THE GLOBALIZATION OF R&D AND INNOVATION: SCALE, DRIVERS, CONSEQUENCES, AND POLICY OPTIONS

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The Globalization of R&D and Innovation: Scale, Drivers, Consequences, and Policy Options

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Introduction

During the 110th Congress, the Committee on Science and Technology launched a major initiative directed at better understanding the globalization of research and development (R&D) and innovation. Four hearings, entitled, *"The Globalization of R&D and Innovation,"* were convened to explore the scale, drivers, and consequences of the movement of science, technology, engineering, and mathematics (STEM) jobs and facilities to foreign countries. The hearings focused on four themes: the expected economic and technology impacts of globalization; the higher education response; the factors that attract R&D facilities to particular locations; and the impacts on the science and engineering workforce. Expert witnesses the magnitude of globalization, its causes, the expected impacts on the U.S., and the implications for policy.

The globalization of R&D and innovation is a significant emerging phenomenon that will change how America captures the downstream benefits—such as high-wage jobs and technological superiority—of its investments in innovation and R&D. In addition, the rise of sovereign wealth funds formed by countries interested in access to intellectual property and intellectual capital from American companies adds a new dimension to these questions. These changes require new directions in U.S. innovation policy.

This report, compiled by the staff of the Committee on Science and Technology, will summarize the findings from the series of hearings and present policy recommendations for the Congress to address the mounting challenges of the globalization of R&D and innovation to America's economy and workforce.

Background

One of the new aspects of globalization is that a larger scale and scope of jobs have become newly tradable and those jobs are increasingly vulnerable to offshoring. Economists estimate that a large share of American science, technology, engineering, and mathematics (STEM) jobs is vulnerable to offshoring. Vulnerability does not mean that all of these jobs will be lost. It does mean that

many more jobs will be subject to wage pressures from workers in low-cost countries as those countries actively pursue those industries. Witnesses at the Committee's four hearings provided estimates of expected vulnerability and examples of jobs and operations that have already moved offshore. However, without better tracking of these transfers, it is difficult to analyze the likely impacts of the types and numbers of jobs moving offshore.

Some major U.S. universities have responded to globalization by building branch campuses abroad and establishing joint ventures with foreign universities. There are no good estimates of the scale and scope of all of these ventures, but they appear to be relatively small to date. However, experts agreed that many major U.S. universities are exploring ways to significantly expand abroad, particularly in low-cost countries. The decision-making process and criteria are unique to each university but two primary purposes underlie the moves: serving a rapidly expanding population of foreign students who would not come to the U.S. and many of whom have job opportunities at multi-national companies operating in their home countries; and, offering opportunities for their U.S. students a more international experience through study abroad and for faculty more international collaboration.

There are both positive and negative economic effects from globalization, but witnesses disagreed about the net effects, particularly in the long-term. Three views about the impacts of globalization emerged from the hearings. One view is that globalization is very beneficial to the U.S. and any resulting disruptions—such as job loss caused by offshoring and trade—are small, mostly benign, and can easily be addressed without significant policy change. Another view is that globalization will be beneficial to the U.S. in the long run, but the disruptions caused by offshoring will be considerable and require significant changes in policy, particularly in the social safety net for those who are disadvantaged. The final view is that globalization is harmful to the U.S. economy in the long-term. This view draws a distinction between free trade and shifts in productive capacity between countries. Current globalization trends are mainly comprised of shifts in productive capacity and can be harmful to the country that is moving its productive capabilities abroad.

Another new phenomenon is competition by low-cost countries for R&D facility sites. Other countries are targeting R&D and innovation facilities and are increasingly successful. The criteria companies use for locating R&D facilities are multifaceted, including lower costs, talent, and government subsidies and incentives. Witnesses also pointed out that some governments are requiring companies to place R&D facilities and transfer technologies as a condition of market access.

The witnesses also testified that domestic and foreign firms are building up significant levels of STEM workforce capacity in low-cost countries. Some of these workers will complement American STEM workers while others will use workers in low-cost countries as substitutes. Identifying precisely how many workers are being displaced remains difficult, but a significant share of foreign workers are substituting for U.S. STEM workers.

Summary of Hearings

On June 12, 2007, House Science and Technology Committee Chairman Bart Gordon chaired the first hearing on the globalization of innovation and R&D. The hearing explored the implications of this trend on the U.S. workforce, the U.S. science and engineering education pipeline, competitiveness, economic growth, and America's innovation system.

The hearing witnesses were: Dr. Alan S. Blinder, Professor of Economics at Princeton University, Director of Princeton's Center for Economic Policy Studies, and Vice Chairman of the Board of Governors of the Federal Reserve System from June 1994 until January 1996; Dr. Ralph E. Gomory, President of the Alfred P. Sloan Foundation and Director of Research at IBM Corporation from 1970 to 1986; Dr. Martin N. Baily, senior fellow at the Peterson Institute for International Economics, senior adviser to McKinsey Global Institute and Chair of the President's Council of Economic Advisers from 1999 to 2001; and, Dr. Thomas J. Duesterberg, President and CEO of the Manufacturers Alliance/MAPI.

The witnesses discussed the implications of the globalization of innovation and R&D. They concluded that an increasing share of innovation and R&D work is being offshored but differed on the long-term implications to the U.S. They also pointed out that innovation is much broader than just formal R&D activities and cautioned that tracking the trends as well as policy remedies should not be too narrowly focused on formal R&D. While the witnesses provided a variety of policy recommendations, they concurred that significant policy responses are needed. They also concurred that passage of the *America COMPETES Act* (P.L. 110–69) was an important and significant first step in ensuring America benefits from the globalization of R&D and innovation.

On July 26, 2007, Chairman Brian Baird of the Subcommittee on Research and Science Education held the second Full Committee hearing on the globalization of innovation and R&D, which explored how globalization affects America's universities. The U.S. higher education system is a principal source of America's preeminence in STEM fields. As STEM offshoring increases competition for U.S. STEM workers, universities are responding by modifying their curricula to help their STEM students better compete. Globalization also enables American universities to venture abroad and build programs and campuses overseas to serve the growing demand of foreign STEM students. The hearing explored the internationalization of American universities and the implications for America's competitiveness.

The hearing witnesses were: Dr. David J. Skorton, President of Cornell University; Dr. Gary Schuster, Provost and Vice President for Academic Affairs of Georgia Institute of Technology; Mr. Mark Wessel, Dean of the H. John Heinz III School of Public Policy and Management at Carnegie Mellon University; and Dr. Philip Altbach, Director of the Center for International Higher Education and J. Donald Monan Professor of Higher Education at Boston College.

The witnesses provided expert opinions on the university response to the globalization of innovation and R&D. They concurred that the American higher education system is the envy of the rest

of the world, conveying a special advantage to America particularly in STEM fields. However, they emphasized that other countries have recognized the importance of higher education in fostering innovation and have begun to invest heavily in their higher education systems. The witnesses also testified American universities have begun establishing campuses abroad, and said that this emerging phenomenon is likely to reshape the nature of the American higher education system.

There are no good data on the scale of university presence abroad but the witnesses agreed that establishing a substantial presence abroad is part of the strategic plan of nearly every major research university. Because the trend is so new, the witnesses could only speculate on how this might affect the U.S. innovation and STEM workers but they all believed that the positives would outweigh the negatives. They asserted that for American universities to remain the best in the world, they must be able to attract the best faculty and students regardless of national origins.

Dean Wessel acknowledged a potential downside of the globalization of higher education, saying, "As universities become more global, we are effectively, if unintentionally, increasing the capacity of firms and individuals abroad, to do jobs currently done here in the United States." He then went on to say that he believed that this problem would be small and would be easily outweighed by its benefits. The witnesses only vaguely described their efforts to improve their curricula to improve the competitiveness of U.S. STEM students. This latter activity seems to be subsumed by the universities interests in expanding foreign presence.

On October 4, 2007, Chairman David Wu of the Subcommittee on Technology and Innovation held the third hearing on the globalization of innovation and R&D. This hearing which explored the factors companies use to locate their research and development (R&D) and science, technology, and engineering intensive facilities. Witnesses discussed the policies other countries use to attract such facilities, and how to make the U.S. more attractive to companies. Firms now have many options around the globe when deciding where to locate R&D, design, and production facilities. This hearing explored the trends in, and factors for, site selections for science, technology, and engineering intensive facilities and the policies needed to ensure that the U.S. remains attractive for these investments.

The hearing witnesses were: Dr. Martin Kenney, Professor of Human and Community Development at University of California, Davis, and Senior Project Director at the Berkeley Roundtable on the International Economy, University of California, Berkeley; Mr. Mark M. Sweeney, Senior Principal in McCallum Sweeney Consulting, a site selection consulting firm; Dr. Robert D. Atkinson, President of the Information Technology and Innovation Foundation; Mr. Steve Morris, Executive Director of the Open Technology Business Center; and, Dr. Jerry Thursby, Ernest Scheller, Jr. Chair in Innovation, Entrepreneurship, and Commercialization at Georgia Institute of Technology.

The witnesses testified that while the globalization of R&D is not a new phenomenon, but that low-cost countries, such as India and China, have recently become able to attract a significant share of

STEM-intensive facilities and jobs. Product localization, government pressure, proximity to key customers, lower costs, and supply of high-quality low-cost STEM workers are some of the key factors that have attracted companies to India and China specifically. There was some disagreement of the relative importance of each of these criteria, but the witnesses concurred that government data tracking the location and function STEM facility investments are highly limited. Most believed the commanding lead that the U.S. has traditionally enjoyed in R&D investments is being challenged in new ways by low-cost countries. They also pointed out that the competition from developing countries for R&D facilities has ratcheted up competition for advanced technology facilities by other developed countries.

The fourth, and final, hearing was held by Chairman Wu before the Subcommittee on Technology and Innovation on November 6, 2007. This hearing explored the impact of the globalization of innovation and R&D on the American science, technology, engineering and mathematics (STEM) workforce and students. Witnesses discussed the new opportunities and challenges for workers created by globalization, including how globalization is reshaping the demand for STEM workers and skills. The witnesses also addressed how offshoring is affecting the STEM workforce pipeline and how incumbent workers are responding to globalization.

The hearing witnesses were: Dr. Michael S. Teitelbaum, Vice President of the Alfred P. Sloan Foundation; Dr. Harold Salzman, Senior Research Associate at the Urban Institute; Dr. Charles McMillion, President and Chief Economist of MBG Information Services; Mr. Paul J. Kostek, Vice President for Career Activities of the Institute for Electrical and Electronics Engineers-USA; and Mr. Henry Becker, President of Qimonda North America.

The witnesses testified that an increasing number of U.S. STEM jobs are tradable and thus vulnerable to offshoring. In some cases, that vulnerability has made STEM fields less attractive to students and has made incumbent workers more pessimistic about future prospects for their careers. Incumbent workers are worried about determining whether their jobs are easily out-sourced but face a void of information.

The witnesses said there is no systemic shortage of STEM workers and that a policy response aimed at producing more scientists or engineers, at least in traditional disciplines, is misdirected. Instead, the key is to create a system that produces the right kinds of STEM workers at the right times and ensures that STEM jobs are attractive. This response to globalization would help to address employer complaints about not having enough American workers with the right sets of skills while avoiding a glut of disaffected STEM workers. The witnesses also concluded that education offerings, including continuing education and distance learning, have not kept up with the needs of incumbent workers and employers.

Committee Findings

The globalization of innovation and R&D is increasing in scale and scope. It is a major structural shift making significant impacts on the key components of the U.S. science and engineering enterprise, and as a result it has important implications for the economy

and national security. Many of the developments are still unfolding, making it more difficult to predict their impacts. For instance, only very recently have low-cost countries, such as India and China, been able to attract innovation and R&D facilities. In response, top U.S. research universities are beginning a new aspect of internationalization by planning and building branch campuses abroad, often in low-cost countries. These are both radically new types of structural changes to the U.S. research enterprise and no one is able to model or predict their likely effects.

Policies focusing on improving U.S. science and engineering workers, education, and investments are critically needed to respond to the globalization of innovation and R&D. Witnesses at the Committee's hearings agreed that the data currently collected are woefully insufficient and inadequate to help policy-makers, the private sector, educators, and individuals make good decisions. The shifts are happening very quickly putting a premium on timely data.

There was some disagreement at the hearings about the potential future scale and the scope of offshoring of science and engineering jobs. In his research, Alan Blinder estimates that most STEM jobs are vulnerable to offshoring. Others, such as Ashok Bardhan and Cynthia Kroll from the University of California, Berkeley, have found similar results. Martin Baily said that while he agrees that an increasing share of STEM jobs will become vulnerable, believes that the number of jobs offshored will be smaller and speed of the transition will be relatively slow—enabling U.S. workers ample time to adapt.

There is also disagreement among experts about the characteristics of the jobs that will be vulnerable to offshoring. Dr. Baily asserts that lower wage, lower skill jobs as well as jobs that are easily automated are most vulnerable. Dr. Blinder asserts that there is no correlation between vulnerability and wage or skill level, but rather that other characteristics like whether a job requires face-to-face contact are more important. Other witnesses point out that many very high-skill R&D jobs are in fact moving or are being created in China and India. The characteristics of vulnerable jobs are critical to identify since educators and workers are being advised to focus on less vulnerable occupations and skills. However, they may be making bad bets if the model they are using for decision-making is inaccurate.

There was also contention about globalization's expected effects on the U.S. economy and workforce. Globalization is often confused with theories of free trade. The shifts in the production of goods and delivery of services overseas often result in changes in productivity in sending and receiving countries. These productivity changes are not necessarily benign and can actually harm the sending country. They are not the same thing as free trade. The witnesses disagreed about whether the effects would be harmful or helpful to the U.S. as a whole but did agree that some workers and firms would be harmed. As a result, all supported increasing the safety net for workers with programs to improve unemployment insurance, retrain incumbent workers, offer trade adjustment assistance, and ensure portability of health and pension insurance. They also agreed that greater investments in K–12 education and R&D

would be helpful, but some felt that this was insufficient saying that much more needed to be done to attract and retain high-wage jobs.

The U.S. remains an attractive place to perform R&D and innovation. It has many attributes—top research universities, a talented workforce, and a large consumer market—to attract and retain R&D and innovation work. But some witnesses, including Ralph Gomory, asserted that the globalization of innovation and R&D is rendering obsolete the conventional notion that investments in R&D lead to localized spill-over benefits. Others suggested that the U.S. should be focusing more efforts on assimilating innovative technologies developed overseas, though some disagreed with this premise. They instead asserted that the localized (or national) payoff from R&D investments will continue to be large and increasing those investments should be a centerpiece of U.S. policy.

Many countries are using policies to attract R&D and innovation work and there is clear evidence that these activities are moving to low-cost countries. U.S. multinationals have been rapidly ramping up their engineering and R&D ventures in India and China. The type of work does vary by country, however. Witnesses testified that the R&D in China tended to be more oriented towards product localization, developing products for the local Chinese market whereas the R&D in India tended to be focused on reducing costs and time-to-market for products intended for the global market. The conceptualization and design of new products, strategic research planning, and product roadmapping has mostly remained in the U.S.

The current status and expected trends in offshoring of jobs vary based on occupation, skill set, industry sector, intellectual property regime in the destination country, and a myriad of other factors. For instance, the information technology services sector has built up very substantial head count in low-cost countries in a short period of time, while the pharmaceutical industry has been slower to do so.

India and China are aggressively pursuing R&D and innovation based investments and jobs and have been successful at attracting a number of companies. Policies vary across countries, but some examples include tax incentives, capital-oriented grants, export subsidies, and maintaining an under-valued currency. Also, China particularly uses governmental pressure, either informally or by tying a firm's access to the market to technology transfer or the establishment of an R&D center in the country. A few hearing witnesses, including Robert Atkinson, identified these practices as mercantilist and unfair trade. The witnesses alleged that most of the instances of forced technology transfer and licensing are done through informal back-room negotiations rather than formal policies. Multinational firm executives will not speak publicly about these coercive tactics because they fear retribution and retaliation. However, there are some documented instances of forced technology transfer in the electric power, automotive, and aircraft sectors. In a recent report prepared for the Small Business Administration (SBA), one of the witnesses, Charles McMillion, describes some of these instances. In the electric power sector, McMillion cites a *Wall Street Journal* story about General Electric being re-

quired "to form joint ventures with the state-owned Chinese power companies. GE was also required to transfer to their new partners technology and advanced manufacturing guidelines for its '9F' turbine, which GE had spent more than a half billion dollars to develop."[1,2] His report also cites aviation industry experts David Pritchard and Alan McPherson, who conclude that, "There is no doubt that suppliers are expected to transfer technology to their Chinese out-sourcing partner or offshore facility that will be utilized for China's mission to develop its own large commercial aircraft (twin-aisle)."[3] In the automotive sector, "since 2004 China requires that each new auto production facility be accompanied by a new or expanded R&D center."[4]

The U.S. higher education system is a principal source of America's preeminence in STEM fields. As STEM offshoring increases, the response by higher education is critical. The July hearing explored two types of responses by American universities. First, what are the universities doing to modify curricula to help their STEM students better compete internationally? Second, how American universities are globalizing by building programs and campuses overseas to serve the growing demand from foreign students? The witnesses described some efforts targeted at curricula changes for domestic STEM students, but there was great interest by American universities to establish overseas branches and programs. The university representatives agreed that by becoming more global, the universities would become more competitive, raising standards and quality, and all students would reap benefits from a faculty that was more globally oriented and opportunities to study abroad.

There was also a strong consensus that the globalization of American universities is just beginning and is almost certain to grow rapidly as many top U.S. research universities seek to be global institutions. Data on how many American universities have branch campuses and programs abroad are poor.

The motivations for globalizing are manifold, and the actual decision-making is highly customized to a company's situation. However, U.S. national and/or local interests are only an indirect part of the equation. While it would be ideal if the globalization of universities yields better outcomes for the U.S., especially the STEM workforce, the potential impact has not been studied nor is it considered a critical decision point. Mark Wessel, a witness at the July hearing, did discuss possible detriments to U.S. students saying, "As universities become more global, we are effectively, if unintentionally, increasing the capacity of firms and individuals abroad, to do jobs currently done here in the United States." He went on to say that he believed that the net benefits would far outweigh any costs.

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[1] Charles W. McMillion, "China's Soaring Financial, Industrial and Technological Power," project report prepared for U.S. Small Business Administration, p. 9, September 2007.

[2] "China's Price for Market Entry: Give Us Your Technology, Too—GE Shares Generator Plans To Win $900 Million Deal; Gray Area in WTO Rules Kathryn Kranhold, *The Wall Street Journal,* February 26, 2004, as cited in McMillion.

[3] Charles W. McMillion, "China's Soaring Financial, Industrial and Technological Power," project report prepared for U.S. Small Business Administration, p. 31, September 2007.

[4] *Ibid,* pp. 37–38.

[1] Charles W. McMillion, "China's Soaring Financial, Industrial and Technological Power," project report prepared for U.S. Small Business Administration, p. 9, September 2007.

Incumbent STEM workers and students are concerned that globalization will negatively affect their career prospects. There is widespread support for improving K–12 science and math education, but significant disagreement about whether there is, or will be, a shortage of U.S. STEM workers. However, there is no evidence that U.S. STEM shortages, if they exist, are causing firms to offshore work. Incumbent STEM workers are concerned that policy is overly focused on the pipeline and hasn't spent enough time addressing under-utilization of incumbent and experienced workers.

Issues and Policy Recommendations

Ensure That America's Capacity to Innovate Is Fully Funded

There was consensus that the types of programs authorized in the *America COMPETES Act* are a significant and important step towards ensuring America's continued competitiveness in the face of rising competition in STEM intensive sectors.

1. Fully fund the *America COMPETES Act* to ensure the U.S. is investing sufficiently in science and engineering research, and STEM education from kindergarten to graduate school and postdoctoral education.

Unleash America's Best and Brightest Minds to Address the 21st Century Competitiveness Challenge

There is consensus that America faces major challenges to its capacity to innovate and its leadership in STEM sectors. These challenges, which will be difficult to address, are still evolving. They will require long-term, sustained, and wide-ranging responses from workers, companies, and the government. Programs need to be established to bring the best and brightest minds to help America navigate through these uncharted waters.

1. The National Science Foundation should establish a program studying the globalization of R&D and innovation and its effects on the America's capacity to innovate. The program will be interdisciplinary in nature and oriented towards policy effects. A symposium presenting results to policy-makers could be convened, with the program drawing lessons from the International Economic Policy Research conducted in 1981. Close collaboration between researchers and policy-makers would be required.
2. A Presidential Advisory Commission to provide advice on the implications of the globalization of R&D and innovation should be considered. The Commission would convene a symposium covering the current state of knowledge within three months of its establishment. Commission membership would include an equal representation of leaders from STEM worker groups and labor unions, business, and universities. It would have authority to order research studies and papers as needed, convene meetings, and issue interim or special reports at the Commission's discretion. A final report from the Commission could provide policy-makers with recommendations for action.

Collecting Additional, Better, and Timelier Data

There is a consensus that poor data has severely limited analysis of the globalization of innovation and R&D, thus hindering appropriate public and private responses. To remedy this situation, the National Science Foundation could work with the appropriate agencies within the Departments of Labor and Commerce to begin collecting additional, more timely data on the globalization of R&D and innovation. The broad-based effort would include a number of new initiatives.

1. The NSF Science Resources Statistics (SRS) Division should augment existing data on multinational R&D investments to include detailed STEM workforce data. This data could track the STEM workforce for multinational companies in the U.S. versus other countries. Details should include occupation, level of education, and experience. These data will be reported on an annual basis and in a timely manner such that the data are from the most recent fiscal year reported by the companies.
2. The NSF SRS Division should also collect detailed information on how much and what types of R&D and innovation activities are being done overseas.
3. The NSF Social, Behavioral, and Economic Sciences (SBE) Directorate should institute a research program identifying the characteristics of jobs that make them more or less vulnerable to offshoring. The program would include a study of estimating the numbers of jobs that have been lost to offshoring.
4. The NSF SRS Division should approximate the extent of U.S. university globalization. It could then track trends in university globalization.
5. The NSF SBE Directorate should identify the impacts of university globalization on the U.S. STEM workforce and students and institute a research program identifying and disseminating best practices in university globalization.
6. The Government Accountability Office (GAO) could conduct a study to identify the amount and types of U.S. Government procurement that are being offshored.
7. The Department of Commerce could implement recommendations from prior studies and reports to improve its collection of trade in services data.

Creating Better Career Paths for STEM Workers

STEM offshoring has created a pessimistic attitude among students and incumbent workers about future career prospects. The U.S. needs new programs to create better career paths for STEM workers including improved continuing education, a sturdier safety net for displaced workers, improved labor market and career information, an expanded pool of potential STEM workers that better utilizes workers without a college degree, and improved rates of successful re-entry into the STEM labor market after voluntary and involuntary absences.

1. The National Science Foundation should create a program to improve the adoption and use of low-cost on-line education targeted at incumbent STEM workers. The program would coordinate with the appropriate scientific and engineering professional societies. The pilot program could assess the current penetration rates of on-line education for STEM workers and identify barriers to widespread adoption.
2. The U.S. Department of Labor could work with the appropriate scientific and engineering professional societies to create a pilot program for continuous education of STEM workers and to re-train displaced mid-career STEM workers. The program could complete an assessment of the specific needs of STEM workers and the barriers to meeting them. This assessment would be made through a survey of STEM workers and scientific and engineering professional societies.
3. The NSF SRS Division should issue a report on improving the dissemination of STEM labor market signals, and begin reporting these data on a periodic basis. The report will assess the current state of labor market signals, and ways in which they may be distorted. The focus of the report would be on how workers and students receive information on the current and future prospects for specific STEM careers. The report will include the appropriate data from existing Department of Labor collections.
4. The National Academies could form a study panel to identify opportunities in STEM careers for students who do not go to college. This study would identify how many workers enter STEM careers without formal college degrees and the barriers for additional workers, without college degrees, to enter STEM careers. It could also recommend ways to overcome those barriers.
5. The National Academies could identify effective strategies for displaced STEM workers to more easily re-enter the STEM workforce. STEM workers are more likely to leave the workforce, voluntarily and involuntarily, for extended periods of time.
6. The Congress could extend Trade Adjustment Assistance to services workers since many STEM workers work in the services sectors.

Improve the Competitiveness of the Next Generation of STEM Workers

As universities globalize and multinational firms take the latest tools and technologies to STEM workers in low-cost countries, American STEM workers must find new ways to compete. They can compete by finding new opportunities and niches in the types of jobs and tasks that will remain geographically sticky to the United States. Those opportunities and niches for American STEM workers need to be identified. Entrepreneurship and innovation training have been identified as a comparative advantage for American STEM workers that are yet to be fully exploited.

1. The National Academies could form a study panel to identify the types of curricula reforms that are needed in response to globalization. The goal would be to ensure that U.S. STEM students graduate with the best skills to compete in the world.
2. The National Academies could also form a study panel to examine best practices in teaching innovation, creativity and entrepreneurship to STEM students.
3. The National Science Foundation should encourage expanded study abroad opportunities for STEM students to improve their ability to work in global teams and foreign language skills.

Review University Technology Commercialization Efforts

Witnesses pointed out that the statutes governing university technology licensing are outdated, inhibit university-industry collaboration, and need to be reviewed and revisited. As other countries invest more in their research universities, companies will have greater opportunities to partner with them. To ensure that U.S. universities are competitive, government policies on university technology licensing such as the Bayh-Dole and the Stevenson-Wydler Acts should be reviewed.

1. The National Academies could study the role of university technology licensing to inhibiting or accelerating the commercialization of technologies supported by federally funded research. The study would identify the various policies and practices that universities use to negotiate their technology licensing agreements.

Establish Tax and Trade Policies That Put the U.S. on Equal Footing for Attracting High-Wage STEM Jobs

U.S. tax and trade policies currently discourage investments in high-wage STEM jobs by companies. Changes should be made to tax and trade policies to improve America's ability to recruit and retain R&D and innovation facilities.

1. The U.S. Government could increase and extend the Research and Experimentation tax credit. The U.S. has fallen from first to 17th in its generosity amongst OECD countries.
2. The Department of Commerce could investigate "unfair" trade practices such as linking market access to a country with technology transfer, undervalued currencies, and theft of intellectual property.
3. The U.S. Government could reform the tax system to favor the creation high-wage jobs and disfavor the creation of low-wage jobs.