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Industrial Competitiveness and Technological Advancement: Debate Over Government Policy

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Summary

There is ongoing interest in the pace of U.S. technological advancement due to its influence on U.S. economic growth, productivity, and international competitiveness. Because technology can contribute to economic growth and productivity increases, congressional attention has focused on how to augment private-sector technological development. Legislative activity over the past 30 or more years has created a policy for technology development, albeit an ad hoc one. Because of the lack of consensus on the scope and direction of a national policy, Congress has taken an incremental approach aimed at creating new mechanisms to facilitate technological advancement in particular areas and making changes and improvements as necessary.

Congressional action has mandated specific technology development programs and obligations in federal agencies. Many programs were created based upon what individual committees judged appropriate within the agencies over which they had authorization or appropriation responsibilities. However, there has been recent legislative activity directed at eliminating or significantly curtailing many of these federal efforts. Several programs have been terminated and the budgets for other initiatives have declined.

The proper role of the federal government in technology development and the competitiveness of U.S. industry continues to be a topic of congressional debate. Legislation affecting the research and development (R&D) environment has included both direct and indirect measures to facilitate technological innovation. In general, direct measures are those which involve budget outlays and the provision of services by government agencies. Indirect measures include financial incentives and legal changes (e.g., liability or regulatory reform; new antitrust arrangements). As the Congress develops its appropriation priorities, the manner by which the government encourages technological progress in the private sector again may be explored and/or redefined.

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Technology and Competitiveness

Technological advancement in U.S. industry often has been supported by congressional initiatives over the past 30 or more years. This approach has involved both direct measures that concern budget outlays and the provision of services by government agencies (such as the now terminated Advanced Technology Program (ATP) and the Technology Innovation Program (TIP), as well as the existing Manufacturing Extension Partnership (MEP) of the National Institute of Standards and Technology) and indirect measures that include financial incentives and legal changes. Many of these efforts, however, have been revisited over the past several congresses. Congressional legislation appears to have favored indirect strategies such as tax policies, intellectual property right protection, and antitrust laws to promote technological advancement and government support for basic research over direct federal funding for private sector technology commercialization initiatives.

Interest in technology development and industrial innovation increased as concern mounted over the economic strength of the nation and over competition from abroad. For the United States to be competitive in the world economy, U.S. companies must be able to engage in trade, retain market shares, and offer high quality products, processes, and services while the nation maintains economic growth and a high standard of living. Technological advancement is important because the commercialization of inventions provides economic benefits from the sale of new products or services; from new ways to provide a service; or from new processes that increase productivity and efficiency. It is widely accepted that technological progress is responsible for up to one-half the growth of the U.S. economy, and is one principal driving force in long-term growth and increases in living standards.

Technological advances can further economic growth because they contribute to the creation of new goods, new services, new jobs, and new capital. The application of technology can improve productivity and the quality of products. It can expand the range of services that can be offered as well as extend the geographic distribution of these services. The development and use of technology also plays a major role in determining patterns of international trade by affecting the comparative advantages of industrial sectors. Since technological progress is not necessarily determined by economic conditions—it also can be influenced by advances in science, the organization and management of firms, government activity, or serendipity—it can have effects on trade independent of shifts in macroeconomic factors. New technologies also can help compensate for possible disadvantages in the cost of capital and labor faced by firms.

The Federal Role in Technology Development

American companies have faced increased competitive pressures in the international marketplace from firms based in countries where governments actively promote commercial technological development and application. In the United States, the generation of technology for the commercial marketplace is primarily a private sector activity. The federal government traditionally becomes involved only for certain limited purposes. Typically these are activities which have been determined to be necessary for the "national good" but which cannot, or will not, be supported by industry.

To date, the U.S. government has funded research and development (R&D) to meet the mission requirements of the federal departments and agencies. It also finances efforts in areas where there is an identified need for research, primarily basic research, not being performed in the private sector. Federal support reflects a consensus that basic research is critical because it is the foundation for many new innovations. However, any returns created by this activity are generally long term, sometimes not marketable, and not always evident. Yet the rate of return to society as a whole generated by investments in research is significantly larger than the benefits that can be captured by the firm doing the work.[1]

Many past government activities to increase basic research were based on a "linear" model of innovation. This theory viewed technological advancement as a series of sequential steps starting with idea origination and moving through basic research, applied research, development, commercialization, and diffusion into the economy. Increases in federal funds in the basic research stage were expected to result in concomitant increases in new products and processes. However, this linear concept is no longer considered valid. Innovations often occur that do not require basic or applied research or development; in fact many innovations are incremental improvements to existing products or processes. In certain areas, such as biotechnology, the distinctions between basic research and commercialization are small and shrinking. In others, the differentiation between basic and applied research is artificial. The critical factor is the *commercialization* of the technology. Economic benefits accrue only when a technology or technique is brought to the marketplace where it can be sold to generate income or applied to increase productivity. Yet, while the United States has a strong basic research enterprise, foreign firms appear equally, if not more, adept at taking the results of these scientific efforts and making commercially viable products. Often U.S. companies are competing in the global marketplace against goods and services developed by foreign industries from research performed in the United States. Thus, there has been increased congressional interest in mechanisms to accelerate the development and commercialization processes in the private sector.

The development of a governmental effort to facilitate technological advance has been particularly difficult because of the absence of a consensus on the need for an articulated policy. Technology demonstration and commercialization have traditionally been considered private sector functions in the United States. While over the years there have been various programs and policies to facilitate such activities (such as tax credits, technology transfer to industry, and patents), the approach had been ad hoc and uncoordinated. Many of the programs implemented were based upon what individual committees judged appropriate for the agencies over which they have jurisdiction. Despite the importance of technology to the economy, technology-related considerations often have not been integrated into economic decisions.

There have been attempts to provide a central focus for governmental activity in technology matters. P.L. 100-519 created within the Department of Commerce a Technology Administration headed by a new Under Secretary for Technology. However, this office was abolished as of the end of FY2007 by the America Competes Act. To date, technological issues and responsibilities remain shared among many departments and agencies. This diffused focus has sometimes resulted in actions which, if not at cross purposes, may not have accounted for the impact of policies or practices in one area on other parts of the process. Technology issues involve

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[1] Edwin Mansfield, "Social Returns From R&D: Findings, Methods, and Limitations," *Research/Technology Management*, November-December 1991, 24. See also Charles I. Jones and John C. Williams, "Measuring the Social Return to R&D," *Quarterly Journal of Economics*, November 1998, 1119 and Richard R. Nelson and Paul M. Romer, "Science, Economic Growth, and Public Policy," in Bruce R. Smith and Claude E. Barfield, eds. *Technology, R&D, and the Economy*, (Washington, The Brookings Institution and the American Enterprise Institute, Washington, 1996), 57.

components which operate both separately and in concert. While a diffused approach can offer varied responses to varied issues, the importance of interrelationships may be underestimated and their usefulness may suffer.

Several times, Congress has examined the idea of an industrial policy to develop a coordinated approach on issues of economic growth and industrial competitiveness. Technological advance is both one aspect of this and an altogether separate consideration. In looking at the development of an identified policy for industrial competitiveness, advocates argue that such an effort could ameliorate much of the uncertainty with which the private sector perceives future government actions. Some commentators maintain that consideration and delineation of national objectives could encourage industry to engage in more long-term planning with regard to R&D and to make decisions as to the best allocation of resources. Such a technology policy could generate greater consistency in government activities. Because technological development involves numerous risks, efforts to minimize uncertainty regarding federal programs and policies may help alleviate some of the disincentives perceived by industry.

The development of a technology policy, however, is a contentious issue. There is widespread resistance to what could be and has been called national planning, due variously to doubts as to its efficacy, to fear of adverse effects on our market system, to political beliefs about government intervention in our economic system, and to the current emphasis on short-term returns in both the political and economic arenas. Opponents of a national industrial policy may see this approach as government interference in the marketplace to "pick winners and losers." Instead, it is argued, measures that would occasion a better investment environment for industry to expand innovation-related efforts would be preferable to government decisionmaking in technological advancement.

Consideration of what constitutes government policy (both in terms of the industrial policy and technology policy) covers a broad range of ideas from laissez-faire to special government incentives to target specific high-technology, high-growth industries. Suggestions have been made for the creation of federal mechanisms to identify and support strategic industries and technologies. Various federal agencies and private sector groups have developed critical technology lists. However, others maintain that such targeting is an unwanted, and unwarranted, interference in the private sector which will cause unnecessary dislocations in the marketplace or a misallocation of resources. From their perspective, the government does not have the knowledge or expertise to make business-related decisions. Instead, they argue, the appropriate role for government is to encourage innovative activities in all industries and to keep market related decisionmaking within the business community that has ultimate responsibility for commercialization and where such decisions have traditionally been made.

The relationship between government and industry often is a major factor affecting innovation and the environment within which technological development takes place. This relationship can be adversarial, with the government acting to regulate or restrain the business community, rather than to facilitate its positive contributions to the nation. However, this may be changing as the benefits of industry/government cooperation become more apparent. There are an increasing number of areas where the traditional distinctions between public and private sector functions and responsibilities are becoming blurred. Many assumptions have been questioned, particularly in light of the increased internationalization of the U.S. economy. The business sector is no longer viewed in an exclusively domestic context; the economy of the United States is often tied to the economies of other nations. The technological superiority long held by the United States in many areas has been challenged by other industrialized countries in which economic, social, and political policies and practices foster government-industry cooperation in technological development.

The approach taken by the former Clinton Administration was a divergence from the past. Articulated in two reports issued in February 1993 (*A Vision of Change for America and Technology for America's Economic Growth, A New Direction to Build Economic Strength*),[2] the proposal called for a national commitment to, and a strategy for, technological advancement as part of a defined national economic policy. This detailed strategy offered a policy agenda for economic growth in the United States, of which technological development and industrial competitiveness were critical components.

The approach initially recommended and subsequently followed by the Clinton Administration provided a wide range of options while for the most part reflecting then current trends in congressional efforts to facilitate industrial advancement. This policy, backed by congressional legislation, increased federal coordination and augmented direct government spending for technological development. While many past activities focused primarily on research, the new initiatives shifted the emphasis toward *development* of new products, processes, and services by the private sector for the commercial marketplace. In addition, a significant number of the proposals aimed to increase both government and private sector support for R&D leading to the commercialization of technology.

Recent congresses and the Bush Administration questioned this approach. Instead, policies appeared more supportive of indirect strategies such as tax incentives, intellectual property protection, and antitrust laws to promote technology advancement, increased government support for basic research, and decreased direct federal funding for private sector technology activities. In the 2006 State of the Union Address, former President Bush announced the "American Competitiveness Initiative" to facilitate innovation and provide "our nation's children a firm grounding in math and science." To achieve these goals, the President called for doubling over the next 10 years the amount of federal funding for basic research, particularly in the National Science Foundation, the Office of Science in the Department of Energy, and in the core programs of the National Institute of Standards and Technology, Department of Commerce. In addition, the Initiative would increase the number of math and science teachers and make permanent the research and experiment tax credit.

In April 2009, President Obama indicated his decision to double the budget of the key science agencies, as identified by former President Bush, over the next 10 years. In President Obama's FY2011 budget the timeframe for doubling slipped to 11 years; his FY2012 budget was intentionally silent on a timeframe for doubling. In a speech before the National Academy of Sciences, President Obama put forth a goal of increasing the national investment in R&D to more than 3% of the U.S. gross domestic product (GDP), but did not provide details on how this goal might be achieved.

Despite the continuing debate on what is the appropriate role of government and what constitutes a suitable government technology development policy, it remains an undisputed fact that what the government does or does not do affects the private sector and the marketplace. The various rules, regulations, and other activities of the government have become de facto policy as they relate to, and affect, innovation and technological advancement.

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[2] Available from author.

Legislative Initiatives and Current Programs

Legislative initiatives have reflected a trend toward expanding the government's role beyond traditional funding of mission-oriented R&D and basic research toward the facilitation of technological advancement to meet other critical national needs, including the economic growth that flows from new commercialization and use of technologies and techniques in the private sector. An overview of congressional legislation shows federal efforts aimed at (1) encouraging industry to spend more on R&D; (2) assisting small high-technology businesses; (3) promoting joint research activities between companies; (4) fostering cooperative work between industry and universities; (5) facilitating the transfer of technology from the federal laboratories to the private sector; and (6) providing incentives for quality improvements. These initiatives tend toward removing barriers to technology development in the private sector (thereby permitting market forces to operate) and providing incentives to encourage increased private sector R&D activities. While most focus primarily on research, some also involve policies and programs associated with technology development and commercialization.

Increased R&D Spending

To foster research in the private sector, Congress created a temporary tax credit for incremental increases in qualified research spending. The 1981 Economic Recovery Tax Act (P.L. 97-34) provided a 25% tax credit for the increase in a firm's qualified research costs above the average expenditures for the previous three tax years. Qualified costs included in-house expenditures such as wages for researchers, material costs, and payments for use of equipment; 65% of corporate grants towards basic research at universities and other relevant institutions; and 65% of payments for contract research. The credit applied to research expenditures through 1985. While never made permanent, the Research and Experimentation Tax Credit has been extended many times. Several changes have been made to the rate and to the definition of qualified expenses. Most recently, the credit expired at the end of calendar year 2011.[3]

In 1982, the Small Business Development Act (P.L. 97-219) established Small Business Innovation Research (SBIR) programs within the major federal R&D agencies designed to increase participation of small, innovative companies in federally funded research and development.[4] Extended several times, the program requires that a set percentage of each agency's applicable extramural R&D budget is to be used to support mission-related work in small companies. Funding is, in part, dependent on companies obtaining private sector support for the commercialization of the resulting products or processes. The program had been reauthorized through September 30, 2017. Based on the success of the SBIR initiative, a pilot effort, the Small Business Technology Transfer (STTR) program, was created in 1992 to encourage firms to work with universities or federal laboratories to commercialize the results of basic research performed within these institutions. Also funded by a set-aside, the STTR program has been reauthorized several times and is currently scheduled to sunset on September 30, 2017.

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[3] CRS Report RL31181, *Research Tax Credit: Current Law, Legislation in the 112th Congress, and Policy Issues*, by Gary Guenther.

[4] See CRS Report 96-402, *Small Business Innovation Research (SBIR) Program*, by Wendy H. Schacht, and CRS Report RS22865, *The Small Business Innovation Research (SBIR) Program: Reauthorization Efforts*, by Wendy H. Schacht.

The Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418) created the Advanced Technology Program (ATP) at the Department of Commerce's National Institute of Standards and Technology (NIST).[5] ATP provided seed funding, matched by private sector investment, for companies or consortia of universities, industries, and/or government laboratories to accelerate development of generic technologies with broad application across industries. The first awards were made in 1991. As of the end of 2007, when ATP was terminated and replaced by the Technology Innovation Program, 824 projects had been funded representing approximately $1.6 billion in federal dollars matched by $1.5 billion in private sector financing. About 68% of the awardees were small businesses or cooperative efforts led by such firms; 227 projects were joint ventures.[6]

The Technology Innovation Program was created by P.L. 110-69, the America COMPETES Act.[7] Until funding for the program ended in FY2012, TIP was similar to ATP in the intent to promote high-risk R&D that would be of broad-based economic benefit to the nation. However, there were several differences in the operation of the new activity. Awards under TIP were limited to small and medium-sized businesses whereas grants under ATP were available to companies regardless of size. In addition, in the Advanced Technology Program, joint ventures were required to include two separately owned for-profit firms and could include universities, government laboratories, and other research establishments as participants in the project but not as recipients of the grant. In the TIP initiative, a joint venture could involve two separately owned for-profit companies but could also have been comprised of one small or medium-sized firm and a university (or other non-profit research organization). A single company could receive up to $2 million for up to three years under ATP; under TIP, the participating company (which must be a small or medium-sized business) could have received up to $3 million for up to three years. In ATP, small and medium-sized companies were not required to cost share (large firms provided 60% of the total cost of the project), while in TIP there was a 50% cost sharing requirement which, again, only applied to the small and medium-sized businesses that are eligible. There were no funding limits for the five-year funding available for joint ventures under ATP; the TIP limited joint venture funding to $9 million for up to five years. The Advisory Board that was created to assist in the Advanced Technology Program included industry representatives as well as federal government personnel and representatives from other research organizations. The Advisory Board for the Technology Innovation Program was comprised of only private sector members.

In January 2009, nine awards were announced for "new research projects to develop advanced sensing technologies that would enable timely and detailed monitoring and inspection of the structural health of bridges, roadways and water systems that comprise a significant component of the nation's public infrastructure." According to TIP, $42.5 million in federal money was expected to be matched by $45.7 million in private sector support. Twenty more awards were announced in December 2009 totaling almost $71.0 million in NIST financing with approximately $145.7 million in funding from other sources. Of the projects selected for the two solicitations, thirteen were in the area of monitoring and inspection of civil infrastructure; four were in the area of advanced repair of civil infrastructure; eleven were in the area of process scale up for advanced materials; and one was in the area of predictive modeling for advanced materials. Nine additional projects in various areas including biopharmaceuticals, electronics,

[5] See CRS Report 95-36, *The Advanced Technology Program*, by Wendy H. Schacht.

[6] National Institute of Standards and Technology, "Historical Statistics on ATP Awards/Winners," available at http://www.atp.nist.gov/eao/statisticshtm.

[7] See CRS Report RS22815, *The Technology Innovation Program*, by Wendy H. Schacht.

nanotechnology, renewable energy, and energy sources received awards of more than $22 million in December 2010. Federal funding for these projects was expected to be matched by approximately $24 million in private sector support.[8]

According to NIST, no new TIP awards were made in FY2011. The $44.8 million appropriated for the program in P.L. 112-10 was used for the continued support of ongoing TIP and ATP projects.[9] No FY2012 funds were appropriated for TIP.

Industry-University Cooperative Efforts

The promotion of cooperative efforts among academia and industry is aimed at increasing the potential for the commercialization of technology.[10] Traditionally, basic research has been performed in universities or in the federal laboratory system while the business community focuses on the manufacture or provision of products, processes, or services. Universities are especially suited to undertake basic research. Their mission is to educate and basic research is an integral part of the educational process. Universities generally are able to perform these activities because they do not have to produce goods for the marketplace and therefore can do research not necessarily tied to the development of a commercial product or process.

Subsequent to World War II, the federal government supplanted industry as the primary source of funding for basic research in universities. It also became the principal determinant of the type and direction of the research performed in academia. This resulted in a disconnect between the university and industrial communities. The separation and isolation of the parties involved in the innovation process is thought by many observers to be a barrier to technological progress. The difficulties in moving an idea from the concept stage to a commercial product or process may be compounded when several entities are involved. Legislation to stimulate cooperative efforts among those involved in technology development has been viewed as one way to promote innovation and facilitate the international competitiveness of U.S. industry.

Several laws have attempted to encourage industry-university cooperation. Title II of the Economic Recovery Tax Act of 1981 (P.L. 97-34) provided, in part, a 25% tax credit for 65% of all company payments to universities for the performance of basic research.[11] Firms were also permitted a larger tax deduction for charitable contributions of equipment used in scientific research at academic institutions. The Tax Reform Act of 1986 (P.L. 99-514) kept this latter provision, but reduced the credit for university basic research to 20% of all corporate expenditures for this over the sum of a fixed research floor plus any decrease in non-research giving.

The 1981 act also provided an increased charitable deduction for donations of new equipment by a manufacturer to an institution of higher education. This equipment must be used for research or

[8] National Institute of Standards and Technology, "NIST Announces $22 Million in Funding for Advanced Manufacturing Research in Electronics, Biotechnology and Nanotechnology," December 15, 2010, available at http://www.nist.gov/tip/tip_121510.cfm.

[9] See http://www.nist.gov/tip/.

[10] For more information see CRS Report RL33526, *Cooperative R&D: Federal Efforts to Promote Industrial Competitiveness*, by Wendy H. Schacht.

[11] See CRS Report RL31181, *Research Tax Credit: Current Law, Legislation in the 112th Congress, and Policy Issues*, by Gary Guenther.

research training for physical or biological sciences within the United States. The tax deduction is equal to the manufacturer's cost plus one-half the difference between the manufacturer's cost and the market value, as long as it does not exceed twice the cost basis. Extended numerous times, with certain changes, the research and experimentation tax credit expired at the end of calendar year 2011.

An additional legislative initiative to foster interaction between academia and the business community is contained in amendments to the patent and trademark laws, commonly referred to as the "Bayh-Dole Act."[12] This law is intended to use patent ownership as an incentive for private sector development and commercialization of federally supported R&D. Title to inventions made by contractors receiving federal research funds is to be vested in the contractor if they are small businesses, universities, or not-for-profit institutions. Certain rights to the patent are reserved for the government and these organizations are required to commercialize within a predetermined and agreed upon time frame. Providing universities with patent title is expected to encourage licensing to industry where the technology can be manufactured or used thereby creating a financial return to the academic institution. University patent applications and licensing have increased significantly since this law was enacted.

Subsequently, the CREATE Act, P.L. 108-453, made changes in the patent laws to further promote cooperative research and development among universities, government, and the private sector. The bill amends Section 103(c) of title 25, United States Code, such that certain actions between researchers under a joint research agreement will not preclude patentability.[13]

Joint Industrial Research

Private sector investments in basic research are often costly, long term, and risky. Although not all advances in technology are the result of research, it is often the foundation of important new innovations. To encourage increased industrial involvement in research, legislation was enacted to allow for joint ventures in this arena. It is argued that cooperative research reduces risks and costs and allows for work to be performed that crosses traditional boundaries of expertise and experience. Such collaborative efforts make use of existing and support the development of new resources, facilities, knowledge, and skills.

The National Cooperative Research Act (P.L. 98-462) encourages companies to undertake joint research. The legislation clarifies the antitrust laws and requires that a "rule of reason" standard be applied in determinations of violations of these laws; cooperative research ventures are not to be judged illegal "per se." It eliminates treble damage awards for those research ventures found in violation of the antitrust laws if prior disclosure (as defined in the law) has been made. P.L. 98-462 also makes changes in the way attorney fees are awarded. Defendants can collect attorney fees in specified circumstances, including when the claim is judged frivolous, unreasonable, without foundation, or made in bad faith. However, the attorney fee award to the prevailing party may be offset if the court decides that the prevailing party conducted a portion of the litigation in a manner which was frivolous, unreasonable, without foundation, or in bad faith. These

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[12] See CRS Report RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, by Wendy H. Schacht and CRS Report RL30320, *Patent Ownership and Federal Research and Development (R&D): A Discussion on the Bayh-Dole Act and the Stevenson-Wydler Act*, by Wendy H. Schacht.

[13] See CRS Report RS21882, *Collaborative R&D and the Cooperative Research and Technology Enhancement (CREATE) Act*, by Wendy H. Schacht.

provisions were included to discourage frivolous litigation against joint research ventures without simultaneously discouraging suits of plaintiffs with valid claims. Between 1985 (when the law went into effect) and August 2009, 1,343 joint ventures have filed with the Justice Department.[14]

P.L. 103-42, the National Cooperative Production Amendments Act of 1993, amended the National Cooperative Research Act by, among other things, extending the original law's provisions to joint manufacturing ventures. These provisions are only applicable, however, to cooperative production when (1) the principal manufacturing facilities are "located in the United States or its territories, and (2) each person who controls any party to such venture ... is a United States person, or a foreign person from a country whose law accords antitrust treatment no less favorable to United States persons than to such country's domestic persons with respect to participation in joint ventures for production."

Commercialization of the Results of Federally Funded R&D

Another approach to encouraging the commercialization of technology involves the transfer of technology from federal laboratories and contractors to the private sector where commercialization can proceed. Because the federal laboratory system has extensive science and technology resources and expertise developed in pursuit of mission responsibilities, it is a potential source of new ideas and knowledge which may be used in the business community.[15]

At the time legislation relating to technology transfer was considered by Congress in the late 1970s, the commercialization level of the results of federally funded R&D remained low despite the potential offered by the resources of the federal laboratory system. Studies indicated that only approximately 10% of federally owned patents were ever utilized. There were many reasons for this low level of usage, one of which is the fact that some technologies and/or patents have no market application. However, industry unfamiliarity with these technologies, the "not-invented-here" syndrome, and perhaps more significantly, the ambiguities associated with obtaining title to or exclusive license to federally owned patents also contribute to the low level of commercialization.

Over the years, several governmental efforts have been undertaken to augment industry's awareness of federal R&D resources. The Federal Laboratory Consortium for Technology Transfer was created in 1972 (from a Department of Defense program) to assist in moving technology from the federal government to state and local governments and the private sector. To expand on the work of the Federal Laboratory Consortium, and to provide added emphasis on the commercialization of government technology, Congress passed P.L. 96-480, the Stevenson-Wydler Technology Innovation Act of 1980. Prior to this law, technology transfer was not an explicit mandate of the federal departments and agencies with the exception of the National Aeronautics and Space Administration. To provide "legitimacy" to the numerous technology activities of the government, Congress, with strong bipartisan support, enacted P.L. 96-480 which explicitly states that the federal government has the responsibility, "to ensure the full use of the results of the nation's federal investment in research and development." Section 11 of the law

[14] Dean V. Williamson, How do Research Joint Ventures Exploit Government R&D Program?: Evidence from the National Cooperative Research Act, the Advanced Technology Program, and the Department of Defense, Preliminary study, June 2010, 6, available at http://extranet.isnie.org/uploads/isnie2010/williamson.pdf.

[15] See CRS Report RL33527, *Technology Transfer: Use of Federally Funded Research and Development*, by Wendy H. Schacht.

created a system within the federal government to identify and disseminate information and expertise on what technologies or techniques are available for transfer. Offices of Research and Technology Applications were established in each federal laboratory to distinguish technologies and ideas with potential applications in other settings.

Several amendments to the Stevenson-Wydler Technology Innovation Act have been enacted to provide additional incentives for the commercialization of technology. P.L. 99-502, the Federal Technology Transfer Act, authorizes activities designed to encourage industry, universities, and federal laboratories to work cooperatively. It also establishes incentives for federal laboratory employees to promote the commercialization of the results of federally funded research and development. The law amends P.L. 96-480 to allow government-owned, government-operated laboratories to enter into cooperative R&D agreements (CRADAs) with universities and the private sector. This authority is extended to government-owned, contractor-operated laboratories by the Department of Defense FY1990 Authorization Act, P.L. 101-189.[16] Companies, regardless of size, may be allowed to retain title to inventions resulting from research performed under cooperative agreements. The federal government retains a royalty-free license to use these patents. The Technology Transfer Improvements and Advancement Act (P.L. 104-113), clarifies the dispensation of intellectual property rights under CRADAs to facilitate the implementation of these cooperative efforts. The Federal Laboratory Consortium is given a legislative mandate to assist in the coordination of technology transfer. To further promote the use of the results of federal R&D, certain agencies are mandated to create a cash awards program and a royalty sharing activity for federal scientists, engineers, and technicians in recognition of efforts toward commercialization of this federally developed technology. These efforts are facilitated by a provision of the National Defense Authorization Act for FY1991 (P.L. 101-510), which amends the Stevenson-Wydler Technology Innovation Act to allow government agencies and laboratories to develop partnership intermediary programs to augment the transfer of laboratory technology to the small business sector.

Amendments to the Patent and Trademark law contained in Title V of P.L. 98-620 made changes which are designed to improve the transfer of technology from the federal laboratories—especially those operated by contractors—to the private sector and increase the chances of successful commercialization of these technologies. This law permits the contractor at government-owned, contractor-operated laboratories (GOCOs) to make decisions at the laboratory level as to the granting of licenses for subject inventions. This increased the potential for effecting greater interaction between laboratories and industry in the transfer of technology. Royalties on these inventions are also permitted to go back to the laboratory contractor to be used for additional R&D, awards to individual laboratory inventors, or education. While there is a cap on the amount of the royalty returning directly to the lab in order not to disrupt the agency's mission requirements and congressionally mandated R&D agenda, the establishment of discretionary funds gives contractor-operated laboratories added incentive to encourage technology transfer.

Under P.L. 98-620, private companies, regardless of size, are allowed to obtain exclusive licenses for the life of the patent. Prior restrictions allowed large firms use of exclusive license for only 5 of the 17 years (now 20 years) of the life of the patent. This was expected to encourage improved technology transfer from the federal laboratories or the universities (in the case of university operated GOCOs) to large corporations which often have the resources necessary for

[16] See CRS Report 95-150, *Cooperative Research and Development Agreements (CRADAs)*, by Wendy H. Schacht.

development and commercialization activities. In addition, the law permits GOCOs (those operated by universities or nonprofit institutions) to retain title to inventions made in the laboratory within certain defined limitations. Those laboratories operated by large companies are not included in this provision.

P.L. 106-404, the Technology Transfer Commercialization Act, altered practices concerning patents held by the government to make it easier for federal agencies to license such inventions. The law amends the Stevenson-Wydler Technology Innovation Act and the Bayh-Dole Act to decrease the time delays associated with obtaining an exclusive or partially exclusive license. Previously, agencies were required to publicize the availability of technologies for three months using the *Federal Register* and then provide an additional 60 day notice of intent to license by an interested company. Under this legislation, the time period was shortened to 15 days in recognition of the ability of the internet to offer widespread notification and the necessity of time constraints faced by industry in commercialization activities. Certain rights are retained by the government. The bill also allows licenses for existing government-owned inventions to be included in CRADAs.

The Omnibus Trade and Competitiveness Act created a program of regional centers to assist small manufacturing companies use knowledge and technologies developed in the government research establishment.[17] Federal funding for the centers is matched by non-federal sources including state and local governments and industry. Originally, seven Regional Centers for the Transfer of Manufacturing Technology were selected. The initial program was expanded in 1994 to create the Manufacturing Extension Partnership (MEP) to meet new and growing needs of the community. In a more varied approach, the Partnership involves both large centers and smaller, more dispersed affiliated organizations. Centers now operate in all 50 states and Puerto Rico. Since the manufacturing extension activity was created in 1989, awards made by NIST have resulted in the creation of approximately 400 regional offices. [It should be noted that the Department of Defense also funded 36 centers through its Technology Reinvestment Project (TRP) in FY1994 and FY1995. When the TRP was terminated, NIST took over support for 20 of these programs in FY1996 and funded the remaining efforts during FY1997.]

A new NIST program of partnerships between industry and other educational or research institutions to develop new manufacturing processes, techniques, or materials was authorized (but not funded) by the American COMPETES Act. In addition, the COMPETES Act authorized a manufacturing fellowship program with stipends available for post-doctoral work at NIST that has not been instituted to date.

In October 2010, NIST announced the award of $9.1 million in cooperative agreements for 22 projects "designed to enhance the productivity, technological performance and global competitiveness of U.S. manufacturers."[18] The funding was granted on a competitive basis to non-profit organizations that will work with the MEP centers and address one or more of the areas that have been identified by NIST as critical to U.S. manufacturing. These activities differ from the established MEP effort in which no new manufacturing research is conducted and funded as existing manufacturing technology is applied to the needs of small and medium-sized firms.

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[17] See CRS Report 97-104, *Manufacturing Extension Partnership Program: An Overview*, by Wendy H. Schacht.

[18] National Institute of Standards and Technology, NIST Manufacturing Extension Partnership Awards $9.1 Million for 22 Projects to Enhance U.S. Manufacturers' Global Competitiveness, Press Release, October 5, 2010, available at http://www.nist.gov/mep/upload/100410-MEP-Competition-press-release-FINAL.pdf.

A Different Approach?

As indicated above, the laws affecting the R&D environment have included both direct and indirect measures to facilitate technological innovation. In general, direct measures are those which involve budget outlays and the provision of services by government agencies. Indirect measures include financial incentives and legal changes (e.g., liability or regulatory reform; new antitrust arrangements). Supporters of indirect approaches argue that the market is superior to government in deciding which technologies are worthy of investment. Mechanisms that enhance the market's opportunities and abilities to make such choices are preferred. Advocates further state that dependency on agency discretion to assist one technology in preference to another will inevitably be subjected to political pressures from entrenched interests. Proponents of direct government assistance maintain, conversely, that indirect methods can be wasteful and ineffective and that they can compromise other goals of public policy in the hope of stimulating innovative performance. Advocates of direct approaches argue that it is important to put the country's scarce resources to work on those technologies that have the greatest promise as determined by industry and supported by its willingness to match federal funding.

In the past, participants in the debates generally did not make definite (or exclusionary) choices between the two approaches, nor consistently favor one over the other. For example, some proponents of a stronger direct role for the government in innovation also have supported enhanced tax preferences for R&D spending, an indirect mechanism. Opponents of direct federal funding for specific projects may have nevertheless backed similar activities focused on more general areas such as manufacturing or information technology. However, in recent congresses, legislators directed many of their efforts toward eliminating or curtailing some of the programs that previously had enjoyed bipartisan support. Initiatives to terminate the Advanced Technology Program and the Technology Innovation Program reflected concern over the role of government in developing commercial technologies. While appropriations for several programs decreased, and both ATP and TIP are no longer funded, support for several ongoing activities has continued. How the debate over federal funding evolves in the Congress may serve to redefine thinking about the government's efforts in promoting technological advancement in the private sector.

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