

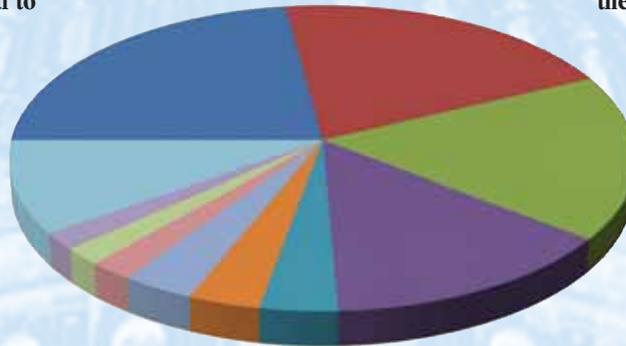
The Evolution of Federal Funding for University Research: History and Current Trends

By Elizabeth Haney

Federal funding is essential to research at universities and leads to new solutions to important problems. For example, a federally funded study at the University of Nebraska allowed Prof. Stephen DiMugno to study the behavior of ions in solution. Although

this topic seems very basic and far removed from medicine, this work was essential to improving PET scans that are used to detect cancer (1). Federally funded research can also address more trivial issues—the cloud computing industry that lets us enjoy games of Candy Crush on iPhones would not exist if it were not for federally funded research at the University of California Santa Barbara that laid the foundations for this technology (1). Federal funding also allows great thinkers to share their knowledge with the world. It will support Walter Isaacson, author of the best-selling biography *Steve Jobs*, when he gives a lecture this May at the John F. Kennedy Center for the Performing Arts about historical figures who fused the sciences and the humanities in their careers (2). You could say that federal funding is the engine that drives the research enterprise at universities.

Scratch that. Maybe engines and driving are not the best metaphors just yet. After all, federal support for research was invented long before the automobile. It began early in our nation's history, only 11 years after the signing of the Constitution. On July 16, 1798, the predecessor to



the Public Health Service (PHS), the Marine Hospital Service, was established by President John Adams. Although the Marine Hospital Service initially focused on the relief of sick and disabled seamen, by the time the automobile was invented in 1886,

there was a small intramural research program. So it is metaphorically correct to say that by then, federal funding was truly an engine driving research. It is also historically correct; in 1887, the government set up a one-room lab at the Marine Hospital on Staten Island, NY (3) where a single scientist who was only 27 years old studied the deadly microorganisms that caused yellow fever, cholera, and smallpox. That scientist, James Kinyoun, referred to his lab as the Laboratory of Hygiene. It was renamed the Hygienic Laboratory in 1891, when it was also relocated to Washington, DC, and today we know the organization, much changed of course, as the National Institutes of Health (NIH) (3,4). The first formal extramural grants from the PHS did not come until 1918 when the Chamberlain-Kahn Act authorized grants to 25 institutions; this law set the precedent for the federal government to give grants to university scientists to fund their research (4). These first grants reflected the PHS's priorities for research at the time—they were specifically for the study of venereal diseases. This fact is less surprising when we recall that the PHS started as an agency to provide medical care to retired sailors.



This small lab ultimately became the 27 institutes and centers that make up the NIH. Images from National Cancer Institute, National Institute of Health



One of the earliest NSF funded projects was the National Radio Astronomy Observatory.



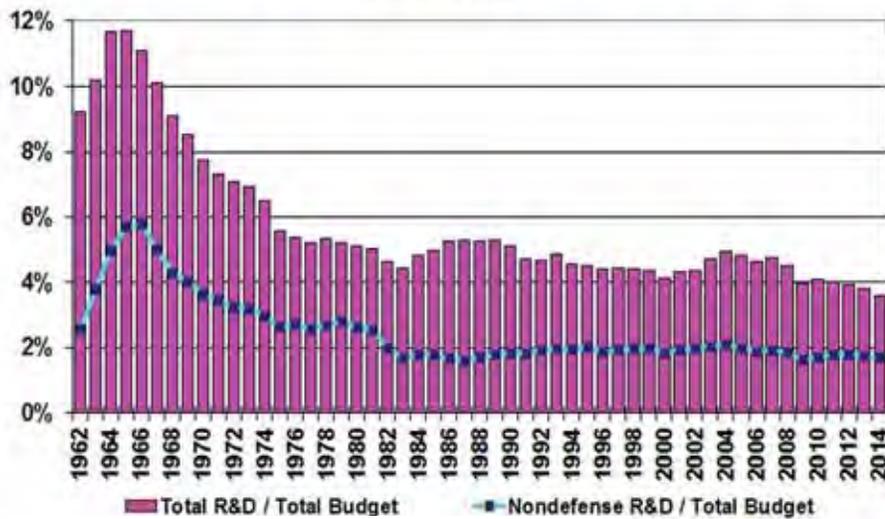
The engine of federal funding is what drives research at universities. Although federal funding for university research began with grants to 25 institutions in 1918, by 1967 the NSF alone funded almost a half a billion dollars in research. This change is like going from a horseless buggy to a mustang!

The Golden Age of Federal Funding: Filling the Gas Tank and Revving the Engine

In 30 years, we went from a one horsepower engine (James Kinyoun's lab) to 25 horsepower (those first grants). Just over 20 years later, in 1940, the engine driving the university research enterprise had even more horsepower. Those first few federal grants had grown into \$350 million in federal funds for research at the top 100 universities in the U.S. (5). And this was just the beginning of a period of major growth. The U.S. developed a robust system of support for university research using public funds in the years following World War II. The PHS Act of 1944 established the legislative authority behind the NIH's postwar research program (4), and the National Science Foundation (NSF) was established in 1950 by Public Law 507(6). Under the guidance of its first director, Alan Tower Waterman, NSF began awarding grants and fellowships in 1952 with a budget of \$3.5 million (7). Its first major areas of research focus were astronomy—NSF financed the construction of the National Radio Astronomy Observatory (NRAO) in Green Bank, WV—and computer science, which was first funded by the NSF in 1955 (8). By 1967, NSF's budget had grown to \$480 million (7). This increase in support for the NSF of more than 100 fold in just 15 years showed that the government and the public agreed that scientific progress was essential, and that everyone had the need for speed. Indeed you could argue that the engine of federal funding was as popular as the engine in the 1967 Ford Mustang.

R&D as Percent of the Federal Budget:

FY 1962-2014, in outlays



Source: *Budget of the U.S. Government FY 2014 Historical Tables*. FY 14 is the request. Note: FY 13 figures do not reflect final appropriations or sequester. © 2013 AAAS



The Modern Age of Federal Funding: Coasting Along

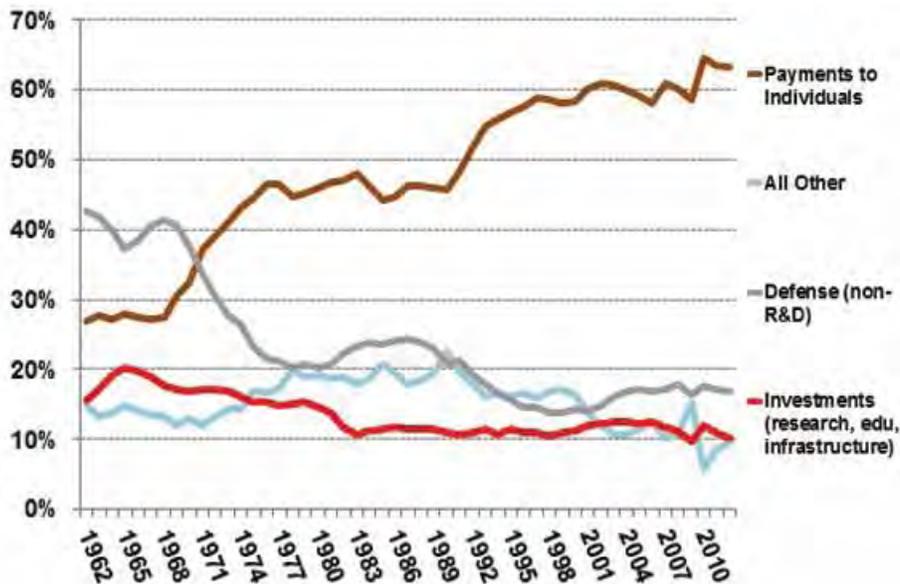
According to data compiled by the American Association for the Advancement of Science (AAAS), federal funding for research as a percentage of the federal budget was at its peak in 1965. It began to decline in the 1970s, and by the late 1970s, federal funding for research as a percentage of the federal budget was mostly flat (9). This trend coincided with a rise in the percentage of the federal budget that was devoted to direct payments to citizens through programs such as Medicare, Medicaid, and Social Security. In terms of our driving metaphor, the trend since the 1970s is kind of like trading in that 1967 Ford Mustang for a Ford Taurus.

But we did not have to trade in our muscle car for a family wagon; we could have kept both. The direct payments to individuals in the federal budget were financed by increases in taxes on individuals beginning in the mid-1940s, so the families bought their own station wagons. And it's not like we couldn't afford the payments on the Mustang. Although federal funding for research has been flat since the 1970s, the U.S. economy has grown exponentially, according to data from the Government Printing Office. That economic growth has not translated into corresponding growth in the federal budget because tax rates on individuals are mostly flat and tax rates on corporations have greatly declined since the golden age of federal funding for research in the 1950s and 1960s. Basically, we decided that instead of paying for our Mustang, we would let businesses keep that money to buy their own vehicle—a Rolls Royce.

As we keep on rolling through current trends, we can still think about two

Composition of the Federal Budget

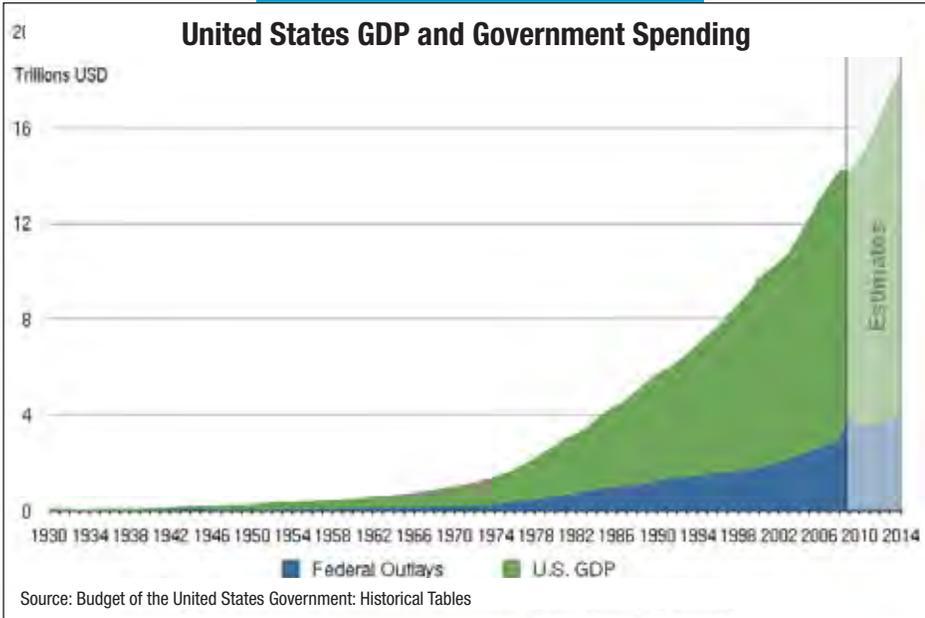
Outlays as share of total budget, 1962-2012



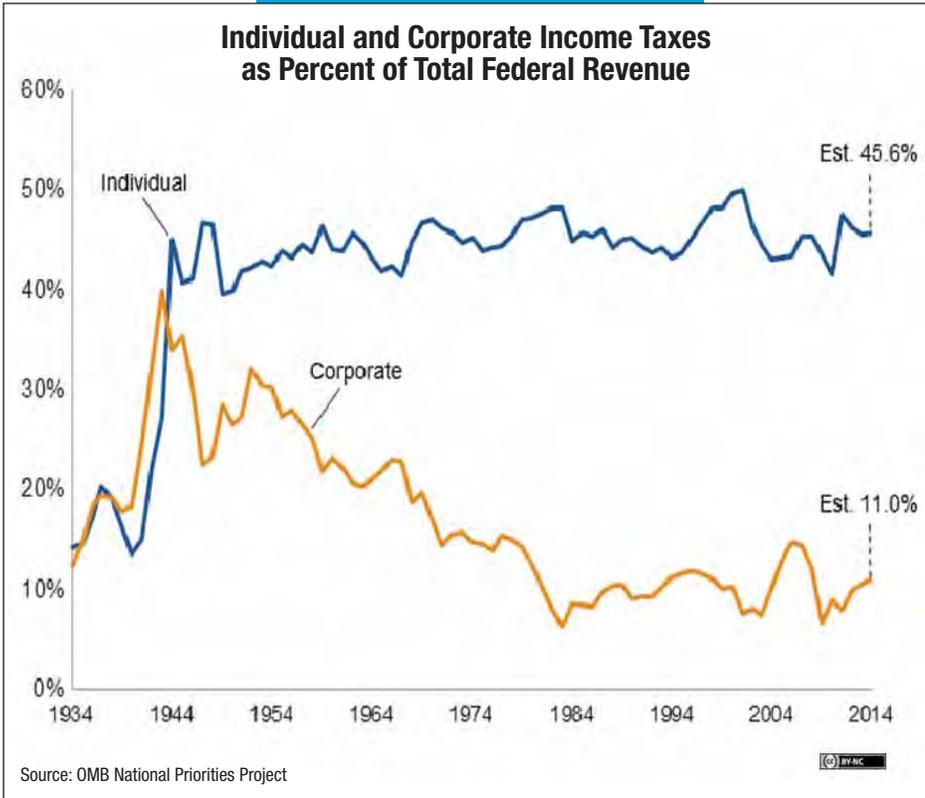
Source: *Budget of the United States Government, FY 2014*. "Investments" include outlays for R&D, education and training, direct nondefense infrastructure, and grants for transportation and other physical capital. "Payments to Individuals" are primarily entitlement programs like Medicare, Medicaid, and Social Security, but also many other public assistance programs. See OMB Historical table 11.3 for details. © 2013 AAAS

Federal funding for research peaked in 1964 and 1965 and has declined since then. Funding levels have been mostly flat since the 1970s. The decline in federal funding for research coincides with a rise in federal funding for other priorities.

Data and Figures from AAAS.



cars: a Ford for the non-defense related research and a Jeep for defense-related research. Both these cars have been cruising along at a constant level of federal funding for research since the heyday of the 1960s, but since 1982, the Jeep has been in front. Federal research funding on defense-related research has outstripped funding for non-defense related research when measured in constant dollars (9). But based on the most recent data from 2012, funding for non-defense related research is beginning to catch up. Indeed, the Ford is starting to tailgate the Jeep.



The U.S. gross domestic product (GDP) has grown exponentially since the 1970s, but the federal budget has not. During this period of GDP growth, corporate taxes have declined substantially as a source of revenue for the federal government.

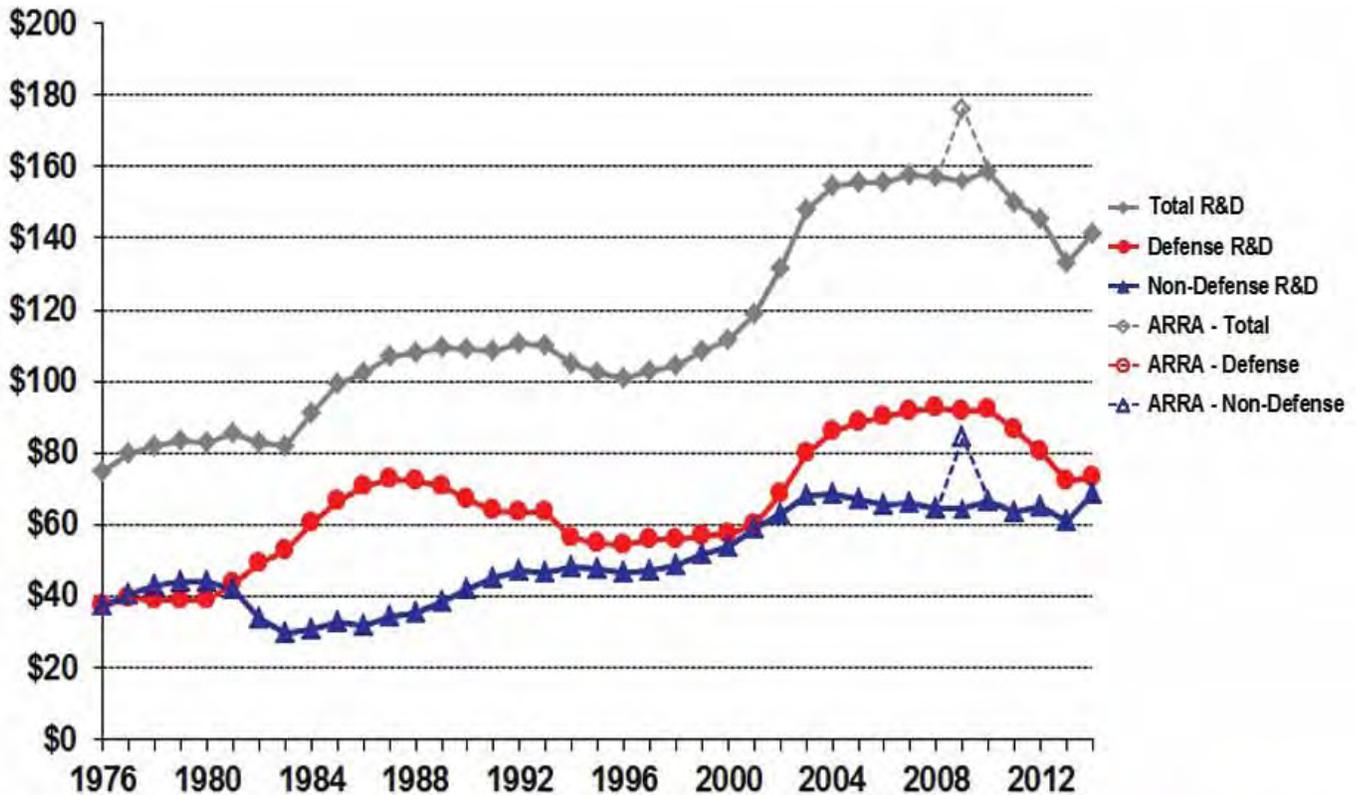
Data and Figures from US Government Printing Office (left) and Office of Management and Budget. (right).



Although federal funding for research has been on cruise control, the private sector has been revving the engine on that Rolls Royce. In the mid-1980s, around the time when the Jeep passed the Ford, the percentage of research funded by the federal government began to be less than that funded by industry. By 2009, around two-thirds of research and development in scientific and technical fields was funded not by the government, but by businesses (9)—this Rolls Royce is driving way

Trends in Federal R&D, FY 1976-2014

In billions of constant FY 2013 dollars



Source: AAAS Research and Development series. FY 2013 figures are current AAAS estimates; FY 2014 is the President's request. R&D includes conduct of R&D facilities. © 2013 AAAS



Since 1982, funding for defense-related research has been greater than funding for non-defense related research. Note: Federal funding for research as a percentage of GDP has been flat since the 1970s; although this graph shows an upward trend, this is because the data are in total dollars and not percentages.

Data and Figures from AAAS. Images from Google

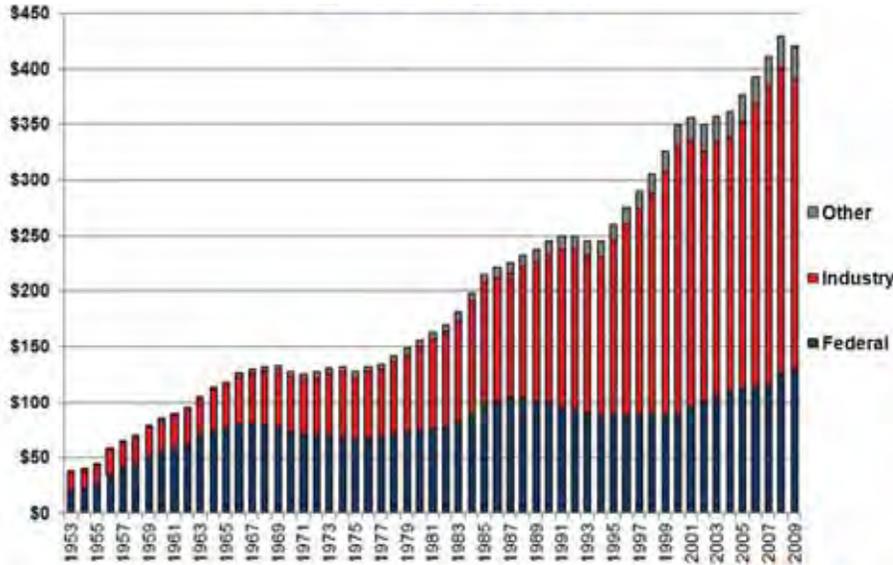
I really appreciate the cleverness of the analogy in this article between engines, driving, and cars and the evolution of federal funding for university research. Did you know that AAA—formerly known as the American Automobile Association—has actually been saving lives through grant funding? For the past 15 years, AAA Michigan has been donating funds for 'Jaws of Life' state-of-the-art hydraulic lifesaving equipment to needy communities in the state, having provided 55 grants totaling \$835,000 to date. In March 2014, two new grants were awarded to Fire Departments along heavily traveled routes that serve Michigan's tourism industry that will allow them to buy their own 'Jaws.' Previously they would wait 40 minutes or longer after an accident occurred for it to be delivered from a neighboring jurisdiction. According to AAA, "the safety and security of our members and the traveling public are always first and foremost at AAA Michigan." Personally, I have new respect for that little card I carry in my wallet.

See <http://www.prnewswire.com/news-releases/aaa-michigan-celebrates-15-years-of-jaws-of-life-grant-awards-56896267.html> for more information.

– NCURA Magazine Co-Editor, Kristine Kulage,
Columbia University School of Nursing

National R&D by Funder

Expenditures in billions, FY 2012 dollars



Source: National Science Foundation, National Patterns of R&D Resources series. Constant-dollar conversions based on GDP deflators from Budgets of the Government FY 2013. © 2013 AAAS

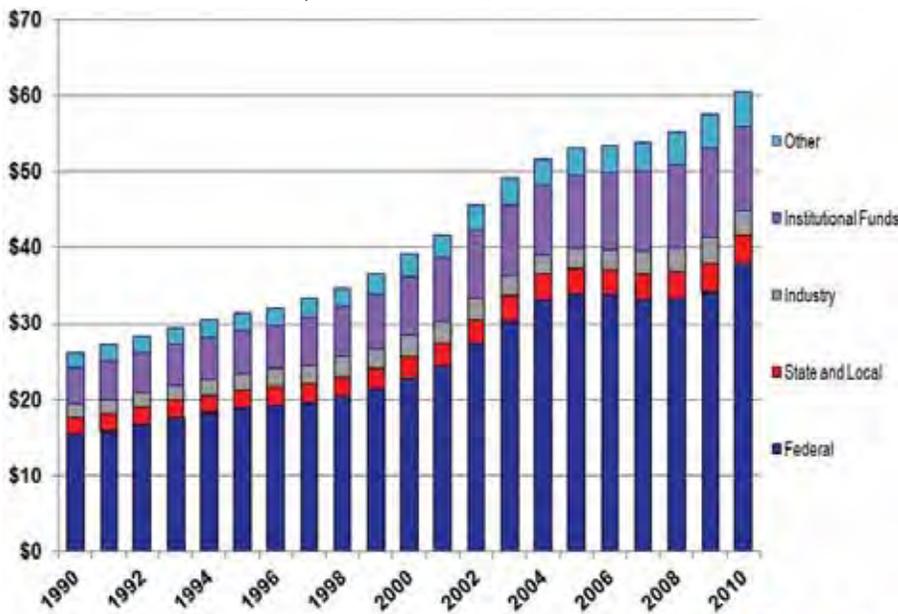


ahead of the other two vehicles. Despite the growth in industry-funded research, this source of funds as a contributor to university research has been more or less constant since the 1990s, and it is much lower than the amount of funding from the government (9). So, we may want to stop thinking of the Rolls Royce as being on the same highway; rather, it took an exit onto a private road.

Before we pull over this train of thought for a pit stop, it is important to remember why we are so interested in all this driving and who is behind the wheel. Publicly funded academic research has been shown to have a large positive contribution to the overall economic growth (10), whereas industry-funded research tends to benefit only the industry and its shareholders. Furthermore, the rate of return from public investment in academic research has been estimated at 28 percent (11). So unlike the engines in all these metaphorical vehicles we have been discussing, the engine of federal funding is no gas guzzler. Rather, by driving the research enterprise at universities, federal funding for research actually refills the nation's gas tank, with economic benefits such as new knowledge and information; skilled, highly trained graduates; new instruments and methods; networks of experts; and new spin-off companies (12).

University R&D Funding by Source

Expenditures in billions, FY 2012 dollars



Source: NSF, National Center for Science and Engineering Statistics, Higher Education R&D series, based on national survey data. FY 2009 and FY 2010 include Recovery Act R&D funding. © 2013 AAAS



Industry funding for research has grown even as federal funding has remained flat. However, this industry-funded research is not being performed at universities.

Data and Figures from AAAS.

The Future of Federal Funding: What's Around the Next Corner and Which Way Should We Turn

Before we take the exit and head off into the sunset, let's back up for just a moment and retrace our route. Federal funding for research began as a horseless buggy in 1798, with the creation of the predecessor to the PHS. By 1887, it resembled a rudimentary automobile, with the establishment of a one room lab that later became the NIH. The engine of federal funding increased in horsepower over the next hundred years, beginning with grants to 25 institutions in 1918, and growing to \$350 million in federal funds for research at the top 100 universities in the U.S. in 1940 and \$5.6 billion in 1986. Federal funding for research as a percentage of the federal budget was at its peak in 1965, but by the late 1970s, it was mostly flat and the engine was set on cruise control. Since 1982, there has been more federal funding for defense-related research than for non-defense-related research, but both combined were less than the amount of industry funding for research. Although industry funds almost two thirds of re-

search in the U.S., the percentage of industry funded research that is conducted by universities is small and is not growing. The engine of federal funding not only drives the research enterprise, it also does so with amazing fuel economy: a dollar spent on academic research has a 28 percent rate of return in the form of overall economic growth. This look into our rearview mirror can help inform which road to take as we continue on our drive. If I were on the pit crew, I might suggest we siphon some of the gas from the tank of that Rolls Royce and put it into the tank of the Jeep—or better yet the Ford—and see if that gives a turbo boost to the economy. ■



Elizabeth Haney was a recipient of federal research funding in the form of a National Science Foundation Graduate Research Fellowship in 2002. Today, as Senior Research Officer at the Wyss Institute for Biologically Inspired Engineering at Harvard University, she manages a portfolio of over \$20M in federal research funds. Although she does not really like driving, she does like staying active in NCURA. This year she is AV coordinator for the Region 1 Spring meeting in Mystic, CT, and she was also selected for the Region 18 Executive Shadow Program. She can be reached at elizabeth.haney@wyss.harvard.edu

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