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A U.S. Investment Strategy for Defense

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A key element in responding to China is to invest in the development of critical technologies in the United States. And while investing in research and development (R&D) is likely to be an obvious and relatively noncontroversial response, it is important to understand why and how this investment will pay off if we are to make the most of the resources dedicated to it. A strategy of investment worked for the United States in the last century and although the circumstances then were decidedly different, it remains relevant today. However, today's strategy must be tailored to reflect China's rise and to complement the increasingly commercial and global nature of R&D.

A Successful Defense Investment Strategy

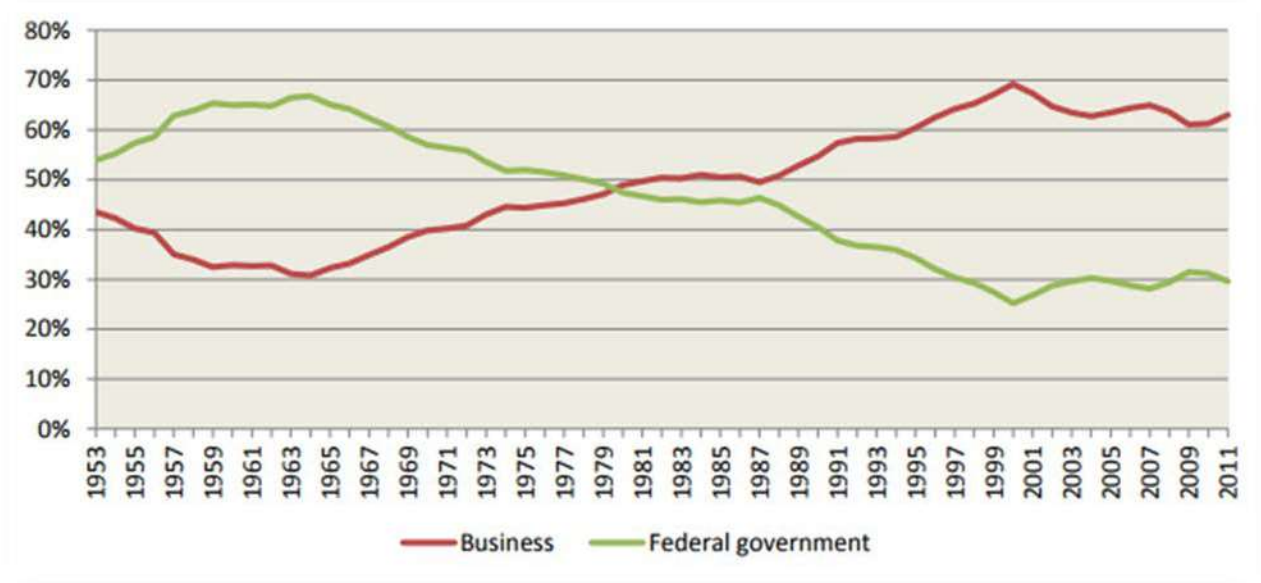
After World War II, the United States decided to make a massive investment in technology a key part of its strategy for global superpower competition. While the United States was not known for its investments in military technology prior to World War II, with the success of the Manhattan Project and the onset of the Cold War, the United States emphasized investing in technology as a linchpin of its strategy. Investment was central in the newly dawned nuclear age where it was believed that "strategic" systems, that is, nuclear weapons, would dominate the global security landscape. And while it became clear quickly that nuclear weapons were not going to end all nonnuclear competition, the United States remained committed to investing in technology to offset the numerical advantage in conventional forces that the Soviet Union and its allied Warsaw Pact countries had compared to the United States and its NATO allies.

The Department of Defense, along with NASA and the Atomic Energy Commission, invested heavily in R&D throughout the second half of the twentieth century resulting in the procurement of successive generations of technologically cutting-edge systems. The U.S. commitment to an investment strategy was so firm that in the mid-1960s, the U.S. government share of R&D investment represented two-thirds of total U.S. R&D, as shown in Figure 3. Total investment by the private sector was only a third of the U.S. total. A key feature of the U.S. investment strategy was scope and scale.

The Soviet Union was also investing in R&D throughout this period, and it had a cadre of talented researchers as well. The United States out-competed them, however, by ensuring that its investment in R&D was substantially larger, and by making investments across a huge range of technologies in a wide variety of fields. The Soviets proved unable to match, and increasingly fell farther behind. President Reagan's decision to invest heavily in missile defense in the 1980s is sometimes cited as a major reason the Soviet Union fell. In truth, the U.S. strategy of out-

investing the Soviet Union started much earlier and was much broader than this reading of history suggests. But the investment in missile defense does provide an illustration of the larger story of the success of the U.S. investment strategy. The U.S. investment strategy led to decades of technological superiority for U.S. military forces. It also had a wide variety of nonmilitary benefits, laying the foundation for technological advances such as GPS and the internet, which have delivered huge economic benefits.

Figure 3: Share of Funds for R&D in the United States, 1953–2011



Source: Ryan Crotty and Andrew Hunter, *Keeping the Technological Edge: Leveraging Outside Innovation to Sustain the Department of Defense's Technological Advantage* (Washington, DC: CSIS, June 2015), 9. Data derived from National Science Foundation, *Science and Engineering Indicators 2014*, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series).

The Changing Structure of Global R&D

A new U.S. investment strategy to compete with China can't simply be a copy of the approach taken in the second half of the twentieth century. The game has been fundamentally changed by the enormous increase in private-sector R&D, which completely reversed the ratio of government-to-private-sector R&D in the United States by the 1990s to favor the private sector. Equally important is the increasing globalization of R&D, driven in no small part by the rise of China, but also reflecting the R&D occurring in a variety of other nations. The dominance of private-sector funding for R&D means that key technologies such as artificial intelligence, robotics, additive manufacturing, space, and biotech will be fundamentally driven in most of the world by private-sector rather than government investment. The increasingly globalized nature of R&D means that most commercially driven technologies will be available to systems developers around the world. Most technologies are unlikely to remain the sole purview of any nation for more than a handful of years. These factors must lead the United States to develop a different investment strategy. There simply isn't much reason for the United States to use government resources to duplicate the work that the private sector will perform on its own.

Care must also be taken in developing military applications of commercial technologies that are also available to both allies and adversaries alike.

The Role for Government Investment

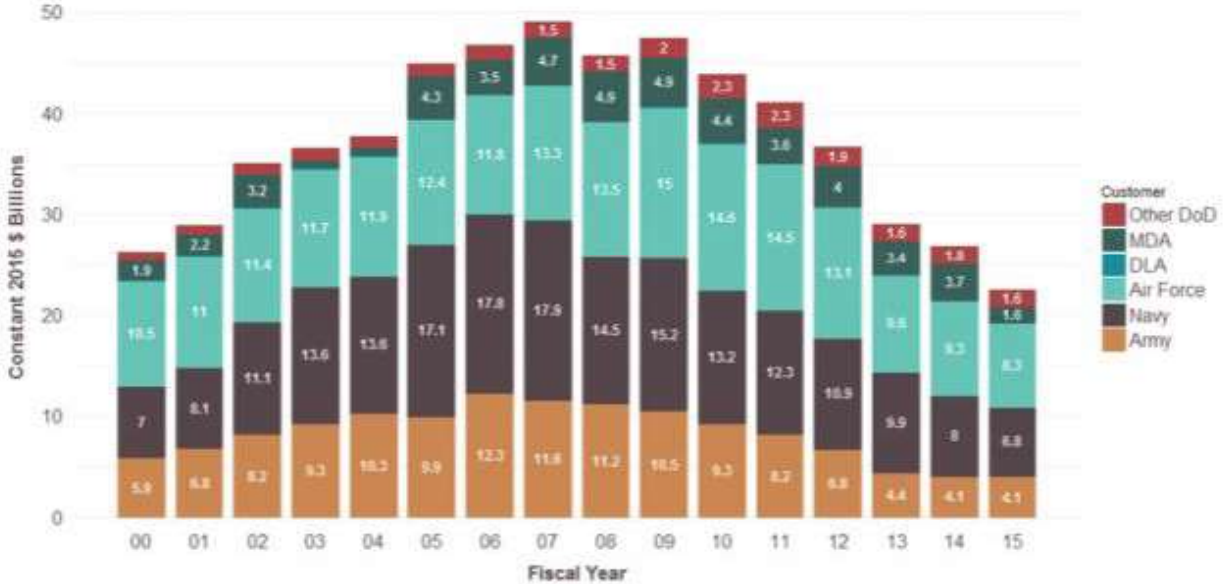
Government investment retains a critical role in a U.S. investment strategy, however, in making the kinds of investment that the private sector won't. The private sector primarily invests where it sees an attractive return on investment (ROI) in a time frame of five years or less. Only a relatively small number of companies have the resources and secure market position to make investments that need a decade or more to pay off. A related group of firms work in industries where the scope and scale of the work necessitates longer ROI time horizons, for example in designing and building large airframes or disrupting large entrenched industries, but even so they mostly focus on those investments with clear potential commercial ROI in the billions. Government investment must continue to fill the gap in funding early-stage R&D that hasn't yet demonstrated compelling commercial ROI.

Look deeply into the source of private sector R&D and you will usually find a history of defense research that pioneered the early stages of the technology. Frequently the Defense Advanced Research Projects Agency was a significant player in the early days of development of new technologies. Before the 1980s, NASA played a similar role for many space and aviation technologies though it has much reduced that role in recent decades. In addition to early-stage R&D, government investment is frequently necessary to apply cutting-edge commercial technologies to specific military problems. Commercial electronics may need to be adapted to operate in austere or extreme environments in military applications and additional features added. More extensive development may be required to convert commercially developed industrial capabilities to produce advanced military systems in the necessary performance regimes, such as fighter planes and the highly specialized engines that power them. In addition, government investment is often necessary to sustain the unique industrial capabilities that support these advanced military systems. The United States needs a strategy that supports these critical government roles.

A Defense Investment Strategy to Compete with China

The U.S. investment strategy that helped defeat the Soviet Union will not perform nearly as well if it is used as the strategy for competition with China. The changes in the structure of global R&D already discussed implicitly call into question the likelihood that a strategy of overwhelming scope and scale in R&D can be meaningfully executed. The growth of China's economy and the regime's clear commitment to R&D suggest, in fact, that the United States may soon be challenged to match the scope and scale of China's investment. While there will likely be a residual U.S. advantage in many military-related fields for several years, that advantage should be expected to erode without action. One clearly needed step is to recommit the United States to investment in defense R&D. The years since 2009 have seen an unprecedented decline in the defense R&D funding going to industry in constant dollar terms as shown in Figure 4.

Figure 4: DoD R&D Contract Obligations by Component, 2000–2015



Source: Jesse Ellman et al., *Defense Acquisition Trends, 2016: The End of the Contracting Drawdown* (Washington, DC: CSIS, March 2017), 19.

In fact, R&D is the only area of defense contract spending that did not increase in 2016, the year in which overall defense contract spending began to recover, and it is unlikely to recover significantly in 2017 or 2018. A concerted effort is needed to reverse this R&D contract decline and it must begin in earnest in the budget for fiscal year 2019. Other major sources of U.S. government R&D funding come from the National Institutes for Health, the Department of Energy, and NASA. While the R&D investment of these agencies didn't fall nearly as much as DoD's in the last several years, increasing their investment is also warranted. The key technology areas for investment are increasingly matters of consensus, and include the predominately commercial technology areas mentioned earlier as well as more military-specific technologies such as hypersonics, electronic warfare, energetic materials, and cyber-attack. The U.S. investment strategy should seek to complement and leverage the massive investments being made by the private sector (which typically builds on and exploits government-funded basic research) even as it focuses on the more military specific investments that the private sector is unlikely to pursue.

Invest in a More Flexible and Resilient Supply Chain

An increase in government-sponsored R&D as part of a U.S. investment strategy is necessary, but not sufficient, however. China is explicitly seeking to achieve market dominance in several key technologies, and China's past behavior suggests that it may seek this position in part to have the leverage to cut off access to critical resources to other countries. An example of this came in 2010 when China established strict export quotas on rare earth metals, effectively limiting access to nearly all of then-active world production to manufacturers in China. Rare earth metals are used in a wide variety of national security applications including missile guidance systems and power generation in addition to many important civilian applications. This

effort, if intended to force the on-shoring of upstream component production, largely failed because suppliers of rare earth metals elsewhere in the world were able to increase production as world prices of this resource increased. However, if China had been able to establish itself as the sole reliable provider of rare earth materials, it is very likely it could have leveraged that market power to establish dominance in making a series of critical components higher up the defense value chain.

The possibility that China will use whatever dominant market positions it achieves—and it will inevitably succeed in establishing significant market power in at least some technology areas as they have with solar photovoltaic panels—means that the U.S. investment strategy should focus, in part, on developing flexibility and resilience in the defense supply chain. China couldn't force rapid on-shoring of the production of components using rare earth metals in 2010, but it is not inconceivable that it could try again and succeed in the future. It is also entirely possible that China could achieve such an outcome over time by working with, rather than against, market forces. However, there are substitutes for rare earth metals in most applications as there are for many other materials and technologies that China may seek to dominate. The U.S. investment strategy should include research into developing and making practical alternatives in key areas of the supply chain where U.S. access could be threatened, enabling the United States to reconstitute supply chains more quickly. This suggests a commitment to developing second sources of key components and materials wherever U.S. access could be cut off.

Leverage Partnerships with Other Nations

The U.S. investment strategy must also leverage the increasingly global structure of R&D. In the twentieth century, the overwhelming scope and scale of U.S. investment in R&D was coupled with a strict technology control system designed to keep the fruits of all that investment in the United States, with some limited access also provided to allies on a case-by-case basis. But R&D today is already far more diffuse and egalitarian than it was during the Cold War. Many U.S. partners and allies are also making key R&D investments and cutting-edge technologies are increasingly being developed outside the United States. The U.S. investment strategy should capitalize on, leverage, and enable complementary investments by partners and allies. We can do so by coordinating with key partners and allies to research critical technologies together or in complementary fashion. We can also increase our utilization of foreign designs (but with production in most cases in the United States) especially in areas where the United States has under-invested in the last decade, such as advanced protection capabilities for ground vehicles. A U.S. investment strategy that leverages the enormous investments being made by our partners will be more powerful and successful than one that attempts to utilize U.S. resources alone. This approach requires that the United States continue to modernize its technology control system to enable more cooperation with allies and partners, and to actively seek partners in the key technologies of the future through defense trade. Working with our allies can also make the response to aggressive efforts by China (or Russia) to use market power much more effective.

Develop, Attract, and Retain the Best People

The last key element of the U.S. investment strategy is people. The United States must invest in science, technology, engineering, and mathematics (STEM) education for any U.S. investment

strategy to succeed, and must create a cultural environment conducive to the development and success of technical talent. The United States is in a high-stakes competition for technical talent with every other nation in the world. A key factor in the success of the U.S. investment strategy of the twentieth century was the influx of technical talent from Europe and Asia that resulted from the World Wars. The United States has been a favored destination for innovators and the scientifically minded for decades. Nothing can be more critical than that it remain so. Happily, the fostering of domestic technical talent and the ability to attract foreign talent are highly complementary. The same conditions tend to lead to success in both cases. People are perhaps the most vulnerable aspect of this proposed U.S. investment strategy because China has an abundance of technical talent to draw upon. If the United States neglects this element of the strategy, or adopts policies that discourage technical talent from developing or coming to the United States, the rest of the strategy will likely have no meaningful effect.

Recommendations

- Increase U.S. investment in defense R&D focusing on basic research, leveraging commercial R&D for military applications, pursuing design and development of critical military technologies, and developing greater resilience in the U.S. supply chain.

- Leverage the R&D of partners and allies by cooperating in R&D of critical technologies and by purchasing and domestically producing foreign designs where they are best in world.

- Establish a research environment that fosters the development of U.S. technical talent and that attracts the best technical minds from other countries to the United States.