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ITIF Comments Responding to Administration Request for Information Regarding Federal Technology Transfer Authorities and Processes

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The Information Technology and Innovation Foundation (ITIF) is a nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy and which has been recognized as the world's leading science and technology policy think tank. ITIF is pleased to provide feedback in response to the administration's call for comments related to technology transfer authorities and processes.

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. While the U.S. government should expand federal support for scientific research, it needs just as importantly to improve the efficiency of the process by which federally funded knowledge creation leads to U.S. innovation and jobs.[2] In December 2016, in its report "Localizing the Economic Impact of Research and Development: Policy Proposals for the Trump Administration and Congress," ITIF released a comprehensive list of 50 policy recommendations the administration could undertake to bolster institutions supporting technology transfer, commercialization, and innovation; expand technology transfer and commercialization-related programs and investments; promote high-growth, tech-based entrepreneurship; stimulate private-sector innovation; and strengthen regional technology clusters.[3] That report provides an exhaustive suite of policy recommendations that can help bolster the return on investment from federally funded research. This submission contains many of those proposals yet also responds to the administration's specific requests for comment on particular issues identified in its RFI.

(a) Core federal technology transfer principles and practices that should be protected, and those which should be adapted or changed.

The federal government has played a long and foundational role in funding basic and applied scientific research that has produced tremendous commercial and social benefits for the United States. This role must persist. However, in the post World-War II era the U.S. science, technology, and innovation system pursued a "linear model" of innovation that pumped seemingly limitless funding for basic research into U.S. universities and government labs on the front-end with the expectation that industry virtually alone would conduct the applied and translational work needed to transform that basic research into technologies and products that could be commercialized (and manufactured at scale in the United States) on the back-end. That approach also viewed all scientific research as essentially equal and didn't prioritize scientific research funding based on its ability or likelihood to help support U.S. economic competitiveness, which was taken as a given. While this model worked for a time—when many fewer other nations had the technological capabilities to translate basic research into commercial products—it's ill-suited to today's intensely competitive global economy. Thus, **a new approach is needed to guide federally funded R&D and its impact on the U.S. innovation system, and it should focus on two key areas of importance: what research is funded and how that research is commercialized.**

The reason we need better policies to spur commercialization is that the prevailing linear innovation approach is ineffective and incomplete. The "universities perform only basic research while industry performs only applied research" paradigm is woefully outdated. The notion that the U.S. innovation system produces the biggest bang for the buck with universities and national laboratories solely performing basic research, and with industry solely primarily performing applied research, suffers from several shortcomings. First, U.S. basic research is a non-rivalrous global public good that other nations free ride upon by focusing on applied research.[4] Second, U.S. industry does not perform nearly enough applied research. In reality, U.S. enterprises have not only cut back on the growth of their research budgets but have also reallocated their research portfolios more toward product development efforts and away from longer-term and more-speculative basic and applied research. In fact, from 1991 to 2008, basic research as a share of corporate R&D conducted in the United States fell by 3.6 percent and applied research fell by roughly the same amount, 3.5 percent, while development's share increased by 7.1 percent.[5] Moreover, the belief that if all policy does is fund basic research that commercialization will naturally come out the other end of the pipeline assumes that there are no barriers or problems. Yet the reality is that the commercialization 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.

Furthermore, not all scientific research funding is created equal. The United States can simply no longer afford the post-war consensus that postulated a seemingly unlimited amount of money to fund basic science, especially when much of the rest of the world free rides off of it. It's time to recognize that certain research programs are much more important to our country's economic well-being and competitiveness than others, and that policy should favor research in the fields of science most likely to produce direct economic and industrial benefits for the United States. In particular, **the United States should increase research investments in math and the physical sciences, engineering, computer and information sciences, and biological sciences. That's because certain research programs are much more important to our country's economic well-being and competitiveness than others.** In particular, Congress should direct, and the administration should implement, a reallocation of National Science Foundation (NSF) resources toward the kinds of science that have direct economic and industrial benefits for the United States. In particular, this means increasing NSF budgets for four key directorates: 1) math and physical sciences; 2) engineering; 3) computer and information sciences and engineering (CISE); and 4) biological sciences, while permitting research budgets for the geosciences and social sciences to shrink.

With regard to how research is commercialized, the key insight is that successful commercialization is not a secret; we know what works and what doesn't. The challenge is not developing best practices. Any university or federal lab that seeks to attain global best practice for technology commercialization can do so. There are plenty of comprehensive guides out there, such as the fantastic book *Innovation U 2.0: Reinventing University Roles in a Knowledge Economy.*[6] The challenge is ensuring that all organizations, and particularly national laboratories and other federally funded research centers, have the motivation and incentive to do better. That should be the key focus of federal technology transfer reform efforts.

ITIF's following recommendations will be offered with the above two principles in mind. However, one principle that should not change is recognition that the broad partnership between the federal government and America's higher education system to create the modern research university has been one of the most significant catalysts of U.S. economic growth over the past half century, particularly through government funding of research conducted in U.S. higher-education institutions (in addition to that supporting federal laboratories).[7]

But this funding can be of little relevance to the domestic innovation ecosystem if the resulting knowledge is not transferred out to domestic entrepreneurs and companies. In other words, obtaining the full benefits of federally funded research relies on the effective transfer of knowledge from universities (and national laboratories) to the private sector so that it can be developed into marketable innovations. Here, the 1980 Bayh-Dole Act, which gave universities rights to intellectual property (IP) generated from federal funding, spurred many more universities to work more with industry and so created a vehicle for leveraging U.S. investment in basic research into a far stronger engine for commercialization. Allowing U.S. institutions to earn royalties through the licensing of their research has provided a strong incentive for universities and other institutions to pursue commercialization opportunities.[8] Indeed, before the passage of Bayh-Dole in 1980, only a small handful of universities even had technology transfer or patent offices.[9] The Bayh-Dole Act has been widely praised as a significant factor contributing to the United States' "competitive revival" in the 1990s.[10] *The Economist* called it "possibly the most inspired piece of legislation to be enacted in America over the past half-century. It unlocked all the inventions and discoveries that had been made in American laboratories throughout the United States with the help of taxpayers' money."[11] Countries throughout the world—including Brazil, China, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, South Africa, Taiwan, and many others—have since followed the United States in establishing policies that grant their universities IP ownership rights.[12] Kazakhstan and Zimbabwe are currently looking at implementing Bayh-Dole-like legislation, recognizing its power to help turn universities into engines of innovation and commercialization in their nations. These countries have done so because they recognize that Bayh-Dole works.

Indeed, the Bayh-Dole Act almost immediately led to an increase in academic patenting activity. For instance, in 1980, only 390 patents were awarded to universities; but, by 2009, that number had increased 100-fold to 3,088. By 2015, 6,680 such patents were issued. Over 80,000 U.S. patents have been issued to academic research institutions over the past 25 years.[13] In fact, university research is about five times more likely to result in a licensed patented technology and about seven times more likely to result in an active patent license than research conducted at federal laboratories.[14] According to a report prepared for the Association of University Technology Managers (AUTM), "The Economic Contribution of University/Nonprofit Inventions in the United States: 1996-2015," from 1996 to 2015 academic patents and their subsequent licensing to industry— no doubt substantially stimulated by the Bayh-Dole Act—bolstered U.S. industry gross output by up to $1.33 trillion, U.S. GDP by up to $591 billion, and supported up to 4,272,000 person years of employment.[15] AUTM's 2016 Annual Survey again revealed what a significant force academic technology transfer is in driving economic development. It found that the number of invention disclosures has been on the rise over the past five years, growing to 25,825 in 2016, and that 16,487 new U.S. patent applications were filed that year, a gain of 3 percent over 2015, with 7,021 U.S. patents issued, a 5 percent increase over 2015. Perhaps more importantly, it identified 1,024 new startups formed on the basis of academic research and or technology transfer in 2016.[16] In fact, every day of the year, the United States launches approximately three new start-up companies and two new products as a result of university inventions brought to market in part thanks to Bayh-Dole.[17]

The Bayh-Dole Act has been an unparalleled success, yet some have advocated for undermining some of its key provisions. At issue are so-called "march-in rights," a provision within the Bayh-Dole Act that permits the government, in specified circumstances, to require patent holders to grant a "nonexclusive, partially exclusive, or exclusive license."[18] Some have called on Congress to exert pressure on the National Institutes of Health (NIH) to exploit march-in rights to "control" allegedly high drug prices. At least six petitions have been filed requesting that the NIH "march in" with respect to a particular pharmaceutical drug.[19]

Yet, as even Senator Birch Bayh has himself noted, the Bayh-Dole's march-in rights were never intended to control or ensure "reasonable prices" (in fact, Bayh-Dole contains no definition thereof).[20] Rather, Bayh-Dole's march-in provision was designed as a fail-safe for limited instances in which a licensee might not be making good-faith efforts to bring an invention to market or when national emergencies required that more product is needed than a licensee is capable of producing. That's part of the reason why the NIH has denied all six petitions to apply march-in rights, with the agency noting that the drugs in question were in virtually all cases adequately supplied and moreover that concerns over drug pricing were not, by themselves, sufficient to provoke march-in rights.[21] March-in rights have never been exercised during the 38-year history of the Bayh-Dole Act.[22]

Yet such assaults on the private IP rights that Bayh-Dole enables are part and parcel the position of drug populists who, in their quest to shrink the for-profit drug discovery and development industry, have floated a variety of proposals to shift responsibility for drug development and discovery from the private to public sector. Such proposals have included having employers pay a medical research fee, which they would allocate to any research organization, including government; subjecting firms to compulsory licenses (where they must make patented discoveries available to other firms) but having the government pay patent holders directly to compensate them; having the government buy patents from firms through an auction; establishing government-funded corporations to develop and sell drugs; using prizes; and, finally, giving NIH the task outright.[23] For instance, Knowledge Ecology International, a leading drug-populist organization, has advocated eliminating drug patents and instead having the government issue prizes for drug development.[24] Dean Baker, an economist with the Center for Economic and Policy Research, has written, "We could expand the public funding going to NIH or other public institutions and extend their charge beyond basic research to include developing and testing drugs and medical equipment."[25]

Yet in their zeal to undermine Bayh-Dole and its provisions creating private IP rights stemming from federally funded research, advocates miss that not one single new drug was created from federally funded inventions under the previous (to Bayh-Dole) approach.[26] In contrast, there are over 200 new drugs and vaccines on the market worldwide today as a result of Bayh-Dole, compared to zero before.[27] Bayh-Dole has undoubtedly contributed to the explosion of bio-medical innovation over the past several decades, with 500 new medicines approved by the FDA since 2000 and over 7,000 new medicines now under development globally. Robust IP rights lie at the heart of America's world-leading life-sciences innovation system, as they provide companies with the certainity that they'll have the opportunity to recoup the significant investments they must make to transform early-stage discoveries made at universities (or other research institutions) into new medicines that pass a rigorous series of clinical trials. Private sector companies can invest hundreds of millions of dollars in developing drugs and conducting clinical trials to prove their clinical efficacy and safety. For instance, one study found that the cost to develop a new prescription medicine that gained marketing approval in 2013 was $2.6 billion (a 145 percent increase over 2003 costs), while estimated post-approval R&D costs of $312 million "boosts the full product life cycle cost per approved drug" to close to $3 billion.[28] These investments are often orders of magnitude larger than the original basic research which may have suggested a disease target or biomarker. In fact, one study found that that companies invest $100 in development for every $1 the government invests in research leading to an invention.[29] Weakening the certainty of access to IP rights provided under Bayh-Dole by employing march-in to address drug-pricing issues—especially if this meant a government agency could walk in and retroactively commandeer innovations that private-sector enterprises invested hundreds of millions, if not billions to create—would significantly harm medical discovery and innovation.[30] Put simply, policymakers should resist calls to misuse Bayh-Dole march-in provisions to subvert private IP rights to "control" drug prices, as even the law's architects agree. As Birch Bayh and Bob Dole wrote in *The Washington Post*, "Bayh-Dole did not intend that government set prices on resulting products. The law makes no reference to a reasonable price that should be dictated by the government."[31]

(b) Approaches to improve efficiency and reduce regulatory burdens for technology transfer to attract private sector investment in later-stage R&D, commercialization, and advanced manufacturing.

In a number of instances, publicly supported institutions that could contribute to greater levels of innovation and commercialization are underutilized. One way to increase technology transfer activity from the national labs, and to facilitate their deeper involvement with regional economies, would be by implementing performance-based, rather than rules-based, management approaches. In particular, the administration should allow Department of Energy (DOE) labs to engage in non-federal funding partnerships that do not require DOE headquarters approval (i.e., the so-called $1 million signature authority). Further, the administration should allow national labs to repurpose a small portion of existing funds (up to 5 percent) to fund timely regional collaborations.[32]

One way to increase the use of America's national R&D infrastructure would be through an "Open Innovation Infrastructure" initiative that 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 policy would remove many such barriers and broaden the use of publicly funded equipment, facilities, or infrastructure as an engine for innovation.

U.S. tax code and Revenue Procedure 97-14 places burdensome restrictions on the ability of universities to effectively engage companies. The procedure precludes companies sponsoring research projects from receiving preferential treatment in licensing. In effect, it requires universities to essentially stipulate that companies cannot own the IP arising from research they fund. It's a barrier unique to the United States and a major competitive disadvantage. Efforts were made in Revenue Procedure 2007-47 to mitigate the impact of these provisions, yet even these changes still largely preclude the ability of companies to readily obtain exclusive licenses for research that they fund in buildings financed with tax-exempt bonds.[33]

Essentially, Section 141 treats tax-exempt bonds issued by state and local governments as governmental bonds if the issuer limits private business use and other private involvement sufficiently to avoid treatment as "private-activity bonds." Bonds generally are classified as private-activity bonds under a two-part test if more than 10 percent of the bond proceeds are both: 1) used for private business use, and 2) payable or secured from property or payments derived from private business use.

Subsidiary restrictions further reduce the permitted thresholds of private involvement for governmental bonds in several ways. Section 141(b)(3) imposes a 5 percent unrelated or disproportionate private business use limit. Section 141(b)(4) imposes a $15 million cap on private business involvement for governmental output facilities (such as electric, gas, or other output generation, transmission, and distribution facilities, but excluding water facilities). Section 141(c) imposes a private loan limit equal to the lesser of 5 percent or $5 million of bond proceeds. Section 141(b)(5) requires a volume cap allocation for private business involvement that exceeds $15 million in larger transactions which otherwise comply with the general 10 percent private business limits.

The 10 percent private business limit generally represents a sufficient and workable threshold for governmental bond status. The volume cap requirement for private business involvement in excess of $15 million serves as a control on private business involvement in larger transactions. The particular subsidiary restriction which imposes a 5 percent limit on unrelated or disproportionate private business use introduces undue complexity, a narrow disqualification trigger, and attendant compliance burdens for state and local governments. The 5 percent unrelated or disproportionate private business use test requires difficult factual determinations regarding the relationship of private business use to governmental use in financed projects. This test is difficult to apply, particularly in governmental bond issues that finance multiple projects. Ideally, **the IRS would repeal the 5 percent unrelated or disproportionate private business use test under section 141(b)(3) to simplify the private business limits on tax-exempt governmental bonds.**

(c) New partnering models and technology transfer mechanisms with the private sector, academia, other federal agencies, state, and other public-sector entities to support technology development and maturation.

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. Federal policy should explicitly address this challenge.

In particular, the 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.[34] For instance, ITIF 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.[35] 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.[36] 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 administration should broaden beyond universities the number of institutions that are eligible for commercialization funds.** At the state and regional levels many organizations outside universities play a critical role in assisting faculty and students in the commercialization of research. Institutions such as 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.

As noted, America's institutions of higher education have been tremendous engines of innovation and economic dynamism. However, even more could be achieved. Indeed, despite the many strengths of America's university system, the reality is that competitor countries' governments and businesses invest more in university research funding than does the United States, on a per-capita basis. For instance, a recent ITIF study found that, of 39 nations, the United States ranked just 24th in government funding and 27th in business funding of university research as a share of GDP.[37] The leading seven nations in that study actually invested more than double the U.S. level of university research funding on a per-capita basis.

One reason the United States has fallen behind in business funding of university R&D is that other nations have designed more-innovative tax instruments to incentivize industry funding of university R&D. For instance, at least a dozen nations—including Belgium, Chile, Denmark, France, Hungary, Italy, Japan, the Netherlands, Norway, Spain, and the United Kingdom—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.[38] The United States actually 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 Trump administration should work with Congress to **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.**[39] 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.[40]

The U.S. innovation system could realize much more leverage from its network of Engineering Research Centers (ERCs) and Industry/University Cooperative Research Centers (I/UCRCs). Unfortunately, both programs are quite small, and the ERCs especially engage with industry only weakly and too often conduct academic research of limited relevance to industry.[41] There is good reason to look to bolster these programs' impact, for the ERC and I/UCRC programs represent some of the most impactful initiatives in the federal government. Current estimates show each dollar invested by I/UCRC generates $64.70 in economic impact.[42] Yet very few ERCs are truly engaged in engineering R&D and transitioning technologies to the marketplace as opposed to simply producing more journal papers. Both programs need considerably more funding, which should be focused on centers addressing advanced-manufacturing technology issues, which could be funded by transferring funds from other NSF programs to these. In addition, **the administration should require NSF to give much higher priority in allocating awards to the share of industry funding contributed. It should also advocate for a policy change that federal funding for all ERCs be matched at least 40 percent by industry by 2019.** ERCs failing to attract at least a 40 percent industry match within five years should lose their federal funding.

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. **The administration 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 based on criteria such as an 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."

Oak Ridge National Laboratory (ORNL) 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.[43] 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. It's important to note that MDFs are not the same thing as the Institutes of Manufacturing Innovation that form Manufacturing USA; 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. **The administration should create 15 additional manufacturing development facilities to bring to market the fruits of scientific and technical research discoveries made by federal laboratories run by agencies including Department of Defense (DOD), DOE, and other federal agencies.**

Another promising initiative that could foster greater technology transfer and innovation has been DOE Energy Efficiency and Renewable Energy's (EERE's) Small Business Voucher Pilot program, which has provided vouchers to 33 small business across 20 states working with nine national labs. One example has been that Tennessee and the Oak Ridge National Laboratory collaborated to launch "RevV," a $2.5 million manufacturing innovation program. The pilot program offers vouchers allowing Tennessee manufacturers access to the world-class researchers and facilities available at ORNL. **The administration should work with Congress to extend such vouchers across the entire federal lab system by authorizing $50 million that would be state-matched.**

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. Building on precedents at federal biomedical research agencies, the administration should launch a Department of Energy Foundation (DOEF), which could leverage the U.S. government's investments in energy R&D to attract further investment from the private sector to accelerate the maturation of clever ideas hatched at DOE overseen national labs.[44] 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.

(d) New approaches that will reduce or remove barriers, and enable accelerated technology transfer, with a focus on areas of strategic national importance.

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.[45] 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 lacking such firms out of the game.[46] 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.[47] 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.[48] 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.

(e) Better metrics and methods to evaluate the ROI outcomes and impacts arising from federal R&D investments.

One way the administration could incent more entrepreneurial activity from universities would be by establishing stronger university entrepreneurship metrics. This could be achieved in several ways. First, the United States could collect better data on faculty and student new business starts or spin-offs of new companies from universities as well as information on the extent of technology licensing and patenting. The administration could direct the National Science Foundation to develop a metric by which universities report this kind of information annually. NSF could use this data to reward universities that do a better job; for example, by awarding bonus points on research grant proposals for federally funded research applications from private investigators. Applicants from universities that do a great job of promoting entrepreneurial spinoffs/start-ups would be more likely to have their private investigator grants funded. In addition, the Department of Commerce should use data available through the ES-202 form (Unemployment Insurance Tax Records), which tracks how many employees an establishment has every quarter. The form could also be made to note the university that the founder of the organization attended, and then that information could be combined, anonymously, to find out which colleges and universities have graduates that are founding and running the most high-growth businesses.

Another way the administration could better collect ROI data is by **requiring federal research agencies to submit five years of data on their patents licensed and royalties received to the Office of Management and Budget as part of their annual budget requests.**[49] As Joe Allen notes, that data can be run through the methodology utilized in the report "The Economic Impact of University/Nonprofit Inventions in the United States: 1996-2013" to calculate how agencies' licensing activities contributed to GDP, jobs supported, new companies launched, etc.

Part of the challenge is that there's not a clear entity in the federal government charged with making such an analysis or even conducting the broader federal technology transfer enterprise. Accordingly, the 2013 White House Lab-to-Market Inter-Agency Summit called for **creating a high-level Office of Innovation and Federal Technology Partnerships.**[50] The mission of such an office would include, among other responsibilities: 1) leveraging cross-agency synergies and increasing efficiencies regarding agency R&D and commercialization; 2) strengthening public-private partnerships, promoting increased dialogue with the private sector on current and emerging markets and appropriate alignment with federal R&D; 3) creating innovative public-private partnership initiatives and investment vehicles to accelerate commercialization; and 4) assessing the value of innovation efforts and promote proven practices.[51]

(f) New approaches to motivate significantly increased technology transfer outcomes from the federal sector, universities, and research organizations.

Many countries seek to increase their R&D efficiency by using existing funding for scientific research to incent universities to focus more on technology commercialization. For example, in Sweden, 10 percent of regular research funds allocated by the national government to universities are now distributed using performance indicators. Half of these funds are allocated based on the amount of external funding the institutions have been able to attract, with the other half based on the quality of scientific articles published by each institution (as determined through bibliometric measures such as the number of citations).[52] Finland also has started to base its university budgets on performance—25 percent of the research and research training budgets of Finnish universities are based on "quality and efficacy," including the quality of scientific and international publications and the university's ability to attract research investment from businesses.[53] In other words, without increasing government budgets, these nations are using existing funds to provide a strong incentive for universities to become greater engines of national innovation. Federal research agencies, particularly NSF, should use indicators of university effectiveness of commercialization and industry-relevance to allocate research funding.

As many countries have done in their efforts to make universities more accountable for results, **the amount of industry-funded university research should be the first variable used to make allocation decisions.** This could be achieved by **requiring the inclusion of university performance in the evaluation of all NSF research grants.** Holding universities accountable matters because, as former-NIST senior economist Gregory Tassey wrote in "Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy," a country's R&D policy is based on three critical drivers: the amount of R&D, the composition of R&D, and the efficiency of R&D—in other words, the level of return from each dollar invested in R&D.[54] Raising R&D efficiency is increasingly important as research dollars become scarcer and as R&D cycle times shrink in an increasingly competitive global economy. As Tassey writes, "The increasingly diffuse distribution of R&D in high-tech supply chains also requires more cooperation among multiple industries, universities, and levels of government."[55] It's important to note that holding universities more accountable and increasing the extent of industry-university collaboration does not compromise academic integrity. Indeed, Dennis Gray at North Carolina State University has demonstrated that if industry-university research collaboration is structured right, there is no negative impact on academic freedom.[56]

Making technology transfer more of a priority in federally funded entities such as the national laboratories should be a higher priority. 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.[57] 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.[58]

New institutional approaches to promoting technology transfer from federally funded entities have borne fruit and should be expanded. For instance, the Lab-Embedded Entrepreneurship Program (LEEP) seeks to “spin-in” entrepreneurs to the U.S. national labs. There are currently three LEEPs—Cyclotron Road at Lawrence Berkeley, the Chain Reaction Innovations (CRI) program at Argonne National Laboratory, and the Innovation Crossroads program at Oak Ridge National Laboratory—with a fourth coming.[59] The LEEPs are helping to develop a new technology transition model of “inside-out” innovation, getting the labs to transition from a historical focus only on moving their own technologies outside the lab, to a new “outside-in” model that gives entrepreneurs access to the advanced technology, equipment, and know-how that the national labs possess. Cyclotron Road in particular has played 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.[60] Beyond external offices, microlabs can serve as funding gateways to align multiple public and private research dollars to meet industry needs.

As ITIF writes in “Think Like an Enterprise: Why Nations Need Comprehensive Productivity Strategies,” governments need to articulate national productivity policies that go beyond market conditions, factor conditions, and firm incentives for tool adoption. They need to focus on policies to transfer technologies and support innovations that boost productivity (e.g., R&D on robotics) and the widespread deployment of system tools (e.g., technology platforms). So part of the administration’s strategy should be to identify top commercial technology needs related to productivity and innovation and boosting federal R&D support for these areas, including through vehicles like the ERCs. Particular focus should be placed on platform technologies such as robotics, autonomous vehicles, advanced materials with longer functional lives, and platform digital technologies such as 5G, cognitive radio, and full-duplex transmission.

Finally, in the interest of motivating increased technology transfer outcomes from the federal sector, universities, and research organizations, **the government should require that applications for federally funded research include a summary one-pager on potential commercialization applications from the research.** While it’s understood that basic scientific research into physical phenomenon such as black holes will be less applicable, even the basic research done into bacterium eventually contributed to the development of CRISPR gene editing technology. So, especially for NSF departments such as engineering, computer and information science and engineering, and mathematical and physical sciences, a required component of the grant application should be disclosure of potential downstream commercialization opportunities that the research activity could ultimately inform.

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