unemployed). This method of adjustment is most prominent during time characterized by high unemployment rate.

ii. Increased labor participation rates – characterized by more people joining or remaining in the labor force due to higher wages and less time needed to obtain employment.

iii. Longer hours worked – employed persons will work longer hours, such as moving from part-time to full-time employment.

iv. Greater immigration – more foreign-national workers come to or remain in the United States.

v. Crowding out – the sectors with growing demand will increase wages to incentivize workers to leave current jobs. The sectors losing workers then could adjust by substituting capital or other factors of production for labor and/or by reducing their production levels).

The input-output approach used in this study assumes that processes i to iv above will be dominant, and that the demand for more workers in oil-related sectors will be met to a large degree without constraining other sectors.

6. Estimated government revenues and balance of trade impacts of crude oil exports.

Government revenue increases due to crude exports are led by an increase in federal, state, and local tax receipts due to the increase in GDP changes, as well as a slight increase in federal land royalties for hydrocarbon production.

The balance of trade impacts arise from the value of crude oil and petroleum product exports, based on prices derived from the WORLD Model and ICF's alternative methodology.

3.5 Issues Not Captured in the WORLD Model

The WORLD Model reflects an "annual average" analysis of the market for the various cases as defined. It does not model short periods of transition such as seasonal demand and supply changes, refinery turnarounds, or inventory builds or draws). The model results are based on a balanced assessment of global supply and demand, including assessing required refinery capacity changes to meet increased demand.

The "balancing" aspect of the model—while providing a consistent and deep analysis of each of the cases evaluated—can tend to understate the potential impact of the rapid increase in tight oil and oil sand supply on the North American market for several reasons:

- The model has certainty of policy—for example, a case assuming "no crude exports allowed" has complete clarity. The model will take action to invest in increased domestic refinery capacity since lack of crude export ability will force higher domestic runs. In reality, the lack of a definite yes or no on allowing exports would likely create hesitation on the part of refiners for major investments, as well as hesitation on producers and midstream players on adding export facilities. This would likely lead to deeper and longer discounts for domestic crude prices than reflected in the balanced model results.

- Without allowing crude oil exports, the seasonality of the refining business can have a market effect that could be greater than shown in average model runs. While demand variation can be managed through more or fewer product exports, the required annual spring and fall of maintenance work periods for refineries is likely to become more challenging to manage, as could meeting tighter summer constraints on gasoline quality. Historically, these periods have resulted in reduced refinery runs of up to a million barrels per day or more for several months. Annual refinery runs have recently averaged 15 MMBPD, but there have been periods when throughputs have been as low as 14 MMBPD or above 16 MMBPD. These variations have normally been managed by a combination of reducing imported supply during turnaround periods and holding more inventory in refinery tanks, and then gradually drawing inventory and restoring imports after the turnaround.
- As increased domestic and Canadian crude supply continues to reduce imports, a much higher use of North American crude would be expected, with U.S. crude production as a share of U.S. liquids consumption increasing from 40 percent in 2013 to between 62.8 percent and 64.4 percent averaged over 2015–2035 according to model results. Consequently, the ability to use imports to manage refinery turnaround demand changes would become less feasible as their volumes decline, and refiners would need to either store domestic crude or reduce domestic purchases. With storage capacity for domestic crude essentially limited to Cushing, the impact of reduced refinery demands during turnarounds may be very bearish on the market without the ability to export crude. Crude storage ability on the Gulf Coast is limited as major distribution hubs are becoming more congested handling and distributing the additional tight oil and ultimately heavy Canadian. The resulting buildups in Cushing could result in downward spikes in WTI potentially similar to those seen in 2011 and 2012.

Such issues are not captured in the WORLD Model in that it is an annual model that balances supply and demand for 365 days at a time rather than seasonally or monthly. Therefore differences in supply or demand that occur seasonally are not separately represented. This means the model will not forecast potential price declines for domestic crudes caused by greater use of North American crudes and less flexibility to modulate crude imports to manage refinery turnarounds during short periods.

The WORLD Model is also a “perfect foresight” model in that volumes, prices, and policies are assumed to be known to all market participants and there is no uncertainty that might delay investments or changes in behavior. This means that the model can optimize investments and eliminate price disequilibria faster than would occur in the real world where uncertainty about U.S. production growth, pipeline construction, market demand, and government policies can lead to delays.

4 Energy Impacts of Crude Exports

This study found that lifting the U.S. crude export restrictions alters the crude and petroleum product supply-demand balance in a number of ways. Lifting the restrictions:

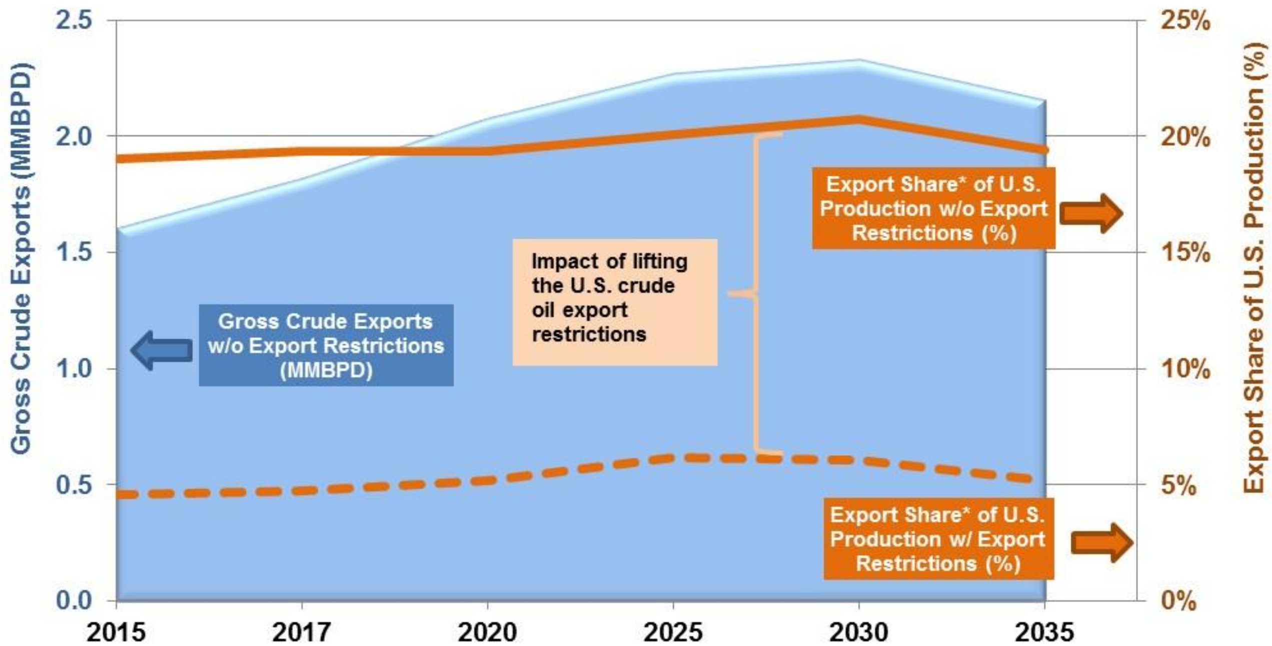
- Increases U.S. and Canadian crude oil production
- Increases domestic crude oil prices, while decreasing global crude and petroleum product prices
- Narrows the current differential between U.S. and international crude oil prices
- Reduces U.S. refinery margins
- Alters crude import/export patterns

While robust shale resources mean U.S. crude oil production will continue growing in all cases, lifting the export restrictions leads to incremental production as producers respond to a more attractive pricing environment relative to the expected environment where domestic crudes are bottlenecked by export restrictions. Most of U.S. production growth will be light sweet crude from tight oil formations whereas Canadian production growth will be concentrated on oil sands.

This study found that the U.S. oil resource base could economically accommodate gross crude oil exports of roughly 20 percent of U.S. total crude oil production on average between 2015 and 2035, as shown below. This equates to an average of 2.1 MMBPD in gross crude exports over the period if export restrictions were to be lifted, up from 580,000 BPD (averaging 5.5 percent of U.S. oil production) if export restrictions remain in place.[42]

[42] The United States currently allows export of domestic crude oil in a few cases, such as the following: 1) from oil produced in Alaska's North Slope and Cook Inlet, 2) up to 25,000 BPD in production from California's heavy oil fields, and 3) crude exports to Canada if the crude supplies remain in Canada or are re-exported to the United States. Other options are also permitted (e.g., exports of oil in exchange for strategic petroleum reserve volume) under defined conditions.

Exhibit 4-1: Gross Crude Exports and Share of U.S. Crude Production



Source: ICF International and EnSys Energy

Note: Based on the Low-Differential Scenario. * Refers to gross crude exports share of total U.S. production

Depending on the pace of infrastructure development to align with crude production growth, the pricing of different North American crudes could vary, having implications on refinery operations and export economics. The petroleum industry has announced investments to enhance pipeline and rail capacity to bring bottlenecked crudes to markets, as well as investments to handle lighter crudes and condensates. There remain significant uncertainties in terms of whether and when these investments will be realized.

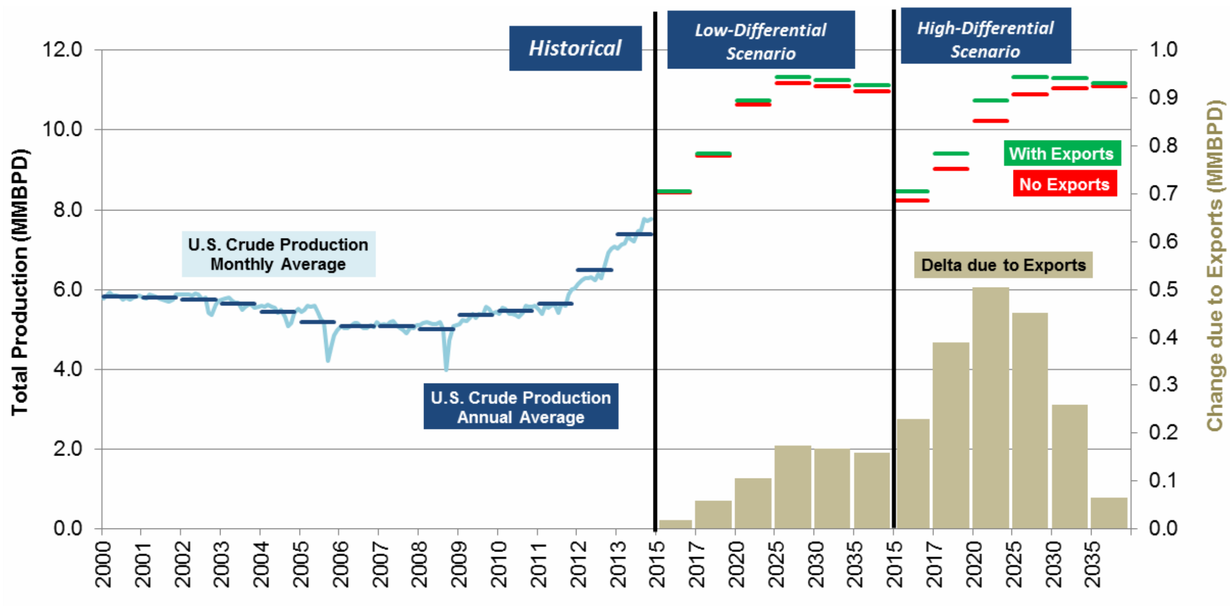
In the short run, if exports are not allowed, refineries could face operational issues in handling lighter crude slates because many U.S. refineries have optimized their configurations to run heavier crudes. Petroleum product net imports will continue the current declining trend with increasing gross product exports and declining gross product imports. Lifting the crude export restrictions has the effect of substituting some of these product exports (particularly naphthas) with crude exports, as this could be a more economic choice than investing in refinery infrastructure to process lighter crudes.

4.1 Volume Impacts

Crude and Condensate Production

Allowing exports improves crude oil economics for producers, as buyers will no longer require a discount for domestic crudes to account for logistical bottlenecks and refinery processing issues. As shown in Exhibit 4-2, U.S. oil production is projected to increase to an average of 10.7 MMBPD from 2015 to 2035 when crude exports are allowed. Depending on the scenario, this production level is 130,000–300,000 BPD higher on average than when crude exports are restricted. With current export restrictions, production only averages 10.6 MMBPD over the same period in the Low-Differential Scenario because domestic crude continues to suffer from the logistical bottlenecks. In the High-Differential No Exports Case, where WTI maintains the current price discount to Brent for a longer period of time, producers receive even lower values for their crudes than in the Low-Differential No Exports Case, with production averaging 10.4 MMBPD over the forecast period. Allowing crude oil exports leads to an increase in U.S. oil production of 110,000 to 500,000 barrels per day by 2020. This additional crude production would mean $15.2–$70.2 billion in additional investment between 2015 and 2020, depending on scenario.

Exhibit 4-2: U.S. Crude Production Impact

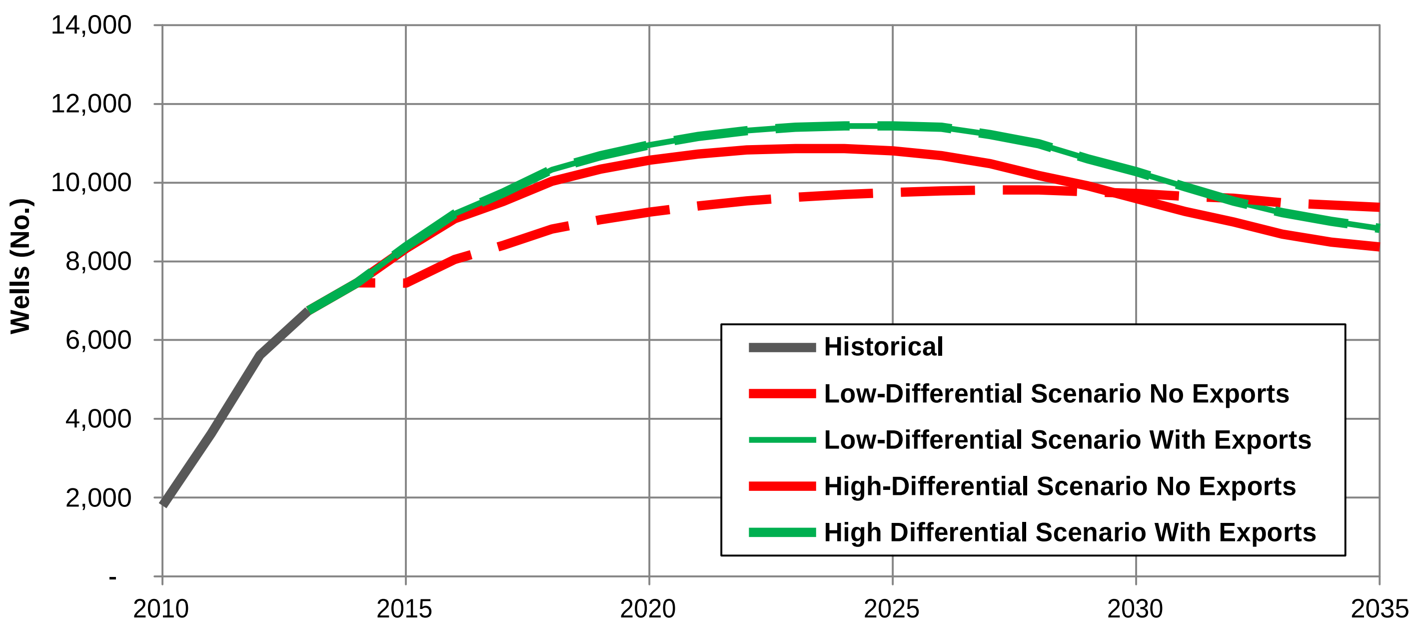


Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Tight oil well drilling increases by an average of 500–1,000 annual wells between 2015 and 2035 if exports are allowed. Major tight oil production will be seen from plays such as the Bakken Shale in the Williston Basin (North Dakota), the Eagle Ford Shale in South Texas, the Niobrara in the Denver Basin (Colorado), and various plays in the Permian Basin of West Texas and southeastern New Mexico, which has become a major component of U.S. oil production.

The projection of tight oil wells drilled each year are made separately for each play based on a marginal economic analysis using forecasted light crude prices coming from the WORLD Model. The economics for each play are based on the average capital and operating costs per well in each play and the projected average well recovery—barrels of crude oil and million cubic feet (MMcf) of gas produced over the lives of new wells drilled in each year. In the forecasting model, well productivity starts out at the historical average estimated for each play and then is adjusted downward each year to account for resource depletion such that the average productivity, if all wells were to be drilled, equals that expected average productivity estimated by ICF map-based resource base analysis. The effect of new technologies is modeled as an upward adjustment to well recoveries. The number of wells drilled each year in each play is a function of how the value of revenues earned by each well compare to capital and operating cost including a 10 percent real rate of return. Drilling activity grows when revenues far exceed costs, are flat as revenues and cost are similar, and decline when revenues fall below the cost target. As shown in Exhibit 4-3, when exports are allowed, the U.S. can sustain growing levels of tight oil drilling through about 2025, after which the best portions of some plays are fully developed and drilling levels decline. When U.S. crude exports are restricted the resulting lower domestic prices for crude oil slow drilling levels, which results in different patterns of drilling in the forecast period.

Exhibit 4-3: U.S. Tight Oil Wells



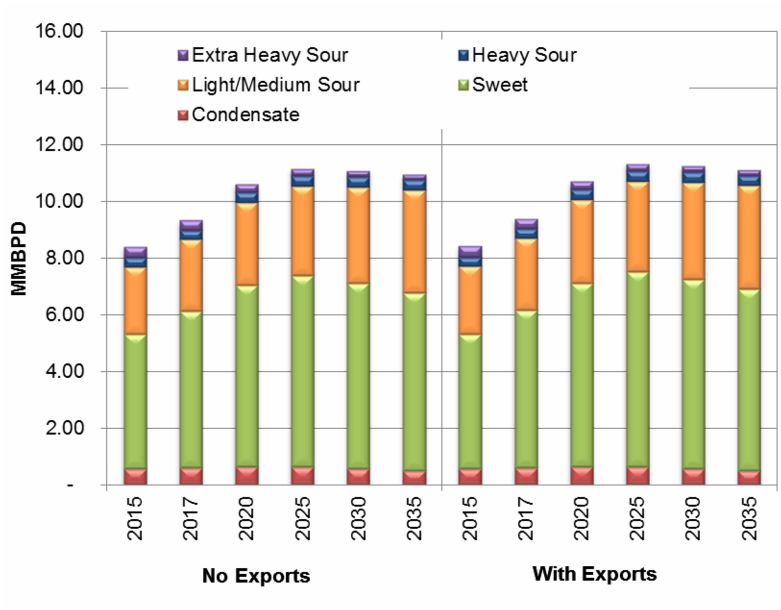
Sources: ICF analysis

In 2010, tight oil accounted for six percent of U.S. production.[43] By 2013, the percentage increased to 24 percent. Virtually all tight oil production volumes are light sweet, effectively increasing the API gravity of domestically produced crude as a whole. Exhibit 4-4 shows the projected makeup of U.S. produced crude 2015 to 2035. When exports are allowed, sweet crude production will grow to an estimated 6.5 MMBPD by 2020 and average 6.3 MMBPD over the study period, accounting for roughly 59 percent of total U.S. crude production. Light and medium sour crude will account for roughly 30 percent of production while condensates will make up about five percent. Growth in medium U.S. crudes will come mostly from the deep-water Gulf of Mexico. Light crude production is slightly stronger in the exports case due to the

[43] Based on ICF analysis. Other studies may show different results.

incremental tight oil well drilling, but the breakout of crude production is very similar with or without exports. This abundance of domestic light sweet crudes will have major implications for refinery operations and midstream investment considerations.

Exhibit 4-4: U.S. Crude Production by Type



Sources: EnSys WORLD Model

If exports are allowed, the resulting increase in U.S. and Canadian crude production will feed into global crude supply growth. ICF projects global crude and condensate production to reach 94.3 MMBPD in 2035 with exports, up from 94.1 MMBPD in 2035 without U.S. crude exports. This supply growth will exert modest downward pressure on global crude prices as will be further discussed below. Of course there are uncertainties underlying this projection such as OPEC response to growing U.S. and Canadian supply and other uncertainties in oil markets. However, the additional North American supplies will make it more difficult for OPEC to maintain prices since its market share of world crude demand will be reduced.

Along with crude production growth due to U.S. crude exports, global liquids production rises to a 2015–2035 average of 103.5 MMBPD. If U.S. export restrictions remain, global liquids production is slightly affected, reaching 103.4 MMBPD.

Refinery Changes

U.S. refiners have historically invested in complex units to process heavier crude slates. With the tight oil revolution, however, refiners and midstream companies have announced investments to better process lighter oils to take advantage of the price depression in U.S. crude prices (relative to global oil prices). Exhibit 4-5 outlines these investments. Most of these investments take advantage of the robust light oil and condensate production in the Eagle Ford and the Utica shales.

Exhibit 4-5: U.S. Announced Refinery Investments to Accommodate Light Crude and Condensate

Company	Location	Capacity (TBD)	Cost	Investment Type
Alon	Big Spring	5	Unknown	Refinery expansion
American Energy Holdings	Devils Lake, ND	20	$250 million	New refinery
Castleton Commodities Intl	Corpus Christi, TX	100	Unknown	Condensate splitter
Dakota Oil Processing	Trenton, ND	20	$200 million	New refinery
HollyFrontier	Woods Cross, UT	14	$300 million	Refinery expansion
Husky	Lima, OH	40	$300 million	Increase heavy crude capacity
Kinder Morgan	Galena Park, TX	100	$360 million	Condensate splitter
Magellan Partners	Corpus Christi, TX	Unknown	Unknown	Condensate splitter
Marathon	Canton, OH	25	$250 million for the Canton, OH and Catlettsburg, KY facilities	Condensate splitter
Marathon	Catlettsburg, KY	35		Condensate splitter
Marathon	Robinson, IL	60	$160 million	Increase light crude capacity
Martin Midstream	Corpus Christi, TX	50-100	Unknown	Condensate splitter
MDU/CLMT Dakota Prairie	Dickinson, ND	20	$300 million	New refinery
NCRA	McPherson, KS	15	$327 million	Refinery expansion
Tesoro	Salt Lake City, UT	4	Unknown	Refinery expansion
Three Affiliated Tribes	Dickinson, ND	20	$450 million	New refinery
Trafigura	Corpus Christi, TX	50	Unknown	Condensate splitter
Valero	Corpus Christi, TX	70	$350 million	Crude topping unit
Valero	Houston, TX	90	$400 million	Crude topping unit
Valero	Port Arthur, TX	15	Unknown	Increase light crude capacity
Valero	McKee, TX	25	Unknown	Refinery expansion
Western	El Paso, TX	25	Unknown	Refinery expansion

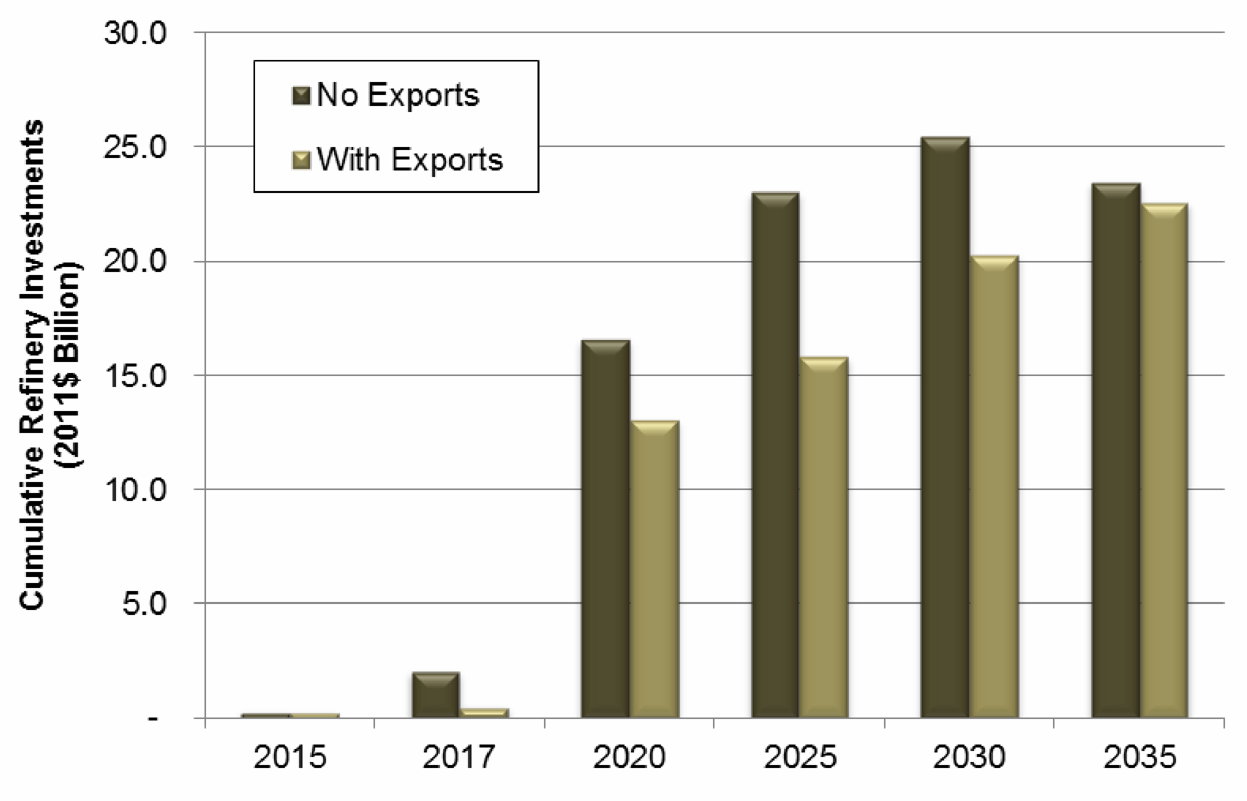
Source: Compiled from various public sources by ICF International

Note: Due to limitations in other process units, total crude input capacity will not necessarily increase by the same amounts as the project capacities shown in this exhibit. The capacity for projects with announced capacities totals between 803,000 to 853,000 barrels per day.

Exhibit 4-6 shows ICF's forecast of U.S. refinery investments over and above firm projects, which include expansions and modifications to accommodate lighter oils. These facilities are needed to accommodate future crude supply and demand conditions with or without exports. If exports are not allowed, refinery investments ramp up in the earlier years. A key driver is the need to increase light oil processing capacity to handle growing production of U.S. light crude oils that cannot be exported. When exports are allowed, the investments required are lowered by up to $5–$7 billion on a cumulative basis; this is because part of the incremental light crude supplies can be exported, reducing the need to revamp refineries to deal with them.[44]

[44] All projected prices for 2015-2035 in this report are in 2011 dollars, unless otherwise specified.

Exhibit 4-6: U.S. Refinery Cumulative Investments over Firm Projects



Sources: EnSys WORLD Model

The crude oil slate refers to the proportion of oil that distills/condenses within a certain range. The WORLD Model found that without crude oil exports, the average API gravity would increase (i.e., refineries would process lighter oils than when crude exports are allowed), as shown in the exhibit below. This would require more investments to accommodate processing of lighter oils.

Exhibit 4-7: API Gravity by PADD

PADD	With Exports						Without Exports					
	2015	2017	2020	2025	2030	2035	2015	2017	2020	2025	2030	2035
PADD 1	34.50	34.93	36.13	34.48	35.90	36.62	33.59	37.81	34.82	38.47	37.95	39.32
PADD 2	32.53	32.59	32.88	32.11	32.42	32.53	32.67	32.82	33.05	32.50	32.45	32.39
PADD 3	31.75	31.60	32.49	32.60	31.68	31.19	33.31	33.35	34.74	34.12	33.15	32.45
PADD 4	30.95	31.26	34.26	34.03	33.86	34.05	30.95	31.27	34.45	34.70	34.05	34.05
PADD 5	27.96	28.58	29.00	29.01	29.45	29.22	28.43	29.67	29.68	29.37	29.90	29.87
U.S.	**31.49**	**31.58**	**32.35**	**32.12**	**31.88**	**31.66**	**32.30**	**32.85**	**33.55**	**33.31**	**32.84**	**32.53**

Source: EnSys WORLD Model

With the increasing production of domestic light crude, ICF expects the crude slate coming into U.S. refineries to become lighter. From 2010 to 2012, average API gravity of crude input into

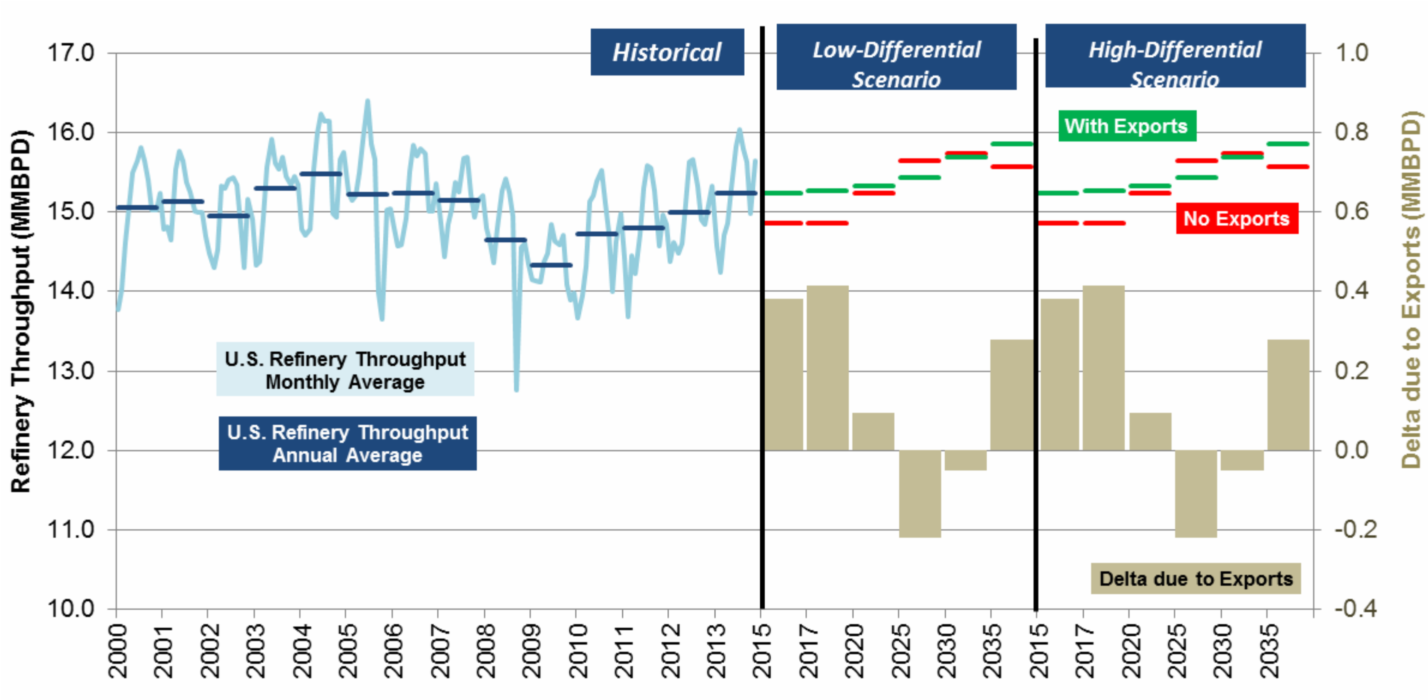
U.S. refineries increased from 30.71 to 31.00 degrees API.[45] If exports are allowed, the average API gravity of crude inputs is expected to rise to a 2015–2035 average of 31.91 degrees, down from 32.97 degrees API when exports are not allowed. This seemingly small difference in the long-term national averages masks the fact that the bulk of the impact is likely to be in one U.S. refining region, namely the Gulf Coast (PADD 3). Within that region, the impacts are projected to be sharper, especially short term. Versus an average crude gravity of 31.0 in 2012 and 30.0 in 2013, PADD 3 crude slate is projected to lighten rapidly to 33.33 degrees API in 2015 to 2017 if crude exports are not allowed. As previously stated, allowing exports enables the lightest crudes to be exported (partially offsetting imports of heavier crudes). As a result, PADD 3 crude slate in the 2015/2017 period rises only to around 31.68 degrees API. This is a more manageable rise that (a) leads to less need to invest in distillation capacity purely to handle the light crudes and (b) reduces the risk of the refineries in the region having to cut throughputs in the short term because the light crudes constrain their processing capacity.

On average over the forecast period, exports increase throughput by better matching crude types to the appropriate refinery.

A question being posed by many analysts is how much light crude U.S. refineries can absorb without significant modifications. Refineries typically have a certain degree of feedstock flexibility (i.e., the ability to process a crude slate lighter or heavier than the usual diet), though this ability varies by refinery. In the short term, and depending on refiners' cumulative flexibility (there are no data available), not allowing crude exports could result in constrained throughputs as U.S. refiners struggle to digest light crudes and condensates. Allowing crude exports would relieve this problem, enabling refineries to better optimize their crude streams, and thereby could increase refinery runs (or avoid reductions) in the short term, as shown in Exhibit 4-8.

[45] U.S. Energy Information Administration. "U.S. API Gravity (Weighted Average) of Crude Oil Input to Refineries". U.S. EIA, accessed 3/7/2014: Washington, DC. Available at: http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrapus2&f=a

Exhibit 4-8: U.S. Refinery Throughput Impacts



Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

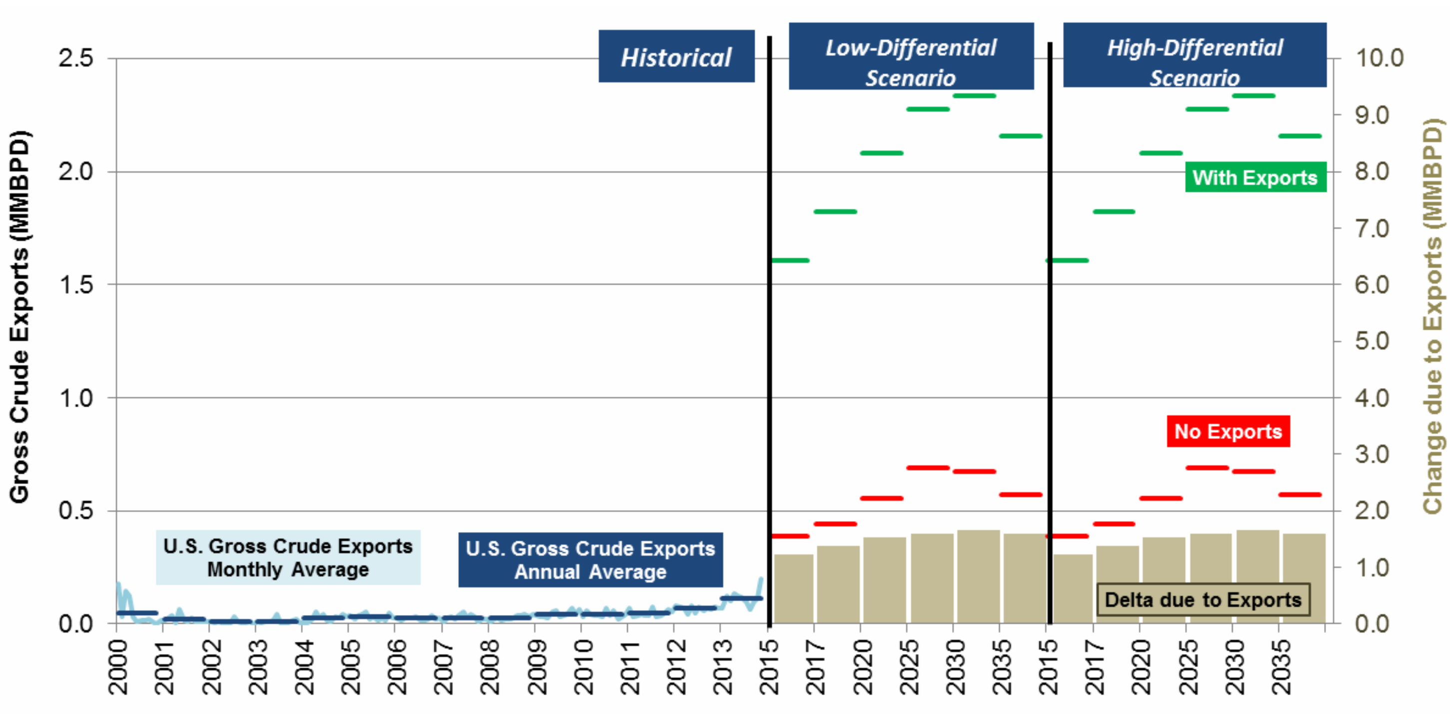
The modeling analysis projected a small near-term increase in refinery throughputs when export restrictions are lifted. However, all scenarios with and without exports, show a general long-term upward trend in U.S. refinery throughput. U.S. refineries are projected to enjoy competitive advantages due to low-cost domestic crude oil and natural gas and higher refinery complexity, compared to those in other parts of the world. Historically, U.S. refinery throughput rose from an annual average of 15.1 MMBPD in 2000 to 15.2 MMBPD in 2013. Refinery throughput is expected to increase to a 2015–2035 average of 15.5 MMBPD when the crude export restrictions are lifted, which is 100,000 BPD or 0.6 percent higher than would exist if the restrictions were kept in place.

It should be noted that the upward impact on refinery runs of allowing exports that is evident in the early years, is expected to diminish relative to a No Exports outlook, as refineries gradually adapt operations to the generally lighter domestic crude in the long term. Allowing exports could have small downward impacts on refinery throughputs in later years. In general and with all other factors being equal, higher refinery margins tend to lead to increased throughput. With the cost of domestic crude slightly higher with exports and refined products slightly lower U.S. refinery margins and throughput could be slightly lower in some years. However, on average over the forecast period, exports increase throughput by better matching crude types to the appropriate refinery.

Crude Trade Trends

If U.S. crude export restrictions are lifted, gross crude exports are projected to increase fairly rapidly, reaching approximately 1.8 MMBPD in 2017. Over the study period, lifting the exports restrictions results in the United States exporting a 2015–2035 average of 2.1 MMBPD, which is an average of 1.5 MMBPD more exports than in cases with continued export restrictions. Note that crude exports can increase to Canada and from Alaska in the export-restricted cases. Historically, the United States exported 50,000 BPD of crude in 2000 and up to 110,000 BPD by 2013.

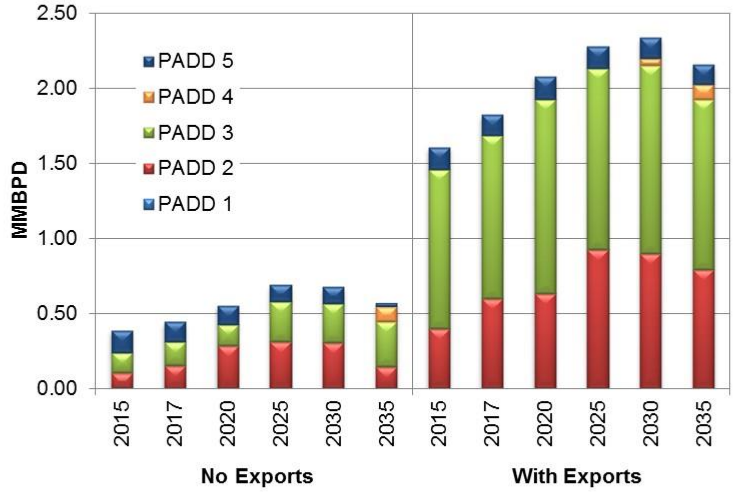
Exhibit 4-9: U.S. Gross Crude Exports Impacts



Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Between 80 and 92 percent of crude exports are projected to originate from PADD 2 (Midwest) and PADD 3 (Gulf Coast). In the No Exports outlook, crude exports from PADD 2 and PADD 3 origins each reach a 2015–2035 average of 0.23 MMBPD. In the With Exports outlook, crude exports originating in PADD 2 reach 0.75 MMBPD while those from PADD 3 production increase to 1.19 MMBPD averaged over the study period. This is consistent with the current U.S. production growth trend particularly in the Bakken and Eagle Ford regions. In addition there is a small volume of Alaskan crude production projected to be exported. This accounts for the 0.1–0.14 MMBPD of crude exports from PADD 5 (West Coast) averaged over 2015–2035. Alaskan North Slope crude is currently authorized for exports under current crude oil export policy and ICF expects producers to take advantage of this allowance in the No Exports Case.

Exhibit 4-10: PADDs of Origin of Exported Crude



Sources: EnSys WORLD Model

As shown in Exhibit 4-11, exported crudes consist mostly of sweet crude and condensates, which account for between 85 percent and 95 percent of crude exports, in addition to a small volume of light, medium and extra heavy sour crude. Since it is the lighter crudes that U.S. refineries are projected to have difficulty processing, it is those crudes that are economically advantageous to export.

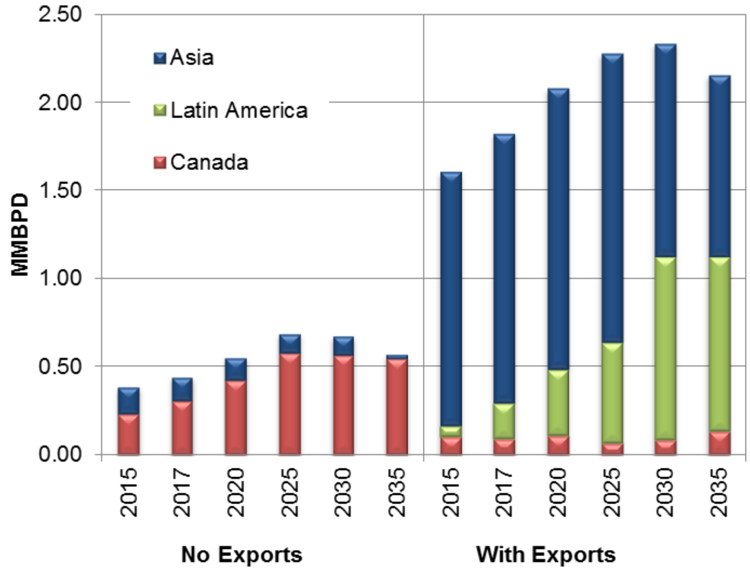
Exhibit 4-11: Types of Exported Crudes

Sources: EnSys WORLD Model

Exhibit 4-12 shows that when export restrictions are lifted, most of the exported volumes go to Asia. A smaller but steadily increasing volume of exports goes to Latin American markets.

Under current regulations exports of crude are only allowed to Canada, therefore exports to Canada make up the majority of exports in the No Exports Case.

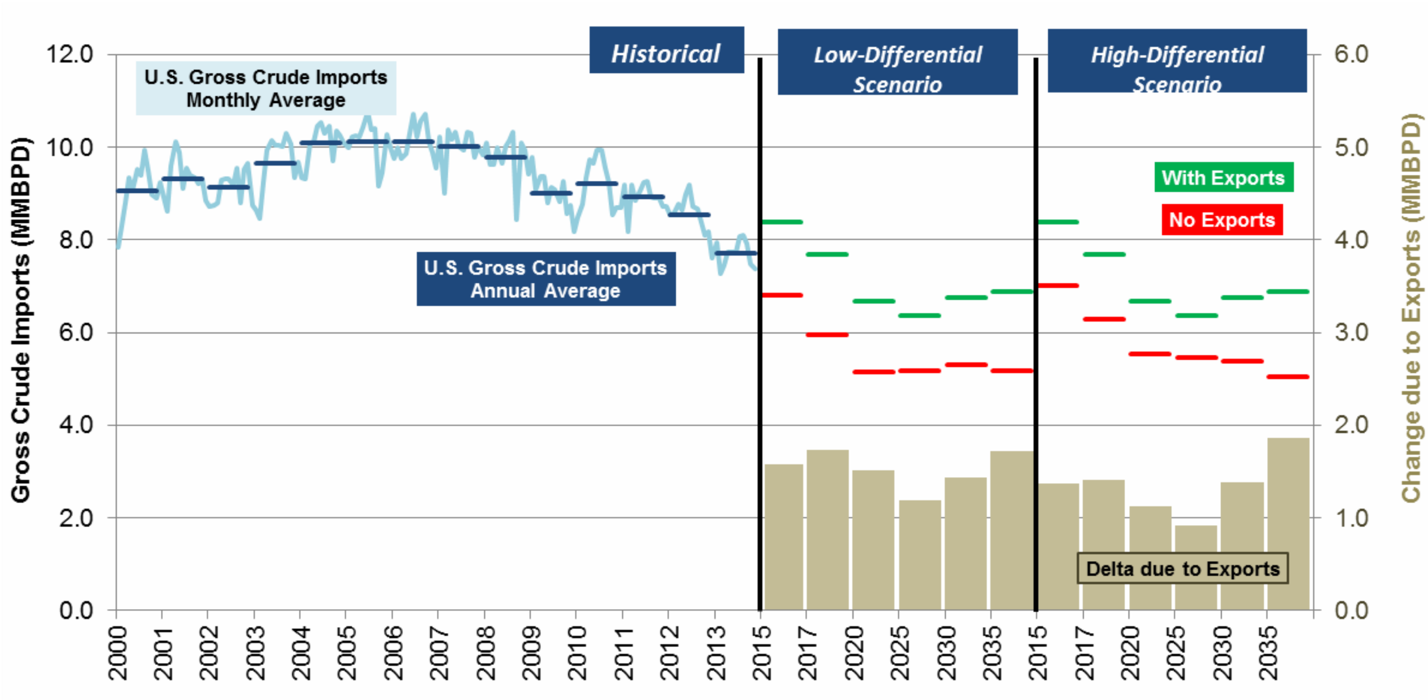
Exhibit 4-12: U.S. Crude Exports by Destination Market



Sources: EnSys WORLD Model

Gross crude imports decline after 2015 in all cases with *and* without crude oil exports, and remain below historical levels. Gross crude imports are expected to decrease from recent levels (8.5 MMBPD in 2012 and 7.7 MMBPD in 2013) to an average of 6.9 MMBPD when crude export restrictions are lifted. On average over the forecast period, this is 1.5–1.7 MMBPD higher than when the export restriction is in place, as the U.S. exchanges exported domestic light crude for imported medium and heavy crudes.

Exhibit 4-13: U.S. Gross Crude Imports Impacts

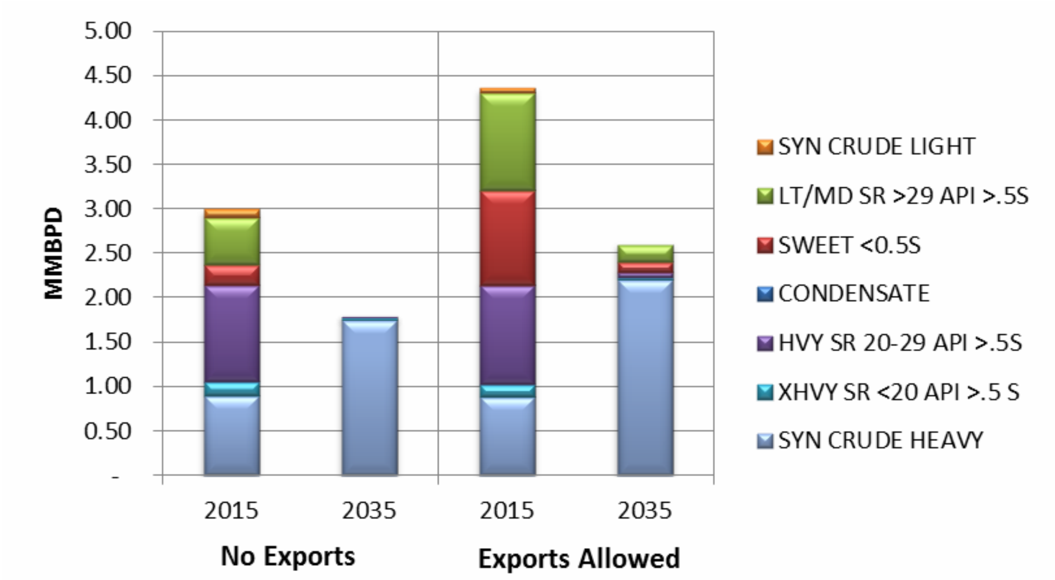


Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Over the past three years, U.S. refineries have imported decreasing volumes of light crude as a share of total crude input. Because the incremental U.S. oil production will be primarily light sweet crude, we expect to see the continuation of this trend of light crude import substitution. Heavier crudes will comprise an increasing share of imports as U.S. tight oil and condensate production backs out light imports.

Exhibit 4-14 shows the forecast crude import trends in the Gulf Coast. Note that the sweet crude volumes shown as remaining in 2015 are entirely medium sweet crude grades. These in turn are projected to gradually disappear over the period. Non-Canadian heavy crude imports are expected to persist in the short term, through 2015, in part because the Keystone XL pipeline was assumed to be approved but not fully on-stream until 2016. Existing contractual arrangements in the Gulf Coast to import heavier crudes from Mexico and the Middle East could also be a factor at least in the shorter term. In the longer term, heavy crudes from western Canada are projected to be primary remaining imports into PADD 3.

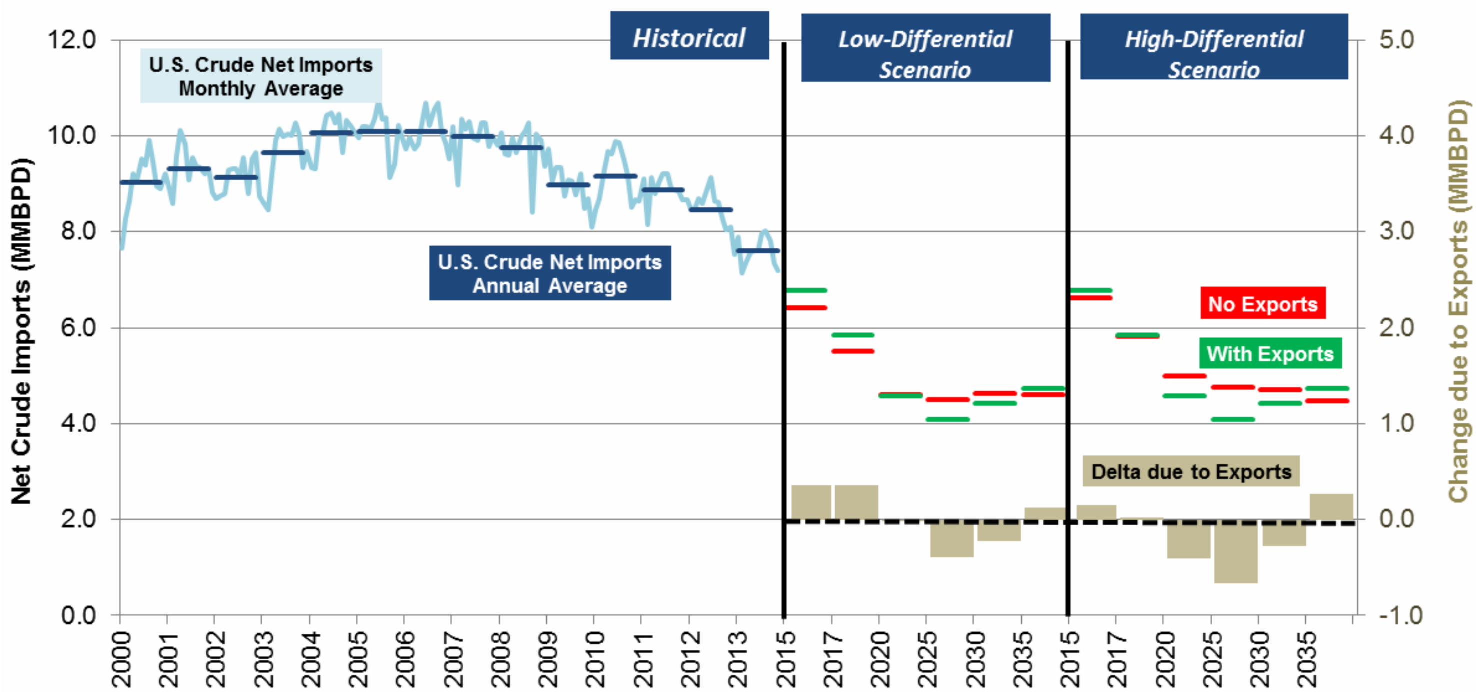
Exhibit 4-14: PADD 3 (Gulf Coast) Crude Imports by Type



Sources: EnSys WORLD Model

Average *net* imports of crude are approximately equal in all cases with and without exports (within 30,000 BPD on average between 2015 and 2035). For historical reference, net crude imports averaged 9.0 MMBPD in 2000 and dropped to 7.6 MMBPD by 2013. Net crude imports are projected to be between 4.5 and 4.8 MMBPD by 2035 in all scenarios.

Exhibit 4-15: Net Crude Imports



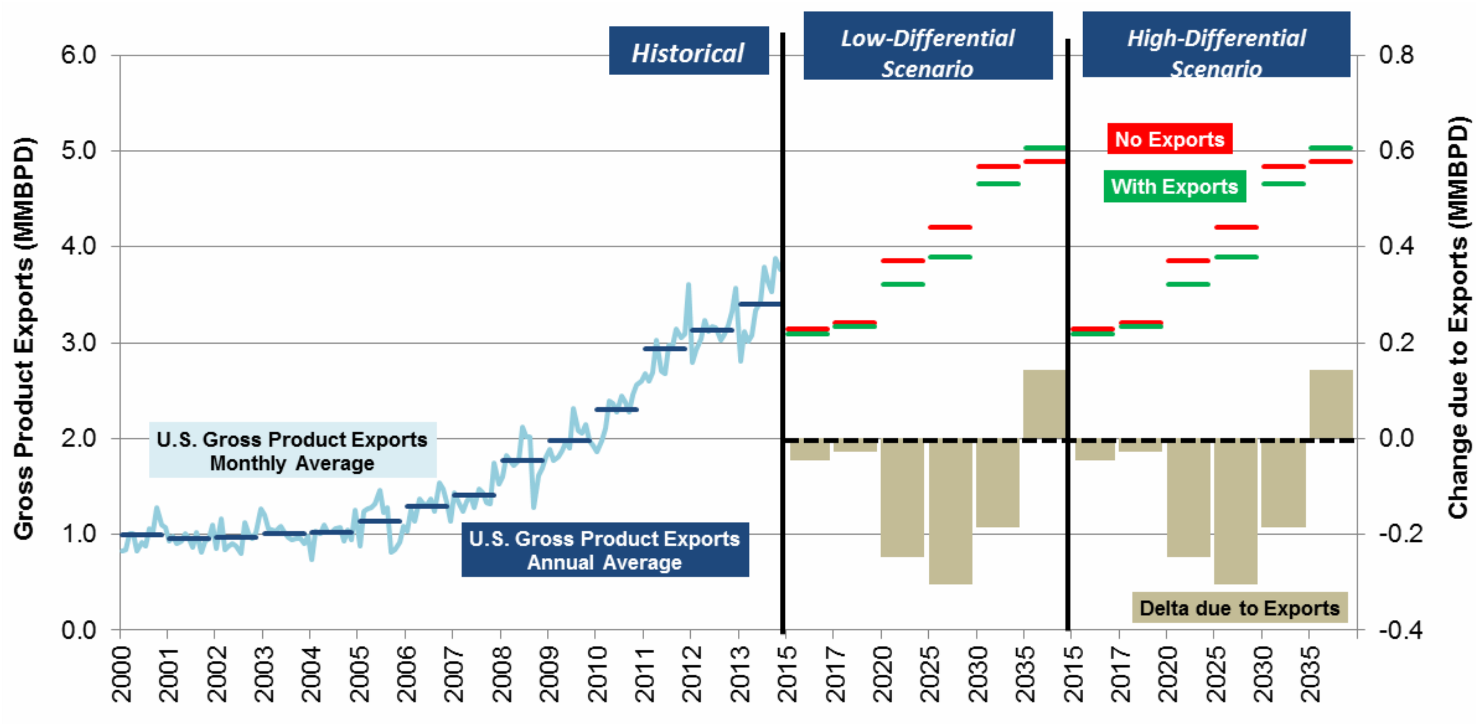
Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Petroleum Product Trade Trends

As shown in Exhibit 4-16, U.S. petroleum product exports increase to an average of 4.1 MMBPD in the With Exports Case over the 2015 to 2035 period, down 130,000 BPD from the No Exports Case. The general upward trend in product exports is partly driven by the slowing liquid fuels demand in the United States (the EIA projects U.S. liquid fuels demand to decline from the peak of 19.8 MMBPD in 2020 to 18.9 MMBPD in 2035).[46] U.S. petroleum product exports also continue being attractive globally because U.S. refineries are projected to continue to benefit from relatively lower natural gas and crude prices.

[46] U.S. Energy Information Administration (EIA). "Annual Energy Outlook". U.S. EIA, April 2013: Washington, D.C. Available at: http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf

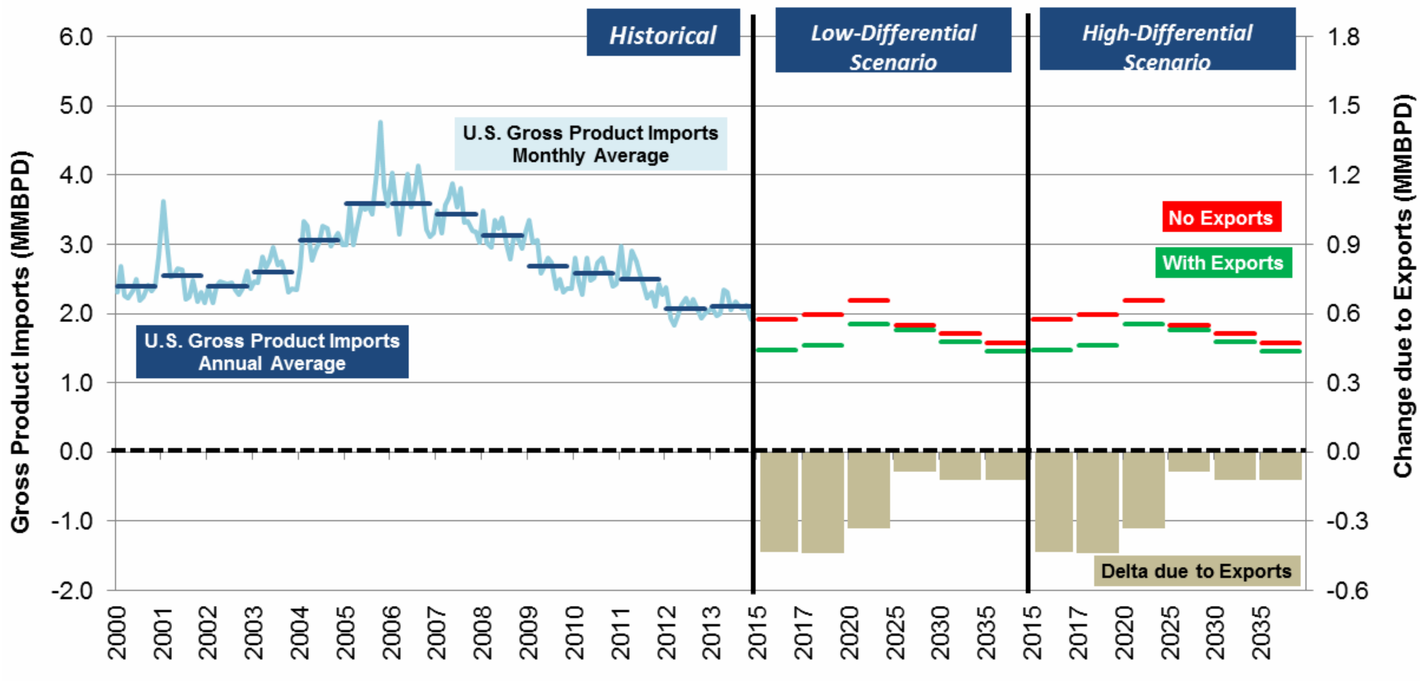
Exhibit 4-16: Gross Product Exports Impacts



Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Exhibit 4-17 shows gross product imports to decline in all cases. Lifting the export restrictions lowers gross product imports by an average of 0.3 MMBPD. The impact of lifting the export restrictions is greater through 2025 than in the later years.

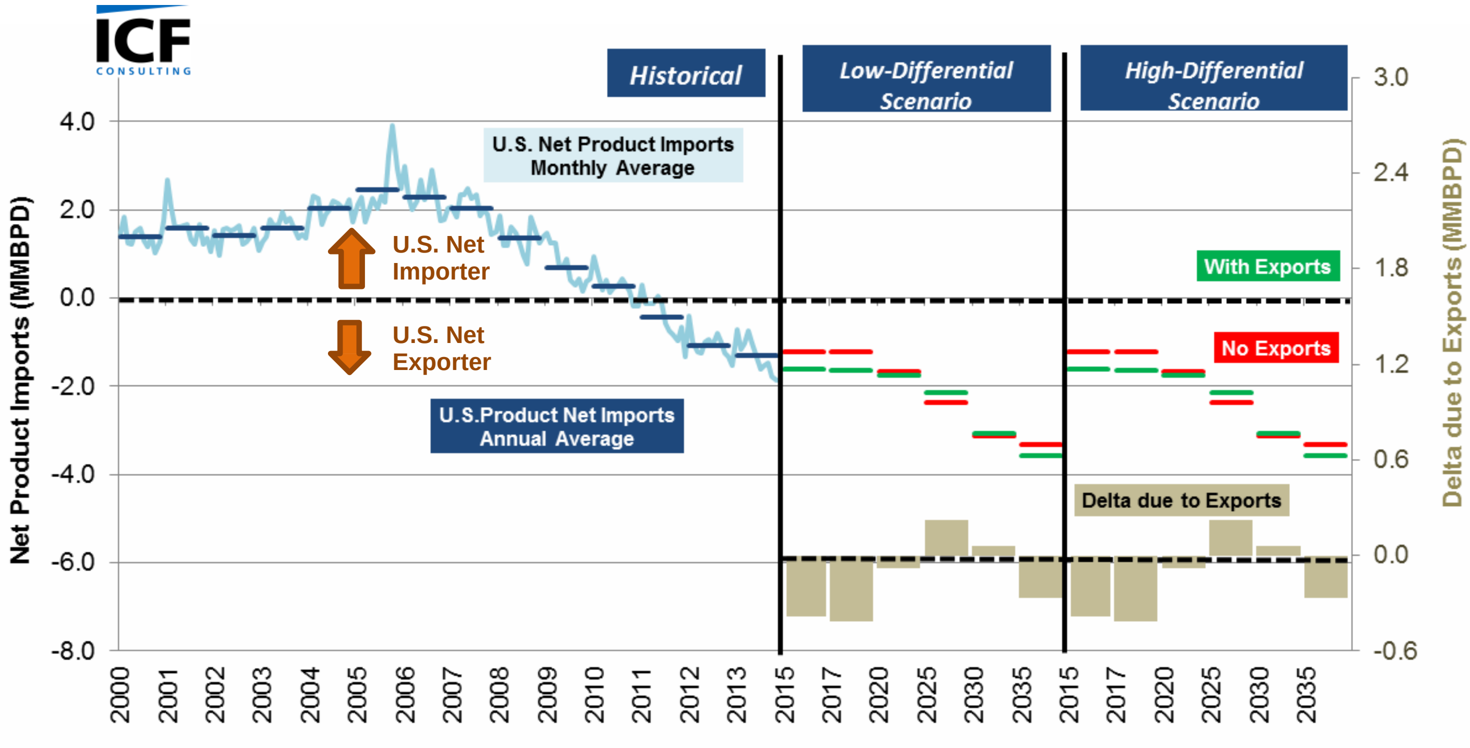
Exhibit 4-17: Gross Product Imports Impacts



Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

As shown in Exhibit 4-18, the combination of higher gross product exports and lower gross product imports results in lower *net* product imports across both the No Exports and With Exports outlooks. The United States has become a net importer of petroleum products since 2011, due to robust global demand for petroleum products (particularly distillate) and access to increasingly abundant domestic crude.[47] This international trade reversal fundamentally altered the U.S. trade in petroleum products, as the country has been a net importer of petroleum products for several decades, as shown in the exhibit below. Net product exports increased from 1.3 MMBPD in 2013 to 2.4 MMBPD in the Export Case, or 2.3 MMBPD with crude exports restricted. This shows that allowing crude exports actually raises net product exports 100,000 BPD on average over the forecast period. Higher net product exports translate to improvements in the U.S. balance of trade, as will be further discussed in Section 5.

[47] U.S. Energy Information Administration. "U.S. petroleum product exports exceeded imports in 2011 for first time in over six decades". U.S. EIA, 7 March, 2012: Washington, DC. Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=5290



Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Note: Lower negative values actually denote higher exports and/or lower imports).

4.2 Pricing Impacts

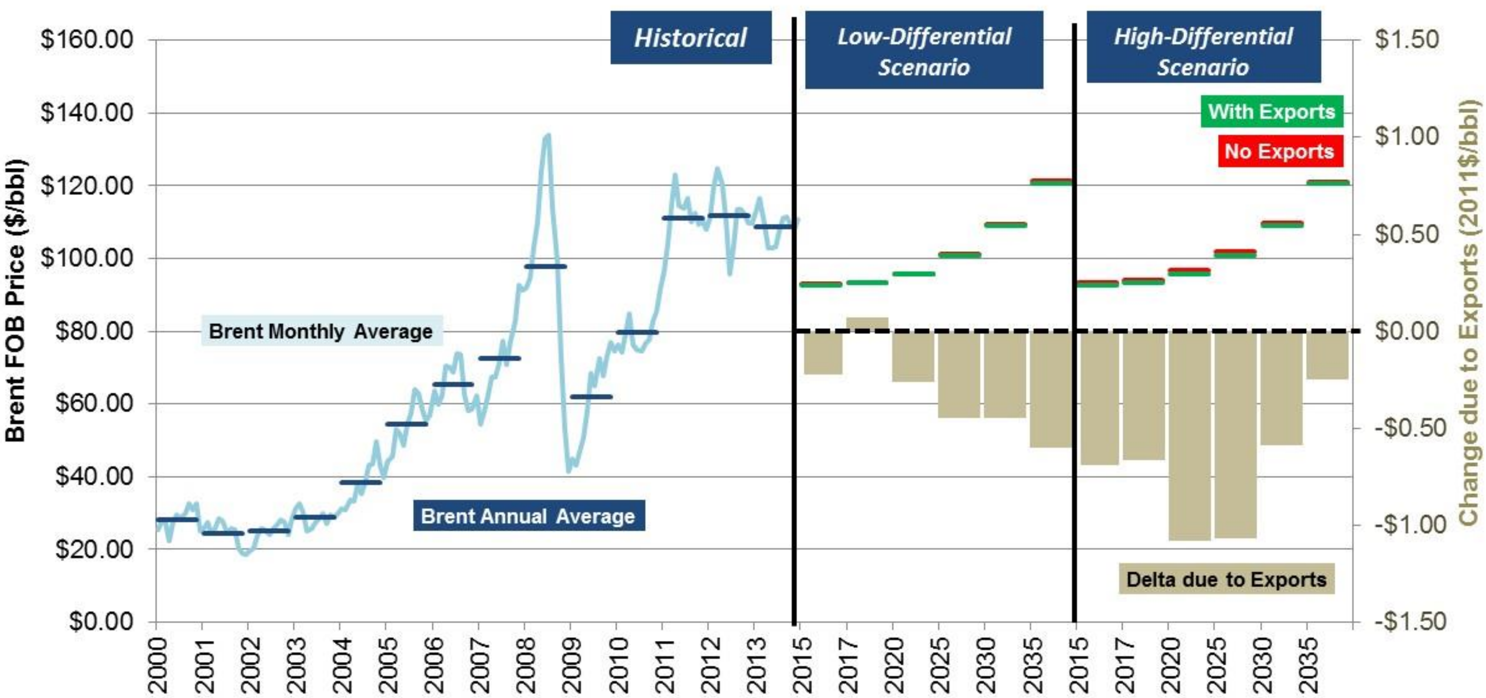
The increase in U.S. crude production accompanied by a relaxation of crude export constraints would tend to increase the overall global supply of crude oil, thus putting downward pressure global oil prices. Although the U.S. is the second largest oil producer in the world and could soon be the largest by 2015, according to the International Energy Agency (IEA)[48], the price impact of crude exports is determined by the incremental production, rather than total production. For this study, ICF used Brent crude as proxy for the global crude price as affected by forces of global crude supply and demand. The impact of lifting crude exports on Brent prices, as shown in Exhibit 4-19, is relatively small, about $0.05 to $0.60/bbl in the Low-Differential Scenario and about $0.25 to $1.05/bbl in the High-Differential Scenario.

It should be noted that Brent prices are affected by various factors such as emerging supply sources, OPEC responses to increasing U.S. and Canadian production, and geopolitical events. Changes in any of these factors could mean actual Brent prices would deviate significantly from our forecasts. However, in general, higher global production leads to lower crude prices, all other factors being equal.

[48] Smith, Grant. "U.S. to be top oil producer by 2015 on shale, IEA says". Bloomberg, 12 November, 2013. Available at: http://www.bloomberg.com/news/2013-11-12/u-s-nears-energy-independence-by-2035-on-shale-boom-iea-says.html

Allowing crude exports results in a Brent average price of $103.85/bbl over the 2015–2035 period, down $0.35/bbl from the Low-Differential Scenario without exports and down $0.75/bbl from the High-Differential Scenario without exports.

Exhibit 4-19: Brent Price Impacts

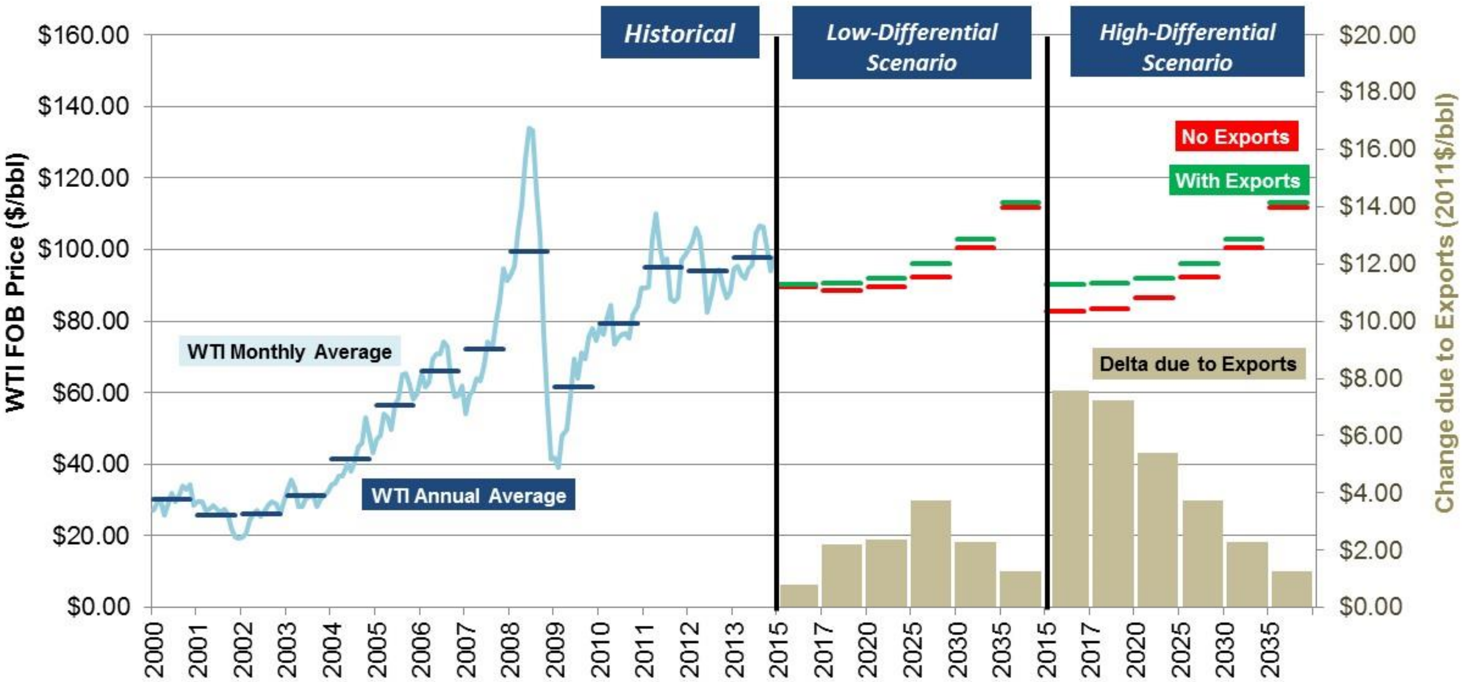


Sources: Bloomberg – historical; EnSys WORLD Model and ICF analysis – projections

Note: Historical data are nominal dollars and the forecasts are in real 2011 dollars.

While global crude prices drop, domestic crude prices gain strength when exports are allowed because lifting the restrictions helps relieve the U.S. crude oversupply situation and allows U.S. crudes to fully compete and achieve pricing in international markets close to those of similar crude types. Exhibit 4-20 shows WTI prices increase to an average of $98.95/bbl over the 2015–2035 period in the Low-Differential and High-Differential With Exports Cases as opposed to $96.70/bbl in the Low-Differential No Exports Case and $94.95/bbl in the High-Differential No Exports Case. The range of increase related to allowing exports is $2.25 to $4.00/bbl averaged over 2015 to 2035.

Exhibit 4-20: WTI Price Impacts

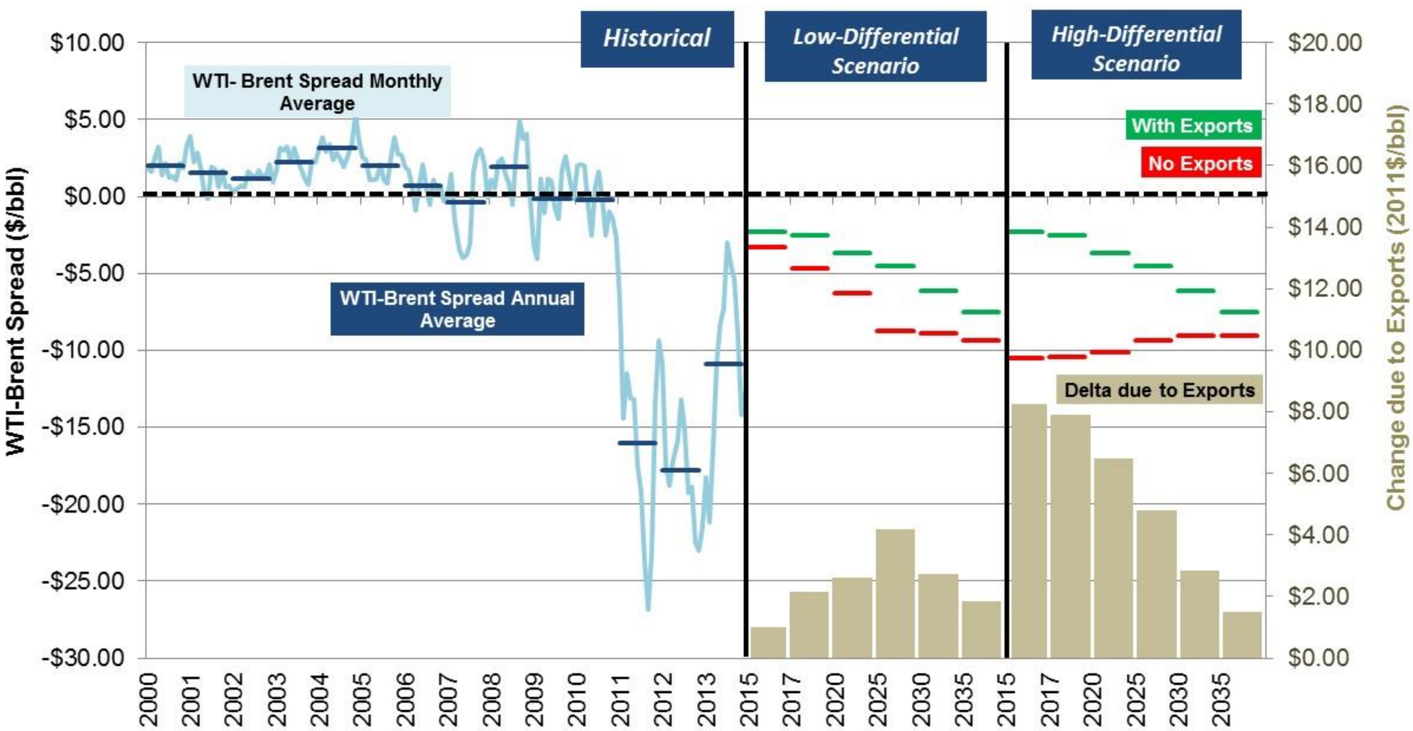


Sources: Bloomberg – historical; EnSys WORLD Model and ICF analysis – projections

Note: Historical data are nominal dollars and the forecasts are in real 2011 dollars.

Going forward, ICF expects WTI prices will not fully recover their historical parity to Brent and could remain discounted relative to Brent, particularly in the near term if refiners are not able to react fast enough to rising light and condensate production. Factors affecting the pace of refinery changes could include delays in environmental permitting of new refinery facilities, persistence of existing contracts for imported crudes, U.S. production rising faster than refiners anticipate, and uncertainties in government policies related to crude exports. These factors could result in a market where steep discounts are required to process a sub-optimum mix of crudes, particularly when exports are not allowed. Exhibit 4-21 shows the WTI-Brent differential widens by up to an average of $7.50/bbl over the period when U.S. exports are constrained or up to $9.60/bbl in the High-Differential Scenario. The average differential is much lower in the Low and High-Differential With Exports Cases, at $4.85/bbl.

Exhibit 4-21: WTI-Brent Price Differentials Impacts

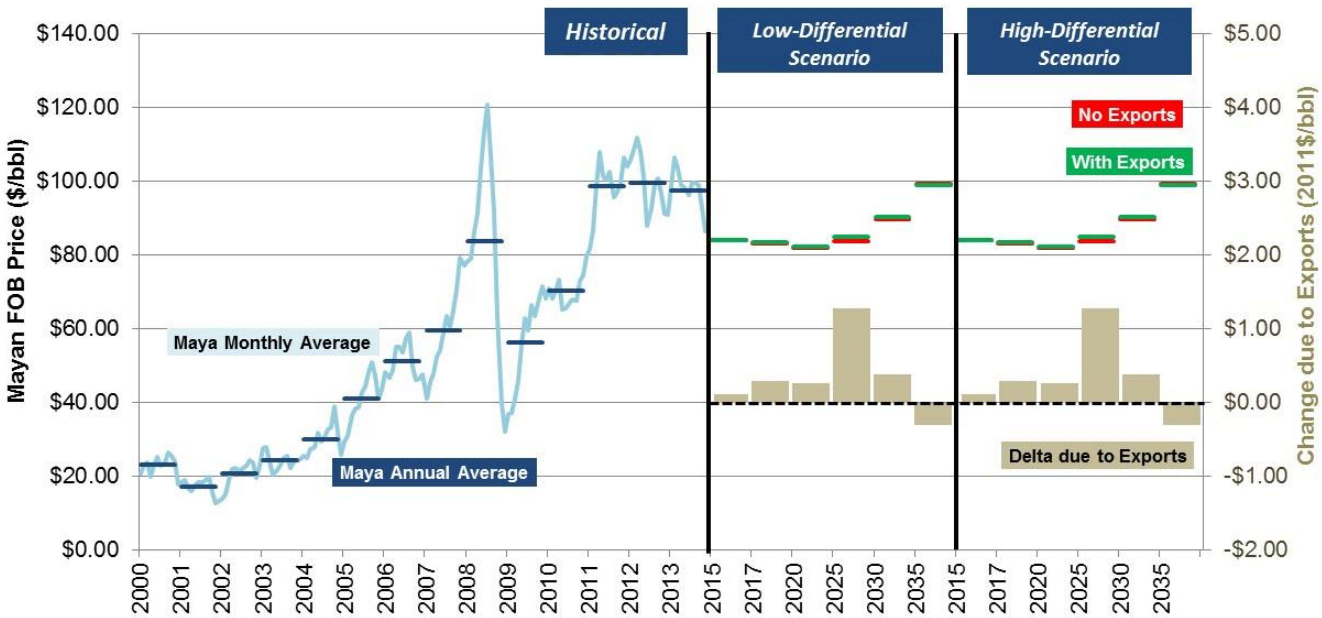


Sources: Bloomberg – historical; EnSys WORLD Model and ICF analysis – projections

Note: Historical data are nominal dollars and the forecasts are in real 2011 dollars.

The constraints on U.S. crude exports also moderately depress heavy crude prices as the existence of abundant light domestic crude oil that must be processed within the country pushes out imports of heavy oil, whether from Latin America, Canada, or elsewhere. Heavy crude prices affect the economics of “coking refineries” that process vacuum residuum into lighter products. The price of Mexican Mayan, which ICF and EnSys used as the proxy price for heavy crudes, increases to a 2015–2035 average of $88.05/bbl when exports are allowed, up $0.35/bbl from when exports are not allowed. These higher prices for heavy crudes reduce margins for coking refineries when exports are allowed. The impact of lifting crude exports restriction on Mayan crude prices is highest in 2025, reflecting the strong U.S. crude exports and production this year.

Exhibit 4-22: Mayan Price Impacts



Sources: Bloomberg – historical; EnSys WORLD Model and ICF analysis – projections

Note: Historical data are nominal dollars and the forecasts are in real 2011 dollars.

4.2.1 Refined Product Pricing Impacts and Consumer Fuel Savings

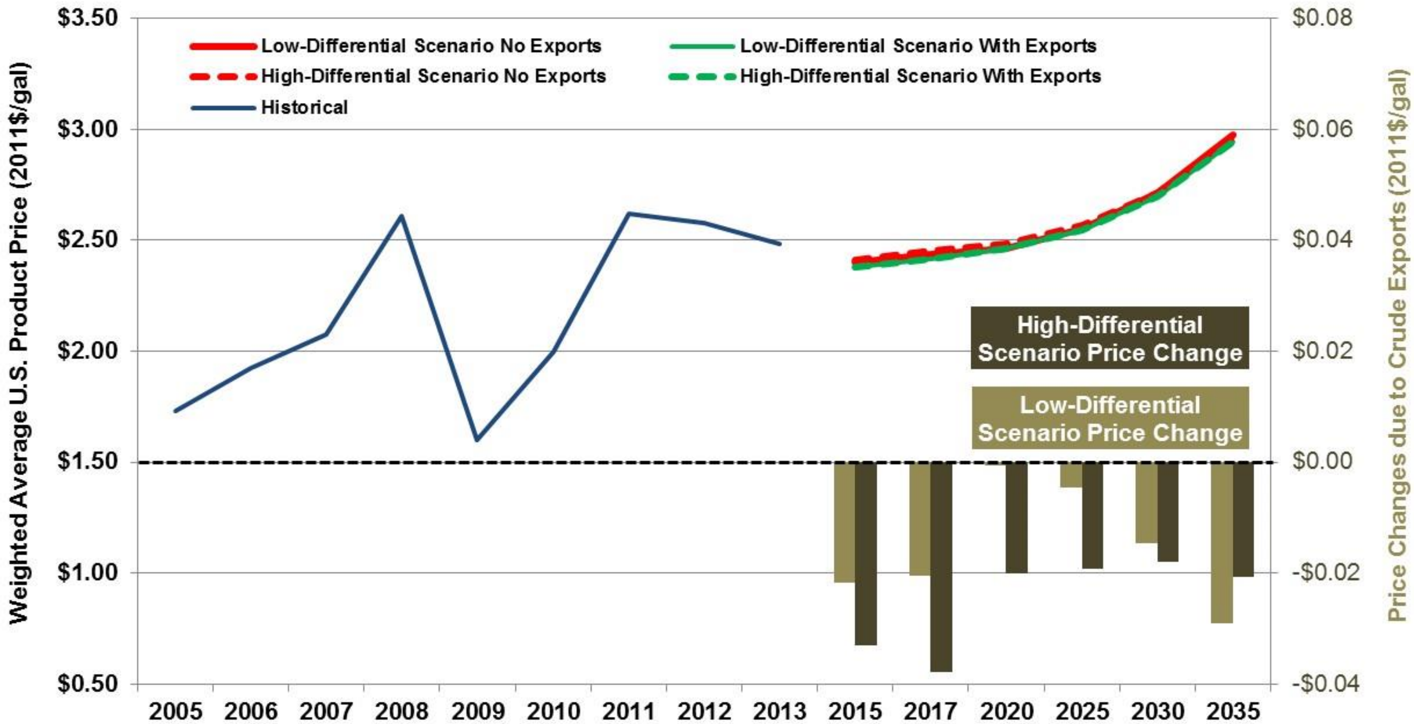
Over the last eight years, the United States has seen a 43 percent increase in average wholesale petroleum product prices, weighted by product type volumes, from $1.73 per gallon in 2005 to $2.48 per gallon in 2013. While the recession dropped petroleum product prices by about $1 per gallon in 2009, prices have rebounded close to pre-recession levels, and have fallen slightly recently.

This study found that average U.S. product prices decline an average of 1.4–2.3 cents per gallon between 2015 and 2035 due to crude oil exports, with prices averaging $2.60 per gallon over 2015 to 2035 with crude exports. This price decline could save American consumers up to $5.8 billion per year, on average, over the 2015–2035 period. Price declines due to crude exports are largest in 2017 in the High-Differential Scenario, with U.S. product prices dropping 3.8 cents. This price drop translates to consumer fuel savings of $9.7 billion that year. These declines are attributable to a larger global petroleum product supply made possible by a larger crude supply when the U.S. exports crude oil (see Section 4.1). Over the study period, product prices will still grow relative to historical levels because of continued strong global demand, but stronger global supply in the With Exports Case leads to lower product prices overall. This price decline is similar in magnitude to another study of crude exports and impacts on U.S. pricing.[49]

[49] A recent Resources for the Future (RFF) study found that lifting the U.S. crude oil export restrictions would result in a decrease in the wholesale price of gasoline by 1.7 to 4.5 cents per gallon.

The WORLD Model uses an assumed international (market) crude price, as well as freight costs between markets to effectively model global pricing and arbitrages in forecasting refinery operations. These forecasts, which affect petroleum products such as gasoline and diesel, highlight the global nature of petroleum product costs, in that they drop when U.S. crudes are allowed to impact international oil prices and U.S refineries are, in parallel, able to operate more efficiently.

Exhibit 4-23: Weighted Average U.S. Wholesale Product Price Impacts

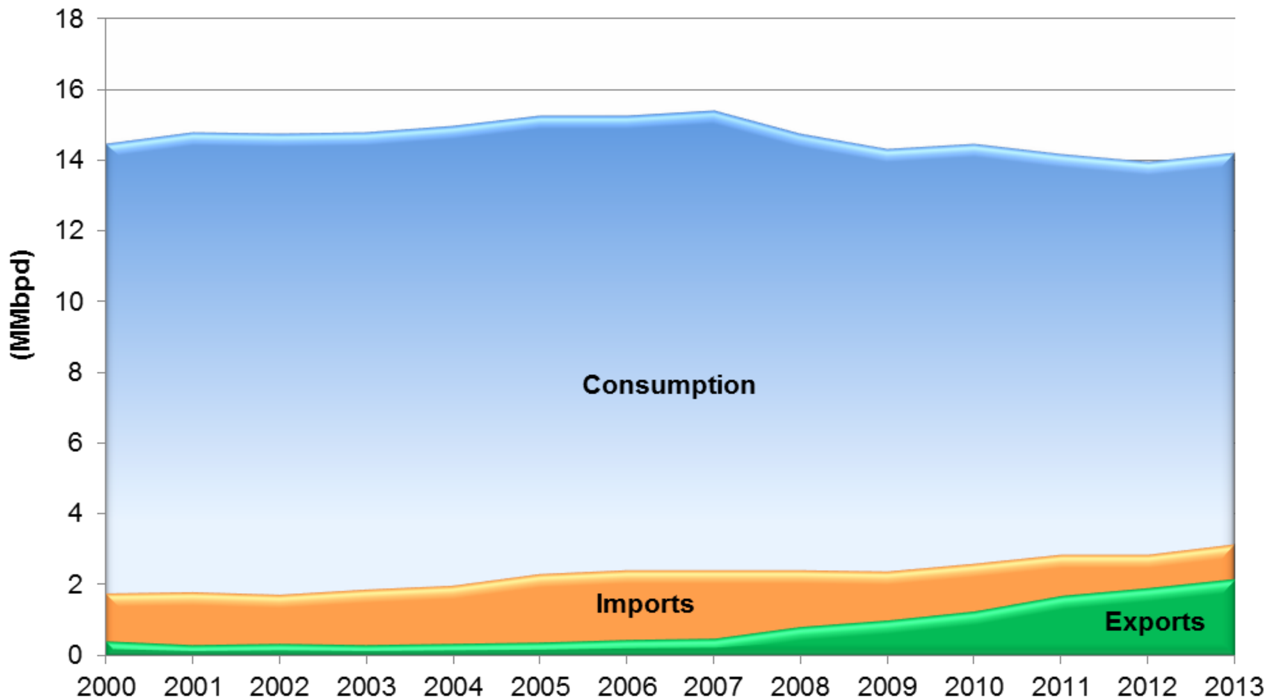


Sources: Historical – ICF analysis of EIA data; projections – EnSys WORLD Model and ICF analysis

The United States has long participated in the international trade in refined petroleum products. Between 2000 and 2013, U.S. trade in major refined petroleum products (gasoline, distillates such as diesel and heating oil, jet fuel, kerosene, and propane) increased from 1.8 MMBPD in 2000 to 3.1 MMBPD in 2013, as shown in the exhibit below. Over the period, imports have trended down slightly, while exports have increased from 0.4 MMBPD to 2.2 MMBPD. Imports and exports now comprise 22 percent of consumption, up from 12 percent in 2000. This trend illustrates that a large portion of U.S. product supply has either been imported from or exported into the global markets.

Brown, Stephen P.A.; Charles Mason; Alan Krupnick; and Jan Mares. "Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States." Resources for the Future (RFF), February 2014: Washington, D.C. Available at: http://www.rff.org/RFF/Documents/RFF-IB-14-03-REV.pdf

Exhibit 4-24: Consumption and Trade of Selected U.S. Petroleum Products*



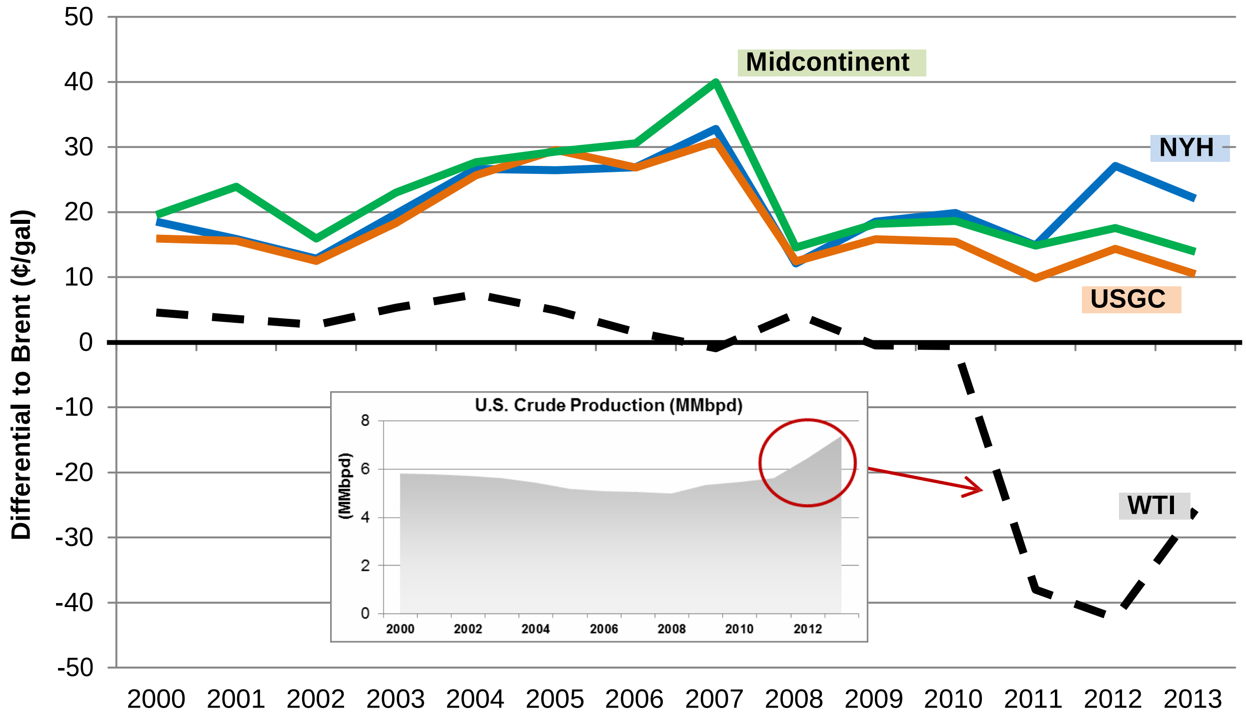
Source: U.S. Energy Information Administration (EIA). "Prime Supplier Sales Volumes." EIA, 25 February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_cons_prim_dcu_nus_m.htm U.S. Energy Information Administration (EIA). "Petroleum and Other Liquids: Exports." EIA, 25 February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_move_exp_dc_nus-z00_mbblpd_m.htm U.S. Energy Information Administration (EIA). "Petroleum and Other Liquids: Imports." EIA, 14 March 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_move_imp_dc_nus–z00_mbblpd_a.htm

* Includes gasoline and gasoline blendstocks, distillates, jet fuel, kerosene, and propane

The cost of delivered crude oil and the value of the primary products from refining impact the U.S. refining sector. U.S. refiners are competing with global suppliers (traders and foreign refiners) who have the ability to bring product into the U.S. market or purchase product in the U.S. market to export. U.S. refiners supply both domestic and international demand, and also receive product from international sources. In recent years U.S. refiners have benefitted from relatively lower domestic crude and natural gas prices to sustain or increase crude runs (despite lower domestic demand) and export gasoline, diesel and propane to global markets at prices which support processing the crude oil.

As shown in Exhibit 4-25, the discount in WTI prices after 2010, relative to international competitors such as Brent crude, did not translate to lower U.S. refined product prices. This was the case even in the midcontinent, where WTI is physically bought and sold. The midcontinent region is short of refinery capacity to meet its own demands and imports product from the Gulf Coast at Gulf Coast product price levels to balance supply and demand.

Exhibit 4-25: U.S. Petroleum Product Prices Linked to Global Crude Prices



Source: Prices – Bloomberg. Crude production – U.S. Energy Information Administration (EIA). "U.S. Field Production of Crude Oil." EIA, February 2014: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS2&f=M

Note: Group 3 refers to Midcontinent 87 octane gasoline prices (Bloomberg ticker: G3OR87PC Index), NYH refers to New York Harbor (NYH) 87 octane gasoline prices(Bloomberg ticker: MOINY87P Index), USGC refers to U.S. Gulf Coast (USGC) 87 octane gasoline prices (Bloomberg ticker: MOINY87P Index). WTI refers to West Texas Intermediate (WTI) crude oil spot price (Bloomberg ticker: U.S.CRWTIC Index). Brent refers to Brent crude oil spot price (Bloomberg ticker: EUCRBRDT Index). Prices on graph show the differential to Brent prices.

Although the impact on global crude prices is relatively modest, this translates into lower international petroleum product prices, which then determine U.S. petroleum product prices. (The continuing free flow of import and export trade in products between the U.S. and other countries, and the ability to move products between regions within the U.S., notably coastal and inland, ensure U.S. product prices remain connected to and therefore determined by international market prices. Analysis of recent historical price data confirms this.)

Refinery gross margins are calculated based on the difference between the refinery feedstock inputs (primarily the cost of crude oil) and outputs (such as gasoline, diesel, and other refined petroleum products). This study found that allowing U.S. crude exports would reduce U.S. refinery margins for two reasons:

1) Higher refinery input costs: With export restrictions in place, domestic crude prices are depressed, relative to international prices. Lifting the export restriction increases U.S. crude oil prices as light U.S. crude oils, in particular, are able to flow into international markets and approach world price levels. In contrast, U.S. prices are discounted relative

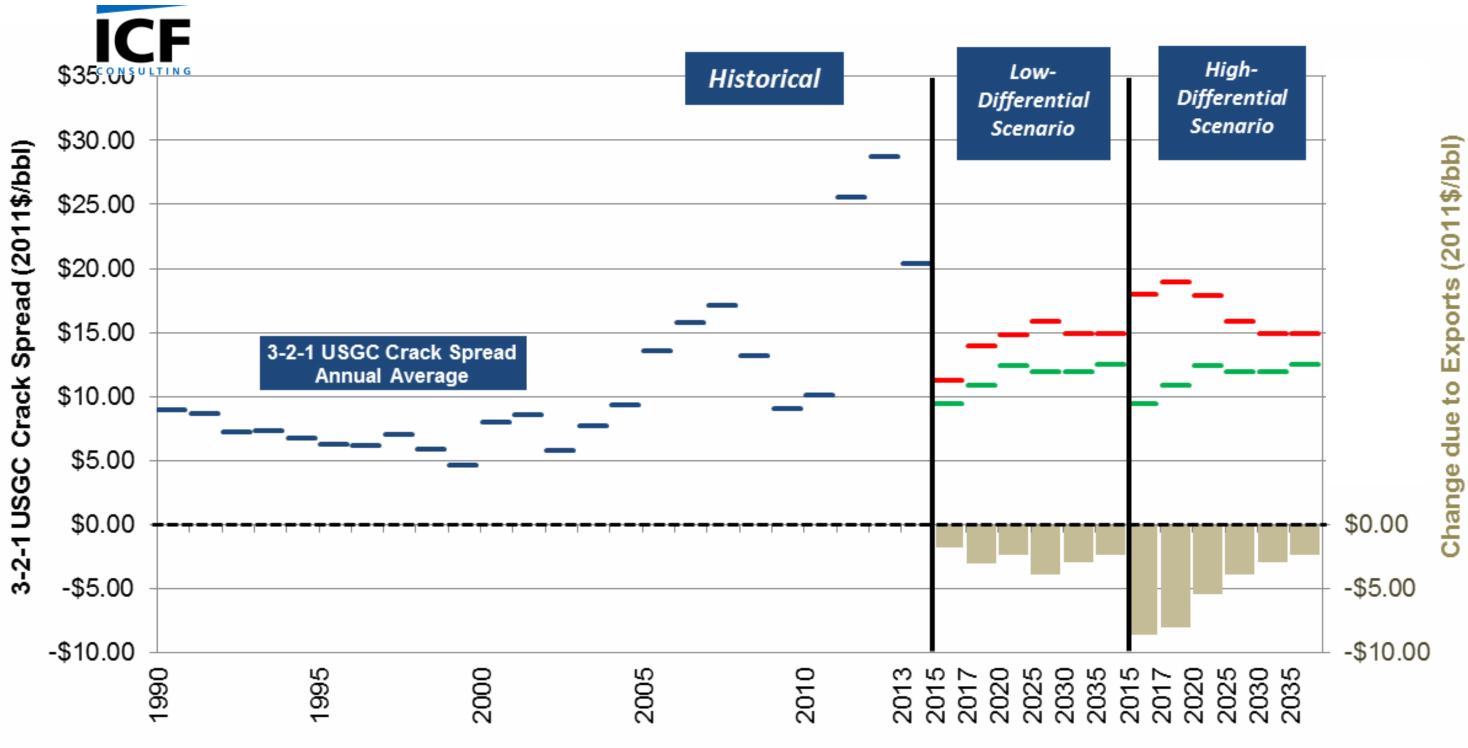
to world prices when domestic crude must be processed within the U.S. because exports are not allowed.

2) Slightly lower petroleum product values: Consumer petroleum product prices are largely determined by global product prices because U.S. imports and exports of petroleum products are not restricted. If U.S. crude exports were allowed, average consumer petroleum product prices would drop slightly as U.S. crude production and thus global supplies increase, dropping international oil prices slightly, and, by extension, U.S. petroleum product prices.

ICF projections of the differential when exports are not allowed vary depending on the scenario setup. In the Low-Differential Scenario, the impact of crude export restrictions on the differential increases through 2025 due to increasing U.S. tight oil production and then narrows after 2025 as U.S. production slows down. The High-Differential Scenario assumes higher inertia in crude pricing, thus a more dramatic WTI price depression in the short term, but the long-term impact due to export restriction becomes closer to that of the Low-Differential Scenario with No Exports to reflect long-term trends in U.S. crude production.

It is important to note that even with this decline due to exports, refinery margins will remain consistent with historical rates over the past 25 years and may see a slight improvement. As Exhibit 4-26 shows, historical 3-2-1 crack spread[50] in the Gulf Coast as based on WTI crude largely stayed below $10 until 2010. Due to the tight oil revolution, WTI crude became depressed throughout 2011–2013 whereas petroleum product markets, which remain closely linked to global markets, did not experience a pass-through of crude price reduction. This has translated into quite high 3-2-1 crack spreads in recent years, giving a boon to U.S refineries. ICF expects crack spreads to return to more normal levels over the study period, at between $9.40 and $12.50/bbl when exports are allowed. In other words, lifting export restrictions lessens the distorted situation seen recently in oil markets.

[50] The 3-2-1 crack spread is an easily calculated but approximate indicator of refinery profitability. It is calculated as the cost of **three** barrels of crude (here WTI) subtracted from the wholesale value to **two** barrels of gasoline plus **one** barrel of distillate oil.

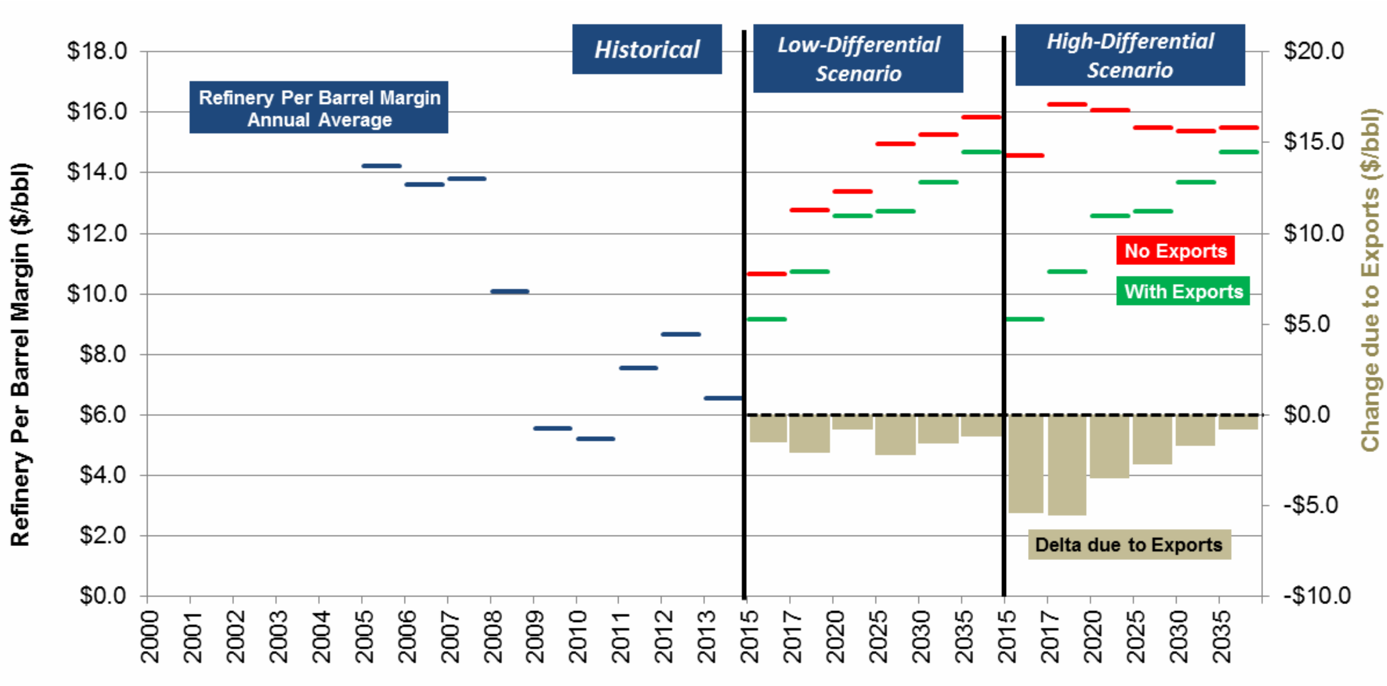


Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Note: Historical data are nominal dollars and the forecasts are in real 2011 dollars.

The increase in domestic crude prices is much larger than the reduction in world crude oil prices, and so the average cost of crude to U.S. refineries goes up more than do refined product prices. This is the major reason why refinery margins (the difference between the value of the products they produce versus the cost of their crude inputs) decline. For reference, gross refinery margins (which do not include deductions for capital and non-feedstock operating costs) averaged $14.23/bbl in 2005, and dropped to $6.54/bbl in 2013. Per-barrel refinery margins are projected to average $12.75/bbl over the period to 2035 when crude exports are allowed, roughly $1.50/bbl lower than when exports are restricted in the Low-Differential Scenario, or $2.85/bbl lower in the High-Differential Scenario with export restrictions.

Exhibit 4-27: U.S. Refinery Margin Impacts



Sources: EIA – historical; EnSys WORLD Model and ICF analysis – projections

Note 1: Historical data are nominal dollars and the forecasts are in real 2011 dollars.

Note 2: Data not available between 2000 and 2004.

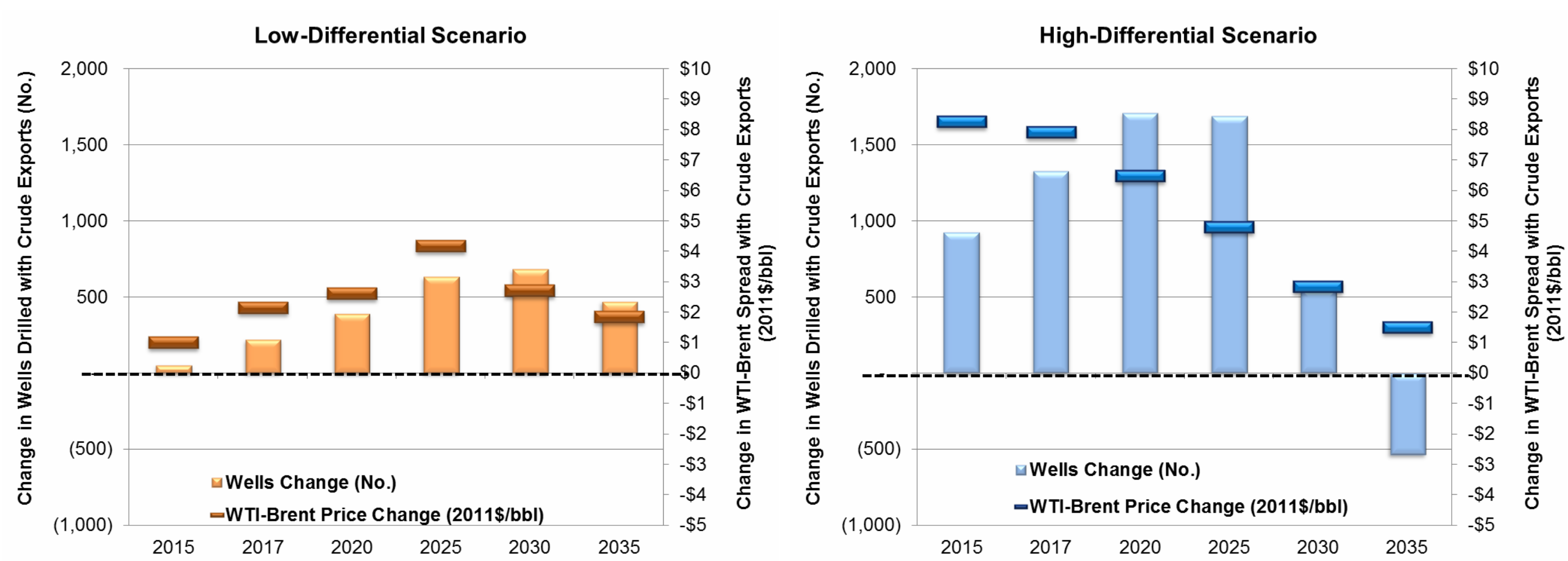
5 Employment and Economic Impacts of Crude Exports

The Low- and High-Differential Scenario employment and economic trajectories were determined by the calculated differences in drilling activity and other economic indicators between the With Exports and No Exports cases over the forecast period. The bulk of U.S. production growth is expected to be from tight oil production, so well drilling trends and the associated employment and economic activity follow tight oil production trends. The drilling activity is, in large part, a function of U.S. crude oil prices. When prices increase, drilling activity, likewise, increases as a price increase generates additional revenue to producers.

Crude oil exports create a larger difference in drilling activity and production in the High-Differential Scenario in comparison to the Low-Differential Scenario, particularly in the early years. However, over the long term, WTI-Brent price differentials with and without crude exports in the High-Differential Scenario are closer to those in the Low-Differential Scenario. Thus, the impacts on drilling levels and production are similar. In the very last years of the forecast, the drilling impacts are greater in the Low-Differential Scenario because wells are delayed in the High-Differential Scenario without exports (leading to less difference in drilling compared to the with exports cases).

Exhibit 5-1 below shows the drilling activity and WTI-Brent price differential changes attributable to lifting crude export restrictions. As shown in the columns in the left-hand chart, drilling activity changes due to crude exports being lower in the Low-Differential Scenario relative to the High-Differential Scenario, as shown in the right-hand chart. The driving force behind these well drilling changes is well economics driven by the WTI-Brent price differentials, as illustrated by the dashed lines in both charts.

Exhibit 5-1: Tight Oil Drilling Activity and WTI-Brent Price Differential Changes due to Crude Exports



Source: ICF and EnSys analysis

ICF assessed a number of economic and employment impacts due to relieving crude export constraints. Based on ICF's study findings, as discussed, the primary categories included were:

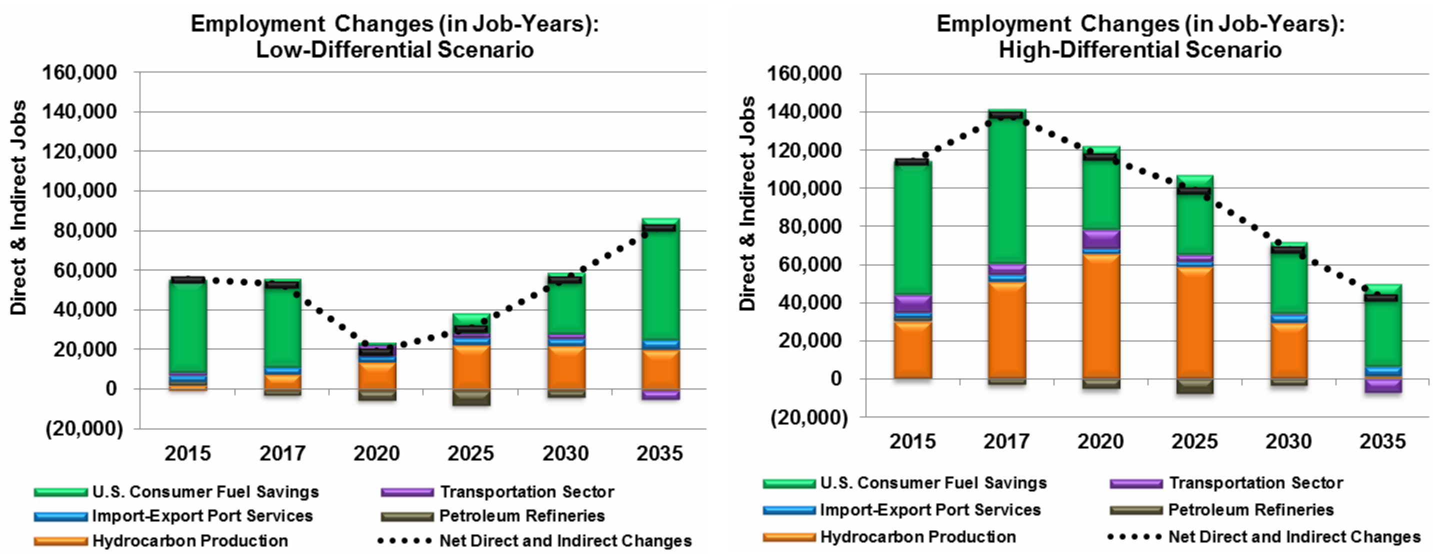
- Hydrocarbon production – Relieving the crude oil export constraint stimulates U.S. hydrocarbon production. This study assessed the increase in crude oil, lease condensate, natural gas, and natural gas liquid (NGL) volumes, shipment value, GDP contributions, and employment changes from lifting the crude oil export constraint.
- Petroleum refineries – Lifting the crude export restrictions both increases U.S. oil prices and puts downward pressure on global and U.S. petroleum product prices. Thus, refinery gross margins are reduced by both an increase in input costs, and a decline in output revenues. This study assessed the refinery sector changes due to lifting the crude export restriction, examining changes in U.S. refinery throughput, refinery investment changes, refiners' acquisition of crude costs (RACC), import price changes, and the weighted average price changes of U.S. petroleum products. The study assessed the volume, shipment value, GDP contributions, and employment changes due to lifting the crude export restrictions in the refinery sector.
- Consumer fuel savings – U.S. petroleum product prices decrease when crude export restrictions are lifted, as U.S. crude exports expands global crude supply, reducing global crude and petroleum product prices (and by extension, U.S. petroleum product prices). This study assessed the total consumer fuel savings attributable to lifting the crude export restrictions, as well as the GDP and employment impacts as these savings are spent throughout the economy.
- Import-export port services – Expanding crude exports results in additional marine transport activity, increasing U.S. port fees on both import and export of crude oil and petroleum products resulting from a release of the crude export constraints. This study assessed the volume increase in import/export activity, as well as the port service value, GDP contributions, and employment changes attributable to crude exports.
- Transportation sector – Lifting the crude export restrictions alters U.S. petroleum transportation primarily through increasing flows of additional crude production and altering flow patterns. This study quantified the transportation sector impacts of lifting the crude export restrictions in terms of changes in interregional and intraregional flows, as well as changes in flows to and from Canada. The study also quantified the GDP and employment impacts on the transportation sector of lifting the crude export restrictions.

The employment and economic impacts discussed below show the differences between the With and Without Exports Policy cases for the Low- and High-Differential Scenarios. The Low-Differential and High-Differential scenarios for the With Exports Policy cases are the same. Differences between the Low- and High-Differential scenarios are entirely due to the differences in the two No Exports Policy cases. Therefore, employment, GDP, and government revenue impacts due to crude exports are different between the Low- and High-Differential scenarios. When calculated impacts between the With and Without Exports Policy cases are smaller, this indicates that the crude prices in the With and Without Exports Policy cases are relatively close. In contrast, years that show larger employment, GDP, and government revenue changes indicate that U.S. crude price differences are wider between the With and Without Exports Policy cases.

5.1 Employment Impacts

ICF calculates direct and indirect employment impacts relative to the trend of no exports by multiplying the change in production in a given sector, measured in dollars or physical units times the labor needed per unit of production. Over the forecast period, crude exports are projected to increase net direct and indirect employment by an average of 48,000 and 91,000 jobs in the Low-Differential and High-Differential scenarios, respectively. Direct and indirect job gains are predominately due to money spent in the economy from fuel savings and from increased oil and gas development. Therefore, employment gains will most likely be in consumer-related and oil- and gas-related sectors. Exhibit 5-2 below shows the sources of direct and indirect employment changes associated with lifting the crude export restrictions.

Exhibit 5-2: Direct and Indirect Employment Increases due to Crude Exports



Source: ICF analysis

Note 1: Excludes multiplier effect (or induced) employment impacts.

Note 2: A job-year represents a single job occurring over 12 months or equivalent amounts of employment, such as two jobs occurring for six months each.

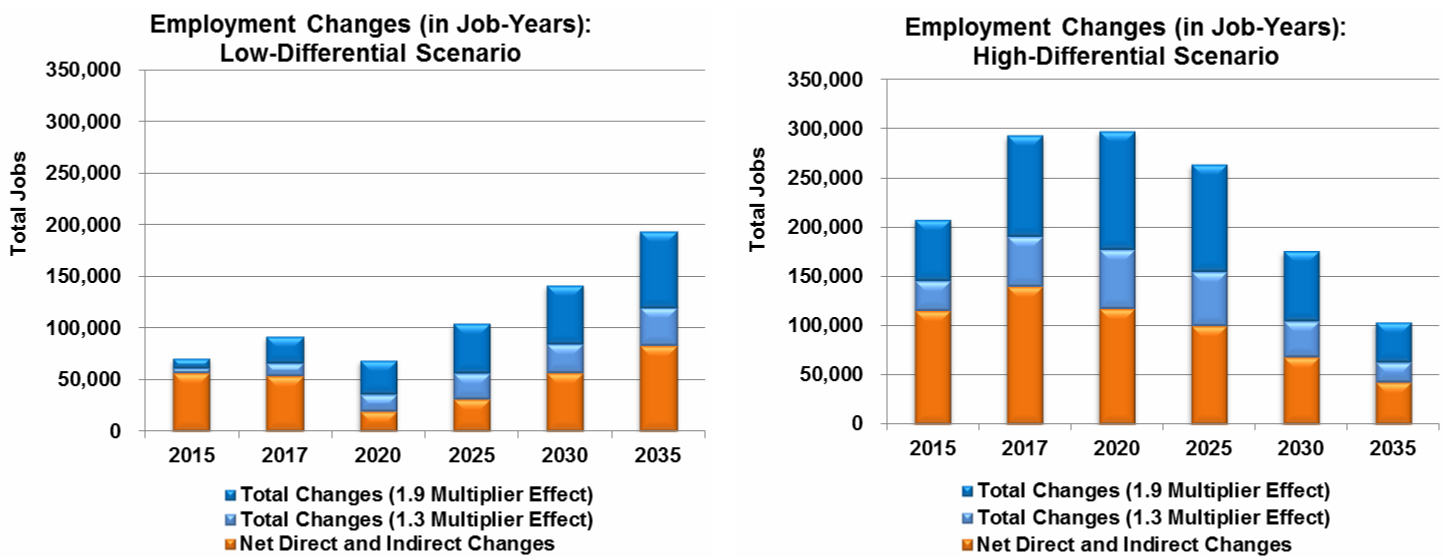
Total employment gains are projected to be higher than just the direct and indirect effects (see Exhibit 5-3 below). Additional income generated in the direct and indirect sectors is spent throughout the economy, supporting additional employment. Employment gains could reach up to 300,000 jobs in 2020 when crude exports are allowed, led by consumer products and services and hydrocarbon production sectors.[51] Employment gains are expected to average nearly 72,000–118,000 jobs annually between 2015 and 2035 in the Low-Differential Scenario,

[51] Based on the 1.9 multiplier effect.

and between 134,000-220,000 jobs in the High-Differential Scenario, with ranges based on the multiplier effect range.

As with GDP changes discussed below, the trajectory of employment changes between the Low-Differential and High-Differential scenarios are heavily impacted by WTI price changes between the With Exports and Without Exports Policy cases.

Exhibit 5-3: Total Employment Goes up when Crude Exports Are Allowed



Source: ICF analysis

Note 1: Multiplier effects can be higher when there is slack in the economy (not at full employment) and less when the economy is running near capacity. Hence, the estimated total employment impacts are shown as a range.

Note 2: A job-year represents a single job occurring over 12 months or equivalent amounts of employment, such as two jobs occurring for six months each.

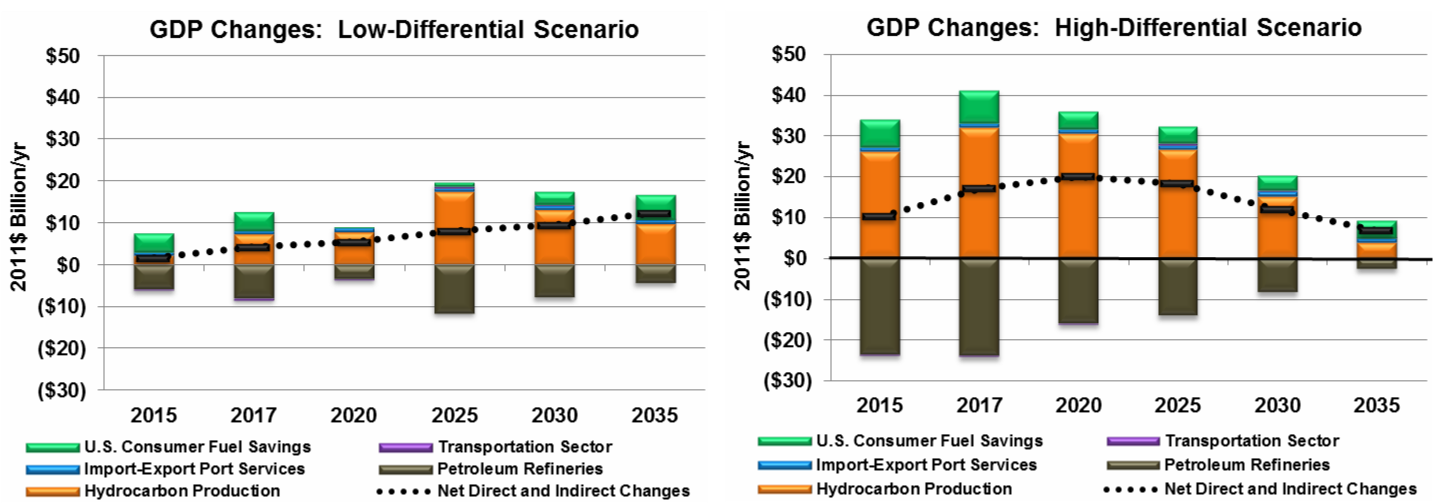
5.2 GDP Impacts

The ICF methodology calculates direct and indirect GDP impacts (relative to the base case trend of no exports) by assessing the change in relevant sectors and impact on GDP. Direct and indirect GDP changes attributable to crude oil exports include:

- The market value of additional crude oil and other hydrocarbon (such as associated natural gas and NGLs) production
- Changes in revenues to petroleum refineries due to changes in throughput and margins
- Increase in import-export port fees for additional crude oil exports
- Changes in the transportation sector revenues as crude oil exports alter pipeline and rail routes
- Increases to U.S. consumers as crude oil exports reduce global oil prices and volatility (and by extension, U.S. petroleum prices, which remain heavily influenced by global prices)

Lifting the restrictions on crude exports results in economic gains, mostly from increasing U.S. crude oil production. This change in production stimulates indirect activities such as the manufacture of drilling equipment and increases demand for steel pipe, cement, and other materials, as well as equipment and services. In addition, the hydrocarbon production sector GDP changes includes increased benefits to mineral-rights owners, as incremental impacts are due to both a projected increase in volume and a projected relative increase in price. Additional hydrocarbon production royalties average $2.0 billion annually between 2015 and 2035 in the Low-Differential Scenario, and $4.0 billion annually in the High-Differential Scenario. Impacts from consumers spending their fuel savings on other areas of the economy is the second largest source of direct and indirect GDP changes. From 2015 to 2035, crude exports increase direct and indirect GDP by an average of $7.8 billion to $14.3 billion per year, depending on scenario. Net economic impacts are positive in all forecast years.

Exhibit 5-4: Allowing Crude Exports Adds to Direct and Indirect GDP



Source: ICF analysis

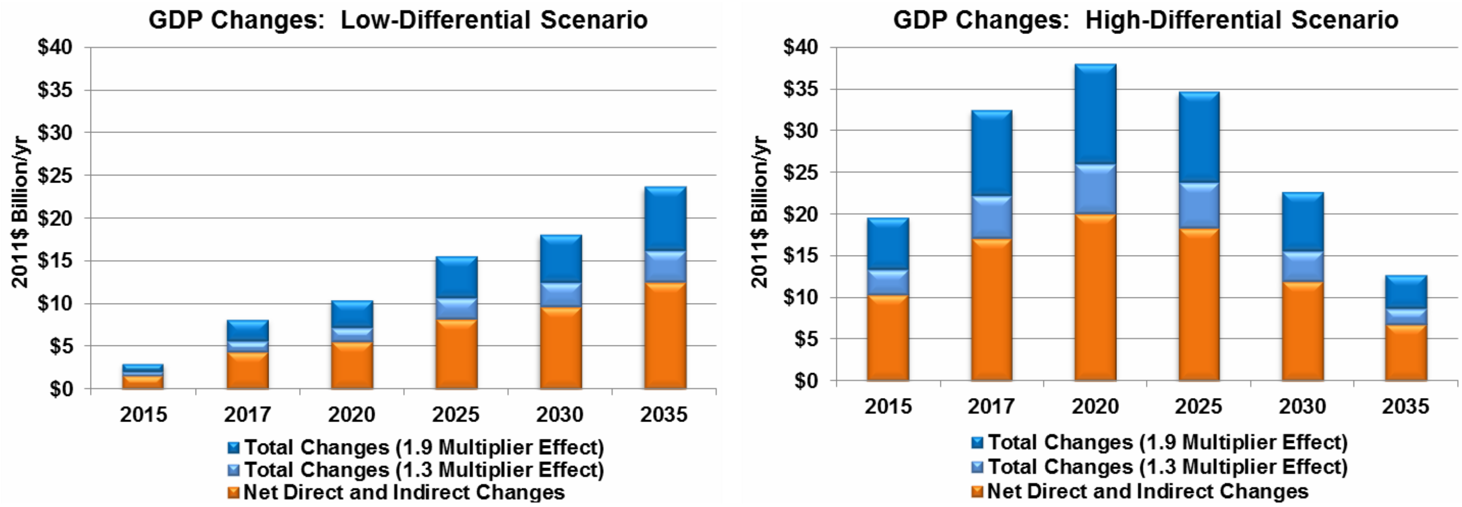
Note: Excludes multiplier effect (or induced) GDP impacts.

The main GDP declines are from the reduction in the calculated contribution to GDP (value added) from the petroleum refining sector. Higher domestic crude costs, slightly lower U.S. and global petroleum product prices, and lower refiner margins, therefore, decrease the GDP contribution per unit. However, the volume of refined product produced in the United States is similar in all cases. U.S. refinery operations, including employment, are similar in all scenarios.

Beyond direct and indirect GDP impacts, there are induced or "multiplier" effects. This represents the economic impacts as incremental income is spent throughout the economy by employees in the direct and indirect sectors. Given the uncertainty surrounding multiplier effects, this study applied a range of 1.3 to 1.9 for the multiplier effect. Generally, when the economy has a lot of slack, the multiplier is higher, since there are unused resources available. Lower multiplier effects are seen in economies near full employment. This means that every $1 of direct and indirect GDP generates an additional $0.30 to $0.90 of additional GDP due to additional consumer spending throughout the economy.

Over the 2015 to 2035 forecast period, total GDP increases (direct, indirect, and induced GDP changes) due to crude exports are expected to average between $10.1–$14.8 billion in the Low-Differential Scenario, and between $18.6–$27.1 billion in the High-Differential Scenario, depending on the multiplier effect. The High-Differential Scenario has the largest WTI-Brent differentials in the early years when exports are restricted. Potential GDP impacts of releasing crude exports are expected to reach a maximum of $38.1 billion per year in 2020 with the High-Differential Scenario.[52]

Exhibit 5-5: Total GDP Increases when Exports Are Allowed



Source: ICF analysis

Note: Multiplier effects can be higher when there is slack in the economy (not at full employment) and less when the economy is running near capacity. Hence, the estimated total GDP impacts are shown as a range.

5.2.1 Government Revenue Impacts

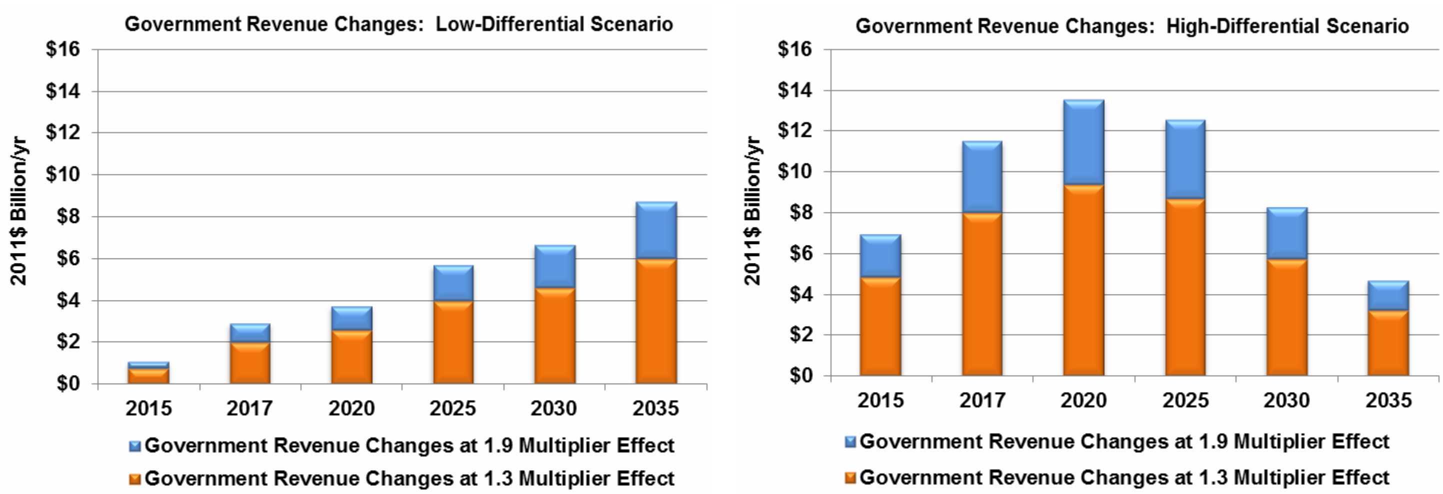
Federal, state, and local governments benefit from crude oil exports both in terms of the generation of GDP, which is then taxed at these levels, but also through royalties on federal lands where drilling takes place. Total government revenues, including U.S. federal, state, and local tax receipts attributable to GDP increases from expanding crude oil exports, could increase up to $13.5 billion in 2020.[53] ICF calculated that crude exports are expected to cause government revenues to increase an annual average of $3.7 to $5.4 billion over the forecast period in the Low-Differential Scenario, and $6.7 to $9.7 billion in the High-Differential Scenario, depending on the multiplier effect. Government revenues include taxation on the following categories: employee compensation, proprietor income, indirect business tax, household taxes, and corporate taxes. Government revenue increases due to crude exports are led by an increase in federal, state, and local tax receipts due to the increase in GDP, as well as a slight increase in federal land royalties for hydrocarbon production. Federal tax receipts comprise roughly 54 percent the total, with state and local taxes (including severance taxes for oil

[52] *Ibid.*

[53] *Ibid.*

production) comprising an additional 44 percent. Roughly two percent come from federal land royalties due to additional hydrocarbon production.

Exhibit 5-6: Government Revenue Changes

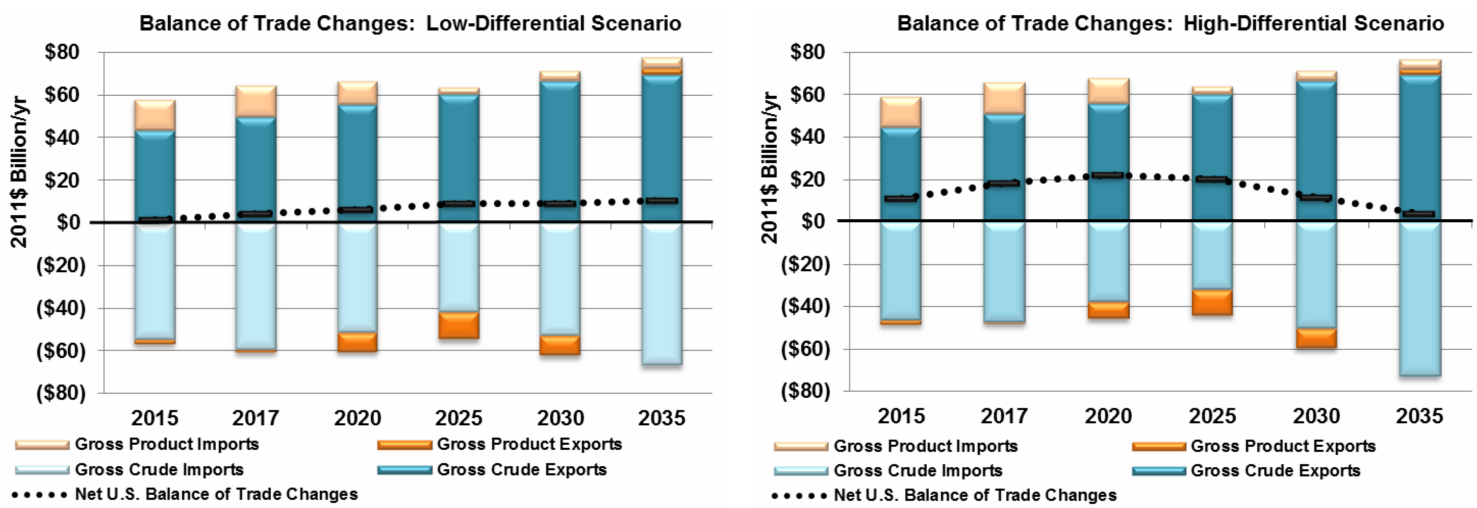


Source: ICF analysis

5.3 Balance of Trade Impacts

The change in exports and imports of crude oil and petroleum products attributable to lifting the crude oil export restriction results in a reduction of the U.S. trade deficit. Crude oil exports could narrow the U.S. trade deficit by $22.3 billion in 2020 through increased international trade of U.S. crude oil. The net U.S. balance of trade changes are expected to average $7.6 billion in the Low-Differential Scenario and $14.6 billion in the High-Differential Scenario over the period 2015 to 2035. Balance of trade gains to the U.S. due to crude exports are led by gross crude exports and an increase in net product exports.

Exhibit 5-7: Balance of Trade Changes due to Crude Exports



Source: ICF analysis

Note: Increases in gross import values shown as negative values, due to the negative impact on the U.S. balance of trade. This means that an increase in the gross import value (increasing the U.S. international trade deficit) is shown as negative, whereas a decrease in gross import value (decreasing the U.S. international trade deficit) is shown as positive.

Exhibit 5-8 below shows U.S. goods exports by category. The items highlighted in yellow are major commodities and materials, which together make up roughly 20 percent of U.S. goods exports between 2011 and 2013. Crude oil and petroleum products are now the second largest goods export category. Allowing crude exports would mean crude and petroleum product exports would likely become the U.S.' largest goods export category.

Exhibit 5-8: U.S. Historical Goods Exports ($ Millions)

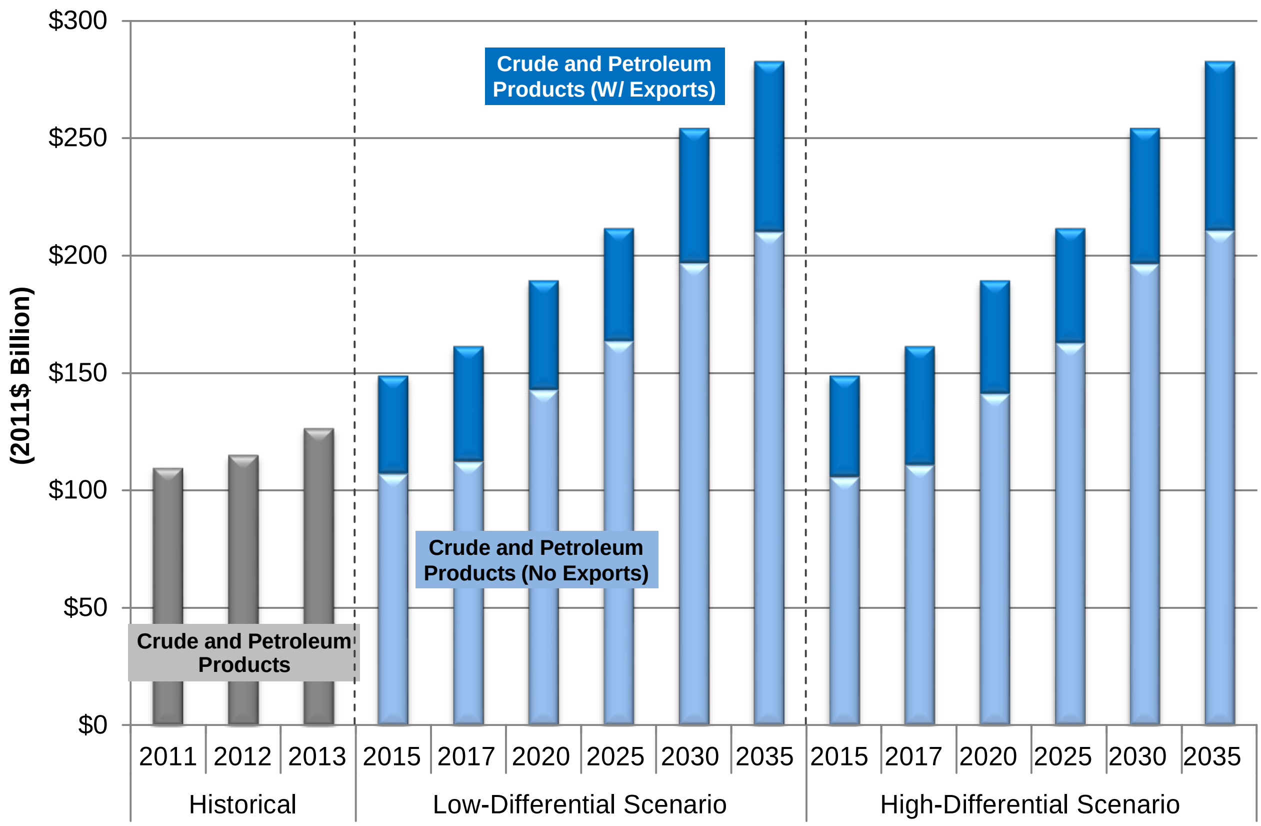
Item	2011	2012	2013
Automotive vehicles, parts, and engines	132,849	146,126	152,095
Crude oil and petroleum products	109,509	119,182	130,006
Civilian aircraft	33,386	45,375	54,398
Industrial machines, other	45,294	46,168	48,803
Pharmaceutical preparations	44,962	47,903	47,938
Semiconductors	44,713	42,067	42,580
Electric apparatus	35,286	38,288	40,138
Telecommunications equipment	35,859	38,552	39,711
Plastic materials	36,019	35,301	36,174
Chemicals–organic	39,538	35,536	35,419
Medicinal equipment	32,033	33,646	34,086
Nonmonetary gold	33,927	36,599	33,345
Computer accessories	31,556	32,326	31,362
Chemicals–other	28,759	29,497	30,378
Engines–civilian aircraft	26,256	27,643	29,659
Industrial engines	28,145	30,029	29,200
Measuring, testing, control instruments	23,837	24,820	24,751
Other industrial supplies	23,064	23,757	24,682
Cell phones and other household goods, n.e.c.	20,479	21,626	23,594
Soybeans	18,091	25,992	22,933
Parts–civilian aircraft	20,546	21,348	21,490
Gem diamonds	19,229	18,114	20,909
Finished metal shapes	17,993	19,493	20,206
Meat, poultry, etc.	17,130	18,022	18,463
Computers	16,838	16,942	16,689
Materials handling equipment	15,748	18,071	15,290
Excavating machinery	16,682	17,588	14,714
Generators, accessories	13,024	14,673	14,180
Newsprint	13,489	13,166	13,377
Other foods	10,749	12,009	12,862
Drilling & oilfield equipment	10,865	12,397	12,247
Jewelry, etc.	9,063	10,266	11,763
Toiletries and cosmetics	9,859	10,649	11,310
Iron and steel mill products	12,498	12,254	11,118
Photo, service industry machinery	10,234	11,119	11,073
Laboratory testing instruments	10,668	10,902	10,980
Wheat	11,306	8,336	10,687
Steelmaking materials	14,847	12,507	10,675
Toys, games, and sporting goods	10,512	10,451	10,276
Minor categories of goods below $10b/year (excl. crude oil)	397,510	399,473	404,039
Total for All Goods	**1,480,290**	**1,545,709**	**1,578,893**
Sum of Major Commodities and Materials	**309,126**	**320,972**	**328,080**
Major Commodities and Materials as % of Exported Goods	**20.9%**	**20.8%**	**20.8%**

Source: U.S. Census Bureau. "U.S. International Trade in Goods and Services (FT900)," exhibits 6 and 7. U.S. Census Bureau, March 2014: Washington, D.C. Available at: www.census.gov/ft900

Note: Ranked by 2013 values. Line items highlighted in yellow indicate major commodities or materials.

Between 2011 and 2013, crude oil and petroleum products exports accounted for between 35 and 39 percent of major commodities and materials exports, or between seven percent and eight percent of total U.S. exports. This equates to annual crude and petroleum products exports of $110–$126 billion. Crude and petroleum products exports are expected to grow an additional 50 percent over 2013 levels by 2020, reaching nearly $190 billion. By 2035, these exports are expected to near 125 percent over 2013 levels, totaling $283 billion.

Exhibit 5-9: Gross Crude and Petroleum Product Exports



Sources: Historical – U.S. Census Bureau. "U.S. International Trade in Goods and Services (FT900)," exhibits 6 and 7. U.S. Census Bureau, March 2014: Washington, D.C. Available at: www.census.gov/ft900 Projections – ICF and EnSys analysis.

6 Conclusions

The analytic questions posed by consideration of policy options to remove restrictions of U.S. crude exports are complex in that they involve future U.S. oil production, current U.S. refinery capabilities and future investments, world crude oil prices, the pricing of petroleum products and the impacts of these factors on U.S. employment, GDP, and balance of trade. This study by ICF International (in cooperation with EnSys Energy) used historical data, scenario design, and forecasting models to quantify these various elements so as to provide logical and consistent information to support discussions of changes to current U.S. crude export polices.

The main conclusions of this study can be summarized as follows:

- U.S. oil production has been growing due to the application of horizontal well drilling and multi-stage hydraulic fracturing. U.S. oil production has increased by 2.1 million barrels per day (39 percent) over the last five years and is projected in this study to increase up to an additional 3.2 to 3.3 million barrels per day through 2020. The bulk of that future growth will be from tight oil production, but there will also be a substantial contribution from Deepwater Gulf of Mexico production.
- The ICF estimates of tight oil production used in the study are based on geologic assessment of various plays in the United States. In those assessments ICF has identified approximately 1,936 billion barrels of tight oil in place, of which approximately 54 billion barrels are technically recoverable under current technologies and practices and 104 billion barrels are expected to be recoverable by 2035 using evolving technologies and practices. The highest forecasts of tight oil drilling presented in this report represent 44 percent of this advanced technology resource base being developed by 2035.
- Historically, U.S. refiners were adapted to process heavier crude oil. However, the new and growing U.S. production is primarily light crude oil and lease condensate. Thus, there is a mismatch between U.S. refinery capabilities and the country's newfound supply.
- Since August 2013, the U.S. light crudes and condensates have experienced large differentials with comparable but higher price world crude such as Brent. Analysts have attributed these large differentials to U.S. refiners hitting constraints that prevent them from easily processing the growing U.S. light crude and condensate volumes.
- Refiners are planning some investments to better process lighter oils, but at the same time need to keep up with growing U.S. light crude and condensate production. There is a high probability that this differential between U.S. and comparable international crudes will persist for some time.
- This ICF analysis also suggests that if the timing of infrastructure development (pipelines, rail facilities, refinery investment, etc.) were to lag behind domestic crude production growth more significantly, even more reductions in crude prices and crude production may occur without the ability to export crude oil. Normal seasonal

maintenance activities at refineries that require reduced crude oil processing may put further downward pressure on crude oil prices and production at certain times of the year.

- Crude oil exports would provide a means for domestic producers of light crude oils and condensates to realize higher international value for their products. This would lead to greater investments and production of U.S. oil. ICF analysis estimates that additional U.S. oil production would mean $15.2–$70.2 billion in additional investment between 2015 and 2020, leading to an increase in U.S. oil production of 110,000 to 500,000 barrels per day by 2020.
- This ICF analysis suggests that if crude exports were allowed, it would not dramatically change U.S. refinery throughputs but would lead to an exchange in that the United States would export light crude oils and condensate and import more medium and heavy crude. Between 2015 and 2020, the additional U.S. exports of crude would be 1.2–1.5 MMBPD, offset by 1.5–1.6 MMBPD in additional imports. U.S. refiners would still import primarily heavy crudes and lube crudes to optimize the refinery performance. U.S. refinery throughput is expected to average 15.5 MMBPD over the forecast period without crude export restrictions, which is 100,000 barrels per day higher than with the restrictions.
- U.S. international trade in petroleum products is not subject to volume restriction for imports or exports and so U.S. product prices are set by international markets. Allowing U.S. crude exports reduces U.S. and world petroleum product prices by moderating world crude oil prices and allowing for more efficient refinery operations.
- This ICF analysis anticipates that this additional U.S. production will tend to moderate world oil prices slightly, and, by extension, U.S. petroleum product prices. U.S. weighted average petroleum product prices decline as much as 2.3 cents per gallon when U.S. crude exports are allowed. The greatest potential annual decline is up to 3.8 cents per gallon in 2017. These price decreases for gasoline, heating oil, and diesel could save American consumers up to $5.8 billion per year, on average, over the 2015–2035 period.
- Allowing crude exports would reduce refinery margins due to higher domestic crude costs and slightly lower U.S. and global petroleum product prices. Because the volume of refined product produced is similar with and without exports, refinery employment is not projected to be significantly impacted.
- Employment supported by these GDP gains could near 300,000 jobs by 2020.[54] Employment gains are expected to average 118,000 jobs annually between 2015 and 2035 in the Low-Differential Scenario, and 220,000 jobs in the High-Differential Scenario.[55]

[54] Based on the 1.9 multiplier effect.

[55] *Ibid*.

- U.S. GDP is estimated to increase up to $38.1 billion in 2020 if expanded crude exports were allowed.[56] Over the 2015 to 2035 forecast period, GDP increases due to crude exports are expected to average $14.8 billion in the Low-Differential Scenario, and $27.1 billion in the High-Differential Scenario.[57] GDP increases are led by increases in hydrocarbon production and greater consumer product spending (due to lower prices for gasoline and other petroleum products).
- Lifting crude oil export restrictions could narrow the U.S. trade deficit by up to $22.3 billion in 2020 through increased international trade of U.S. crude oil, or between $7.6 and $14.6 billion on average annually over the forecast period.
- Crude oil and petroleum products are now the second largest category of goods exported from the United States. Removing restrictions on crude exports will likely make them the largest category.

[56] *Ibid*.
[57] *Ibid.*

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8 Appendices

Appendix A: ICF International's Detailed Production Report

ICF International's Detailed Production Report

Providing Detailed Hydrocarbon Production Results from ICF's Gas Market Compass

ICF's Detailed Production Report provides a complete outlook for U.S. and Canada natural gas, natural gas liquids (NGL), and oil production from 2007 through 2035. The report presents annual production projections for over 50 different areas throughout the U.S. and Canada, and summed results across the U.S. and Canada.

Information Provided

- Natural Gas Production
- Natural Gas Liquids Production
- Crude Oil Production
- Gas Well Completions
- Oil Well Completions
- Total Well Completions
- Oil, gas, and NGL Recoveries by Well Type
- Decline Curves for Each Region
- Vintage Production Charts Showing Total Production and Production Declines

Detailed Information is Presented in Spreadsheet Tables and Charts

- **Regional Tables** provide production and well activity in tabular format for each region. Tables also provide recoveries per well.
- **Regional Charts** provide decline curves and vintaged production charts for each region.
- **U.S. Tables** provide summed production and well activity along with well recoveries for the U.S. in total.
- **U.S. Charts** provide vintaged production charts for the U.S. in total.
- **Canada Tables** provide summed production and well activity along with well recoveries for Canada in total.
- **Canada Charts** provide vintaged production charts for Canada in total.
- **U.S. and Canada Tables** provide summed production and well activity along with well recoveries for the U.S. and Canada in total.
- **U.S. and Canada Charts** provide vintaged production charts for the U.S. and Canada in total.
- **Database Tables** provide the detailed information, over 250,000 rows of data, for all regions in a database format.

Regional Coverage

- Alaska
- Alberta and Saskatchewan Conventional and Tight
- Alberta CBM
- Anadarko Woodford Shale
- Antrim Shale
- Appalachia Other
- Arkla Conventional and Tight
- Arkoma Woodford Shale
- Avalon & Bone Springs
- Bakken Shale
- British Columbia Conventional and Tight
- California EOR
- Denver Niobrara
- Denver Tight
- Denver-Park-LA
- Eagle Ford Shale
- Eastern Canada Offshore/Other
- Fayetteville Shale
- Fort Worth Barnett Shale
- GOM Deepwater
- GOM Shelf
- Granite Wash
- Gulf Coast Conventional and Tight
- Haynesville Shale
- Horn River Shale
- Jonah-Pinedale
- Marcellus Shale
- Michigan and Illinois
- Mississippi, Alabama, Florida
- Montney Shale
- North Central TX Conventional and Tight
- Northern Midcontinent Conventional and Tight
- Other Alberta Shales
- Other W TX Shales
- Pacific Offshore
- Pacific Onshore Other
- Paradox Basin Shales
- Permian Basin Conventional and Tight
- Piceance Basin
- Powder River CBM
- Powder River Niobrara
- Raton CBM
- San Juan CBM
- San Juan Other
- Southern Midcontinent Conventional and Tight
- SW WY and NE UT Other
- Uinta Basin
- Uinta-Piceance Other
- Utica Shale
- Virginia CBM
- Warrior CBM
- Williston Basin
- Wind River and Big Horn Basins
- Wolfberry

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ISSUE BRIEF

Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States

Stephen P.A. Brown, Charles Mason, Alan Krupnick, and Jan Mares

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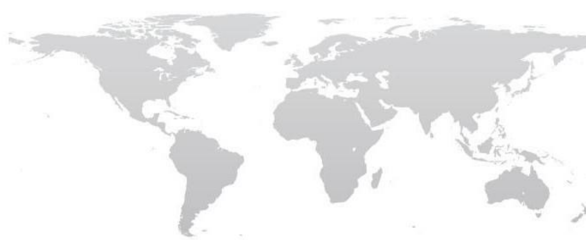

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Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States

Stephen P.A. Brown, Charles Mason,
Alan Krupnick, and Jan Mares[1]

Key Points

- The "fracking" revolution has led to an excess supply of light crude oil in the United States, particularly in the Midwest.
- These excess supplies of light crude oil, combined with a US ban on exporting crude oil and transport bottlenecks, have led to sharply reduced crude oil prices in the Midwest.
- These lower crude oil prices in the Midwest do not seem to have resulted in lower prices for refined products in the Midwest.
- US refineries are better suited to process heavy crude oil, while refineries in other countries are better suited to process light crude oil.
- As a result, lifting the ban on US crude oil exports would allow for a more efficient distribution of crude oil among refineries in the Western Hemisphere and elsewhere in the world.
- A better allocation of refinery activity will result in more gasoline production, which will lower gasoline prices.

Background

The ban on US crude oil exports began as a reaction to the oil embargo in the early 1970s and later was codified in law and Department of Commerce rules for granting export permits. Currently, crude oil can be exported to Canada, but only for use there, not for re-export; from Alaska if it comes through the Trans-Alaska pipeline or from Cook Inlet; if it is foreign oil; if it is in conjunction with operation of the Strategic Petroleum Reserve, and for a few other small exceptions. Refined products, however, can be exported without restriction.

Until recently, the possibility of exporting US crude oil was not an issue because the United States was importing so much oil from the rest of the world and

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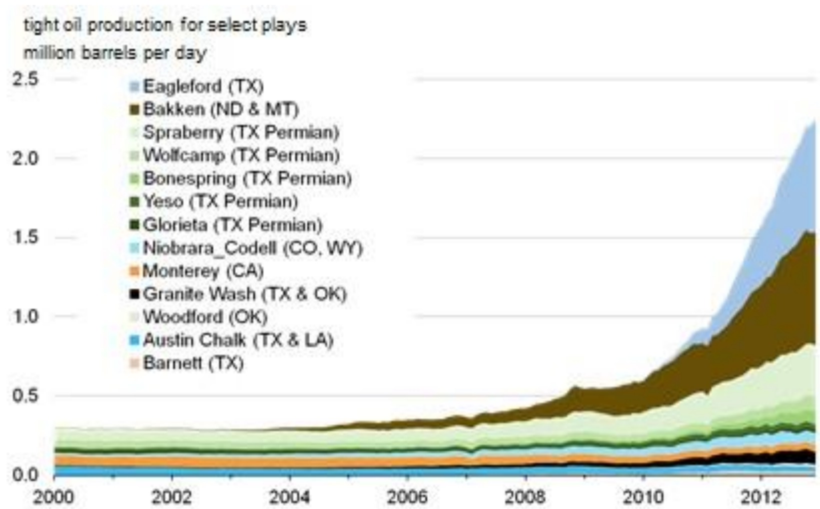
forecasts of US oil production were showing a decline. All this changed with the "fracking" revolution (meaning a combination of hydraulic fracturing, horizontal drilling and seismic imaging technology), which quickly opened up vast resources of "tight" oil to exploitation—primarily in North Dakota (the Bakken play) and Texas (the Eagle Ford play and the Permian play)—and reduced US oil imports to new lows.

Combined with limited pipeline and rail transport capacity, this increase in oil production in the United States (see Chart 1) has led to bottlenecked oil supplies in the Midwest and a reduction in crude prices there. The situation has been exacerbated by the inability of most US refineries to efficiently process the light crude coming from these fields (particularly in refinery hubs along the Louisiana and Texas Gulf Coast, although Valero is an exception).

Chart 1. Growth in Production of Domestic Tight Oil, 2000–2012



Source: EIA 2013c.

Stakeholder Positions

The reaction to this situation has been predictable. Most of the oil and gas industry wants the export ban lifted. The additional demand for US light crude oil will increase profits, although probably not prices because oil is priced in a world market (more to be said about this below). However, some refiners are benefitting from the bottlenecked supplies because they can process the discounted light crude and sell refined products—gasoline primarily—that generally have prices tied to world markets. They oppose lifting the ban.

Environmental groups also oppose lifting the ban. They see increased demand for fossil fuels as contributing to greenhouse gas emissions worldwide and are concerned about other environmental risks posed by expanded production and distribution of such fuels (such as rail accidents and spills).

All parties can agree that lifting the ban confers some advantages to the United States as a whole. It would improve our trade balance and provide us with greater geopolitical leverage.

There are other areas of clear disagreement: the consequences for US energy security and economic growth are two. But the area of greatest and most specific disagreement concerns the effect of lifting the export ban on US gasoline prices. We take up this issue below after first explaining some details about oil markets.

Understanding Petroleum Markets

Crude oil comes in many varieties, the most important here being light (an API specific gravity over 35) and heavy (API gravity of 25 or less). It also has different sulfur contents, which affect the costs of refining. Crude oil also may be found with natural gas and other liquids, called condensates, which are also valuable products. For instance, much of the condensates from the Bakken field are being exported to Canada (their trade to Canada is unrestricted) to serve as diluting agents to make it easier to move the bitumen from oil sands through pipelines.

Crude oil is traded in markets all around the world. Among the most important prices for the debate over exports are those for West Texas Intermediate (WTI, which is priced at Cushing, OK) and Brent (which is produced in the North Sea and priced at Rotterdam). Differing prices for crude oil also exist across the United States, and are conveniently reported by Petroleum Administration for Defense Districts (PADDs) covering the East Coast, Midwest, Gulf Coast, Rocky Mountains, and West Coast. Because the transportation costs of crude oil are relatively low compared to its market prices, these prices tend to track each other very closely, as any imbalance will lead to a shift of oil to the higher priced market. The same holds true for oil traded internationally, which leads to the conclusion that oil is traded and *priced* in a world market (Nordhaus 2009).

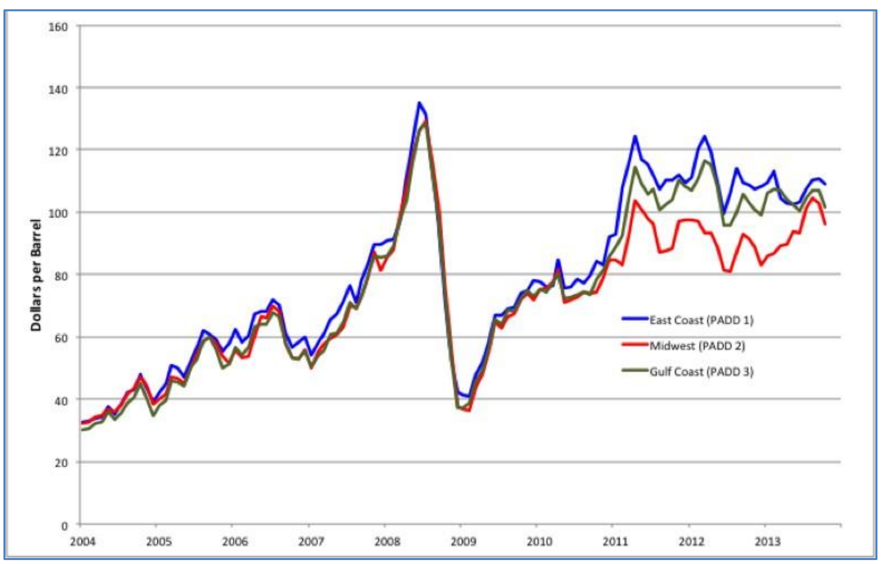
Whether the world oil market is competitive is another matter. Many analyses show that the Organization of Petroleum Exporting Countries (OPEC) exercises sufficient market power to keep the world oil price high. OPEC’s production costs are so low that it can manipulate prices by withholding production. However, it operates under its own internal pressures and each country needs the revenues from selling oil to meet its own economic goals.

Crude oil needs to be refined into products to be useful to consumers. The refining process is very complex and is optimized to be as profitable as possible, given the prices of products that can be produced and the prices of the crude oils that have various properties (for example, light versus heavy, and high versus low sulfur content). Historically, a substantial quantity of US crude oil imports has been of the heavy variety, and so most US refineries are designed to process heavy crude specifically. The US refineries designed to handle heavy crude can process light crude, but they will be underutilizing their facilities and will find it less profitable to do so.

The United States has relatively few remaining refineries that were designed to handle light crude exclusively. Indeed, one of the few major light crude refineries—in Philadelphia—was about to be decommissioned before the tight oil revolution got under way. Valero is in the process of refitting a large refinery in Texas to process Eagle Ford light crude. To accommodate lighter crudes, such as that produced from the Eagle Ford or Bakken shale, US refineries need to invest in specialized distillation units that can yield a variety of light products, such as propane, in addition to gasoline, jet fuel, and diesel.

Combined, the increased production of light crude, a lack of pipeline capacity, and the inability of local refineries to efficiently handle light crude have bottlenecked supplies in the Midwest. One consequence is that railroad use to transport crude oil has spiked dramatically, causing its own problems. (One recent rail accident and oil spill was associated with transport of Bakken crude to an Eastern Canadian refinery.) The transport bottlenecks also have led to sharply reduced crude oil prices in the Midwest, where light crude is in the most excess supply (Chart 2).[2] Contrary to popular belief, however, low crude oil prices in the Midwest do not seem to have resulted in lower prices for refined products in the Midwest (Chart 3).

Chart 2. Refiners' Acquisition Cost (Composite)



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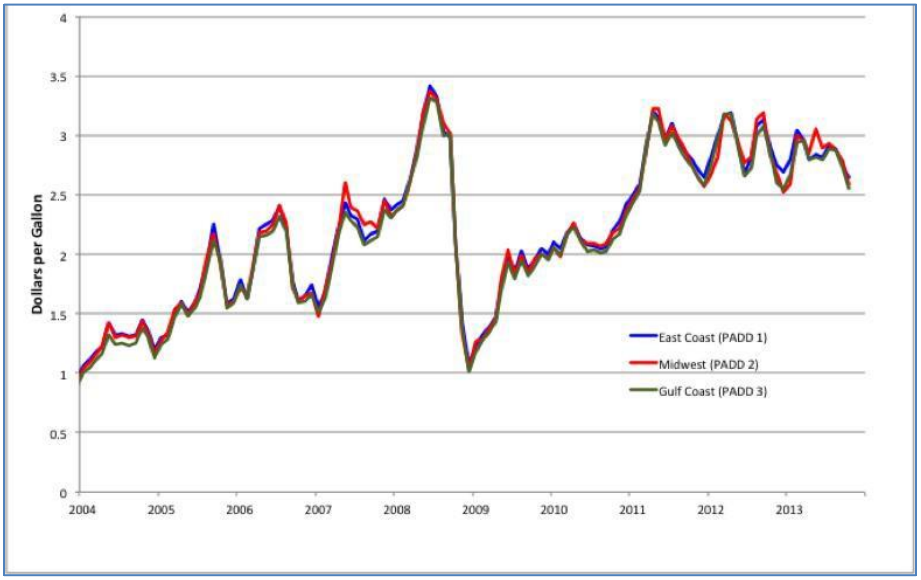
[2] The crude oil refined in PADD 2 has a lower API gravity and higher sulfur content than that refined in PADD 1. It also has a higher API gravity and a lower sulfur content than that refined in PADD 3. Therefore, the data shown in Chart 2 overstate the price differential between PADD 1 and PADD 2 and understate the price differential between PADD 2 and PADD 3.

Chart 3. Wholesale Gasoline Prices



The Economics of Lifting the Ban on Crude Oil Exports

Prior to the fracking revolution, world oil production had been shifting toward heavier crudes. US refiners reacted by investing in facilities (known as "cracking" facilities) that could convert the heavier crudes to the lighter products most valued in the market, such as gasoline, jet fuel, and diesel. Other refiners in the Western Hemisphere and other parts of the world did not invest as heavily in such facilities, and their operations remained more dependent on working with lighter crude oils.

The fracking revolution brought considerably more light crude oil onto the US market and created excess supply. The ban on US exports of crude oil means that the excess supply of light crude oil stuck in the United States cannot be sent to refiners elsewhere in the world, and the surfeit of light crude keeps the heavier crudes produced outside the United States from being refined in the United States. The efficiency of global refinery operations would be improved considerably if the ban on US exports of crude oil were to be lifted—but how would lifting the ban affect prices for crude oil and refined products in the United States?

CRUDE OIL MARKETS

Because the ban on US exports of crude oil has created a situation in which light crude oil is bottlenecked in the Midwest, lifting the ban would cause the price of light crude oil in the Midwest to rise toward world prices. The increased supply of crude oil reaching the international market would put downward pressure on international crude oil prices, assuming OPEC doesn't respond with matching cutbacks in its output.

In addition, the improved efficiency of refinery operations and competitive pressure would slightly reduce what is known as the crack spread (the difference between prices for refined products and crude oil). A reduced crack spread would increase the supply of refined products and at the same time boost the international demand for crude oil, putting downward pressure on refined product prices and upward pressure on international crude oil prices. Whether international crude oil prices would rise or fall on net would depend on the relative increases in supply and demand.

We find that crude oil in the Midwest is currently priced $6.34 per barrel below the price for comparable crude oil. (See Box 1. Analytical Methods.) If the ban on US crude oil exports were lifted, more oil would be produced in the Midwest and the areas of Canada supplying the Midwest. At the same time, competitive pressures and the increased efficiency of refinery operations would reduce the crack spread and boost world oil demand, pushing world oil prices upward. Assuming no OPEC response, we find that the increase in demand would dominate the increase in supply with an estimated net effect of increasing the world price of crude oil by about $0.15 per barrel. The Midwest would see an increase of about $6.49 per barrel.

Given these price changes, we estimate that oil production in Canada and the Midwest would gradually increase by about 84,000 barrels per day. Production elsewhere in the world would increase by 54,000 barrels per day. In total, world oil production would rise by 138,000 barrels per day.

BOX 1. ANALYTICAL METHODS

The first step in our analysis was to estimate the value of light crude oil, because the price information does not make a distinction between crude type, including its sulfur content and specific gravity. To that end, we collected data from the Energy Information Administration (EIA 2013a, 2013b; EIA 2014) that includes average monthly refinery acquisition costs for each of the five PADDs (the major source of excess supply is PADD 2, which includes North Dakota and, hence, the Bakken play). We augmented these data with information on average sulfur content on crude oil deliveries to refineries and average specific gravity, both by PADD and month. This information is available for each month from January 2004 to November 2013, which allowed us to construct a panel data set for the 5 PADDs for 119 months. Adding data for 2013 is important because we now have observations after the flow reversal of the Cushing pipeline connecting the Gulf Coast area in 2012 and its expansion in 2013.

Using this panel data set, we used a “hedonic regression” approach to explain the difference between regional prices and the average monthly spot price of crude oil at the Brent trading hub (the currently accepted global benchmark). Acquisition costs were broadly similar for PADDs 1, 2, 3 and 5 prior to 2010, the start of the rapid expansion of oil production from the Bakken and Eagle Ford shale plays; after 2010, acquisition costs in PADD 2 and 4 (the land-locked PADDs) differed markedly from PADDs 1, 3 and 5. In light of these observations, we allowed for idiosyncratic effects in PADD 4, both before and after 2010, and for idiosyncratic effects in PADD 2 after 2010.

We found that each one percent increase in specific gravity raises the relative acquisition cost of oil by $0.643 per barrel, while each one percent increase in sulfur content lowers average acquisition cost by $2.88 per barrel. After 2010, PADD 2 refiners received an average discount of $6.34 per barrel. On average, PADD 4 refiners paid $8.84 per barrel less for oil than other refiners prior to 2010, and received an additional discount of $2.62 per barrel after 2010. Much of the oil production from PADD 4 comes from Montana, and in particular the western part of the Bakken play.[a]

We then plugged the price difference for PADD 2 into a small static simulation model similar to that developed by Brown and Kennelly (2013) and modified for purposes of this project. The model is calibrated to world oil market conditions for 2012 and it links the world crude market to a global refined product market via refinery operations. As such, the model represents supply and demand for crude oil with the demand for crude oil derived from the demand for refined products.

The model relies on elasticities of supply and demand taken from the economics literature, such as Brown and Huntington (2003), Smith (2009), Dahl (2009, 2010a, 2010b, 2010c, 2010d, and 2010e), Serletis et al. (2010), and Allaire and Brown (2012). For the wholesale price of gasoline, the assumed long-run elasticities for US and world gasoline demand are -0.58 and -0.39, respectively. The latter elasticity is lower because many European countries have high gasoline taxes that blunt the response of consumption to changes in the wholesale price. Combined with the elasticity of demand for other refined products, we obtain an overall elasticity for world crude oil demand of -0.45. The assumed elasticity of crude oil supply is 0.4.

With a greater equalization of crude oil prices across regions and an assumed reduction in the cost of global refinery operations of 0.5 percent, we find world oil prices will rise by $0.15 per barrel. With higher crude oil prices in the Midwest, we estimate that production in the region and Canada will increase by 84,000 barrels per day. Higher world oil prices boost production elsewhere by 54,000 barrels per day for a total increase of 138,000 barrels per day.

With the world's refineries operating more efficiently and processing more crude oil, world gasoline production is estimated to increase by 35,000 to 104,000 barrels per day. We find that the addition of that much more gasoline to global markets reduces its price by $0.017 to $0.045 per gallon.

A sensitivity analysis conducted by altering underlying assumptions yields a range of estimates. For instance, if we assume that there is no cost reduction in global refinery operations as the result of the United States lifting its ban on crude oil exports, the world price of oil will sink by $0.10 per barrel, and the wholesale price of gasoline will fall by $0.007 to $0.016 per gallon. Even though the price of oil falls, a smaller decline in gasoline prices occurs because refinery costs are not reduced. On the other hand, if global refinery costs are reduced by 1.0 percent, the world price of oil will rise by $0.40 per barrel, but the wholesale price of gasoline will fall by $0.027 to $0.074 per gallon. The increase in refinery efficiency pushes up the price of crude oil at the same time it reduces the price of gasoline.

Changes in the assumed elasticity of crude oil supply slightly affect gasoline pricing. If we assume the elasticity of crude oil supply is 0.3 (instead of 0.4), lifting the ban on US crude oil exports will increase the world price of crude oil by $0.20 per barrel, and the wholesale price of gasoline will fall by $0.015 to $0.039 per gallon. If we assume the elasticity of crude oil supply is 0.5, lifting the ban will boost the world price of crude oil by $0.11 per barrel, and the wholesale price of gasoline will fall by $0.019 to $0.050 per gallon.

Changes in the assumed elasticities of demand also have only a small effect on gasoline pricing. If we assume the elasticity of world crude oil demand is -0.55 (with a world elasticity of demand for gasoline of -0.48), lifting the ban on US oil exports will increase the world price of crude oil by $0.18, and the wholesale price of gasoline will fall by $0.015 to $0.041 per gallon. If we assume the elasticity of world crude oil demand is -0.35 (with a world elasticity of demand for gasoline of -0.30), lifting the ban will boost the world price of crude oil by $0.10 per barrel, and the wholesale price of gasoline will fall by $0.019 to $0.051 per gallon.

[a] This aspect of our results suggests the regional pricing effects of rising tight oil production might extend beyond PADD 2. As such, one could view our analysis as somewhat conservative.

OPEC'S LIKELY RESPONSE

With changes in world oil demand and non-OPEC supply, many would look to OPEC for a possible response. With the relatively small changes in global market conditions that would result from lifting the US export ban, OPEC may do relatively little. Nonetheless, if OPEC acts to hold global crude oil prices firm, oil prices may not change as described above.

Would OPEC seek to push oil prices even higher? Those modeling OPEC behavior have not reached a consensus about how OPEC responds to changes in world oil market conditions. Some argue that OPEC targets market share, and some argue that elements within OPEC behave more like a cartel that pursues monopoly pricing.

IF OPEC acts to maintain market share, its response to increased oil production from Canada and the United States will be to increase its own production, which will contribute to downward pressure on the price of oil.

If OPEC exerts some form of monopoly power, its actions will be affected by the demand for its oil production. In particular, we might think of OPEC as a monopolist facing some supply competition. Changes in market conditions that increase the demand for OPEC oil and make demand less price sensitive (less elastic) will foster price increases. Changes in market conditions that decrease the demand for OPEC oil and make demand more price sensitive (more elastic) will foster price decreases. So even in the monopolist case, a crude oil price increase is not a given.

Indeed, if the primary effect of lifting the ban is to increase the efficiency of refinery operations and increase their demand for oil, the demand for OPEC oil (and non-OPEC oil) will increase and become less elastic. OPEC would have an incentive to increase its output, but not by enough to prevent an increase in world oil prices.

On the other hand, if the primary effect of lifting the ban is to increase the supply of non-OPEC oil, the demand for OPEC oil will likely decrease and become more elastic, both of which would induce OPEC to produce less, but with the net effect of increased global supplies. In such an event, the market price would fall. It has been argued that such dynamics governed the world oil market in the 1980s, when North Sea oil came on line. During that period of time, OPEC's ability to prop up prices was badly compromised, with member states in the cartel consistently exceeding their quotas. Either way, the changes in oil market conditions will be sufficiently small that the effect on prices will be slight.

US REFINED PRODUCT PRICES

With the increased efficiency of Western Hemisphere refinery operations that would come from lifting the ban, US prices for refined products will be reduced—even as world oil prices increase.[3] Because consumers in the Midwest do not appear to be seeing any price reductions for refined products as the result of the depressed crude oil prices in that part of the country, we conclude refined product prices in the Midwest move with prices in the rest of the country. Consequently, we expect the Midwest will see declines in prices for refined products that are comparable to those in the rest of the country.

Given our projections for the change in crude oil prices and increased efficiency in refinery operations, we estimate US gasoline prices would be reduced by 1.7 to 4.5 cents per gallon.[4] This range reflects two assumptions. The lower bound counts only the oil production increase, not a change in the mix of refinery outputs. The upper bound represents the oil production increase and change in the mix of refinery outputs. Realization of this price decline may take a few years—depending on how quickly additional oil is produced in the United States and how quickly the industry is able to shift its crude oil supplies between refineries.

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3 Because any increase in world oil prices is the result of increased demand from more efficient refinery operations, product prices will be reduced.

4 Using annual data, we estimate oil in the Midwest is priced $14.83 per barrel below the price of comparable oil elsewhere. In that case, we find lifting the U.S. ban on oil exports reduces gasoline prices by somewhat more than using monthly data (2.8 to 6.9 cents per barrel using annual data, 1.7 to 4.5 cents using monthly data). Using monthly data is preferred because of the greater detail.

OIL SECURITY AND CARBON DIOXIDE EMISSIONS

The impact on oil security and world carbon dioxide (CO_2) emissions will depend on the extent to which there is increased production of crude oil. Any increases of oil production in North America or other politically stable areas of the world will improve world oil security (Brown and Huntington 2013). These increases in crude oil production and consumption also will increase CO_2 emissions by 1.16 million Mcf per day, which corresponds to 21.98 million metric tons per year,[5] although the substitution of more abundant petroleum products for coal in parts of the world that use both fuels may result in some offsetting reductions in CO_2 emissions.

Conclusions

One of the most contentious issues in the debate about whether the crude oil export ban should be lifted is how US gasoline prices will be affected. Commenters span the full range from finding that gasoline prices will increase, decrease, and remain unchanged. In this issue brief, we offer economic logic and estimates from our modeling and data analysis suggesting that the price of gasoline will likely fall by around three to seven cents a gallon. These results are driven by the increase in refinery efficiency made possible by lifting the ban and from a nuanced consideration of OPEC behavior. Indeed, Box 1 presents sensitivity analyses showing that falling gasoline prices are quite robust to alternative assumptions about demand and supply elasticities, as well as assumed refinery cost reductions. Even with more equivocal results, we believe that the economic arguments for lifting the ban are strong, based primarily on the gains from free trade and the example it sets when we live by our market principles. Such action will create winners and losers, however, and may lead to increases in greenhouse gases.

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[5] On average, every barrel of oil refined and combusted generates 8.4 Mcf (Van't Veld et al, 2013). The conversion between Mcf and tonnes is not constant—it depends on things like atmospheric pressure—but a reasonable rule of thumb is 19.25 Mcf per tonne.

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COUNCIL on FOREIGN RELATIONS

The Case for Allowing U.S. Crude Oil Exports

Policy Innovation Memorandum No. 34

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Federal lawmakers should overturn the ban on exporting crude oil produced in the United States. As recently as half a decade ago, oil companies had no interest in exporting U.S. crude oil, but that has changed. Oil production has grown more in the United States over the past five years than anywhere else in the world, even as domestic oil consumption has declined. With these changes has come a widening gap among the types of oil that U.S. fields produce, the types that U.S. refiners need, the products that U.S. consumers want, and the infrastructure in place to transport the oil. Allowing companies to export U.S. crude oil as the market dictates would help solve this mismatch. Under federal law, however, it is illegal for companies to export crude oil in all but a few circumstances. Over the past year, the Department of Commerce granted licenses to several oil companies to export a small amount of U.S. crude oil. But these opaque, ad hoc exceptions are insufficient. Removing all proscriptions on crude oil exports, except in extraordinary circumstances, will strengthen the U.S. economy and promote the efficient development of the country's energy sector.

The Issue

When Congress in the 1970s made it illegal to export domestically produced crude oil without a license, the goal of the legislation was to conserve domestic oil reserves and discourage foreign imports. In reality, the export ban did not help accomplish either of these objectives. It has now become more of a hindrance than a help. The opaqueness of the export approval process discourages would-be exporters from applying for licenses. Companies see a lack of legal clarity and fear inconsistent regulation. They are hesitant to incur negative publicity on Capitol Hill when they doubt they will be granted approval.

Two important elements of the U.S. oil export equation have changed in the past few years. First, exporting U.S. crude oil has become economically attractive to the energy industry. Crude oil exports have grown from next to nothing in 2007 to around one hundred thousand barrels per day in March 2013, all of which went to Canada. Second, the United States has become one of the world's largest gross exporters of refined oil products, such as gasoline and diesel. Unlike crude oil, which is unprocessed, oil that has been refined can be exported freely under U.S. law. Roughly three million barrels per day of refined oil products were exported in December 2012, a major increase from prior decades. Until 2011, the United States had not been a consistent net exporter of oil products since 1949.

Restrictions on crude oil exports are already beginning to undermine the efficiency of the U.S. oil economy. Much of the country's rapidly growing production of light crude oil, including lease condensates (i.e., ultra-light oil), comes from either areas where refiners are not interested in or able to process it, given that many U.S. refineries are configured to run lower-quality crude oil, or in parts of the country with inadequate transportation infrastructure. With few viable domestic buyers, producers are forced to choose between leaving oil in the ground and pumping it at depressed prices. These artificially low prices slow additional U.S. crude oil production. New refineries and pipelines currently under construction will help remedy some of these market distortions over time, but a simpler, more cost-effective solution would include allowing U.S. crude to be exported. Doing so will not raise gasoline prices. Prices at the pump will continue to be determined by the global market, regardless of whether the United States exports crude oil. Were the ban overturned today, crude exports would immediately rise by several billion dollars a year, according to industry executives, likely surpassing five hundred thousand barrels per day by 2017.

U.S. Law Governing Crude Oil Exports

The primary laws prohibiting crude exports are the Mineral Leasing Act of 1920, the Energy Policy and Conservation Act of 1975, and the Export Administration Act of 1979. The so-called short supply controls in the Export Administration Regulations (EAR) of the Bureau of Industry and Security (BIS), an agency of the Department of Commerce, spell out these restrictions.

A few obscure types of crude oil automatically qualify for export licenses under EAR. These types include crude oil produced in Alaska's Cook Inlet or exported to Canada, as long as it is consumed there; and small amounts of heavy (or viscous) crude oil produced in California. Other niche cases do not require licenses. Crude oil transported via the Trans-Alaska Pipeline System or produced overseas and stored in the U.S. Strategic Petroleum Reserve may be exported.

Some U.S. crude oil can be exported with a presidential finding. This includes crude oil of U.S. origin transported on federal right-of-way pipelines, crude oil produced from the outer continental shelf, and crude oil produced from naval petroleum reserves that were once set apart for use by the military but that are now almost entirely commercialized.

In nearly all other cases, U.S. crude oil can only be exported if the BIS finds that proposed exports are "consistent with the national interest and the purposes of the Energy Policy and Conservation Act." The agency has the right to accept or reject applications for an export license according to its own unarticulated definition of the "national interest." The only specific case the EAR mentions as meeting these strict criteria is when the exported crude is exchanged for more or better refined oil imports, under a contract that can be terminated if U.S. oil supplies are "interrupted or seriously threatened," and could not have "reasonably [been] marketed" in the United States.

A Better Approach

A better approach would be to allow companies to freely export oil as the market dictates, eliminating the requirement that companies obtain a license for each crude oil export transaction. The only exception to this policy should be when the president determines there is a national emergency. To make this change, Congress should repeal EAR's short-supply controls that apply to crude oil exports.

Benefits Versus Costs

Exporting energy is good for the economy. Crude oil exports could generate upward of $15 billion a year in revenue by 2017 at today's prices, according to industry estimates. Those gains would be partially offset by displacing some refined product exports, however. Today's export restrictions run the risk of dampening U.S. crude oil production over time by forcing down prices at the wellhead in some parts of the country. Letting drillers reap extra profits from selling crude oil overseas, if the market dictates, would provide greater incentives for drilling, stimulating new supply. It would also encourage investment in oil and gas production in the United States rather than abroad. In oil-producing regions, more workers would be hired for oil exploration and production, as well as for local service industries. Greater policy certainty regarding exports would also catalyze the expansion of U.S. energy infrastructure.

As it stands, the primary beneficiaries of the export ban are a few fortunate oil refineries in the central United States—not U.S. consumers—that are able to buy crude oil at depressed prices before selling it at prevailing market rates. Current law arbitrarily works to the benefit of these companies. In several years, a wider range of refineries will benefit from the ban as pipeline capacity constraints are alleviated and more light oil flows to the U.S. Gulf Coast. These pipelines will help reduce the discount that some producers face in the domestic market, but they would be more effective at bringing domestic oil prices in line with global ones if U.S. crude oil could be freely exported and other restraints on shipping were removed.

Allowing crude oil exports will not affect U.S. energy security. Proponents of the export ban might argue that it increases national security by slowing the depletion of U.S. oil fields. Yet the ban also slows production growth, increasing the country's reliance on imported energy. Insofar as oil self-sufficiency would be economically and militarily useful in a time of crisis, removing the ban would increase U.S. security by catalyzing oil production. Were an international emergency to arise, exports could be temporarily suspended, providing extra oil for domestic needs, though such extreme measures would likely hurt U.S. trade relationships.

Liberalizing the crude oil export regime would advance U.S. foreign policy. It would demonstrate Washington's commitment to free and fair trade, even in a politically sensitive sector, bolstering its negotiating position on other trade issues. It would also avoid putting Washington at odds with allies that would like to source their oil from the United States. If the United States were to become a major crude exporter, its leverage as an oil trade partner would grow significantly.

To the extent that exports mean greater domestic production of tight oil from hydraulic fracturing, or "fracking," allowing exports could bring environmental risks such as water contamination and local pollution. These risks, however, are manageable through prudent regulation. Continuing to ban crude oil exports is not an effective means of preventing harm to the environment. Environmental regulators will need to manage the risks of oil production regardless of whether the United States exports more crude oil.

Conclusion

Without compelling reasons for continuing to restrict crude exports, and given the potential benefits, Congress should liberalize the crude oil export regime. Republicans and Democrats alike, including President Obama, express support for boosting U.S. exports in general. Crude oil should be no exception. Some observers might object to exports on the grounds that U.S. oil production could fall short of today's optimistic forecasts or that exports will cause gasoline prices to rise. These should not be major concerns. U.S. crude exports are self-limiting: if the supply gains expected do not materialize, the market will induce producers to keep the oil at home rather than to send it abroad. Though the companies that benefit from today's export restrictions might oppose any change in the status quo, the broader gains available to the United States from allowing crude exports make it the far better choice.

More About This Publication

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MANHATTAN INSTITUTE FOR POLICY RESEARCH

PRIME THE PUMP: The Case For Repealing America's Oil Export Ban

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INTRODUCTION

The world looked very different 40 years ago when Congress forged the Energy Policy and Conservation Act (EPCA) that would be signed into law one year later, in December 1975, by President Ford. The Act was a matter of national urgency after the 1973 Arab oil embargo created domestic shortages, politically toxic lines at gasoline stations, and, practically overnight, pushed crude prices up some 400 percent.[1]

Motivations for the Act's sweeping provisions to conserve and control energy markets were also fueled by the fact that, after nearly a century of unbridled growth in output from American oil fields, the half dozen years prior to 1975 saw, for the first time, a reversal and precipitous decline in U.S. crude production. At the same time, domestic oil consumption continued its rise, leading to soaring imports—with the economic and geopolitical implications obvious to all. Given such conditions, it was understandable that the EPCA would also implement a ban on crude exports by American firms, driven, as it was, by concerns over import dependency and shortages.[2]

Now, nearly a half-century later, conditions have changed dramatically. The United States has emerged as the world's fastest growing oil-producing nation, with the country's import dependency disappearing no less fast. What caused this permanent, secular shift in oil markets? New technologies deployed by thousands of small and mid-sized businesses. Yet current American oil policy—a misguided mix of thinly veiled industrial planning and state control over a major segment of the U.S. economy—remains locked in historical time warp.

Published by the Manhattan Institute

Encouragingly, the first hint of political recognition of America's new energy realities came this June when the *Wall Street Journal* reported that a "U.S. Ruling Loosens Four-Decade Ban On Oil Exports."[3]

Nevertheless, the headline is misleading: the provisions of the EPCA that prohibit American companies from exercising the right to sell crude oil overseas have not changed. Instead, the U.S. Department of Commerce was merely exercising its EPCA case-by-case authority over the oil export market by granting limited waivers to just two U.S. companies, while re-affirming that there has been "no change in policy on crude oil exports." Only a handful of such waivers have been granted in 40 years.

Still, the Administration's action is a positive step towards what *should* happen: a wholesale legislative reversal of the export ban, such that productive U.S. companies do not have to beg federal permission to sell their products to willing buyers around the world, where demand is surging.

As this Issue Brief will argue, the time has come to revoke the 40-year-old law's ban on oil exports. Such action would open up world markets to all of the small, mid-sized, and large American oil companies (not merely the occasional few that win Washington's regulatory lottery), unleashing yet more production, generating billions of dollars of tax revenues, creating millions more jobs, and reshaping global geopolitics.

I. THE PSYCHOLOGY OF "OIL SCARCITY"

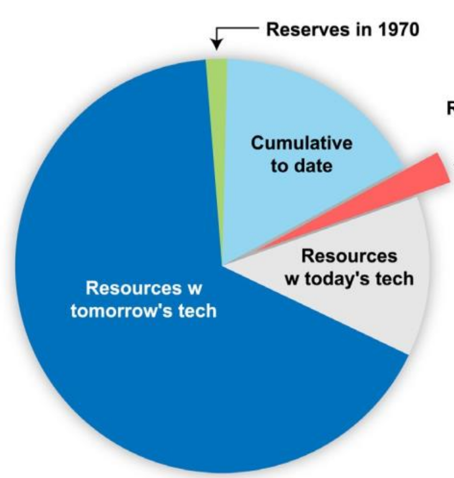
In 1975 Congress passed the EPCA, which incorporated a directive that the President should "promulgate a rule prohibiting the export of crude oil and natural gas produced in the United States, except that the President may...exempt from such prohibition such crude oil or natural gas exports which he determines to be consistent with the national interest and the purposes of this chapter."[4]

The Act entered into law in a climate of unprecedented fear over U.S. energy security. Indeed after a century of steady growth in American oil output, 1970 marked the start of a sharp, multi-year production decline. The 1973 Arab oil embargo followed, causing a 400 percent jump in oil prices practically overnight, stunning the U.S. citizenry and policymakers alike. In 1979 a second oil price shock struck, which—along with ensuing decades of declining U.S. output and rising dependence on oil from often hostile, anti-Western regimes—further reinforced the paradigm of domestic scarcity. All this happened in a stew of popular neo-Malthusian worries, and on the tail of best-sellers such as Paul Ehrlich's 1968 *The Population Bomb* and the 1972 Club of Rome's *Limits To Growth*.

Today, widespread illusions of meager U.S. oil resources continue not only with the persistent (though disproven) 'limits' paradigm, but also from a misunderstanding of, and focus on, reported oil "reserves"—a measure that says nearly nothing useful about long-run supply.

Reserves are determined by a combination of factors: corporate decisions to spend money to map a specific project; legally required financial accounting metrics; and, not least, access to technology capable of extracting a specific resource at a market price, all in the short time-frames associated with narrow business decisions. Reserves, in other words, neither measure geophysical reality nor predict technological progress.

FIGURE 1: U.S. RESOURCES & RESERVES OF OIL*



*U.S. resources & reserves of oil >1,000 billion barrels

Data sources: Energy Information Administration; Congressional Research Service[6]

In 1970, for example, total U.S. "reserves" were officially reported as about 30 billion barrels of oil (see Figure 1). But from 1970 to the present, the U.S. produced nearly 200 billion barrels from those fields. Today, U.S. reserves are, once again, estimated at about 30 billion barrels. Future production will come from new reserves that expand as time, technology, and financial needs progress, thereby allowing developers to access the vast underlying geophysical resources.[5]

Thus, annual U.S. consumption of about seven billion barrels of oil should be juxtaposed against the nearly 1,000 billion barrels of America's resources identified by the Energy Information Administration (EIA).[7] Even that enormous resource figure understates the geophysical reality according to myriad scientific studies, including the U.S. Geological Survey (USGS). For example, one recent USGS report identified between 1,500 and 3,000 billion barrels in just *one* untapped shale region, half of which is thought to be recoverable.[8] It bears noting that this (largely unheard of) Green River formation resides under mainly off-limits federal Bureau of Land Management (BLM) lands in Utah, Colorado, and Wyoming.

The importance of the psychology of "resource adequacy" is revealed in the results of a remarkable new survey from FTI Consulting.[9] The study finds that support for exports amongst both the public and decision leaders increases the greater the belief that America has lots of oil.

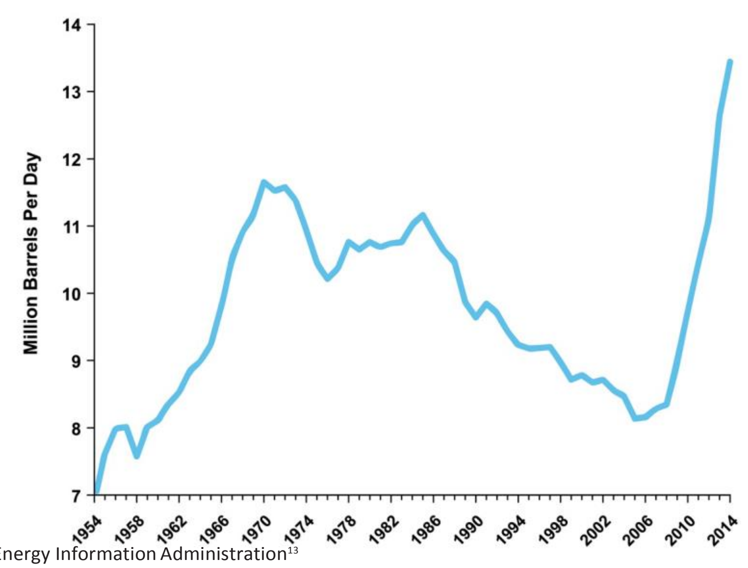
The problem: FTI's poll also found that among D.C. "elite decision leaders", just 22% of Democrats, 31% of Independents, and only a slight majority (58%) of Republicans believe "domestic oil resources are abundant." Similarly, the poll found a mere 14% of the general public and just 34% of D.C. elites know that U.S. oil production is growing at a torrid pace.

II. THE NEW OIL ORDER

We now have abundant evidence that the energy neo-Malthusians were wrong. Continually evolv- ing technology, and the transformation of global markets—wherein America has converted from a growing consumer to an expanding producer—has permanently restructured today's world order.

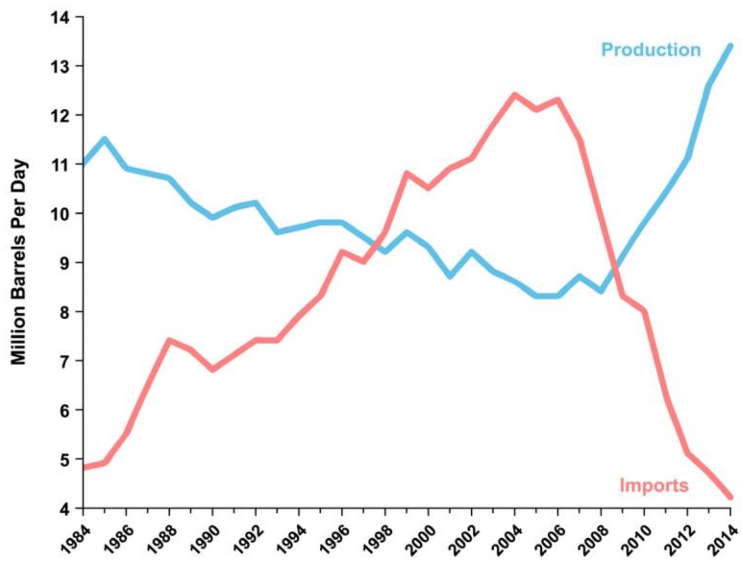
In a few short years, thousands of small and mid-sized companies, using modern smart-drilling technology, have turned America into the world's fastest growing (and soon to be largest) producer of hydrocarbon liquids.[10] In six years, oil production has expanded

FIGURE 2. SIX DECADES OF U.S. PETROLEUM & LIQUIDS PRODUCTION



Data source: Energy Information Administration[13]

FIGURE 3. U.S. PRODUCTION vs IMPORTS: PETROLEUM & OTHER LIQUIDS



Data source: Energy Information Administration[16]

nearly 50 percent.[11] All this activity has added some one million jobs to the U.S. economy.[12] By the end of 2014, U.S. oil production will surpass levels not seen in a half-century—and will continue to grow.

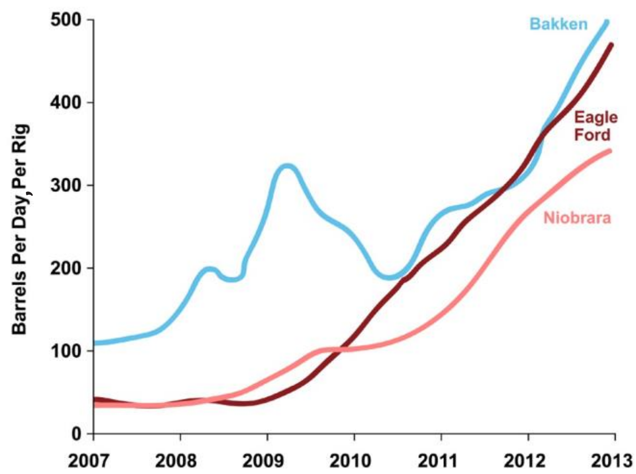
Consequently, the U.S., which imported 60 percent of its oil only a decade ago, saw import dependency drop to just 33 percent in 2013—and is on track to see dependency drop to just 23 percent by 2015, according to conservative estimates by the EIA.[14] In a few more years, bullish forecasts see America becoming a net oil exporter.[15]

The critical point is that today's oil abundance has not arisen from new "discoveries"— the shale fields have been known for ages, with the USGS mapping many a century ago[17]—but from technology progress, in particular from smart drilling. Consider one measure of technology: from 2007-11, twice as many patents were issued for hydrocarbon-related energy technologies as for all non-hydrocarbon energy areas *combined*.[18] While patents are directionally predictive, it is with operational productivity that we see a clear measure of the pace of technological progress. Figure 4 illustrates the rapid, recent gains in the productivity of a shale-oil rig. This alone explains why America is experiencing an oil (and natural gas) boom—and why the traditional practice of simply counting drilling rigs is an insufficient measure of oil production.

In well under a decade, the industry has seen remarkable productivity gains not only in output per rig, but in all measures including: wells per rig, distances drilled per rig, and speed of deployment, all at no significant increase in costs.[20] There is, moreover, much pent-up shale-related technology yet to be unleashed.[21]

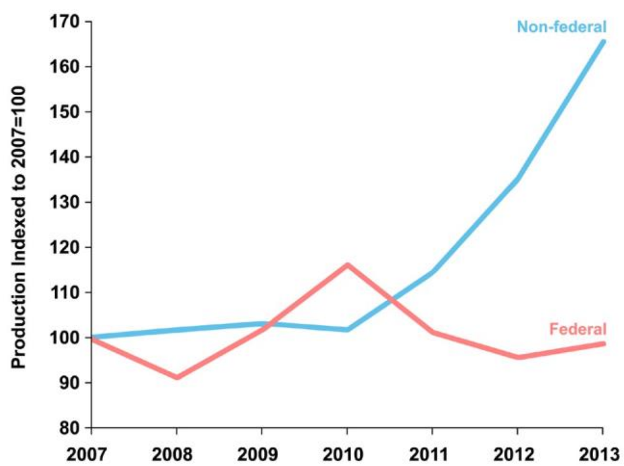
Meanwhile, existing technology could unleash even more from largely untapped federal lands—which account for over half of the continental U.S. and 80 percent of off-shore territory. But thus far, the Congressional Research Service (CRS) has documented that all of the growth in U.S. oil (and natural gas) output has occurred on private and state lands (Figure 5).[22] The main reason? While it takes typically from one week to one month to obtain a state drilling permit, it takes at least ten *times* longer to get a permit on federal land.[23] Worse yet, the average time for a federal permit has risen from 218 days in 2006 to 307 days last year.[24]

FIGURE 4. GROWTH IN OIL RIG PRODUCTIVITY IN MAJOR U.S. SHALE OILFIELDS



Data source: Energy Information Administration[19]

FIGURE 5. CHANGE IN U.S. OIL PRODUCTION: FEDERAL LANDS vs PRIVATE & STATE LANDS



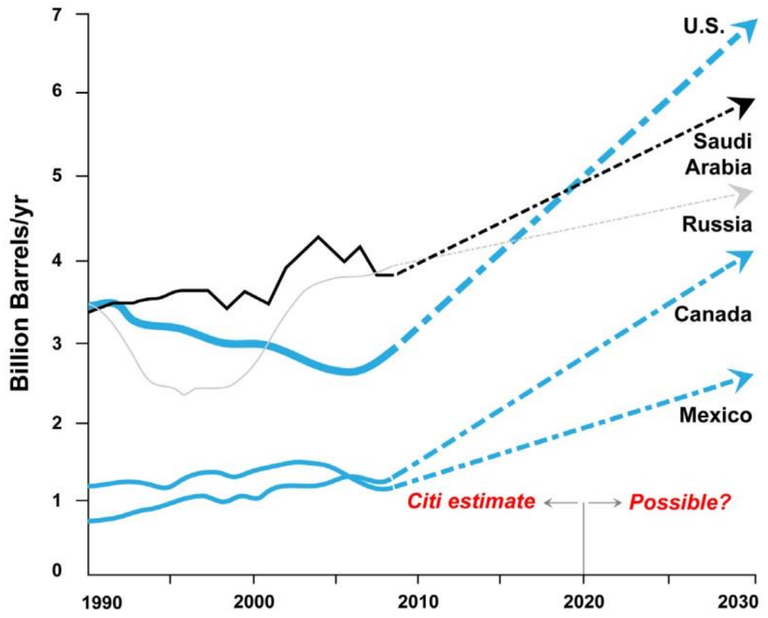
Data source: Congressional Research Service[25]

III. THE POTENTIAL FOR EXPORTS

With soaring world demand but slow growth in U.S. oil consumption, the potential for productive American companies to sell into global markets is greater now than at any time since the turn of the 20th century. The combination of this new reality, along with technology-enabled domestic productivity, creates an extraordinary opportunity for an unparalleled geopolitical, economic, and jobs windfall in the United States. Realizing this opportunity will, of course, depend on pursuing policies that not only allow recent trends to continue, but encourage them too.

Oil remains essential as ever for transportation, and will be for decades.[26] Indeed, with an anticipated growth in air traffic measured in trillions more air miles[27], as well as nearly a billion more cars[28] added to the world over the coming few decades, global oil

FIGURE 6. THE OPPORTUNITY FOR U.S. OIL DOMINANCE: FORECAST OUTPUT FROM MAJOR PRODUCERS



Source: "Unleashing The North American Energy Colossus," Manhattan Institute, Mills, 2012

demand is on track to rise by an amount equal to adding an *entire* U.S. worth of consumption (see Figure 7). If policymakers desire cheaper, more abundant oil, they should unleash domestic producers to make more of it *and* supply global markets.

The new American abundance has driven expansions in refineries,[30] the construction of thousands of rail tanker cars,[31] as well as more than 80 new pipelines.[32] And many existing pipelines, originally built to carry imported oil inland, have had their flow direction reversed to accommodate the complete reversal of where oil is produced.

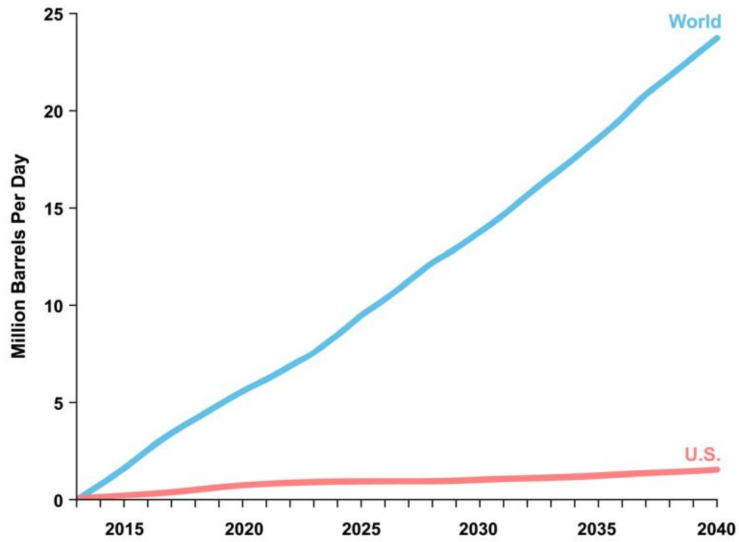
But even as more infrastructure is completed to handle the new output, producers of crude oil are deprived of the freedom to select the most profitable path to markets, in particular higher prices offered by overseas buyers. Without unfettered access to global markets, the full productive capacity of America's hydrocarbon businesses cannot be unleashed.

The current U.S. ban on crude exports, it should be noted, does not extend to selling *refined* oil products, like gasoline, diesel, and aviation fuel. In fact, just a few years ago, the U.S. became a net exporter of refined oil products for the first time since 1949.[33]

Other potential benefits of repealing the ban on crude exports are numerous. Repeal is small-business friendly. Thousands of small, independent American oil companies, not "big oil," created the recent shale- oil boom. It is also small and mid-sized companies that are responsible for 75 percent of all domestic oil and gas production.[34] Moreover, every oil-field job created gives birth to four or five related domestic jobs, from services and hospitality, to transporta- tion, manufacturing, and education, the majority of which are in small businesses too.[35] In every domain, it is the small business sector, a long-favored political constituency, that constitutes the epicenter of job growth.

As such, opening up world markets to domestic producers, thereby stimulating greater production, would add another million American jobs to the more than one million already created in the past half-dozen years in the oil and gas sector.[36]

FIGURE 7. FORECAST GROWTH IN OIL DEMAND



Data source: Energy Information Administration[29]

Though not the focus of this Issue Brief, there are also important geopolitical reverberations associated with America's transformation from a dependent state to a global energy supplier.[37] Already, thanks to the same new shale field technologies, the U.S. has displaced Russia as the world's number one natural gas producer. The geopolitical impact of this is already being felt, despite the fact that significant natural gas exports will not occur for years because of the construction time required to build multi-billion-dollar facilities to liquefy the gas. By comparison, the infrastructure necessary for exporting crude is inexpensive and can be built practically overnight.

IV. ARGUMENTS AGAINSTEXPORTING

Politicians fret that they might be blamed for any future gasoline price spikes if they support lifting the export ban, and thus potentially damage their reelection prospects. Reform will therefore require dispelling popular misconceptions among both the political class and public at large.

At the core of the necessary re-education effort is the need to dispel the myth that, compared to other commodities,oil is a different and, somehow, inherently scarce product.

The first-order determinant of abundance is access to the land that holds any resource, including politically-favored ones like wind or sunlight. Whether energy, minerals, or other resources, once governments allow access to land or sea, it is technology that determines what can be tapped at a reasonable price. Deep-water technology, for instance, unlocked access to the offshore oil resources in the Gulf of Mexico, North Sea, and Brazil's Campos Basin. More recently, smart drilling technology (where hydraulic fracturing was just one feature) unlocked the shales.

To believe the U.S. is in imminent danger of running out of oil requires the belief that we are running out of technology. On the contrary, everything happening in big data, automation, and materials science suggests otherwise—with as much implication for hydrocarbons as for everything else.

As for gasoline prices, economic theory, as well as the long history of other commodities, also points to oil exports creating more global competition and, in turn, lowering average U.S. gas prices. This is also the conclusion of a major new study from IHS-CERA, a respected consultancy.[38] And when oil price spikes do occur—inevitable, given geopolitical realities—the impact on the U.S. economy will be offset by higher revenues and profits flowing to America's exporters, along with an associated reduction in the national trade deficit. There will be no such offset without exports. Moreover proponents of the view that oil—unlike, say, wheat, minerals, or microprocessors—should not be exported, ignore not only basic economic principles, the historical record, and long-standing international trade conventions[39], but also the constitutional freedoms of American businesses to sell their products. As the CRS recently observed, existing export restrictions stand in blatant violation of the 1994 General Agreement on Tariffs and Trade, unless the U.S. government claims national security interests to "protect an exhaustible natural resource."[40] The latter can no longer be credibly claimed in the 21st century.

Finally, certain U.S. constituencies oppose lifting the export ban because they are currently enjoying a bonanza of cheap domestic crude. This is particularly the case for American refineries, which, for the first time in decades, buy crude at prices below those on world markets because American production has risen so fast, so unexpectedly, that the capability to transport, store, and process it all has not kept pace.

The logic to maintain an export ban to benefit U.S. crude refiners is indistinguishable from forcing, say, American tire makers to sell only to domestic auto companies, while allowing the latter to sell globally. Or, forcing American microprocessor manufacturers to sell only to domestic computer companies, while allowing the latter to sell globally. In addition, since gasoline prices are largely set in global markets[41], the current export ban means bigger profit margins for many refineries, not cheaper gasoline for consumers.[42]

Nonetheless, U.S. refiners correctly note that their business is also hampered by another outdated law constraining access to *domestic* markets. The 1920 Merchant Marine Act requires all sea shipments between U.S. ports to use ships built, owned, and operated by American firms. Gulf-coast refiners point out that this doubles or triples transportation costs of American-refined gasoline to the U.S. northeast versus to, say, Canada.[43] (Protectionist instincts of the 1920 Congress aside, one worthy feature of that Act is the national security goal of preserving U.S. ship building capabilities—though rather than hobble the productive capacity of America's oil industries, a more cost-effective solution should be found.[44])

As a practical matter, the current ban on exports constitutes an ill-advised mechanism for the government to pick winners and losers across the hydrocarbon supply chain.

V. PROPOSALS FOR CHANGE

According to the White House Office of the U.S. Trade Representative:[45]

> "Trade is critical to America's prosperity—fueling economic growth, supporting good jobs at home, raising living standards and helping Americans provide for their families with affordable goods and services."

Trade involves, by definition, both buying *and* selling on world markets. The White House and Energy Secretary Ernest Moniz have recently said that oil exports should be on the table;[46] the new Commerce Department waivers are a small, promising step in the right direction.

Yet maintaining current U.S. export bans on crude oil represents little more than old-fashioned domestic price controls and Soviet-style industrial policy. That's something that both Presidents Nixon and Carter tried in oil markets, with regrettable results.

The bottom line: It is time for policymakers to embrace the nation's once-in-a-lifetime economic and geopolitical opportunity by pursuing three key steps to re-align U.S. oil policy with the realities of 21st century technologies and the new market dynamics.

1. Repeal EPCA's constraints on crude oil exports. This can be done in due course by Congress, but in the meantime the Administration should explore simply issuing a blanket waiver to all American businesses—instead of merely two companies with the tenacity to navigate the federal bureaucracy to secure one of the rarely granted waivers.

2. Repeal constraints on domestic hydrocarbon shipping created by the 1920 Merchant Marine Act, while seeking a more cost-effective solution to national security interests associated with subsidizing a domestic ship-building industry.

3. Open up and accelerate access to exploration and production on federally-controlled lands, both on-shore and offshore. This would not only boost domestic economic opportunities, but also send a powerful message to the world about U.S. oil export intentions; the geopolitical impact would rival, in the inverse, the 1973 Arab oil embargo.

Of course, policymakers should also ensure that incentives, rather than impediments, comprise the organizing principles underlying sensible federal regulations impacting oil (and all hydrocarbon) production, transport, and processing.

Finally, there is one further way to prime the pump on exports if Congress and the Administration fail to advance positive reform. Instead of seeking permission to sell oil overseas, a brave domestic crude oil producer could litigate to test the legal validity of one of the most outdated statutes on the books. Such an action would surely end up before the U.S. Supreme Court, where we see precedent emerging regarding the Court's intolerance for antiquated statutes restraining economic rights of American businesses.[47]

ENDNOTES

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REVIEW & OUTLOOK

Exporting American Oil

Moniz breaks the taboo against selling U.S. crude overseas.

Updated Dec. 16, 2013 8:43 p.m. ET

The happy paradox of U.S. energy markets is that the domestic fossil-fuels boom has been overwhelming destructive federal government policy. The latest example of emerging common sense is Energy Secretary Ernest Moniz's suggestion last week that the U.S. may need to reconsider its 40-year ban on most oil exports.

"Those restrictions on exports were born, as was the Department of Energy and the Strategic Petroleum Reserve, on oil disruptions," Mr. Moniz told reporters at the Platts Global Energy Outlook Forum in New York. "There are lots of issues in the energy space that deserve some new analysis and examination in the context of what is now an energy world that is no longer like the 1970s."

Thank you, Mr. Secretary. The oil export ban was one result of the oil-price political panic of the 1970s, which created the worst energy policy in U.S. history until the Pelosi Congress arrived in 2007 to repeat some of the same mistakes. Mr. Moniz is right to raise the issue, and we hope his comments will spur Congress into action.

The U.S. oil boom driven by private investment and ingenuity has transformed North American oil markets, and the International Energy Agency estimates America will surpass Saudi Arabia and Russia as the world's largest oil producer by 2015. Yet with a few exceptions, U.S. producers are barred from exporting crude oil without a license from the Commerce Department.

Commerce has been granting more licenses, albeit fitfully, and the U.S. has been exporting a little less than 100,000 barrels a day on average, mainly to Canada. But this is far less than oil producers would be able to export if they didn't have to submit to such ad hoc bureaucratic review.

Energy Secretary Ernest Moniz *ASSOCIATED PRESS*

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Oil exports would help with the U.S. trade balance, but far more important is that they would allow energy markets to operate more efficiently. Surging domestic production has led to a mismatch between the oil produced in U.S. fields and the types needed by U.S. refiners. The booming new U.S. fields often produce lighter crude that doesn't match the heavier, lower-quality crude from abroad that U.S. refiners typically handle. Without being able to export oil, U.S. drillers have a more restricted market for their high-quality crude and less incentive to expand production.

Opponents of exporting oil claim that lifting the ban would raise U.S. gasoline prices, but that misunderstands that oil is a global market. U.S. pump prices would continue to rise or fall with world oil prices regardless of exports. But lifting the ban would lead to more domestic production, which means more jobs in oil drilling and services and everything that goes along with such growth. See the booming Williston Basin in North Dakota or the Eagle Ford Formation in South Texas.

The opposition to lifting the ban will also play the energy "independence" card, but the best protection for America's energy supply is more domestic production that exports would induce. Some of the opponents don't want such production precisely because they want to stop the U.S. oil boom so world prices rise and renewable energy can replace fossil fuels. That's what motivates Senator Ed Markey (D., Mass.) and others on the environmental left.

The oil export ban is an example of self-defeating resource nationalism that hurts U.S. investment and the living standards of American workers. It was a bad idea in the 1970s, and today it is merely one more obstacle to America's energy renaissance.

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REVIEW & OUTLOOK

Oil Export Folly

The U.S. ban is harming the oil patch and raising gasoline prices.

PHOTO: GETTYIMAGES

Updated March 13, 2015 6:47 p.m. ET

Lower oil prices are roughing up what has been a thriving U.S. oil patch, with some 74,000 layoffs since November and the drilling rig count down 38%. If the political class wants to do more than wring its hands, it could save American jobs and investment by lifting the ban on oil exports—and soon.

Richard Nixon imposed the export ban during the oil-supply panic of the early 1970s, and for decades it hardly mattered. U.S. oil production kept declining so export markets weren't needed. Then came hydraulic fracturing (or fracking) and horizontal drilling, which has turned the U.S. into the world's largest producer of petroleums and related liquids.

Harold Hamm, the founder of Continental Resources and one of the leaders of the shale drilling revolution, refers to the U.S. oil patch as Cowboyistan. He means the Bakken formation in North Dakota, the Eagle Ford in Texas and the new Permian Basin straddling west Texas and New Mexico. Since 2008, says Mr. Hamm, Cowboyistan has "generated 50% of the world's oil production growth" and 70% of North America's.

That production is now under pressure from lower prices, but the damage could be reduced if U.S. producers were able to export more of their product to meet demand in the global market. American frackers produce the light, sweet crude known as West Texas Intermediate (WTI), and world refineries are eager for more.

But U.S. producers can't export their oil, and U.S. refineries are mainly built to process heavier oil imported from Mexico, Venezuela and Canada. This refining mismatch means that U.S. oil is piling up in storage or being sold at a discount. WTI now trades 20% below the world market price, which means additional pressure on U.S. producers to stop drilling.

That plays into the hands of Russia and Saudi Arabia, which are only too happy to see U.S. production fall so global prices can climb again. The Saudis all but said that undercutting U.S. drillers was their goal when they decided last year not to cut their production quotas. Why would Washington want to help Vladimir Putin?

The political fear is that lifting the ban would increase U.S. gasoline prices, but the opposite is true. U.S. pump prices are mainly tied to the price of Brent crude, which is freely traded on the world market and is higher than it might otherwise be because of the ban on U.S. exports.

If U.S. producers were allowed to compete globally, prices of Brent and WTI would converge over time, and U.S. gasoline prices would come down, all other things being equal. As former Obama White House economic aide Larry Summers explained at the Brookings Institution last summer, "permitting the export of oil will actually reduce the price of gasoline."

The export bottleneck is also taking a toll on jobs and investment. A 2014 report from the consultancy IHS Global estimated that lifting the ban "will create at its peak one million jobs and increase GDP by $135 billion." Instead, Continental Resources estimates that in addition to the 73,500 layoffs, capital spending in the oil patch has declined by $61 billion since November and the rig count has dropped by 737 to 1,192. This implies a output decline in Cowboyistan of 1.55 million barrels a day by midyear.

One of our friends in private equity estimates that the U.S. shale industry will have a net negative cash flow in 2015 of about $100 billion. Producers are trying to ride out this storm with oil bonds and other bridge financing in the hope that world prices will bounce back soon. But with China's economy slowing and the U.S. dollar (oil trades in dollars) reaching new heights, the price could stay down for months or years.

All of which makes lifting the export ban an easy call. It would help U.S. producers adjust to lower prices while creating an incentive to maintain more American production. The result would be less reliance on foreign oil, while reducing bankruptcies in the oil patch if global prices stay low.

Key Republicans and the White House understand this, but they're moving slowly for their own reasons. The GOP fears a populist backlash pushed by Democrats like Chuck Schumer and Ed Markey playing the phony nationalism card.

As for President Obama, he could do more to lift export curbs through executive action. Yet this is one area in which he refuses to act on his own. The longer he waits, the more we suspect that he may want less U.S. oil production because of his hostility to carbon fuels in the name of limiting climate change. Whether he goes along or not, Republicans should start to explain to the public that the oil export ban is harming U.S. workers, producers and consumers.

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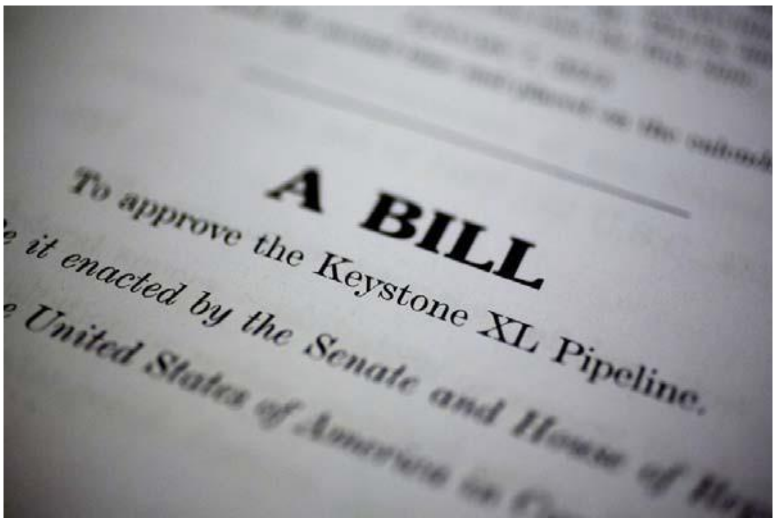
REVIEW & OUTLOOK

Oil Export Myths

Lifting the ban will increase U.S. supply and energy security.



A copy of S.1, a bill to approve the Keystone XL Pipeline *PHOTO: BLOOMBERG*

Jan. 16, 2015 6:46 p.m. ET

The new Congress is set to make the biggest changes in U.S. energy policy in nearly a decade, against the backdrop of the domestic shale boom. This represents major progress, assuming that some Republicans aren't intimidated by economic myths about energy security.

The first big Senate debate concerns approval of the Keystone XL pipeline, which seems likely to pass. The GOP majority also wants to speed up approvals for liquid-natural gas terminals, reduce limits on drilling, and block new regulatory roadblocks from the Administration. These are all pro-growth moves.

But the Keystone debate is taking place under new Majority Leader Mitch McConnell's pledge to allow amendments, in contrast to Harry Reid's kindergarten class. Democrats naturally want to join the debate, and some of them plan to offer measures that would harm U.S. production under the false flag of reducing oil exports.

One liberal target is to prevent any easing in the 39-year-old ban on oil exports. The ban makes less sense each year as U.S. production increases, with the latest estimate at 9.3 million barrels per day in 2015, up from about nine million last year. But the ban makes for good populist politics, and New York Senator Chuck Schumer is promoting an amendment requiring that any oil that flows through the Keystone XL must stay in the U.S.

This makes no economic sense, starting with the fact that the oil market is global. What matters for prices are global supply and demand. To the extent more U.S. crude makes it to the global market, prices will be lower, other things being equal.

All the more so given that most U.S. oil is lighter crude that can't all be processed by U.S. refiners. American refineries on the Gulf Coast were built to process heavy imported crude from the likes of Venezuela. Light crude is valuable and should be fetching a premium. Instead, U.S. producers are at the mercy of U.S. refiners, since the export ban means they have nowhere else to sell.

As U.S. supplies have swelled, those refineries have had more leverage to push down prices for U.S. shale oil. While the price of Brent crude, the world benchmark, is still about $50 a barrel, producers in the Bakken Shale in North Dakota this month are averaging about $34 a barrel for light crude. Exports would allow a more efficient oil market.

Opponents of lifting the ban argue that keeping U.S. oil here will enhance U.S. energy security, as if it can be stockpiled for use in an emergency. The feds already have the Strategic Petroleum Reserve, which can provide some relief in a genuine crisis. But companies are only going to drill if they can sell oil at a profit.

The best guarantee of energy security is robust American production capacity. Allowing exports will at the margin provide more incentive to drill. By the way, consumers don't purchase crude oil. They buy refined products, of which the U.S. is already a net exporter.

The federal Government Accountability Office, Congressional Budget Office, the Brookings Institution, Aspen Institute and IHS consultants have published studies showing that more oil exports would benefit U.S. consumers. The studies estimate drivers would realize anywhere from a 1.5-cent to a 12-cent per-gallon reduction in gasoline prices, as well as lower costs for heating and diesel fuel.

The studies also show that oil exports would result in big economic and job gains, as producers plow higher returns back into production. A recent study by consultants ICF International for the American Petroleum Institute found that allowing exports would increase U.S. oil production by as much as 500,000 barrels a day by 2020, creating as many as 300,000 more jobs and adding $38 billion to GDP.

To the extent it increases supply, U.S. oil exports would also provide a strategic benefit. Lower world prices put pressure on rogue regimes that are big oil producers such as Russia, Iran and Venezuela.

Most liberals know all this, which betrays that their real reason for supporting the oil export ban isn't energy security. It's climate-change politics. They know the shale boom has undermined their drive for renewable fuels by providing cheap oil and natural gas. They also know that exporting U.S. oil will increase the U.S. incentive to drill, and they'd rather all that oil and gas stay in the ground.

There's an inside-the-Beltway debate about the best timing for a vote to lift the export ban, and we'll leave that to the pros. The point is that allowing oil exports ought to be as much a part of the GOP energy agenda as Keystone XL, liquid-gas exports or relief from the Environmental Protection Agency. It's the kind of pro-growth policy that voters elected a GOP Congress to support.

The Washington Post

The Post's View

Commerce Dept. should allow exports of U.S. crude

By Editorial Board August 6, 2014

THE UNITED States is a rising oil exporter. That sentence is amazing when you consider that federal law technically bans crude oil exports.

Last week, the BW Zambesi oil tanker left Texas City, Tex., with $40 million worth of minimally processed condensate, a form of oil, and headed to South Korea. This was the first shipment following a Commerce Department determination that decades-old federal restrictions on crude oil exports do not apply to condensate from which drillers have removed various natural compounds. That stuff, regulators said, falls under an exception to the export ban that allows the shipping of oil that has been processed. This policy change may clear the way for more U.S. crude exports. While polls show Americans are worried about that prospect, it actually is an unambiguous win for the country. If anything, the rules should get less restrictive.

The case against U.S. oil exports seems simple and obvious: Why allow them when the country still imports some crude? The answer is slightly more complicated. The U.S. has become an energy powerhouse, with crude oil production leaping some 48 percent in the last few years. New technology is tapping oil-bearing shale formations in states such as North Dakota and Texas. Most of this product is light oil, which does not require heavy refining. Some of the most advanced refineries in the world are along the Gulf Coast , but that's actually a problem: Their owners invested in expensive facilities suited to refining heavier crude, so there is a mismatch between the refining infrastructure and the type of crude flowing from U.S. wells. In the deeply interconnected global oil market, in which borders matter less than many people think, the obvious solution is to allow oil companies to ship the light crude to refineries suited for processing it, supporting U.S. profits and U.S. jobs in the process, and to tolerate imports of crude oil that U.S. refineries can handle.

But what about energy security? The Council on Foreign Relations's Blake Clayton points out that expanded exports would encourage the development of oil fields and transport infrastructure, which would help the country weather some disruption in the global oil trade. Then there is the question of what lifting the ban would mean for domestic gasoline prices. This embarrassing debate discredits the Obama administration as it lectures other nations about irrational government barriers and supports in the fossil fuels business, which skew consumption habits and reduce the resilience of the world oil market on which everyone depends.

The export ban was a desperate ploy in the 1970s to control commodities markets amid spikes in oil prices induced by the Organization of the Petroleum Exporting Countries. Keeping it in place now is an economically incoherent policy, particularly when removing it would encourage an industry that is transforming the fortunes of large swaths of the nation. Congress should lift the ban entirely. Until then, Commerce should allow as much oil as it can to flow through the ban's exceptions.

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FINANCIAL TIMES

August 3, 2014 7:12 pm

US should end energy protectionism

Obama must include energy in proposed EU trade deal

US energy policy passed a milestone of sorts earlier this month after two companies revealed they had been given permission by the US commerce department to export "condensate", an ultralight form of oil, after minimal processing. Unfortunately the broader ban on US crude oil exports, imposed after the 1970s Arab oil embargo, remains in place. The White House was quick to clarify that the permissions were exceptional. Similar if somewhat less restrictive inhibitions apply to the export of US liquefied natural gas – the fruits of its hydraulic fracking boom. Barack Obama's administration is resisting the EU's demand to include an energy chapter in the transatlantic trade and investment partnership. He should think again. If TTIP is to fulfil anything close to its ambitions, it must tackle energy. Add in the threat Vladimir Putin poses to Europe's energy security and the case looks unanswerable. The time has come to put an end to US energy protectionism.

The best argument for doing so is economic. US oil refiners have benefited hugely from the 1975 export ban but at the expense of almost everyone else. Those who lose out include US oil producers and consumers as well as European refiners. In the case of the first, producers get a smaller market for their product – they are forced to sell to domestic refiners. Meanwhile US consumers pay global prices at the pump even though domestic oil is currently $7 a barrel cheaper. There is also a growing mismatch between US supply and demand. Many US refineries are designed to process heavy crude from the Middle East and elsewhere. They are ill-equipped to handle the lighter and sweeter crude that comes from the US shale oil boom. America still imports about a third of its oil. But that share is falling rapidly. Unless the export ban is lifted, the US could face the paradox of a glut of light domestic crude in the Gulf region, even as millions of barrels per day of heavy oil imports are still coming into the country.

There is also a powerful strategic case. Europe relies heavily on Russian gas pipelines. Mr Putin has shown no compunction about using the threat of cutting supplies – or jacking up prices – as a lever to extort diplomatic concessions. Ukraine and other near neighbours have been the principal victims. There is nothing to stop Mr Putin from threatening Germany and others with similar measures. As the EU comes around to Mr Obama's agenda of tougher sanctions on Russia, it is strongly in US interests to support its energy diversification. It would also help revive the case for TTIP in Europe by giving governments a stronger case to take to their electorates. At the moment most of the oxygen is taken by those who oppose any deal because of fears of lower US food standards, weaker data privacy protections and so forth. Adding an energy chapter would restore flagging momentum to TTIP's supporters.

Mr Obama is reluctant to risk a showdown with environmentalists and industry lobby groups ahead of November's midterm elections. Adding an energy chapter to TTIP would risk provoking one. Greens oppose exporting US hydrocarbons partly because of global warming. Some manufacturers oppose liberalising LNG exports because it would reduce their price advantage from cheaper shale gas. Both arguments are mistaken. Gas is the least carbon-intensive fossil fuel and it makes no difference where it is consumed. As for the second point, US manufacturers would still enjoy lower gas prices. Boosting shale exports would also stimulate further investment in its supply. The case for going ahead is compelling. Mr Obama has staked much of his reputation on building a 21st-century transatlantic economic partnership. He must not allow a noisy but small group of protectionists to stand in his way.

Letter in response to this editorial:

A reckless rush to embrace fossil fuel / From Mr Samuel Lowe

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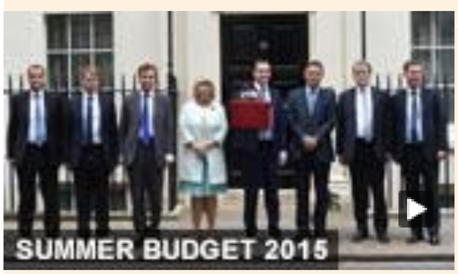

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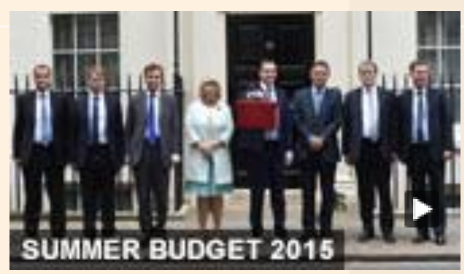

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Energy

Seize the day

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The fall in the price of oil and gas provides a once-in-a-generation opportunity to fix bad energy policies

Jan 17th 2015 | From the print edition

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MOST of the time, economic policymaking is about tinkering at the edges. Politicians argue furiously about modest changes to taxes or spending. Once in a while, however, momentous shifts are possible. From Deng Xiaoping's market opening in 1978 to Poland's adoption of "shock therapy" in 1990, bold politicians have seized propitious circumstances to push through reforms that transformed their countries. Such a once-in-a-generation opportunity exists today.

The plunging price of oil, coupled with advances in clean energy and conservation, offers politicians around the world the chance to rationalise energy policy. They can get rid of billions of dollars of distorting subsidies, especially for dirty fuels, whilst shifting taxes towards carbon use. A cheaper, greener and more reliable energy future could be within reach.

The most obvious reason for optimism is the plunge in energy costs. Not only has the price of oil halved in the past six months, but natural gas is the cheapest it has been in a decade, bar a few panicked months after Lehman Brothers collapsed, when the world economy appeared to be imploding. There are growing signs that low prices are here to stay: the rising chatter of megamergers in the oil industry (see article) is a sure sign that oilmen are bracing for a shake-out. Less noticed, the price of cleaner forms of energy is also falling, as our special report this week explains. And new technology is allowing better management of the consumption of energy, especially electricity. That should help cut waste and thus lower costs still further. For decades the big question about energy was whether the world could

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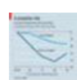
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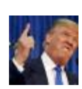
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Money talks: July 8th 2015: Separation anxiety

produce enough of it, in any form and at any cost. Now, suddenly, the challenge should be one of managing abundance.

Clean up a dirty business

That abundance provides the potential for reform. Far too many economies are littered with the detritus of daft energy policies, based on fears about supply. Even though fracking has boosted America's oil output by two-thirds in just four years, the country still bans the export of oil and restricts exports of natural gas, a legacy of the oil shocks of the 1970s—and a boondoggle for American refiners and petrochemical firms. Congress also keeps handing out money to Iowa's already coddled corn farmers to produce ethanol and has not reviewed generous subsidies for nuclear power despite the Fukushima disaster and ruinous cost over-runs at new Western plants. Instead, it has spent four long years bickering about whether to allow the proposed Keystone XL pipeline to Canada's tar sands. In Europe the giveaways are a little different—billions have gone to wind and solar projects—but the same madness often prevails: Germany's rushed exit from nuclear power ended up helping boost American coal and Russian gas.

The most straightforward piece of reform, pretty much everywhere, is simply to remove all the subsidies for producing or consuming fossil fuels. Last year governments around the world threw $550 billion down that rathole—on everything from holding down the price of petrol in poor countries to encouraging companies to search for oil. By one count, such handouts led to extra consumption that was responsible for 36% of global carbon emissions in 1980-2010.

Falling prices provide an opportunity to rethink this nonsense. Cash-strapped developing countries such as India and Indonesia have bravely begun to cut fuel subsidies, freeing up money to spend on hospitals and schools (see article). But the big oil exporters in the poor world, which tend to be the most egregious subsidisers of domestic fuel prices, have not followed their lead. Venezuela is close to default, yet petrol still costs a few cents a litre in Caracas. And rich countries still underwrite the production of oil and gas. Why should American taxpayers pay for Exxon to find hydrocarbons? All these subsidies should be binned.

What a better policy would look like

That should be just the beginning. Politicians, for the most part, have refused to raise taxes on fossil fuels in recent years, on the grounds that making driving or heating homes more expensive would not only annoy voters but also hurt the economy. With petrol and natural gas getting cheaper by the day, that excuse has gone. Higher taxes would encourage conservation, dampen future price swings and provide a more sensible way for governments to raise money.

An obvious starting point is to target petrol. America's federal government levies a tax of just 18 cents a gallon (five cents a litre)—a figure that it has not dared change since 1993. Even better would be a tax on carbon. Burning fossil fuels harms the health of both the planet and its inhabitants. Taxing carbon would nudge energy firms and consumers towards using cleaner fuels. As fuel prices fall, a carbon tax is becoming less politically daunting.

That points to the biggest blessing cheaper energy brings: the chance to inject some coherence into the world's energy policies. Governments have a legitimate role in making sure that energy is abundant, clean and secure. But they need to learn the difference between picking goals and deciding how to reach them. Broad incentives are fine; second-guessing scientists and investors is not. A carbon tax, in other words, is a much better way to reduce emissions of greenhouse gases than subsidies for windmills and nuclear plants.

By the same token, in the name of security of supply, governments should be encouraging the growth of seamless global energy markets. Scrapping unfair obstacles to energy investments is just as important as dispensing with subsidies. The more cross-border pipelines and power cables the better. America should approve Keystone XL and lift its export restrictions, while European politicians should make it much easier to exploit the oil and gas in the shale beneath their feet.

This ambitious to-do list will drive regiments of energy lobbyists potty. But for the first time in years it is within the realm of the politically possible. And it would plainly lead to a more efficient and greener energy future. So our message to politicians is a simple one. Seize the day.

From the print edition: Leaders

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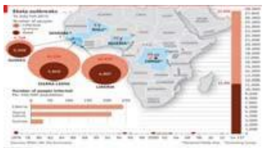
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BloombergView

ENERGY

For Energy Security, Export Oil

APR 6, 2015 11:13 AM EDT

By The Editors a A

It's a pernicious bit of American mythology that is used to justify the law against domestic oil producers selling their crude overseas: The U.S. needs "energy independence." Never mind that the law actually undermines this goal, or that the goal itself is practically impossible to achieve. It's the wrong goal. What the U.S. should be striving for is not independence, but energy security.

The story behind the myth goes something like this: If the U.S. doesn't hoard all its oil, then it can't hope to attain energy independence. And until it does that, it has to keep buying oil from politically unstable or unfriendly regimes. Therefore U.S. consumers must tolerate volatile prices for gasoline and heating oil.

The tale is false, but it brushes against one truth: When instability in other countries affects the price of oil, the U.S. economy can suffer. Just last month, the price jumped almost *S* percent when Saudi bombs began to fall on rebel targets in Yemen. Such unpredictable spikes make it difficult for many U.S. businesses to plan ahead, and this means less investment and less hiring.

The way to lessen U.S. vulnerability, however, is not to withdraw from the world oil market altogether (if that were even possible). It's to sell more of the U.S.'s expanding crude stores abroad. As a bigger player, the U.S. would have a greater influence on price.

This reality was not obvious when Congress imposed the export ban in the 1970s in response to the Arab oil embargo. Back then, no one foresaw that the U.S. could become such an enormous producer. Now, however, technologies such as hydraulic fracturing and horizontal drilling enable the U.S. to produce more than 9.2 million barrels of crude per day, up from million just five years ago.

This oil -- much of it from shale deposits in North Dakota and Texas is light, sweet crude, which would fetch a relatively good price if it could be sold abroad. But it's stuck in the domestic market, where many refineries are configured to process heavier crudes, which they can buy from Venezuela, Canada or Mexico at lower prices.

At the moment, the difference between oil's global benchmark price for May delivery (about $57) and its U.S. price (about $51) is a considerable spread. It could grow as U.S storage facilities fill up. This makes things unnecessarily difficult for U.S. producers.

Meanwhile, the situation does nothing to keep U.S. consumer gasoline and heating oil prices low, because the export ban doesn't include those refined products. They're exported and imported freely, so their prices are set on the global market. The discount that U.S. refiners get for American crude isn't passed along to consumers. If U.S. oil could be exported, it would help keep oil and gasoline prices down worldwide

It's true that the oil bonanza has enabled the U.S. to reduce oil imports. Still, they amount to more than 7 million barrels a day. And while exporting would cause that amount to increase, U.S. producers would produce more oil, and net imports would fall

So why not just lift the ban? Because members of Congress are basically afraid that if they were to do that, and the price of gasoline were to rise, they would get the blame. Balanced against the reward of a more stable and reliable energy market -- and the reality of currently low gasoline prices -- that doesn't seem such a huge risk. In any case, it's the kind of risk politicians are elected to take

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Lift oil export ban: Our view

The Editorial Board, *7:52 p.m. EST February 4, 2014*

It's an unsuccessful attempt to insulate Americans from volatile global energy markets.

(Photo: Jeff Morehead, AP)

In October 1973, Arab oil-producing nations angry at America's support for Israel in the Yom Kippur War began an oil embargo that slashed U.S. supplies, shocking Americans long used to cheap and plentiful gasoline.

Huge lines sprang up at gas stations, and it was common to wait an hour or more to fill up. Prices soared more than 40%, and sales were rationed.

The embargo ended in March 1974 (http://history.state.gov/milestones/1969-1976/oil-embargo), and many of the measures it spawned have faded away over the past 40 years, including the nationwide 55 mph speed limit and year-round daylight savings. But some ghosts from the 1970s still haunt U.S. policy, and it's time for them to go, too. A prime candidate is the ban on exporting U.S. crude oil, an unsuccessful attempt to insulate American consumers from volatile global energy markets.

OPPOSING VIEW: Keep every drop of oil at home (/story/opinion/2014/02/04/oil-supply-center-for-american-progress-editorials-debates/5212431/)

Domestic oil production was beginning a long decline in the early 1970s, and in the general panic, it seemed reasonable to try to keep every drop here at home, even if that meant meddling with the nation's usual commitment to free trade.

That was then. Now, North American oil production is surging, thanks largely to the "fracking" boom in areas such as North Dakota. Energy producers are pushing to have the ban on exports lifted and, last week, the Senate held its first hearing in 25 years on the subject.

Defenders of the export ban claim it keeps consumer prices down, but that seemingly logical argument ignores how the global oil markets work. U.S. crude oil is about $9 a barrel less expensive than the benchmark world price, but that difference doesn't go to drivers in the form of lower gasoline prices. It fattens the profits of refinery owners.

Refiners banned from exporting crude face no such prohibition on exporting oil products such as gasoline. So they can buy crude low and sell gas high, at the world price. No wonder some refiners defend the export ban.

Trying to artificially hold down the price of domestic crude will, over time, discourage exploration and mute a stunning production boom that is helping drive the USA tantalizingly close to energy independence, a national goal since the '73 oil shock.

Further, banning most oil exports is dangerously hypocritical for a nation that hauls other countries before the World Trade Organization for similar behavior, such as China's policy of restricting exports of rare earth minerals (http://www.usnews.com/news/blogs/at-the-edge/2013/04/02/chinas-continuing-monopoly-over-rare-earth-minerals) that are crucial to the manufacture of electronics from iPhones to missile guidance systems.

Except in rare instances, U.S. consumers benefit when energy policy favors open markets. That includes allowing construction of the stalled Keystone XL pipeline, which would bring oil from Canada to the United States. The pipeline would help displace the crude the nation still imports from less friendly nations, would be safer than rail transport and, according to a new State Department study, wouldn't significantly harm the environment (http://apps.washingtonpost.com/g/page/politics/keystone-xl-pipeline-environmental-impact-statement/789/).

An end to the export ban is a heavy lift in a congressional election year, but politicians who defend the ban shouldn't be allowed to hide behind the argument that it helps consumers. Like leisure suits and other vestiges of the 1970s, it deserves to fade away.

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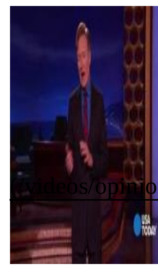
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Chicago Tribune

Editorial: Lift the U.S. ban on oil exports

Capitalize on America's energy boom

December 30, 2013

An oil well near Tioga, North Dakota. (Karen Bleier, Getty-AFP)

Uncle Sam has a chance to make one of the good-news stories of 2013 even better next year. Thanks to the extraction technique known as fracking, the U.S. is producing much more oil than was expected just a few years ago. Modern industrial economies run on oil, so a boost in domestic supply helps business to grow, and lessens the nation's dependence on the volatile Middle East.

Trouble is, America's oil policies haven't kept up. Some key laws date to the oil embargo of 1973, when Middle East suppliers abruptly cut off America and Europe. Prices soared, and long lines formed at fueling stations. In response, the U.S. set out to promote conservation and domestic exploration, and also to control the free market by restricting trade — always a mistake in the long run. Among other anti-competitive steps, Congress made it illegal to export domestically produced crude oil. That policy didn't discourage foreign imports or conserve domestic reserves in the way Congress intended. Instead, it discouraged new production.

U.S. crude can be exported only if the federal government deems the shipments consistent with the national interest. That vague legal standard has in effect made it impossible for oil producers to export crude, except a small amount sent to Canada, although exports of gasoline and other refined products have been soaring lately.

Like free trade in general, selling American oil overseas would be good for our economy. It would make the oil market more efficient, encourage a build-out of the U.S. energy network and stabilize prices over time for consumers.

This is no small matter: By some estimates, drillers could be generating billions of dollars in annual revenues from exports within a few years if the ban were lifted. That additional business would translate into job creation as the oil industry invested in refineries and transportation networks to handle the light, high-quality crude being produced domestically. (Much of the U.S. oil infrastructure is geared for heavier crudes from Canada, Mexico and Venezuela.)

Lifting the export ban also would demonstrate Washington's commitment to free and fair commerce as trade negotiations get rolling with Europe and Asia.

Congress should have lifted the ban years ago. Politicians have been wary, however, fearing that exports will result in rising prices at the pump, and a backlash from voters.

Those fears are misguided. The ban does nothing to keep domestic gasoline prices lower. The big winners are the operators of U.S. refineries that can buy light crude oil at depressed prices because there is nowhere else to process it. Those same refineries can sell their gasoline and other products at market prices, reaping a windfall. Producers, meantime, are stuck selling at a discount, or reluctantly leaving their oil in the ground.

The best outcome for U.S. consumers would be a further boom in U.S. oil production, resulting in exports that drive down global oil prices and thereby dampen fuel costs here. More likely, however, gas prices wouldn't budge much at all as a result of the ban being lifted. Americans still would benefit, mainly from the economic development that would follow, and the positive influence of reducing the nation's dependence on foreign supplies.

We were encouraged by the recent comments of Energy Secretary Ernest Moniz, who called for "new analysis and examination in the context of what is now an energy world that is no longer like the 1970s." If Congress won't act, the Obama administration could suspend the export ban, or issue much broader licenses for exports than it has so far.

We recognize that helping consumers and the economy is not the only consideration. The federal government also must view oil exports in the context of national security: The government should retain its ability to restrict or ban exports of this strategic petrochemical during severe product shortages or other national emergencies.

Today, however, the government has no reason to keep holding back one of the nation's most promising industries.

The Boston Globe

Editorial

Lift outdated oil export ban

IN A SHOWDOWN between oil companies and refineries, consumers and environmentalists might wish they could both lose. But as Washington considers a major change in US energy policy that has divided the fossil fuel industry, it's the oil companies who have a better argument. The current ban on exporting oil has done pretty much nothing to help everyday consumers, but it has enriched refineries. There is no longer a convincing justification for this outdated policy.

Since the 1970s, federal law has prohibited oil companies from exporting most oil drilled in the United States, a ban that was supposed to promote energy independence. It didn't. Instead, the ban's impact has been to create two markets for oil: one in the United States, and one in the rest of the world. Typically, the price of crude oil in the United States is a bit lower than the world price. Refineries that buy the oil at the lower price to turn into gas, though, don't pass on the savings: a recent government study confirmed that the price of gasoline American consumers pay follows the world price, not the domestic price, since there's no ban on exporting refined products.

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The main support for keeping the ban comes from some refineries like Valero, who've enjoyed a windfall from artificially low prices, and their workers, who see the ban as a jobs-protection measure. Oil companies counter that they create jobs too, and that lifting the ban would help them create more. They've never liked the ban, but rarely complained when the spread between the US and world price was small. Since 2010, though, with American production surging, the difference has at times exceeded $10 a barrel.

For businesses on both sides of the fight, the fate of the export ban is simply a matter of profit. The deciding factors for the Obama administration and Congress should be the enviromental and consumer impacts. On the consumer side, there's already evidence to suggest little would happen; in 1996, President Clinton relaxed the export ban on some types of Alaska oil, and it had no impact on consumer prices. A recent GAO report found that the impact of lifting the entire ban might be mixed, with some regional variation. The Northeast, for instance, could see higher gasoline prices. On the whole, though, because lifting the American ban would probably slightly reduce the world price of oil, and because gas prices follow the world price, lifting the ban could push prices down.

Environmentally, lifting the ban could make it more profitable to drill in the United States and thus, according to the GAO, may increase greenhouse gas emissions. But it would also make it less profitable to drill elsewhere, and could reduce crude oil production in other parts of the world. From a climate perspective, if more barrels of American light crude oil on the market displaced dirtier Venezuelan crude or Canadian tar sands oil, the net impact could be positive.

With no clear-cut consumer or environmental case supporting the ban, its main defender, Massachusetts Senator Ed Markey, instead cites its initial purpose: to encourage energy independence. Just like 40 years ago, the United States still imports some types of oil, and will continue to do so for the foreseeable future. Markey is right that that's a problem — but nearly four decades of experience show that the crude oil export ban won't solve it. The goal of American policy should be to reduce demand for oil — for instance, through a carbon tax — rather than tinker with the supply. The current policy takes from Big Oil and gives to refineries, but serves no public purpose.

TRIBLIVE | Opinion/The Review

Our energy boom: Export bonsuses

By The Tribune-Review
Tuesday, Dec. 2, 2014, 9:00 p.m.

Repealing America's 1970s-era ban on oil exports is what its shale oil industry needs to continue thriving amid depressed global oil prices — and what U.S. consumers need for lower gasoline prices to continue.

A change in gasoline's global pricing negates the old notion that sending more U.S. oil overseas would raise domestic pump prices, The Washington Times explains. Before 2010, U.S. gasoline prices were linked to the New York Mercantile Exchange's “West Texas Intermediate” (“WTI”) oil price. That price has been lower in recent years than the Intercontinental Exchange's “Brent” oil price, to which U.S. gasoline prices have been linked since 2010 in a market globalized by U.S., Saudi and other gasoline exports.

Repealing the U.S. oil export ban would allow U.S. shale oil producers to sell at higher “Brent” prices overseas, instead of at lower “WTI” prices to glutted domestic refineries. And adding U.S. exports to global supply also would lower oil's global “Brent” price — and, thereby, what Americans pay for gasoline.

That's what General Accountability Office and private studies have found. It's what an upcoming Energy Information Administration report is expected to find, too. The benefits for America's shale industry, consumers and the overall economy make repealing the export ban a no-brainer — and the opposition of too many congressional Democrats an outmoded relic.

EDITORIALS

Ban on oil exports should be lifted

By The Denver Post Editorial Board

Energy independence is one those slogans that politicians mouth without thinking, no doubt because it sounds so appealing. What could be better than freeing the U.S. from dependence on unstable or predatory regimes with vast energy reserves?

There's one major flaw in the argument, though. While natural gas does indeed have a domestic market that is largely untethered to gas markets in, say, Europe or East Asia, the same is not true of oil. The world market for oil is highly intertwined, especially for refined products. U.S. consumers would suffer a price shock at the pump in the event of a major disruption in supplies almost anywhere — say, a major Middle East oil field falls prey to a terrorist attack — even if the U.S. produced enough for its own consumption.

And yet the U.S. continues to impose a ban on oil exports that was enacted in the 1970s in the wake of the Arab oil embargo. For years the ban was relatively harmless, but today it inhibits domestic production and should be lifted.

Soaring U.S. production — from 5.5 million barrels of crude per day five years ago to 9.2 million today — is one of the major reasons the world price of oil fell so dramatically last year. But U.S. producers could have an even larger impact on world supplies and thus prices if they could directly export oil rather having to refine it here first — particularly because many refineries were set up to handle heavier crude imported from abroad.

The Brookings Institution is one of several policy organizations to conclude the export ban is outdated. Charles Ebinger and Heather Greenley of Brookings summed up their findings last year. "The report's analysis shows categorically that the crude oil export ban does not, and for some time has not, advanced U.S. energy security," they wrote. "To the contrary, our analysis demonstrates that lifting the ban will increase U.S. oil production, diversify global supply, reduce U.S. gasoline prices and provide net benefits to the U.S. economy."

The president has the power to lift the ban on his own. Congress could do it, too. If they did, they'd be creating jobs and aiding consumers with a single stroke.

Editorial: Oil exports

Texans are leading the charge to end a decades-old ban on crude exports.

 Updated 11:15 pm, Friday, March 13, 2015

The hot commodity in today's energy industry isn't oil or gas, but the lack thereof - storage space. Around the nation, oil storage facilities are filled to the brim. Crude supplies are at the highest level in more than 80 years, at nearly 70 percent of the nation's available space, according to the Energy Information Administration. Salt domes are being filled while new storage tanks remain under construction. Even oil tankers, normally used to shuttle petroleum across the ocean, are being viewed as a potential storage option. All this oil has nowhere else to go. Refineries are in a seasonal spring slowdown and an outdated federal law against crude exports keeps oil trapped on our shores. Innovations in hydraulic fracturing and horizontal drilling have ushered an end to the age of oil scarcity. It is about time our nation's energy policies caught up.

Texans are leading the march to tear down this outdated trade barrier.More than 100 members of the Texas House have signed on to a proposed resolution that calls the 1970s-era ban on oil exports "a relic from an era of scarcity and flawed price control policies." The bipartisan document, HCR 57, lays out a robust argument for ending our nation's one-way ticket policy on oil, from the positive impact it would have on international relations to the stability it would bring to global markets.

There's little reason why Texas wildcatters shouldn't be allowed to sell their products on the open market like anyone else. Instead we're stuck with a policy that leads to a perversion of the market, where Texas oil is less expensive than global prices. This hurts folks coming and going: Producers have to sell their wares for less and drivers have to pay more at the pump. After all, gasoline and other refined products are traded on an international market, while crude oil remains trapped behind an export ban.

If Congress finally removes this ban, local manufacturers that rely on crude oil will still benefit from the lower transportation costs that come from being at the end of a pipeline. And refineries are likely to import crude one way or another, with the billion-dollar marvels of engineering specifically tooled to handle heavy crude, rather than the light, sweet stuff that's being produced in domestic shale plays.

Despite all the arguments, the Republican-controlled Congress seems hesitant to change this national policy. Given the high-decibel passion for building the Keystone XL pipeline across the U.S.-Canada border, it seemed like the Republican Party had found a new cause célèbre in promoting international trade of crude oil. Yet House Energy and Commerce Chairman Fred Upton, R-Mich., has called for a "careful and deliberative approach" to finally eliminating the crude export ban. That's quite the policy flip-flop from the rush to build Keystone. The Texas resolution against the export ban alone references study after study in support.

Complex condensate

New export rules show a nation moving in the right direction, but we need more leaders.

 Updated 2:51 pm, Saturday, June 28, 2014

To explain the Texas attitude toward exporting oil and gas, we'll follow the lead of U.S. Rep. Gene Green, D-Houston, and crib a line from Blue Bell Ice Cream: We eat all we can and sell the rest.

But energy policy isn't as simple as ice cream. The problem right now is that America simply isn't hungry for what places like the Eagle Ford Shale produce. Before America's fracking boom, the prevailing wisdom was that our nation's oil would come from places like Canada and South America, which produce a heavy crude. Refineries were designed to handle this sort of dense, viscous oil.

But these days, booming shale reserves are producing something more like Houston tap than Texas tea: an extremely light, broadly defined mixture of hydrocarbons known as condensate. Up to half of all oil production in the Eagle Ford Shale qualifies as condensate, according to the federal Energy Information Administration, and it makes up as much as 12 percent of all U.S. crude production. The big oil and gas players are rushing to build specialty refineries known as splitters that can process this condensate into natural gas and other hydrocarbons. Despite this construction, the U.S. still has more condensate than we can handle, and outdated federal rules dating back to the Arab Oil Crisis prohibit its export.

That changed last week, when the Obama administration opened the export door by a tiny crack. It used to be that while companies could freely sell condensate processed at splitting plants, any condensate refined at the oil patch still qualified as crude and ran into that 39-year-old ban. The Commerce Department's Bureau of Industry and Security removed that distinction for two energy companies, allowing them to export condensate run through on-site distillation towers. This change won't affect most crude, but it indicates our nation's changing energy attitude, which recognizes we've transitioned from a market of oil and gas scarcity to one of surplus. But that surplus isn't universal.

Despite all the simplified talk about oil and gas production, the reality is a complex puzzle of various types of crude, differing refining needs and both local and global markets. Federal regulations, and our national conversation, need to catch up to this new reality. Gluts in some areas, and shortages in others, will likely necessitate a mix of imports and exports to ensure that our energy demand matches supply. Removing regulatory barriers will lead to a broader market, meaning more stable prices as demand is allowed to match supply. Hoarding our energy wealth at home will only end up backfiring, suppressing prices and killing production, all while denying some much-needed energy to our global allies in Asia and Europe.

The U.S. House pushed in the right direction last week when it voted to speed up the approval of natural gas export projects. The bipartisan plan was brokered by that Blue Bell fan, Rep. Green, who was able to bring 46 Democrats on board with a compromise that requires the Energy Department to rule on export applications within 30 days. And unlike many bills that come out of the House, this one looks like it will pass the Senate, which has a similar bill with a 45-day timeline.

Our natural gas bridge to a cleaner energy future also acts as a bridge across the partisan divide, and there is symbolism in the fact that this bill was sponsored by Green, a Democrat in a red state, and Rep. Cory Gardner, R-Colo., a Republican in a blue state. Shale reserves cut across our nation, and more politicians can show their dedication to policy over partisanship by working on these important energy issues in a productive manner.

Our nation needs more leaders who can explain the nuances and cost-benefit analysis of fracking in an atmosphere all too often defined in black and white. The House passed a good bill, and the fact that Houston's own made it happen was the cherry on top.

Obama, Congress should do what they can to keep oil cheap

By WASHINGTON EXAMINER • 12/23/14 5:00 AM

In June 2014, a barrel of oil cost $115. Currently, it goes for about $60. The historic plunge continued Monday as Saudi Arabia made clear it had no p]ans to cut production in order to prop up prices.

This week, the Wall Street Journal told more of the incredible story behind the recent oil bust. Contra1y to what some say, the Saudis are not letting prices fall to crush the new crop of North American shale producers. The reality is more subtle. The Saudis and the Organization of the Petroleum Exporting Countries' other Arab members have accepted that with U.S. production expanding so rapidly, U.S. shale operators will benefit from any OPEC production cuts by gobbling up more market share and cashing in on the highe[' OPEC-set prices.

And so OPEC's aim in letting production continue is not to stop the U.S., but to slow its growth, so that oil prices (they hope) will rebound. It's a risky bet. Many shale producers can remain profitable, at least on an operating basis, with oil as low as $40 a barrel, but no oil-dependent OPEC government can balance its budget seUing oil at plices anywhere near that low.

In the meantime, OPEC's inaction has nearly given rise to a free market in oil, creating panic among the ranks of petro-despots (including both OPEC leaders and Russia's Vladimir Putin) and immense benefits for American businesses and consumers. What better illustration could there be of how markets work when self-interested players make rational choices? The world's oil oligopolists are suddenly panicking, turning against and underbidding one another, behaving like real market actors do in a desperate scramble to maintain market share.

There is a lesson here. Many opponents of policies that promote U.S. oil exploration and infrastructure argue that the resources don't help Americans if they are shipped overseas. Current events demonstrate how wrong they are. Oil is a commodity, and it sells at a world price. Significant new production can change that price dramatically — in this case, it has nearly halved the price in a matter of months.

OPEC's manipulation of prices, it turns out, had its limits. The extraordinarily high prices of the last few years spurred new innovations in energy exploration in the U.S. — especially the perfection of hydraulic fracturing and horizontal drilling techniques. The Saudis and other OPEC countries are now reaping the benefits of their own greed.

If you like paying less for gasoline, there is a clear path Obama and the new Congress can take to keep prices <lown. Simply remove government obstacles — including everything from slow permitting processes on pipelines to the existing ban on U.S. oil exports — and it will immediately exert some amount of downward pressure on oil prices. Such actions can reduce shale producers ' costs, expand their customer base, and make OPEC's goal of slowing down U.S. production that much less realistic.

Putin and the world's other bad-apple oil potentates have had lots of time and money this decade to harass U.S. interests in their respective corners of the world. It's high time they were given something bigger to worry about.

Editorial: Lift ban on energy exports

The Detroit News *12:05 a.m. EDT April 14, 2015*

Congress should pass bill to allow foreign sale of America's abundant oil and gas resources

(Photo: Todd McInturf / The Detroit News)

Now that U.S. oil and gas production is booming, there's little justification for maintaining the ban on liquefied natural gas exports. Removing the 1970s ban would stimulate domestic energy production, keep the fracking-induced job boom going and increase national economic output.

Domestic crude oil production recently reached its highest level since 1972, hitting 9.1 million barrels per day. According to the International Energy Agency, the United States is now the world's largest oil and gas producer, ahead of Saudi Arabia and Russia.

Hydraulic fracturing and other technologies have opened up production, especially in Texas and North Dakota, which produced almost half the nation's oil in April 2014, according to the Energy Information Agency (EIA).

Yet only one export permit has been approved since 2010 to provide natural gas to a country with which the U.S. doesn't have a Free Trade Agreement. Last year the Obama administration approved exporting a lighter crude oil, a condensate, that's passed through distillation towers and is therefore considered a petroleum byproduct. That gave two Texas companies the green light to export the condensate.

The House Energy and Commerce Committee, under the leadership of Rep. Fred Upton, has persistently pushed for Congress and the Obama administration to move on bipartisan legislation that would lift the ban. This year and last, the House passed bills to expedite the approval process for natural gas exports. The Senate is considering similar measures, and President Barack Obama has acknowledged advantages to opening up exports.

Those opposed to exports fear global competition will hike domestic gas prices. Manufacturing and chemical companies in particular have been fighting efforts to lift the ban, including Dow Chemical of Midland.

Opening up exports might increase natural gas prices in the U.S., but the current market provides enough price cushion to at least test out the impact of expanded exports. Further, the domestic natural gas market would respond to increased demand, likely with more production.

Even from an environmentally-conscious perspective, opening up exports makes sense. The modest increase in natural gas prices might push consumers to turn to alternative energy sources, including renewables. Data from an October 2014 EIA study backs this up.

The U.S. economy could add up to 300,000 or 400,000 jobs over the next several decades by expanding exports, and could reduce the trade deficit by $22 billion. A Brookings Institute study found crude exports could add between $600 billion and $1.8 trillion to GDP by 2039.

The perceived oil scarcity that led to the LNG export ban is no longer an issue for the United States.

Energy policy is critical to the country's economic growth, and it's time this outdated ban is lifted.

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02:41

Convertible in the winter? No

Debate on U.S. oil export ban needs to focus on reality: Editorial

Keystone XL Pipeline Protest
Over a dozen local activists braved single digit temperatures to participate in a rally in front of the First Congregational Church in Williamstown, Mass. urging President Obama to reject the controversial Keystone XL pipeline. The rally was part of a campaign to try and stop the pipeline from impacting the climate and communities along the proposed pipeline route. The event is part of a national campaign led by organizations like CREDO, Rainforest Action Network, the Sierra Club and 350.org, calling on the president to keep his commitment to reduce carbon pollution by rejecting the pipeline. January, 13, 2015. (AP Photo/The Berkshire Eagle, Gillian Jones)

The Republican Editorials By **The Republican Editorials**
on January 14, 2015 at 10:30 AM, updated January 14, 2015 at 10:56 AM

Do some of those who back continuation of a ban on the export of oil from the United States still have 8-track players in their cars? Do they still wear bell-bottoms?

If so, there'd be a sort of logical consistency at work, as their views on oil exports are mired completely in 1970s-style thinking.

When the export ban became law four decades back, our nation was beholden to the giant oil-exporting states, most of them in the Middle East. We'd seen gas shortages and price spikes, lines at gas stations – when there was fuel available for sale. At that moment, the notion of selling some of our own precious crude oil onto the global market seemed unimaginable. And so, the ban.

An awful lot has changed since the disco days. Yet the export ban remains in place.

Now, finally, **there's been some talk about repealing the ban on selling our oil to overseas markets.** While the economics of the matter are pretty simple – virtually every single economist on the planet believes that the ban should be lifted – the politics of the affair are something else again.

There's the anti-oil left, the bicycle riders and Prius drivers who gather together at rallies to sing the sun's praises. For this crowd, allowing oil to be exported is akin to throwing our arms around the slimy product they so love to hate. There are the panderers, playing to the America-first crowd, arguing implausibly that our oil ought to be for us alone, no matter the realities of the global market for commodities of all sorts. And there are the just plain fearful, folks who don't want to rock the boat, who believe that leaving things as they are is generally the best political answer, no matter the question.

The list adds up to nothing but inaction.

As the Senate debates the Keystone XL oil pipeline, some side debates will be part of the story. One of those will concern the removal of the export ban. Expect so much more heat than light on this front. Sadly.

The oil export ban is a 1970s anachronism that should have no more place in today's world than rotary phones.

THE OKLAHOMAN

Further evidence of need to end U.S. oil export ban

Continental Resources CEO Harold Hamm among those urging policy change

By The Oklahoman Editorial Board Published: March 8, 2015

HERE's a toast to good old American ingenuity — and a renewed call to end a bad old American energy policy.

In this we're seconding what Harold Hamm, CEO of Continental Resources Inc., said last week during in his keynote speech to the Society of Petroleum Engineers conference in Oklahoma City.

The reasons the United States is awash in crude oil today, Hamm noted in his typical everyman vernacular, are "rigs, rednecks and royalties." Technological advancements — primarily horizontal drilling and hydraulic fracturing — have led the boom that has seen America become the world's top producer of oil and natural gas.

Together, the Bakken field in North Dakota and the Permian and Eagle Ford fields in Texas — "Cowboy-istan," Hamm called it — have accounted for half of the global production growth since 2008. Those three fields alone would be the world's seventh-largest liquids producer, Hamm said.

"A lot of people thought this would spread around the world, but it's not happening anywhere else to the extent it's happening here," he said.

The boom has produced hundreds of thousands of good-paying jobs in the United States. But some of those jobs, in Oklahoma and elsewhere, are now peeling away and companies are shutting down rigs as energy prices have tumbled, the result of production exceeding demand.

One way to ease this problem would be to export our crude oil, but that's not allowed under a ban put in place 40 years ago following the Arab oil embargo. At the time, the idea was that the United States needed all the domestic fuel it could get. That reasoning doesn't hold true anymore. The ban has long been obsolete.

Opposition to lifting the ban remains strong in some circles. Environmental groups argue that lifting it would hurt the environment because it would result in more oil development here and around the world. Some in Congress contend exporting our crude would mean higher prices at the pump.

THE OKLAHOMAN

No good reasons to maintain U.S. ban on crude oil exports

By The Oklahoman Editorial Board Published: November 13, 2014

THOSE octane numbers on gasoline pumps relate to chemical composition. The higher the number, the higher the price.

Motorists know that not all gasoline is the same, but the assumption is that the stuff from which gas is made *is* the same. But crude varies considerably in its makeup; price differentials are seen in crude as well as in gasoline.

In general, U.S. refineries are set up to process the so-called heavy, sour crudes. Thus, the lighter and sweeter crude being produced as part of the shale revolution is available for other markets. But it can't reach those markets if Washington continues a longstanding ban on crude oil exports.

The United States is poised to surpass Saudia Arabia as the leading producer of oil (it's already the top natural gas producer). This is a remarkable turnaround from the mid-1970s, when the Arab oil embargo led to the export ban here. The thinking was that this country needed all the domestic fuel it could get. Why allow *any* of it to leave our shores?

That was then. Domestic supplies are now abundant. The export ban is beyond obsolete. It's time to open the spigots.

Oil prices (and gasoline prices) have been dropping as a result of lower demand and greater supply. North American energy independence is within reach. Allowing domestic supply to be shipped to other countries might seem to be a bad idea, but it's not.

Crude is produced and sold in a global market. For too long, the U.S. was more of a buyer than a seller in that market. We need to be both. U.S. producers need the freedom to ship their product to customers in other countries.

David Williams of the Taxpayer Protection Alliance cites a Brookings Institution study that says lifting the export ban would increase the U.S. gross domestic product by $600 billion to $1.8 trillion over the next 25 years. Lifting the ban could reduce unemployment, the study says, by about 200,000 annually from 2015 to 2020.

Lift the ban on crude oil exports

EXPRESS-NEWS EDITORIAL BOARD : APRIL 21, 2015

An already compelling case for lifting the ban on U.S. crude exports just hit a bit closer to home. It's been accepted for a while that drillers in Texas and other oil-producing states would broadly benefit. But a new study from Rice University notes that Eagle Ford crude would reap greater rewards.

The study by Ken Medlock concludes that lifting the ban would benefit those shale plays that produce lighter and less sulfurous oil. And that is precisely what Eagle Ford, along with North Dakota's Bakken formation, produces.

A recent Express-News article by Jennifer A. Dlouhy of the Hearst Newspapers' Washington Bureau explained that domestic oil production generally would benefit by the ability to sell abroad but that Eagle Ford oil and others like it would fetch even higher prices. Exports of petroleum products such as gasoline and diesel are permitted but not so for most raw, unprocessed crudes. The ban is an outgrowth of the OPEC oil embargo of the '70s.

Times and circumstances have changed. The U.S. is scheduled to overtake Saudi Arabia and Russia in oil production. Hydraulic fracturing reinvigorated the domestic oil industry. New markets could mean even more production. And that's jobs saved and created. Texas' congressional delegation should be on the front lines in this fight. Congress should lift the ban

OIL&GAS JOURNAL

End the export ban

03/18/2013

The US should scrap its antique prohibition against the export of domestically produced crude oil. The sole argument for retaining the export ban is unsound. Perhaps unwittingly, it also conspires with antioil politics impeding another important element of North American petroleum logistics.

Congress banned exports of crude oil when it passed the Energy Policy and Conservation Act of after the Arab oil embargo of 1973-74. The law also extended oil-price controls, set vehicle fuel-use standards, and established the Strategic Petroleum Reserve.

Strategic concerns

Much has changed since 1975, when US production of crude oil was in a decline thought to be permanent and oil imports were rising. The changes demolish arguments for an export ban based on strategic concerns. For example:

- Oil production now is rising, and imports are falling.

- Oil trade, no longer dominated by long-term contracts between producers and refiners, is vastly more fluid than it was in the 1970s. Pricing is much more transparent. Computing and communications technologies that didn't exist when Congress passed EPACT enhance the flexibility, which makes the market much more resilient than it was when curtailment of shipments to only two countries created havoc.

- The SPR, strategic oil hoards elsewhere in the industrialized world, and a comprehensive international oil-sharing scheme discourage the politically motivated disruption of oil supply. Furthermore, major exporters have much more-sophisticated economies to support than they did in the 1970s and can less afford to cut production capriciously. Oil-importing countries can do without oil from rogue exporters more readily than exporters can do without oil sales.

While old strategic arguments against exports no longer apply, other changes since the 1970s make the export ban, along with that other issue important to petroleum logistics, bad for oil consumers.

The US refining industry has developed a world-leading ability to process heavy feedstock and convert residues of distillation into light products. Most of the essential equipment is on the Gulf Coast. There, refiners not only can run heavy, low-value feedstock; they need it to operate crude and processing capacities at optimum rates. Yet most of the recent production surge is of lighter oil with lower sulfur content—oil with greater value at refineries less sophisticated than many of those on the Gulf Coast.

Because price differences steer oil toward locations where its value is greatest, bitumen produced in Alberta gravitates to the Gulf Coast. Absent political opposition that makes sense only to extremists, the Keystone XL pipeline already would be under construction. If and when Keystone XL becomes operational, and if production continues to build from unconventional plays in the US interior, the country might find itself with growing amounts of medium and light oil worth more elsewhere. To continue banning exports under that scenario would make no sense.

Opponents to crude exports will say a foreign pull on supply would raise domestic prices. They will be overlooking the vitally important influences value and location differentials exert in the modern oil market. And they will be wrong.

Market efficiency

As always, the policies that moderate oil prices most successfully are those that help the market work most efficiently. In North America, that increasingly means expediting movement of bitumen blends from Alberta to the Gulf Coast and accommodating the sale of lighter crudes that might become surplus to domestic needs—in other words, approving Keystone XL and ending an obsolete export ban.

At this stage in a rapidly evolving market, no one can be certain how these trends will develop. Many Gulf Coast refiners might decide to reconfigure plants to run lighter domestic feeds; some already have done so. In that case, more of the oil flowing away from the US might come from Alberta. There's nothing objectionable about that. What's important, what's best for consumers, producers, refiners, and governments, is that the oil flows to where it has most value. Statutory relics, like antioil obstructionism, must not be allowed to stand in the way.

ORANGE COUNTY REGISTER

Editorial: Get the U.S. back in the oil-exporting game

2014-12-16 15:18:49

The House Energy and Power Subcommittee met last week to consider whether the time has come at last to lift restrictions on U.S. crude oil exports, a statutory relic of the Arab oil embargo of 40 years ago.

With the United States reestablishing itself as the world's foremost oil producer – surpassing Saudi Arabia and Russia – legislation from Rep. Joe Barton, R-Texas, proposes to repeal a section of the 1975 Energy Policy and Conservation Act that makes it unlawful for U.S. oil producers to sell their crude abroad.

"We need to rethink outdated laws that were passed during an energy scarcity," he stated.

In 1975, the U.S. was dependent on foreign oil, two-thirds of which was supplied by the unfriendly Organization of the Petroleum Exporting Countries.

Four decades later, the U.S. has largely weaned itself from dependence on foreign oil, with the U.S. Energy Information Administration projecting that crude imports will account for only one-fifth of U.S. consumption in 2015.

That turnabout is almost entirely attributable to America's black gold rush – domestic crude production has increased from 5 million barrels a day in 2008 to a projected 9.4 million barrels a day in 2015. This game-changing development was brought about by advances in horizontal drilling and hydraulic fracturing.

There is, of course, opposition to both disruptive technologies from those who think oil an unnecessary evil that should be replaced by such environmentally correct alternatives as biofuels or electricity derived from wind power or solar energy.

But there is no disputing the tremendous economic boost brought about by the nation's oil boom. Goldman Sachs economists said last week that the savings Americans have gleaned from lower gasoline prices is equivalent to a middle-class tax cut of $100 billion to $125 billion.

Some suggest that lifting the ban on U.S. oil exports, as Rep. Barton proposes, would reduce the supply of oil on the domestic market and put upward pressure on pump prices.

But the EIA released a study in October in which it concluded that U.S. gasoline prices would be unaffected if U.S. oil exports were allowed. That's because the price U.S. motorist pay at the pump is determined not by U.S. oil producers, but by the global market.

We agree with the Texas lawmaker that the 40-year ban on U.S. crude exports should be repealed. It would be at once good for the U.S. economy and good for national security.

Charleston Daily Mail

Wednesday, May 27, 2015

Editorial: Congress needs to allow crude oil exports

With one action, the U.S. Congress could reduce the nation's trade deficit, grow U.S. jobs, increase revenue and assure more U.S. influence across the world.

But because of Congressional inaction, the export ban remains in place 40-plus years later. The ban was enacted by Congress following the 1973 Arab oil embargo. That embargo created a domestic energy crisis, causing shortages, lines for gasoline and mayhem across the U.S.

For most of the period since, the U.S. remained generally an importer of energy. In those circumstances, the ban was not a cause for concern. Times are different now.

Thanks to new technology that allows oil producers to extract oil from previously hard to get shale sands, the U.S. is now the largest petroleum producer in the world, recently surpassing Russia and Saudi Arabia.

While exporting crude oil is banned, petroleum products refined from crude, such as gasoline and diesel fuel, can be. In fact, in 2014 the U.S. exported $147 billion worth of refined petroleum products. The U.S. also exports coal, natural gas and natural gas liquids – making crude oil the only form of energy banned from export.

Lifting that ban would not just help U.S.-based oil producers create more American jobs and revenue, but would give the U.S. considerably more non-military influence in foreign policy."

The pathway to achieving U.S. goals also can be economic," wrote former U.S. Central Intelligence Agency director and Defense Secretary Leon Panetta, along with former National Security Advisor Stephen Hadley, in the Wall Street Journal recently."

The U.S. can provide friends and allies with a stable alternative to threats of supply disruption," [from Russia] the two wrote. "This is a strategic imperative as well as a matter of economic self-interest."

The authors also wrote to dispel the common fear that exporting crude oil would cause domestic gasoline prices to rise.

They pointed to several studies that show oil exports would actually put downward pressure on prices."

Too often foreign-policy debates in America focus on issues such as how much military power should be deployed ..." Panetta and Hadley wrote. "Ignored is a powerful, nonlethal tool: America's abundance of oil and natural gas. The U.S. remains the great arsenal of democracy. It should also be the great arsenal of energy."

Congress should act to remove the ban on oil exports.

THE REGISTER-HERALD.COM

Give 'em the gas

Looser regs on export of oil and gas has several benefits

Posted: Thursday, May 21, 2015 3:00 am

The latest figures on the U.S. trade deficit showed the goods we export from America to markets overseas totaled $187.8 billion in March.

But the goods we import totaled $239.2 billion.

Why is this important? It's important because having such a large trade deficit of $51.4 billion means Americans are subsidizing jobs overseas to make products that are shipped in and sold here.

So what's this have to do with West Virginia?

A lot, actually.

The United States, thanks to hydraulic fracturing, or fracking, has become a world leader in tapping into new, previously unreachable reserves of oil and natural gas.

But the problem is, due to federal regulations put in place 40 years ago during the height of the Arab oil crisis in the 1970s, oil exports to an energy-hungry world are prohibited. And regulations on exporting natural gas are so restrictive, not much of that gets exported, either.

The thinking at the time was, with long lines and high prices at U.S. service stations, any oil produced domestically should be consumed domestically. But fracking has dramatically changed that, and the United States now has the capability to deliver vast amounts of excess oil or liquefied natural gas to Europe and Asia. Easing the restrictions on selling LNG overseas would mean major new job creation in West Virginia's gas fields as well as higher severance taxes for the state.

Exporting LNG from West Virginia, which next to Pennsylvania has the largest known reserves of natural gas, would not only provide jobs and tax revenue, it could eat into that U.S. trade deficit substantially.

Sen. Shelley Moore Capito, R-W.Va., is a big supporter of easing the restrictions on energy exports.

“We have more than enough natural gas to power both an industrial renaissance back home in West Virginia and to export liquefied natural gas,” Capito told the Senate Energy/Natural Resources Committee earlier this year.

The state’s senior senator, Sen. Joe Manchin, D-W.Va., is also on board with the idea of making it easier for the United States to export energy resources.

This week, Manchin and fellow Democrat Sen. Heidi Heitkamp of North Dakota joined Republican Sens. Bob Corker of Tennessee and Lisa Murkowski of Alaska in introducing the American Crude Oil Export Equality Act to finally lift the outdated four-decade ban on energy exports.

“This bill triggers to stop exports if (gasoline) prices increase or if our economy is adversely affected,” Manchin said. “Lifting the ban on oil exports will improve our national security interests by reducing our trade deficit …”

Enabling the United States to export its oil, Manchin noted, would to some degree “neutralize” the influence of oil-exporting counties like Iran. Another key national security interest that would be addressed by easing export restrictions on natural gas would help Europe reduce Russia’s stranglehold on the energy market there.

To date, due to its geology and other factors, fracking hasn’t taken off in Europe. Which means Europeans remain dependent on importing Russian natural gas. They also are pressured by the political influence Moscow gains from exercising that near-monopoly.

The 40-year-old laws put in place by the United States during the 1970s regarding energy exports need to be reviewed.

It’s good to see West Virginia’s senators at the forefront of getting them changed.

Grand Forks Herald

OUR OPINION: Lift America's embargo on exporting its own oil

By Tom Dennis on May 14, 2015 at 5:00 a.m.

On balance, has the OIl Boom been good for North Dakota?

If you answer "yes," then you should favor lifting the U.S. government's ban on exporting oil.

Because one sure result of lifting the ban would be a longer and stronger boom.

There'd be more drilling, which would mean more jobs, more people, more schools, more housing, more money (a lot more money)—in short, more growth, in North Dakota and throughout the Midwest.

That's why North Dakota's U.S. senators are leading the effort to repeal the ban. That's why the North Dakota Legislature supports the repeal and asked that a copy of its support be sent to every member of Congress.

And that's why Minnesota's senators should pledge allegiance to the cause—because oil production in the Bakken has juiced not only the North Dakota economy but also the jobs-and-growth outlook in Minnesota and beyond.

"U.S. Sens. Lisa Murkowski, R-Alaska, and Heidi Heitkamp, D-N.D., jointly introduced legislation that would end a 40-year ban on exports of crude oil produced in the U.S.," Oil and Gas Journal reported Wednesday.

Sen. John Hoeven, R-N.D., and 10 other Republican senators cosponsored the measure. That makes Heitkamp's involvement significant, because at this point, she's the only Democrat to have offered support.

As Heitkamp put it, "the 1970s-era ban on exporting American crude oil is as outdated as the typewriters on which the policy was written. It's past time for an upgrade."

She's right. And if Minnesota's senators take time to weigh the benefits and costs of repealing the ban, we're confident they'll sign on, too.

To understand why, picture North Dakota as a country, not a state. Would it benefit North Dakotans to keep all oil production—and electricity and wheat production, for that matter—in-house?

After all, just think about the low, low prices for gas, electricity and bread that such an arrangement would bring about.

But of course, the reality is that "export bans" would leave North Dakotans much worse off. For one thing, farmers, drillers and coal-miners couldn't make much money in such a small market, so their production would fall. For another, North Dakotans themselves would be a lot poorer than they are now, because so many fewer dollars would be flowing their way from out of state.

Far better for North Dakotans (and Coloradans and Rhode Islanders) to "export"—that is, to sell their wares to willing buyers, wherever those buyers can be found. And that's true even though the trade leads to North Dakotans "importing" products that easily could be made in-state, such as gasoline and bread.

Basically, the same holds true at the national level, especially for wheat, oil and other commodities. Trade constraints twist the market in ways that leave the population worse off. Easing constraints untangles the twists, encourages investment and lets producers meet demands more efficiently.

That's how it works with cars, corn, computers and cell phones, as Americans know.

And that's how it works with oil, too.

There is, however, one objection to lifting the ban that's worth considering, because it reflects something real: the sense that oil production would go up.

As Marcie Keever of Friends of the Earth said in a recent statement, "a repeal would increase fracking, putting communities at even greater risk of air and water pollution and earthquakes."

Well—exactly, at least as far as increasing fracking is concerned. That's a feature, not a bug, of repealing the ban.

It all comes back to our original question: On balance, has the Oil Boom been a net plus for North Dakota?

For that matter, has it benefited the United States?

The answer to both questions clearly is "yes." Which means Congress should lift the oil-export ban, because doing so would make a good thing even better.

-- Tom Dennis for the Herald

Your News, Your Way.
Tyler Morning Telegraph

Lifting oil export ban makes sense

Published on Wednesday, 11 February 2015 20:16 - Written by

How rare is it for common sense to come out of Washington? Because this makes perfect sense:

“Falling oil prices have some Texas lawmakers looking to reshape U.S. policy on crude oil in the mold of another iconic Texas product: Blue Bell Ice Cream,” the Dallas Morning News reports. “Blue Bell’s motto is ‘We eat all we can, and we sell the rest.’ Texas legislators think that should also apply to oil by lifting the ban on crude oil exports — a policy that’s been in place since the oil crisis of the 1970s.”

Oil exports make perfect sense. So do exports of natural gas.

“A drop in the price of crude, from about $100 in mid-2014 to around $50 now, has threatened to halt the recent boom in U.S. oil production,” the News explained. “The oil industry is slashing thousands of jobs and looking at selling off assets in response. The price drop has heated up discussions in Washington of lifting the export ban on crude oil — and Texans are leading the charge. On Tuesday, Rep. Joe Barton, R-Arlington, filed a bill to ‘remove all restrictions on the export of crude oil, which will provide domestic economic benefits, enhanced energy security, and flexibility in foreign diplomacy.’”

Alex Mills of the Texas Alliance of Energy Producers explained recently why this makes sense.

“Oil production has grown more in the United States over the past five years than anywhere else in the world,” he wrote. “With these changes has come a widening gap among the types of oil that U.S. fields produce, the types that U.S. refiners need, the products that U.S. consumers want, and the infrastructure in place to transport the oil. Allowing companies to export U.S. crude oil as the market dictates would help solve this mismatch. Removing all proscriptions on crude oil exports will strengthen the U.S. economy and promote the efficient development of the country’s energy sector. Crude oil exports could generate upward of $15 billion a year in revenue by 2017 at today’s prices, according to industry estimates.”

Some worry that exporting oil could drive up gasoline prices, which are already starting to increase.

“But research by Michael Plante, a senior research economist at the Federal Reserve Bank of Dallas, shows that lifting the export ban might lower prices at the pump,” the News countered. “That’s also supported by a Congressional Budget Office report from December 2014, and a slew of other independent analyses.”

How? By stabilizing the market and encouraging expanded exploration and extraction.

And then there's the issue of jobs. With the restrictions in place, oil companies are pressured by simple economics to fund exploration and development in other countries. With the export ban lifted, those companies would inevitably do more in the U.S.

There's even an environmental benefit. Crude oil produced here and sold on the world market is likely produced more cleanly than, say, crude from Russia.

So it's nice to see common sense in Washington — even if it was brought there by Texans.

Longview News-Journal

Editorial: Prepare now for likely effects of low oil prices

By Longview News-Journal
Jan. 10, 2015 at 11 p.m.

Anyone who's been around Texas awhile understands that the price of oil rises and falls. That's the norm with any commodity.

Oil isn't just any commodity, of course. The prices of corn or wheat are important, but don't begin to compare with how the U.S. economy lurches to and fro along with the price of oil.

But while Texans like to believe we've seen it all before, chances are we haven't seen anything quite like the current swoon in the price of oil, and the likelihood is that the market isn't going to be "straight" anytime soon.

A report by the Federal Reserve Bank of Dallas suggests oil prices will stay low through 2015 and that supply will continue to outstrip global demand.

One of the differences in this oil price drop and others is that it is driven in large part by production in the United States, particularly in Texas and the Eagle Ford shale, which accounts for a whopping 40 percent of all oil production in our state.

And, the Fed report says, though prices have been falling for six months, production has not slowed. In fact, more oil was produced per day this December than during the same month a year ago.

But at some point - we don't know when and the Fed isn't predicting, either - the supply is going to grow so large or the price is going to drop so low that companies will slow or stop production. When that happens the inescapable layoffs will follow, which are going to have an obvious effect on us in East Texas.

The situation could be alleviated to some degree if oil producers were given the ability to export crude oil, which has been largely banned since the first oil crisis in the 1970s. This is a controversial subject and any lifting of the ban must come with controls but it might help stabilize the market. We hope Congress gives it thoughtful consideration.

As the situation unfolds, our area should not just watch and wait. Much work already has been done to diversify our economy but energy is still its main driver, so we should make it a priority to further broaden the range of industries across our area.

We also should ready retraining programs for those who face layoffs from the oilfield. Longview-area unemployment has been low, so it will probably be possible for good workers to move from one field to another.

The Legislature also must be aware the oil-driven Texas miracle is sputtering. That means the state government that relies so heavily on taxing the oil industry will be working with less revenue for a few years. Given that transportation already is under-funded and with the reality they'll have to find more money for education, lawmakers must realize now isn't the time for politically motivated tax cuts.

There's a bright side, even for state government. Every business and public entity buys gasoline and travel, both of which are less expensive because of depressed oil prices. Consumers will have more money to spend on goods because they're paying less for fuel. In theory, this should help state and local sales tax collections. Other industries - including manufacturing and chemical production - also benefit from low oil prices.

Amid so much uncertainty in this situation, we are confident of this: The Texas economy of today is much different than the one that took us through the last major collapse in oil prices.

Today's Texas economy is more diverse, with other sectors producing more new jobs in recent years than energy. The latest boom has increased our population and further broadened our industry base.

We hope Texas and its new economy are ready to pass this test.

The Tribune
Serving Greeley and Weld County, CO

Tribune Opinion: U.S. should allow crude oil exports

The American Petroleum Institute is pushing for America to export more oil and gas globally, a move that would boost our economy for decades to come, and we agree.

“Energy is fundamental to our society, to our way of life, and thanks to American innovation and entrepreneurial spirit … our nation stands among the world’s leaders in energy production and is poised to be the leader well into the future if we get American energy policy right,” said API President Jack Gerard in his address on the “State of American Energy” Tuesday in Washington, D.C.

“We have a once-in-a-lifetime opportunity to reshape, to realign and to reorder the world’s energy market and improve domestic prosperity to an unprecedented degree,” Gerard said.

Global fuel demand will increase by 20 percent in the next 20 years, Gerard said, and the United States can seize an opportunity to become a worldwide exporter of both oil and gas because of its growing availability.

In the past five years, the United States has reduced its oil imports to 34 percent from 60 percent, and that number will continue to go down because of increasing drilling of U.S. oil fields.

“The free market is the best factor to determine price and supply and demand,” Gerard said. “The worst thing for government to do now is distort the marketplace. We’ve now reduced imbalance of trades by 26 percent because of the export of refined products.”

Currently, only refined oil can be exported. The United States has had a ban on crude oil exports for 40 years.

Gerard said the United States should consider export limitations on crude but seek to expand liquefied natural gas exports.

“We should not be bound by past practices or the visions of the Arab oil embargo in the ’70s. It’s a new day. It’s a new time. It’s a new America as it relates to oil and gas.”

Exporting more oil and gas will create more jobs for Americans and go a long way toward balancing the trade deficit.

Congressman Cory Gardner, a member of the House Committee on Energy and Commerce who represents Weld County, said oil and gas exports would be a boon.

“We’ve got some great opportunities when it comes to exporting natural gas that would benefit people in Colorado,” Gardner said.

America will continue to ramp up oil and gas production regardless of limitations on exporting because of the success of fracking and horizontal drilling.

It certainly makes sense to export what we don’t need domestically to stabilize the global economy by helping keep energy costs down worldwide.

— The Tribune Editorial Board

The Washington Times

EDITORIAL: The untapped potential oil sheikdom of America

Ending the ban on U.S. crude-oil exports would boost the nation's economy

Wednesday, October 29, 2014

Saudi Arabia is no longer king of the oil patch, and the United States can put the 1970s oil shortage down the memory hole and act again like the world's No. 1 producer. American drillers pull 12.3 million barrels of oil out of the ground every day. The Saudis pump 11.6 million barrels daily. But American companies can't sell any of the bounty overseas.

Only refined oil products may be sold abroad, and American refineries are shipping gasoline and diesel fuel abroad at historic rates. A ban on crude-oil exports has been in place for decades, a relic of the 1973 OPEC oil embargo. With a few exceptions — a barrel or two make their way to Canada and Mexico — oil can't leave American shores.

The Brookings Institution estimates that eliminating the ban would boost America's gross domestic product by $1.8 trillion. National Economic Research Associates figures 380,000 unemployed Americans would return to the workforce next year if the ban were eliminated. The domestic price of gasoline would tumble, thanks to the increased global supply of crude. Ordinary Americans could live like sultans (without the harems or sheep's eyes soup), or at least better than they do today.

Much has changed since the era of Jimmy Carter to make the ban obsolete. Oil men have figured out how to extract the juice from previously inaccessible places. Instead of boomtowns, the shale revolution has created a boom state in North Dakota, which has defied the malaise with an unemployment rate half the national average.

The most important Asian trading partners, including Japan and South Korea, are clamoring to import American crude. The Europeans are eager to reduce reliance on the good graces of Vladimir Putin.

Apart from certain environmentalists and isolationists, the most important supporters of the restriction are the refiners, who don't want a drop of oil to leave America unless it has gone through their refineries first.

Sen. Lisa Murkowski, Alaska Republican, has been leading the charge to get rid of the ban, and Sen. Ron Wyden of Oregon, the Democratic chairman of the Senate Finance Committee, says he wants to study the policy. President Obama could do it overnight with a telephone call to Commerce Secretary Penny Pritzker, who would then approve the necessary waivers to get the crude moving.

Mr. Obama is several yards shy of an economic legacy worth having, and here's his opportunity. Republicans and Democrats could work together to exploit this wealth. This would make everybody happy.

BOSTON Herald.com

Freeing up oil exports

Sunday, January 5, 2014

By: Herald Staff

U.S. crude oil producers are questioning the wisdom of the near-total ban on exports and, according to The Wall Street Journal, are winning sympathy from Washington officials.

It really is time to end the prohibition. It never made much sense except to allow politicians to argue that they had done *something* for American consumers.

Tulsa World Editorial: Time to strike 40-year oil export ban

| Posted: Monday, June 8, 2015 12:00 am

For 40 years, U.S. producers have been legally prohibited from exporting crude oil. As the old saying goes, "it seemed like a good idea at the time."

Now, however, it's time to reconsider this policy.

Oklahoma Sens. Jim Inhofe and James Lankford have joined 12 other senators, including one Democrat, to introduce Senate Bill 1312, the Energy Supply and Distribution Act, which would end the ban on crude oil exports.

The ban was instituted in 1975 in the wake of the 1973-74 oil embargo by OPEC that disrupted the U.S. economy and sent consumers into long lines at gasoline pumps. It also was considered a security measure that would stabilize oil supplies in the United States.

Things have changed. Thanks to new technologies, the U.S. has an abundance of domestic oil, enough oil to allow for exports.

The market-control notions of the 1975 ban were never met, and the ban has become more hindrance than help.

The restrictions on exports have, over the years, made producers choose, by limiting buyers, between leaving oil in the ground or selling it domestically at depressed prices. With the development of ways to recover shale oil, the market has seen an abundance of oil. Much of it with no place to go.

Some fear lifting the ban could force up gasoline prices. That is unlikely. The ban never restricted export of refined oil products such as gasoline. The U.S. is already a world leader in exporting refined oil products. Some sources predict that allowing market conditions to operate could in fact reduce domestic gasoline prices.

Others argue that lifting the ban could threaten national security by accelerating the depletion of U.S. oil fields. In fact, the opposite is true. Expanding potential markets for U.S. crude oil would promote development of new oil fields and new technologies in old fields, driving up domestic production and increasing our energy independence.

U.S. oil companies ought to be allowed to export their product freely. Oil is no different than any other good in that exports are self-limiting. If there is enough, it will sell on the world market. If supplies are tight, producers will limit exports.

There simply are no good arguments to continue the ban. Republicans, Democrats and President Barack Obama support increasing exports to improve the economy. Why should crude oil be an exception?

It's time to strike the 40-year ban. Give U.S. oil producers a level playing field and American consumers will be the beneficiaries.

Transcript of Dr. Lawrence H. Summers Speech at the Brookings Institute's "Changing Markets: The Future of U.S. Energy Security and Oil Export Policy" Conference

September 9th, 2014

Larry Summers: Strobe, thank you for those very, very kind words. I'm reminded of what Lyndon Johnson used to say when he was introduced very nicely. I wish my parents would have been here for that. My father would have appreciated it and my mother would have believed it. You have failed me in only one regard, one you know from the world of politics and that is in the management of expectations. It would be very difficult for me to live up to those kind words.

Strobe and I have known each other well now for 21 and 1/2 years, since the beginning of the Clinton administration when he, a polished member of the foreign policy establishment charged with leading the Clinton Administration's efforts with respect to Russia and the former Soviet Union encountered me, possibly a diamond but surely in the rough, attempting to deal with that set of problems. We have not always agreed but I at least have always learned an enormous amount from my conversations and dialog with Strobe. As someone who has followed Brookings now for the better part of 35 years very closely think that it is in a Renaissance era under his leadership for which Brookings, and I think the world, should be very grateful.

It is said that only very hard public policy problems reach the desk of the President of the United States because if the problem was easy it would not reach the desk of the President of the United States. That is, I think, a good generalization but it is I believe wrong in the case of the problem and the issue that is our focus this afternoon. I believe that the question of whether the United States should have a substantially more permissive policy with respect to the export of crude oil and with respect to the export of natural gas is easy. The answer is affirmative. The merits are as clear as the merits with respect to any significant public policy issue that I have ever encountered and it is an important test of the efficacy and functioning of our democracy whether within the next nine months we will get to that correct solution. What I want to do in my remarks today is to explain why I think that.

The first question you always have to ask in proposing change in an important public policy is, "Well it got put there for a reason, maybe it's a good reason, and so it should stay." Some presumption naturally attaches to the status quo and you have to have compelling reasons to overcome that presumption. What are the roots of the ban on crude oil exports and do they have relevance today?

The reason we have a ban on crude oil exports in the United States is that in the 1970s when the price of oil spiked due to the formation and effective implementation of the OPEC cartel, we found ourselves dangerously vulnerable and much more importantly we responded to that vulnerability rightly or wrongly with a system of price controls on oil and a system in particular of price controls on old oil.

Now, if you are one country in a free world and you wish to control the price of a quantity you have no choice but to associate that control with an export ban because if you don't everything you produce will be exported. So we put this in place, this export regime, in place for a good reason. That good reason was that we had price controls. Price controls might or might not havehave been a good idea. I doubt they were a good idea but it's not relevant for the purpose of this argument. What is relevant is that those price controls were eliminated 34 years ago.

Now, for most of those 34 years, did this ban matter? No. We were a large-scale importer of all kinds of crude oil. It would have been goofy for us to have exported the oil. The ship would have come to our port, and then the ship would've left our port. It wouldn't have made any sense. So, this restriction was like the PGA Tour passing a restriction that said that Larry Summers was ineligible to play. It didn't really matter given the realities of the situation. The feared outcome would not materialize even in the absence of the restriction. So, we have, for the first time, a situation today that we have not had in at least two generations, namely that the market is sending signals that it is desirable on free market grounds to export U.S. oil.

So, the first thing to say is there's nothing in the history of the establishment of the policy that creates any reason for believing that it is functional on a continuing basis today.

The second thing to say, by way of a priori argument, if you like, before I get to the specifics, is that the United States is part of a global system that has a strong presumption against policies of this sort. United States and every President of the United States since the Second World War has professed our allegiance to the concept of free trade. The part of the concept of free trade that gets the most discussion is, of course, the avoidance of the restriction of imports. But the logic of free trade applies equally in opposition to the restriction of exports, and in particular, condemned on free trade grounds is the idea that exports should be restricted so as to give a competitive advantage to domestic producers. This is not just some hypothetical economic theory stuff. On dozens if not hundreds of occasions the United States at the World Bank and at the IMF has voted in favor of programs that included conditionality where the conditionality stopped export controls with respect to raw materials that were motivated by helping domestic producers.

Just to make that more concrete, some country in Africa had lumber and in order to help them develop a domestic furniture industry they limited the export of lumber so that there would be low cost wood available to their furniture industry so that they could develop one. What was the position of the United States? Against free trade, inappropriate, must be removed as a condition for IMF and World Bank support. It's not a position we've taken once, it's not a position we've taken five times, it's a position we've taken dozens to hundreds of times as part of a general commitment to an open world economy. We have a long history of believing that export restrictions are not an appropriate policy tool.

Third prefatory observation - what are the arguments that are made in favor of maintaining these restrictions? There are two that are made primarily. The first is, "Well, if we keep our oil here won't we have lower priced oil and won't that mean that American motorists will have a lower price of gasoline and won't that be good?" The answer is no. It would be good if we had a lower price of gasoline. The answer however is that permitting the export of oil will actually reduce the price of gasoline.

Why? To understand it you have to recognize one little bit of complexity, the kind the panel after me will get to in great detail, and that is that all oil is not the same. Oil in one place has a value different than oil in a different place because of transportation costs and there are different kinds of oil. Oil that is made into gasoline is oil that at the margin is imported from the rest of the world. It is tied to the price of Brent oil, the world benchmark price for oil.

Marginal U.S. production doesn't go to Brent. It can't be exported. Marginal production in the United States goes to West Texas. There's a lot of oil in West Texas and there's not so many places you can get it to from West Texas and so the amount varies but the price of oil in West Texas is $5-10 less than the price of oil in Brent.

What would happen if you allowed oil to be exported? If you allowed oil to be exported people would ship it from West Texas to Brent or to someplace that would otherwise receive it from Brent. They would make a profit. There would be a larger supply of Brent oil. The same demand and a larger supply means a lower price and so in fact the price of gasoline would be lower. How much lower? There have been three large scale econometric evaluations that I'm aware of - one that you're going to hear about this afternoon, one that was done under the auspices of the American Petroleum Institute, and one that was done under the auspices of Dan Yergin and his IHS organization. They all agree that the price of gasoline will be lower. They differ on the amounts with a range of estimates from about two cents a gallon to about twelve cents a gallon. But the crucial point is that the price of gasoline will be lower and will not be higher and so if you want to help American consumers consume gasoline at lower costs or for that matter American heating oil consumers in New England consume heating oil at lower cost, you want there to be more oil exports.

The second argument that's made is an argument, and it's made also with respect to natural gas exports, is that if we have more exports then we'll produce more oil and if we produce more oil then that will be bad because it will have various adverse environmental consequences - either that the process of production and transportation will lead to difficulties or that when it is ultimately burned that will lead to difficulties. Here there's both a theoretical and an empirical response. The theoretical response, which doesn't go quite as far back as Adam Smith but almost in economics, is the principle that you should always use the most targeted policy instrument possible. So if you are concerned that fracking does damage to the ground water then you should regulate fracking appropriately and having regulated fracking appropriately you should then let the market operate.

If you are concerned that the production of oil generally does harm in some way then you should put a tax on the production of oil. There is no environmental argument for a policy that distinguishes between oil produced in the United States for domestic consumption and oil produced in the United States for foreign consumption. There is no argument for similar distinctions on the basis of natural gas. So I am not taking a position one way or the other on how extensively fracking should or should not be regulated and I recognize that the answer to that question will influence how much oil or natural gas the United States is able to export. But the environmental consideration does not constitute an argument for the regulation of oil, does not constitute an argument for a prohibition or a limitation on the exports of oil or natural gas.

Indeed, the empirical force of this point is highlighted by the practice of what somebody called in conversation with me, and maybe it's a common term, "spitting refineries". We permit and have permitted forever the export of refined products. We don't permit the export of crude oil. Well, as you can imagine, what constitutes refined versus crude oil is a question with considerable nuance that has enriched quite a number of law firms over time.

It is estimated that several hundred million dollars are being spent each year on these so called "spit refineries". The term "spit refineries" refer to the fact that basically what's happening is you're getting a bunch of crude oil, somebody's spitting in it and calling that refining the oil, and the oil is basically the same as it was before but because it's been processed by this several hundred million dollar thing that has considerable environmental impacts, therefore it is eligible for export to some other place where it is refined again. So we are engaged in pseudo-refinement activity in order to arbitrage these restrictions which should at least be suggestive of their absurdity.

So far, I have made the argument that one, there is nothing in the history of these policies that provides any warrant for their continued existence. Two, they go against longstanding U.S. principles constantly insisted on with respect to other countries. And three, that the purported advantages of these policies are either, in fact, disadvantages in the case of price or are inappropriately applied in the case of purported environmental benefits. If this were a trial perhaps it would be time to call for summary judgement on these policies. But the real case for change lies in three other areas - economic growth, environmental impact, and geopolitical results. Let me talk a little bit about each of them and then offer a couple of concluding remarks.

Again, the various econometric studies are all over the map on the question of just how large the impact is of increasing exports. What is agreed by all is that U.S. petroleum production and U.S. natural gas production will substantially increase over the foreseeable horizon of the next 10 to 15 years, that the extra investment that will result will be a significant spur to economic growth, that the process will generate substantial employment opportunities, and that those employment opportunities will be disproportionately for the group, less educated men who work with their muscles as well as their mind, that is most threatened in the American economy. There is I believe no disagreement on any of that nor is there any disagreement that the higher domestic price that will result from permitting the export of oil will lead to more drilling. Nor is there any disagreement that the availability of export as an option will create substantial need for the creation of infrastructure which will itself be a substantial employment generator.

Optimists think that this could mean as much as one percent more GDP by the end of this decade. Those who are less optimistic think that it is several tenths of a percent. Optimists think that it could be as much as half a percent on the unemployment rate. Pessimists think that it could be a couple tenths of a percent on the unemployment rate. I don't think anybody can know precisely the answer. What they can know is that we are a growth starved nation that it is now five years since all the TARP money was repaid. It is now five years since every dollar, since credit spreads were basically normalized. And during that five year period the United States has established GDP growth of no more than two percent and that's with the tailwind of falling unemployment that has fallen from about ten to about six percent suggesting that in normal times without the tailwind of falling unemployment since it can't fall forever, the underlying growth rate might be less than two percent.

In such circumstances I would suggest that we need all of the economic growth that we can get. The estimates that I have just quoted have assumed normal economic conditions. If, and it is only a hypothesis, the situation of secular stagnation that I have written about in a different context applies and if the economy is in a long-run sense demand constrained then the impact on output will be substantially greater. In essence the question is when you hire more workers to work on exporting oil are you hiring workers who otherwise would have been unemployed or are you hiring workers who otherwise would have been in some other job? In normal times you would tend to be mostly hiring people who would have been in some other job. But to the extent that we have a demand constrained economy, you may mostly be hiring unemployed people, in which case the impact will be substantially larger.

How large is what I'm talking about? To generate half a percent more GDP with fiscal policy would require spending an extra $60 or $70 billion a year. That's a substantial fiscal program. It's one that's not likely to pass. It's one that would have substantial debt consequences if it did and it's available to us as a free lunch.

There are other economic benefits as well. I haven't added in the extra spending that would result from the lower price of gasoline, relief to consumers budgets. Nor have I factored in the fact that a reduced trade deficit will mean a stronger dollar, will mean lower priced imports which operates to make America richer.

There is no serious argument that the average income of middle income families will not be higher in the United States if oil exports are permitted than if oil exports continue to be banned. No serious argument at all.

Second set of considerations go to the environment. I want to be absolutely clear at the outset in discussing environmental issues. Whether as Strobe said global climate change is the most important long run problem in the world or whether it is one of the two or three most important problems along with the risk of nuclear conflict and pandemic is a question that I think reasonable people can debate and I'm probably not as certain as Strobe that it's the single most important problem. That it is a profoundly important problem and a moral responsibility for our generation is I believe beyond question. I do not suppose and no one should suppose that the increased export of natural gas, which would confer significant environmental benefits by replacing coal exports, constitutes a large part of an American, let alone a global solution, to climate change. We will not solve climate change without moving in an economic and efficient way beyond fossil fuels and whether we move beyond fossil fuels will not be affected one way or the other by our oil export policy or our natural gas export policy.

What is true, however, is that more extensive and more widespread use of natural gas in replacing coal, assuming that the production of natural gas is carefully regulated so there are not excessive leaks of methane associated with its production, will reduce emissions in the near to medium term.

The United States has a record today in terms of carbon emissions that is substantially better than anyone would have imagined plausible a decade ago. That is for two reasons. One is that the GDP is substantially lower than anyone would have imagined plausible a decade ago. That is not a happy reason. The other is that we have had expanded use of natural gas on a scale that would have been unimaginable a decade ago. There is enough natural gas to last the United States for several centuries on the basis of what we now know. If there's going to be a planet for us to enjoy we will not be using fossil fuels on a large scale one century from now.

So the question is whether we are going to organize our public policies in a way that enables that natural gas to be shared with the rest of the world so that it can do there what it has done here, permit the displacement of coal, or whether we seek to hoard that natural gas here and allow coal exports to continue on a substantial scale and allow the new tobacco, which is coal, to take over a growing fraction of markets in the developing world.

I cannot see a rational argument for the latter course. No one should suppose that export policy represents environmental salvation but it will represent environmental improvement and that is sufficient case for it to move forward.

Third, think about Saudi Arabia. Saudi Arabia doesn't have that many people. Saudi Arabia doesn't have that much of what we conventionally think of as soft power assets. Saudi Arabia does not have vast prowess with technology. Saudi Arabia has been an extraordinarily influential country in the world over the last 40 years. That is for one reason. That is because of its production and export of oil.

It either has happened or will happen within the next 18 months. That American production of oil, will exceed, Saudi, production, of oil. Do we want, the world's largest, and most vital democracy, largest in an economic sense, and most vital democracy, to be able to have the kind of influence, when it is also the world's largest oil producer that comes from being able to sell oil, freely on the world market? Or do we wish, to deny ourselves that, on some a priori ground? The question it seems to me, answers itself. Do we want others to depend on us, and have all the consequences that come with that dependence which includes a certain amount of influence on our part, or do we wish them to depend on, the Middle-East? Do we wish the roots, through which oil travels to be dominantly those of the contested seas of the Pacific? Or of those more proximate, to us? Seems to me that question, answers itself, as well.

Strobe knows vastly more than I will ever know, about Russia and, the former Soviet Union. But I know, enough to know, that, when, most of the places, to the west, to the immediate west of the Soviet Union, are dependent to keep warm in the winter, on Russia that that creates, a vulnerability, that is not on net constructive, in the world of today, in light of recent developments. If, the United States was in a position to be a major supplier, of natural gas, that would affect, in a very important way, this dynamic. If we wish to have more power and influence in the world, in support of our security interests, and in support of our values. If we wish to have an influence that we pay for with neither blood nor taxes I do not see a more constructive approach than permitting the export of fossil fuels.

One last remark on this and then a concluding remark. Many of you will be listening to this and thinking, "Well, yeah, this must be right but god before they can export oil, before they can export natural gas, to Europe the terminals will have to get build, factories will have to get built, and tankers will have to get constructed and its all years from now and the geopolitical crisis is now." That's true but I'd say two things. One is there's a geopolitical crisis now. There might be a geopolitical crisis in a few years and it's probably good to prepare for the possibility that there will be one. But there's a second point that maybe comes more out of analytical economics that I would emphasize and that is that the price of oil today has a lot to do with the expected price of oil tomorrow. The price of natural gas today has a lot to do with the expected price of natural gas.

Think about it. If you have some of it under the ground, the price were $40 this year and you thought it was going to be $70 next year, you probably wouldn't produce your oil, would you? If the price of oil was $80 today and you thought it was going to be $50 tomorrow you'd probably produce as much as you could this year. So the expectation that things will be done that reduce the future price has the effect of reducing the current price as well. Actions that carry the prospect of change several years from now will be reflected in markets very quickly in the form of lower prices.

I would suggest to you that the principle that we shouldn't have prohibitions without a reason is a reason to permit oil exports. The economic growth consequences is a reason to permit oil exports. The environmental calculus, all things considered, points towards permitting oil exports. The geopolitics of how should the world's largest oil producer behave speaks in favor of permitting oil exports. All four things together speak overwhelmingly in favor of permitting oil exports.

This does not require a new law. Probably the best way for it to happen would be to repeal the old law that prohibits oil exports and for the government to move to a presumption of permission as long as environmental reviews are completed with respect to natural gas export terminals. But if it cannot happen that way, there's absolutely explicit language in the existing statute that says that if the President of the United States judges that it is in the national interest, not that there is an overwhelming security imperative, not that there's some kind of desperate emergency, just that it is in the national interest to permit exports, he has that authority. The President has spoken often of his commitment to act where Congress will not and his determination to use executive authority to the fullest extent. If necessary, it should be used to remove restrictions on the export of oil.

There may be policies in different spheres that would have larger net benefits than repeal of the oil export ban. I know of none that have as high a ratio of benefits to costs because there are essentially no costs as this step. I hope that it will be undertaken as rapidly as possible and I hope that the research to be presented later in this program will contribute to making that case both in Washington and to a broader public. Thank you very much.

Charles Ebinger: All I can say is I wish we had written our report with the clarity that he spoke about the issue because I think almost every issue he touched upon are ones that we feel very strongly are indeed supported by our analytical analysis that you will hear about in a few minutes.

We have time for a few questions for Dr. Summers. So I won't interject given the time constraints any of my own but will go directly to the floor if anyone has a question they'd like to ask. Yes. We have some roving mics I think somewhere. One's coming to you.

Question: Thank you, Dr. Summers. You said that price controls have not been active about the exports of oil since 1980 or so and given the amount of time that we've had very staunchly free trade presidents, why is it 2014 and we're still talking about this? What are the political and if any economical obstacles?

Dr. Summers: It's because until very recently the restrictions have been a nullity. Nobody's wanted to export oil. It's been completely non-economic to export oil. If you had oil it would be better to ship it to some place in the United States than it would be to ship it to some other place. If you looked at the spread of oil, if you look at the spread that I described, between Texas oil and Brent oil, in general, Texas oil has been more expensive than Brent oil so there's been no reason to export it. That was sort of my point about my wisecrack about the PGA's restriction on Larry Summers playing golf on the tour would only start to become an issue that anybody would discuss when Larry started shooting in the 60s rather than the 90s.

Now so to speak, Larry is shooting in the 60s in the sense that economic actors given a free choice would choose to export oil and this is the first time that's been the case. That's why it's now a live issue.

Charles Ebinger: Can we please have people identify themselves before they ask their question? One right here... I guess we have two near each other.

Question: Hello, Dr. Summers. Thank you for your remarks. I thought you were very, very clear. It's great how you can give a presentation without looking at any notes. My name is Steve Meyer. I'm an independent consultant in the energy industry and I support your theses. However, I'd like you to explain how you would address those people that are concerned that a lower oil price will destabilize the Middle East with all the Middle East economies based upon maybe $100 a barrel of oil.

Larry Summers: First, as recently as ten years ago, twelve years ago, the price of oil was $30-40 and I'm not aware that the Middle East was conspicuously more unstable at that time. If anything, the current era of higher oil prices has gone along with a less stable Middle East. So I guess the question we have to ask ourselves going down that route is it's estimated that ISIS and other terrorist groups receive $2 million a day in black market oil. If that fell by five percent would it be a better world or a worse world? I think it would be a better world. A five percent reduction in the price of oil would take some number in the $10 billion range away from Iran. Would that be a better world or a worse world? I think it would be a better world.

So I think that all of the evidence is that the huge flows of oil dollars have been more of a contributor to instability than that they have been a contributor to stability. So I think if I had been getting signs that there was a little bit of restlessness and it would be good for me to finish my remarks. I would in the geopolitical section have actually remarked and presented some calculations suggesting how much less money would flow to Iran, how much less money would flow to Russia, and I would think that countries that we are sanctioning, we would generally prefer for the workings of the market to be generating less money for them than more money. So I think of that as yet an additional geopolitical virtue rather than a cost of the course that I'm recommending.

In any event, Tom Friedman described this, wrote about this, on the same side of the argument that I was and suggested that it be $25 or $30. It's not right. The numbers are in the five. You could argue for three dollars. You could argue for ten dollars. I don't think you could argue for thirty cents and I don't think you can argue for $30 as the impact of permitting oil exports. So call it five to ten dollars. That is well within the range of annual fluctuation in the price of oil so it's hard to believe that's a reason why we should maintain the ban.

Charles Ebinger: We have two up here if we could bring the mic up to these two gentlemen.

Dr. Summers: Why don't you both ask your question and then I'll respond to them.

Question: Thank you for coming today, Dr. Summers. I really appreciate your elaboration...

Charles Ebinger: Can you identify yourself please?

Question: My name is Rex Wimpen. with Northern Resource here in Washington, D.C. My question is since you ended on the note that there should be no prohibition without a reason I was hoping you might explain the geopolitical ramifications of continuing to prohibit the extension of the Keystone XL pipeline versus the U.S. and China and U.S. and Canadian relations. Thank you.

Dr. Summers: Didn't I step far enough in it today already? My hope would be that we'll get to a better place than where we are now with respect to the question of pipelines in general and the Keystone pipeline in particular. If you think about it, we're in the 21st century and shipping oil on trains is an early 20th century technology. The use of trains rather than pipelines to ship oil is good for Warren Buffet because he owns railroad companies but I'm not aware that he's one of the more needy members of our society. So I would hope that we would be able to work through the various environmental issues more expeditiously than we have. I am very much aware of the toll that the Keystone issue has taken on relations with a crucial U.S. ally. But it's a complicated issue and in all honesty my impression from talking to people who are much more knowledgeable than I is that because of a variety of developments in the evolution of the oil market the Keystone pipeline per se is probably less centrally important to the way the energy markets will evolve than might have appeared likely two or three years ago.

So I think that focusing everything on that totem is probably not the right way to think about the problem. But I think that if you ask the question in almost any area of infrastructure, and certainly with respect to pipelines, what is the risk that on the current path the United States will build too much. What is the risk on the current path that the United States will build too little? The overwhelmingly preponderant risk is the latter.

Charles Ebinger: We have time just for one more question.

Question: I'm Jim Lucier with Capital Alpha Partners. I'd like to thank you for a brilliant, clear, compelling, masterful presentation. I really don't have a profound question.

Dr. Summers: I guess that means you agreed with the policy conclusion?

Question: Well, no, I do agree with the presentation. I just wanted to make sure that I didn't mishear part of it. Did you mention at the beginning that you thought there might be a policy change or a movement towards a policy change in six to nine months and if so, is there a macroeconomic factor behind that or even is there some macroeconomic factor we should be looking at over the next few years as the policy develops?

Dr. Summers: I was very careful to keep my remarks normative and not predictive so I did not make any prediction as to what the administration would do. I hope I was relatively clear on what I thought the administration should do.

Look, I think that the more we are a demand constrained, I think this is the right thing to do almost no matter what happens to the macroeconomic picture. I think this is the right thing to do almost no matter what happens geopolitically. The margin by which it is the right thing is greater the softer the economy is because when you permit free trade you draw resources into their most highly valued market use and that's a good thing to do. But if the people you draw in and the capital you draw in to oil is coming from doing something else, then if the market is sending it into oil that's good, that's better, but if it's sitting unemployed then it's overwhelmingly better. So the softer the economy is the greater is the imperative of this change. But on any plausible economic path this is the right thing to do that will improve economic welfare in the United States.

In all honestly, I don't understand the opposition. With respect to most areas of public policy, I think we should either have a carbon tax or some form of cap and trade. But I don't have any difficulty understanding why somebody might disagree with me and how they would understand the world which would cause them to disagree with me. I have certain views on financial regulation. I have no difficulty understanding why somebody else would have a view that was different from mine. They have a different understanding of how the world works or they have a different set of values.

This issue is quite extraordinary in my experience because I don't understand what are the values that you could have that I don't have that would cause you to want to maintain the restriction nor do I understand what your theory of how the world works is that would cause you to have a different view. Economists have a concept called Pareto optimality and Pareto comparison. Pareto is the guy who invented it. That's why it's called that. Basically what it says is if I took a dollar from everybody on this side of the room and I gave $1,000 to everybody on this side of the room that would be a good thing to do but it wouldn't be a Pareto improvement because the people in this half of the room would be worse off. A Pareto improvement is when some people are better off and no one is worse off. Usually in public policy you don't have... usually it's like a textbook thing because usually anything you do that's important there's some winners and there's some losers and they fight it out.

Here, I don't really understand exactly who the losers are who are very important. There's one group that are losers here and that is if you are in the business of refining the oil that is sitting in Texas right now you are getting an extremely cheap input because the people who have it can't sell it abroad. You're getting a really cheap input and you're selling it into a market where the market price is set on the big world market by the Brent price.

People who own oil refineries in the Wouthwest of the United States and who don't also own crude oil are worse off. But how that group could be. And you see that by the way when the Commerce department made a small change in the rules a month ago, a couple of months ago, the price a couple of refineries plummeted. So there is a very small group but how that group could be strong enough to stand against the various interests that I described is really a mystery to me.

Charles Ebinger: I'm afraid we're going to have to cut off there to get the rest of our program in. I want you all to join me in thanking Dr. Summers for a very provocative presentation. Thank you, sir."

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Fred Dews | September 9, 2014 3:53pm

Larry Summers Argues Case for Lifting the Crude Oil Export Ban

"I believe that the question of whether the United States should have a substantially more permissive policy with respect to the export of crude oil and with respect to the export of natural gas is easy," Lawrence H. Summers told a Brookings audience today. "The answer is affirmative. The merits are as clear as the merits with respect to any significant public policy issue that I have ever encountered. And it is an important test of the efficacy of the functioning of our democracy whether within the next nine months we will get to that correct solution."

Summers, the Charles W. Eliot university professor and president emeritus at Harvard University, delivered the remarks during his keynote remarks at an event sponsored by the Energy Security Initiative (ESI) at Brookings on the future of U.S. energy security and oil export policy.

Watch below *(full video and audio are available on the event's page):*

Three Arguments against the Export Ban

Summers explained three reasons why the current U.S. law {the 1975 Energy Policy and Conservation Act) banning the export of crude oil and natural gas is bad policy, and then offered three additional reasons to support the case for change:

1. The original reason for the policy, enacted in the 1970s, was U.S. vulnerability to price spikes. But as he explained, price controls were eliminated in 1981. "[T]here is nothing in the history of the establishment of the policy that creates any reason for believing that it is functional on a continuing basis today."

2. The ban conflicts with long-standing U.S. insistence on free trade, including stances against other countries' export restrictions. "[W]e have a long history of believing that export restrictions are not an appropriate policy tool."

3. Responses to two objections to lifting the export restrictions: that keeping U.S. oil here will mean gasoline will be cheaper; and that lifting the export ban will have adverse environmental consequences. On the first, he cited economists' research showing that the price of gasoline would be lower in a range from 2 cents to 12 cents per gallon if oil could be

> exported into the global market. And on the environmental concern, Summers explained that "there is no environmental argument for a policy that distinguishes between oil produced in the United States for domestic consumption and oil produced in the United States for foreign consumption." The question of regulation of fracking is a different concern than the prohibition on exports, he said.

In fact, Summers argued later that environmental considerations argue for lifting the ban, along with additional economic growth and geopolitical factors.

Natural Gas Exports would Displace Coal

"That [the environment] is a profoundly moral problem and a moral responsibility for our generation is," he averred, "beyond question." He continued:

> I do not suppose and no one should suppose that the increased export of natural gas, which would confer environmental benefits by replacing coal exports, constitutes a large part of an American, let alone global, solution to climate change. We will not solve climate change without moving in an economic and efficient way beyond fossil fuels. And whether we move beyond fossil fuels will not be affected one way or the other by our export policy, or our natural gas export policy. What is true, however, is that more extensive and more widespread use of natural gas in replacing coal, assuming that the production of natural gas is regulated, so that there aren't excessive leaks of methane associated with its production, will reduce emissions in the near- to medium-term.

Summers argued that allowing natural gas exports would "permit the displacement of coal" in markets around the rest of the world. "And if there is going to be a planet for us to enjoy," he added, "We will not be using fossil fuels on a large scale one century from now."

Geopolitical Reasons to Lift Ban

On the geopolitical front, Summers observed that within the next 18 months, American production of oil will exceed Saudi production of oil. From that fact, he posed a series of questions:

> Do we want the world's largest and most vital democracy ... to be able to have the kind of influence when it is also the world's largest oil producer that comes from being able to sell oil freely on the world market, or do we wish to deny ourselves that on some a priori ground? The question it seems to me answers itself.
>
> Do we want others to depend on us, and have all the consequences that come with that dependence-which includes a certain amount of influence on our part–or do we wish them to depend on the Middle East?
>
> Do we wish the routes through which oil travels to be dominantly those of the contested seas of the Pacific, or those that are more proximate to us? Seems to me that question answers itself as well.

In this context, he also mentioned Russia's supply of heating oil to countries in Europe to the west. "If we wish to have more power and influence in the world, in support of our security interests, and in support of our values," he said, "and if we wish to have an influence that we pay for with neither blood nor taxes. I do not see a more constructive approach than permming the export of fossil fuels."

At the end of his remarks, Summers observed that the president of the United States has statutory authority in the 1975 law to lift the ban if he judges it to be in the national interest. "He has that authority," Summers said, and if Congress is unable to act legislatively, he said that he hopes the export ban will be lifted "as rapidly as possible."

The event also launched ESI's new report, "Changing Markets: Economic Opportunities from Lifting the U.S. Ban on Crude Oil Exports," which looks at the economic and national security consequences of allowing U.S. crude oil exports. The report, by Senior Fellow Charles Ebinger, director of ESI, and Heather Greenley, a research assistant in Foreign Policy, is based on a macroeconomic study contracted from National Economic Research Associates.

Fred Dews
Managing Editor, New Dlgltal Products

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March 19, 2015

U.S. Senate Committee on Energy and Natural Resources United States Crude Export Policy

Michèle Flournoy
CEO and Co-Founder, Center for a New American Security

The unconventional energy revolution in the United States over the last several years has brought about a new era of energy abundance in our country. Crude oil production has increased significantly, from 5 million barrels per day in 2008 to over 9 million barrels per day today. In 2013, the United States surpassed Saudi Arabia to become the largest producer of liquid fuels, including oil and refined petroleum products, in the world. Remarkably, after decades of concern about the scarcity of American energy, our nation has seen a reversal of heavy and growing energy import reliance, to become a major exporter of refined petroleum products and a powerhouse in the production of energy-intensive petrochemicals and industrial manufacturing. Our nation is also on the cusp of exporting Liquefied Natural Gas.

The United States, however, is not a major exporter of crude oil. This is not for lack of potential and available supplies. Rather, it is due to laws that restrict the export of this commodity and that were put in place in response to the OPEC oil embargo of the 1970s. Crude oil export restrictions create distortions in the domestic oil market and pose a risk to U.S. oil production growth. They stifle economic growth and also hamper the ability of U.S. foreign policy and national security leaders to seize strategic benefits presented by the energy revolution.

Lifting oil export restrictions will yield a variety of security dividends to the United States. These include stoking U.S. oil production growth, which will strengthen the U.S. economy and better support the ability of our nation to play a strong leadership role on international security and economic affairs. Stimulating U.S. oil production growth also expands energy security by increasing global oil supply from a stable producer, via maritime transit routes free from the threat of conflict. Lifting the oil export ban also sends the right signal to international trading partners that the United States supports free trade, a regulatory decision in keeping with our WTO commitments and that will support the ability of the United States to win a trade dispute with another nation that may withhold its natural resources from the market. Shunning protectionism is the right message to send at time when U.S. negotiators are pursuing major free trade agreements with Atlantic and Pacific partners.

Another significant security benefit associated with lifting oil export restrictions is the greater flexibility this will provide to impose energy sanctions in the future. Sanctions are a critical national security tool that has a place alongside force projection and diplomatic activities in many of the major security challenges that confront the United States today, including illicit Iranian nuclear enrichment and Russia's destabilization of Eastern Ukraine. But imposing sanctions that take oil off the market is a viable policy only if there is adequate alternative oil supply. The United States should encourage new supplies of oil to enter the market if it wants to sustain and enhance the ability to use oil sanctions in the future. Lifting the ban on U.S. oil export will help to accomplish just this by stimulating additional oil supplies.

Our closest allies, including those in Europe and Northeast Asia, would welcome—and have asked for— the unrestricted export of U.S. crude oil. It will offer them energy security benefits by expanding the diversity of their oil supply pool and contributing to more efficient global oil markets. This is good for their economic growth. The United States is stronger and more secure when our allies are energy secure and economically vital. We are also stronger when we have lucrative and mutually beneficial energy trade with allies. Policymakers in the United States should embrace these various benefits to our allies and ourselves and liberalize our crude export rules. Market conditions merit such a step, and security dividends will not be fully realized without it.

Michèle Flournoy
CEO and Co-Founder, Center for a New American Security

Michèle Flournoy is Co-Founder and Chief Executive Officer of the Center for a New American Security (CNAS).

She served as the Under Secretary of Defense for Policy from February 2009 to February 2012. She was the principal adviser to the Secretary of Defense in the formulation of national security and defense policy, oversight of military plans and operations, and in National Security Council deliberations. She led the development of DoD's 2012 Strategic Guidance and represented the Department in dozens of foreign engagements, in the media and before Congress.

Prior to confirmation, Ms. Flournoy co-led President Obama's transition team at DoD.

In January 2007, Ms. Flournoy co-founded CNAS, a non-partisan think tank dedicated to developing strong, pragmatic and principled national security policies. She served as CNAS' President until 2009.

Previously, she was senior adviser at the Center for Strategic and International Studies for several years and, prior to that, a distinguished research professor at the Institute for National Strategic Studies at the National Defense University (NDU).

In the mid-1990s, she served as Principal Deputy Assistant Secretary of Defense for Strategy and Threat Reduction and Deputy Assistant Secretary of Defense for Strategy. She has received several awards from the Secretary of Defense and the Chairman of the Joint Chiefs of Staff.

Ms. Flournoy is a member of the President's Intelligence Advisory Board, the Defense Policy Board, the DCIA's External Advisory Board, the Council on Foreign Relations, and the Aspen Strategy Group, and a Senior Fellow at Harvard's Belfer Center for Science and International Affairs. She serves on the boards of the Mitre Corporation, Rolls Royce North America, Amida technology Solutions, the Mission Continues, and CARE, and is a Senior Advisor at the Boston Consulting Group.

Ms. Flournoy earned a bachelor's degree in social studies from Harvard University and a master's degree in international relations from Balliol College, Oxford University, where she was a Newton-Tatum scholar.

United States Government Accountability Office

GAO

Testimony
Before the Committee on Agriculture, House of Representatives

For Release on Delivery
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CRUDE OIL EXPORT RESTRICTIONS

Studies Suggest Allowing Exports Could Reduce Consumer Fuel Prices

Statement of Frank Rusco, Director, Natural Resources and Environment

GAO-15-745T

GAO Highlights

Highlights of GAO-15-745T, a testimony before the Committee on Agriculture, House of Representatives

Why GAO Did This Study

After decades of generally falling U.S. crude oil production, technological advances in the extraction of crude oil from shale formations have contributed to increases in U.S. production. In response to these and other market developments, some have proposed removing the 4 decade old restrictions on crude oil exports, underscoring the need to understand how allowing crude oil exports could affect crude oil prices, and the prices of consumer fuels refined from crude oil, such as gasoline and diesel.

This testimony discusses what is known about the pricing and other key potential implications of removing crude oil export restrictions. It is based on GAO's September 2014 report (GAO-14-807), and information on crude oil production and prices updated in June 2015. For that report, GAO reviewed four studies issued in 2014 on crude oil exports; including two sponsored by industry and conducted by consultants, one sponsored by a research organization and conducted by consultants, and one conducted at a research organization. Market conditions have changed since these studies were conducted, underscoring some uncertainties surrounding estimates of potential implications of removing crude oil export restrictions. For its 2014 report, GAO also summarized the views of a nongeneralizable sample of 17 stakeholders including representatives of companies and interest groups with a stake in the outcome of decisions regarding crude oil export restrictions, as well as academic, industry, and other experts.

View GAO-15-745T. For more information, contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov.

July 8, 2015

CRUDE OIL EXPORT RESTRICTIONS

Studies Suggest Allowing Exports Could Reduce Consumer Fuel Prices

What GAO Found

In September 2014, GAO reported that according to studies it reviewed and stakeholders it interviewed, removing crude oil export restrictions would likely increase domestic crude oil prices, but could decrease consumer fuel prices, although the extent of price changes are uncertain and may vary by region. The studies identified the following implications for U.S. crude oil and consumer fuel prices:

- **Crude oil prices**. The four studies GAO reviewed estimated that if crude oil export restrictions were removed, U.S. crude oil prices would increase by about $2 to $8 per barrel—bringing them closer to international prices. Prices for some U.S. crude oils have been lower than international prices—for example, one benchmark U.S. crude oil averaged $52 per barrel from January through May 2015, while a comparable international crude oil averaged $57. In addition, one study found that, when assuming low future crude oil prices overall, removing export restrictions would have no measurable effect on U.S. crude oil prices.
- **Consumer fuel prices.** The four studies suggested that U.S. prices for gasoline, diesel, and other consumer fuels follow international prices. If domestic crude oil exports caused international crude oil prices to decrease, consumer fuel prices could decrease as well. Estimates of the consumer fuel price implications in the four studies GAO reviewed ranged from a decrease of 1.5 to 13 cents per gallon. In addition, one study found that, when assuming low future crude oil prices, removing export restrictions would have no measurable effect on consumer fuel prices.

Some stakeholders cautioned that estimates of the price implications of removing export restrictions are subject to several uncertainties, such as the extent of U.S. crude oil production increases, and how readily U.S. refiners are able to absorb such increases. Some stakeholders further told GAO that there could be important regional differences in the price implications of removing export restrictions.

The studies GAO reviewed and the stakeholders it interviewed generally suggested that removing crude oil export restrictions may also have the following implications:

- **Crude oil production**. Removing export restrictions may increase domestic production—over 8 million barrels per day in 2014—because of increasing domestic crude oil prices. Estimates ranged from an additional 130,000 to 3.3 million barrels per day on average from 2015 through 2035.
- **Environment**. Additional crude oil production may pose risks to the quality and quantity of surface groundwater sources; increase greenhouse gas and other emissions; and increase the risk of spills from crude oil transportation.
- **The economy**. Three of the studies projected that removing export restrictions would lead to additional investment in crude oil production and increases in employment. This growth in the oil sector would—in turn—have additional positive effects in the rest of the economy, including for employment and government revenues.

Chairman Conaway, Ranking Member Peterson, and Members of the Committee:

Thank you for the opportunity to discuss our work on the implications of removing crude oil export restrictions. After decades of generally falling U.S. crude oil production, technological advances in the extraction of crude oil from shale formations have contributed to increases in U.S. production. Crude oil production increased by about 74 percent from 2008 through 2014 to reach over 8 million barrels per day in 2014, and production increases in 2012, 2013, and 2014 were the largest annual increases since the beginning of U.S. commercial crude oil production in 1859, according to the Energy Information Administration (EIA).[1] More recently, however, crude oil prices have declined by 40 percent, from about $100 per barrel in the summer of 2014, to about $60 in May 2015. In response to these and other market developments, some have proposed removing the 4 decade old restrictions on crude oil exports, underscoring the need to understand how allowing crude oil to be exported could affect crude oil prices, and the prices of consumer fuels refined from crude oil, such as gasoline and diesel.

My testimony discusses what is known about the pricing and other key implications of removing crude oil export restrictions. It is based on our September 2014 report that examined these and other issues,[2] and information on crude oil prices and production updated in June 2015. For the 2014 report, we reviewed four studies issued in 2014 on crude oil exports; including two sponsored by industry and conducted by consultants, one sponsored by a research organization and conducted by

[1]EIA is a statistical agency within the Department of Energy that collects, analyzes, and disseminates independent information on energy issues.

[2]GAO, *Changing Crude Oil Markets: Allowing Exports Could Reduce Consumer Fuel Prices, and the Size of the Strategic Reserves Should Be Reexamined,* GAO-14-807 (Washington, D.C.: Sept. 30, 2014).

consultants, and one conducted at a research organization.[3] Market conditions have changed since these studies were conducted, underscoring some uncertainties surrounding estimates of potential implications of removing crude oil export restrictions. For our 2014 report, we also summarized the views of a nongeneralizable sample of 17 stakeholders including representatives of companies and interest groups with a stake in the outcome of decisions regarding crude oil export restrictions, as well as academic, industry, and other experts. Although not generalizable to all potential stakeholders, these views provide illustrative examples. More details on our scope and methodology for that work can be found in the issued report. We conducted the work on which this statement is based in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The export of domestically produced crude oil has generally been restricted since the 1970s. In particular, the Energy Policy and Conservation Act of 1975 (EPCA) led the Department of Commerce's Bureau of Industry and Security (BIS) to promulgate regulations that require crude oil exporters to obtain a license.[4] These regulations provide that BIS will issue licenses for the following crude oil exports:

- exports from Alaska's Cook Inlet,
- exports to Canada for consumption or use therein,
- exports in connection with refining or exchange of SPR crude oil,
- exports of certain California crude oil up to twenty-five thousand barrels per day,

[3] Resources for the Future, *Crude Behavior: How Lifting the Export Ban Reduces Gasoline Prices in the United States* (Washington, D.C.: Resources for the Future, February 2014, revised March 2014); ICF International and EnSys Energy (ICF International), *The Impacts of U.S. Crude Oil Exports on Domestic Crude Production, GDP, Employment, Trade, and Consumer Costs* (Washington, D.C.: ICF Resources, Mar. 31, 2014); IHS, *U.S. Crude Oil Export Decision: Assessing the Impact of the Export Ban and Free Trade on the U.S. Economy* (Englewood, CO: IHS, 2014); NERA Economic Consulting, *Economic Benefits of Lifting the Crude Oil Export Ban* (Washington, D.C.: NERA Economic Consulting, Sept. 9, 2014).

[4] 15 C.F.R. § 754.2(a).

- exports consistent with certain international energy supply agreements,
- exports consistent with findings made by the President under certain statutes, and
- exports of foreign origin crude oil that has not been commingled with crude oil of U.S. origin.

Other than for these exceptions, BIS considers export license applications for exchanges involving crude oil on a case-by-case basis, and BIS can approve them if it determines that the proposed export is consistent with the national interest and purposes of EPCA.[5] In addition to BIS's export controls, other statutes control the export of domestically produced crude oil, depending on where it was produced and how it is transported.[6] In these cases, BIS can approve exports only if the President makes the necessary findings under applicable laws.[7] Some of the authorized exceptions, outlined above, are the result of such presidential findings.

As we previously found, recent increases in U.S. crude oil production have lowered the cost of some domestic crude oils.[8] For example, prices for West Texas Intermediate (WTI) crude oil—a domestic crude oil used as a benchmark for pricing—were historically about the same price as Brent, an international benchmark crude oil from the North Sea between Great Britain and the European continent.[9] However, from 2011 through 2014, the price of WTI averaged $12 per barrel lower than Brent (see fig.

[5]15 C.F.R. § 754.2(b)(2).

[6]For example, the Mineral Leasing Act of 1920 restricts exports of domestically produced crude oil transported by pipeline over certain rights-of-way (30 U.S.C. §185(u)); the Outer Continental Shelf Lands Act restricts exports of crude oil from the outer continental shelf (29 U.S.C. §1354); the Naval Petroleum Reserves Production Act restricts the export of crude oil produced from the Naval Petroleum Reserves (10 U.S.C. §7430) and Section 201 of Pub. L. No. 104-58, "Exports of Alaskan North Slope Oil," provides for exports of domestically produced crude oil transported by pipeline over rights-of-way granted pursuant to section 203 of the Trans-Alaska Pipeline Authorization Act (30 U.S.C. §185(s)).

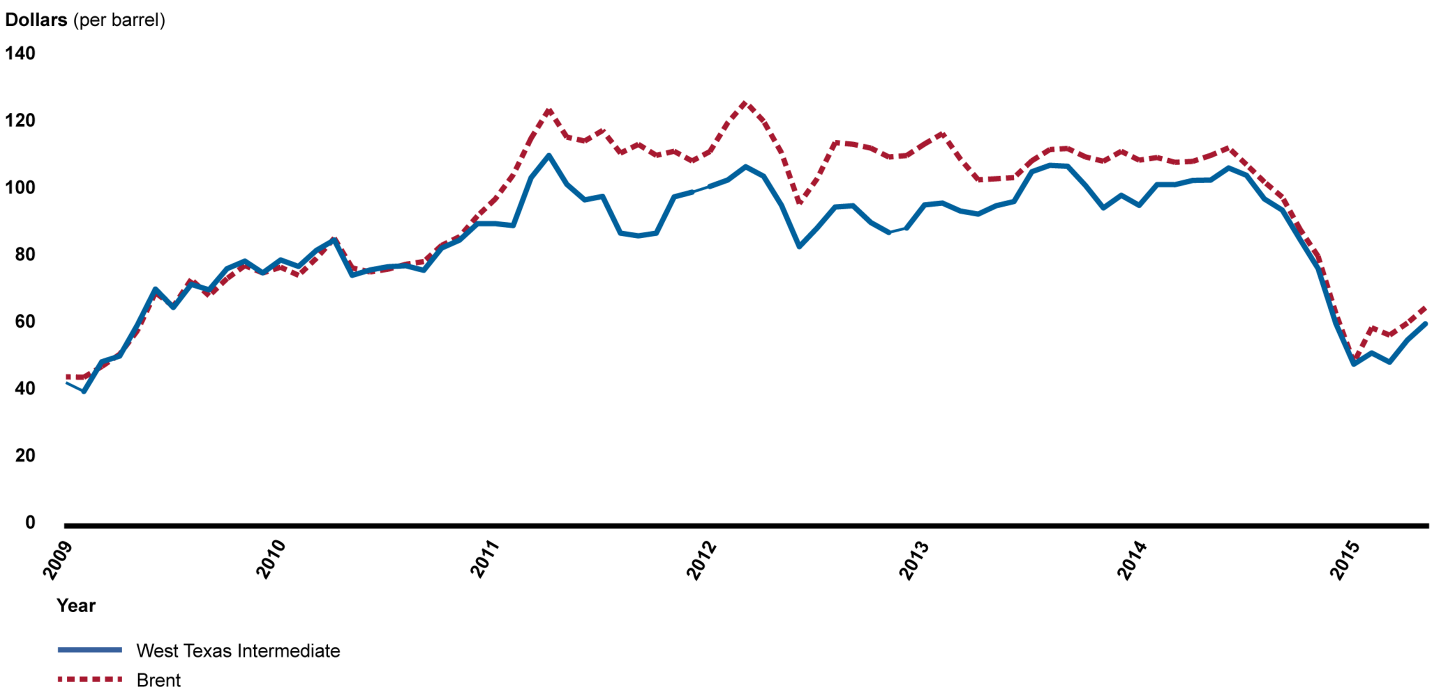
[7]15 C.F.R. § 754.2(c).

[8]GAO, *Petroleum Refining: Industry's Outlook Depends on Market Changes and Key Environmental Regulations,* GAO-14-249 (Washington, D.C.: Mar. 14, 2014).

[9]Because of the large number of grades of crude oils, buyers and sellers use benchmark crude oils as a reference in pricing crude oil. A benchmark crude oil is typically an abundantly produced and frequently traded crude oil. For example, crude oils produced in North and South America are typically priced in reference to WTI.

1). In 2014, prices for these benchmark crude oils narrowed as global oil prices declined, and WTI averaged $52 from January through May 2015, while Brent averaged $57. The development of U.S. crude oil production has created some challenges for crude oil transportation infrastructure because some production has been in areas with limited linkages to refining centers. According to EIA, these infrastructure constraints have contributed to discounted prices for some domestic crude oils.

Figure 1: Monthly West Texas Intermediate and Brent Crude Oil Prices, 2009-May 2015

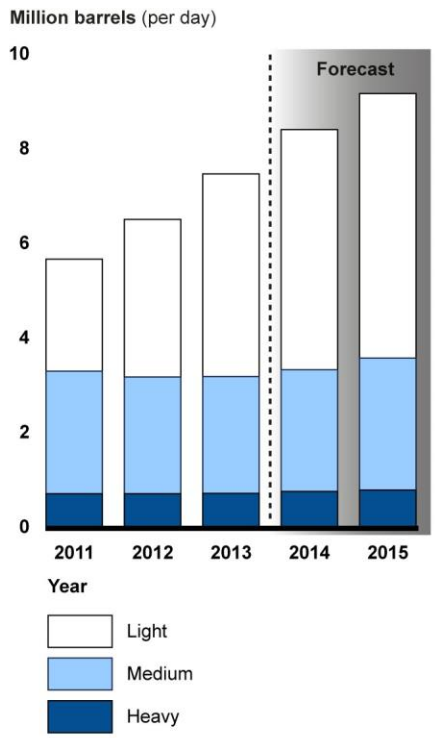


Source: GAO analysis of Energy Information Administration data. | GAO-15-745T

Note: West Texas Intermediate is a domestic crude oil used as a benchmark for pricing, and Brent is an international benchmark from the North Sea between Great Britain and the European continent.

Much of the crude oil currently produced in the United States has characteristics that differ from historic domestic production. Crude oil is generally classified according to two parameters: density and sulfur content. Less dense crude oils are known as “light,” and denser crude oils are known as “heavy.” Crude oils with relatively low sulfur content are known as “sweet,” and crude oils with higher sulfur content are known as “sour.” As shown in figure 2, according to EIA, most domestic crude oil produced over the last 5 years has tended to be light oil. Specifically, according to EIA estimates, about all of the 1.8 million barrels per day increase in production from 2011 to 2013 consisted of lighter sweet crude oils.[10]

Figure 2: U.S. Crude Oil Production and Energy Information Administration Forecast of Production by Crude Oil Type, 2011-2015



Source: GAO analysis of Energy Information Administration data. | GAO-15-745T

Note: The density, or gravity, of a crude oil is specified using the American Petroleum Institute (API) gravity standard, which measures the weight of crude oil in relation to water, which has an API gravity of 10 degrees. Heavy crude oils include those with an API gravity of less than 27; medium includes crude oil with an API from 27 to 35; and light includes crude oil with API gravities of 35 and above.

[10]The density, or gravity of a crude oil is specified using the American Petroleum Institute (API) gravity standard, which measures the weight of crude oil in relation to water, which has an API gravity of 10 degrees. For the purposes of this estimate, we considered light oils as those with an API gravity of 35 degrees or above. See: Energy Information Administration, *U.S. Crude Oil Production Forecast-Analysis of Crude Types* (Washington, D.C.: May 29, 2014).

Light crude oil differs from the crude oil that many U.S. refineries are designed to process. Refineries are configured to produce transportation fuels and other products (e.g., gasoline, diesel, jet fuel, and kerosene) from specific types of crude oil. Refineries use a distillation process that separates crude oil into different fractions, or interim products, based on their boiling points, which can then be further processed into final products. Many refineries in the United States are configured to refine heavier crude oils and have therefore been able to take advantage of historically lower prices of heavier crude oils.[11] For example, in 2013, the average density of crude oil used at domestic refineries was 30.8, while nearly all of the increase in production in recent years has been lighter crude oil with a density of 35 or above.

According to EIA, additional production of light crude oil over the past several years has been absorbed into the market through several mechanisms, but the capacity of these mechanisms to absorb further increases in light crude oil production may be limited in the future for the following reasons:

- **Reduced imports of similar grade crude oils:** According to EIA, additional production of light oil in the past several years has primarily been absorbed by reducing imports of similar grade crude oils. Light crude oil imports fell from 1.7 million barrels per day in 2011 to 1 million barrels per day in 2013. As a result, there may be dwindling amounts of light crude oil imports that can be reduced in the future, according to EIA.
- **Increased crude oil exports:** Crude oil exports have increased recently, from less than thirty thousand barrels per day in 2008 to 396 thousand barrels per day in June 2014. Continued increases in crude oil exports will depend, in part, on the extent of any relaxation of current export restrictions, according to EIA.
- **Increased use of light crude oils at domestic refineries:** Domestic refineries have increased the average gravity of crude oils that they refine. The average American Petroleum Institute (API) gravity of crude oil used in U.S. refineries increased from 30.2 degrees in 2008 to 30.8 degrees in 2013, according to EIA. Continued shifts to use additional lighter crude oils at domestic refineries can be enabled by

[11] In general, heavier crude oils require more complex and expensive refineries to process the crude oil into usable products but have been less expensive to purchase than lighter crude oils.

- investments to relieve constraints associated with refining lighter crude oils at refineries that were optimized to refine heavier crude oils, according to EIA.
- **Increased use of domestic refineries:** In recent years, domestic refineries have been run more intensively, allowing the use of more domestic crude oils. Utilization—a measure of how intensively refineries are used that is calculated by dividing total crude oil and other inputs used at refineries by the amount refineries can process under usual operating conditions—increased from 86 percent in 2011 to 88 percent in 2013. There may be limits to further increases in utilization of refineries that are already running at high rates, according to EIA.

Removing Crude Oil Export Restrictions Is Expected to Increase Domestic Crude Oil Prices and Could Decrease Consumer Fuel Prices

In our September 2014 report, we reported that according to the studies we reviewed and the stakeholders we interviewed, removing crude oil export restrictions would likely increase some domestic crude oil prices, but could decrease consumer fuel prices, although the extent of consumer fuel price changes are uncertain and may vary by region. As discussed earlier, increasing domestic crude oil production has resulted in lower prices of some domestic crude oils compared with international benchmark crude oils. Three of the studies we reviewed also concluded that, absent changes in crude oil export restrictions, the expected growth in crude oil production may not be fully absorbed by domestic refineries or through exports (where allowed), contributing to even wider differences in prices between some domestic and international crude oils. According to these studies, by removing the export restrictions, these domestic crude oils could be sold at prices closer to international prices, reducing the price differential and aligning the price of domestic crude oil with international benchmarks.

While the studies we reviewed and most of the stakeholders we interviewed agreed that domestic crude oil prices would increase if crude oil export restrictions were removed, stakeholders highlighted several uncertainties that could affect the extent of price increases. The studies we reviewed made assumptions about these uncertainties, and actual price implications of removing crude oil export restrictions may differ from those estimated in these studies depending on how export restrictions and market conditions evolve. Specifically, stakeholders raised the following three key uncertainties:

- **Extent of future increases in crude oil production**. According to two stakeholders, in the absence of exports, higher production of domestic light sweet crude oil would tend to increase the mismatch between such crude oils and the refining industry. This was corroborated by two of the studies. As a result, one study indicated that a greater increase in production would increase the price effects of removing crude oil export restrictions. On the other hand, lower than anticipated production of such crude oil would lower potential price effects as the additional crude oil could more easily be absorbed domestically.

- **Extent to which crude oil production increases can be absorbed**. The domestic refining industry and exports to Canada have absorbed the increases in domestic crude oil production thus far, and one stakeholder told us the domestic refining industry could provide sufficient capacity to absorb additional future crude oil production. On the other hand, some stakeholders suggested that the U.S. refining industry will not be able to keep pace with increasing U.S. light crude oil production. For example, IHS stated that refinery investments to process additional light crude oil face significant risks in the form of potentially stranded investments if export restrictions were to change, and this could result in investments not being made as quickly as anticipated.[12]
- **Extent to which export restrictions change**. Aspects of the export restrictions could be further defined or interpreted in ways that could change the pricing dynamics of domestic crude oil markets. In 2014, for example, the Department of Commerce provided clarifications that condensate—a type of light crude oil[13]—that has been processed through a distillation tower is not considered crude oil and so not

[12]IHS is a firm that provides comprehensive economic and financial information on countries, regions, and industries.

[13]Specifically, the Department of Commerce's definition of crude oil includes condensates, which are light liquid hydrocarbons recovered primarily from natural gas wells.

subject to export restrictions.[14] One stakeholder stated that this may lead to more condensate exports than expected.[15]

Within the context of these uncertainties, estimates of potential price effects vary in the four studies we reviewed, as shown in table 1. Specifically, estimates in these studies of the increase in domestic crude oil prices due to removing crude oil export restrictions ranged from about $2 to $8 per barrel.[16] For comparison, at the beginning of June 2014, WTI was $103 per barrel, and these estimates represented 2 to 8 percent of that price. In addition, NERA Economic Consulting found that removing export restrictions would have no measurable effect in a case that assumes a low future international oil price of $70 per barrel in 2015 rising to less than $75 by 2035.[17] According to the NERA Economic Consulting study, current production costs are close to these values, so that removing export restrictions would provide little incentive to produce more light crude oil.

[14]Specifically, companies often process condensate through stabilization units to reduce their volatility and prepare the condensate for transport to markets. Some stabilization units include distillation towers. In March and May 2014, the Department of Commerce issued commodity classifications to two companies that determined that condensates processed through a crude oil distillation tower, as described by the two companies requesting clarification, did not meet the definition of crude oil in BIS's regulations and thus were not subject to the export prohibitions applicable to U.S. produced crude oil. The Department of Commerce clarified the factors it will consider in determining whether a product has been "processed through a crude oil distillation tower" in December, 2014.

[15]This clarification provided by the Department of Commerce occurred after the publication of the Resources for the Future, ICF International, and IHS studies and thus this was not taken into consideration in the studies. NERA Economic Consulting also did not consider the potential effect of the clarification in its study.

[16]Unless otherwise noted, dollar estimates in the rest of this report have been converted to 2014 year dollars. These are average price effects over the study time frames, and some cases in some studies projected larger price effects in the near term that declined over time.

[17]NERA Economic Consulting is a global firm of experts dedicated to applying economic, finance, and quantitative principles to complex business and legal challenges.

Table 1: Crude Oil Price Implications of Removing Crude Oil Export Restrictions from Four Studies Issued in 2014

	Resources for the Future	ICF International	IHS	NERA Economic Consulting
U.S. crude oil price	Midwest refiner acquisition costs increase $6.68 per barrel.[a]	West Texas Intermediate crude oil prices increase $2.35 to $4.19 per barrel on average from 2015-2035.	Prices increase $7.89 per barrel on average from 2016-2030.	Prices increase $1.74 per barrel in the reference case and $5.95 per barrel in the high case on average from 2015-2035.[b]

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA Economic Consulting studies. | GAO-15-745T

Note: Estimates are in 2014 year dollars.

[a]Refiner acquisition costs are the costs of crude oil including transportation and other fees paid by the refiner. Such costs may be closely related to the prices of crude oil.

[b]Implications refer to the difference between the reference case and its baseline with export restrictions in place, and also the difference between the high oil and gas recovery case and its corresponding baseline. NERA Economic Consulting also found that removing crude oil export restrictions would have no measurable effect in the low world oil price case.

Regarding consumer fuel prices, such as gasoline, diesel, and jet fuel, the studies we reviewed and most of the stakeholders we interviewed suggested that consumer fuel prices could decrease as a result of removing crude oil export restrictions. A decrease in consumer fuel prices could occur because such prices tend to follow international crude oil prices rather than domestic crude oil prices, according to the studies reviewed and most of the stakeholders interviewed. If domestic crude oil exports caused international crude oil prices to decrease, consumer fuel prices could decrease as well.[18] Table 2 shows that the estimates of the price effects on consumer fuels varied in the four studies we reviewed. Price estimates ranged from a decrease of 1.5 to 13 cents per gallon. These estimates represented 0.4 to 3.4 percent of the average U.S. retail gasoline price at the beginning of June 2014. In addition, NERA Economic Consulting found that removing export restrictions would have no measurable effect on consumer fuel prices when assuming a low future world crude oil price.

[18]Resources for the Future also estimates a decrease in consumer fuel prices but this decrease is as a result of increased refinery efficiency (even with an estimated slight increase in the international crude oil price).

Table 2: Consumer Fuel Price Implications of Removing Crude Oil Export Restrictions from Four Studies Issued in 2014

	Resources for the Future	ICF International	IHS	NERA Economic Consulting[a]
U.S. consumer fuel prices	Gasoline prices would decline by 1.8 to 4.6 cents per gallon on average.	Petroleum product prices would decline by 1.5 to 2.4 cents per gallon on average from 2015-2035.	Gasoline prices would decline by 9 to 13 cents per gallon on average from 2016-2030.	Petroleum product prices would decline by 3 cents per gallon on average from 2015-2035 in the reference case and 11 cents per gallon in the high case. Gasoline prices would decline by 3 cents per gallon in the reference case and 10 cents per gallon in the high case. Fuel prices would not be affected in a low world oil price case.

Sources: GAO analysis of Resources for the Future, ICF International, IHS, and NERA Economic Consulting studies. | GAO-15-745T

Note: Dollar estimates are in 2014 year dollars.

[a]Implications refer to the difference between the reference case and its baseline with export restrictions in place, and the difference between the high oil and gas recovery case and its corresponding baseline.

Price Effects of Allowing Alaskan North Slope Crude Oil Exports

In 1995, Congress removed the restrictions on the export of Alaskan North Slope crude oil. From the time the restrictions were removed until 2004, about 2.7 percent of Alaskan North Slope crude oil was exported; however, no Alaskan North Slope crude oil has been exported since 2004.The experience of allowing Alaskan North Slope crude oil exports may illustrate some of the potential effects of removing crude oil export restrictions nationally. In 1999, we reviewed the effects of allowing Alaskan North Slope crude oil exports and concluded that:[a]

- lifting the export ban raised the relative prices of Alaskan North Slope and comparable California crude oils by between $0.98 and $1.30 per barrel;[b]
- some refiners' costs increased commensurate with the increase in crude oil prices; and
- consumer fuel prices for gasoline, diesel, and jet fuel did not increase.

The effect of removing the export restrictions for Alaskan North Slope oil is not completely understood due to data limitations and the difficulty of separating the effects of removing the export restrictions from other market changes that occurred at the same time.

Source: GAO. | GAO-15-745T

[a]GAO, Alaskan North Slope Oil: Limited Effects of Lifting Export Ban on Oil and Shipping Industries and Consumers, GAO/RCED-99-191 (Washington, D.C., July 1, 1999).

[b]These estimates have not been adjusted for inflation.

The effect of removing crude oil export restrictions on domestic consumer fuel prices depends on several uncertainties, as we discussed in our September 2014 report.[19] First, it would depend on the extent to which domestic versus international crude oil prices determine the domestic price of consumer fuels. A 2014 research study examining the relationship between domestic crude oil and gasoline prices concluded that low domestic crude oil prices in the Midwest during 2011 did not result in lower gasoline prices in that region.[20] This research supports the assumption made in the four studies we reviewed that to some extent higher prices of some domestic crude oils as a result of removing crude oil export restrictions would not be passed on to consumer fuel prices. However, some stakeholders told us that this may not always be the case and that more recent or detailed data could show that lower prices for some domestic crude oils have influenced consumer fuel prices.

Second, two of the stakeholders we interviewed suggested that there could be important regional differences in consumer fuel price implications and that prices could increase in some regions—particularly the Midwest and the Northeast—due to changing transportation costs and potential refinery closures. For example, these two stakeholders told us that because of requirements to use more expensive U.S.-built, -owned, and -operated ships to move crude oil between U.S. ports, allowing exports could enable some domestic crude oil producers to ship U.S. crude oil for less cost to refineries in foreign countries.[21] Specifically, representatives of one refiner told us that, if export restrictions were removed, they could ship oil to their refineries in Europe at a lower cost than delivering the same oil to a refinery on the U.S. East Coast. According to another stakeholder, this could negatively affect the ability of some domestic refineries to compete with foreign refineries. Additionally, because refineries are currently benefiting from low domestic crude oil prices, some studies and stakeholders noted that refinery margins could be reduced if removing export restrictions increased domestic crude oil prices. As a result, some refineries could face an increased risk of

[19]GAO-14-807.

[20]See Severin Borenstein and Ryan Kellogg, "The Incidence of an Oil Glut: Who Benefits from Cheap Crude Oil in the Midwest?" *The Energy Journal 35, no. 1* (2014).

[21]The Merchant Marine Act of 1920, also known as the Jones Act, in general, requires that any vessel (including barges) operating between two U.S. ports be U.S.-built, -owned, and -operated.

closure, especially those located in the Northeast. However, according to one stakeholder, domestic refiners still have a significant cost advantage in the form of less expensive natural gas, which is an important energy source for many refineries. For this and other reasons, one stakeholder told us they did not anticipate refinery closures as a result of removing export restrictions.

Removing Crude Oil Export Restrictions Is Expected to Increase Domestic Production and Have Other Implications

The studies we reviewed for our September 2014 report,[22] generally suggested that removing crude oil export restrictions may increase domestic crude oil production and may affect the environment and the economy:

- **Crude oil production.** Removing crude oil export restrictions may increase domestic crude oil production. Even with current crude oil export restrictions, given various scenarios, EIA projected that domestic production will continue to increase through 2020.[23] If export restrictions were removed, according to the four studies we reviewed, the increased prices of domestic crude oil are projected to lead to further increases in crude oil production. Projections of this increase varied in the studies we reviewed—from a low of an additional 130,000 barrels per day on average from 2015 through 2035, according to the ICF International study, to a high of an additional 3.3 million barrels per day on average from 2015 through 2035 in NERA Economic Consulting's study.[24] This is equivalent to 1.5 percent to almost 40 percent of production in April 2014.
- **Environment.** Two of the studies we reviewed stated that the increased crude oil production that could result from removing the restrictions on crude oil exports may affect the environment. Most stakeholders we interviewed echoed this statement. This is consistent

[22]GAO-14-807.

[23]See EIA, *Annual Energy Outlook 2015, DOE/EIA-0383(2015)* (Washington, D.C.: April 2015).

[24]In addition, Resources for the Future estimated that oil production in Canada and in the Midwest United States would gradually increase if the restrictions were lifted by about 84,000 barrels per day. Resources for the Future estimated production elsewhere in the United States and the rest of the world would increase by 54,000 barrels per day for a total increase in world production of 138,000 additional barrels per day. IHS projected an additional 1.2 to 2.3 million barrels per day of crude oil production from 2016 through 2030.

with what we found in a September 2012 report.[25] In that 2012 report we found that crude oil development may pose certain inherent environmental and public health risks. However, the extent of the risk is unknown, in part, because the severity of adverse effects depends on various location- and process-specific factors, including the location of future shale oil and gas development and the rate at which it occurs. It also depends on geology, climate, business practices, and regulatory and enforcement activities. The stakeholders who raised concerns about the effect of removing the restrictions on crude oil exports on the environment identified risks including those related to the quality and quantity of surface and groundwater sources; increases in greenhouse gas and other air emissions, and increases in the risk of spills from crude oil transportation.

- **The economy.** The four studies we reviewed suggested that removing crude oil export restrictions would increase the size of the economy. Three of the studies projected that removing export restrictions would lead to additional investment in crude oil production and increases in employment. This growth in the oil sector would—in turn—have additional positive effects in the rest of the economy.[26] For example, NERA Economic Consulting's study projected an average of 230,000 to 380,000 workers would be removed from unemployment through 2020 if export restrictions were eliminated in 2015.[27] These employment benefits would largely disappear if export restrictions were not removed until 2020 because by then the economy would have returned to full employment. Two of the studies we reviewed suggested that removing export restrictions would increase government revenues, although the estimates of the increase vary. One study estimated that total government revenue would increase by a combined $1.4 trillion in additional revenue from 2016 through 2030,

[25]GAO, *Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks,* GAO-12-732 (Washington, D.C.: Sept. 5, 2012).

[26]Growth in one sector of the economy can result in economy-wide growth through follow-on effects. For example, researchers at the Federal Reserve Bank of Dallas found that oil development in the Eagle Ford region of South Texas has had profound effects on jobs, income, and spending in the region with effects beyond those in the oil sector alone. See: Gilmer, Robert W., Raúl Hernandez, and Keith Phillips, "Oil Boom in Eagle Ford Shale Brings New Wealth to South Texas," *Southwest Economy* (Federal Reserve Bank of Dallas: Second Quarter, 2012).

[27]According to the NERA study, because of the increase in economic growth triggered by investment in more production capacity and infrastructure, there will be a corresponding acceleration of the rate at which the economy moves toward full employment.

and another study estimated that U.S. federal, state, and local tax receipts combined with royalties from drilling on federal lands could increase by an annual average of $3.9 to $5.7 billion from 2015 through 2035.

Chairman Conaway, Ranking Member Peterson, and Members of the Committee, this completes my prepared statement. I would be pleased to answer any questions that you may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff members have any questions concerning this testimony, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Other individuals who made key contributions include Christine Kehr (Assistant Director), Quindi Franco, Alison O'Neill, and Kiki Theodoropoulos.

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THE WALL STREET JOURNAL.

The Oil-Export Ban Harms National Security

The U.S. is willfully denying itself a tool that could prove vital in dealing with threats from Russia, Iran and others.

The United States faces a startling array of global security threats, demanding national resolve and the resolve of our closest allies in Europe and Asia. Iran's moves to become a regional hegemon, Russia's aggression in Ukraine, and conflicts driven by Islamic terrorism throughout the Middle East and North Africa are a few of the challenges calling for steadfast commitment to American democratic principles and military readiness. The pathway to achieving U.S. goals also can be economic—as simple as ensuring that allies and friends have access to secure supplies of energy.

Blocking access to these supplies is the ban on exporting U.S. crude oil that was enacted, along with domestic price controls, after the 1973 Arab oil embargo. The price controls ended in 1981 but the export ban lives on, though America is awash in oil.

The U.S. has broken free of its dependence on energy from unstable sources. Only 27% of the petroleum consumed here last year was imported, the lowest level in 30 years. Nearly half of those imports came from Canada and Mexico. But our friends and allies, particularly in Europe, do not enjoy the same degree of independence. The moment has come for the U.S. to deploy its oil and gas in support of its security interests around the world.

Consider Iran. Multilateral sanctions, including a cap on its oil exports, brought Tehran to the negotiating table. Those sanctions would have proved hollow without the surge in domestic U.S. crude oil production that displaced imports. Much of that foreign oil in turn found a home in European countries, which then reduced their imports of Iranian oil to zero.

The prospect of a nuclear agreement with Iran does not permit the U.S. to stand still. Once world economic growth increases the demand for oil, Iran is poised to ramp up its exports rapidly to nations whose reduced Iranian imports were critical to the sanctions' success, including Japan, South Korea, Taiwan, Turkey, India and China. U.S. exports would help those countries diversify their sources and avoid returning to their former level of dependence on Iran.

More critically, if negotiations fail, or if Tehran fails to comply with its commitments, the sanctions should snap back into place, with an even tighter embargo on Iranian oil exports. It will be much harder to insist that other countries limit Iranian imports if the U.S. refuses to sell them its oil.

There are other threats arising from global oil suppliers that the U.S. cannot afford to ignore. Libya is racked by civil war and attacks by the Islamic State. Venezuela's mismanaged economy is near collapse.

Most ominous is Russia's energy stranglehold on Europe. Fourteen NATO countries buy 15% or more of their oil from Russia, with several countries in Eastern and Central Europe exceeding 50%. Russia is the sole or predominant source of natural gas for several European countries including Finland, Slovakia, Bulgaria and the Baltic states. Europe as a whole relies on Russia for more than a quarter of its natural gas.

This situation leaves Europe vulnerable to Kremlin coercion. In January 2009, Russia cut off natural gas to Ukraine, and several European countries completely lost their gas supply. A recent EU "stress test" showed that a prolonged Russian supply disruption would result in several countries losing 60% of their gas supplies.
Further, revenue from sales to Europe provides Russia with considerable financial resources to fund its aggression in Ukraine. That conflict could conceivably spread through Central Europe toward the Baltic states. So far, the trans-Atlantic alliance has held firm, but the trajectory of this conflict is unpredictable. The U.S. can provide friends and allies with a stable alternative to threats of supply disruption. This is a strategic imperative as well as a matter of economic self-interest.

The domestic shale energy boom has supported an estimated 2.1 million U.S. jobs, according to a 2013 IHS study, but the recent downturn in oil prices has led to massive cuts in capital spending for exploration and production. Layoffs in the oil patch have spread outward, notably to the steel industry. Lifting the export ban would put some of these workers back on the job and boost the U.S. economy.

Why, then, does the ban endure? Habit and myth have something to do with it. U.S. energy policy remains rooted in the scarcity mentality that took hold in the 1970s. Even now, public perception has yet to catch up to the reality that America has surpassed both Russia and Saudi Arabia as the world's largest producer of liquid petroleum (exceeding 11 million barrels a day). The U.S. became the largest natural gas producer in 2010, and the federal government will now license exports of liquefied natural gas.

The fear that exporting U.S. oil would cause domestic gasoline prices to rise is misplaced. The U.S. already exports refined petroleum, including 875,000 barrels a day of gasoline in December 2014. The result is that U.S. gasoline prices approximate the world price. Several recent studies, including by the Brookings Institution,Resources for the Futureand Rice University's Center for Energy Studies, demonstrate that crude oil exports would actually put downward pressure on U.S. ne prices, as more oil supply hits the global market and lowers global prices.

Too often foreign-policy debates in America focus on issues such as how much military power should be deployed to the Middle East, whether the U.S. should provide arms to the Ukrainians, or what tougher economic sanctions should be imposed on Iran. Ignored is a powerful, nonlethal tool: America's abundance of oil and natural gas. The U.S. remains the great arsenal of democracy. It should also be the great arsenal of energy.

Mr. Panetta served as director of the Central Intelligence Agency (2009-11) and as secretary of defense (2011-13). Mr. Hadley served as national security adviser (2005-09).

IDEAS WORLD AFFAIRS

William S. Cohen: Why President Obama Should Export Crude Oil

Cohen served as Secretary of Defense from 1997-2001 and is the CEO of the Cohen Group.

"The core of our strength overseas is economic strength at home"

As the battle wages on in Congress over President Barack Obama's signature trade agreements and the needed fast-track trade promotion authority (TPA), the president would be wise to consider alternatives that would enhance his trade legacy and also further our strategic priorities overseas. While energy is not included in the Trans-Pacific Partnership (TPP) or Transatlantic Trade and Investment Partnership (T-TIP) negotiations, many of the same Asian, European, and Latin American partners are calling for greater partnership with the United States on energy issues. By allowing the U.S. to become a stable source of supply to global energy markets, counteracting supply disruptions that will inevitably affect other energy-rich regions, President Obama and Congress can double down on promoting long-term economic growth and reinforcing U.S. foreign policy leadership.

The U.S. can do more with its energy resources to support this strategic vision. A direct way of leveraging this opportunity is to lift the ban on the export of crude oil and accelerate approvals for the export of liquefied natural gas (LNG). A series of policies and laws in the 1970s banned exports of U.S. crude oil with only limited exceptions. This ban is a relic from an age of energy scarcity and should be adjusted to reflect present realities. By working with Congress, and via executive order, the president can start taking steps today to boost U.S. exports.

There would be four strategic benefits to doing so.

First, energy exports would strengthen NATO and our broader transatlantic relationship at a time of increased Russian aggression. The European Union has responded to Russia's energy stranglehold by proposing policies designed to avoid future crises of supply and promote self-sufficiency. The E.U. antitrust case against Russian energy company Gazprom is important. But more can and should be done to build a strategic U.S.-European relationship on energy security. Working with our allies and partners, a joint effort to reduce Europe's vulnerability to Russian energy coercion would be an important legacy for President Obama and send a signal to President Vladimir Putin that as long as he chooses to use energy as a weapon, the West will defend itself. While it will take years to build the necessary infrastructure to receive more LNG, enhance transport pipelines, and otherwise increase Europe's energy resilience, there is no better time to start than now.

Second, increased energy trade with our Asian partners would add substance to the U.S. rebalance to Asia, serving to bolster the region's energy security and promote the continued economic vitality of allies such as Japan and South Korea, while also offering new areas for possible collaboration with China, India, and ASEAN members.

Third, energy exports could open up a new era of collaboration in our own hemisphere. As Venezuela scales back its energy exports in response to domestic challenges, this presents a strategic opportunity for the U.S. to fill the energy void with the 17 Central American and Caribbean nations that have depended on Venezuelan energy subsidies. Moreover, increased energy integration among NAFTA members would create a North American energy powerhouse that will reinforce the above objectives.

Finally, the core of our strength overseas is economic strength at home. The “shale revolution” has created thousands of jobs, revitalized and expanded the domestic energy industry, spurred breakthrough technology with a global impact, and significantly improved the U.S. trade balance. The U.S. has tripled its exports of refined oil products over the last decade as a consequence of the recent energy boom. American primary energy firms, however, have been unable to capture higher gas and oil prices on the global market. A prudent way to support the continued expansion of the U.S. energy sector and our domestic energy security is to level the playing field by relaxing restrictions on American crude oil and LNG exports. Legislation such as the bipartisan LNG Permitting Certainty and Transparency Act introduced by Senators John Barrasso, a Republican from Wyoming, and Martin Heinrich, a Democrat from New Mexico, and supported by the Energy Department provide a good foundation to build on.

For the first time in a half century, President Obama has the opportunity to re-write the energy balance of power in our favor and solidify his legacy on trade. President Obama is the only U.S. president in decades who has had the tool of energy abundance at his disposal; he should use it.

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John W. Hickenlooper
Governor

April 30th 2015

The Honorable Penny Pritzker
Secretary, U.S. Department of Commerce
1401 Constitution Avenue, NW
Washington, D.C. 20230

Dear Secretary Pritzker:

We are writing to thank you for your leadership and ongoing support for a healthy energy market. Your decision earlier this year under the Bureau of Industry and Security (BIS) with regard to classification of oil condensate as a petroleum product was a welcomed action, and one for which we are very grateful.

As you may know, Colorado has contributed mightily to the nation's energy renaissance which has resulted in significant capital investment and job creation, accelerating economic growth while also enhancing our domestic energy security as well as national security. As the US recently reached record-levels of domestic production of over 9.4 million barrels per day, we believe that continuing to build upon the BIS decision by ending the outdated and counterproductive ban on crude oil exports is the next logical step to ensuring that domestic producers continue to invest and that energy consumers benefit.

Many states are currently experiencing a downturn in oil and gas drilling, which is leading to job losses, slower economic growth and a decline in tax revenues. Recently, the Brookings Institute projected that ending the ban would increase U.S. GDP by as much as $800 billion to $1.8 trillion through 2039 . Additionally, IHS found that allowing exports would support between 359,000 and 964,000 jobs annually between 2016 and 2018.

Colorado has a well-established history of having high environmental standards for energy development. We were the first state in the nation to regulate methane emissions from oil and gas development, the first to have before and after testing of groundwater, and Colorado developed model regulations for the disclosure of the constituents of hydraulic fracturing fluid. We have developed many of these regulations in conjunction with our industry and with environmental leaders. Colorado's environmental leadership could be a useful model internationally for regulations.

For these reasons, among others, we respectfully request your support and that of the broader Administration for full legislative repeal of the crude oil export ban. Thank you for your consideration of this critical issue, and for your continued leadership on significant economic issues.

John W. Hickenlooper
Governor of Colorado

Honorable Barack Obama
President of the United States
The White House
1600 Pennsylvania Avenue, NW
Washington, DC 20500

Dear President Obama:

Governors know firsthand the economic potential presented by the United States energy revolution. American energy producers, manufacturers and workers deserve a sensible national energy strategy to support the economic growth we are experiencing in our states. Now is the time to end the federal ban on crude oil exports and lift existing restrictions on liquefied natural gas (LNG) exports.

The United States oil and gas industry is literally fueling economic growth in our states. Recent studies show lifting the ban on crude exports would create as many as 300,000 jobs nationwide by 2020. LNG exports would also significantly boost employment, adding 155,000 jobs in natural gas producing states and an additional 38,000 jobs in large manufacturing states. Without a change in the federal approach to energy exports, these jobs will be left on the table during a critical time in the nation's economic recovery.

Updated energy export policies would also enhance American national security in a global energy economy punctuated by conflict and civil unrest. United States energy policy should seek to strike a balance between bolstering our national security by maintaining domestic reserves and opening up economic and diplomatic opportunities to American interests around the globe. The federal government's current approach to energy exports was set in motion when domestic production was down, imported energy was dominating our resource mix and the global market was threatened by hostile international players. The United States now stands as the world's top producer of oil and natural gas, though we continue to import energy from nations adverse to American interests. This approach is impractical and dangerous.

American ingenuity and advances in technology have unlocked vast reserves of crude oil and natural gas here at home. We should be seeking new opportunities for these energy resources by providing customers around the globe unblocked access – driving investment in American energy.

The outdated federal export restrictions on crude oil and LNG are detrimental to American workers, our collective security and economic recovery in our states. A broad coalition of United States Senators has introduced legislation, S. 1312 - Energy Supply Distribution Act, to move sensible export policy forward and we applaud that effort. We ask you to end the ban on crude oil exports, to lift restrictions on LNG exports and to set in motion a cohesive federal energy export strategy.

Sincerely,

Governor Asa Hutchinson
Arkansas

Governor Bobby Jindal
Louisiana

Governor Phil Bryant
Mississippi

Governor Susana Martinez
New Mexico

Governor Jack Dalrymple
North Dakota

Governor Mary Fallin
Oklahoma

Governor Greg Abbott
Texas

Governor Gary R. Herbert
Utah

Governor Scott Walker
Wisconsin

Governor Matthew H. Mead
Wyoming

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Sixty-fourth
Legislative Assembly
of North Dakota

HOUSE CONCURRENT RESOLUTION NO. 3008 with Senate Amendments

HOUSE CONCURRENT RESOLUTION NO. 3008

Introduced by

Representatives Streyle, Headland, Louser, Maragos, Schatz, Skarphol, Thoreson

Senators Armstrong, Casper, Cook, Larsen, Unruh

A concurrent resolution urging Congress to lift the prohibition on the export of crude oil from the United States.

WHEREAS, beginning with the Energy Policy and Conservation Act of 1975, the United States Congress has prohibited the export of crude oil from the United States; and

WHEREAS, the 1970s saw high oil prices as a result of OPEC nations withholding production and a need to increase domestic energy production and supply to provide for energy independence; and

WHEREAS, the reasons for the prohibition were to preserve domestic price ceilings by preventing domestic producers from receiving higher world oil prices and to preserve a depleting domestic reserve; and

WHEREAS, directional drilling and hydraulic fracturing technologies in the Bakken Formation and other shale plays in the United States have made the United States more crude oil independent; and

WHEREAS, the United States is currently exporting over four million barrels of refined products, such as gasoline, out of the United States each day; and

WHEREAS, the continued oil production in this region and across the United States has provided the opportunity for economic growth and stability through the export of crude oil and the prohibition on exports of crude oil is no longer necessary;

NOW, THEREFORE, BE IT RESOLVED BY THE HOUSE OF REPRESENTATIVES OF NORTH DAKOTA, THE SENATE CONCURRING THEREIN:

That the Sixty-forth Legislative Assembly urges the Congress of the United States to lift the prohibition on the export of crude oil from the United States; and

BE IT FURTHER RESOLVED, that the Secretary of State forward a copy of this resolution to each member of Congress.

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By: Seliger, et al. S.C.R. No. 13

CONCURRENT RESOLUTION

WHEREAS, The efficient exploration, production, and transportation of oil in Texas prevents waste of the state's natural resources, contributes to the health, welfare, and safety of the general public, and promotes the prosperity of the state; and

WHEREAS, The tax revenues and economic prosperity deriving from this Texas energy renaissance have greatly benefited Texas public schools, higher education, critical infrastructure development, and public health and safety programs; and

WHEREAS, Improved technologies and abundant resources have made America the world's leading oil and natural gas producer, overtaking Saudi Arabia and Russia; and

WHEREAS, The 1970s-era federal law prohibiting crude oil exports is a relic from an era of scarcity and flawed price control policies; and

WHEREAS, Allowing American crude oil exports will strengthen U.S. geopolitical influence by giving our trading partners a more secure source of supply, and allowing the export of American crude oil will make our allies less dependent on crude oil from Russia and the Middle East; and

WHEREAS, The world's other major developed nations allow crude oil exports, making America the only nation that does not take full advantage of trading a valuable resource in what is an otherwise global free market; and

WHEREAS, Crude oil exports will benefit America's national security interests by decreasing the likelihood that global oil supply can be used internationally as a strategic weapon; and

WHEREAS, Numerous studies have found that allowing American crude oil into the world's free market will benefit U.S. trade and American consumers while creating more high-paying jobs for Texans to fill; and

WHEREAS, According to an analysis by the American Petroleum Institute, Texas will lead all states in job growth following the repeal of the ban, with an estimated 40,291 jobs by 2020; and

WHEREAS, Other studies have similarly found tremendous prospective GDP growth from lifting the 1970s-era ban; and

WHEREAS, The United States is the largest exporter of refined petroleum products and would benefit even more substantially from the export of both crude oil and refined petroleum products; and

WHEREAS, At least seven independent studies have confirmed that repealing the ban on American crude oil exports will lower U.S. gas prices, benefiting Texas consumers and businesses; and

WHEREAS, Thousands of small and large Texas businesses that support oil and gas development will benefit from ongoing production; and

WHEREAS, Manufacturers will benefit from less volatility in energy costs; and

WHEREAS, The technology and brainpower behind the American energy renaissance was mostly pioneered in Texas by Texans; and

WHEREAS, Encouraging a global marketplace that is more free from artificial barriers will better allow the export of Texas leadership and expertise, which will also ultimately economically benefit Texas, the rest of the United States, and our friends around the world; now, therefore, be it

RESOLVED, That the 84th Legislature of the State of Texas hereby urge the United States Congress and the president of the United States to recognize that crude oil exports and free trade are in the national interest and take all necessary steps to eliminate the current ban on crude oil exports; and, be it further

RESOLVED, That the Texas secretary of state forward official copies of this resolution to the president of the United States, to the U.S. secretary of commerce, to the U.S. secretary of energy, to the majority leader of the Senate and the speaker of the House of Representatives of the United States Congress, and to all the members of the Texas delegation to Congress with the request that this resolution be entered in the Congressional Record as a memorial to the Congress of the United States of America.

As Introduced

131st General Assembly
Regular Session
2015-2016

S. C. R. No. 6

Senator Balderson

Cosponsors: Senators Hite, Hughes, LaRose, Seitz, Williams

A CONCURRENT RESOLUTION

To urge the U.S. Congress to lift the prohibition on the export of crude oil from the United States.

BE IT RESOLVED BY THE SENATE OF THE STATE OF OHIO (THE HOUSE OF REPRESENTATIVES CONCURRING):

WHEREAS, Beginning with the Energy Policy and Conservation Act of 1975, the U.S. Congress has prohibited the export of crude oil from the United States; and

WHEREAS, The 1970s saw high oil prices as a result of the Organization of the Petroleum Exporting Countries' withholding of production and a need to increase domestic energy production and supply to provide for energy independence. Thus, the prohibition originally was intended to preserve domestic price ceilings by preventing domestic producers from receiving higher world oil prices and to preserve a depleting domestic reserve; and

WHEREAS, Since that time, the use of directional drilling and hydraulic fracturing technologies in shale formations in the United States has made this country more crude oil independent. Additionally, the United States is currently exporting over four million barrels of refined products, such as gasoline, each day; and

WHEREAS, The continued oil production in Ohio and across the country is providing an opportunity for economic growth and stability through the export of crude oil. Thus, the prohibition on exports of crude oil is no longer necessary; now therefore be it

RESOLVED, That we, the members of the 131st General Assembly of the State of Ohio, urge the U.S. Congress to lift the prohibition on the export of crude oil from the United States; and be it further

RESOLVED, That the Clerk of the Senate transmit duly authenticated copies of this resolution to the President of the United States, the U.S. Secretary of Commerce, the U.S. Secretary of Energy, the President Pro Tempore and Minority Leader of the U.S. Senate, the Speaker and Minority Leader of the U.S. House of Representatives, and the members of the Ohio Congressional delegation.

HOUSE MEMORIAL 105

52ND LEGISLATURE - STATE OF NEW MEXICO - FIRST SESSION, 2015

INTRODUCED BY

Rod Montoya

A MEMORIAL

REQUESTING THE NEW MEXICO CONGRESSIONAL DELEGATION TO SUPPORT RELIEF FROM THE 1970S BAN ON EXPORTING CRUDE OIL SO THAT NEW MEXICO MAY BENEFIT FROM A FREE MARKET THAT ENCOURAGES DEVELOPMENT AND PRODUCES REVENUES FOR NEW MEXICO.

WHEREAS, the efficient exploration, production and transportation of crude oil in New Mexico prevents waste of the state's natural resources, contributes nearly one-third of the general fund revenues for the operation of state government and promotes the economic welfare of New Mexico in general; and

WHEREAS, the tax revenues derived from the oil industry have greatly benefited New Mexico public schools, higher education, critical infrastructure development and public health and safety programs; and

WHEREAS, the 1970s federal law prohibiting most crude oil exports is a relic from an era of oil scarcity arising from the Arab embargo; and

WHEREAS, the price of a barrel of oil in the United States sells for less than the price of a barrel of oil in the international market, and at times the price differential has been nearly twenty dollars ($20.00) a barrel; and

WHEREAS, lifting the crude oil export ban will increase employment in New Mexico and will maximize state revenues by adding millions of dollars; and

WHEREAS, allowing American crude oil exports will strengthen United States geopolitical influence by giving its trading partners and allies a source of supply more secure than depending on crude oil from Russia and the Middle East; and

WHEREAS, the world's other major oil-producing nations allow crude oil exports, making America the only nation that does not take full advantage of trading a valuable resource in what is an otherwise global free market; and

WHEREAS, numerous studies have found that allowing American crude oil into the world's free market will benefit New Mexico and United States trade and American consumers while creating more jobs for New Mexicans; and

WHEREAS, studies have found tremendous prospective gross domestic product growth from lifting the 1970s-era ban; and

WHEREAS, the United States is the largest exporter of refined petroleum products and would benefit even more from the export of both crude oil and refined petroleum products; and

WHEREAS, encouraging a global marketplace that is free from artificial barriers will ultimately economically benefit New Mexico, the rest of the United States and its friends around the world;

NOW, THEREFORE, BE IT RESOLVED BY THE HOUSE OF REPRESENTATIVES OF THE STATE OF NEW MEXICO that New Mexico's congressional delegation be requested to recognize that crude oil exports and free trade are in the national interest and take all necessary steps to eliminate the current ban on crude oil exports; and

BE IT FURTHER RESOLVED that copies of this memorial be transmitted to the New Mexico congressional delegation, the president of the United States, the United States secretary of commerce, the United States secretary of energy, the majority leader of the United States senate and the speaker of the United States house of representatives.

underscored material = new
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