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Localizing the economic impact of research and development: Policy proposals for the Trump administration and Congress

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It's no longer enough to simply fund scientific and engineering research and hope it gets translated into commercial results.

Executive summary

The investments government and businesses make in basic and applied research and development (R&D) plant the seeds for the technologies, products, firms, and industries of tomorrow. They contribute substantially to the fact that at least one-half of America's economic growth can be attributed to scientific and technological innovation[1]. But the increased complexity of technological innovation as well as the growing strength of America's economic competitors mean that it's no longer enough to simply fund scientific and engineering research and hope it gets translated into commercial results. The U.S. government needs to expand federal support for research and, just as important, it needs to improve the efficiency of the process by which federally funded knowledge creation leads to U.S. innovation and jobs[2].

This report provides 50 policy actions the Trump administration and Congress can take to bolster America's technology transfer, commercialization, and innovation capacity, from the local to the national level. These recommendations include:

Strengthen innovation districts and regional technology clusters

1. Prioritize innovation districts within federal R&D outlays
2. Task federal laboratories with a local economic development mission
3. Create off-campus "microlabs" to provide a front door to labs
4. Support technology clusters by assessing and managing local-level federal R&D investments

5. Assess federal real estate holdings and reallocate physical research assets to innovation districts
6. Allow labs to repurpose a small portion of existing funds for timely local collaboration
7. Standardize research partnership contracts within cities
8. Create NIH regional pre-competitive consortia to address national health concerns
9. Allow DOE labs to engage in non-federal funding partnerships that do not require DOE approval
10. Dismantle funding silos to support regional collaboration
11. Incentivize cross-purpose funding based on the economic strength of cities
12. Expand the national Regional Innovation Program
13. Support the innovation potential of rural areas
14. Facilitate regional makerspaces
15. Introduce an "Open Commercialization Infrastructure Act"

Bolster institutions supporting tech transfer, commercialization, and innovation

16. Establish a core of 20 "manufacturing universities"
17. Complete the buildout of Manufacturing USA to 45 Institutes of Manufacturing Innovation (IMIs)
18. Create a National Engineering and Innovation Foundation
19. Create an Office of Innovation Review within the Office of Management and Budget
20. Create a network of acquisition-oriented DoD labs based in regional technology clusters
21. Establish manufacturing development facilities
22. Establish a foundation for the national energy laboratories

Expand technology transfer and commercialization-related programs and investments

23. Increase the importance of commercialization activities at federal labs/research institutes
24. Allocate a share of federal funding to promote technology transfer and commercialization
25. Develop a proof-of-concept, or "Phase Zero," individual and institutional grant award program within major federal research agencies
26. Fund pilot programs supporting experimental approaches to technology transfer and commercialization
27. Support university-based technology accelerators/incubators to commercialize faculty and student research
28. Allow a share of SBIR/STTR awards to be used for commercialization activities
29. Increase the allocation of federal agencies' SBIR project budgets to commercialization activities
30. Modify the criteria and composition of SBIR review panels to make commercialization potential a more prominent factor in funding decisions
31. Encourage engagement of intermediary organizations in supporting the development of startups
32. Expand the NSF I-Corps program to additional federal agencies

33. Authorize and extend the Lab-Corps program
34. Provide federal matching funds for state and regional technology transfer and commercialization efforts
35. Incentivize universities to focus more on commercialization activities
36. Establish stronger university entrepreneurship metrics
37. Expand the collaborative R&D tax credit to spur research collaboration between industry and universities and labs
38. Increase funding for cooperative industry/university research programs at universities
39. Establish an International Patent Consortium

Promote high-growth, tech-based entrepreneurship

40. Encourage student entrepreneurship
41. Help nascent high-growth startups secure needed capital
42. Establish an entrepreneur-in-residence program with NIH
43. Implement immigration policies that advantage high-skill talent
44. Implement a research investor's visa

Stimulate private-sector innovation

45. Implement innovation vouchers
46. Incentivize "megafunds" around high-risk research and development
47. Increase R&D tax credit generosity
48. Ensure that small and medium-sized enterprises are familiar with available R&D tax credits
49. Implement an innovation box to spur enterprises' efforts to commercialize technologies
50. Revise the tax code to support innovation by research-intensive, pre-revenue companies

Introduction

Innovation is key to increasing economic growth and wages in the moderate to long run. Yet innovation does not fall like "manna from heaven," as economists once suggested. It is the product of intentional human action, and, to have more of it, we must enact public policies that connect research and development investments to firms and inventors in the communities where they are located.

After seven years of growth following the end of the Great Recession and after over 70 straight months of employment growth, there is a case to be made that the country has rebounded and the main thrust of economic policy should focus on those who have been left behind. But the reason so many Americans aren't seeing their wages rise fast enough isn't just because they've been left behind, it's because the country as a whole isn't moving ahead fast enough.

It's certainly true the labor market has begun to inch closer to full employment (in fact, in December 2016 the unemployment rate dropped to 4.6 percent), but that's

America's innovation economy exists at three levels: technological, industrial, and spatial.

far from a leading indicator of the health of the U.S. economy. For the reality is the economy still has a long way to go to return to its full potential. Employment growth in the 36 months following the trough of the recession was the slowest of the 11 post-World War II recoveries, and average productivity growth was twice as high in the four decades following World War II as it has been since the end of the Great Recession[4]. Brookings economists Martin Baily and Nicholas Montalbano describe the country's productivity growth as "weak since 2004 and dismal since 2010." And as the Information Technology and Innovation Foundation (ITIF) reports, U.S. productivity growth over the last decade is the lowest since the government started recording the data in the late 1940s[5]. Yet if the United States could boost its productivity levels by even just one percentage point, it could make the economy $2.3 trillion bigger than it is otherwise projected to be in 10 years while shrinking the federal budget deficit by more than $400 billion[6].

Meanwhile, other countries are increasing their technological sophistication, capturing crowded international markets and pushing U.S. firms—and, by extension, U.S. workers—behind. And whereas once America's leading technology competitors were largely isolated to Western Europe and Japan, today many developing nations are crafting innovation strategies designed to wrest leadership in advanced technology categories such as life sciences, clean energy, new materials, flexible electronics, computing and the internet, and advanced manufacturing. As evidence of these trends, the United States has run a trade deficit in advanced technology products every year since 2002; the cumulative deficit since 2010 is $580 billion[7]. Improving America's capacity to innovate is a key step toward confronting these challenges.

America's innovation economy exists at three levels: technological, industrial, and spatial. Much innovation occurs in particular technology areas, for example life science innovation funded by the National Institutes of Health (NIH), additive manufacturing supported by America Makes, and composite and lightweight materials supported by the Institute for Advanced Composites Manufacturing Innovation (IACMI) and the Lightweight Innovations for Tomorrow (LIFT) Institutes for Manufacturing Innovation, respectively. Innovation also occurs across firms in the same industries that collaborate to drive technology advancements (e.g., aerospace and automotive). For this reason, sector- and technology-based innovation policies and programs like Manufacturing USA's Institutes of Manufacturing Innovation and the Advanced Research Projects Agency-Energy do an effective job targeting R&D dollars.

The spatial level of innovation includes not just hot spots like Silicon Valley; Austin, Texas; or Boston, but also scores of communities throughout the country in places like Chattanooga, Tenn.; Denver; Minneapolis; Mobile, Ala.; and Pittsburgh, Pa. which are intensively developing their innovation ecosystems at the regional level. Indeed, as ITIF has shown, innovation occurs in all of America's 435 congressional districts[8].

This dispersion matters because regional technology clusters engender concentrated knowledge flows and spillovers, workers with specialized skills, and dense supply chains that improve firm productivity. Many R&D-intensive firms benefit from proximity to innovation resources such as universities and federal laboratories, and

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this closeness produces myriad "ecosystem" benefits[9].

This is particularly the case for knowledge spillovers—the ability of workers and firms to learn from one another without incurring costs. Recent research shows that the value of proximity for firms and workers to share ideas attenuates extremely quickly with distance. For example, Rosenthal and Strange find that, for software companies, the spillover benefits are 10 times greater when firms are within one mile of each other than when they are two and five miles apart, and by 10 miles there are no more within-city localization benefits[10].

In other words, to be effective, technology policy needs to focus not just on the first two levels, technology and industry, but also on the spatial—the regional. Thus, if America's innovation economy is to function maximally, Washington needs to promulgate smart policies and initiatives that effectively work in concert at the city, regional, state, and national levels.

The central component of an effective national technology policy system is robust government funding of scientific and engineering research. But in that respect, the United States is failing. If the federal government invested as much in R&D today as a share of GDP as it did in 1983, we would be investing over $65 billion more per year[11]. Unfortunately, given budget and political constraints, the Trump administration and the forthcoming 115th Congress may find it difficult to significantly increase overall federal investment in science and technology. This despite the fact that doing so would be a wise investment, as economists estimate that a 1 percent increase in the U.S. R&D capital stock improves GDP by 0.13 percent[12]. But regardless, one thing on which America should be able to achieve bipartisan consensus is the need to find ways to increase the return on investment from existing resources and programs.

What follows are 50 policy recommendations President Trump and Congress can enact to improve the economic impact of existing resources (with some modest additional investments). Many of these recommendations could be added to the COMPETES-related reauthorization legislation currently being considered in both the House and Senate. The recommendations are divided into five categories: strengthening innovation districts and regional technology clusters; launching or extending institutions supporting America's innovation economy; facilitating technology transfer and commercialization activities; promoting the formation of high-growth firms; and stimulating private-sector innovation. These recommendations are the output of a joint research effort between the Brookings Institution and ITIF.

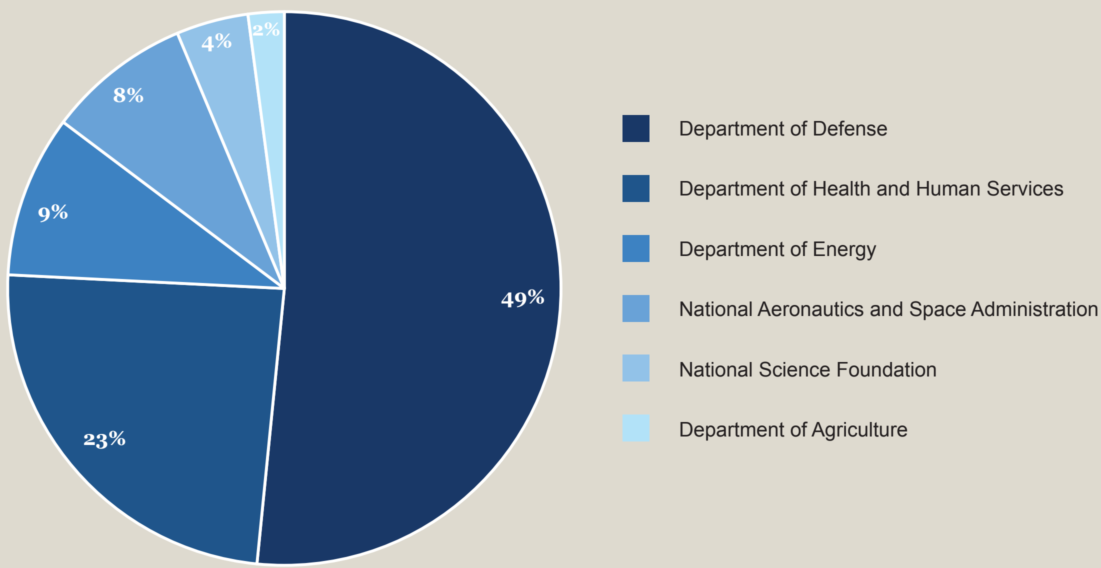
Why and how federal R&D policy impacts local economies

The federal government invests $146 billion a year in R&D, and whether these dollars are directed to military bases, federal laboratories, universities, or small technology firms, they come to ground in communities and play a critical role in local technological capacity. Federal investments often drive high-skilled employment, fund local universities and hospitals, support high-tech entrepreneurs, and lead to exports from large companies—all of which bring outside dollars and jobs into a region.

To maximize and capture the benefits of R&D within regional economies, mayors, regional economic developers, and philanthropic and private-sector leaders should understand their federal research portfolio. Indeed, regions should take stock of their portfolios as they would any other asset class. To do so, regional leaders need to understand how the federal government funds research.

The government allocates R&D through federal agencies. While most agencies have some level of R&D budget, 84 percent of funding flow from the Department of Defense (DoD), the Department of Health and Human Services (DHHS), the Department of Energy (DoE), and the National Science Foundation (NSF). These agencies have different areas of investment and different funding vehicles that impact local economies.

Figure 1: Share of federal R&D allocated by leading federal agencies



Source: The National Science Foundation, 2015.

The Department of Defense: With 49 percent of all federal R&D, DoD represents the largest federal investor in research. But DoD's size is not the only reason the department matters for local communities. No other federal agency has such a quasi-fiduciary relationship with the commercial outcomes of its own R&D funding. DoD pursues basic and applied research through its dozens of labs located in 22 states and then transfers that research to firms that create products and services for the military. For regions, DoD funding often implies near-to-market engineering, computer science, and material research that local firms can utilize to meet defense and civilian needs. Yet research partnerships are conducted predominantly through large defense contractors and less often with small and medium-sized firms[13].

The Department of Health and Human Services: DHHS invests over $32 billion every year in research, the vast majority of which is conducted by and through the National Institutes of Health. The primary vehicle for NIH R&D is competitive grants: currently more than 80 percent of NIH funding is awarded through 50,000 grants to more than 300,000 researchers at universities, medical schools, and other research institutions.

By understanding what government funding flows to their respective regions and then how to leverage agencies' distinct funding vehicles, leaders can better maximize the local influence of R&D.

NIH research dollars touch every state and almost every city, and so the agency is ideally situated to play an important role in improving the return on investment of federal R&D at the local level. Also, because the lion's share of investment comes from NIH's grants to research universities and medical schools, as opposed to being spent at its own labs, NIH is in a unique position to incentivize commercialization across the U.S. university system. Finally, through its investments in teaching hospitals, NIH represents a critical employment driver for local communities.

The Department of Energy: DoE invests heavily in its 17 federal laboratories across the country. Though the labs are not located in dense regional technology clusters, they exist at the frontiers of science and often partner with universities, firms, and other research institutions to improve product development in industries such as aerospace, automobiles, battery storage, and information technology. Regions with companies and institutions that have DoE partnerships are often at the cutting edge of technology and are ideally situated for high-value technology exports.

The National Science Foundation: NSF is an independent federal agency that invests specifically in basic science and engineering and scientific education. Unlike other agencies that focus on specific missions (e.g., defense, health, energy), NSF has a broad mandate to fund discovery, learning, and the research infrastructure across scientific domains. Like NIH, the primary funding vehicle for NSF is its competitive grants that are distributed across the nation's educational, training, and research institutions. NSF represents roughly one-quarter of federal investments in basic science at U.S. universities and colleges

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Strengthen innovation districts and regional technology clusters

Regional technology clusters are a key driver of economic growth and should be viewed by the incoming administration and Congress as a critical component of innovation policy. Large-scale manufacturing clusters can be found in suburban research parks and key agriculture technology clusters in many rural areas throughout the United States.

In many technology sectors—particularly life sciences, software and digital design, and robotics—the geography of innovation is changing. Firms in these industries are now beginning to relocate research activities into employment-dense areas of cities (generally the downtowns and midtowns) to be in greater proximity to other firms, universities, and research labs[14]. Companies are also realizing that attracting and retaining talented workers increasingly means situating themselves in amenity-rich places where their workers want to live. The result has been a rise of "innovation districts," defined by the Brookings Institution as "geographic areas where leading anchor institutions and companies cluster and connect with entrepreneurs. They are

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physically compact, transit- and broadband-accessible, and offer mixed-use housing, office, and retail."[15]

Innovation districts are critical to the nation's innovation capacity because they are home to some of the country's leading universities, research labs, and high-value companies and they generate outsized economic output. For example, research universities located within employment-dense areas of cities outperform their rural and suburban peers in terms of number of patents, invention disclosures, licensing revenue, and startups per student.[16] But federal laboratories built in the shadow of World War II are often located far from firms and cities and have difficulty impacting regional economies. And too often cluster policy receives lip service from Washington, with little actual attention paid to how the federal government can accelerate the economic capacity of regional economies. Reconfiguring the federal government's $146 billion annual R&D investment portfolio to achieve greater economic outcomes should therefore be a prime objective of national policy.

In order to strengthen innovation districts and other regional technology clusters, the next administration should work with Congress on the following goals:

1. Prioritize innovation districts within federal R&D outlays

Federal agencies that fund R&D should prioritize innovation districts because the density of corporate research centers and entrepreneurs increases the likelihood that research will lead to commercial outcomes. Moreover, Federally Funded R&D Centers (FFRDCs) and University Affiliated Research Centers (UARCs) should be assessed in part based on their proximity to corporate research and employment density, and federal grants in engineering, computer science, life sciences, and other similar fields should prioritize academic institutions located within innovation districts. Of course, the geographic location of research assets is not the ultimate determinant of economic impact, but co-location and density are important and should be a consideration for all funding agencies.

2. Task federal laboratories with a local economic development mission

Federal agencies such as DoD, DoE, DHHS, and the NSF that own and fund federal laboratories and FFRDCs should adopt an explicit mission to support the regional economies in which they are located. Many lab managers and agencies approach regional economic development as mutually exclusive from their core missions; this is especially true for weapons labs located within the Departments of Defense and Energy. But defense and weapons labs like Sandia and Los Alamos in New Mexico have successfully integrated regional economic development programs within their broader research objectives. For example, both labs have partnered with the state of New Mexico on the New Mexico Small Business Assistance Program, which connects small businesses seeking technical assistance with lab researchers.[17] Every federal agency and federal lab should view regional economic development as part of its overarching mission. Moreover, increasing the technical capacity of the regions in which labs are located is mutually beneficial for the labs and the local economy. Moreover, given the mobility of the scientific workforce, creating homegrown talent helps labs address attrition.

3. Create off-campus “microlabs” to provide a front door to labs

Federal funding agencies, state governments, and regional consortia that utilize the lab system should work together to create and co-fund a number of off-campus, small-scale “microlabs”—co-located within or near universities or private-sector clusters—that would cultivate strategic alliances with regional innovation clusters. Microlabs would help overcome the problems that most labs are located outside of technology clusters and that most lab research occurs behind the walls of main campuses. These microlabs could take the form of additional joint research institutes or new facilities that allow access to lab expertise for untapped regional economic clusters. Accessible, off-campus lab space would also help labs engage with small to medium-sized enterprises (SMEs). The next administration should work to create microlabs and require state buy-in, or state governments or regional consortia could create voucher programs in concert with DoE and particular labs. Several federal labs are already creating microlabs in cities; for example, Argonne National Laboratory has created office space in the Chicago Innovation Exchange, located on the University of Chicago’s Hyde Park campus. Another example is Cyclotron Road, a program of Lawrence Berkeley National Laboratory funded by the DOE EERE Advanced Manufacturing Office, which provides assistance to entrepreneurial researchers to advance technologies until they can succeed beyond the research lab. Cyclotron Road plays a pivotal role in providing entrepreneurs with technology development support (often leveraging technologies coming directly out of the Lawrence Berkeley laboratory) and helps them with identifying the most suitable business models, partners, and financing mechanisms for long-term impact.[18] Beyond external offices, microlabs can serve as funding gateways to align multiple public and private research dollars to meet industry needs.

4. Support technology clusters by assessing and managing local-level federal R&D investments

The $146 billion invested by the federal government in R&D takes place within specific institutions within communities, and these resources often dwarf the research investments and research-driven employment of non-federal companies and institutions. But federal research dollars do not necessarily pass through local political, civic, or private-sector leadership. As such, mayors, chambers of commerce, and philanthropies are often unaware of the innovation portfolio of their regions. The issue is most pronounced in large cities that can have over a billion dollars flowing annually from Washington. Without understanding their regional innovation portfolios, regions cannot coordinate and maximize federal investment for local economic growth. To address this knowledge barrier, the federal government should help regions understand their research inflows by packaging their federal dollars by institution, areas of science, connections to global markets, and other data points. However, the federal government will never be able to whole cloth catalog what regions need to know about their innovation assets. Therefore, the government should also fund and advise regional innovation asset inventory and management assessments that are tailored to the specific economic development goals of individual communities.

5. Assess federal real estate holdings and reallocate physical research assets to innovation districts

The federal government owns billions of dollars' worth of real estate that houses operations from post offices to federal laboratories. There is no national registry of these holdings and little information regarding their commercial value. Many of these physical operations were created before innovation districts and other technology clusters came into existence and are poorly placed to take advantage of the agglomeration benefits of cities. The Trump administration should task the General Services Administration with identifying federally owned real estate parcels and strategically move research-intensive activities into existing federal buildings in cities. Agencies should also be able to register unused space within their own research institutions to identify and allocate vacant space for regional entrepreneurship and private-sector use. Congressional appropriation committees have traditionally been skeptical of allowing federal labs discretion on the use of space, but allowing lab managers to contract out unused space would increase the flexibility and regional responsiveness of the lab system. For example, Amtrak operates an office building in the heart of the Philadelphia innovation district, just a few blocks from Drexel University and the University of Pennsylvania. Amtrak does no research and extracts little benefit from being near major research universities; on the other hand, NIH, DoD, and NSF operate or fund numerous facilities that would greatly benefit from such a location. One mechanism for better allocating physical assets would be to create an intra-governmental auction whereby agencies could identify strategically located federal buildings and bid on these parcels. Agencies like Amtrak that don't value their legacy locations in cities could sell such buildings to agencies that would benefit, creating a market dynamic within the federal government.

6. Allow labs to repurpose a portion of existing funds for timely local collaboration

Increasing collaboration between regional universities and tech-based entrepreneurs and corporate partners requires greater flexibility in funding contracts. The next administration should allow federal labs to set aside a small amount—perhaps 5 percent—of fiscal year funding for unexpected research partnerships that may emerge throughout the year and that clearly align with lab mission and research goals. Labs would not be required to reserve these funds, nor be required to invest in regional partnerships, but interested labs would have the option. Similar repurposing rules should be encouraged for all federal funding opportunity announcements (FOAs) intended for federal labs.

7. Standardize research partnership contracts within cities

Virtually all innovation districts cluster numerous research institutions, but each one has its own rules relating to the commercialization of research. Cities should work to develop standardized partnership contracts that all research facilities can adopt to help researchers access the full spectrum of activity within a city. For example, in Philadelphia, the Wistar Institute—a National Cancer Institute-designated Cancer Center—has created a simple, standard contract for research partnerships that has been adopted by a number of medical schools in the city. The federal government should incentivize cities with multiple academic medical centers, federal labs, universities, and research institutions to develop standardized, simple research partnership agreements. Their development could either occur through pilot grants from the Economic Development Agency or directly through federal R&D funding agencies, such as NIH. The latter may be particularly effective given that in many cities research institutions with similar areas of expertise receive federal funding from the same federal agencies.

8. Create NIH regional pre-competitive consortia to address national health concerns

Given that over 80 percent of NIH R&D funding is allocated through its more than 50,000 grants across the country, the agency is ideally situated to support regional technology development. However, most NIH research grants don't directly incentivize partnerships that lead to collaboration—particularly at the institutional-leadership level (e.g., for universities, the provost of research or president level). Rather, most collaboration around NIH grants occurs at the principal investigator level. While partnerships between researchers are important, more can be done to stimulate research-based partnerships between the public, civic, and private sectors.

To improve the commercial impact of research grants, the next administration should support regional pre-competitive consortia to address national health concerns. When applying for NIH grants, research institutions should be incentivized to coordinate with peers in their region. Making the consortia pre-competitive (i.e., uninvolved in patent development) will help to avoid intellectual property disputes and allow the efforts of its members to dovetail more closely with the academic missions of NIH research grants. One way to further incentivize partnerships would be to give grant proposals extra weight if multiple technology transfer offices, private-sector actors, and others within a city are designated as principal investigators. NIH already supports some pre-competitive consortia at the national level, such as the Accelerating Medicines Partnership and within its Clinical and Translational Science Awards, but doing so even more within technology clusters at the local level would enable research institutions to take advantage of proximity to form more long-lasting partnerships.[19]

9. Allow DoE labs to engage in non-federal funding partnerships that do not require DoE approval

Currently, DoE must approve all non-DoE lab funding; this model is out of date, given that external funding is not trivial. For example, Oak Ridge National laboratory (ORNL) and Pacific Northwest National laboratory (PNNL) already receive 50 percent and 80 percent of their respective budgets from outside their DoE offices (though the majority of funding still comes from the federal government from agencies such as DoD). DoE should acknowledge that today's multidisciplinary lab work requires varied funding sources. As labs increase their relevance to regional technology clusters, DoE should allow non-federal funding partnerships at lab managers' discretion. Initially, DoE could specify a minimum amount of regional funding to be drawn from non-federal sources without its approval, and then gradually expand the minimum.[20]

10. Dismantle funding silos to support regional collaboration, in a fashion similar to Manufacturing USA or the energy hubs

Stove-piped appropriations keep lab research projects unnecessarily compartmentalized and hinder lab managers from responding to regional demands. Labs should be funded to encourage broad, flexible engagements with numerous public- and private-sector actors. To this end, Congress and DoE should reorganize lab funding to mimic the financial design of Manufacturing USA (formerly known as the National Network for Manufacturing Innovation) or DoE's energy hubs, institutions through which large, unencumbered appropriations are directed to complex, multidisciplinary regional technology and economic issues.

11. Incentivize cross-purpose funding based on the economic strength of cities

Like countries, cities and states specialize in technologies and industries. However, federal R&D funding agencies often ignore the potential interplay between seemingly discrete technologies, and doing so dampens the innovative potential of innovation districts. For example, Houston is an epicenter of the oil and gas and the health care industry, but little of the $160 million DHHS invests annually in the University of Texas MD Anderson Cancer Center considers what the health care field can learn from oil and gas. On the ground, researchers, medical professionals, and industry leaders in Houston recognized the potential for cross-pollination between these two areas of specialization and created "Pumps & Pipes," an association of medical, energy, aerospace, and academic professions with the stated goal of problem solving through "using the other guy's toolkit."[21] Federal agencies should map the research and industrial comparative advantages of cities and create cross-agency funding opportunities in those areas. They should seek similar synergies with state-based technology-based economic development organizations, through which individual states focus on a few core technologies for economic development advantage.

12. Expand the national Regional Innovation Program

Regional innovation programs have proven a highly successful form of economic development for communities across the United States.[22] Programs such as the i6 Challenge and the Jobs and Innovation Accelerator Challenge have helped local, regional, and state entities leverage existing resources, spur regional collaboration, and support economic recovery and job creation in high-growth industries. The Regional Innovation Program operated by the Economic Development Administration identifies and supports regional innovation clusters, convenes relevant stakeholders, creates a cluster support framework, disseminates information, and provides targeted capital investments to spur economic growth.[23] There is great demand for this program from regions all around the nation, but in 2015 just $15 million in grants were awarded. More funding is needed, and more needs to be done to support regional innovation programs in the United States. Accordingly, the next administration and Congress should expand funding for the Regional Innovation Program to as much as $75 million.[24]

13. Support the innovation potential of rural areas

While the vast majority of technology development, commercialization, and innovation occurs in cities and metropolitan regions, the innovation potential of more rural areas should not be neglected, both for these areas' own economic growth prospects and for the contributions they can make to America's innovation system. For example, consider the Natural Resources Research Institute (NRRI) located at the University of Minnesota Duluth. NRRI is a non-profit applied research organization, chartered by the Minnesota legislature, that works to develop and deliver the understanding and tools needed to better utilize Minnesota's mineral, forest, energy, and water resources in a way that expands value-added and jobs in rural communities.[25] Other programs that support rural technology entrepreneurship and manufacturing include the Ben Franklin Technology Partners of Central and Northern Pennsylvania, which funds young companies and provides professional assistance in areas like prototype development and customer site visits.[26]

But the next administration could support a network of institutes such as NRRI nationwide across more sectors, including aquaculture, agriculture, wind and water energy, and mining. One idea would be to have the U.S. Department of Agriculture (USDA) lead a major technology initiative around getting more value-added out of rural communities, whether from fish, fiber, food, wind, water, etc. Such a program, perhaps in coordination with the U.S. Department of Commerce's Manufacturing Extension Partnership (MEP), could also build on and support existing rural manufacturing clusters, such as snowmobiles in northern Minnesota, wine in Western New York, or shipbuilding in Michigan. One aspect of this could be supporting rural Internet of Things projects, such as pilot programs for farms and vineyards.[27]

14. Facilitate regional makerspaces

Makerspaces are community centers that combine manufacturing equipment and education for the purposes of enabling community members to design, prototype, and create manufactured works that couldn't be created with the resources available to individuals working alone.[28] But well-staffed and programmed makerspaces are located disproportionately in large cities. To more fully realize regional innovation potential, especially in manufacturing, the federal government should support a Public Library Makerspace grant program that enables the use of libraries not only for public education but also for economic development. Such a program would democratize the maker movement into communities that are traditional laggards in technology infrastructure, like broadband. This approach would make more widely available so-called lower-level innovation infrastructure (e.g., 3-D printing capability) that could seed innovations that ultimately feed into universities or federal labs. Another proposal to expand access to makerspaces is proposed legislation (in the House, H.R. 1622, in the Senate, S. 1705) that calls for a federal charter to launch a non-profit "National Fab Lab Network" (NFLN).[29] NFLN would act as a public-private partnership whose purpose is to facilitate the creation of a national network of fabrication labs and serve as a resource to assist stakeholders with their operations. The network would be comprised of local digital fabrication facilities providing community access to advanced manufacturing tools for learning skills, developing inventions, creating businesses, and producing personalized products.[30]

15. Introduce an "Open Innovation Infrastructure Act"

Another way to increase the use of America's national R&D infrastructure would be through an Open Innovation Infrastructure Act, which would permit the private use of public-funded equipment and facilities—including universities, federal labs, and public libraries—for certain activities related to entrepreneurial education and training as well as for economic development and job creation. At present, buildings financed through tax-exempt bonds are not permitted to develop private programming within the facility, even though many private operations—such as incubators, accelerators, and training programs—that benefit entrepreneurs and others are important for broader economic development. For example, a small business that would like to use a 3-D printer in a makerspace at a public library to develop a commercial product is restricted from doing so. Such an Open Innovation Infrastructure Act would remove many such barriers.

Summary

Some worry the concept of innovation districts is just the latest urban fad, but there is nothing new about the economics of clusters and agglomeration—they have been studied by economists for over a century. Just as research parks defined much of the geography of innovation over the last half of the 20th century, innovation districts and other technology clusters are becoming emblematic of this century's spatial science and technology research. The next administration should consider innovation districts—and other regional clusters of technology generation (rural, suburban, and urban)—as strategic assets in the same vein as federal laboratories, military research facilities, and the university system. These institutions would not exist as they do without longstanding, substantial support from the federal government. The new president should add innovation districts to the list of national treasures that are supported and nurtured by the federal government, in partnership both with cities and with state technology-based economic development organizations.

Bolster institutions supporting tech transfer, commercialization, and innovation

In the private sector, firms need to innovate to respond to competition. Likewise, the competition for innovation leadership among nations has only grown fiercer.[31] Throughout its history, the United States has responded to international economic competition by chartering new institutions to bolster its innovation economy. For instance, the Morrill Act of 1862 chartered new universities in the agricultural and mechanical arts.[32] In the 1980s, the United States launched Sematech (a semiconductor research consortium) and the Manufacturing Extension Partnership in part as a response to heighted German and Japanese economic competition. The Obama administration launched Manufacturing USA in part to address the erosion of America's industrial commons. Meanwhile, America's global competitors have launched new institutions of their own, as documented in ITIF's report, *The Global Flourishing of National Innovation Foundations*, which catalogued the efforts of almost 50 nations in chartering national innovation foundations and articulating national innovation strategies.[33] Yet the United States still lacks a national innovation foundation. Addressing that need and other proposals to expand the institutions underpinning America's innovation economy are considered below.

16. Establish a core of 20 "manufacturing universities"

Across many American universities, the focus on engineering as a science has increasingly moved university engineering education away from a focus on real-world problem solving toward more abstract engineering questions, leaving university engineering departments more concerned with producing pure knowledge than working with industry to help it solve problems. To address this, the United Sates should designate a core of at least 20 "manufacturing universities" that revamp their engineering programs to focus more on manufacturing engineering and on work that is relevant to industry.[34] This effort would include more joint industry–university research projects, more student training that incorporates manufacturing experiences through co-ops or other programs, and a Ph.D. program focused on turning out more engineering graduates who work in industry.

At these manufacturing universities, criteria for faculty tenure would consider professors' work with or in industry as much as their number of scholarly publications. In addition, these universities' business schools would integrate closely with engineering and focus on manufacturing issues, including management of production. The schools would also appoint a chief manufacturing officer, as Georgia Tech has done, to oversee universities' interdisciplinary manufacturing programs and ascertain how they can maximize their impact on regional economic development. A good model for these manufacturing universities is the Olin College of Engineering in Massachusetts, which reimagined engineering education and curricula to prepare students "to become exemplary engineering innovators who recognize needs, design solutions, and engage in creative enterprises for the good of the world." Olin's students now launch more startups per graduate than even MIT.

The Manufacturing Universities Act seeks to establish a competitive grant program for universities that propose to revamp their engineering programs and to focus much more on manufacturing engineering and in particular work that is more relevant to industry. Academic institutions receiving a manufacturing university designation would be eligible for an annual award of up to $5 million for up to four years.[35] The Manufacturing Universities Act of 2015 was incorporated into the 2017 National Defense Authorization Act (NDAA) passed by the Senate in June 2016, but it was not included in the House's version of the NDAA. Ideally, the conference version of the NDAA that comes out of committee would include the manufacturing universities legislative text. The next administration should make implementation of the manufacturing universities legislation a top priority, directing relevant agencies (notably NSF and the National Institute of Standards and Technology) to implement it swiftly and effectively.

17. Complete the buildout of Manufacturing USA to 45 Institutes of Manufacturing Innovation

Manufacturing USA, launched in 2013 as the National Network for Manufacturing Innovation by the Obama administration and endorsed on a bipartisan basis by Congress through the Revitalizing American Manufacturing Innovation Act, has played a pivotal role in revitalizing America's industrial commons and helping ensure U.S. leadership across a range of advanced manufacturing process and product technologies.[36] Thus far, nine Institutes of Manufacturing Innovation have been launched, focused on additive manufacturing, digital manufacturing and design innovation, lightweight and modern metals, power electronics, advanced composites, integrated photonics, flexible hybrid electronics, clean energy smart manufacturing, and revolutionary fibers and textiles. As of December 2016, six more IMIs are under development, including two in a competition to be overseen by DoE (focused on Chemical Process Intensification and Sustainable Manufacturing), two expected to be led by the Department of Defense (focused on Regenerative Medicine and Assistive and Soft Robotics), and two more open topic competitions to be spearheaded by the Department of Commerce. The Obama administration has articulated a vision for a total of 45 IMIs. The Trump administration should collaborate with Congress to provide funding and authorization to build out the 45-institute network of industry-led Manufacturing USA institutes.

18. Create a National Engineering and Innovation Foundation

Science-based discoveries without a commercialization component mute the potential impact of R&D. Connecting discovery with production requires engineering-based innovation, an appropriable activity through which U.S. establishments can add and capture value.[37] And this requires the United States getting better at generating pathways that turn science into U.S.-made high-technology products. Engineering is not science; the two have distinctly different purposes. As Sridhar Kota, formerly assistant director for advanced manufacturing at the Office of Science and Technology Policy, writes, "Science is about analysis and discovery and dissemination of knowledge. Engineering is about synthesis and invention and turning ideas into reality through a process called innovation and through translational research and entrepreneurship."[38] Both science and engineering are instrumental if American firms are to introduce successful innovations over the long term.

Yet the United States invests significantly more in scientific research than it does in engineering. For example, of the total federal research investments in science and engineering in 2008, approximately 14 percent were allocated to engineering development and the remainder to other scientific fields.[39] NSF invests roughly one-tenth on engineering education as it does on science and mathematics education.

Accordingly, it's time to raise the profile of engineering within our national innovation system. While NSF supports phenomenal work, its primary mission is funding scientific research while its engineering support programs get short shrift. Therefore, the next administration should work with Congress to create a National Engineering and Innovation Foundation as a separate entity operating alongside the National Science Foundation.[40] The new National Engineering and Innovation Foundation would consolidate the current Engineering Directorate within NSF including the ERC and I/UCRC programs, the tech commercialization parts of the National Institute of Standards and Technology (e.g., including MEP and the Advanced Manufacturing Technology Consortia (AMTech) program), DoD's Manufacturing Technology (ManTech) program, and DoE's Advanced Manufacturing office into a single entity with an engineering and innovation focus.

19. Create an Office of Innovation Review within the Office of Management and Budget

Because federal agencies often propose regulations with little consideration given to their effect on innovation, Congress should task the Office of Management and Budget's Office of Information and Regulatory Affairs with creating an Office of Innovation Review (OIR) to review proposed regulations to determine their effect not just on costs in the short term but also on innovation over the long term. OIR would have the specific mission of being the "innovation champion" within agency rule-making processes.[41] It would have authority to push agencies to either affirmatively promote innovation or to achieve a particular regula¬tory objective in a manner least damaging to innova¬tion. OIR would be authorized to propose new agency actions and to respond to existing ones, and could incorporate a "competitiveness screen" in its review of federal regulations that affect globally traded industries.

20. Create a network of acquisition-oriented DoD labs based in regional technology clusters

The Department of Defense is uniquely positioned to commercialize research from its over $70 billion of R&D investments annually because it invests with the intent of deploying R&D outcomes throughout its own operations. According to its own accounting, between 2000 and 2014 DoD paid private companies that had licensing arrangements with its labs $3.4 billion for military technology; during the same period, companies that licensed technology from DoD labs generated $20 billion in sales outside of DoD.[42] This is a positive outcome, because it suggests that even the licensing arrangements companies have with DoD that don't end in procurement still generate broader economic impact. In other words, companies pay to use technology generated by DoD and then develop products and services around the technological discovery to meet defense as well as market needs. This continuous cycle of development well positions the department's R&D to impact the broader economy in general and regional clusters in particular. But the same report finds that the majority of licensing agreements are signed with a few large defense contractors, leaving many regions without such firms out of the game.[43] Moreover, as DoD seeks to acquire technologies beyond munitions, moving into areas such as software, material science, autonomous systems and vehicles, energy, and medical devices, it will need a broader scope of suppliers.

To increase the breadth of R&D-based procurement, the Trump administration should create a network of applied defense R&D facilities around regional technology clusters.[44] The network would be similar to Manufacturing USA but with numerous smaller centers that are highly focused around the virtuous cycle of firms working with DoD labs and creating products and services that meet military needs. DoD is already moving in this direction, in accordance with Secretary of Defense Ash Carter's Third Offset strategy, which seeks to counter declining force sizes with the development of novel capabilities and concepts.[45] For example, the Defense Innovation Unit Experimental (DIUx) seeks to create bridges between the Pentagon and the commercial technology sector. It currently has locations in Silicon Valley, Boston, and Austin, Texas; last year it awarded 12 contracts worth $36.3 million. While DIUx is a good start, its budget is tiny compared to the changing demands for new technologies within the military. Accordingly, DoD should invest $500 million to develop 50 similar centers as technology platforms across the country. Given that DoD already operates dozens of laboratories across 22 states, in many cases existing labs could shift their research and commercialization strategies to better align with adjacent technology clusters. In other regions, the department would need to develop new assets.

21. Establish manufacturing development facilities

Oak Ridge National Laboratory in Tennessee operates the Department of Energy's first manufacturing development facility (MDF), which focuses on assisting industry's adoption of new manufacturing technologies that can lower production costs, speed time to market, and reduce energy consumption in manufacturing processes. The facility focuses on additive manufacturing (3D printing), carbon fiber and other composites, and new battery technologies and is also the location of the Institute for Advanced Composites Manufacturing Innovation, part of Manufacturing USA.[46] The MDF helps bridge basic research at Oak Ridge and the real-time commercial needs of industry. Also, because East Tennessee has historical technical strengths in composites and advanced manufacturing, the MDF is strategically positioned to amplify the region's economy. The next administration should create 20 additional manufacturing development facilities to bring to market the fruits of scientific and technical research discoveries made by federal laboratories run by DoD, DHHS, DoE, and other federal agencies. It is important to note that MDFs are not the same thing as manufacturing institutes; rather, they are specific lab departments, offices, or facilities that are either currently located behind the fence or new facilities that would traditionally be developed behind the fence. Therefore, relocating these assets would require less funding than developing new manufacturing institutes (which are also intended to meet different needs).

22. Establish a foundation for the national energy laboratories

A number of agencies—including USDA, the Department of Veterans Affairs, the Department of the Interior, NIH, the Food and Drug Administration, and DoD—have established foundations to provide them with more flexibility to accomplish their missions. These foundations are legally chartered to accept donations from alumni inventors and scientists, philanthropists, and high-wealth individuals to support research efforts in ways that federal and private funding alone cannot. Foundations are often highly capitalized, for example the foundation for the National Institutes of Health has a $100 million endowment and a $500,000 operating budget. Based off of the success of existing research foundations, the next administration should create a foundation for the national energy laboratories. Because many philanthropies are forbidden by their charters to fund overhead, and the federal lab system is congressionally mandated to charge overhead from donations, a foundation for the national energy labs could serve as a funding intermediary between the civic sector and federal labs. The foundation could also endow research chairs around areas of national interest, help support moving translational research to market, and even fund and take equity in startups.

Publicly funded research institutions—federal laboratories, universities, academic hospitals, military and space laboratories, and non-profit research centers—represent core assets in the U.S. innovation system.

Summary

If the United States wishes to keep pace in the increasingly intense competition for global innovation leadership, it will need to evaluate its existing base of institutions underpinning America's innovation system and consider new ones that can play important roles in bolstering the country's levels of technology transfer, commercialization, and innovation. In launching the Manufacturing USA network of Institutes of Manufacturing Innovation, the United States has shown a commendable ability to do so, but it alone is not enough and continued institutional innovation will be needed going forward.

Expand technology transfer and commercialization-related programs and investments

Publicly funded research institutions—federal laboratories, universities, academic hospitals, military and space laboratories, and non-profit research centers—represent core assets in the U.S. innovation system. Not only do these institutions push the frontiers of science, they are anchors of regional economic growth. While the charters of many of these facilities are related to mission-oriented, non-economic public priorities, their activities are deeply tied to the future of the American economy. Strong R&D in defense supports aerospace and materials science industries, clean energy research promotes clean technologies such as wind turbines and new batteries, and scientific advances in public health lead to drug discoveries and health information technology platforms, to name but a few examples. These institutions also train and employ current and future generations of scientists and engineers. However, realizing the economic potential of R&D activities is no sure thing. In order for university and lab research to reach the market, these institutions must be supported by strong policies, incentives, and funding streams that collectively make commercialization a priority.

To date, the efficacy of technology transfer mechanisms at federal laboratories and federally supported universities is mixed.[47] Some labs and universities have elevated the importance of technology transfer and put in place creative and impactful policies to promote commercialization in their economic regions. For example, in 2015 the Oak Ridge National Laboratory established an innovation voucher program to enable technical assistance to small and medium-sized manufacturers in the state. And universities such as MIT, Pepperdine, and Carnegie Mellon have strong track records of implementing flexible, business-friendly technology transfer agreements. Unfortunately, as the report *Innovation U 2.0: Reinventing University Roles in a Knowledge Economy* documents, there is little consistency and insufficient adoption of best practices across universities, federal laboratories, and funding agencies.[48]

As the largest funder of federal laboratory and university research, the executive branch has an enormous opportunity to incentivize the commercialization of research. President Obama's Lab-to-Market Initiative was a step in the right direction, but there is more to be done. In order to unleash the full economic power of federally funded universities and laboratories, the incoming administration should work with Congress in the following areas:

The current federal system for funding research pays little attention to the commercialization of technology.

23. Increase the importance of commercialization activities at federal labs/ research institutes

America's federal laboratories are insufficiently incentivized to invest time, energy, and resources in facilitating technology transfer, in large part because technology transfer is not even one of the eight main criteria in the Performance Evaluation and Management Plan (PEMP), a kind of annual report card for the federal labs.[49] Rather, PEMP treats successful transfers of technology to market as an afterthought. Elevating this important function to its own category would have significant impacts on the management of the labs and help to reverse the buildup of decades of skepticism and intransigence toward commercialization. Adding a ninth category to the PEMP for "Technology Impact" would create a mechanism to evaluate the economic impact of lab-developed technology, creating a stronger incentive for lab managers to focus on market implementation of valuable government intellectual property assets and technical capabilities.[50]

24. Allocate a share of federal funding to promote technology transfer and commercialization

The current federal system for funding research pays little attention to the commercialization of technology, and is based instead on the linear model of research that assumes that basic research gets easily translated into commercial activity. Yet the reality is that the innovation process is choked with barriers, including institutional inertia, coordination and communication challenges, and lack of funding for proof of concept research and other "valley of death" activities. Accordingly, federal policy should explicitly address this challenge and allocate more funding toward commercialization activities.

The incoming administration should work with Congress to establish an automatic set-aside program that takes a modest percentage of federal research budgets and allocates this money to technology commercialization activities.[51] For instance, the Information Technology and Innovation Foundation has suggested that Congress allocate 0.15 percent of agency research budgets (about $110 million per year) to fund university, federal laboratory, and state government technology commercialization and innovation efforts.[52] Such funds could be used to provide "commercialization capacity-building grants" to organizations pursuing specific innovative initiatives to improve an institution's capacity to commercialize faculty research as well as "commercialization accelerator grants" to support institutions of higher education pursuing initiatives that allow faculty to directly commercialize research.[53] These funds could also support a variety of different initiatives, including mentoring programs for researcher entrepreneurs, student entrepreneurship clubs and entrepreneurship curricula, industry outreach programs, and seed grants for researchers to develop commercialization plans.

In addition, the incoming administration should broaden beyond universities the number of institutions that are eligible for commercialization funds. At the state and regional levels many organizations outside the university play a critical role in assisting faculty and students in the commercialization of research. Institutions like

Congress could support these types of novel approaches by providing $5 million annually to fund experimental programs exploring new approaches to university and federal laboratory technology transfer programs.

BioCrossroads in Indiana and TEDCO in Maryland offer mentorship, funding, and access to customers for research entrepreneurs. These organizations should be eligible for federal research dollars specifically aimed at technology transfer.

25. Develop a proof-of-concept, or "Phase Zero," individual and institutional grant award program within major federal research agencies

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs support innovation, but both SBIR and STTR approval are a high bar for early-stage companies. There is often insufficient funding available at universities (or from other sources) to push nascent technologies to the point where these companies are positioned to receive an SBIR or STTR grant. The problem is essentially that researchers and universities do not have the resources available to support the proof-of-concept work, market analysis, and mentoring needed to translate ideas and nascent technologies from the university laboratory into a commercial product.

A national "Phase Zero" proof-of-concept program would not only help more projects cross the "valley of death," but would also help enhance the infrastructure (e.g., expertise, personnel, support, small business, and venture capital engagement) and facilitate the cultural change necessary for universities, federal laboratories, and other non-profit research organizations to support commercialization activities.

America's competitors have recognized the need for such an instrument. For instance, the European Research Council (ERC) has announced a new proof-of-concept funding initiative to help bridge the gap between ERC-funded research and the earliest stage of marketable innovations.[54] These awards can be as high as $215,000 for individual researchers, in total, equivalent to about 1 percent of ERC's budget.[55] Here in the United States, the Wallace H. Coulter Foundation has established Translational Research (for individual researchers) and Translational Partnership (for institutions) Awards for proof-of-concept research in biomedical engineering.[56] The Translational Research Awards are made in amounts of approximately $100,000 per year, while the university grants have a duration of five years at over $500,000 per year.

Similarly, NIH's Research Evaluation and Commercialization Hub (REACH) program fosters the development of therapeutics, preventatives, diagnostics, devices, and tools that address diseases within NIH's mission in a manner consistent with business case development. The work supported by the REACH program may include technical validation, market research, clarification of intellectual property position and strategy, and investigation of commercial or business opportunities.[57] Finally, a number of states, such as Kentucky and Louisiana, have developed Phase Zero grants to help firms apply for SBIR grants and support early proof-of-concept research. One way for the federal government to implement such a proof-of-concept-program would be through a grant program for states that agree to match the funds dollar-for-dollar.

26. Fund pilot programs supporting experimental approaches to technology transfer and commercialization

A number of organizations throughout the United States are experimenting with novel approaches to bolster technology transfer from universities and federal laboratories to industry and to accelerate the commercialization of university-developed technologies. For example, the Applied Physics Laboratory (APL) at Johns Hopkins University is considering an Innovation Launch Program that would leverage a $110,000 investment to support 10 entrepreneurial student teams in commercializing intellectual property developed at APL. Congress could support these types of novel approaches by providing $5 million annually to fund experimental programs exploring new approaches to university and federal laboratory technology transfer programs. This effort could be funded either through one central agency or through the respective R&D mission agencies and managed by the Department of Commerce's Office of Innovation and Entrepreneurship. Organizations would apply for the grants, and winning proposals would be selected on criteria such as innovative approach to demonstrating a new model, recent documented success of the program, and willingness to publicly disclose best practices learned from the programs. The effort could be thought of as a "Commercialization Experiments Program."

27. Support university-based technology accelerators/incubators to commercialize faculty and student research

As universities try to develop new pathways to commercialize research, the federal government can do more to support university efforts to promote research-based entrepreneurs. For example, Stanford has created StartX, Johns Hopkins has created Fast Forward, and MIT has created the Deshpande Center as technology accelerators and incubators that assist university students and faculty in establishing entrepreneurial ventures that seek to move university-developed discoveries and inventions into the commercial sector. These programs and co-working spaces provide a range of support services that may include physical space, legal advice on incorporation and preferred treatment of intellectual property, connections to sources of capital, and a range of business, technical, and potential customer contacts important to launching a new business. While these types of accelerators are increasingly proliferating throughout the U.S. university system, additional funding could support development into a wider set of universities and colleges, particularly those that don't have large endowments or wealthy alumni to self-fund such programs.

28. Allow a share of SBIR/STTR awards to be used for commercialization activities

Billed as "America's Seed Fund," the Small Business Innovation Research and Small Business Technology Transfer programs provide over $2 billion per year to qualified small businesses to fund R&D activities through multiple federal agencies. While SBIR accounts for only 3.4 percent of federal extramural research funding, the program punches well above its weight, with as much as 22 percent of America's top innovations (as reflected by studies of previous winners of *R&D Magazine*'s R&D 100 innovation awards) coming from companies that received SBIR grants at some point in their history.[58]

Yet SBIR's impact could be even greater, particularly if some facets of the program were geared slightly more strongly toward commercialization. In particular, awardees are currently prohibited from utilizing grant money to fund critical commercialization activities related to building product or service prototypes, acquiring commercial customers, attracting private capital, or accelerating market entry. These activities cover the gamut of important commercial activities, including intellectual property development and prosecution, marketing and market development, and the recruitment of key team members associated with customer acquisition (e.g., marketing and sales)—all critical to commercialization.[59]

SBIR awardees should be permitted to expend up to 5 percent of their award funds for commercialization-oriented activities. For Phase 1 awardees this expansion would include a narrow set of allowable activities (such as market validation), while for Phase 2 awardees, who are closer to market, a broader set of allowable activities would include market validation, intellectual property protection, business model development, and market research. The Support Startup Businesses Act (S. 2751) has a similar goal; it would allow SBIR grantees to devote up to $30,000 for commercialization expenses.[60]

29. Increase the allocation of federal agencies' SBIR project budgets to commercialization activities

In addition to permitting SBIR awardees to increase the share of funds they can allocate to commercialization-oriented activities, the federal agencies making SBIR awards should do the same. Though some participating agencies offer SBIR/STTR award "supplements" to awardees to select their own vendors (or offer commercialization programs organized by outside vendors), these are capped at $5,000 per year per awardee for commercialization activities and cannot be used to fund company employees specifically devoted to these activities.

Accordingly, SBIR/STTR-sponsoring federal agencies should increase the share of SBIR project funds that can be allocated toward commercialization. Agencies should be encouraged or required to evaluate the performance of outside vendors in order to ensure quality, and to match outside vendors to SBIR awardees in order to ensure an appropriate fit with respect to sector, stage, region, and other applicable factors.[61] Additionally, agencies should implement their current authority to allow each individual SBIR awardee to choose outside vendors that provide such services to that awardee. This proposal has been incorporated into the SBIR and STTR Reauthorization and Improvement Act of 2016.

30. Modify the criteria and composition of SBIR review panels to make commercialization potential a more prominent factor in funding decisions

All participating agencies consider commercialization potential and plans in their grant funding decisions. However, agencies differ in the weight or emphasis they place on commercialization. In particular, some agencies, such as NASA and DoD, intend to use the commercial products that flow from their own R&D. In agencies where the intended customers are external, a greater portion of the merit review evaluation criteria and scoring should include commercialization factors, such as the company's understanding of market opportunity, product development timelines, and needed resources.[62] Further, to evaluate these important criteria, the composition of SBIR/STIR review panels at these agencies should include industry experts, investors with relevant industry or technology expertise, and/or representatives from commercialization intermediary organizations or venture development organizations.

31. Encourage engagement of intermediary organizations in supporting the development of startups

While agencies have expanded their commercialization programs through funding services offered by third-party organizations, federal R&D funding agencies should fund and encourage the engagement of science- and technology-oriented intermediary organizations that have been effective in translating science-based plans into commercial opportunities in regions around the country. As a key pillar of economic development, these organizations could more effectively leverage federal funding, engage local resources in various functions, and generate local interest amongst awardees. Therefore, funding agencies should systematically map intermediary organizations within technology clusters and support startup grant awardees in connecting with these institutions. Moreover, these organizations should be eligible for federal R&D funding that relates to technology commercialization.

SBIR/STTR investments that are coupled with guidance from regional intermediaries experienced in helping innovators have greater likelihood for success and long-term stability.[63] Currently, ad hoc consultations occur across the board, but this proposal would help fund and create formal pathways linking the many efforts that have grown in the past few years to the program itself and add a level of higher-touch support to companies than federal agencies are able to provide.

32. Expand the NSF I-Corps program to additional federal agencies

The National Science Foundation’s I-Corps program has successfully helped scientists and researchers translate federally funded technologies into marketable products and services. I-Corps has three distinct components: teams, nodes, and sites. Teams are composed of the principal investigator(s), an entrepreneurial lead, and a mentor. Nodes serve as hubs for education, infrastructure, and research that engage academic scientists and engineers in innovation. Sites are academic institutions that catalyze the engagement of multiple local teams in technology transition and strengthen local innovation.[64]

NIH and DoE have created similar programs, but current funding levels are too low to truly impact startup activity across the vast panoply of federal funding agencies. The scale of NSF’s I-Corps program should be increased across the federal government so that it can be made available to scientists and engineers at all federal agencies. For example, the American Innovators and Entrepreneurs Act would provide additional funding for the I-Corps program and encourage collaboration between the NSF I-Corps program and other federal agencies, including the Small Business Administration. The bill would also ensure accountability regarding the I-Corps program by requiring NSF to submit to Congress biennial reports regarding the program’s effectiveness.

The I-Corps program gets paid out of 3 percent administrative funds generated as part of general SBIR program funding, but the current version of the SBIR/STTR Reauthorization of Act of 2016 failed to include a five-year reauthorization of that element of the program, meaning that in theory funding for the SBIR program could lapse in August 2017 (before the following fiscal year begins in October 2017). Congress should reinsert allowance for the 3 percent administrative funding for I-Corps into the SBIR/STTR Reauthorization of Act of 2016, or if necessary provide a fix in subsequent COMPETES or National Defense Authorization Act (NDAA) legislation. Further, ideally, the final SBIR/STTR Reauthorization of Act of 2016 would contain language affirming the permanency of the commercialization pilot program for civilian agencies by omitting the words “pilot program” from current Small Business Act legislation (15 U.S.C. 638(gg)(7) and inserting the words “commercialization development program” instead.

33. Authorize and extend the Lab-Corps program

The Department of Energy created the Lab-Corps pilot program (modeled after NSF’s I-Corps program) for the national labs to support investments in technology maturation, entrepreneurs, mentors, scientists, and engineers. The program has not been formally authorized by Congress, but the Accelerating Technology Transfer to Advance Innovation for the Nation (ATTAIN) Act would authorize the program and expand it to engage all national laboratories as well as entrepreneurs and innovators who are competitively selected through an open solicitation.

34. Provide federal matching funds for state and regional technology transfer and commercialization efforts

Many states and regions fund technology transfer and commercialization efforts between their universities and the private sector; examples include TEDCO in Maryland and the Georgia Research Alliance. These programs have strong track records and are strategically tied to regional technical capabilities. But states underfund these efforts, in part because the benefits can spill over beyond their borders. Federal funds should match these state efforts at some percentage level to bolster their impact. One example is Senate bill S. 4047, which would create a Federal Acceleration of State Technologies Deployment Program, or “FAST,” a federal funding strategy for accelerating the local commercialization of newly developed technologies by matching cash-poor state programs.[65] The matching federal funds would be available concomitant with a state’s level of investment (pro-rated against state population with a maximum cap) in its technology commercialization programs. States would use the money for direct, merit-based project grants to existing SMEs or to startup companies looking to commercialize new products or technologies (with the expectation that a major source for those technologies would be ones currently untapped at local colleges and universities).

35. Incentivize universities to focus more on commercialization activities

A number of countries have sought to increase their R&D efficiency by using existing funding for scientific research to incentivize universities to focus more on technology commercialization.[66] For example, in Sweden, 10 percent of regular research funds allocated by the national government to universities are now distributed using performance indicators. Finland allocates 25 percent of the research budgets of Finnish universities based on "quality and efficacy," including the quality of scientific and international publications and the university's ability to attract research investment from businesses. In other words, without increasing government budgets, these nations are using existing funds to provide an incentive for universities to become greater engines of national innovation.[67]

In the United States, federal research funding agencies, particularly the National Science Foundation, should consider allocating a small share (e.g., 5 percent) of university R&D funding based on indicators of universities' effectiveness in attracting industry funding for university research as well as success at commercialization-oriented activities (e.g., number of faculty and student spinoffs or startups, extent of technology licensing, etc.). As in Sweden, the amount of industry-funded university research should be the first variable used to make such allocation decisions. This goal could be achieved by making a share of NSF institutional support grants (which support infrastructure, research, teaching, etc.) contingent on industry collaboration and commercialization performance.

36. Establish stronger university entrepreneurship metrics

The United States should collect better data regarding new business startups coming out of U.S. universities. For example, Congress could direct the National Science Foundation to develop a metric by which universities report such information annually. Funding agencies could use this data to reward universities—for example, by giving bonus points on research grant proposals. In addition, the Department of Commerce could use data available through the ES-202 form (unemployment insurance tax records), which tracks how many employees an establishment has every quarter. If the form noted the university that the founder of the organization attended, it could reveal which colleges and universities have graduates who are founding and running high-growth businesses.

37. Expand the collaborative R&D tax credit to spur research collaboration between industry and universities and labs

Over the last two decades, firms have increased their collaborations with institutions, particularly universities, in order to lower the cost of research and increase effectiveness by maximizing idea flow and creativity. Recognizing this, at least a dozen nations have established collaborative R&D tax credits designed to incentivize industry investment in collaborative research, often including universities, and enrolling multiple partners to do so.[68] The United States has a collaborative R&D credit, but only for the energy sector: as part of the Energy Policy Act of 2005, Congress created an energy research credit that allowed companies to claim a credit equal to 20 percent of the payments to qualified research consortia for energy research. The next administration and Congress should allow firms to take a flat credit of 20 percent for collaborative research undertaken in conjunction with universities, research institutes, federal laboratories, or multi-firm consortia.[69] This has been suggested before: in 2006, several bills were proposed which would have allowed all research consortia, not just energy-related ones, to become eligible for a 20 percent credit.[70]

The ERC and I/URC programs represent some of the most impactful initiatives in the federal government... the goal is to prioritize those federal programs and initiatives that have demonstrated the most powerful impacts.

38. Increase funding for cooperative industry/university research programs at universities

Industry-university partnerships spur greater levels of commercialization and innovation. In the United States, NSF's Engineering Directorate operates two kinds of industry-university partnerships: Engineering Research Centers (ERCs) and Industry/University Cooperative Research Centers (I/UCRCs). The ERCs are a group of 19 interdisciplinary centers located at universities, where academia and industry collaborate in pursuing strategic advances in complex engineered systems and systems-level technologies that have the potential to spawn whole new industries or to radically transform the product lines, processing technologies, or service-delivery methodologies of current industries.[71] The 75 I/UCRC programs forge partnerships between universities and industry, featuring industrially relevant fundamental research, industrial support of and collaboration in research and education, and direct transfer of university-developed ideas, research results, and technology to U.S. industry to improve its competitive posture in global markets.[72] In other words, the ERCs are focused on collaborative research among universities in advanced engineering systems, whereas the I/UCRCs bring in the industry component of advanced engineering systems research in collaboration with universities.

The Trump administration should work with Congress to increase I/UCRC funding to at least $50 million annually (a considerable increase from the $8 million budgeted in 2016).[73] The National Science Foundation has requested $61 million to fund 18 ERCs in FY 2017, but by 2020 Congress and the administration should look to grow the network of ERCs to 30 with appropriations of $100 million.[74] There is good reason to do so, for the ERC and I/UCRC programs represent some of the most impactful initiatives in the federal government. For instance, each dollar invested by I/UCRC generates an estimated $64.70 in economic impact.[75] While the increased funding being called for here for the two programs is relatively minor (about $80 million), even this need not increase spending, since funds can be reallocated in a budget-neutral manner from other activities. Again, the goal is to prioritize those federal programs and initiatives that have demonstrated the most powerful impacts.

39. Establish an International Patent Consortium

U.S. government and university technology transfer offices cannot afford to file and prosecute foreign patent applications on all their technology inventions. Accordingly, foreign rights to technologies invented at U.S. federal laboratories or universities often go wanting, and so commercialization opportunities are missed in foreign markets. One solution would be to create an International Patent Consortium, comprising country-specific (or regional) groups of international industry, financial, government, economic development, and technology transfer professionals who would collectively pay the patent expenses for at least two inventions per year from a U.S. technology transfer office in exchange for the exclusive marketing rights to those inventions (within a foreign country or region), with such rights then locally sublicensed by the consortium. This process could help ameliorate the current practice of filing foreign patents in only a handful of countries. The consortium concept could increase the breadth and value of the intellectual property portfolio of

U.S. government labs and provide their U.S. licensees (particularly small companies) with international marketing and distribution partners who could also provide complementary technology, equity, and international business experience.

Summary

Given mounting fiscal pressures, both the incoming Trump administration and Congress need to focus on improving the economic return on investment from existing infrastructure and resources. It is clearly time to elevate the importance attached to commercialization-oriented activities associated with federal R&D funding programs as well as raise commercialization's profile in the missions of federal laboratories and federally funded universities.

Promote high-growth, tech-based entrepreneurship

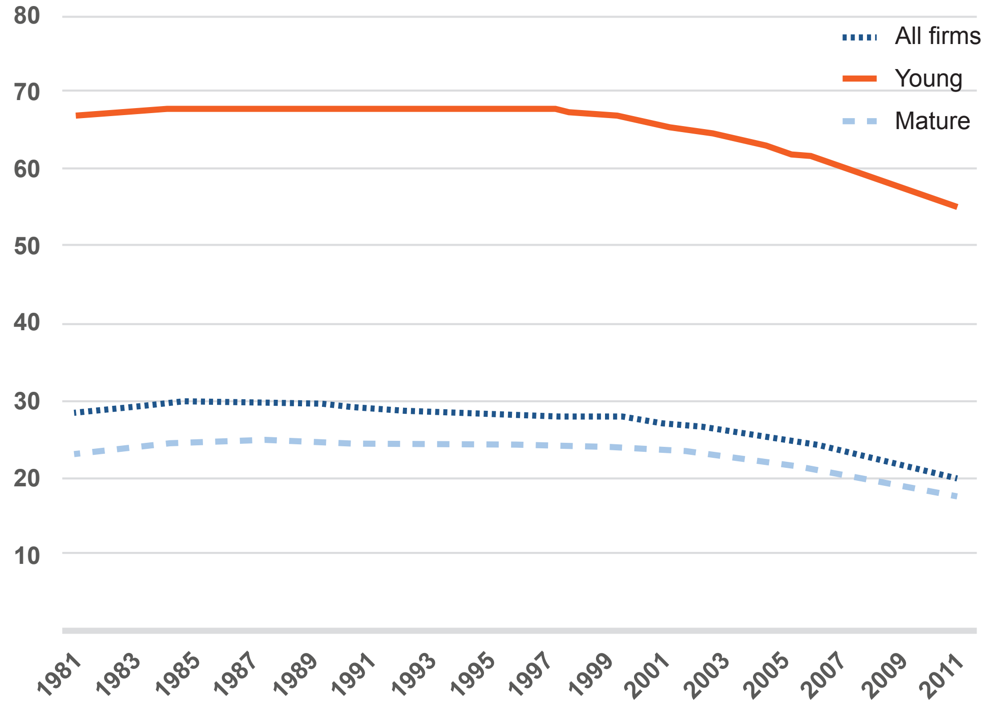
One key step the federal government can take to boost the economy is to better support high-growth, tech-based startups because these firms play an important role in job creation and innovation. According to research by MIT economist Scott Stern, 75 percent of employment generated by startups can be attributed to just 5 percent of entrepreneurs.[76]

Moreover, the relationship between young firms and larger companies is an essential ingredient for innovation.[77] Large companies house much of the industry knowledge needed for finding new solutions, but they often have tightly controlled product lines and corporate governance structures that can make radical innovation difficult. At the same time, young firms lack the market intelligence to know exactly what solutions can be monetized, but they represent a disproportionate share of radical innovation and are often acquired by large companies better suited to market new ideas. Dense, regional clusters are important to the interplay between young and large firms because economic research shows that entrepreneurs and larger firms collaborate most when they are geographically close.[78]

Unfortunately, the job-creating capacity of high-growth entrepreneurial firms has declined over the last 15 years. Decker et al. find that before 2000 the fastest-growing young firms (those in the 90th percentile of all young firms) grew employment at a steady rate of just under 70 percent a year, but by 2012 that rate had declined to 55 percent.[79] The authors also find that the portion of young, high-growth technology firms has declined since 2000, as Figure 2 shows.[80]

While startups once represented a wellspring of employment opportunities in new technology industries, today the flow is smaller. Therefore, supporting high-growth entrepreneurship should be a key pillar of the next administration's innovation policy priorities.

Figure 2: High-growth firms by firm age and annual employment growth rates, 1980-2012



Source: Decker et al,, "Where Has All the Skewness Gone? The Decline in High-Growth (Young) Firms in the U.S." (Cambridge, Mass.: National Bureau of Economic Research, 2016).

40. Encourage student entrepreneurship

The next administration should encourage universities to define an entrepreneurial leave policy for undergraduate and graduate students in which students could retain full-time student status for one to two years while launching their own companies. In the United States, for example, federal agencies supporting university research in science, technology, engineering, and mathematics (STEM) education should adopt a policy whereby any graduate or post-doctoral students on an assistantship, fellowship, or other form of federal support can petition for a no-cost one- to two-year extension of their status as they take "entrepreneurial leave." Another option would be to provide graduates an entrepreneurial student loan deferment when they are attempting to start a business. The deferment could be extended if certain metrics were being met, such as jobs created or venture capital raised.

41. Help nascent high-growth startups secure needed capital

In 1995, Silicon Valley accounted for 22.6 percent of U.S. venture capital, Los Angeles/Orange County 12.5 percent, Boston 9.9 percent, New York 6.4 percent, and all other areas of the United States 48.6 percent. Twenty years later, in 2015, Silicon Valley had more than doubled its share, to 46.4 percent, New York's share rose to 12.4 percent, Boston moved to 10.2 percent, and Los Angeles to 8.7 percent, while the share for the rest of the United States fell to 22.2 percent.[81] In other words, today just four regions of the United States account for 78 percent of all U.S. venture capital investment, while the remainder of the country fights over the remaining one-fifth.

Thus, a substantial number of promising young businesses scattered throughout all regions of the United States likely have difficulty securing capital, particularly venture capital, because most venture capital investment is concentrated on America's coasts. The Small Business Jobs Act of 2010 helped to address this problem; it created the State Small Business Credit Initiative (SSBCI), a $1.5 billion fund designed to strengthen state programs that support lending to small businesses and small manufacturers.[82] The SSBCI gave states significant flexibility to design programs to meet local market conditions, with SSBCI supporting 152 small business programs from 2011 to 2015. Approximately 69 percent of the funding supported lending or credit support programs and 31 percent supported venture capital programs. From 2011 to 2015, SSBCI programs supported nearly $8.4 billion in new capital in small business loans and investments.[83] In effect, SSBCI provides an opportunity for states to supplement existing venture capital programs, revitalize programs lacking sufficient state support, and create new programs where state managers perceive unmet needs in evolving entrepreneurial ecosystems. The SSBCI has made a positive impact in expanding high-potential businesses' access to credit, and so the next administration should reauthorize it and double its funding.

42. Establish an entrepreneur-in-residence program with NIH

While all federal funding agencies should support greater research-driven entrepreneurs, NIH is unique in that health care and life science startups are particularly difficult to grow—but often represent significant economic value when they do. Moreover, among all agencies, NIH distributes the largest share of federal funding to universities, many of which have only recently begun to seriously think about technology transfer through faculty and student-generated businesses. Universities and academic medical centers that receive funding from NIH often follow the narrow and traditional path to commercializing research that revolves around patenting and licensing. In the "classic" model of technology transfer, researchers at universities and medical centers apply for NIH and other federal funds to pursue basic science and patent their discoveries. The technology transfer office at the university/medical center then takes these patents and licenses their use to biotechnology and pharmaceutical firms for the development of products. While the classic model can be an appropriate vehicle for commercialization, it often lacks strong connections between firms and research organizations. Successfully scaling a life-sciences startup requires social and capital networks, mentorship, public-private partnerships, and access to both scientific and managerial talent. Developing, recruiting, and coordinating these disparate pieces of the medical entrepreneurial ecosystem is difficult but once achieved can spur new economic clusters, firms, and employment.

For years venture capital firms have run entrepreneur-in-residence (EIR) programs, where the firm hires proven entrepreneurs to review its patent portfolio and work with other star entrepreneurs to help them grow. By establishing an entrepreneur-in-residence program at universities that receive NIH research funding, including basic and translational (DHHS already has an EIR program that serves a different purpose), the agency can help universities identify, support, and grow the research efforts best positioned to become high-growth companies.[84]

43. Implement immigration policies that advantage high-skill talent

Talent has become the world's most sought-after commodity. Immigration plays an important role in contributing to a country's knowledge pool and creative potential by bringing in new perspectives and needed skills. As the report *Not Coming to America: Why the U.S. Is Falling Behind in the Global Race for Talent* finds, at least nine nations—Australia, Canada, Chile, China, Germany, Ireland, Israel, Singapore, and the United Kingdom—have implemented innovative policies to attract foreign entrepreneurs and investors to their countries as part of a concerted effort to drive economic and employment growth. These countries "see immigration as an integral part of their national economic strategy—a factor in their prosperity as significant as education and infrastructure."[85]

America's immigration policies should adopt a more open approach toward high-skill talent. One simple way to accomplish this is to grant more work visas to foreign students in American universities after they graduate. In the 2014-2015 school year approximately 975,000 foreign nationals were attending U.S. universities; 57 percent of the students were in STEM fields.[86] Extending a green card to foreign-born students graduating in STEM fields would provide a boost to the U.S. innovation economy. Accordingly, the United States should make it easier for talented individuals from foreign nations who receive a graduate degree in STEM fields to stay in the United States after graduation by making them eligible for permanent residency.

44. Implement a research investor's visa

The United States should create a research investors' visa for foreign individuals investing substantially in ongoing federally funded R&D activities at U.S. universities or federal laboratories.[87] Such a visa could make important contributions to U.S. economic and employment growth.

One reason a research investor's visa could have a particularly powerful economic effect is that it would specifically support the most R&D-intensive sectors of the U.S. economy that are best positioned to compete globally. A potential weakness of the immigrant entrepreneurs' visa is that it is impossible to know which entrepreneurial activities will grow to global scale and become a source of employment. By specifically focusing on high-value, scientifically focused startups, the new visa would better capture growth-oriented firms. For example, the Kauffman Foundation finds that a general startup visa program would create significantly fewer jobs, perhaps only one-third as many, as a program focused on high-technology or engineering startups.[88]

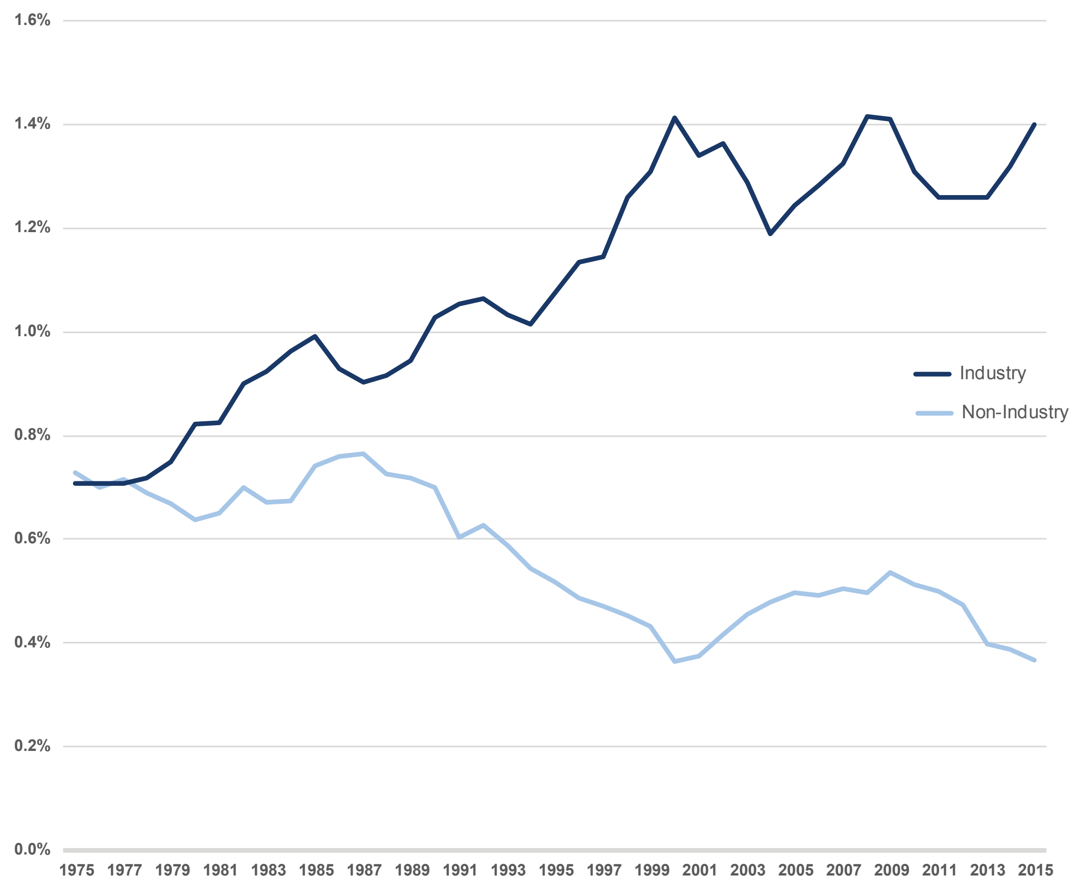
Summary

Political economists Peter Hall and David Soskice argue that the United States' entrepreneurship ecosystem is central to the country's ability to produce innovations that lead to new industries—automobiles, planes, electronics, software, etc.[89] While other countries such as Germany have strong industrial policies that allow legacy industries to remain competitive through technology adoption, radical innovation through new firms is a unique American strength. To continue to build on this, the next administration will need to create policies that better support high-growth tech-based startups and attract foreign tech-based entrepreneurs while also incentivizing universities, federal labs, and other federally funded institutions to encourage entrepreneurship.

Stimulate private-sector innovation

Leveraging federal R&D alone won't be enough to re-establish U.S. leadership in advanced manufacturing and technology sectors. Because over two-thirds of R&D is performed by the private sector, the administration must also incentivize and support private-sector R&D and create stronger linkages between public and private R&D. Supporting such R&D is crucial because it is a critical input to the private-sector innovations that drive long-term U.S. economic growth.

Figure 3: Investment in development as a share of GDP, industry and non-industry



Source: National Science Foundation, Science and Engineering Indicators, 2016

There are at least four reasons why the government should support private-sector innovation. First, without government incentives for R&D, worker training, and investments in new capital equipment, the private sector would underinvest in innovation because new technologies are often easily replicated and transferred between firms. This is particularly true as technology imitation occurs far more quickly today than in the past, due in part to the global base of technology competitors and the speed of reverse engineering. Consider the iPad, first released in March 2010. At the 2011 Consumer Electronics Show, close to a dozen competing tablets were on display.[90] Effects like these are why the economist Lorin Hitt finds that spillovers to other firms from firms' investments in information technology are "almost as large in size as the effect of their own investments."[91] This is good for the economy but badfor the innovative company that cannot reap the full market benefits of its technology.

Second, the gulf between federal and private-sector R&D is widening. Over the last half century, firms have moved away from investing in basic research and toward market-oriented development research; at the same time, the federal government has shifted its R&D portfolio toward basic science. Between 1965 and 2015, the share of federal R&D going to basic research increased from less than 10 percent to 25 percent.[92] Figure 3 shows that federal investment in development-oriented activities (i.e., the "D" in "R&D") as a share of GDP has trailed off significantly since the mid-1980s. The impact of these trends is that now federal research outcomes leave off far too early for corporate research centers to commercialize. To fix the problem, greater linking mechanisms are needed.

Third, economic research clearly shows that innovation-oriented tax credits work. Bloom, Griffith, and Van Reenen find that R&D tax credits stimulate $1.10 for every dollar lost in tax revenue.[93] Coopers and Lybrand find higher benefits, of between $1.30 and $2.90.[94] Similarly, Klassen, Pittman, and Reed find that, for every one dollar of tax revenue lost, the R&D credit induces $2.96 in private-sector R&D.[95]

Finally, the United States now lags far behind many other countries in innovation-incentivizing tax policy. The United States invented the R&D tax credit in the early 1980s, and as late as 1992 ranked first globally in R&D tax incentive generosity. But today the United States ranks 27th.[96] While in 2015 Congress laudably made the R&D tax credit permanent, other countries have raced ahead, creating robust investment tax credits, bridging public and private R&D, and incentivizing workforce training and technology investments by the private sector.

To stimulate private sector innovation, the incoming administration should work with Congress on the following policies.

45. Implement innovation vouchers

Innovation vouchers are low-cost tools for connecting startups with public research institutes or universities to incentivize R&D among young, innovative firms. The main goals of an innovation voucher are to enable knowledge transfers between startups and research institutes, support sectoral innovation in manufacturing, support innovation management and advisory services, speed commercialization of startup ideas, and focus research institutions on the commercial applications of their research. Several countries, including Austria, Belgium, Canada, Denmark, Germany, the Netherlands, Ireland, and Sweden, have begun using innovation vouchers to support R&D, innovation, and new product development in small businesses. With traditional voucher programs SMEs can typically receive a $5,000-$10,000 voucher for a cooperation project with a university, community college, or research institution for R&D assistance, technology feasibility studies, analysis of technology transfer, or analysis of the innovation potential of a new technology. The voucher creates an incentive to bring SMEs and academia closer together and also empowers innovation at SMEs.

Several U.S. states, including New Mexico, Rhode Island, and Tennessee, are experimenting with innovation vouchers. For example, in 2015, Oak Ridge National lab established an innovation voucher program to enable technical assistance to SME manufacturers in Tennessee. Los Alamos and Sandia national laboratories in New Mexico operate a similar program.[97] And the Energy Efficiency and Renewable Energy office within DoE has created a pilot innovation voucher for its national laboratories. Congress should extend vouchers to entire federal lab system by authorizing $50 million to the National Institute of Standards and Technology to fund a program operated by select states that agree to match the funding dollar for dollar (perhaps through tax credits to national labs within their borders). As a potential source of funds to keep the initiative revenue-neutral, one option would be to reallocate 0.5 percent of the laboratories' current budgets to fund the vouchers.[98]

46. Incentivize "megafunds" around high-risk research and development

In 1960, private-sector R&D was split one-third to research and two-thirds to development. Today, only one-fifth of firm R&D goes to research. One reason companies are moving away from basic and applied research is because of the risk involved in financing. In drug development, for example, it often takes years or decades and hundreds of millions of dollars to produce a profitable product. Individual companies and even venture capitalists often lack the appetite for such long-term, high-risk investments.

This risk could be mitigated through large portfolios that aggregate and manage risk. Mutual funds, pension funds, and 401(k) retirement accounts work this way, and MIT economist Andrew Lo has proposed extending this idea by establishing "megafunds" that utilize financial engineering techniques to fund R&D in long-term, high-risk, high-payoff areas such as drug discovery for cancer or orphan diseases.[99] However, to date, no such megafunds have been created by the market. The government incentives required for the creation of these funds could include one or more approaches from four broad categories: research and investment data streams; clear rules for private foundation program-related megafund investments; federal credit support; and tax incentives for funds investing in technologies with high societal impact (for example through the establishment of schedules and values of basis point step-ups and penalties).

To promote the creation of R&D megafunds, the Trump administration should establish an office within the Department of Commerce to develop and implement the needed incentives and oversight. The office would be tasked with establishing the rules for the funds and coordinating with federal agencies and the private sector to identify the technical areas of national interest where private-sector engagement is needed and the incentives required. The office should work with researchers, industry, and regulators to develop data-reporting and transparency standards that promote the translation of research to the market, provide better understanding of the societal benefits of research and an efficient data stream for regulation, and coordinate with federal funding agencies to enforce the provision and collection of such data.

47. Increase R&D tax credit generosity

R&D tax incentives are one of the most effective policy instruments in spurring a nation's private-sector R&D investment. Almost all scholarly studies conducted since the early 1990s find R&D tax incentives to be both effective and efficient. Studies of the U.S. credit find even greater benefits, with the research-investment-to-tax-cost ratio falling between 1.3 and 2.9.[100] Yet France and Spain offer R&D tax credits over five times more generous than those of the United States, and even Brazil, China, and India have exceeded the United States in R&D tax credit generosity. Ideally, the United States should increase the rate of the Alternative Simplified Credit from 14 to 24 percent. ITIF has calculated that expanding the R&D tax credit would pay for itself in added revenues from growth after 15 years.[101]

48. Ensure that small and medium-sized enterprises are familiar with available R&D tax credits

It is important that America's SMEs take full advantage of tax incentives, whether for R&D or investment in new machinery and equipment. Congress passed the PATH Act in December 2015 to expand small businesses' access to the R&D credit by permitting them to claim the credit against their employment taxes or against their alternative minimum tax. But not enough small businesses are aware that this legislation greatly expands their access to the credit. Accordingly, Congress should pass the Support Small Business R&D Act, which would require the Small Business Administration and the Internal Revenue Service to expand knowledge sharing and training on these instruments and provide a report to Congress on their progress.

49. Implement an innovation box to spur enterprises' efforts to commercialize technologies

A growing number of nations have put in place tax incentives to spur the commercialization of R&D, not just the conduct of R&D. These patent box —also called "innovation box"—incentives allow corporate income from the sale of patented products (or in some countries from innovation-based products) to be taxed at a significantly lower rate than other income.[102] A number of nations—including Belgium, China, France, Ireland, Luxembourg, the Netherlands, Spain, Switzerland, and the United Kingdom—have established patent boxes. The United Kingdom implemented its policy in 2013 with a tax rate of 10 percent on income generated from patented products, compared to the standard rate of 28 percent. France's patent box reduces corporate income tax from 34 percent to 15 percent on qualifying income.

A patent box that reduces the corporate tax rate on revenue from qualifying intellectual property, coupled with an incentive for corresponding R&D and production to be located in the United States, would provide firms with a much stronger incentive to innovate and to produce in the United States. The Innovation Promotion Act of 2015 calls for creating an innovation box that allows companies to claim an effective

10.15 percent tax rate for income derived from a wide range of qualifying intellectual property, including patents, inventions, formulas, processes, and designs and patterns, as well as other types of intellectual property, such as copyrighted computer software. Innovation boxes have received bipartisan support in the Senate.[103] The incoming administration should work with Congress to develop legislation to implement an innovation box for the United States.

50. Revise the tax code to support innovation by research-intensive, pre-revenue companies

The primary mechanism in the tax code to facilitate innovation is the R&D tax credit, but the credit is less useful for pre-revenue companies because it requires tax liability, which requires income. In other words, the tax credit is designed more for established innovators, not so much for research-intensive, pre-revenue companies that are trying to develop new technologies such as medical devices or biopharmaceutical drugs. These are extremely R&D-intensive companies, which tend to invest 75 percent or more of their expenditures in R&D.
Firms in this position often find it difficult to raise the capital needed to get them through the long development phase until they are near enough to profitability to conduct an initial public offering or be attractive to a prospective buyer. The PATH Act (Protecting Americans From Tax Hikes) of 2015 made the R&D tax credit refundable for small businesses (i.e., it allowed small businesses to take the credit against their payroll taxes). But two additional tax reform proposals could further address these challenges.

The first proposal would amend Section 469 of the tax code to permit passive investors to take advantage of the net operating losses and research tax credits of companies in which they invest.[104] (The Tax Reform Act of 1986 severely limited this ability because it was seen as a way for high-income individuals to reduce their taxes by investing in operations that were never meant to be profitable.) Under this reform, investors could immediately use their share of net operating losses, as well as any credits for research and development. The percentage of losses or credits that could be passed through would be limited to the portion of investment that was specifically targeted for qualified research activities as determined for purposes of the research and development tax credit. In order to qualify, a company would have to devote at least half of its expenses to research and development. The company would also have to have fewer than 250 employees and less than $150 million in assets. A recent study by Ernst & Young estimates that this change would increase investment in such companies by $9.2 billion, allowing them to create 47,000 jobs.[105] The proposal is currently contained in both the Start-Up Jobs and Innovation Act (S. 341) and the COMPETE Act (S. 537).

The second change would make it easier for small companies to carry net operating losses forward even as they continue to attract new investors. Small, research-intensive companies often go through several rounds of financing as they rack up expenses while getting nearer to their goal of profitability. Unfortunately, Section 382 of the tax code prevents companies from carrying net operating losses forward if they undergo an ownership change. This rule eliminates an attraction to investors. It also means that the company will start paying taxes on its revenue long before its total revenues exceed it total expenses. Under the proposed change, Section 382 would not apply to net operating losses generated by qualifying research and development activities conducted by a small business. The Ernst & Young analysis estimated that this change would increase direct investment in these companies by $4.9 billion and boost their employment by 25,000 jobs.[106]

Summary

Coming out of World War II the United States was the first country to make research and development a national priority. At the time the federal government accounted for over 50 percent of global R&D, public and private. Today, the federal government accounts for 8 percent of global R&D investment. While robust, U.S. federal investments in science represent a shrinking portion of technology development. In order for the United States to remain competitive, firms must find a country to be an attractive location to innovate. The incoming administration should use the tax system and other policy levers to ensure the United States remains the top destination of enterprise R&D.

Conclusion: The American economy in 2025 and beyond

There will be no shortage of pressing issues for the Trump administration to focus on in its first 100 days. But none will affect as many Americans for as long a period as stagnant economic growth. Indeed, the trajectory of the American economy in 2025 and beyond begins on January 1, 2017. Without a multi-decade turnaround of the U.S. economy, neither party will be able to achieve its other economic priorities. In the absence of consistent economic success, those on the left will find the social safety net overburdened and underfunded, while those on the right will find public coffers too diminished to lower taxes. At the same time, American families will continue to be squeezed.

The first step toward fixing America's economy is correctly diagnosing the problem. It is not automation or globalization. Rather, the United States has a productivity and innovation problem. Both are lacking, and that's problematic when productivity growth is the fundamental source of economic growth and when innovation drives productivity. Upon entering the White House, President Obama was faced with the 2008 financial crisis and was able to leverage the moment to pass the American Recovery and Reinvestment Act, investing $787 billion in the economy. Bold action will likewise be needed from the incoming Trump administration, and the policy proposals outlined here provide a template to maximize the levels of technology transfer, commercialization, and innovation that will drive America's economy robustly forward into the future.

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