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Executive Summary

Key takeaways:

- In inflation-adjusted dollars, total academic research and development (R&D) has grown every year since 1975. Academic institutions in the United States performed $79.4 billion in R&D in 2018, and they have long been responsible for performing about half of all U.S. basic research. Nearly two of every three academic R&D dollars supports basic research, whereas both applied research and development receive smaller but growing shares.
- The federal government is the largest funder of academic R&D, providing more than half of total funds in 2018. After several years of declining funding levels, federal funding for academic R&D has increased by 5% since 2015 in inflation-adjusted dollars. Institutional support has increased more rapidly and represents an increasingly larger share of total academic R&D. In 2018, institutional funds constituted more than one-quarter of university R&D, up from less than one-fifth in 2010.
- Most academic R&D is performed by a small percentage of U.S. higher education institutions. The highest research activity doctoral universities perform three-quarters of all academic R&D. These institutions also award around three-quarters of U.S. science and engineering (S&E) doctoral degrees.
- Academic institutions added more than 32 million net assignable square feet (NASF) of S&E research space between 2007 and 2017, reaching a total of 220 million NASF. Research space in the biological and biomedical sciences accounted for 40% of this growth. S&E funds expended on research equipment have fluctuated over the past several years but are at levels similar to those a decade ago when adjusted for inflation.

R&D conducted by higher education institutions is a key component of the overall R&D system of the United States. Academic institutions have long been responsible for performing about 10% to 15% of total U.S. R&D, including about half of all U.S. basic research. Nearly two-thirds (62% in 2018) of the R&D performed by academic institutions is basic research, around one-quarter is applied research, and about one-tenth is development. Both applied research and development have increased in recent years as percentages of overall academic R&D.

In 2018, academic institutions performed $79.4 billion in R&D, most of it funded by a small number of sources. The federal government is the largest funder, providing more than half (53%, or around $42 billion) of total funds in 2018. The federal share has declined from 59% in 2010 (excluding funds from the American Recovery and Reinvestment Act of 2009 [ARRA]) and from 69% in 1973. Six agencies provide more than 90% of federal support for academic R&D. The Department of Health and Human Services (HHS) is the largest, at 55% of federal funding for R&D in 2018 ($22.9 billion), followed by the Department of Defense at 14% ($5.9 billion), the National Science Foundation (NSF) at 13% ($5.3 billion), the Department of Energy (DOE) at 4% ($1.8 billion), the National Aeronautics and Space Administration (NASA) at 4% ($1.5 billion), and the Department of Agriculture (USDA) at 3% ($1.2 billion). In 2018, institutional funds constituted more than one-quarter of university R&D, up from less than one-fifth in 2010 and from about one-tenth in 1973. Additional academic R&D funders include nonprofit organizations, businesses (industry), and state and local governments.

U.S. academic R&D performance is concentrated in a small percentage of higher education institutions. The 115 highest research activity doctoral universities, as defined by Carnegie classification, perform three-quarters of academic R&D. Institutions with medical schools also perform a large amount of academic R&D. The concentration of most R&D performance in a few institutions is greater for private universities than public universities.

Most academic R&D is also concentrated in a few S&E fields. The life sciences have long accounted for more than half of total academic R&D; engineering constitutes about another 15%. The federal government provides the majority of funding for academic R&D in all broad S&E fields except social sciences. Each of the six main federal agencies that sponsor academic R&D funds a portfolio consistent with its mission. Most resources from each type of nonfederal academic R&D funder are allocated to life sciences. In each broad S&E field, institutions themselves contributed half or more of nonfederal academic R&D.

Physical infrastructure underlies the ability of academic institutions to perform R&D. Academic institutions added 32 million NASF of S&E research space between 2007 and 2017, led by the addition of 13 million NASF in biological and biomedical sciences. Research space in all S&E fields increased over the past decade by varying amounts, except for space devoted to computer and information science research, which declined by 600,000 NASF. Despite some fluctuations, research equipment expenditures at academic institutions are at levels similar to those a decade ago when compared in constant dollars. Finally, the federal share of total funding for research equipment expenditures remained below 50% for the fifth consecutive year in 2018. Before 2014, federal support for research equipment had not fallen below 50% since data were initially collected in 1981.

Introduction

This report provides a portrait of R&D conducted by higher education institutions in the United States, including trends over time. The report is divided into two main sections: funding and infrastructure. The funding section provides an overview of academic R&D in the United States. It discusses sources of support for academic R&D: primarily the federal government, followed by academic institutions themselves, along with nonprofit organizations, businesses, and state and local governments. The funding section closely examines the higher education institutions performing most academic R&D and describes differences between public and private institutions and differences between those with and without medical schools. This section also provides information on funding across S&E fields and discusses the costs associated with academic R&D. The infrastructure section provides information on research facilities at higher education institutions, including how much space is devoted to research in different S&E fields and trends in research space over time. It also looks at trends in funding for research equipment.

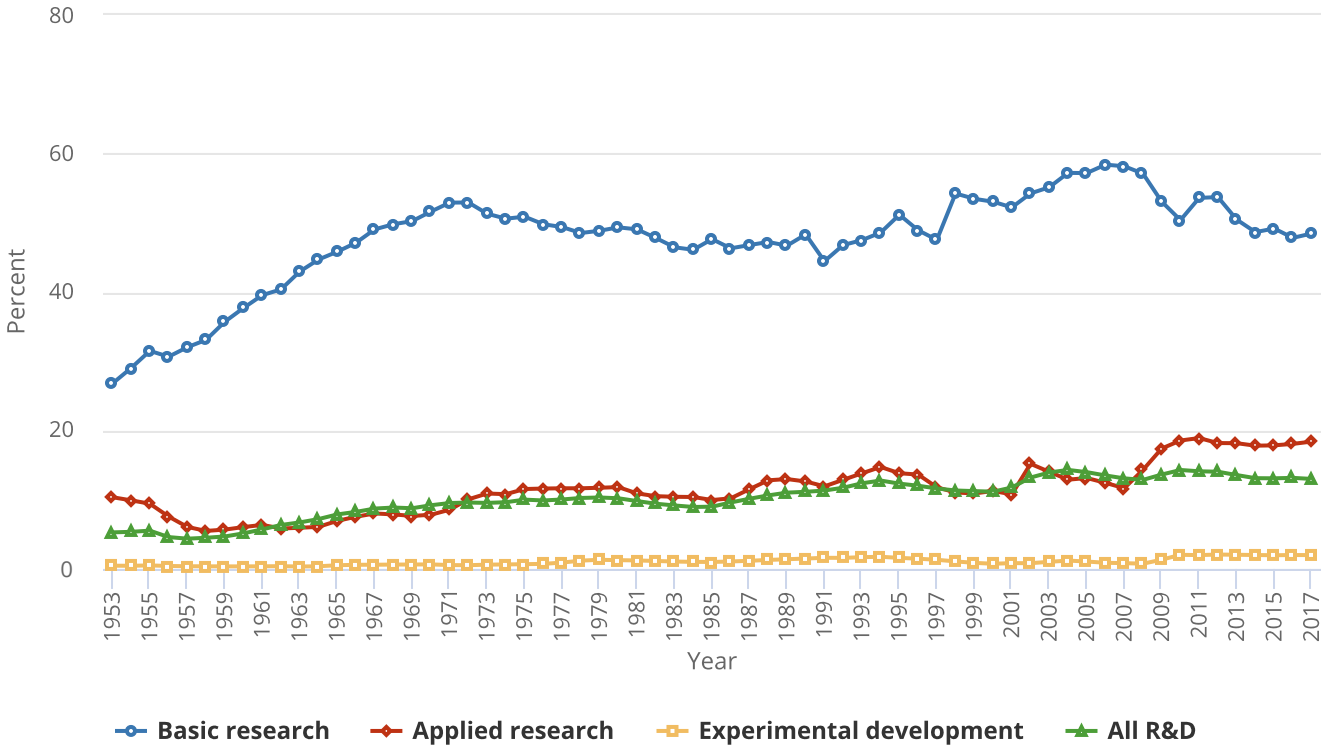
Additional context on the subjects covered in this report is available in other *Indicators 2020* reports. See the *Indicators 2020* report "Research and Development: U.S. Trends and International Comparisons" for discussion of the overall U.S. R&D system. Graduate students studying S&E are discussed in *Indicators 2020* report "Higher Education in Science and Engineering" and the academic workforce is discussed in *Indicators 2020* report "Science and Engineering Labor Force."

Academic R&D in the United States

R&D conducted by higher education institutions ("academic R&D") is a key component of the overall U.S. R&D system. In 2017, the higher education sector performed 13% of the overall $548 billion in U.S. R&D, a proportion that has fluctuated within a narrow range for several decades (**Figure 5b-1**; NCSES ***NP 2018***: **Table 2**).[1] Although universities perform all types of R&D, they have long been the nation's largest performers of basic research. For examples of basic research, see National Institutes of Health (2019).[2] After a period of increase beginning in the early 1990s, the proportion of U.S. basic research performed by the higher education sector declined from 58% in 2007 to 48% in 2017.[3] Higher education institutions also performed about 18% of all U.S. applied research and 2% of all U.S. experimental development in 2017; these percentages have increased over the last 10 years.

FIGURE 5B-1

Academic R&D as a percentage of U.S. R&D, by type of R&D: 1953–2017



Note(s)

Before 2003, higher education R&D covered only S&E fields; in 2003 and later years, R&D in non-S&E fields is also included. In 1998 and later years, the higher education R&D data have been adjusted to eliminate double counting of R&D funds passed through from academic institutions to other academic and nonacademic (business, nonprofit organization, other) subrecipients.

Source(s)

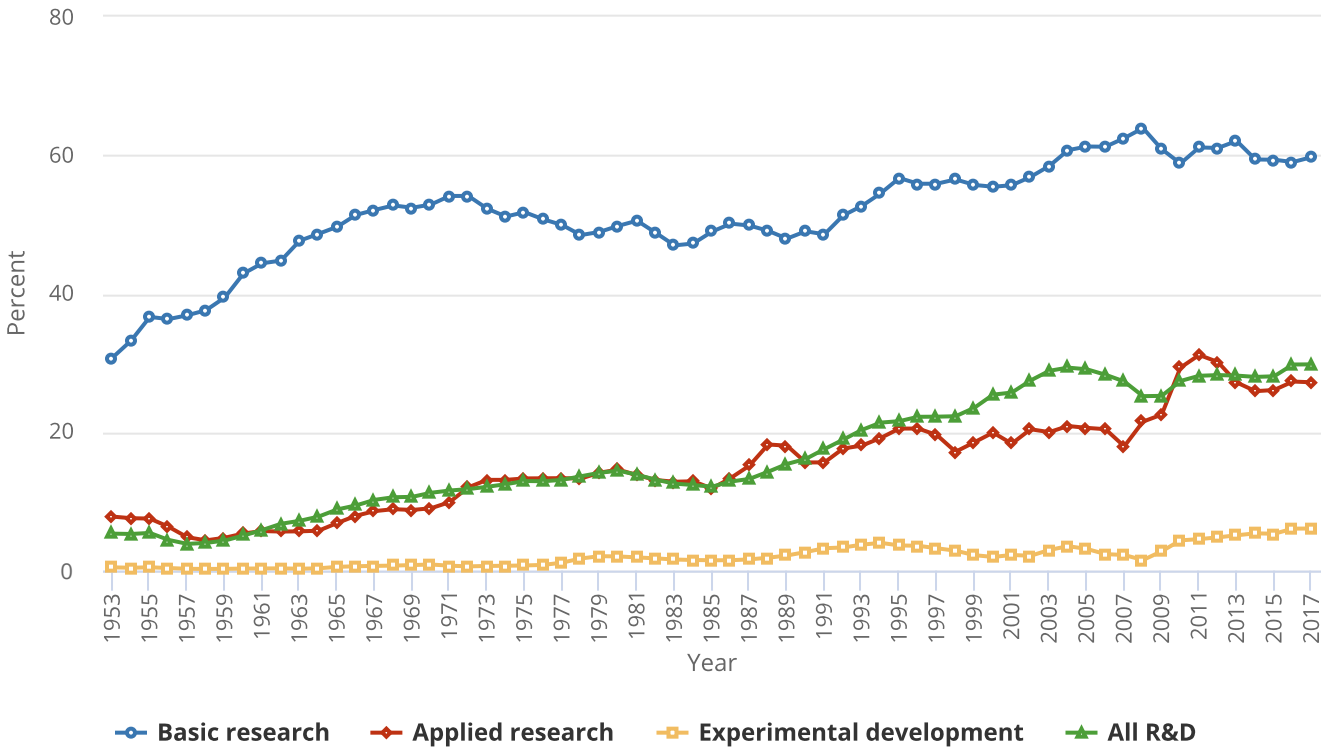
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources.

Science and Engineering Indicators

The federal government provides more R&D funding to higher education than to any other sector, including federal intramural R&D (NCSES ***NP 2018***: **Table 6**). In 2017, the higher education sector performed around 30% of all federally funded R&D, a proportion that has generally increased over time (**Figure 5b-2**; NCSES ***NP 2018***: **Table 6**). Academic institutions performed around 60% of federally funded basic research, 27% of federally funded applied research, and 6% of federally funded experimental development. The share of federally funded basic research performed by universities declined from a high of 64% in 2008 while the shares of applied research and of experimental development increased since then.

FIGURE 5B-2

Federally funded academic R&D as a percentage of U.S. federally funded R&D, by type of R&D: 1953–2017



Note(s)

Before 2003, higher education R&D covered only S&E fields; in 2003 and later years, R&D in non-S&E fields is also included. In 1998 and later years, the higher education R&D data have been adjusted to eliminate double counting of R&D funds passed through from academic institutions to other academic and nonacademic (business, nonprofit organization, other) subrecipients.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources.

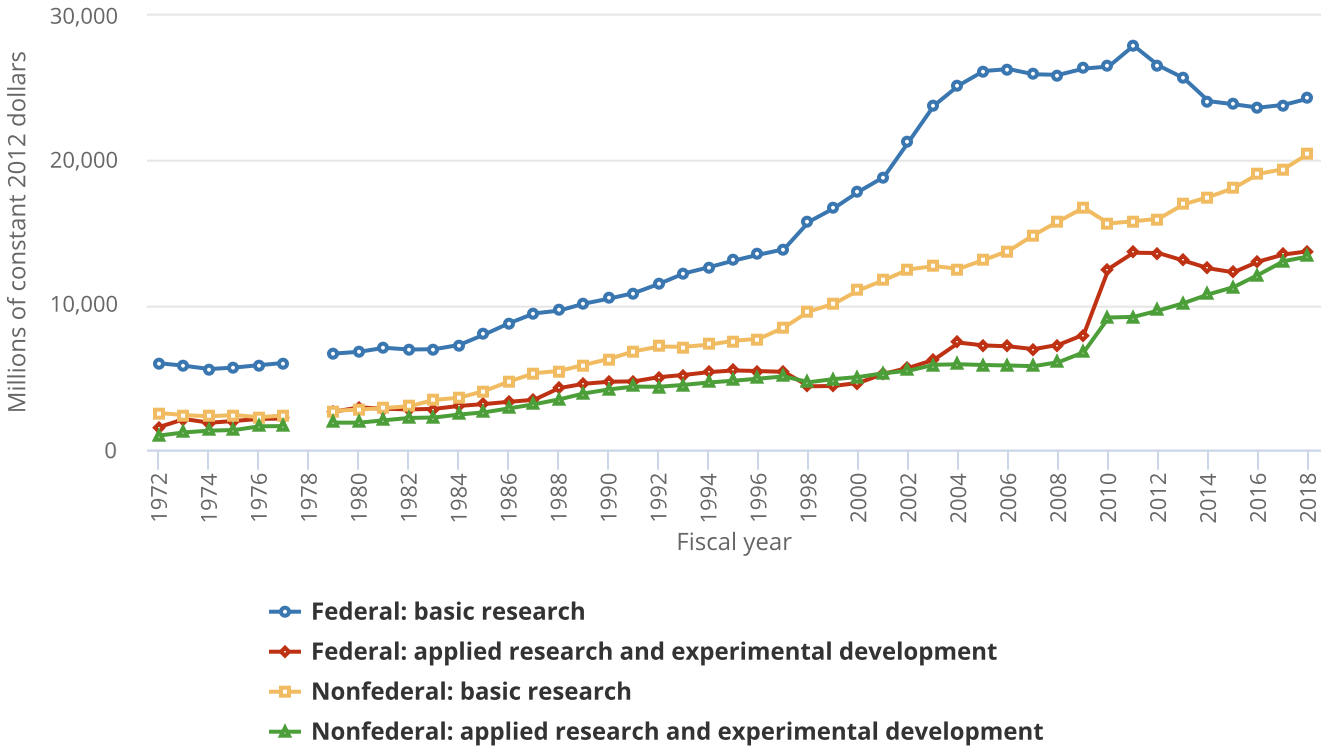
Science and Engineering Indicators

Type of R&D Performed by Academic Institutions

In inflation-adjusted dollars, total academic R&D has grown every year since 1975, and in 2018, academic institutions performed $79.4 billion in R&D (NCSES ***HERD 2018***: **Table 1**).[4] Nearly two-thirds (62% in 2018, or around $49 billion) of the R&D performed by academic institutions is basic research, a percentage that has declined slightly in recent years (NCSES ***HERD 2018***: **Table 7**). After a long period of increase, federal support for basic research at academic institutions has declined over the last 10 years (**Figure 5b-3**; note that the federal amounts in this figure include funds from ARRA). Basic research support from nonfederal sources has continued to increase. Around one-quarter of university R&D is applied research, and around one-tenth is development (NCSES ***HERD 2018***: **Table 8**). Applied research, and development, have increased slightly since 2010 as percentages of overall academic R&D.[5] Federal and nonfederal support for applied research and development increased (**Figure 5b-3**).

FIGURE 5B-3

Federally funded and nonfederally funded higher education R&D expenditures, by type of R&D: FYs 1972–2018



Note(s)

Separate data for federally financed basic research, applied research, and experimental development were not collected for FY 1978. Type of R&D estimation procedure was revised for FY 1998 and later years; hence, these data are not directly comparable with data for FY 1997 and earlier years. Before FY 2010, R&D expenditures by type of R&D were based on percentage estimates of basic research provided by universities and colleges. Beginning in FY 2010, institutions were asked for dollar amounts of federally funded and nonfederally funded R&D expenditures for basic research, applied research, and experimental development. For inflation adjustment, gross domestic product implicit price deflators based on calendar year were used. Gross domestic product deflators come from the U.S. Bureau of Economic Analysis and are available at **https://www.bea.gov/national**, accessed August 2019. Federal figures include funds from the American Recovery and Reinvestment Act of 2009 (ARRA).

Source(s)

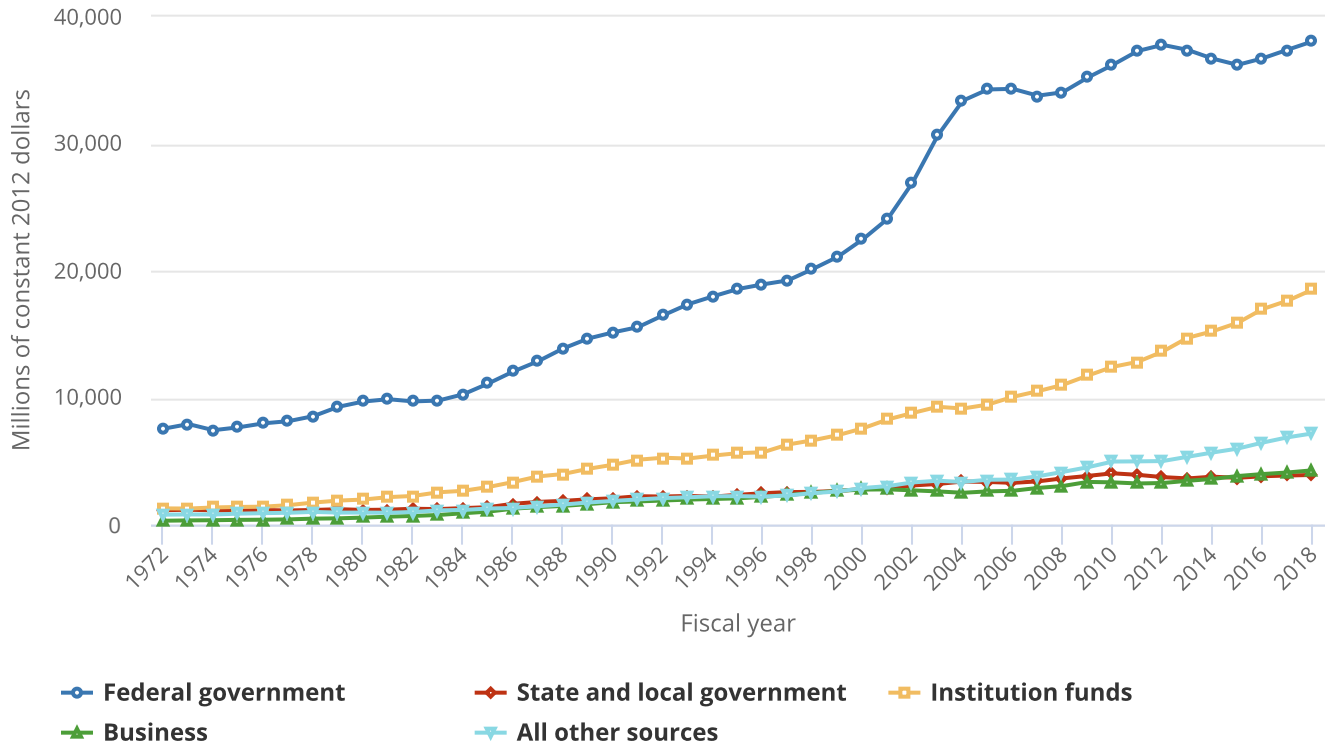
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD).

Support for Academic R&D

Most academic R&D is funded by a small number of sources (**Figure 5b-4**). The federal government is by far the largest funder of academic R&D, although its share of total academic R&D has declined. Academic institutions themselves are the second-largest funder, and their share of total academic R&D has grown. Nonprofit organizations and businesses contribute small but slowly growing shares, while the share from state and local governments has declined.

FIGURE 5B-4

Higher education R&D expenditures, by source of funds: FYs 1972–2018



Note(s)

FY 1978 data are estimated based on data collected from doctorate-granting institutions only. Totals for FYs 1972–2002 represent R&D expenditures in S&E fields only. From FY 2003 through FY 2009, some institution totals for all R&D expenditures may be lower-bound estimates because the National Center for Science and Engineering Statistics did not attempt to estimate for nonresponse on non-S&E R&D expenditures items before FY 2010. Source of fund detail data do not sum to total for FYs 2003–09 because data by source were collected for S&E fields only. Total non-S&E expenditures were collected in a separate item. For inflation adjustment, gross domestic product implicit price deflators based on calendar year were used. Gross domestic product deflators come from the U.S. Bureau of Economic Analysis and are available at **https://www.bea.gov/national**, accessed August 2019. Federal figures do not include funds from the American Recovery and Reinvestment Act of 2009 (ARRA). In this figure, the All other sources category includes nonprofits.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD).

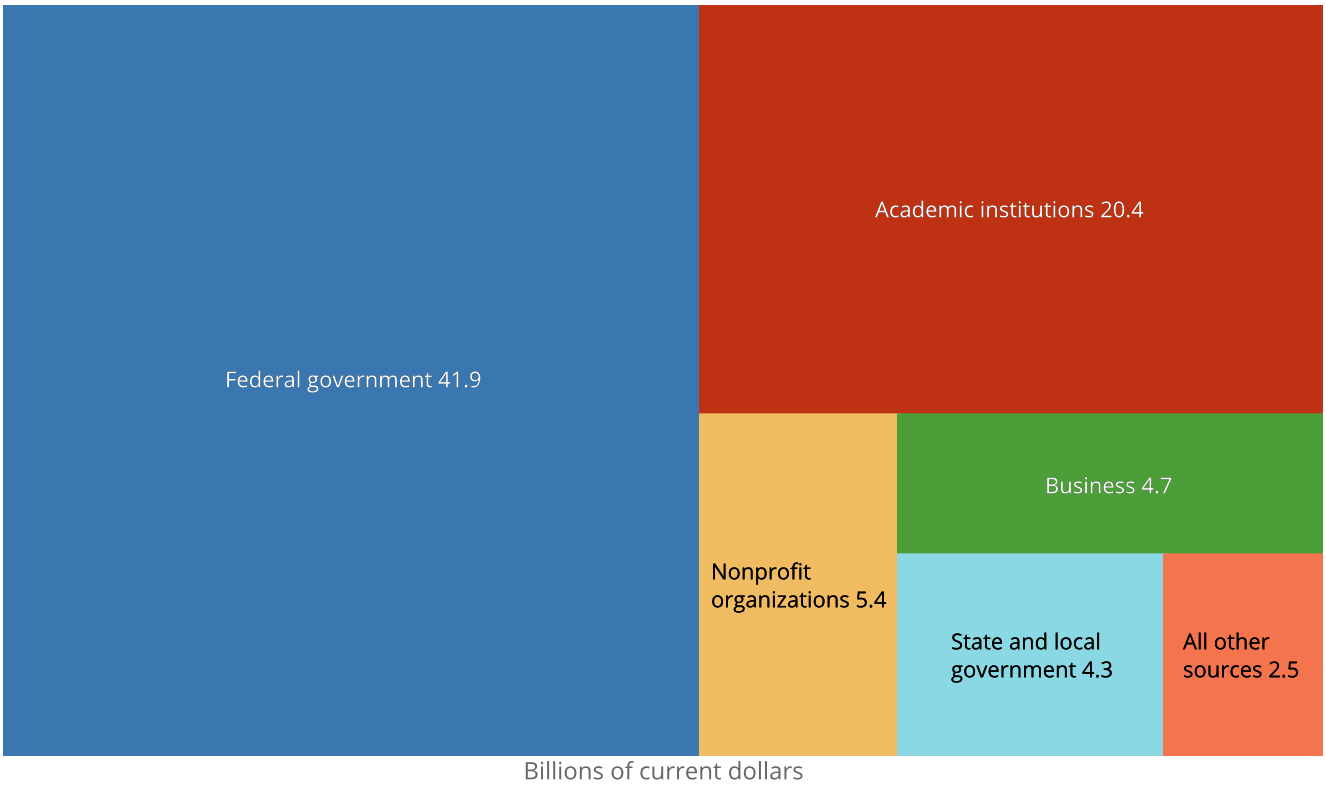
Science and Engineering Indicators

Federal Support

The federal government is the largest funder of academic R&D, providing more than half (53%, or around $42 billion) of total funds in 2018 (**Figure 5b-5**). When adjusted for inflation, federal funding for higher education R&D increased by 1.8% between 2017 and 2018 (**Figure 5b-6**; NCSES ***HERD 2018***: **Table 1**). After several previous years of declining funding levels, federal funding for academic R&D has increased by 5% since 2015.

FIGURE 5B-5

Academic R&D expenditures, by source of support: FY 2018



Note(s)

Numbers may not add to totals in other figures because of rounding.

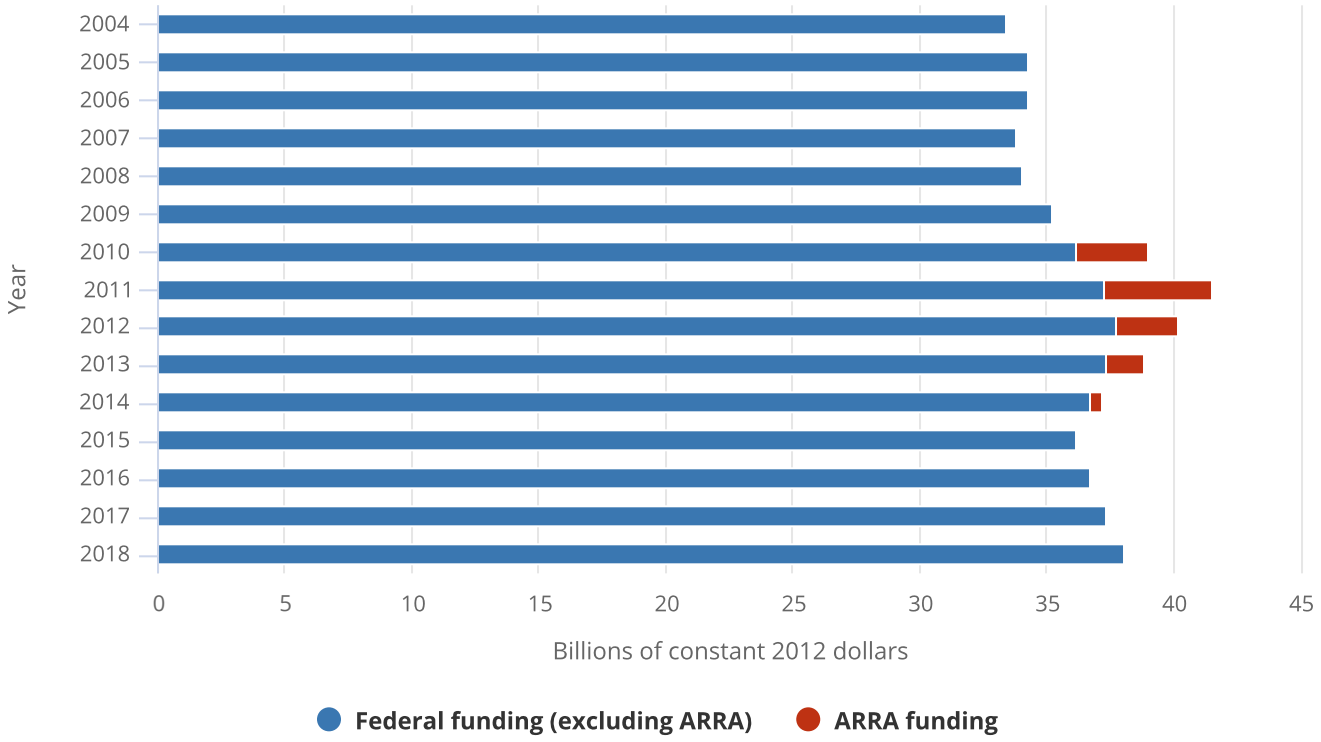
Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Science and Engineering Indicators

FIGURE 5B-6

Federal funding for academic R&D expenditures: 2004–18



ARRA = American Recovery and Reinvestment Act of 2009.

Note(s)

The American Recovery and Reinvestment Act of 2009 (ARRA) was an important source of federal expenditures for academic R&D during the economic downturn and recovery from 2010 through 2012 and continued to contribute to such spending, although in smaller amounts, in 2013 and 2014. By 2015, all ARRA funds had been spent. For inflation adjustment, gross domestic product implicit price deflators based on calendar year were used. Gross domestic product deflators come from the U.S. Bureau of Economic Analysis and are available at **https://www.bea.gov/national**, accessed August 2019.

Source(s)

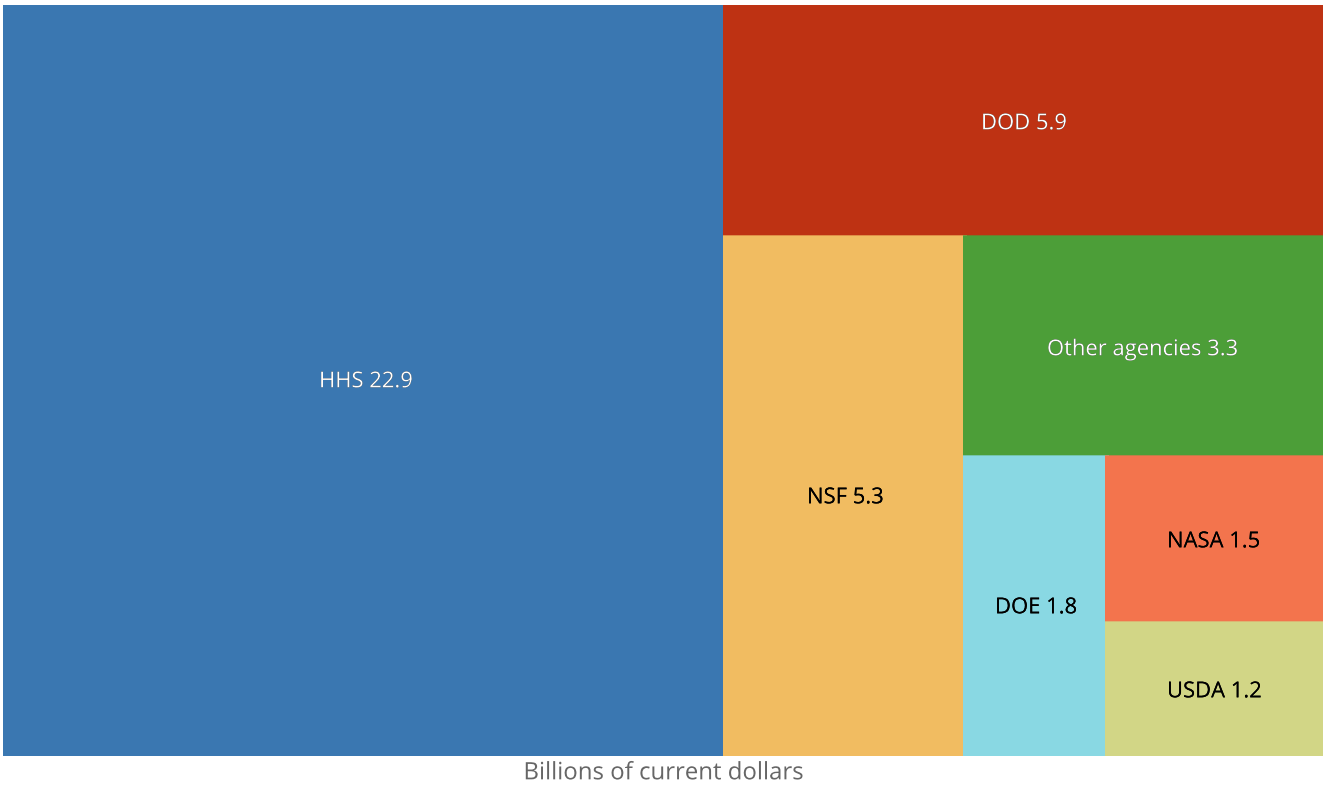
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD).

Science and Engineering Indicators

In the federal government, six agencies provide more than 90% of support for academic R&D (**Figure 5b-7**). HHS, largely through the National Institutes of Health, is by far the largest, providing more than half (55%, or $22.9 billion) of federal support in 2018. The Department of Defense (14%, or $5.9 billion) and NSF (13%, or $5.3 billion) are next, followed by DOE (4%, or $1.8 billion), NASA (4%, or $1.5 billion), and USDA (3%, or $1.2 billion).[6] The percentage of total federal academic R&D funding provided by each of these agencies has changed little over the last 10 years.[7]

FIGURE 5B-7

Federally financed academic R&D expenditures, by agency: FY 2018



DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

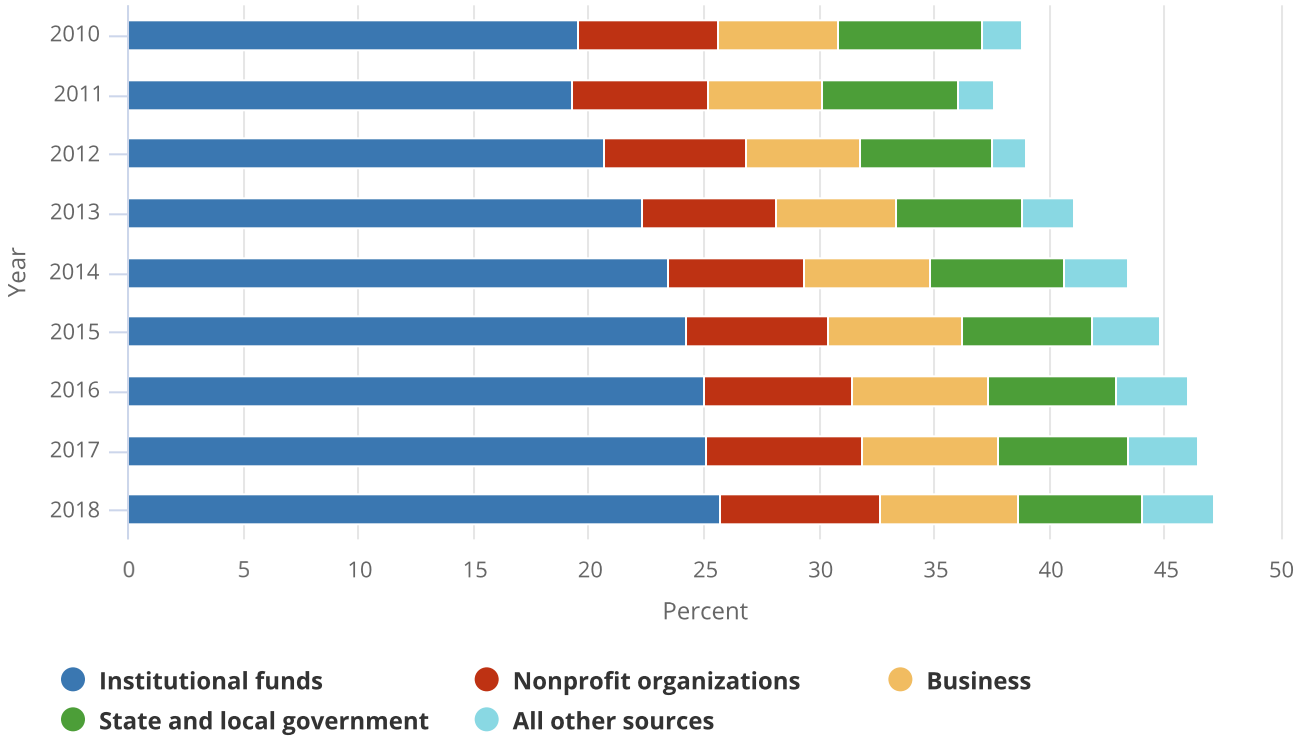
Science and Engineering Indicators

Institutional Support

Institutional support represents an increasingly larger share of total academic R&D (**Figure 5b-8**). Institutions provided more than $20 billion of academic R&D funding in 2018 (**Figure 5b-5**), and institutional funds constituted more than one-quarter of university R&D, up from less than one-fifth in 2010. When adjusted for inflation, institutional funding for higher education R&D increased by nearly 50% between 2010 and 2018. The increase over this period, while faster than in the past, continues a longer-term trend of a rising share of institutional funds; for comparison, institutions contributed 11%–12% of academic R&D funds in the early to mid-1970s.

FIGURE 5B-8

Nonfederal funding sources as a percentage of total academic R&D expenditures: 2010–18



Note(s)

Percentages are based on total academic R&D expenditures, which for 2010–14 include funds from the American Recovery and Reinvestment Act of 2009 (ARRA).

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD).

Science and Engineering Indicators

Institutionally funded R&D expenditures include three main components: direct funding for R&D, cost sharing, and unrecovered indirect costs.[8] Each has increased since 2012, with the largest increase in direct funding for R&D (**Gibbons 2019**: **Figure 2**).

Institutionally financed research includes organized research projects fully supported with internal funding and all other separately accounted-for institutional funds for research. It does not include funds spent on research that are not separately accounted for, such as estimates of faculty time budgeted for instruction that is spent on research. Funds for institutionally financed R&D may derive from sources including general-purpose state or local government appropriations; general-purpose awards from industry, foundations, or other outside sources; endowment income; and gifts. Universities may also use income from patents and licenses or revenue from patient care to support R&D. For more on the topic of institutional funding sources, see Council on Governmental Relations (2019).

Precise accounting of institutionally financed R&D is difficult, and the trends described here represent increased institutional contributions to R&D and improved measurement of those contributions over time.[9]

Other Sources of Support

Nonprofit Organizations

Nonprofit organizations provided $5.4 billion (about 7%) of academic R&D funding in 2018 (**Figure 5b-5**). When adjusted for inflation, nonprofit funding for higher education R&D increased by about 27% between 2010 and 2018, representing a big rise from a small base.

Businesses (Industry)

Businesses provided $4.7 billion (around 6%) of academic R&D funding in 2018 (**Figure 5b-5**). When adjusted for inflation, business funding for higher education R&D increased by about 28% between 2010 and 2018. As with nonprofit funding, this represents a big rise from a small base.

State and Local Governments

State and local governments provided $4.3 billion (around 5%) of academic R&D funding in 2018 (**Figure 5b-5**). When adjusted for inflation, state and local government funding for higher education R&D declined by more than 3% between 2010 and 2018.

Other Sources

In 2018, all other sources of support—such as foreign-government funding, other universities, or gifts designated for research—collectively accounted for $2.5 billion (3%) of academic R&D funding (**Figure 5b-5**). About half ($1.3 billion) of these funds come from foreign sources. More detail on funding from foreign sources is available in NCSES ***HERD 2018***: **Table 14**.

Performance of Academic R&D

Most academic R&D is performed by a small percentage of U.S. higher education institutions. Out of approximately 4,400 postsecondary degree-granting institutions in the United States (*Indicators 2020* report "Higher Education in Science and Engineering"), fewer than 1,000 reported R&D expenditures in 2018.[10] An even smaller number of universities, the 115 doctoral universities with highest research activity, perform three-quarters of all academic R&D. Public and private institutions show different patterns of support, as do institutions with medical schools.[11]

Academic R&D at Research Universities

Academic R&D and doctoral training often occur at the same higher education institutions, as reflected by the historic partnership between the federal government and the nation's research universities to integrate basic scientific research performance with the education and training of the next generation of scientists and engineers (National Research Council 2012). The 115 doctoral universities with highest research activity, based on Carnegie classification, performed three-quarters ($59.4 billion) of all U.S. academic R&D in 2018 and awarded around the same percentage of U.S. S&E doctoral degrees (*Indicators 2020* report "Higher Education in Science and Engineering").[12] Even in this group, R&D activity is concentrated in relatively few institutions: the top 25 R&D performers among the highest research activity doctoral universities are responsible for nearly half ($29 billion) of total R&D performed by these types of institutions and more than one-third of the national total. The concentration of most R&D activity in a small number of institutions is a long-standing trend (see ***Indicators 2018***: **Figure 5-5** for illustration).

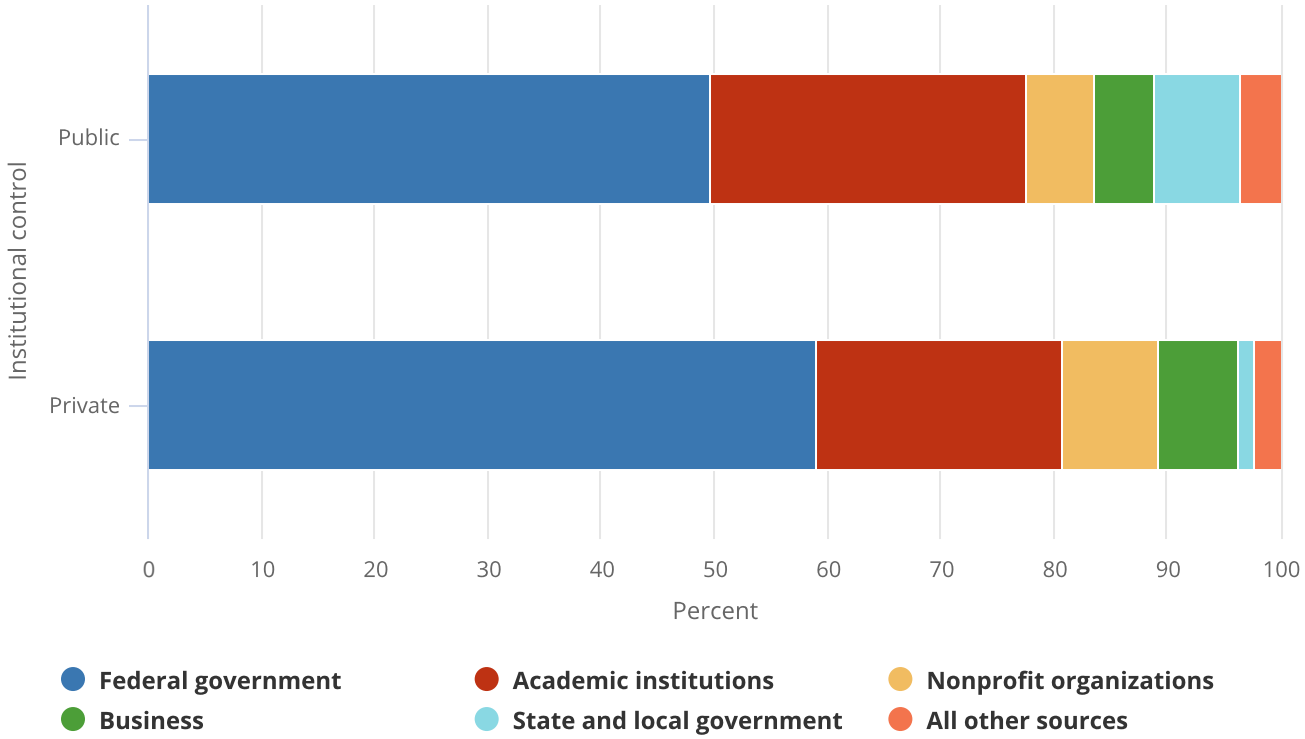
Academic R&D at Public and Private Institutions

Although only about one-third of doctoral-granting institutions are public universities (*Indicators 2020* Table 2-1), they performed two-thirds ($52.1 billion) of academic R&D in 2018 (NCSES ***HERD 2018***: **Table 69**). Additionally, more public universities than private universities report R&D expenditures.[13] The top 25 public universities performed $23.8 billion in R&D, around 46% of the public university total (NCSES ***HERD 2018***: **Table 36**). The concentration of R&D performance in a few institutions is greater in private universities: the top 25 performed $20.9 billion in R&D, more than three-quarters of the total performed by private universities (NCSES ***HERD 2018***: **Table 37**).[14]

The relative shares of funding sources differ between public and private institutions (**Figure 5b-9**). Private universities receive a higher proportion of their academic R&D funding from the federal government (nearly 60%) compared with public universities (50%). Public universities derive a higher percentage from their own institutional funds and from state and local governments.

FIGURE 5B-9

Academic R&D expenditures, by institutional control and source of support: FY 2018



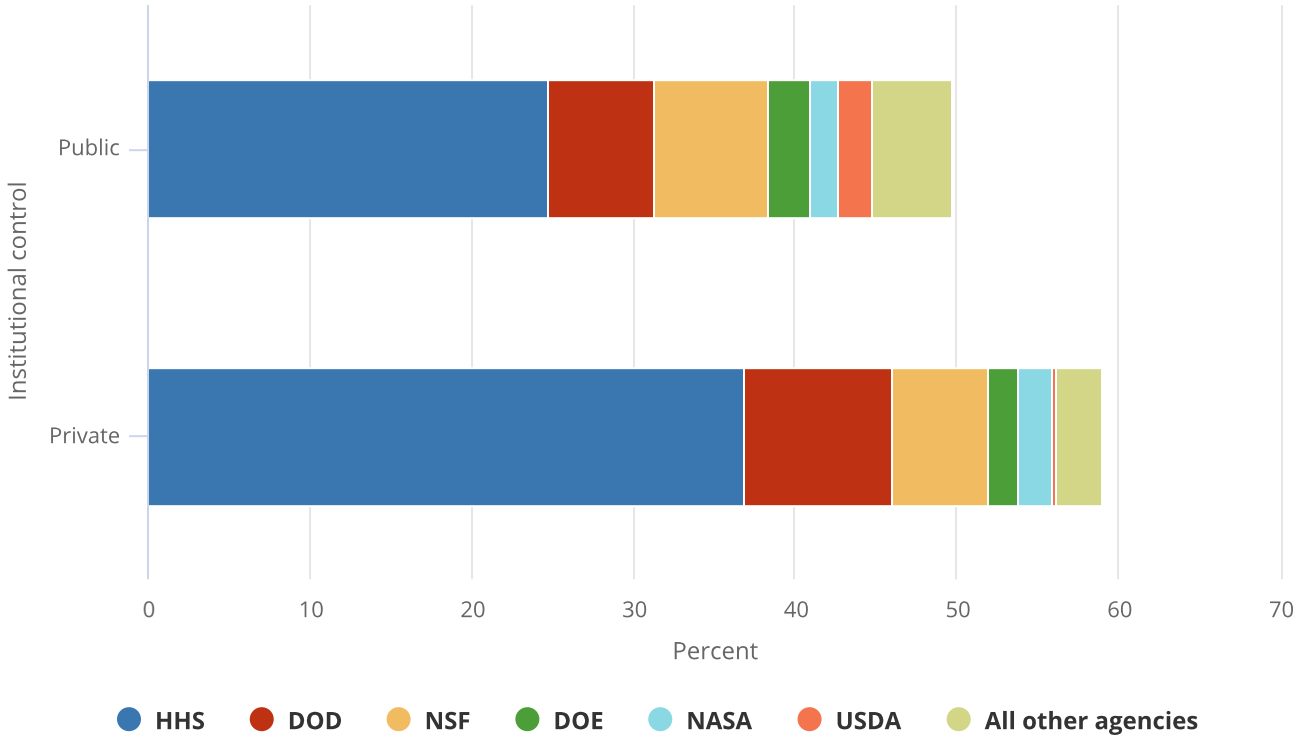
Note(s)
"Control" is a classification of whether an institution is operated by publicly elected or appointed officials (public control) or by privately elected or appointed officials and derives its major source of funds from private sources (private control).

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Public and private institutions also differ in the relative importance of particular federal agencies as funding sources (**Figure 5b-10**). For example, private universities derive more than one-third of their R&D funding from HHS, compared with about one-quarter for public universities. Although USDA provides a relatively small amount of academic R&D funding, public universities, primarily land grant universities, derive a much higher proportion of funds from this agency.[15]

FIGURE 5B-10

Federally financed academic R&D expenditures as a percentage of total academic R&D expenditures, by institutional control and agency: FY 2018



DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture.

Note(s)

"Control" is a classification of whether an institution is operated by publicly elected or appointed officials (public control) or by privately elected or appointed officials and derives its major source of funds from private sources (private control).

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Science and Engineering Indicators

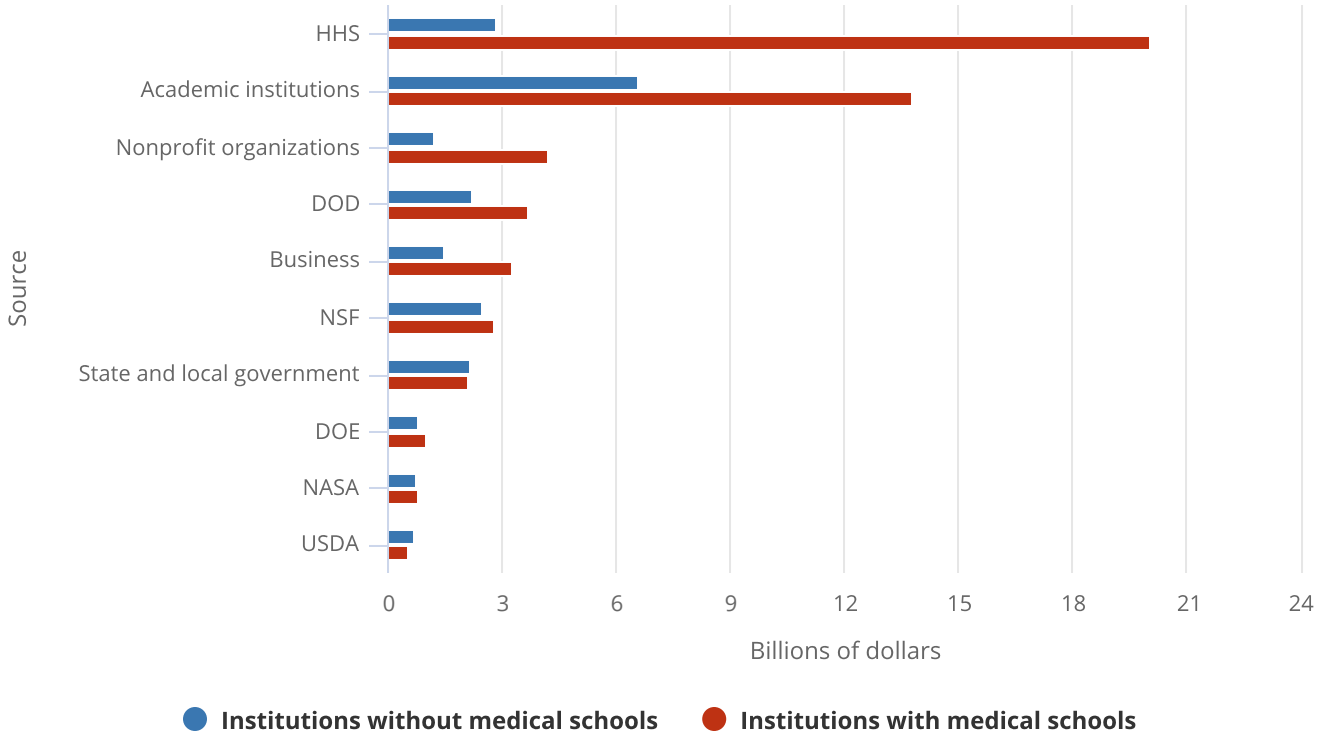
Academic R&D at Institutions with Medical Schools

In 2018, 156 institutions with medical schools reported R&D expenditures (NCSES ***HERD 2018***: **Table 18** and **Table 71**).[16] These institutions, around half of which are also doctoral universities with highest research activity, performed nearly $56 billion of academic R&D, or 70% of the total.[17] Roughly half of these expenditures ($28 billion) were associated with the medical schools themselves, whereas the other half were associated with other parts of these same institutions.

Institutions with medical schools received nearly $31 billion from the federal government (nearly three-quarters of all federal funding for academic R&D), including $20.1 billion from HHS, or about 88% of the HHS total. The remainder comes from nonfederal sources and constitutes two-thirds of nonfederal funding for academic R&D. Institutions with medical schools received more than half the funding from each federal agency except USDA and from each main type of nonfederal funding source except state and local government (**Figure 5b-11**).

FIGURE 5B-11

Academic R&D expenditures at institutions with and without medical schools, by source of funding: FY 2018



DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture.

Note(s)

In FY 2018, HERD included 490 institutions without medical schools and 156 institutions with medical schools, with expenditures over $1 million. This figure excludes other federal and nonfederal sources of funding.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

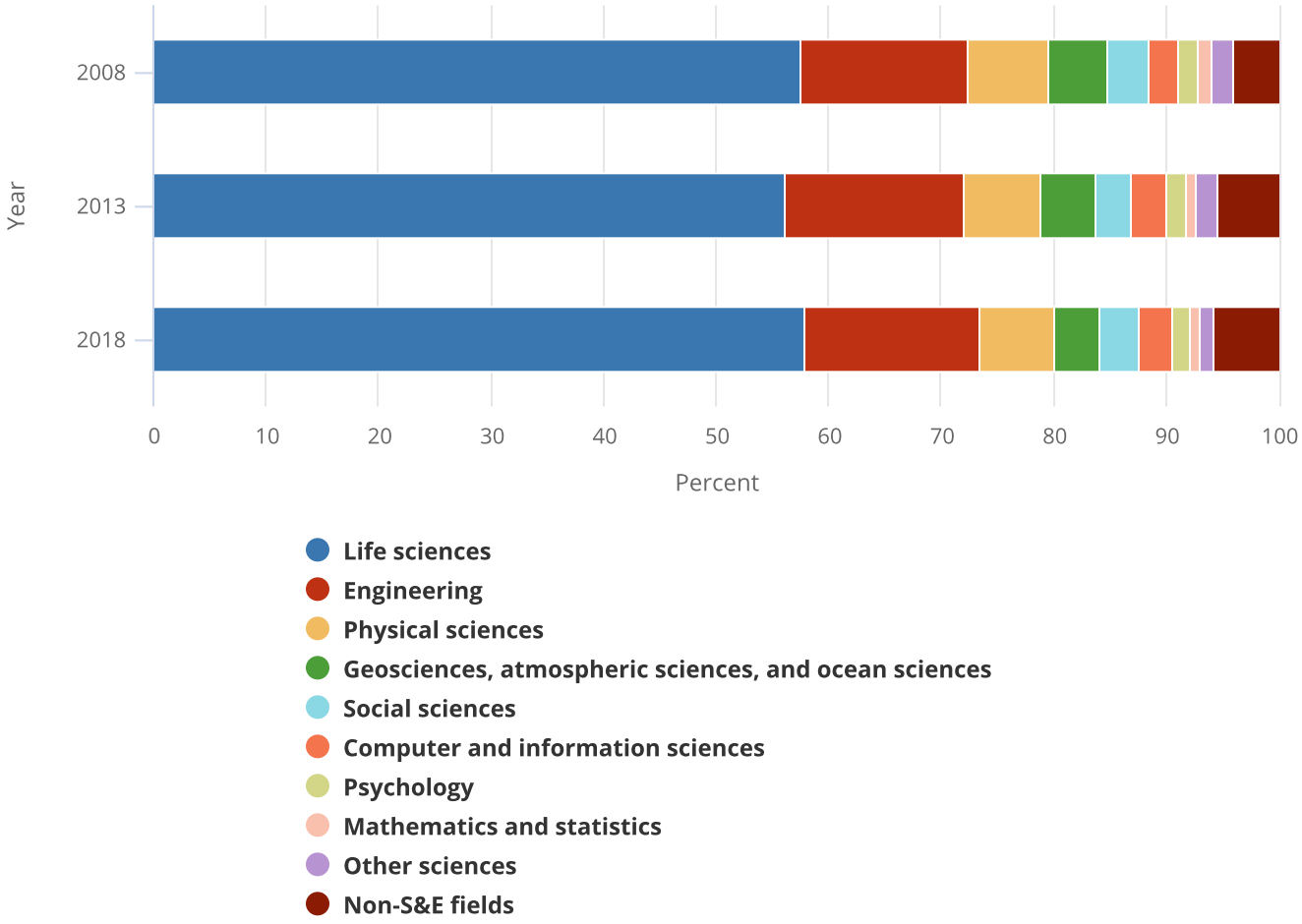
Science and Engineering Indicators

Academic R&D, by Field

The relative amount of resources provided to different fields has changed little over the last 10 years. The life sciences—primarily biological and biomedical sciences and health sciences—have long accounted for the bulk of academic R&D: $45.8 billion in 2018, more than half the total (**Figure 5b-12**; NCSES ***HERD 2018***: **Table 12**). Life sciences and engineering ($12.4 billion, or 16%) together constitute nearly three-quarters of academic R&D, with other fields making up smaller shares of 7% or less. Consistent with the overall pattern, academic R&D funding across most broad S&E fields comes primarily from the federal government, with academic institutions themselves as the second-largest source. In the federal government, each federal agency funds a portfolio across fields that is consistent with its mission.

FIGURE 5B-12

Academic R&D expenditures, by field: 2008, 2013, and 2018



Note(s)

Percentages may not sum to total because of rounding. Expenditures for 2013 include funding from the American Recovery and Reinvestment Act of 2009 (ARRA).

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD).

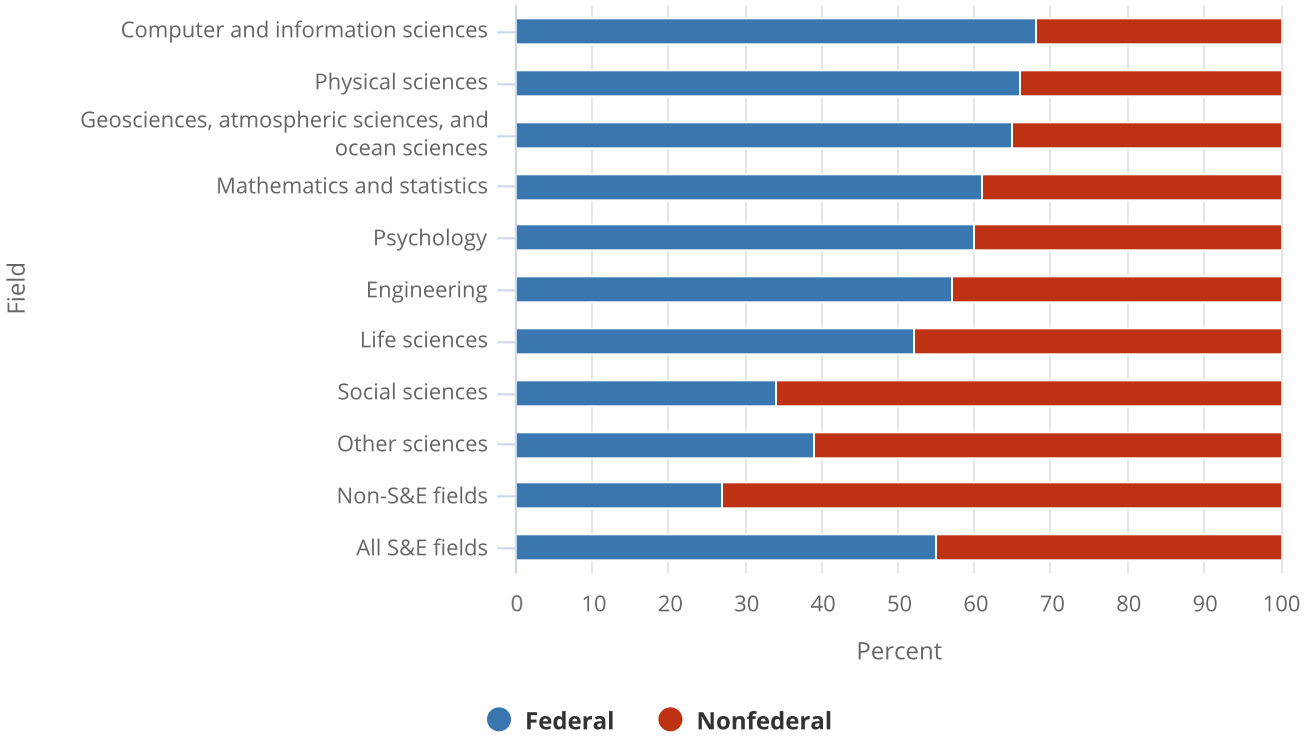
Science and Engineering Indicators

Federal Support for Academic R&D, by Field

The percentage of total academic R&D funding provided by the federal government varies across fields, from around 35% for social sciences to nearly 70% for computer and information sciences in 2018 (**Figure 5b-13**).[18] Although life sciences receive the most resources, funding for academic R&D in this field is split nearly evenly between the federal government and nonfederal sources.

FIGURE 5B-13

Federal and nonfederal support for academic R&D, by field: FY 2018



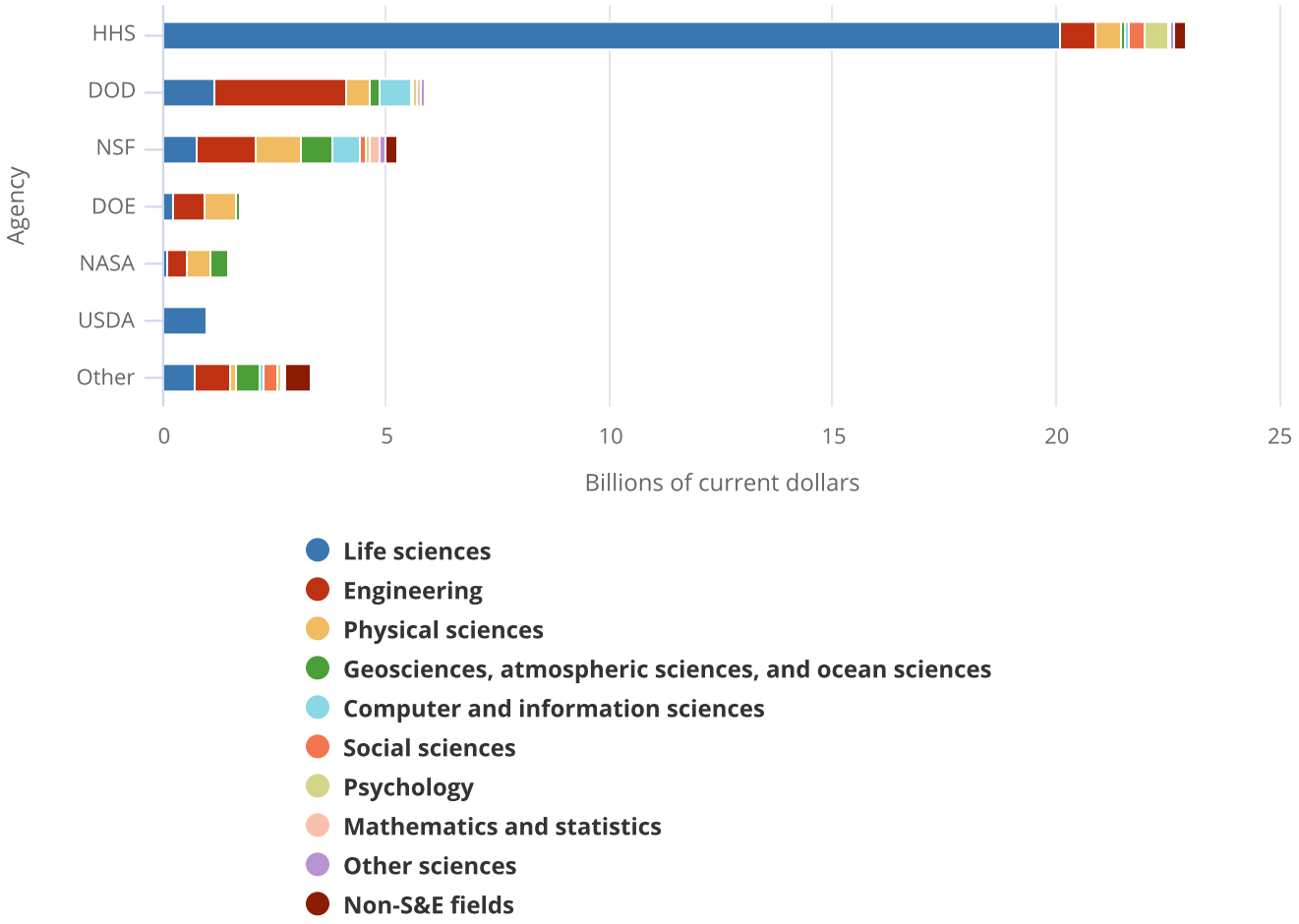
Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Science and Engineering Indicators

Each of the six primary federal agencies that sponsor academic R&D funds a portfolio across fields consistent with its mission (**Figure 5b-14**). For example, the vast majority ($20 billion, or nearly 90%) of the academic R&D funded by HHS is in life sciences. Around 80% ($1.4 billion) of DOE's academic R&D funding is in physical sciences and engineering. NSF supports substantial amounts of academic R&D across a range of S&E fields. Unsurprisingly, agencies' academic R&D support patterns across S&E fields largely mirror their support patterns for graduate students (*Indicators 2020* Figure 2-4).[19]

FIGURE 5B-14

Federally financed academic R&D expenditures, by agency and field: FY 2018



DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture.

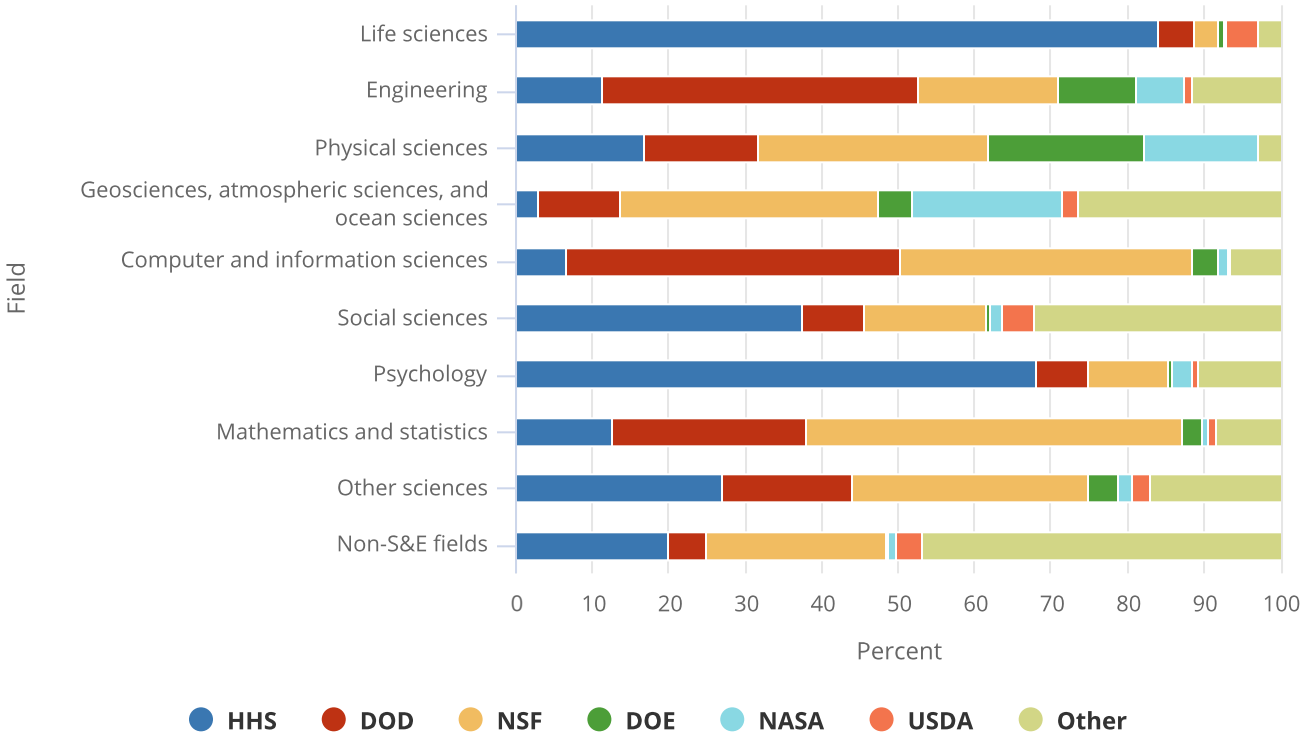
Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Science and Engineering Indicators

In each S&E field, the portion of R&D supported by specific agencies differs (**Figure 5b-15**). For example, HHS provides 84% of total federal support for academic R&D in life sciences and about two-thirds of such support for psychology. NSF contributes just under half of total federal academic R&D funding for mathematics and statistics, as well as significant portions of the totals for several other fields. Agencies sometimes target funds narrowly to specialized fields (NCSES ***HERD 2018***: **Table 13**). USDA, for example, provides around two-thirds of federal support for academic R&D in agricultural sciences (most of this support is allocated to public land grant universities). NASA provides around two-thirds of federal support for academic R&D in astronomy and astrophysics, and NSF provides nearly half the federal support for academic R&D in anthropology.

FIGURE 5B-15

Federally financed academic R&D expenditures, by field and agency: FY 2018



DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

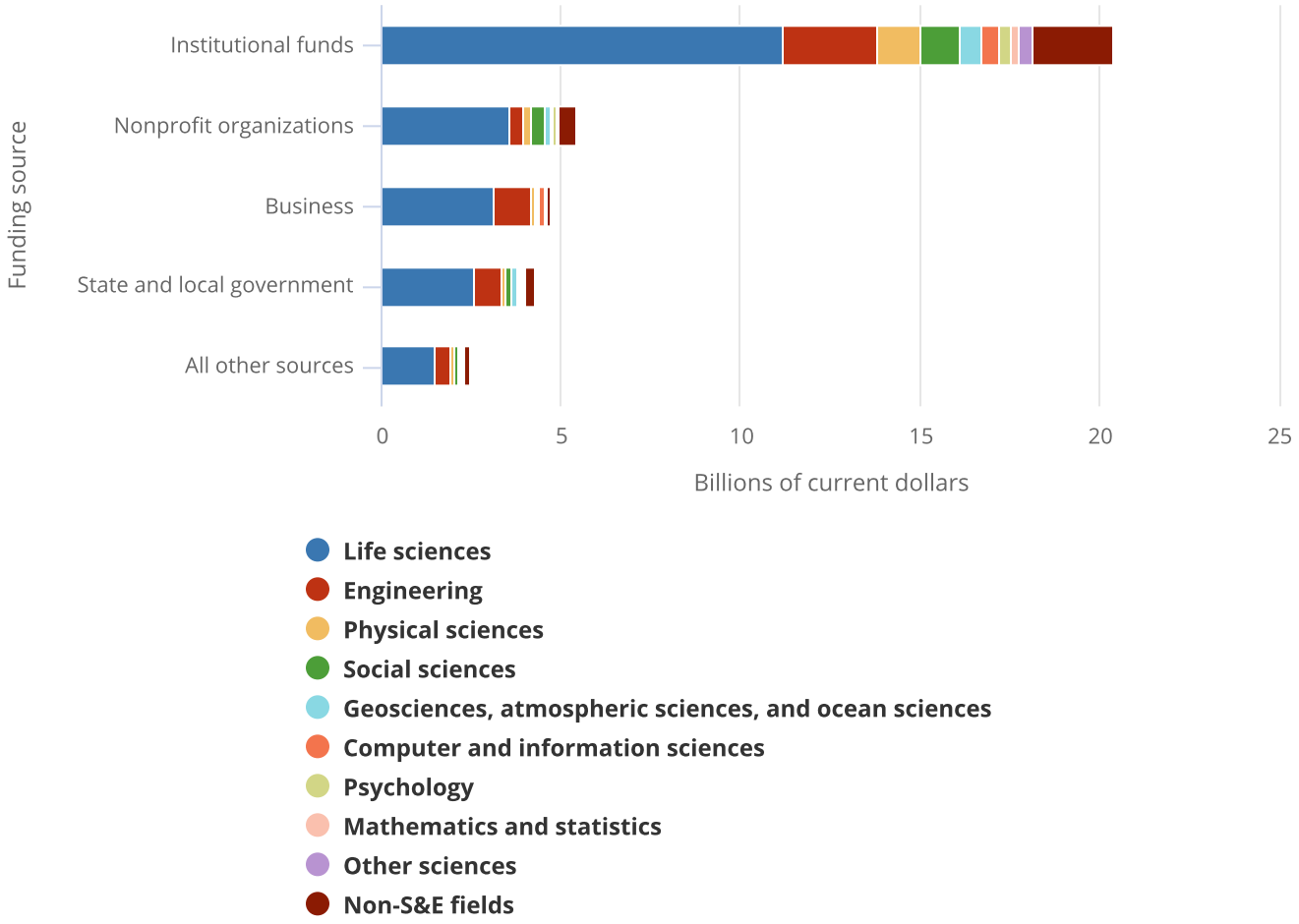
Science and Engineering Indicators

Nonfederal Support for Academic R&D, by Field

Unlike federal agencies, nonfederal academic R&D sources represent aggregations of funders, each of which may have its own funding priorities. However, in 2018, more than half of the total funding from each type of nonfederal academic R&D source—academic institutions themselves, nonprofit organizations, businesses, and state and local governments—was allocated to life sciences (**Figure 5b-16**). Engineering was the second-largest recipient for all but nonprofit funding. Underlying this pattern were smaller-scale differences in how these types of sources allocated funds. Businesses, for example, devoted nearly a quarter of their total academic R&D funding to engineering and less than 1% to social sciences. Nonprofit organizations, by contrast, devoted slightly more funds to social sciences than engineering (around 7% for each).

FIGURE 5B-16

Nonfederally financed academic R&D expenditures, by funding source and field: FY 2018



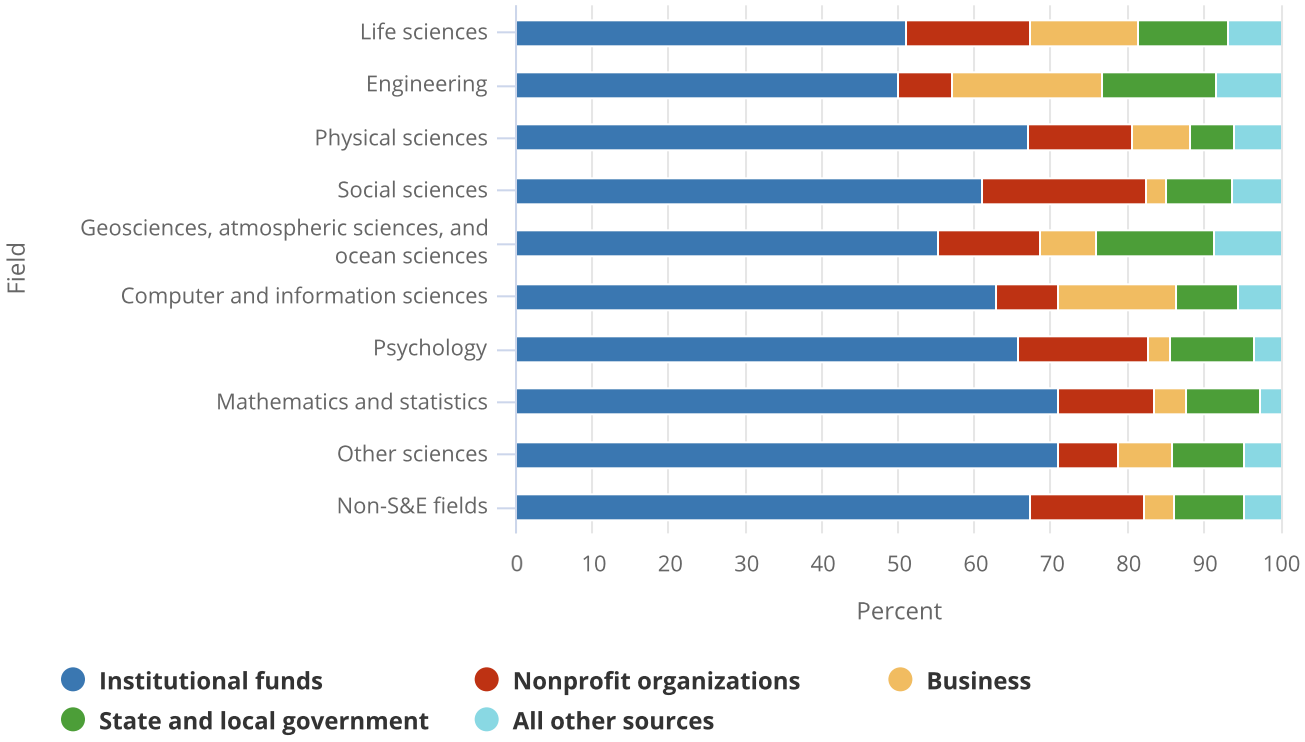
Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Science and Engineering Indicators

Academic institutions contributed half or more of nonfederal academic R&D funding for all broad fields (**Figure 5b-17**; NCSES ***HERD 2018***: **Table 12**). Nonprofit organizations contributed nearly one-quarter of total nonfederal academic R&D funding for social sciences. Businesses contributed around one-fifth of nonfederal academic R&D funding for engineering. State and local governments contributed smaller percentages more uniformly divided among a range of fields.

FIGURE 5B-17

Nonfederally financed academic R&D expenditures, by field and funding source: FY 2018



Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (HERD), FY 2018.

Science and Engineering Indicators

Cost Components of Academic R&D

Academic R&D expenditures are composed of direct and indirect costs (NCSES ***HERD 2018***: **Table 16**; see also Council on Governmental Relations [2019]). According to a report from the National Research Council, direct costs of research are those that can be attributed to a specific project, such as researcher salaries, travel, and the costs of laboratory materials. Indirect costs include outlays for facilities and administration, including library costs and other elements that support multiple projects or an institution's entire research program (National Research Council 2012).[20] A key distinction between these types of costs is that while funders, including the federal government, *pay* the direct costs of R&D, they may also *reimburse* institutions for all or part of the indirect costs associated with that R&D.

In 2018, direct costs were around three-quarters ($61.0 billion) of total academic R&D spending. The largest direct cost component includes the salaries, wages, and fringe benefits of those who conduct the R&D; in 2018, this was $34.8 billion, or around 44% of total academic R&D spending. Other direct cost components include software and equipment purchases, as well as funds passed to subrecipients.

Indirect costs include those recovered by institutions and unrecovered costs for which institutions are not reimbursed.[21] The relationship between levels of federal funding and levels of institutional funding, including the unrecovered indirect cost component, is complex. As mentioned earlier, precise accounting of institutionally financed R&D is difficult, and funds may be derived from many sources (for more, see Council on Governmental Relations [2019]; Droegemeier [2017]).

As shown in **Gibbons 2019**: **Figure 2**, while the total amount of unrecovered indirect costs increased slightly in inflation-adjusted dollars between 2012 and 2018 (from around $4.6 billion to $5.0 billion), institutional direct funding for research increased much faster (from $7.7 billion to $12.0 billion). During this time, unrecovered indirect costs as a percentage of total institutionally funded R&D expenditures decreased from around one-third to around one-quarter.

As a percentage of total indirect costs, unrecovered indirect costs are higher for public institutions (around 35%) than for private institutions (around 23%) (NCSES ***HERD 2018***: **Table 16**). However, when compared with total institutional spending on R&D, the proportions are about the same.[22]

Infrastructure for Academic R&D

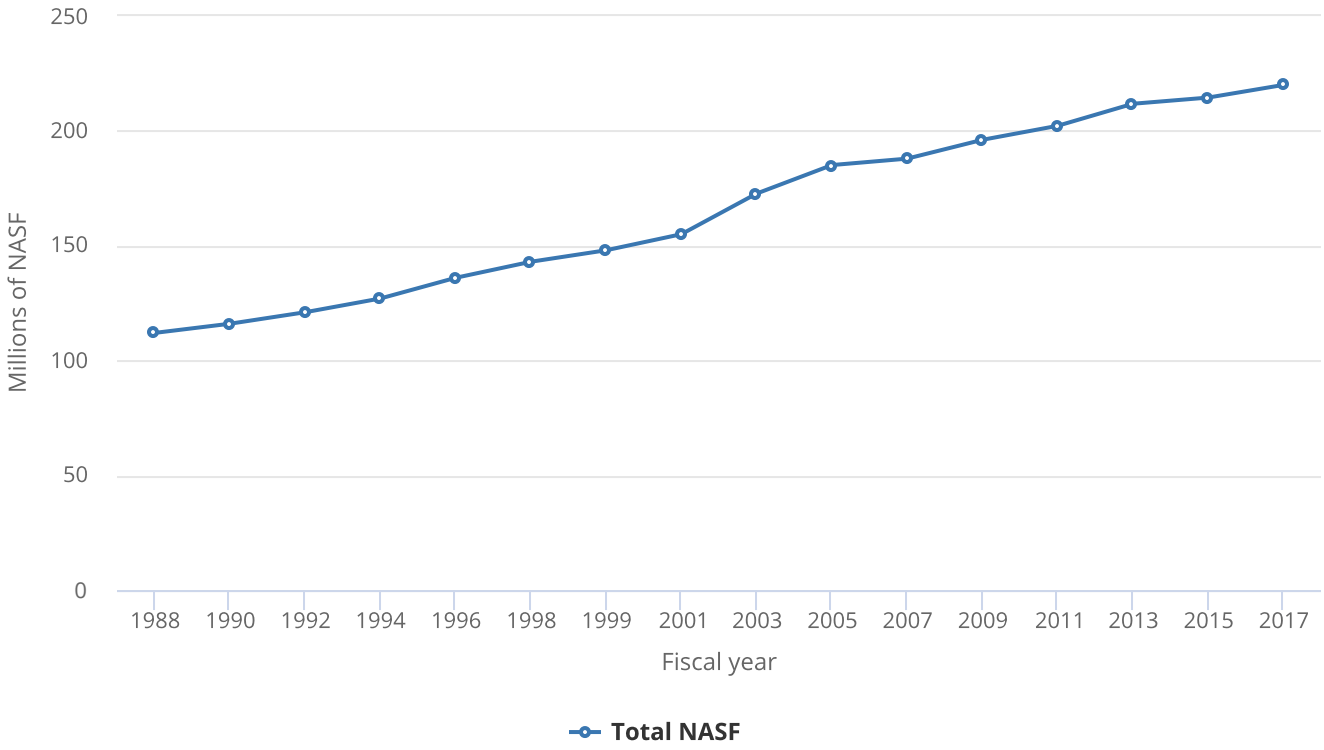
Physical infrastructure is an essential resource for the performance of R&D at academic institutions. The principal indicators of this infrastructure are the square footage of designated research space and research instrumentation expenditures. Two fields of research primarily drive the continual increases in academic S&E research space: biological and biomedical sciences and engineering. These two fields accounted for more than 60% of total research space growth from 2007 to 2017. Research equipment expenditures have fluctuated over the past 15 years in constant dollars but stand at levels similar to those a decade ago. Federal funding of research equipment declined to less than 50% in 2014 for the first time in decades and has remained below that threshold since.

Research Facilities

Research-performing universities and colleges in the United States had 220.0 NASF of research space available at the end of 2017, up 5.5 million NASF (2.6%) from 2015 (**Figure 5b-18**). The total increase in research space between 2015 and 2017 was more than twice the square footage of space added between 2013 and 2015 (2.7 million NASF).

FIGURE 5B-18

S&E research space in academic institutions: FYs 1988–2017



NASF = net assignable square feet.

Note(s)
The biennial survey cycle ran on even years from FYs 1988 to 1998 and on odd years from FYs 1999 to 2017.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Survey of Science and Engineering Research Facilities.

Science and Engineering Indicators

Despite some fluctuations, research space in most S&E fields increased from 2007 to 2017. One exception to this trend was computer and information sciences, which declined 13% (from 4.8 million to 4.2 million NASF) (**Table 5b-1**). Engineering is the only major field where total research space steadily increased during this 10-year interval. This is similar to the trend in R&D expenditures over the same period: engineering was the only major field with continuous growth in expenditures, while other fields increased overall, despite some periodic fluctuations (NCSES ***HERD 2016***: **Table 9**; NCSES ***HERD 2017***: **Table 9**).

TABLE 5B-1

S&E research space in academic institutions, by field and research animal space: FYs 2007–17

(Millions of net assignable square feet)

Field	FY 2007	FY 2009	FY 2011	FY 2013	FY 2015	FY 2017
All research space	187.9	196.1	202.2	211.8	214.5	220.0
Agricultural sciences	27.9	29.5	27.6	30.5	28.3	28.1
Biological and biomedical sciences	44.8	50.3	53.7	57.2	55.9	57.5
Computer and information sciences	4.8	5.2	5.0	4.3	4.3	4.2
Engineering	28.4	30.2	31.7	33.5	34.2	35.1
Geosciences, atmospheric sciences, and ocean sciences	8.4	8.0	7.8	7.8	8.1	8.5
Health sciences	37.0	36.3	36.7	38.0	39.2	40.0
Mathematics and statistics	1.6	1.5	1.5	1.7	1.8	1.8
Natural resources and conservation	na	na	na	na	3.5	4.3
Physical sciences	20.3	20.5	21.8	22.9	22.7	23.1
Psychology	4.9	5.2	5.5	5.5	5.5	5.6
Social sciences	6.0	5.5	5.7	5.7	6.0	6.1
Other	3.7	3.9	5.2	4.8	4.9	5.8
Research animal space[a]	17.8	18.1	18.4	18.9	19.2	19.1

na = not applicable; see Note(s).

[a] Research animal space is listed separately and is included in individual field totals.

Note(s)

S&E fields and their disciplines were revised in FY 2015. Specifically, "Agricultural sciences and natural resources sciences" has been split into "Agricultural sciences" and "Natural resources and conservation." "Physical sciences" and its subfields "Earth, atmospheric, and ocean sciences" and "Astronomy, chemistry, and physics" are now reported under "Geosciences, atmospheric sciences, and ocean sciences" and "Physical sciences," respectively. Data were not collected separately for "Natural resources and conservation" before the FY 2015 survey and are included in the "Agricultural sciences" field for earlier cycles.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Survey of Science and Engineering Research Facilities.

Science and Engineering Indicators

Overall, biological and biomedical sciences accounted for 40% of total S&E research space growth over the past 10 years. The 57.5 million NASF of biological and biomedical sciences research space also accounted for the largest share of research space, with 26% of the total. Health sciences (18%), engineering (16%), agricultural sciences (13%), and physical sciences (11%) comprised the next-largest shares of S&E research space.

New research space is added each year through construction projects and the repurposing of existing space. Academic institutions broke ground on 7.0 million NASF of new S&E research space construction projects in 2016–17, which was the largest amount of new research space construction started since 2010–11 (NCSES ***Facilities 2017***: **Table 8**). Institutions reported $6.2 billion in completion costs for these new construction projects, which were largely funded by the institutions' internal funds (71%) (NCSES ***Facilities 2017***: **Table 24**). Academic institutions also expended $5.1 billion on major repairs and renovation of S&E research space in 2016–17 (NCSES ***Facilities 2017***: **Table 25**).[23]

Research Equipment

In 2018, universities spent about $2.1 billion on capitalized equipment necessary for the conduct of academic research projects (Table S5b-1).[24] This spending accounted for close to 3% of the $79.3 billion in total academic R&D expenditures and represented a 4% decline from 2017 when adjusted for inflation.[25] Annual equipment spending has generally ranged between $1.9 billion and $2.3 billion over the last 15 years when adjusted for inflation. The 2018 inflation-adjusted total is the lowest during this period.

Research equipment expenditures continue to be concentrated in three fields: life sciences (41%), engineering (28%), and physical sciences (18%). While shares for these three fields have consistently accounted for about 80% or more of total equipment expenditures, the combined shares have been at or near the highest on record for the past several years. Also noteworthy is that more than one-third of all research equipment expenditures stem from two life sciences subfields: biological and biomedical sciences (18%) and health sciences (17%).

When adjusted for inflation, the 2018 level of equipment spending in engineering was well below the 2013 and 2014 totals, which were the highest levels reached in decades. It was also lower than the equipment expenditures in the other years after 2010. However, engineering equipment expenditures were substantially greater than the 2004–09 period preceding these higher totals. In comparison, the 2018 level of science equipment spending was the second lowest of the past 15 years. Total science equipment spending in 2018 was also 23% lower than the high point reached in 2004.

Unlike funding for new construction of research space, which relies heavily on institutional funds, most academic research equipment funding typically comes from the federal government. Before 2014, the share of research equipment expenditures funded by federal sources remained above 50% since data were initially collected in 1981, including a high of 63% as recently as 2010. Since 2014, the federal government has funded 44% to 47% of research equipment expenditures (Table S5b-2).

The federal share of research equipment funding varies significantly by R&D field and subfield. Atmospheric sciences and meteorology (77%) and physics (73%) were the only fields receiving 70% or more of their R&D equipment funding from federal sources. Economics (5%), social sciences (16%), and natural resources and conservation (19%) were the only S&E subfields receiving less than 20% federal support for R&D equipment. Several non-S&E fields also received less than 20% federal support for R&D equipment. This reflects the less equipment-dependent nature of research in these fields.

Conclusion

Higher education institutions are an essential component of the U.S. R&D system, performing almost half of U.S. basic research and training the next generation of scientists and engineers across fields. In inflation-adjusted dollars, total academic R&D has grown every year since 1975. The federal government, primarily through six agencies, provides more than half of academic R&D funding, although its share has declined over time. Academic institutions themselves are the second-largest contributor to academic R&D, and their share has grown over time. Most academic R&D is performed by the same small percentage of U.S. higher education institutions that award the majority of S&E doctoral degrees. Among S&E fields, life sciences and engineering continue to dominate academic R&D. Overall spending on research equipment has not grown in the past decade when adjusted for inflation. As with overall academic R&D spending, the federal share has declined, and academic institutions are playing a more important funding role than in the past.

Glossary

Definitions

Control (of institution): A classification of whether an institution is operated by publicly elected or appointed officials (public control) or by privately elected or appointed officials and derives its major source of funds from private sources (private control).

Net assignable square feet (NASF): Unit for measuring research space. NASF is the sum of all areas on all floors of a building assigned to, or available to be assigned to, an occupant for a specific use, such as research or instruction. NASF is measured from the inside face of walls.

R&D: Research and experimental development comprise creative and systemic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture, and society—and to devise new applications of available knowledge (OECD 2015).

> **Basic research:** Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
>
> **Applied research:** Original investigation undertaken in order to acquire new knowledge; directed primarily toward a specific, practical aim or objective.
>
> **Experimental development:** Systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

Research space: The budgeted and accounted-for space used for sponsored R&D activities at academic institutions. Research space is the net assignable square feet of space in buildings within which research activities take place. Research facilities are located within buildings. A building is a roofed structure for permanent or temporary shelter of people, animals, plants, materials, or equipment. Structures are included as research space if they are (1) attached to a foundation; (2) roofed; (3) serviced by a utility, exclusive of lighting; and (4) a source of significant maintenance and repair activities.

Key to Acronyms and Abbreviations

ARRA: American Recovery and Reinvestment Act of 2009

DOE: Department of Energy

FY: fiscal year

HERD: Higher Education Research and Development Survey

HHS: Department of Health and Human Services

NASA: National Aeronautics and Space Administration

NASF: net assignable square feet

NCSES: National Center for Science and Engineering Statistics

NSB: National Science Board

NSF: National Science Foundation
R&D: research and development

S&E: science and engineering

USDA: Department of Agriculture

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Notes

1 Data in this section are drawn from the National Center for Science and Engineering Statistics National Patterns of R&D Resources, the same source used in *Indicators 2020* report "Research and Development: U.S. Trends and International Comparisons." Totals from this source may differ from those used in the rest of the report, which are from the Higher Education Research and Development Survey (2010 onward) and its predecessor, the Survey of Research and Development Expenditures at Universities and Colleges (1972–2009), for reasons outlined in more detail in endnote 4. The 13% in this sentence is calculated based on $71.3 billion in higher education R&D expenditures from NCSES *NP 2018*.

2 A concise description of the differences between basic and applied research is available at **http://www.sjsu.edu/people/fred.prochaska/courses/ScWk170/s0/Basic-vs.-Applied-Research.pdf**.

3 U.S. basic research in 2017 totaled $91.5 billion. Businesses were the second-largest performer of basic research (27%).

4 In the rest of this report, financial data on academic R&D are drawn from the National Center for Science and Engineering Statistics (NCSES) Higher Education Research and Development (HERD) Survey (2010 onward) and its predecessor, the Survey of Research and Development Expenditures at Universities and Colleges (1972–2009). HERD data are in current-year dollars and are reported on an academic year basis. For example, FY 2018 covers July 2017–June 2018 for most institutions and is referred to in this report as 2018. Comparisons over more than 1 year are made in inflation-adjusted constant 2012 dollars using gross domestic product implicit price deflators based on calendar year. Gross domestic product deflators come from the U.S. Bureau of Economic Analysis and are available at **https://www.bea.gov/national**, accessed August 2019. The totals presented from HERD differ from similar totals reported in NCSES's National Patterns of R&D Resources and *Indicators 2020* report "Research and Development: U.S. Trends and International Comparisons." These other sources remove approximately $6 billion in pass-through funds that are double-counted in the HERD totals because such funds are counted by the universities initially receiving the money and by the universities to which the funds are passed. These other sources also present calendar year approximations based on fiscal year data.

5 Applied research has increased from 25% to 28%, and development has increased from 9% to 10%.

6 The remainder, $3.3 billion (8%), is awarded by all other federal agencies.

7 The largest changes were the funding shares of the Department of Defense, which increased from 10% in 2008 to 14% in 2018, and HHS, which decreased from 58% to 55% during this same interval.

8 *Unrecovered indirect costs* are calculated as the difference between an institution's negotiated indirect cost rate on a sponsored project and the amount that it recovers from the sponsor. *Committed cost sharing* is the sum of the institutional contributions required by the sponsor for specific projects (*mandatory cost sharing*) and the institutional resources made available to a specific project at the discretion of the grantee institution (*voluntary cost sharing*). For more on unrecovered indirect costs, see the section **Cost Components of Academic R&D**.

9 The accounting systems or administrative practices of some universities, including some with highest research activity, do not enable the separation of the R&D component of multipurpose accounts. Because the HERD Survey measures only spending that is fully budgeted as R&D for these institutions, reported institutional funds are less than the full amount of academic R&D that the schools fund. More details on efforts to improve the measurement of institutionally financed R&D are in the HERD Technical Notes, available at **https://ncsesdata.nsf.gov/herd/2018/herd18-tech-notes.pdf**.

10 The 2018 HERD Survey included 915 institutions that had reported $150,000 or more in R&D expenditures during the previous fiscal year. For more detail on the survey population, see (NCSES ***HERD 2018***: **Table A-4**).

11 Whether an institution is operated by publicly elected or appointed officials, or by privately elected or appointed officials and derives its major source of funds from private sources, is referred to as its control.

12 The Carnegie Classification of Institutions of Higher Education (**http://carnegieclassifications.iu.edu/**) is widely used to characterize differences in academic institutions. The Basic Classification categorizes academic institutions primarily based on highest degree conferred, level of degree production, and research activity. This report uses the 2015 Carnegie classification. This categorization does not include some academic institutions that are top R&D performers but whose training programs are exclusively focused on a small number of fields (i.e., exclusively biomedically focused institutions). Note that although the 2018 Carnegie classification contains revised names and institutional memberships in some categories, it does not change the main findings in this report. In 2018, the Carnegie-classified "highest research activity" doctoral universities received around three-quarters of the totals provided by each main academic R&D funding source, with the exception of state and local government funding (about 63%). These institutions also received the vast majority of funds from the top six federal agencies, ranging from 70% (USDA) to 86% (DOE).

13 Of the 915 institutions included in the 2018 HERD Survey, 523 (57%) were public institutions and 392 (43%) were private institutions (NCSES ***HERD 2018***: **Table A-4**). Among the 115 highest research activity doctoral universities, 81 (70%) are public. Among the 60 U.S. institutions that are members of the Association of American Universities, 34 (57%) are public (**https://www.aau.edu/who-we-are/our-members**). Additionally, public universities, although less numerous overall, tend to be larger, as they enroll more students and award more degrees (*Indicators 2020* report "Higher Education in Science and Engineering").

14 These summations are of top R&D performers overall and include some institutions not in the highest research activity category. Johns Hopkins University includes the Applied Physics Laboratory, with $1.5 billion in total R&D expenditures in FY 2018.

15 In 2018, public universities received $1.1 billion (92%) of USDA's funding for academic R&D. Almost all of that funding ($1.0 billion) went to the 77 public land grant institutions reporting expenditures.

16 A total of 94 of these universities are public, and 62 are private.

17 Of the 115 doctoral universities with "highest research activity," 71 reported medical school expenditures, including 47 public universities and 24 private universities.

18 As shown in **Figure 5b-13**, the percentage of total support for non-S&E fields provided by the federal government was lower, at less than 30%.

19 However, the amount of academic R&D provided by each agency is not proportional to the number of graduate students supported. For example, for the most recent year of data, HHS funded more than four times as much academic R&D as NSF but supported about the same number of graduate students as NSF.

20 An infographic displaying the difference between direct and indirect costs is available at **https://www.aau.edu/sites/default/files/Costs-of-Research-Infographic.pdf**. The history of indirect cost reimbursement in the context of the university–government research partnership is reviewed in Droegemeier (2017).

21 The academic R&D reported here includes separately accounted-for R&D and related recovered indirect costs. It also includes committed cost sharing and institutional estimates of unrecovered indirect costs associated with externally funded R&D projects. Some indirect costs are recovered as a result of indirect-cost proposals that universities submit based on their actual costs from the previous year.

22 Unrecovered indirect costs as a percentage of total institutional spending on R&D were about 27.5% for private universities and 27.0% for public universities.

23 More details on these and other research space trends are available on the NSF website for the Survey of Science and Engineering Research Facilities at **https://nsf.gov/statistics/srvyfacilities/**.

24 Capitalized equipment is collected on the NCSES HERD Survey as payments for movable equipment exceeding an institution's capitalization threshold, including ancillary costs such as delivery and setup.

25 The $79.3 billion noted here includes only institutions reporting $1 million or more in total R&D expenditures in FY 2017. Institutions reporting less than $1 million in total R&D expenditures in FY 2017 completed a shorter version of the NCSES HERD Survey form in FY 2018 that did not include a question on research equipment. Respondents to the short form questionnaire accounted for $151 million (0.2%) of total R&D expenditures in FY 2018.

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