Reauthorization of the America COMPETES Act: Selected Policy Provisions, Funding, and Implementation Issues

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Summary

On January 4, 2011, President Barack Obama signed P.L. 111-358, the America COMPETES Reauthorization Act of 2010. The new law responds to concerns about national competiveness by authorizing $45.6 billion in funding for, among other things, research and development (R&D) in the physical sciences and engineering and in science, technology, engineering, and mathematics (STEM) education. P.L. 111-358 reauthorizes selected provisions from the 2007 America COMPETES Act (P.L. 110-69).

America COMPETES 2010 retains the central policy thrust of the 2007 act: a commitment to increased funding for R&D in the physical sciences and engineering and to certain federal STEM education programs. New programs established by the reauthorization include the Regional Innovation Program, Loan Guarantees for Innovative Technologies in Manufacturing, and the STEM-Training Grant Program. The 2010 reauthorization also repeals certain STEM education programs—such as the Math Now program—and makes other changes. Among these changes are provisions directing the National Science Foundation to maintain its minority-serving institutions programs as distinct programs.

Funding provisions are some of the most closely watched parts of the 2007 and 2010 America COMPETES acts. In particular, some analysts focus on so-called "doubling path" provisions for R&D funding at the National Science Foundation, National Institute of Standards and Technology laboratories, and the Department of Energy's Office of Science. The 2007 law authorized a funding growth rate for these accounts that is consistent with a seven-year doubling path. The 2010 law's growth rate is consistent with approximately an 11-year doubling path. Given the FY2011 and FY2012 debates about the federal budget, actual appropriations for America COMPETES 2010 funding provisions may be difficult to realize.

Funding may become a central implementation issue for the new law. In general, unfunded provisions of the original America COMPETES Act were not implemented. In addition to funding questions, other implementation and oversight issues for the new law center on the commercialization and diffusion of research; coordination and duplication in the federal STEM education effort; (opportunity) cost and broadening participation; and competitiveness and evaluation. With 10 titles and 77 provisions, implementation and oversight issues are likely to be numerous.

This report reviews major policy arguments raised in the congressional debate about the 2007 America COMPETES Act and 2010 reauthorization, examines and analyzes selected policy and funding provisions in these laws, and identifies some potential implementation and oversight issues for Congress.

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Introduction

Federal policymakers have focused on scientific and technological advancement since the Founding. Policies designed to advance science and technology were debated at the Constitutional Convention and have been a recurring subject of congressional attention ever since.[1] Major post-World War II legislation in this area includes the National Science Foundation Act of 1950 (P.L. 81-507); the Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480); and the 2007 America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act (P.L. 110-69). Congress passed, and the President later signed, a three-year reauthorization of the America COMPETES Act in December 2010.[2]

The contemporary federal conversation about scientific and technological advancement generally centers on concerns about prosperity and security.[3] The possibility that the United States has or could lose its historic strengths in scientific and technological advancement—and therefore has or could lose the prosperity and security attributed to that advancement—has become the central rationale for a portfolio of otherwise disparate federal programs, policies, and activities. Sometimes identified as "innovation" or "competitiveness" policy, these programs, policies, and activities address education, tax, patent, immigration, economic development, research and development, telecommunications, and other issues—either alone or in combination—that policymakers perceive as critical to the U.S. scientific and technological enterprise.

The 2007 America COMPETES Act is an example of this type of policymaking. Designed to "invest in innovation through research and development, and to improve the competitiveness of the United States," the law authorized $33.6 billion in appropriations between FY2008 and FY2010 for federal programs and activities in research and development (R&D) in the physical sciences and engineering and in science, technology, engineering, and mathematics (STEM) education, among other things. Within these policy areas, the 2007 law established new programs, such as the Math Now program, and reauthorized existing programs, such as the Manufacturing Extension Partnership program. The law also increased funding levels for certain programs and activities, the largest of which were for the National Science Foundation (NSF), National Institute of Standards and Technologies (NIST) laboratories, and the Department of Energy (DOE), Office of Science. America COMPETES 2007 was not fully funded.[4]

[1] Arguably, the most well known example of early federal efforts to promote science is Article 1, Section 8, Clause 8 of the U.S. Constitution, commonly known as the "copyright and patent clause." However, other options to support science (e.g., national universities) were discussed at the Constitutional Convention and in subsequent Congresses. See A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities to 1940* (Cambridge, MA: Belknap Press of Harvard University Press, 1957), pp. 1-19.

[2] This report refers to the America COMPETES Reauthorization Act of 2010 as "America COMPETES 2010" or "America COMPETES Reauthorization Act of 2010," and to the America COMPETES Act as "America COMPETES 2007" or the "2007 America COMPETES Act."

[3] Historic debate also addressed the contributions of science to the American political system. For example, in the first State of the Union Address in 1790, President George Washington appealed to Congress to patronize science on the grounds that scientific knowledge in the electorate was essential for a democratic republic. See President George Washington, "First Annual Message to Congress on the State of the Union," *The American Presidency Project Website*, January 8, 1790, http://www.presidency.ucsb.edu/ws/index.php?pid=29431#axzz1IIvN0cSi.

[4] Some of the law's authorized programs and activities received no appropriated funding. Others received funding below authorized levels. Some programs and activities that did not receive regular appropriations, or that received funding below authorized levels, were funded through supplemental appropriations. For more information, see CRS (continued...)

The America COMPETES Reauthorization Act of 2010 reaffirms the central policy thrust of the 2007 America COMPETES Act, including provisions designed to increase R&D funding at the NSF, NIST laboratories, and DOE Office of Science. It adds new provisions authorizing inducement prizes at federal agencies, establishing a loan guarantee program for manufacturers, and establishing a Regional Innovation Program, among other things. America COMPETES 2010 also repeals certain programs included in the 2007 law. Primary among these are STEM education programs that went unfunded during the original authorization period, such as the Math Now program.

Both the 2007 and 2010 America COMPETES acts are statutory authorization measures. This means they give affected agencies permission to run certain programs, and to spend funds, as directed by the acts. However, these measures do not provide actual funding. Actual funding must come from annual Congressional appropriations and budget activities.

The 2007 America COMPETES Act (P.L. 110-69, H.R. 2272) passed both chambers with bipartisan support. In final form, H.R. 2272 passed by unanimous consent in the Senate and by a vote of 367-57 in the House. Although the America COMPETES Reauthorization Act of 2010 (P.L. 111-358, H.R. 5116) also passed the Senate by unanimous consent, legislative opposition was pronounced in the House. The final vote on H.R. 5116 was 228 to 130.

This report reviews major policy arguments raised in the Congressional debate about both the 2007 and 2010 America COMPETES acts, analyzes selected policy provisions of these laws, examines funding issues, and identifies some potential implementation and oversight issues for Congress.

The Debate

Although America COMPETES 2010 changes some of the policies and programs established by the 2007 America COMPETES Act, the new law retains the central policy thrust of the original law: a commitment to increasing funding for R&D in the physical sciences and engineering and to certain federal STEM education programs. As such, Congressional debate about these measures was substantively similar.

America COMPETES 2007 and 2010 advocates argued that the laws' support for R&D in the physical sciences and STEM education would lead to innovation and long-term U.S. competitiveness.[5] They noted that innovation, particularly technological innovation, is widely recognized as a driving force behind U.S. economic growth. As such, many observers consider innovation a crucial national asset.

Proponents asserted that the United States is at risk of losing our innovation advantage. They argued that a combination of external pressures and internal weaknesses threatens the U.S. global position. For example, changes in the industrial bases and educational attainment rates of rapidly

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Report R40519, *America COMPETES Act and the FY2010 Budget*, by John F. Sargent Jr., and CRS Report RL34328, *America COMPETES Act: Programs, Funding, and Selected Issues*, by Deborah D. Stine.

[5] Representative Bart Gordon, "America COMPETES Reauthorization Act of 2010," remarks in the House, *Congressional Record*, daily edition, Vol. 156 (December 21, 2010), pp. H8841-H8842.

developing countries like China and India have led many analysts to conclude that these countries will be able to compete for a growing percentage of the world's high-value jobs and industry. Signs of potential domestic weakness in areas that have long been U.S. strengths appear to accompany these global changes. In particular, America COMPETES act proponents have raised concerns about perceived weaknesses in U.S. physical sciences and engineering research funding;[6] and in the domestic development of scientists, engineers, and technicians.[7]

Opposition to both America COMPETES 2007 and 2010 tended to fall into three broad categories: (1) questions about fundamental assumptions, (2) preferences for alternatives policies or approaches, and (3) cost. For example, some analysts disputed fundamental assumptions driving provisions designed to increase the number of STEM graduates, arguing that there is no evidence of across-the-board workforce shortages and that the bigger challenge is a dearth of attractive employment opportunities in university research.[8] Other analysts preferred to use regulatory and tax policy tools to achieve the acts' objectives, arguing that direct federal investment in R&D in the physical sciences and engineering and in STEM education would distort markets.[9] Finally, opponents raised concerns about costs, arguing that proposed funding increases were too expensive in light of the federal fiscal condition, deficit, and debt.[10]

The America COMPETES Reauthorization Act of 2010 (P.L. 111-358)

Like America COMPETES 2007, America COMPETES 2010 is designed to "invest in innovation through research and development, to improve the competitiveness of the United States, and for other purposes." In total, the America COMPETES Reauthorization Act of 2010 authorized approximately $45.6 billion in appropriations between FY2010 and FY2013 for federal R&D in the physical sciences and engineering and STEM education, among other things.[11] It has 10 titles

[6] This case is laid out more fully in National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, Committee on Prospering in the Global Economy of the 21st Century: An Agenda for America Science and Technology, and Committee on Science, Engineering, and Public Policy, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academies Press, 2007, http://www.nap.edu/catalog/11463.html.

[7] Provisions in the 2007 America COMPETES Act can also be traced to a George W. Bush Administration proposal, the American Competitiveness Initiative (ACI). The ACI proposed programs and policies—such as Math Now and increased funding for basic research—that became part of P.L. 110-69. See U.S. President (G.W. Bush), "Address before a Joint Session of Congress on the State of the Union," *The America Presidency Project Website*, January 31, 2006, http://www.presidency.ucsb.edu/ws/index.php?pid=65090#axzz1IZD3cJnu.

[8] Testimony of Alfred F. Sloan Foundation Vice President Michael S. Teitelbaum, in U.S. Congress, House Committee on Science and Technology, Subcommittee on Technology and Innovation, *The Globalization of R&D and Innovation, Part 4*, hearings, 110th Cong., 1st sess., November 7, 2007, http://democrats.science.house.gov/publications/Testimony.aspx?TID=9735.

[9] Testimony of Competitive Enterprise Institute Vice President for Policy/Director of Technology Studies, House Committee on Science and Technology, *The Future of Manufacturing: What Is the Role of the Federal Government in Supporting Innovation by U.S. Manufacturers?*, hearings, 111th Cong., 2nd sess., March 17, 2010, http://gop.science.house.gov/Media/hearings/full10/mar17/Crews.pdf.

[10] For example, see House debate, "Conference Report on H.R. 2272, America COMPETES Act," *Congressional Record*, daily edition, vol. 153 (August 2, 2007), pp. H9592-H9604.

[11] Approximation based on CRS analysis of selected appropriations in P.L. 111-358. Number is rounded. May not include all appropriations authorizations. See **Table A-1** for data.

and 77 sections directing specific programs and policies at the Office of Science and Technology Policy (OSTP), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), National Institute of Standards and Technology (NIST), National Science Foundation (NSF), Department of Commerce (DOC), Department of Energy (DOE), and Department of Education (ED).

America COMPETES 2010 increases funding at the NSF, NIST laboratories, and the DOE Office of Science and authorizes new technology transfer and commercialization activities at certain federal agencies. With respect to STEM education, America COMPETES 2010 seeks to provide greater coordination of federal STEM education programs, authorizes support for academic programs that provide concurrent teacher certification with a bachelors degree in a STEM field, and repeals certain unfunded STEM education programs authorized by the 2007 America COMPETES Act, among other things.

Selected R&D Provisions

A central pillar of the America COMPETES Reauthorization Act of 2010 is funding for R&D in the physical sciences and engineering. However, the new law also makes some policy changes to existing research activities at selected federal science agencies and adds new programs. Many of the new law's research provisions provide for research in specific STEM fields or authorize efforts to stimulate innovation and commercialization.

The provisions in America COMPETES 2010 that provide for research in specific STEM fields include the Green Manufacturing and Construction initiative provisions, which require NIST to develop (1) sustainability metrics for use in manufacturing and (2) standards and validated measurement data for high performance green buildings.[12] Other specific areas of research authorized by the new law include Green Chemistry Basic Research[13] and fundamental research in transformative advances in manufacturing technologies programs at NSF.[14]

Commercialization and innovation provisions in America COMPETES 2010 typically amend existing research programs in ways that are designed to stimulate technology transfer or the commercialization of products developed from federal research. The new law also contains new programs and activities designed for similar purposes. By agency, such provisions include but are not limited to the following:

- *National Science Foundation*—Partnerships for Innovation,[15] and Academic Technology Transfer and Commercialization of University Research.[16]

[12] Title IV, Sec. 408.

[13] Title V, Subtitle A, Sec. 509.

[14] Title V, Subtitle A, Sec. 506.

[15] Title V, Subtitle A, Sec. 508.

[16] Title V, Subtitle A, Sec. 520.

- *Department of Commerce*—Office of Innovation and Entrepreneurship,[17] Federal Loan Guarantees for Innovative Technologies in Manufacturing,[18] and NIST Green Jobs.[19]
- *Department of Energy*—Advanced Research Project Agency—Energy.[20]

In addition, America COMPETES 2010 struck language in the National Aeronautics and Space Act of 1958 (P.L. 85-568, as amended) requiring that NASA innovation prizes conform only to authorizing provisions in that act. The law also repealed the Commerce, Science, and Technology Fellowship Program at the Department of Commerce.[21]

Selected STEM Education Provisions

Among America COMPETES 2010's STEM education provisions are those that seek to increase coordination and reduce duplication in the federal STEM education effort,[22] to improve the non-STEM skills of STEM graduate students (e.g., communication and teaching skills),[23] and that seek to replicate the widely lauded UTeach program.[24] The law also allows students in specialized STEM high schools to participate in certain National Science Foundation data collection efforts,[25] and allows grants to colleges to provide academic support for private sector or professional association STEM student internships.[26]

America COMPETES 2010 also reauthorizes, and makes changes to, existing STEM education programs at the NSF, DOE, and ED. For some programs, the law only adds new annual funding authorizations for FY2011-FY2013; for others, the law changes programs and policy in substantive ways. For example, the law provides funding authorizations for the DOE Summer Institutes and Nuclear Science Talent programs, but makes no major substantive policy changes.[27] On the other hand, the new law makes substantive policy changes to both the NSF's Robert Noyce Teacher Scholarship (Noyce) program and to ED's Advanced Placement and International Baccalaureate (AP/IB) program. In particular, the law reduces certain nonfederal matching requirements for both the Noyce [28] and for AP/IB[29] programs.

[17] Title VI, Sec. 601.

[18] Title VI, Sec. 602.

[19] Title VII, Sec. 703.

[20] Title IX, Sec. 904.

[21] Title IV, Sec. 407.

[22] Title I, Sec. 101.

[23] Title V, Subtitle A, Sec. 527.

[24] Title V, Subtitle B. UTeach is a University of Texas at Austin academic program granting baccalaureate degrees in STEM fields with concurrent teacher certification. For more information, see http://commerce.senate.gov/public/index.cfm?p=PressReleases&ContentRecord_id=b2497358-490b-4d85-998e-49974057c48d&ContentType_id=77eb43da-aa94-497d-a73f-5c951ff72372&Group_id=59da2fee-2988-4fe9-b1dd-ee3219b6f868.

[25] Title V, Subtitle A, Sec. 513.

[26] Title V, Subtitle A, Sec. 515.

[27] Title IX, Sec. 901.

[28] For fellowship track grants of less than $1.5 million. Title V, Subtitle A, Sec. 511.

[29] Title X, Sec. 1003.

America COMPETES 2010 also repeals several STEM education programs authorized by the 2007 law. Many of these programs did not receive funding during the original authorization period. Repealed STEM education programs include

- *Department of Energy*—Pilot Program of Grants to Specialty Schools for Science and Mathematics, Experiential-Based Learning Opportunities, and National Energy Education Development.[30]
- *Department of Education*—Promising Practices in Science, Technology, Engineering, and Mathematics Teaching, Math Now for Elementary School and Middle School Students Program, Summer Term Education Programs, Math Skills for Secondary School Students, Foreign Language Partnership Program, and Mathematics and Science Partnership Bonus Grants.[31]

Finally, America COMPETES 2010 neither repeals nor specifically reauthorizes funding for certain expiring STEM education provisions from America COMPETES 2007.[32] The new law is silent on, among other things, reauthorization of the Discovery Science and Engineering Innovation Institutes program (P.L. 110-69, Sec. 5008) and on Hydrocarbon Systems Science *Competitiveness Grants* (but not *Expansion Grants*) for Institutions of Higher Education (P.L. 111-69, Sec. 5005) at the DOE.[33]

Selected Broadening Participation Provisions

America COMPETES 2010 includes several provisions designed to increase the participation of underrepresented populations (e.g., racial and ethnic minorities, women, persons from rural communities, etc.) in STEM education and employment. Also known as "broadening participation" policies, these provisions generally fall into two categories: (1) those that authorize or establish broadening participation as a program goal, and (2) those that relate to Minority-Serving Institutions (MSI) of higher education.

In different ways and through various programs, America COMPETES 2010 directs NASA, NOAA, the NSF, and NIST to include the goal of promoting or increasing the participation of underrepresented populations in STEM education and federal research. NASA[34] and NOAA[35] provisions include this goal in agency education programs. NSF[36] and NIST[37] provisions incorporate it into certain research-related activities, such as the review process (NSF) and fellowships (NIST).

[30] Title IX, Sec. 901.

[31] Title X, Sec. 1002.

[32] U.S. Congressional Budget Office, *Unauthorized Appropriations and Expiring Authorizations*, January 2011, p. 17, http://www.cbo.gov/ftpdocs/120xx/doc12044/01-14-UAEA_Approps.pdf.

[33] However, P.L. 111-358 *does* specifically fund Hydrocarbon Systems Science Program *Expansion Grants* (emphasis added) for Institutions of Higher Education.

[34] Title II, Sec. 202. NASA provisions are included in "Sense of Congress" language are nonbinding.

[35] Title III, Sec. 302.

[36] Title V, Subtitle A, Sec. 526.

[37] Title IV, Sec. 406.

Among other MSI-related provisions in America COMPETES 2010, section 512 directs the NSF to continue supporting the Historically Black Colleges and Universities Undergraduate Program, the Louis Stokes Alliances for Minority Participation program, the Tribal Colleges and Universities Program, and Hispanic-serving institutions programs as separate programs.[38] NSF had previously proposed merging these programs as part of its FY2011 budget submission to Congress.

Selected Other Provisions

In addition to the STEM research and education provisions in the America COMPETES Reauthorization Act of 2010, P.L. 111-358 contains other provisions that seek to improve U.S. competitiveness and innovation. Among these are provisions authorizing inducement prizes and research competitions at federal agencies,[39] directing the Department of Commerce to complete a comprehensive study of U.S. competitiveness and innovation,[40] and establishing regional economic development programs.[41] The new law also changes the NIST director's title to "Undersecretary of Commerce for Standards and Technology."[42]

Funding Provisions in P.L. 111-358[43]

America COMPETES 2010 authorizes approximately $45.6 billion in specific funding for R&D in the physical sciences and engineering and STEM education related activities at the Departments of Commerce, Education, and Energy, and at the National Science Foundation.[44] **Table A-1** (see **Appendix A**) includes a list of specific America COMPETES 2010 funding provisions by program and authorized fiscal year.

Doubling Path

Like America COMPETES 2007, America COMPETES 2010 pursues a "doubling path" for funding at the NSF, NIST laboratories,[45] and the DOE Office of Science—albeit at a reduced rate of growth and over a longer period. The new growth rate and time frame in America COMPETES 2010 are consistent with actual appropriations for America COMPETES 2007 during the FY2008-FY2010 authorization period. However, given the FY2011 and FY2012 debates about the federal fiscal condition, achieving the authorization levels in America COMPETES 2010 may prove difficult.

[38] Title V, Subtitle A, Sec. 512.

[39] Title I, Sec. 105.

[40] Title VI, Sec. 604.

[41] Title VI, Sec. 603.

[42] Title IV, Sec. 403.

[43] This report uses the term "specific" to describe authorizations of appropriations that include a specific dollar amount (e.g., $30 million) and the term "indefinite" to describe authorizations of appropriations that do not include a specific dollar amount (e.g., "such sums as may be necessary" or general appropriations).

[44] Number is rounded and based on CRS analysis of selected specified appropriations authorizations in P.L. 111-358.

[45] The NIST accounts targeted for doubling include Scientific and Technical Research Services and Construction of Research Facilities.

America COMPETES 2007 authorized appropriations over a three-year period. These funding authorizations set a seven-year doubling pace at an annual growth rate of about 10.3% for aggregate funding in the targeted accounts. America COMPETES 2010 authorizes a 6.3% annual growth rate, which is closer to the 6.4% growth rate in actual appropriations during the FY2008-FY2010 authorization period. If future appropriations align with funding authorizations, the 6.3% growth rate would double combined funding for the targeted accounts in a little over 11 years (from the 2006 baseline).[46] See **Figure B-1**, **Appendix B**.

Funding for New Programs

New programs—as compared to America COMPETES 2007—with specific funding provisions in America COMPETES 2010 include the following.

- *National Science Foundation*—$10.0 million per year for the STEM-Training Grant Program.[47]
- *Department of Commerce*—$20.0 million per year for Federal Loan Guarantees for Innovative Technologies in Manufacturing;[48] $100.0 million per year for the Regional Innovation Program;[49] and $7.0 million per year for Loan Guarantees for Science Park Infrastructure.[50]
- *National Institute of Standards and Technology*—$7.0 million per year for the National Institute of Standards and Technology Competitive Grant Program (NIST GREEN JOBS Act of 2010).[51]

Funding in P.L. 110-69 and P.L. 111-358

As presented in **Table C-1** (see **Appendix C**), a comparison of major funding provisions in America COMPETES 2007 and 2010 shows that reauthorization funding generally falls short of the growth rate established by the original law.[52] Funding drops for some accounts (e.g., NSF and DOE Office of Science) between FY2010 and FY2011. It comes back up after FY2011, but at a slower pace than originally authorized in 2007. By FY2013, most major accounts appear to return to, or exceed, FY2010 authorization levels. [53]

[46] Based on CRS analysis. Data available upon request.

[47] Title V, Subtitle B, Sec. 556.

[48] Title VI, Sec. 602.

[49] Title IV, Sec. 603. The President's FY2012 budget request for DOC's Economic Development Administration includes a $40.0 million request to establish this program.

[50] Title VI, Sec. 603.

[51] Title VII, Sec. 703.

[52] For the purpose of this section and Table 2, "major provisions" and "major accounts" are specified appropriations authorizations worth at least $100 million in any given fiscal year between FY2008 and FY2013.

[53] Based on CRS analysis of selected specified appropriations authorizations in P.L. 110-69 and P.L. 111-358. Additional data available upon request.

Discussion: Implementation and Oversight Issues

With 10 titles and 77 provisions, the America COMPETES Reauthorization Act of 2010 has the potential to generate a variety of implementation and oversight issues over its three-year authorization period (FY2011-FY2013). These include cost and funding; commercialization and diffusion of research and innovation; coordination and duplication in the federal STEM education effort; (opportunity) cost and broadening participation; and competitiveness and evaluation.

Cost and Funding

A frequent criticism of America COMPETES 2007 is that actual appropriations fell short of authorized funding levels. Given the debate about the FY2011 and FY2012 federal budgets, supporters of the new law may find the America COMPETES 2010-authorized funding levels difficult to achieve. America COMPETES 2010 provides for increases in federal expenditures at a time when many policymakers are looking to reduce federal spending. Cost was central to the debate in the House[54] and since then legislators have proposed measures to reduce funding or repeal programs included in the new law.[55] Some observers have raised questions about whether agencies targeted for research funding increases—in particular, the NSF—have the capacity to manage additional funding if Congress provides it.[56] Finally, the Obama Administration's time frame for the doubling effort is now indefinite.[57]

Part of the reason that it may be difficult to provide full funding for America COMPETES 2010 is that analysts disagree about how to stimulate innovation.[58] Some analysts argue that underfunding federal R&D in the physical sciences and engineering and STEM education threatens the fundamental underpinnings of the economy and therefore justifies increasing national investment in these areas even in an era of fiscal constraint.[59] Others see the national deficit and debt as

[54] See House debate, "America COMPETES Reauthorization Act of 2010," *Congressional Record*, daily edition, Vol. 156 (December 21, 2010), pp. H8841-H8842.

[55] For example, see H.R. 408, the Spending Reduction Act of 2011, and S. 178. These measures would reduce overall federal spending to 2008 levels—including America COMPETES Act programs—and would repeal the Teachers for a Competitive Tomorrow Program, which was established by the 2007 America COMPETES Act and reauthorized in 2010.

[56] Testimony of NSF Inspector General Allison C. Lerner, in U.S. Congress, House Appropriations Committee, Subcommittee on Commerce, Justice, Science, and Related Agencies, *Oversight of the National Science Foundation and National Aeronautics and Space Administration*, hearings, 112th Cong., 1st sess., February 10, 2011, http://appropriations.house.gov/_files/NSFIGAppshearingFeb102011FinalTestimony.pdf.

[57] In FY2010, the President's Plan for Science and Innovation (PPSI) indicated that the doubling period was from FY2006 to FY2016 (10 years). In FY2011, the PPSI indicated that the doubling would occur between FY2006 and FY2017 (11 years). The FY2012 PPSI does not include an end-date and Office of Management and Budget-published historical tables for the FY2012 budget estimate that NSF funding would only increase by 38% by FY2016. See, CRS Report R41706, *Federal Research and Development Funding: FY2012*, coordinated by John F. Sargent Jr.

[58] On February 7, 2011, the Information Technology & Innovation Forum (ITIF) hosted a debate between policy analysts who hold these disparate views. Robert Atkinson, president of ITIF, and Fred Block, senior fellow, Breakthrough Institute, argued for increased federal direct investment in research. Jerry Taylor, senior fellow, Cato Institute, and David Kreutzer, research fellow, Heritage Foundation, argued for deficit reduction and reduced federal spending. A webcast of the debate is accessible at http://www.itif.org/events/cut-or-invest-what%E2%80%99s-best-way-grow-our-economy.

[59] Mark Muro, "America COMPETES: Vehicle for Innovating at Innovation," *The New Republic*, April 14, 2010, http://www.tnr.com/blog/the-avenue/america-competes-vehicle-innovating-innovation.

greater threats to economic growth and assert that the current U.S. fiscal condition makes cuts necessary.[60]

Commercialization and Diffusion of Research

R&D's historic contribution to economic growth is well established. However, for R&D to produce economic growth and jobs, R&D activities must result in goods, services, or processes—a process known as *commercialization*. Further, commercialization has an important partner in driving growth, the *diffusion* of innovation throughout the economy.[61] America COMPETES 2010 includes provisions that seek to foster commercialization and diffusion, but their effectiveness and impact will depend—in part—on implementation.

Observers point to a wide variety of perceived problems in the commercialization and diffusion of federally funded research. These include concerns about the "valley of death"[62] (i.e., the gap between proof-of-concept and mass production) and industry-university research collaborations.[63] Persistent disagreement about the role of the federal government in these processes has led to an incremental policy approach and relatively frequent attempts at reform.[64] Some analysts prefer increased federal attention to commercialization and diffusion as a way to address perceived market failures.[65] Others argue that federal programs are unnecessary corporate subsidies[66] or that they distort the market by favoring a particular technology, company, or industry.[67] Still others see federal commercialization and diffusion activities as an appropriate response to structural changes in the economy—arguing that

[60] Brian M. Riedl, *How to Cut $343 Billion from the Federal Budget*, Heritage Foundation, Backgrounder no. 2483, October 28, 2010, http://www.heritage.org/research/reports/2010/10/how-to-cut-343-billion-from-the-federal-budget.

[61] Alan Hughes, *Innovation Policy as Cargo Cult: Myth and Reality in Knowledge-Led Productivity Growth*, Centre for Business Research, University of Cambridge, Working Paper No. 348 (June 2007), p. 5.

[62] For example, see T. Randolph Beard, et al., "A Valley of Death in the Innovation Sequence: An Economic Investigation," *Research Evaluation*, vol. 18, no. 5 (December 2009), pp. 343-356.

[63] Robert Litan, et al., "Commercializing University Innovations: Alternative Approaches," *Innovation Policy and the Economy*, vol. 8, no. 1 (April 2008), pp. 31-58, http://www.nber.org/chapters/c5301.pdf.

[64] Historically, the federal government played a more limited role in the commercialization process. The private sector was expected to take products to market. This arrangement was based on assumptions of a linear relationship between discrete stages of R&D where basic research investments at one end were expected to result in a concomitant level of commercial activity at the other. Many analysts now see greater complexity in this relationship. They note that research stages are not necessarily discrete and that commercial activity develops within a complex private-public ecosystem. See Gregory Tassey, *The Technology Imperative* (Northampton, MA: Edward Elgar Publishing, Inc., 2007), p. 106.

CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by Wendy H. Schacht

[65] Testimony of Information Technology and Innovation Foundation President Robert D. Atkinson, in U.S. Congress, House Committee on Science and Technology, Subcommittee on Technology and Innovation, Supporting Innovation in the 21st Century Economy, hearings, 110th Cong., 2nd sess., March 24, 2010, http://sciencedems.house.gov/publications/Testimony.aspx?TID=15394.

[66] Testimony of Heritage Foundation Grover M. Hermann Fellow in Federal Budgetary Affairs Brian M. Riedl, in U.S. Congress, Senate Homeland Security and Government Affairs Committee, Subcommittee on Federal Financial Management, Government Information, and International Security, *An Assessment of Federal Funding for Private Research and Development*, hearings, 109th Cong., 1st sess., S. Hrg. 109–349, http://www.gpo.gov/fdsys/pkg/CHRG-109shrg21826/pdf/CHRG-109shrg21826.pdf.

[67] Tad Dehaven and Chris Edwards, "Business Subsidies," *Downsizing the Federal Government Website*, Cato Institute, February 2009, http://www.downsizinggovernment.org/commerce/subsidies.

> To renew unemployment and stimulate demand, government action has to extend beyond saving existing industries into creating new industries that rely more heavily on a knowledge base.[68]

Coordination and Duplication in STEM Education

Estimates of the number, nature, and quality of federal STEM education programs vary. [69] Accordingly, some policymakers have criticized the federal effort as uncoordinated and potentially duplicative. Congress responded to these concerns by including a provision in America COMPETES 2010 that directs the National Science and Technology Council (NSTC) to establish a committee to inventory, coordinate, and review federal STEM education programs. The provision also directs the NSTC committee to specify and prioritize annual and long-term objectives for STEM education, and to ensure that federal efforts do not duplicate each other, among other things. The new law directs the NSTC to report to Congress annually on its activities and findings.[70] Policymakers have also separately directed the Government Accountability Office to undertake related research on the federal STEM education effort.

On March 4, 2011, the NSTC Committee on STEM Education met for the first time. The Committee established working groups to inventory federal STEM education programs and to coordinate the federal effort. The Committee charter, however, does not include identifying duplication as a committee function.[71] According to the White House, the Committee will focus its efforts on "producing highly effective teachers and motivated students along with ongoing, measurable improvements in capabilities throughout the educational system."[72] These goals are consistent with the September 2010 recommendations of the President's Council of Advisors on Science and Technology.[73] America COMPETES 2010 directs the Committee to report to Congress annually on progress and findings.

[68] Henry Etzkowitz and Marina Ranga, "A Trans-Keynesian Vision of Innovation for the Contemporary Economic Crisis: 'Picking Winners' Revisited," *Science and Public Policy*, vol. 36., no. 10 (December 2009), pp. 799-808.

[69] Several reports have highlighted an information gap in our general understanding of the federal STEM education effort. See U.S. Department of Education, Academic Competitiveness Council, *Report of the Academic Competitiveness* Council, May 2007, http://www2.ed.gov/about/inits/ed/competitiveness/acc-mathscience/report.pdf; and U.S. Government Accountability Office, *Higher Education: Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends*, GAO-06-114, October 2005, http://www.gao.gov/new.items/d06114.pdf.

[70] Title I, Sec. 101.

[71] Executive office of the President, National Science and Technology Council, Committee on Science, Technology, Engineering, and Mathematics (STEM) Education, *Charter of the Committee on Science, Technology, Engineering, and Mathematics (STEM) Education*, February 1, 2011, http://www.whitehouse.gov/sites/default/files/microsites/ostp/CoSTEM%20Charter%20signed%2001-31-11.pdf.

[72] Greg Gershuny, "New Science, Technology, Engineering, and Mathematics Committee Launched," *Office of Science and Technology Policy blog*, The White House, March 4, 2011, http://www.whitehouse.gov/blog/2011/03/04/new-science-technology-engineering-and-math-education-committee-launched.

[73] Executive Office of the President, President's Council of Advisors on Science and Technology, Report to the President: Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future, prepublication version, September 2010, http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf.

(Opportunity) Cost and Broadening Participation

One longer-term implementation issue for America COMPETES 2010's broadening participation provisions—particularly those provisions that seek to address racial, ethnic, and gender gaps in educational achievement through school policy—may be opportunity cost. Some researchers suggest that exclusive attention to schools (as opposed to nonschool factors, such as poverty or dysfunctional families)[74] is a limitation of typical achievement gap policies.[75] Others, finding similarly, conclude that enhancing early life parenting resources would be a more cost-effective response to gaps than later-life remediation.[76]

However, the desire to broaden participation in STEM occupations, and well-known disparities in the STEM education pipeline in particular, may make close attention to school-based factors the best policy response in this case, according to recent National Academies reports.[77] Researchers have identified several school-based issues specific to STEM education achievement gaps—such as concerns about the quality and quantity of STEM teachers in minority schools[78] and about relatively low STEM college degree attainment rates among underrepresented populations.[79] Further, although policy analysts disagree about how to respond to concerns about STEM teachers and degree attainment rates, these issues are well documented and widely believed to be problematic.

A shorter-term broadening participation oversight issue for both America COMPETES 2007 and 2010 centers on provisions authorizing a program to support Hispanic-Serving Institutions (HSIs) at the National Science Foundation. Section 7033 of America COMPETES 2007 directed the NSF to establish a program for HSIs. Section 512 of America COMPETES 2010 directs the NSF to maintain its HSI program separately from other minority-serving institution programs at the Foundation. However, the Foundation has not established an HSI program as directed by either law.

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[74] For an historic analysis of the black-white achievement gap and the factors believed to contribute to it, see Paul E. Barton and Richard J. Coley, *Policy Information Report: The Black-White Achievement Gap: When Progress Stopped*, Educational Testing Service, Policy Evaluation and Research Center, Policy Information Center, July 2010, http://www.ets.org/Media/Research/pdf/PICBWGAP.pdf.

[75] Tamara Wilder, et al., "Narrowing the Achievement Gap for Low-Income Children: A 19-year Life Cycle Approach," paper prepared for the 2008 Equity Symposium of the Campaign for Educational Equity, Comprehensive Educational Equity: Overcoming the Socioeconomic Barriers to School Success, Teachers College, Columbia University, November 17-18, 2008, p. 3, http://epi.3cdn.net/07bc530ac6dfe6ec1d_jkm6bhwro.pdf.

[76] James J. Heckman, *The American Family in Black and White: A Post-Racial Strategy for Improving Skills to Promote Equality*, National Bureau of Economic Research, Working Paper no. 16841, March 2011, http://www.nber.org/papers/w16841.

[77] This was the recommendation of a recent National Academies report. See Committee on Underrepresented Groups and the Expansion of Science and Engineering Workforce Pipeline; Committee on Science, Engineering, and Public Policy; Policy and Global Affairs; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*, prepublication copy, National Academies Press, September 30, 2010, http://www.nap.edu/catalog.php?record_id=12984.

[78] Alfinio Flores, "Examining Disparities in Mathematics Education: Achievement Gap or Opportunity Gap?," *The High School Journal*, vol. 91, no. 1 (October/November 2007), pp. 29-42.

[79] Hollie Young, "Secondary Education Systemic Issues: Addressing Possible Contributors to a Leak in the Science Education Pipeline and Potential Solutions," *Journal of Science Education and Technology*, vol. 14, no. 2 (June 2005), pp. 205-216.

Competitiveness and Evaluation

Fundamental assumptions about U.S. competitiveness shape both America COMPETES 2007 and 2010. Some analysts and academics disagree about some of these assumptions—such as the notion that nations compete,[80] the types of policies that make a nation competitive,[81] and the relative competitive position of the United States.[82] Further, ambiguities deriving from the term "competitiveness," for which there is no definition in either the 2007 or 2010 law, may make oversight, implementation, and evaluation a challenge.

Evaluation of America COMPETES 2007 has proven to be a particularly difficult implementation challenge and may be an issue for America COMPETES 2010 as well. A Government Accountability Office (GAO) report on the 2007 law's effectiveness noted that evaluation issues significantly limited its assessment and findings. Among these challenges were some that are inherent (e.g., research is unpredictable and results may take a long time) and some that may be able to be addressed by decision makers, such as linking individual program results more clearly with agency or government goals. Although GAO was not able to evaluate the overall effectiveness of the law, it concluded: (1) that agencies have made progress collecting data that will pave the way for future evaluations, but that (2) they have not consistently reported to Congress about their high-risk, high reward activities as required under the 2007 law.[83]

Provisions in America COMPETES 2010 directed the GAO to undertake a similar analysis of the 2010 law.[84] This analysis may be hindered by the same limitations as the first. However, efforts to improve evaluation tools for federal investments in R&D are underway. For example, the STAR METRICS project seeks to develop an empirical framework to measure the outcomes of science investments and demonstrate the benefits of scientific investments to the public.[85]

Finally, there is a larger question: What happens to U.S. R&D and education when federal policies are justified primarily as a way to improve U.S. global economic competitiveness? The United States has historically funded R&D and education in the pursuit of a variety of goals: winning the Cold War, fighting disease, protecting the environment, strengthening democracy, and increasing social equity, among others. Today, many analysts cite global economic competitiveness concerns as a primary rationale for increased support for R&D and education. A

[80] For an example of the debate about whether nations compete, see Paul Krugman, "The Competition Myth," *New York Times*, January 23, 2011, http://www.nytimes.com/2011/01/24/opinion/24krugman.html; and a direct response from Information Technology and Innovation Foundation (ITIF) Senior Analyst Stephen Ezell, "Krugman Flat Wrong that Competitiveness Is a Myth," *ITIF Innovation Policy Blog*, January 25, 2011, http://www.innovationpolicy.org/krugman-dead-wrong-that-competitiveness-is-a. Two classic papers on this topic include Michael E. Porter, "The Competitive Advantage of Nations," *Harvard Business Review*, March-April 1990, pp. 73-93; and Paul Krugman, "Competitiveness: A Dangerous Obsession," *Foreign Affairs* vol. 73, no. 2 (March/April 1994), pp.28-44.

[81] For example, see Lawrence Mishal and Richard Rothstein, "Schools as Scapegoats," *The American Prospect*, October 2007, vol. 18, no. 10, p. 44.

[82] For example, see Gary P. Pisano and Willy C. Shih, "Restoring American Competitiveness," *Harvard Business Review*, July 1, 2009; and a direct response from R.A., "Falling Behind," *The Economist: Free Exchange* (blog), from September 30, 2010, http://www.economist.com/blogs/freeexchange/2010/09/competitiveness.

[83] U.S. Government Accountability Office, *America COMPETES Act: It is Too Early to Evaluate Programs Long-Term Effectiveness, but Agencies Could Improve Reporting of High-Risk, High-Reward Research Priorities*, GAO-11-127R, October 7, 2010, http://www.gao.gov/products/GAO-11-127R.

[84] Title VIII, Sec. 801.

[85] For more information about the STAR METRICS program, go to http://sites.nationalacademies.org/PGA/fdp/PGA_057189.

few warn, however, that tying R&D and education so closely to the important, but relatively narrow goal of producing tangible economic returns could diminish the importance of noneconomic national priorities.[86] The long-term impact of the shift to a "competitiveness rationale" on U.S. R&D and education remains to be seen.

[86] For example, in a piece reminiscent of Jonathan Swift's essay, *A Modest Proposal*, one education scholar satirically writes, "Indeed, we have already made great strides in shifting the conversation about education to what will prove useful in workplaces rather than wasting time discussing what might support 'democracy' (an 18th-century notion, isn't it?) or what might promote self-development as an intrinsic good (a concept that goes back thousands of years and is therefore antiquated by definition)." Alfie Kohn, "When 21st-Century Schooling Just Isn't Good Enough: A Modest Proposal," *District Administration*, February 2009, p. 38. See also, Alfie Kohn, "Against 'Competitiveness,'" *Education Week*, September 19, 2007, p. 32.

Appendix A. Table A-1

Table A-1. Specified Funding Authorizations in P.L. 111-358: FY2011-FY2013

(in millions of dollars, rounded)

Section	Department/Agency	Program	FY2011	FY2012	FY2013
402	DOC/NIST	Total	$918.9	$970.8	$1,039.7
		—Scientific & Technical Research and Services (STRS)	$584.5	$661.1	$676.7
		—Construction & Maintenance	$124.8	$84.9	$121.3
		—Industrial Technology Services (ITS)	$209.6	$224.8	$241.7
		—Manufacturing Extension Partnership	*$141.1*	*$155.1*	*$165.1*
		—Malcolm Baldrige National Quality Award	*$10.0*	*$10.3*	*$10.6*
703	DOC/NIST	NIST GREEN JOBS Act of 2010	$7.0	$7.0	$7.0
503	NSF	Total	$7,424.4	$7,800.0	$8,300.0
		—Research & Related Activities	$5,974.8	$6,234.3	$6,637.8
		—Education & Human Resources	$937.9	$979.0	$1,041.8
		—Major Research Equipment and Facilities Construction	$164.7	$225.5	$236.8
		—Agency Operations & Award Management	$327.5	$341.7	$363.7
		—National Science Board	$4.8	$4.8	$4.9
		—Office of the Inspector General	$14.7	$14.7	$15.0
556	NSF	STEM-Training Grant Program	$10.0	$10.0	$10.0
602	DOC	Federal Loan Guarantees for Innovative Technologies in Manufacturing	$20.0	$20.0	$20.0
603	DOC/EDA	Regional Innovation Program	$100.0	$100.0	$100.0
603	DOC	Loan Guarantees for Science Park Infrastructure	$7.0	$7.0	$7.0
901	DOE/Office of Science	Summer Institutes	$25.0	$25.0	$25.0
902	DOE	Nuclear Science Program Expansion Grants for Institutions of Higher Education	$9.8	$10.1	$10.4

Section	Department/Agency	Program	FY2011	FY2012	FY2013
902	DOE	Nuclear Science Competitiveness Grants for Institutions of Higher Education	$8.2	$8.5	$8.8
902	DOE	Hydrocarbon Systems Science Talent Program	$9.8	$10.0	$10.4
902	DOE/Office of Science	Early Career Awards	$25.0	$25.0	$25.0
902	DOE/Office of Science	Protecting America's Competitive Edge (PACE) Graduate Fellowship Program	$20.6	$21.2	$21.9
902	DOE	Distinguished Scientist Program	$31.0	$32.0	$33.0
903	DOE/Office of Science	Basic Research	$5,247.0	$5,614.0	$6,007.0
904	DOE/ARPA-E	Advanced Research Projects Agency—Energy (ARPA-E)	$300.0	$306.0	$312.0
1003	ED	Teachers for a Competitive Tomorrow	$4.0	$4.0	$4.0
1003	ED	Advanced Placement and International Baccalaureate Programs	$75.0	$75.0	$75.0
1003	ED	Alignment of Education Programs	$120.0	$120.0	$120.0

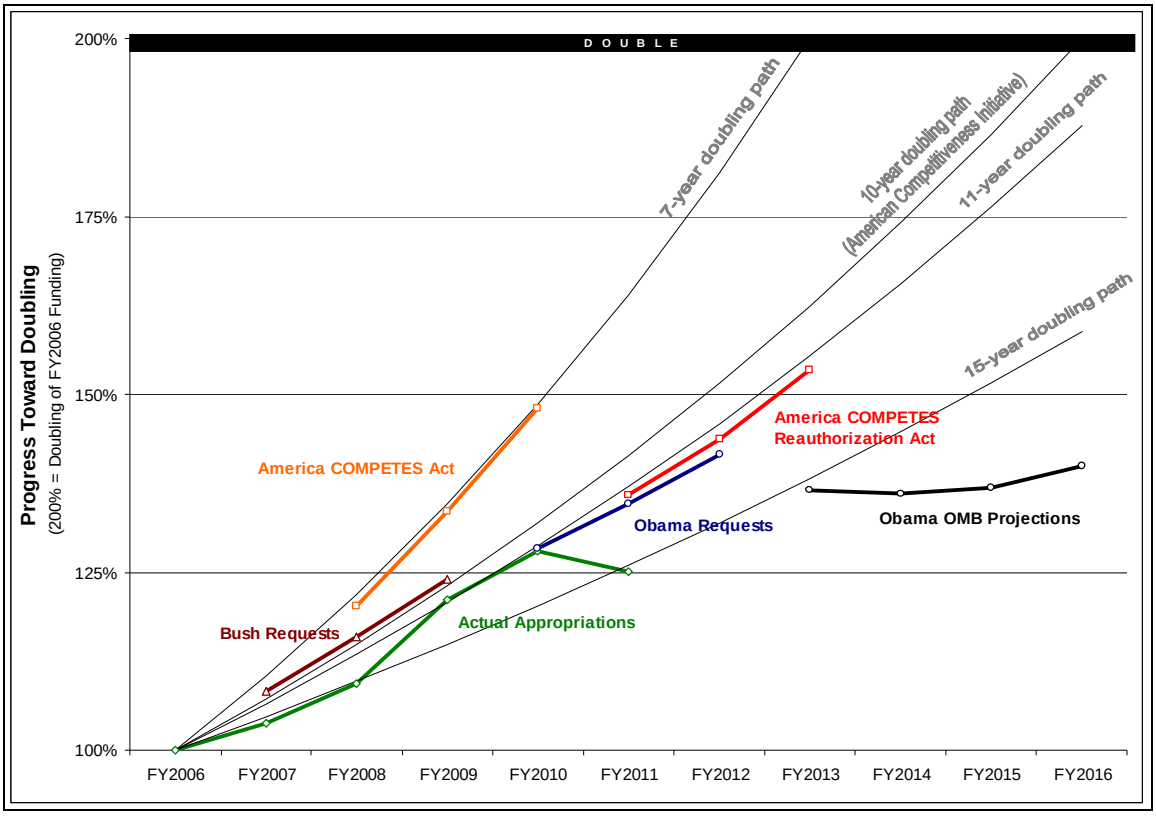
Source: Based on CRS analysis of selected specific appropriations authorizations in P.L. 111-358. May not account for all authorized appropriations.

Notes: The ITS account total in **Table A-1** includes the amounts specifically authorized for the Manufacturing Extension Partnership and Malcolm Baldrige National Quality Award. Specified funds for these sub-accounts are in *italics*.

Appendix B. Figure B-1

Figure B-1. Doubling of Research Funding

Appropriations/Request vs. Selected Rates



Source: John F. Sargent Jr., Specialist in Science and Technology Policy, CRS.

a. "Obama OMB Projections" represent the future year projections (FY2013-FY2016) for the targeted accounts made by the Office of Management and Budget and included as supplemental information in President Obama's FY2012 budget request.

b. In 2009 Congress provided additional funding for the America COMPETES Act (P.L. 110-69) through the American Recovery and Reinvestment Act (ARRA, P.L. 111-5). Figure B-1 does not include ARRA funds.

Appendix C. Table C-1

Table C-1. Comparison of Specified Funding Authorizations in America COMPETES 2007 and 2010

Selected Major Provisions (in millions of dollars, rounded)

Agency	America COMPETES Act			America COMPETES Reauthorization Act of 2010		
	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013
NIST						
Total	not specified	not specified	not specified	$918.9	$970.8	$1,039.7
—Scientific & Technical Research and Services	$502.1	$541.9	$584.8	$584.5	$661.1	$676.7
—Construction & Maintenance	$150.9	$86.4	$49.7	$124.8	$84.9	$121.3
—Industrial Technology Services	$210.0	$253.5	$272.3	$209.6	$224.8	$241.7
Other DOC						
Regional Innovation Program	not included	not included	not included	$100.0	$100.0	$100.0
NSF						
Total	$6,600.0	$7,326.0	$8,132.0	$7,424.4	$7,800.0	$8,300.0
—Research & Related Activities	$5,156.0	$5,742.3	$6,401.0	$5,974.8	$6,234.3	$6,637.8
—Education & Human Resources	$896.0	$995.0	$1,104.0	$937.9	$979.0	$1,041.8
—Major Research Equipment and Facilities Construction	$245.0	$262.0	$280.0	$164.7	$226.0	$236.8
—Agency Operations & Award Management	$285.6	$309.8	$329.5	$327.5	$341.7	$363.7
DOE						
Basic Research	$4,586.0	$5,200.0	$5,814.0	$5,247.0	$5,614.0	$6,007.0
Advanced Research Projects Agency-Energy (ARPA-E)	$300.0	such sums as are necessary	such sums as are necessary	$300.0	$306.0	$312.0
ED						
Alignment of Education Programs	$120.0	such sums as may be necessary	such sums as may be necessary	$120.0	$120.0	$120.0

Agency	America COMPETES Act			America COMPETES Reauthorization Act of 2010		
	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013
Teachers for a Competitive Tomorrow: Baccalaureate Degrees	$151.2	such sums as may be necessary	such sums as may be necessary	$2.0	$2.0	$2.0
Teachers for a Competitive Tomorrow: Master's Degrees	$125.0	such sums as may be necessary	such sums as may be necessary	$2.0	$2.0	$2.0

Source: CRS analysis of P.L. 110-69 and P.L. 111-358.

a. Appropriations Authorizations for basic research at the Department of Energy in 2008 and 2009 are as authorized by the Energy Policy Act of 2005, not the America COMPETES Act (P.L. 110-69).

b. For the purpose of Table 2, "Major Provisions" and "major accounts" are selected specified appropriations authorizations worth at least $100 million in any given fiscal year between FY2008 and FY2013.

c. Funding authorizations for the Teachers for a Competitive Tomorrow program in P.L. 111-358 (FY2011-FY2013) are relatively consistent with actual appropriations for the program during the P.L. 110-69 authorization period (FY2008-FY2010).

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