Joint Economic Committee | Democrats
Senator Amy Klobuchar, Vice Chair

December 2014

The Role of Research & Development in Strengthening America's Innovation Economy

JOINT ECONOMIC COMMITTEE
VICE CHAIR AMY KLOBUCHAR

UNITED STATES CONGRESS
DECEMBER 2014

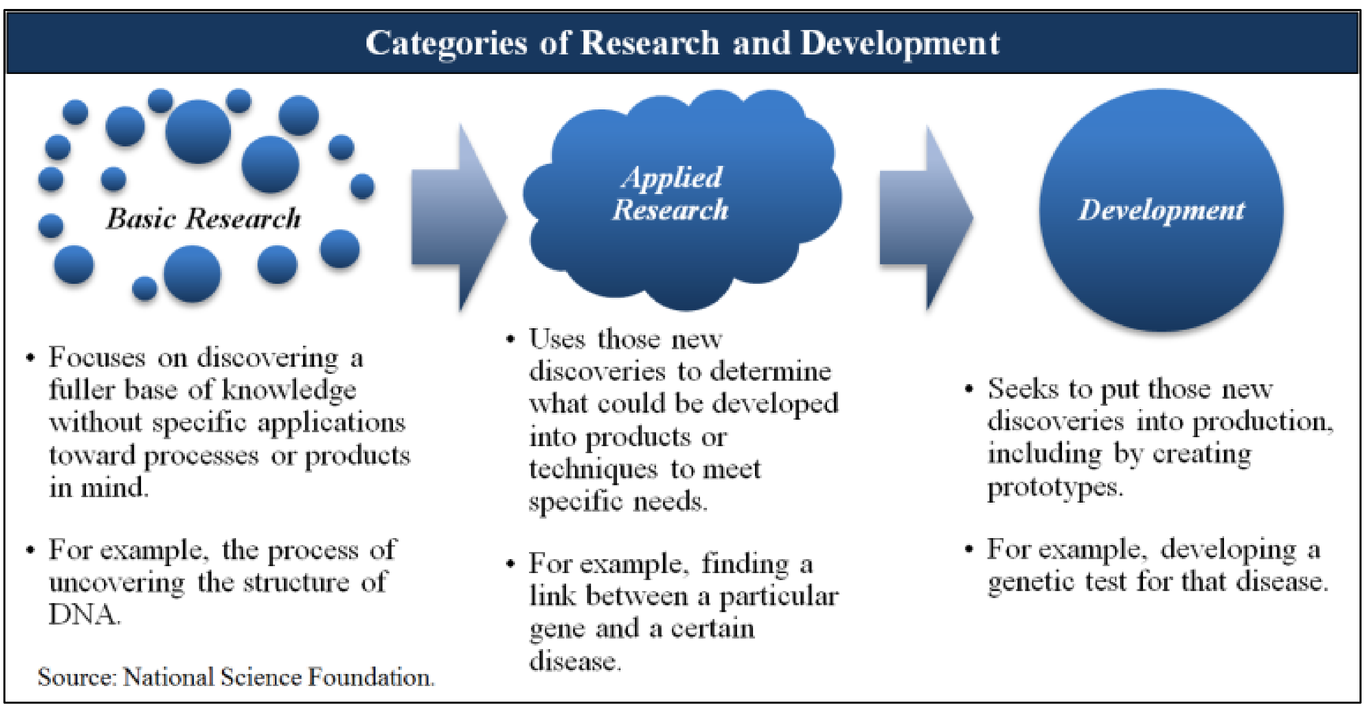
THE ROLE OF RESEARCH AND DEVELOPMENT IN STRENGTHENING AMERICA'S INNOVATION ECONOMY

America has long been at the forefront of innovation, from the light bulb to the mapping of the human genome. American innovations have changed the world by spawning new industries, making businesses more productive, enabling faster communication and transportation, and helping people live longer, healthier lives.

Businesses are the largest source of research and development funding.[1] The federal government also plays a critical role in supporting research and development and funds more than half of basic research.[2] In terms of the total dollar amount, the United States spends more on research and development than any other country.[3]

Yet when measuring research and development spending as a share of gross domestic product (GDP), the United States ranks tenth in the world and has lost some ground in recent years as other countries have increased their spending.[4] One decade earlier, the United States ranked sixth in the world.[5] To maintain its place at the cutting edge of innovation and promote long-term economic growth, the United States must rededicate itself to fostering research and development.

This report describes the contribution of research and innovation to economic growth. It analyzes trends in research and development spending and examines how the United States compares with other countries. It concludes by discussing policy options to strengthen America's innovation economy.



Source: National Science Foundation.

Research and Innovation's Contribution to Economic Growth

Innovation lies at the core of economic growth, job creation and quality of life improvements.[6] For example, innovation enables people to live longer and stay healthier as advances in medical care are made and novel screening methods are developed. Life expectancy in the United States has increased by nearly 50 percent over the past century.[7] Healthier workers are more productive, and countries with longer life expectancies are wealthier.[8]

A significant portion of economic growth in the United States has been attributed to improved productivity resulting in part from innovation.[9] While estimates vary, economic research shows there are substantial private returns to research and development and even higher returns to the broader economy.[10] Spillover benefits account for an estimated three-fifths of the total return on research and development.[11]

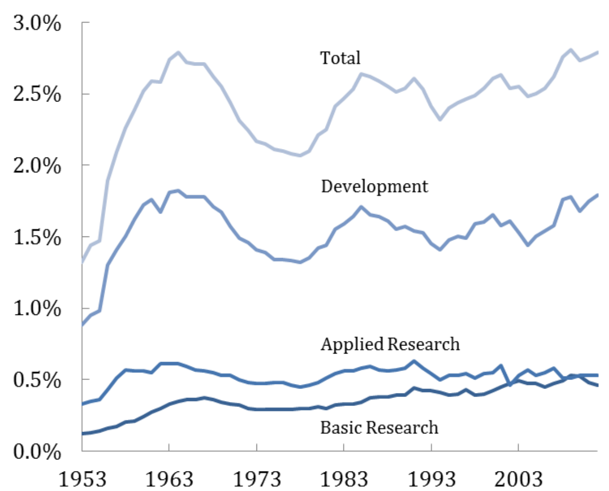
Spending on Research and Development

<u>Overall:</u> In 2012, $453 billion was spent on research and development in the United States.[12] Spending on development was about $291 billion, while funding for basic and applied research was around $75 billion and $87 billion, respectively.

Total research and development expenditures as a share of GDP reached nearly 2.8 percent in 1964, at the height of the space race, before declining to less than 2.1 percent in the 1970s (**Figure 1**).[13] This share rebounded to around 2.6 percent in the 1980s, in part due to the research and development tax credit enacted in 1981.[14] Research and development spending as a share of GDP remained relatively flat from the 1980s until the recent recession, when a declining GDP coupled with a temporary increase in federal spending led to a record high of more than 2.8 percent in 2009. This share has remained near its historical high even as growth has returned.

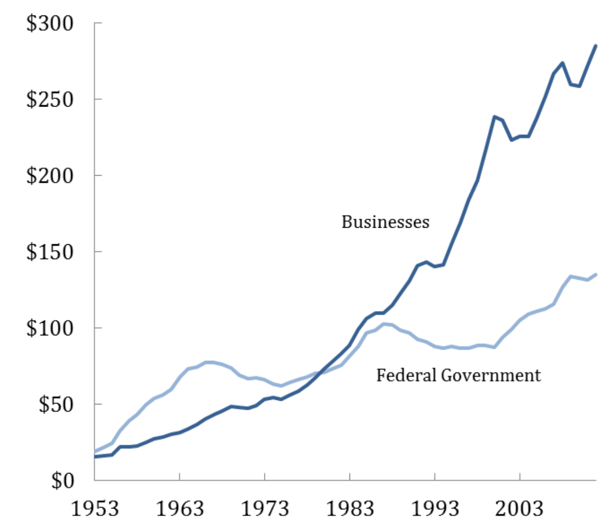
Businesses have been the largest source of research and development spending since 1980 (**Figure 2**). In 2012, businesses accounted for 63 percent of all research and development expenditures ($285 billion), while the federal government spent slightly less than half of that amount, comprising 30 percent ($135 billion). The remaining seven percent came from other sources, including state and local governments, nonprofits and universities.

Figure 1. Research and Development Spending as a Share of GDP
1953-2012



Source: JEC Democratic staff calculations based on data from the National Science Foundation, *National Patterns of R&D Resources: 2011–12 Data Update*, and the Bureau of Economic Analysis.

Figure 2. Total Research and Development Spending
Inflation adjusted, 2012 dollars (billions), 1953-2012



Source: JEC Democratic staff calculations based on data from the National Science Foundation, *National Patterns of R&D Resources: 2011–12 Data Update*, and the Bureau of Economic Analysis.

Businesses: Business expenditures on research and development continue to be concentrated in development because it has more direct commercial applicability. In 2012, development accounted for 78 percent of total business spending on research and development, while much smaller shares were spent on both applied research (16 percent) and basic research (six percent). Still, businesses were responsible for more than half of all spending on applied research.[15]

The manufacturing sector accounts for about 70 percent of all industry research and development spending, about two-thirds of which is in the computer and electronic products industry and the chemical industry. The information industry and the professional, scientific and technical services industry also account for significant research and development spending.[16]

Public sector: In 2012, the federal government directly funded 36 percent of applied research and more than half of basic research (53 percent) (**Figure 3**).[17] This funding often goes to universities and colleges, which perform most basic research.[18]

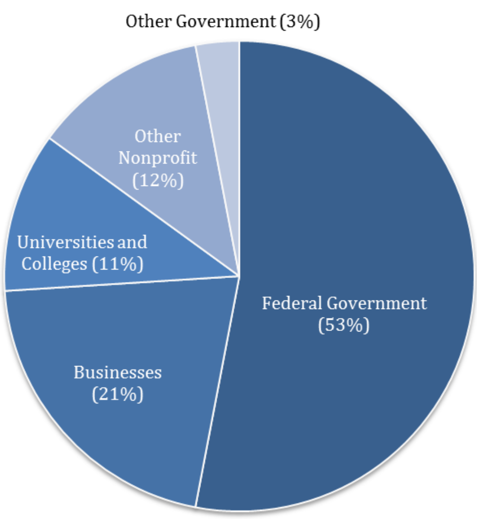
The Department of Defense (DoD) receives about half of federal government funding for research and development, $66 billion in fiscal year 2014.[19] The Department of Health and Human Services received $31 billion (24 percent of total funding), the highest amount of any nondefense agency (**Figure 4**). Almost all of this funding goes to the National Institutes of Health (NIH) ($30 billion), which distributes most of it to the research community through competitive grants, contracts and other awards.[20]

In contrast to DoD, where 90 percent ($59 billion) is directed toward development—mostly for major military systems—other agencies spend the vast majority of federal funds on early-stage research. At nondefense agencies, a combined 89 percent goes to basic research (47 percent) and applied research (42 percent), with 11 percent spent on development.

In addition to supporting research and development directly by appropriating funds to agencies, the federal government also provides indirect support by offering incentives for private firms, such as the research and development tax credit.

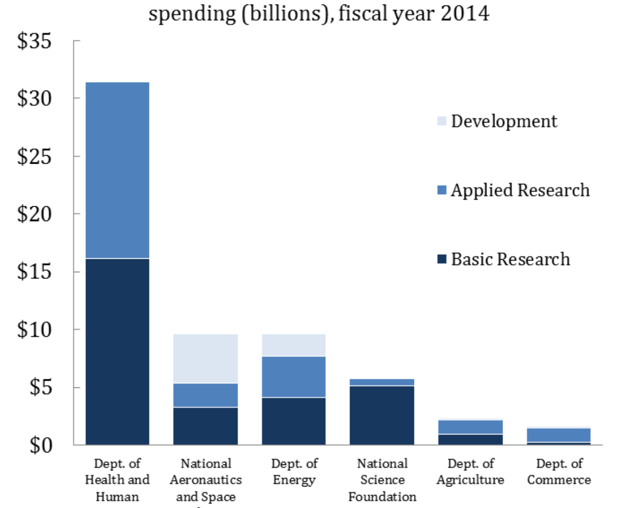
Across the states: Private- and public-sector research and development spending varies from state to state (**Table 1**). Total research and development expenditures are highest in California ($91 billion in 2011, the most recent year for which state-by-state data are available), but when

Figure 3. Basic Research Funding by Source
Share of funding, 2012



Source: JEC Democratic staff calculations based on data from the National Science Foundation, *National Patterns of R&D Resources: 2011-12 Data Update.*

Figure 4. Federal Agency Research and Development Expenditures
Top six nondefense agencies, by category of spending (billions), fiscal year 2014



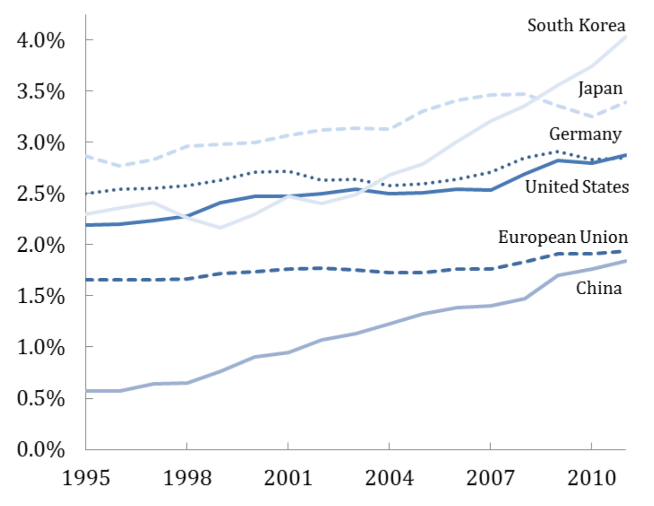
Source: JEC Democratic staff calculations based on preliminary data for fiscal year 2014 from the National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 2012-2014*, Table 7.

measured as a share of the state's GDP, New Mexico ranks first (7.6 percent). Other states at the top for research and development spending as a share of GDP include Maryland (6.3 percent), Massachusetts (5.7 percent), Washington (5.0 percent) and California (4.8 percent).

This variation can be attributed in part to the concentration of large universities, innovative companies and Federally Funded Research and Development Centers (FFRDCs) in certain states.[21] For instance, Los Alamos National Laboratory and Sandia National Laboratories, the two biggest FFRDCs, are located in New Mexico.[22] California is also home to several of the largest FFRDCs.

International comparisons: U.S. spending on research and development continues to exceed spending in every other country.[23] However, when measuring spending as a percentage of GDP, the United States (2.85 percent) ranks tenth in the world.[24] South Korea (4.03 percent), Japan (3.39 percent) and Germany (2.88 percent) are among the countries that devote a higher share of GDP to research and development, and both South Korea and China are increasing spending as a share of GDP at a faster rate than the United States (**Figure 5**).[25]

Figure 5. Research and Development Spending in Select Countries as a Share of GDP
1995-2011



Source: JEC Democratic staff calculations based on data from the National Science Foundation, *National Patterns of R&D Resources: 2011–12 Data Update,* and the Bureau of Economic Analysis.

Policy Proposals to Strengthen America's Innovation Economy

The United States can remain a world leader in innovation by pursuing policies that boost public- and private-sector research and development, and help ensure an ample supply of skilled scientists and engineers. Policies that would strengthen America's innovation economy include:

Providing robust, stable funding to federal agencies for research and development

While the federal government remains the leading source of basic research funding, budget cuts and fiscal uncertainty can undercut progress toward new discoveries. The number of research grants at NIH has been declining in recent years, a result of stagnant funding and the increasing cost of biomedical research.[26] Sequestration in fiscal year 2013 added to the challenges facing the research community that competes for funding from NIH and other agencies.[27] These cuts were particularly harmful to research universities.[28] Tight budgets and historically low grant application success rates can be especially detrimental to young scientific researchers, possibly discouraging them from pursuing a career in research or causing them to seek positions outside of the United States.[29]

Policymakers should provide robust, stable funding for research and development, as well as replace the indiscriminate cuts of sequestration with targeted, balanced deficit reduction. In addition, annual spending bills should be passed in a timely manner to help federal agencies better plan investments.

The Accelerating Biomedical Research Act (S. 2658) would prioritize funding for NIH over the remaining years of the Budget Control Act to help accelerate the discovery of treatments and cures and maintain U.S. global leadership in biomedical research. Specifically, it would allow for restoring the purchasing power NIH had in fiscal year 2003 at the conclusion of a multi-year effort that doubled its funding.

Encouraging private-sector innovation

Policymakers should work to make the research and development tax credit permanent. Bolstering this credit and allowing new businesses to access it can further encourage private-sector research and development.[30] The Startup Innovation Credit Act (S. 193) would help more new businesses benefit from this tax credit by enabling them to claim a credit against their payroll taxes.

An effective patent system is essential to ensuring businesses realize the benefits they deserve from their innovations. Policymakers took initial steps to modernize and streamline the patent system by passing the America Invents Act of 2011 (P.L. 112-29), but a spike in patent litigation in recent years has exposed flaws in this system that need to be addressed. In particular, additional reforms are needed to curtail excessive litigation by certain Patent Assertion Entities (also known as "patent trolls"). While it is important to protect patent holders' ability to defend against infringements, patent trolls often file baseless lawsuits against a wide range of defendants, including small businesses that lack the resources to defend against these suits. These lawsuits can cause companies to become bogged down in litigation at the expense of innovation.

Policies that benefit manufacturers can help spur research and development. Steps should include expanding access to capital, promoting export opportunities, building transportation infrastructure and enacting smarter tax and regulatory policies.[31]

Enhancing coordination and improving regulations

Moving from an idea to commercialization of a product can require much coordination between federal, state and local governments, universities and businesses. It also can involve navigating a number of rules and regulations.

Policymakers can bolster research and innovation by reauthorizing the America COMPETES Act, parts of which expired in 2013. This Act includes provisions to strengthen funding for research and development at federal agencies, improve science education programs and enhance collaboration on policies related to innovation, technology transfer and commercialization. It also establishes loan guarantees for innovative small- and medium-sized manufacturers and supports the development of regional innovation strategies.

The Revitalize American Manufacturing and Innovation Act establishes a network of centers across the country where businesses, universities and state and local governments can come together to share knowledge, develop new processes and foster integrated supply chains.[32]

Improving the federal regulatory process can maximize the economic benefits of research and minimize unnecessary costs they might impose on innovators. Retroactive analysis of regulations to determine whether they are working could improve the regulatory process.[33] The Strengthening Congressional Oversight of Regulatory actions for Efficiency (SCORE) Act (S. 1472) would establish a Regulatory Analysis Division within the Congressional Budget Office that would assess the impact of federal regulations, including by conducting ex-post reviews.

Improving STEM education and training

Workers with science, technology, engineering and math (STEM) capabilities help spur innovation and are better positioned to compete for the jobs of the future.[34] However, not enough Americans are obtaining post-secondary STEM degrees. Over the next decade, the economy will need about one million more STEM professionals than the United States will produce at the current rate.[35]

The Innovate America Act (S. 1777) would double the number of STEM-focused high schools, promote computer science training and expand research opportunities for STEM undergraduates. The Women and Minorities in STEM Booster Act (S. 288) would require the National Science Foundation to award competitive grants to programs aimed at increasing the participation of women and underrepresented minorities in STEM.

Additional policies to improve STEM education include ensuring that schools have the resources to teach these skills and attract STEM graduates as teachers; implementing partnerships between schools and businesses; and helping veterans transition to the civilian workforce.[36]

Enacting immigration reform

Immigrants make critical contributions to advancing U.S. innovation.[37] Immigrants receive patents at a high rate per capita,[38] and they started 25 percent of engineering and technology companies founded between 1995 and 2005.[39] Roughly 30 percent of all U.S.-based Nobel laureates were foreign born.[40] Despite these achievements, current immigration policy prevents many talented scientists and engineers from coming to the United States and staying here.

The Border Security, Economic Opportunity, and Immigration Modernization Act (S. 744), as passed by the Senate last year, would exempt doctoral-degree holders from employment-based green card caps and increase the annual cap for H-1B visas to between 115,000 and 180,000 depending on labor-market conditions and existing demand for these visas. It would also increase the H-1B cap exemption for U.S. advanced-degree holders from 20,000 to 25,000.

Conclusion

America has long been a world leader in innovation. To remain at the forefront, the United States must continue to invest in research and development, as well as cultivate a strong STEM-capable workforce. Bolstering innovation will lay the groundwork for sustained economic growth.

Table 1. Research and Development Spending by State (2011)					
State	Total R&D Spending (millions)	Federally Funded R&D (millions)	Business R&D Spending (millions)	Total R&D Spending as a Share of State Gross Domestic Product	
				Share	Rank
United States Total	$428,163	$129,068	$267,306	2.8%	-
Alabama	$4,946	$3,425	$867	2.8%	15
Alaska	$381	$223	$57	0.7%	45
Arizona	$6,453	$1,722	$3,804	2.5%	21
Arkansas	$678	$201	$318	0.6%	49
California	$91,420	$20,104	$64,580	4.8%	5
Colorado	$6,862	$2,635	$3,704	2.6%	19
Connecticut	$8,736	$1,871	$6,292	3.9%	8
Delaware	$2,296	$157	$1,459	3.6%	9
District of Columbia	$3,418	$3,051	$174	3.2%	10
Florida	$9,073	$3,762	$3,944	1.2%	36
Georgia	$5,779	$1,506	$3,388	1.4%	34
Hawaii	$746	$388	$206	1.1%	39
Idaho	$1,795	$566	$874	3.1%	12
Illinois	$15,974	$3,235	$10,863	2.4%	22
Indiana	$7,579	$818	$5,547	2.7%	16
Iowa	$3,144	$510	$1,770	2.2%	25
Kansas	$2,081	$324	$1,074	1.5%	32
Kentucky	$1,895	$532	$1,038	1.1%	38
Louisiana	$1,523	$713	$422	0.6%	48
Maine	$535	$192	$269	1.0%	41
Maryland	$19,219	$15,066	$2,951	6.3%	2
Massachusetts	$22,022	$6,463	$12,904	5.7%	3
Michigan	$16,372	$2,129	$12,217	4.3%	6
Minnesota	$7,394	$1,069	$5,625	2.6%	17
Mississippi	$941	$543	$207	1.0%	42
Missouri	-	$777	$2,878	-	-
Montana	$408	$215	$120	1.0%	40
Nebraska	$1,115	$288	$621	1.2%	37
Nevada	$889	$224	$557	0.7%	47
New Hampshire	$2,471	$284	$963	3.9%	7
New Jersey	$15,705	$1,524	$12,030	3.2%	11
New Mexico	$6,070	$5,586	$259	7.6%	1
New York	$18,566	$6,494	$9,410	1.6%	30
North Carolina	$9,356	$2,314	$5,458	2.1%	26
North Dakota	$504	$148	$245	1.3%	35
Ohio	$10,359	$3,518	$5,554	2.1%	27
Oklahoma	$1,207	$465	$533	0.8%	44
Oregon	$5,515	$725	$4,438	2.9%	13
Pennsylvania	$13,651	$3,221	$9,177	2.3%	23
Rhode Island	$1,396	$647	$458	2.8%	14
South Carolina	$2,389	$773	$979	1.4%	33
South Dakota	$293	$110	$114	0.7%	46
Tennessee	$4,218	$2,477	$1,309	1.6%	29
Texas	$20,623	$4,137	$13,205	1.6%	31
Utah	$3,276	$1,086	$1,896	2.6%	18
Vermont	$519	$136	$331	2.0%	28
Virginia	$11,166	$7,158	$3,191	2.6%	20
Washington	$17,979	$3,485	$13,694	5.0%	4
West Virginia	$597	$275	$217	0.9%	43
Wisconsin	$5,605	$927	$3,591	2.2%	24
Wyoming	$115	$65	$35	0.3%	50

Notes: Total R&D spending does not represent the sum of federally funded R&D and business R&D as it includes R&D funding from other categories, such as nonprofit organizations and state and local governments. In addition, U.S. total data do not match the sum of states in part because some R&D expenditures cannot be allocated to one of the states. For the states, business R&D refers to the sum of businesses' own R&D spending and excludes R&D funded by other nonfederal sources. "-" indicates that R&D data are not available.
Source: JEC Democratic staff calculations based on data from the National Science Foundation, *National Patterns of R&D Resources*.

Sources:

[1] JEC Democratic staff calculations are based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/pdf/nsf14304.pdf. Those data are based on the NSF's national surveys of the research and development expenditures of U.S. businesses, governments, academic and other organizations. Last year, the Bureau of Economic Analysis (BEA) incorporated research and development investment spending into the U.S. national income and product accounts. While the BEA estimates are generally based on the same sources as the NSF data and are broadly similar, the taxonomy and coverage of the research and development data can differ somewhat from those of the NSF aggregates as BEA adjusts the expenditures data to make them suitable for inclusion in the national accounts. Those differences are not directly relevant to the purposes of this report and, to enable some comparisons that are possible only with the published NSF data, the JEC reports only those data here. For a more detailed discussion of the BEA approach, see Bureau of Economic Analysis, "Preview of the 2013 Comprehensive Revision of the National Income and Product Accounts: Changes in Definitions and Presentations" (Survey of Current Business, March 2013), http://www.bea.gov/scb/pdf/2013/03%20March/0313_nipa_comprehensive_revision_preview.pdf.

[2] JEC Democratic staff calculations based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/.

[3] National Science Foundation, "Science and Engineering Indicators 2014" (February 2014), http://www.nsf.gov/statistics/seind14/content/etc/nsb1401.pdf.

[4] Ibid.

[5] National Science Foundation, "Science and Engineering Indicators 2004" (May 2004), http://www.nsf.gov/statistics/seind04/c4/c4s4.htm#c4s4l2.

[6] For further discussion of the effects of innovation on the economy, see Congressional Budget Office, *Federal Policies and Innovation* (November 2014), http://www.cbo.gov/publication/49487.

[7] Andrew Noymer and Michael Garenne, "The 1918 Influenza Epidemic's Effects on Sex Differentials in Mortality in the United States," *Population and Development Review*, vol. 26, no. 3 (September 2000), http://demog.berkeley.edu/~andrew/1918/PDR_1918_flu.pdf (see data underlying Figure 2 at http://demog.berkeley.edu/~andrew/1918/figure2.html); Donna L. Hoyert and Jiaquan Xu, "Deaths: Preliminary Data for 2011," *National Vital Statistics Reports*, vol. 61, no. 6 (October 10, 2012), http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_06.pdf.

[8] Centers for Disease Control and Prevention, "Workplace Health Promotion" (October 23, 2013), http://www.cdc.gov/workplacehealthpromotion/businesscase/benefits/productivity.html; Yuyan Shi, Lindsay E. Sears, and Carter R. Coberley, "The Association Between Modifiable Well-Being Risks and Productivity: A Longitudinal Study in Pooled Employer Sample," *Journal of Occupational and Environmental Medicine*, vol. 55, no. 4 (April 2013), http://journals.lww.com/joem/toc/2013/04000; Alok Bhargava and others, "Modeling the Effects of Health on Economic Growth," *World Health Organization, Global Programme on Evidence for Health Policy Discussion Paper Series*, no. 33, http://www.who.int/healthinfo/paper33.pdf; Statistical Consultants Ltd, "Life Expectancy at Birth Versus GDP per Capita (PPP)" (accessed August 26, 2014), http://www.statisticalconsultants.co.nz/weeklyfeatures/WF6.html; Diana Bowser, "The Effect of Life Expectancy on Economic Growth in the United States," *Population Association of America Conference* (April 2010), http://paa2010.princeton.edu/papers/101886.

[9] Charles Jones, "Sources of U.S. Economic Growth in a World of Ideas," *The American Economic Review*, vol. 92, no. 1 (March 2002), http://stanford.edu/~chadj/SourcesAER2002.pdf; Jason E. Bordoff and others, "Promoting Opportunity and Growth Through Science, Technology, and Innovation," *The Hamilton Project at the Brookings Institution* (December 2006), http://www.hamiltonproject.org/files/downloads_and_links/Promoting_Opportunity_and_Growth_through_Science_Technology_and_Innovation.pdf.

[10] Bronwyn H. Hall, Pierre Mohnen, and Jacques Mairesse, *Measuring the Returns to R&D*, Working Paper 15622 (National Bureau of Economic Research, December 2009), http://www.nber.org/papers/w15622.

[11] Leo Sveikauskas, *R&D and Productivity Growth: A Review of the Literature*, Working Paper 408 (Bureau of Labor Statistics, September 2007), http://www.bls.gov/ore/pdf/ec070070.pdf.

[12] JEC Democratic staff calculations based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/. All data represent calendar-year approximations unless otherwise noted.

[13] Ibid; Bureau of Economic Analysis, National Income and Product Accounts, Gross Domestic Product. The JEC staff calculations for research and development as a share of GDP differ from those in the NSF data tables. This is because the JEC calculations use the most recent estimates of GDP, which include the BEA's comprehensive revisions to GDP in July 2013. For additional information on these revisions, see http://www.bea.gov/newsreleases/national/gdp/2013/gdp2q13_adv.htm.

[14] Bronwyn H. Hall, *Effectiveness of Research and Experimentation Tax Credits: Critical Literature Review and Research Design* (submitted by Bronwyn H. Hall to the Office of Technology Assessment, Congress of the United States, June 15, 1995), http://eml.berkeley.edu/~bhhall/papers/BHH95%20OTArtax.pdf.

[15] JEC Democratic staff calculations based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/.

[16] JEC Democratic staff calculations based on data from the National Center for Science and Engineering Statistics, "Business R&D Performance in the United States Tops $300 Billion in 2012," (October 2014), http://www.nsf.gov/statistics/2015/nsf15303/nsf15303.pdf.

[17] JEC Democratic staff calculations based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/.

[18] Ibid.

[19] National Science Foundation, "Federal Funds for Research and Development: Fiscal Years 2012-14, Table 7" (September 2014), http://www.nsf.gov/statistics/nsf14316/content.cfm?pub_id=4418&id=2.

[20] National Institutes of Health, "OER and You: An Introduction to Extramural Research at NIH" (accessed August 1, 2014), https://grants.nih.gov/grants/intro2oer.htm.

[21] FFRDCs are privately operated research and development organizations that are exclusively or substantially financed by the federal government. National Center for Science and Engineering Statistics, "Federally Funded R&D Centers Report Declines in R&D Spending in FY 2012" (January 2014), http://www.nsf.gov/statistics/infbrief/nsf14308/nsf14308.pdf.

[22] National Science Foundation, "Master Government List of Federally Funded R&D Centers" (accessed November 19, 2014), http://www.nsf.gov/statistics/nsf06316/.

[23] In 2011, the most recent year with global data, U.S. research and development expenditures were one-third greater than the amount spent in the European Union ($321 billion), more than double China ($208 billion), close to triple Japan ($147 billion) and more than seven times greater than South Korea ($60 billion). JEC Democratic staff calculations based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/.

[24] International accounting standards differ slightly from U.S. measures. National Science Foundation, "Science and Engineering Indicators 2014" (February 2014), http://www.nsf.gov/statistics/seind14/content/etc/nsb1401.pdf.

[25] JEC Democratic staff calculations based on data from the National Science Foundation, "National Patterns of R&D Resources: 2011-12 Data Update, NSF 14-304" (December 2013), http://www.nsf.gov/statistics/nsf14304/; Bureau of Economic Analysis, National Income and Product Accounts, Gross Domestic Product. For further information on the JEC staff calculations, see endnote one.

[26] National Institutes of Health Office of Extramural Research/ Office of Planning, Analysis and Communications/ Divisions of Statistical Analysis and Reporting, "Research Project Grants: Success rates by Type, Activity, and Institute/Center" (accessed November 19, 2014), http://report.nih.gov/DisplayRePORT.aspx?rid=536.

[27] National Institutes of Health, "Fact Sheet: Impact of Sequestration on the National Institutes of Health" (November 4, 2013), http://www.nih.gov/news/health/jun2013/nih-03.htm; Kwame Boadi, "Sequestering American Innovation," Center for American Progress (December 9, 2013), http://www.americanprogress.org/wp-content/uploads/2013/12/SequesteringInnovation-brief-3.pdf; Government Accountability Office, *Sequestration: Observations on the Department of Defense's Approach in Fiscal Year 2013* (November 7, 2013), http://www.gao.gov/assets/660/658913.pdf.

[28] Association of American Universities, Association of Public and Land-Grant Universities and the Science Coalition, "Survey on Sequestration Effects: Selected Results from Private and Public Research Universities" (November 11, 2013), https://www.aau.edu/WorkArea/DownloadAsset.aspx?id=14798; Nick Anderson, "Universities Continue to Lobby Against Sequester's Cuts of Research Funding," *The Washington Post* (November 12, 2013), http://www.washingtonpost.com/local/education/universities-continue-to-lobby-against-sequesters-cuts-of-research-

funding/2013/11/12/64c29e68-4bba-11e3-be6b-d3d28122e6d4_story.html; Libby A. Nelson, "Harvard President Sounds Alarm over Sequester," *Politico* (November 19, 2013), http://www.politico.com/story/2013/11/harvard-president-drew-faust-sequester-100087.html.

[29] For data on grant application success rates at NIH, see National Institutes of Health Office of Extramural Research, Office of Planning, Analysis and Communications, Divisions of Statistical Analysis and Reporting, "Research Project Grants: Success rates by Type, Activity, and Institute/Center" (December 2013), http://report.nih.gov/DisplayRePORT.aspx?rid=565. For a discussion of the impact on young researchers, see Testimony of Ronald J. Daniels, President, Johns Hopkins University, before the United States Senate Committee on Appropriations, *Driving Innovation Through Federal Investments* (April 29, 2014), http://www.appropriations.senate.gov/sites/default/files/hearings/Johns%20Hopkins%20University%20-%20OWT.pdf.

[30] New firms are often unable to qualify for the current research and development tax credit because they are not yet profitable.

[31] For further discussion of policy options to support U.S. manufacturing, see Joint Economic Committee, *Manufacturing Jobs for the Future* (December 2013), http://www.jec.senate.gov/public/?a=Files.Serve&File_id=a5c87e25-ff51-4b4f-9ced-2ee4b0bee12f.

[32] A version of the Revitalize American Manufacturing and Innovation Act (S. 1468) is included in the recently enacted Consolidated and Further Continuing Appropriations Act, 2015 (H.R. 83).

[33] Testimony of Michael Greenstone, 3M Professor of Environmental Economics, Massachusetts Institute of Technology Department of Economics, before the U.S. Congress Joint Economic Committee, *Eliminating Unnecessary and Costly Red Tape Through Smarter Regulations* (June 26, 2013), http://www.jec.senate.gov/public//index.cfm?a=Files.Serve&File_id=6acd31f1-6664-4138-98db-c25915cf74bb.

[34] Richard B. Freeman, "Does Globalization of the Scientific/Engineering Workforce Threaten U.S. Economic Leadership?" *National Bureau of Economic Research*, vol. 6, (August 2006), nber.org/chapters/c0207.pdf.

[35] President's Council of Advisors on Science and Technology, *Report to the President: Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics* (February 2012), http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf.

[36] For further discussion of policy options to strengthen STEM education and training, see Joint Economic Committee, *STEM Education for the Innovation Economy* (January 2014), http://www.jec.senate.gov/public/?a=Files.Serve&File_id=9bfced75-07a0-466b-a94b-8ab399582995.

[37] Testimony of Adriana Kugler, Vice-Provost for Faculty and Professor, Georgetown University's McCourt School of Public Policy, before the U.S. Congress Joint Economic Committee, *Immigration and Its Contribution to Our Economic Strength* (May 7, 2013), http://www.jec.senate.gov/public//index.cfm?a=Files.Serve&File_id=78204a8f-ca20-4e2d-8411-49ef4a044425; Testimony of Madeline Zavodny, Professor, Department of Economics at Agnes Scott College, before the U.S. Congress Joint Economic Committee, *Immigration and Its Contribution to Our Economic Strength* (May 8, 2013), http://www.jec.senate.gov/public//index.cfm?a=Files.Serve&File_id=bbeb6932-939d-4eac-94c1-ebaa478ef6c5.

[38] Marjolaine Gauthier-Loiselle and Jennifer Hunt, "How Much Does Immigration Boost Innovation?" *American Economic Journal: Macroeconomics*, vol. 2, no. 2 (April 2010), http://www.aeaweb.org/articles.php?doi=10.1257/mac.2.2.31; Michael Greenstone and Adam Looney, The Hamilton Project, "Ten Economic Facts About Immigration" (September 2010), http://www.brookings.edu/~/media/research/files/reports/2010/9/immigration%20greenstone%20looney/09_immigration.pdf.

[39] Council of Economic Advisers, *Annual Report of the Council of Economic Advisers* (March 2013), http://www.whitehouse.gov/sites/default/files/docs/erp2013/full_2013_economic_report_of_the_president.pdf.

[40] Jon Bruner, "American Leadership in Science, Measured in Nobel Prizes," *Forbes* (October 5, 2011), http://www.forbes.com/sites/jonbruner/2011/10/05/nobel-prizes-and-american-leadership-in-science-infographic/.