U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

Maintaining U.S. Leadership in Science and Technology

Wednesday, March 6, 2019
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Purpose

On Wednesday, March 6, 2019, the Science, Space, and Technology Committee will hold a hearing to assess the current state of U.S. science and technology (S&T) in the global context and what is needed to maintain U.S. leadership. The hearing will examine the role of federal investments in S&T; partnerships between academia, government and industry; the future of U.S. research universities; STEM education and the U.S. STEM workforce; and increasing international competition in areas of emerging technology as well as opportunities for increased international collaboration on pressing global challenges.

Witnesses

- **Dr. Marcia McNutt,** President, National Academy of Sciences

- **Dr. Patrick Gallagher,** Chancellor, University of Pittsburgh

- **Dr. Mehmood Khan,** Vice Chairman and Chief Scientific Officer, PepsiCo; and Chair, Council on Competitiveness

Overarching Questions

- Why is support for science, technology, and STEM education so critical to America's prosperity? What are the principal challenges the United States faces in these areas as it competes in the global economy?

- What is the role of the federal government in ensuring a thriving S&T enterprise? What is the role of the private sector? How can government and the private sector best partner to advance U.S. S&T?

- What are the benefits, risks, and challenges to international collaboration in S&T?

- What specific steps should the federal government take to ensure that the United States remains the world leader in science, innovation, and job creation?

Status of R&D and STEM Education - by the Numbers

U.S. investments in R&D

In 2015, the US performed a total of $491.5 billion of R&D. While the business sector is focused on applied research and development, the federal government has the largest role in basic research. In 2015, basic research comprised $83.5 billion (16.9 percent) of total R&D expenditures. Of that total, 27 percent was funded by the business sector compared to 44 percent by the Federal government. The business sector accounted for just over one-half of applied research, with more than one-third funded by the Federal government.

In terms of trends in U.S. R&D expenditures, in the seven-year period between 2008-2015, U.S R&D grew at a rate of 1.4 percent annually while GDP grew at a rate of 1.5 percent annually. The preceding ten-year period (1998-2008) featured average annual growth of 3.6 percent for R&D expenditures while GDP grew 2.2 percent annually.

Universities performed $41 billion in basic research in 2017 – nearly half of all basic research that year. Nearly $22 billion of that was federally funded. Only 5.3 percent was funded by business. Universities also performed $17.5 billion in applied research. Again, more than half of that was federally funded and only 6.3 percent came from business. While there has been a recent uptick in industry support for university research, universities have increasingly relied on foundations and their own institutional funds to support their research.

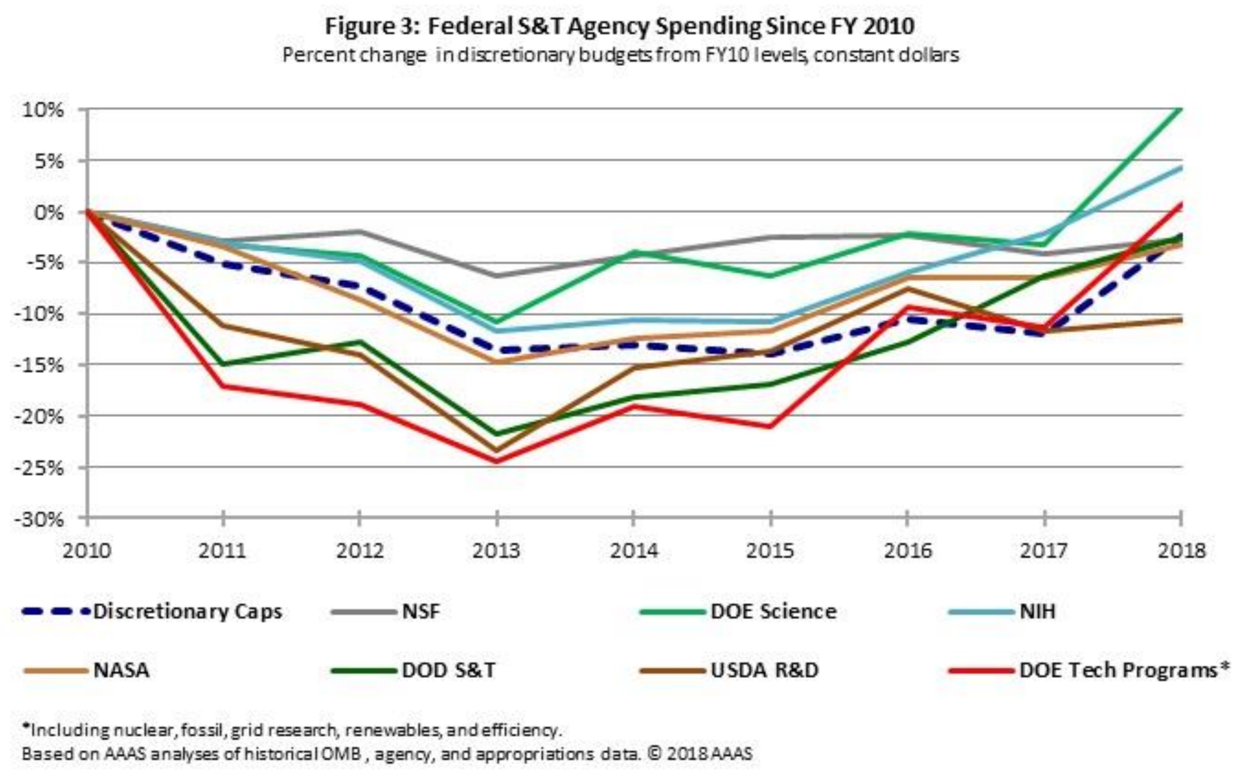
Decades ago, tech companies invested significantly more in basic research. The examples most commonly cited are Bell Labs and Xerox PARC. Nine Nobel awards were given for work completed at Bell Labs, but Bell Labs began its final decline in the 2000s and was shuttered altogether by 2008. Similarly, Xerox PARC no longer exists as such and its successor organization is focused on technology development with short-term returns. Company investment in internal basic research has increased somewhat in the last few years after the steep decline of the 1990s. In 2016 the total was $19.1 billion, compared to $16.3 billion just the year before. Total corporate basic research performance from all sources was $24.6 billion in 2016 - that includes federally funded research at companies. However, the U.S. pharmaceutical industry alone accounts for one-third of corporate basic research. Similarly, philanthropic support for research has been on the rise, but it is overwhelmingly focused on biomedical research. There are a few tech companies, including Google and Uber, who have been investing heavily in basic and applied research, internally and at universities. Their scientists do publish some of their research findings, but much of their research is proprietary.

There are many partnerships between the government, universities, and the private sector, and the Science Committee often explores the nature of those partnership models - what works, what can be expanded, and what new models may be viable. However, those partnerships require a sustained commitment by all parties. Private sector money most often comes *because* the federal money is there. The private sector relies on the quality and imprimatur of the federal science agencies' merit-review processes to identify the most promising research.

Federal Government Investments in R&D

Support for R&D as a percentage of the nondefense discretionary budget has held mostly steady at just over 10 percent since the 1990's, but the total size of the nondefense discretionary budget has been under pressure. Under the 2018 budget deal, that budget has increased from 2017 levels but is still below the 2010 level. The budget caps required under the 2011 budget deal magnify the challenge for R&D funding, unless lifted once again.

The graph below from the AAAS R&D Budget Analysis underscores the loss of buying power at most of our federal science agencies over the last decade. The data are presented relative to 2010 constant dollars. The year 2010 was the second year of the American Recovery and Reinvestment Act, so it saw an unusual increase in R&D expenditures, second only to 2009. However, even with 2011 as the baseline, the trend lines are sobering. In 2018, the National Science Foundation had the same buying power it did in 2011. Other agencies took bigger dips along the way but are better off than they were in 2011. Congress has done well by NIH and DOE in recent years, not so with USDA. NIST, which isn't on the chart, has done better than inflation, but not enough to support the expanded scope of their work during that period. The Trump Administration proposed drastic cuts to federal R&D in FY 2018 and 2019. Congress took a different approach in both years. We have not yet seen the FY 2020 budget proposal, but we have been told to expect similar cuts again this year.



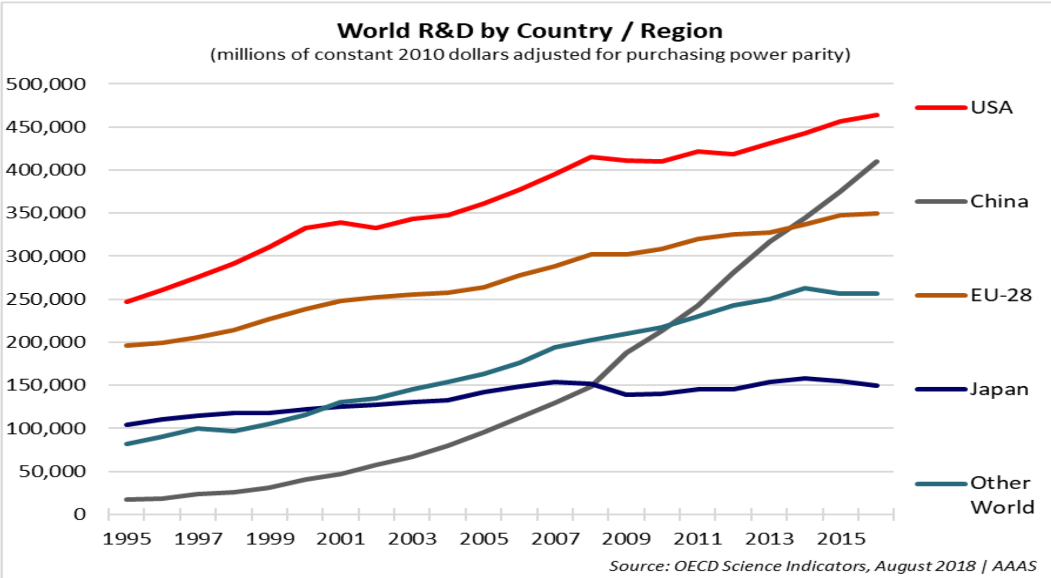
There are suggestions in some corners that the private sector can pick up the difference as the federal government retreats from its previous level of commitment to research. While, as noted previously, there has been some uptick in private sector funding for basic research, the increase does not begin to account for the loss of buying power from the federal government. And the nature of that funding source is such that the research questions themselves are more constrained. Nor is there any realistic path for a return to the Bell Labs model of yesteryear. Corporations, quite simply, are focused on shareholder returns, so research can no longer be central to their mission. Only a few select companies stand out as exceptions to this rule. In the meantime, university researchers are struggling. They spent a significant portion of their time applying for grants from programs with pay lines as low as 10 percent. Further, U.S. research infrastructure is crumbling. Many of our National Lab facilities are 50-60 years old. The same is true on many university campuses. Today's STEM students see these trends and worry about their own future careers in research, or decide outright to leave research or to go abroad where research money is more readily available and facilities more cutting edge. Partnerships with the private sector are important. But for the U.S. to maintain its leadership in S&T, the U.S. government must remain committed to supporting research.

International Competition

Around the world, global R&D funding has been increasingly rapidly, growing more than two and a half times between 2000-2015. In that time frame, the U.S. has shifted from making up 37 percent of global R&D expenditure in 2000 to 26 percent in 2015. The US now ranks 11th in the world in research intensity behind Germany, Taiwan, and South Korea. Further, as a share of GDP, the U.S. is close to dropping out of the top 10 in basic research expenditures.

Between 2005-2016, Germany, South Korea, China, and Taiwan have all increased total R&D spending as a portion of GDP. R&D investments are continuing to shift to countries in East Asia; South Korea doubled R&D expenditure between 1995-2014 to reach 4.3 percent of GDP. In the same time frame, China has increased R&D expenditure as a portion of GDP from 0.64 percent to 2.05 percent, with a plan to spend 2.5 percent of GDP by 2020. The National Science Board predicts China will overtake the U.S. in R&D by the end of 2018.

The U.S. spends more on health R&D than all other OECD countries but ranks near last in agriculture, energy, and environment R&D spending. In areas of emerging technology that will have significant economic and security consequences, the U.S. risks falling behind. Other countries have clear national strategies and large coordinated investments in biotechnology and quantum science and engineering. The UK government has made synthetic biology a national priority since at least 2012. China has also developed an aggressive strategic roadmap in biotechnology, especially in agricultural biotechnology. The EU and China have both made significant commitments in quantum science and engineering, with China building a $10 billion research center for quantum applications. The U.S. is only now putting in place a national strategy for quantum science and engineering, and does not yet have one for engineering biology. The race is on in artificial intelligence as well. In 2017, China's government announced a goal of becoming a global leader in artificial intelligence by 2030. The Trump Administration recently issued an executive order directing science agencies to prioritize AI R&D and is working on developing a research strategy through the National Science and Technology Council. However, even with a strategy in place, funding has to follow to realize the benefits and guard against the security risks.



STEM Education and the Workforce

K-12 Statistics -

The National Assessment of Educational Progress (NAEP) mathematics assessment results show that average mathematics scores for fourth, eighth, and twelfth graders declined slightly for the first time in 2015 and remained flat or showed only small gains between 2005 and 2015. Less than half of fourth, eighth, and twelfth grade students achieved a level of proficient or higher on NAEP mathematics and science assessments in 2015.

In the international context, the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) 2015 data show that the U.S. average mathematics assessment scores were well below the average scores of the top-performing education systems.

Average scores on 2015 NAEP mathematics and science assessments for fourth, eighth, and twelfth grade students who were eligible for free or reduced-price lunch (an indicator of socioeconomic status) were 23 to 29 points lower than the scores of their peers who were not eligible for the program. Score differences between students eligible for free or reduced-price lunch and those who were not persisted within racial or ethnic groups. Performance gaps between white students and black and Hispanic students showed similar patterns across all NAEP assessments and grade levels, with average scores of white students at least 18 points higher than those of Hispanic students and at least 24 points higher than those of black students. Gaps between male and female students on NAEP mathematics and science assessments were small, with average score differences of two to five points in favor of male students.

Higher Education Statistics -

In 2015, underrepresented minority groups comprised 39 percent of the college-age population of the U.S., but only 22.5 percent of students earning bachelor's degrees in STEM fields. U.S.

citizen and permanent resident underrepresented minorities earned only 14 percent of STEM doctorate degrees awarded in 2015. By 2050, underrepresented minorities will comprise 52 percent of the college-age population of the U.S.

Women now earn about half of all STEM bachelor's and doctoral degrees, but major variations persist among fields. In 2015, women earned only 20 percent of all bachelor's degrees awarded in engineering and computer sciences and 40 percent in the physical sciences and mathematics. Similarly, they earned less than one-third of the doctorates awarded in mathematics and statistics, computer sciences, and engineering.

Workforce Statistics -

The majority of scientists and engineers – all individuals trained or employed in STEM - are employed in the business sector (71 percent), followed by the education (19 percent) and government (11 percent). The skilled technical workforce – those who use S&E expertise in their jobs but do not have bachelor's degrees- account for a substantial component of the U.S. STEM workforce. The STEM workforce is aging. The median age of scientists and engineers in the labor force was 43 years in 2015, compared to 41 years in 1995.

In 2015, women constituted 50 percent of the college-educated workforce, 40 percent of employed individuals whose highest degree was in a STEM field, and 28 percent of those in STEM occupations. However, there is significant variation across fields. Women are represented in relatively high proportions in social sciences (60 percent) and life sciences (48 percent) and relatively low proportions in engineering (15 percent), physical sciences (28 percent), and computer and mathematical sciences (26 percent).

In 2015, underrepresented minorities accounted for only 15 percent of STEM highest degree holders and 11 percent of all workers in STEM occupations. Further, minorities accounted for only 13.5 percent of STEM degree holders employed in computing jobs. Based on the Bureau of Labor Statistics data, jobs in computing occupations are expected to account for 60 percent of the projected annual growth of newly created STEM job openings in the period from 2016-2026.

If the percentage of female students and students from underrepresented minority groups earning degrees in STEM fields does not significantly increase– and particularly in fields such as computing and data science - the United States will face an acute shortfall in the overall number of students who earn degrees in STEM fields just as United States companies are increasingly seeking students with those skills. With this impending shortfall, the United States will almost certainly lose its competitive edge in the 21st century global economy.

Data Sources -

All of the data in this memo are from the National Science Board's 2018 Science and Engineering Indicators, the AAAS Federal R&D Budget Trends Analysis, the OECD, or AAAS reporting of OECD data.