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R&D

Research and Development: U.S. Trends and International Comparisons

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This publication is part of the *Science and Engineering Indicators* suite of reports. *Indicators* is a congressionally mandated report on the state of the U.S. science and engineering enterprise. It is policy relevant and policy neutral. *Indicators* is prepared under the guidance of the National Science Board by the National Center for Science and Engineering Statistics, a federal statistical agency within the National Science Foundation. With the 2020 edition, *Indicators* is changing from a single report to a set of disaggregated and streamlined reports published on a rolling basis. Detailed data tables will continue to be available online.

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Executive Summary

Key takeaways:

- The U.S. annual total of research and development (R&D) has expanded steadily since 2010 (reaching $548 billion in 2017), due particularly to sizable annual increases in business R&D performance.
- The United States remains the world's top R&D performer. China continues to close the gap, with an average annual growth rate that is currently nearly three times higher than that of the United States.
- The global concentration of R&D performance continues to shift from the United States and Europe to South Asia and East-Southeast Asia.
- Businesses continue as the predominant performers and funders of U.S. R&D (73% and 70%, respectively, in 2017). Businesses perform the vast majority of U.S. R&D classified as development and considerable shares of U.S. R&D classified as basic or applied research.
- Higher education institutions and the federal government are the second and third largest performers of U.S. R&D (13% and 10%, respectively, in 2017). However, both have experienced some erosion in their shares since 2010.
- The federal government has been a consistent source of funding to all R&D-performing sectors. Federal support varies by sector, ranging from nearly all the R&D performed by the federal government and half of that performed by higher education, to smaller shares for state government, nonprofit organizations, and the business sector. The share of U.S. R&D performance funded by the federal government overall has declined in recent years from 31% in 2010 to 22% in 2017.

Scientific discoveries, new technologies, and inventive applications of cutting-edge knowledge have become increasingly essential for success in a competitive global economy and in addressing challenges and opportunities in diverse societal areas such as health, environment, and national security. As such, the strength of a country's overall R&D enterprise—including both the public and private sectors of this system—is an important marker of current and future national economic advantage and of prospects for societal improvements. In the United States, the nation's overall R&D enterprise relies on the R&D performance and funding of a diverse set of actors, including businesses, the federal government, nonfederal governments, higher education institutions, and other nonprofit organizations.

R&D performed in the United States totaled $547.9 billion in 2017, reflecting yearly increases averaging $20.2 billion over the 2010–17 period. The main driver of this sustained and sizable increase was business R&D performance. Adjusted for inflation, U.S. total R&D over 2010–17 grew modestly faster than U.S. gross domestic product (GDP) (with average annual growth rates, respectively, of 2.7% and 2.2%).

The global total of R&D expenditures has risen at a substantial pace since the turn of the century to $2.153 trillion (current purchasing power parity dollars) in 2017—a threefold increase from 2000 ($722 billion). This expansion reflects the escalating knowledge intensity of economic competition among the world's leading nations, as well as the important role of R&D in addressing global challenges (such as health, environment, and security). The United States and China each account for about a quarter of the global R&D total. The remaining top 16 R&D-performing nations together account for somewhat more than a third of the global total—in decreasing order, Japan, Germany, South Korea, France, India, United Kingdom, Russia, Brazil, Taiwan, Italy, Canada, Spain, Turkey, and Australia.

China's R&D growth rate continues to greatly exceed that of the United States and contributes to the sustained rise in R&D performance of South Asia and East-Southeast Asia—including China, Japan, South Korea, India, and Taiwan. The combined R&D performance across these regions of Asia rose from 25% to 42% of the global total between 2000 and 2017. With these regions continuing to record substantially faster-than-average R&D growth rates, this remaking of the global geography of R&D is unlikely to slow soon.

Businesses continue to be the predominant performers and funders of U.S. R&D, accounting for 73% of total U.S. R&D performance and 70% of its funding in 2017. Year-to-year increases and declines in business R&D greatly influence the overall U.S. R&D total. Businesses perform the vast majority of U.S. R&D classified as experimental development (90% in 2017) and more than half of the applied research (57% in 2017). The business share of basic research has also been increasing significantly in recent years (from 22% in 2010 to 27% in 2017).

The business sectors of the U.S. economy are diverse, with wide differences in the goods and services provided across industries and in the various production inputs required, including roles for R&D. The present peaks in U.S. business R&D are in a relative handful of industries in both manufacturing and nonmanufacturing.

The federal government has long performed mission-supporting R&D; in the last several years, this R&D was conducted primarily by nearly three dozen federal agencies and totaled about a tenth of the annual U.S. R&D total. Relative to R&D performance, the federal role is larger on the funding side (22% of the U.S. R&D total in 2017), where it has been a sizable resource for many of the U.S. R&D-performing sectors—particularly for higher education and for federal agencies' intramural R&D, although it has recently declined as a source of funding for the business sector. The federal government remains the largest source of support for the nation's basic research (although the share has dropped below half since 2012) and is a sizable supporter of the nation's applied research.

Introduction

This report identifies current trends in the performance and funding of the U.S. research and development (R&D) system. The discussion covers the main sectors responsible for U.S. R&D: the business sector, federal government, nonfederal government, higher education institutions, and other nonprofit organizations. At numerous points, the report also directly contrasts these U.S. R&D indicators with broadly comparable data from the world's other major economies.

This report is organized into four major sections addressing the following topics: the recent trends (particularly over the last 5–10 years) in overall U.S. R&D performance; comparison of U.S. R&D performance to those of the world's other leading economies; the U.S. business sector's large role in the nation's overall R&D activity; and the federal government's roles in supporting and conducting U.S. R&D. R&D performed by higher education institutions is treated in more detail in the *Indicators 2020* reports "Publications Output: U.S. Trends and International Comparisons" and "Academic Research and Development." For definitions of key terms used in this report, see the **Glossary** section.

Recent Trends in U.S. R&D Performance

The U.S. R&D system consists of the R&D activities of a variety of performers and sources of funding. Included here are private businesses, the federal government, nonfederal government, higher education (universities and colleges), and other nonprofit organizations. The organizations that perform R&D often receive significant levels of outside funding; furthermore, those that fund R&D may also themselves be significant performers.

The main sources of data for the indicators and analyses discussed in this section come from annual R&D surveys of these performers and funders, sponsored by the National Center for Science and Engineering Statistics (NCSES) within the National Science Foundation.[1]

U.S. Total R&D and R&D Intensity

In 2017, the R&D performed in the United States totaled $547.9 billion, up strongly from $493.7 billion in 2015 and $406.6 billion in 2010 (**Table 4-1** and **Figure 4-1**). (Unless otherwise noted, all amounts and calculations are in current dollars.)

TABLE 4-1

U.S. R&D expenditures, by performing sector and source of funds: 2010–17

(Millions of current and constant 2012 dollars)

Sector	2010	2011	2012	2013	2014	2015	2016	2017[a]
Current $millions								
All performing sectors	406,579	426,160	433,619	453,966	475,425	493,684	515,641	547,886
Business	278,977	294,092	302,251	322,528	340,728	355,821	374,685	400,101
Federal government	50,798	53,524	52,144	51,086	52,687	52,847	51,187	52,553
Federal intramural[b]	31,970	34,950	34,017	33,406	34,783	34,199	31,762	32,231
FFRDCs	18,828	18,574	18,128	17,680	17,903	18,649	19,424	20,322
Nonfederal government	691	694	665	620	583	595	622	641
Higher education	58,083	60,088	60,896	61,547	62,349	64,623	67,800	71,251
Other nonprofit organizations[c]	18,030	17,762	17,664	18,185	19,078	19,798	21,347	23,340
All funding sources	406,579	426,160	433,619	453,966	475,425	493,684	515,641	547,886
Business	248,124	266,422	275,718	297,168	318,383	333,208	355,545	381,137
Federal government	126,616	127,014	123,837	120,130	118,365	119,524	116,492	120,961
Nonfederal government	4,303	4,386	4,158	4,244	4,214	4,267	4,481	4,582
Higher education	12,262	13,103	14,300	15,378	16,210	17,299	18,484	19,723
Other nonprofit organizations[c]	15,275	15,235	15,607	17,046	18,254	19,386	20,640	21,482
Constant 2012 $millions								
All performing sectors	423,033	434,334	433,619	446,136	458,735	471,444	487,370	508,272
Business	290,267	299,733	302,251	316,965	328,767	339,792	354,142	371,173
Federal government	52,854	54,551	52,144	50,205	50,837	50,467	48,380	48,753
Federal intramural[b]	33,264	35,621	34,017	32,830	33,562	32,658	30,021	29,901
FFRDCs	19,590	18,930	18,128	17,375	17,275	17,809	18,359	18,852
Nonfederal government	719	707	665	609	563	568	588	594
Higher education	60,434	61,240	60,896	60,485	60,160	61,712	64,083	66,099
Other nonprofit organizations[c]	18,760	18,103	17,664	17,871	18,408	18,906	20,177	21,653
All funding sources	423,033	434,334	433,619	446,136	458,735	471,444	487,370	508,272
Business	258,165	271,531	275,718	292,043	307,206	318,197	336,051	353,580
Federal government	131,740	129,450	123,837	118,058	114,209	114,140	110,105	112,215
Nonfederal government	4,477	4,471	4,158	4,171	4,066	4,075	4,235	4,251
Higher education	12,758	13,354	14,300	15,112	15,640	16,520	17,470	18,297
Other nonprofit organizations[c]	15,893	15,528	15,607	16,752	17,614	18,513	19,508	19,929

FFRDC = federally funded research and development center.

[a] Some data for 2017 are preliminary and may later be revised.

[b] Includes expenditures of federal intramural R&D, as well as costs associated with administering extramural R&D procurements.

[c] Some components of the R&D performed by other nonprofit organizations are projected and may later be revised.

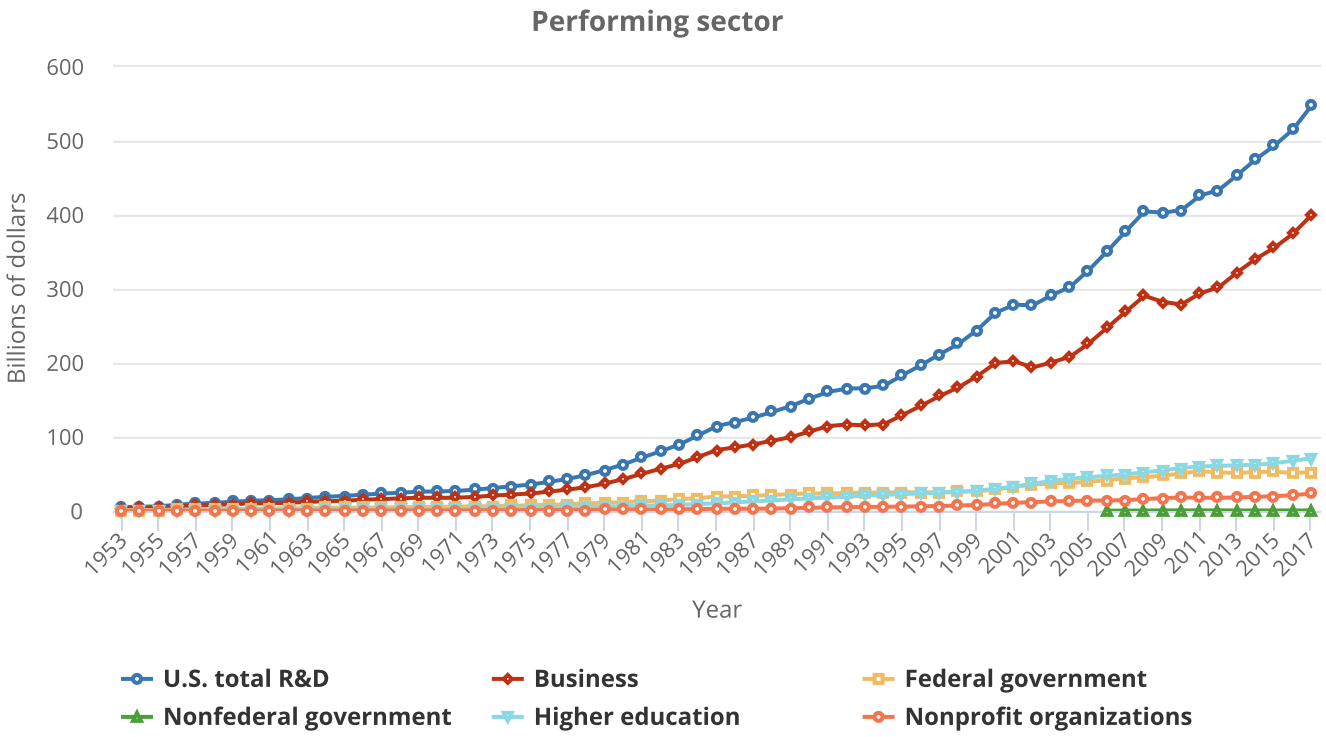
Note(s)
Data are based on annual reports by performers, except for the nonprofit sector. Expenditure levels for higher education, federal government, and nonfederal government performers are calendar year approximations based on fiscal year data.

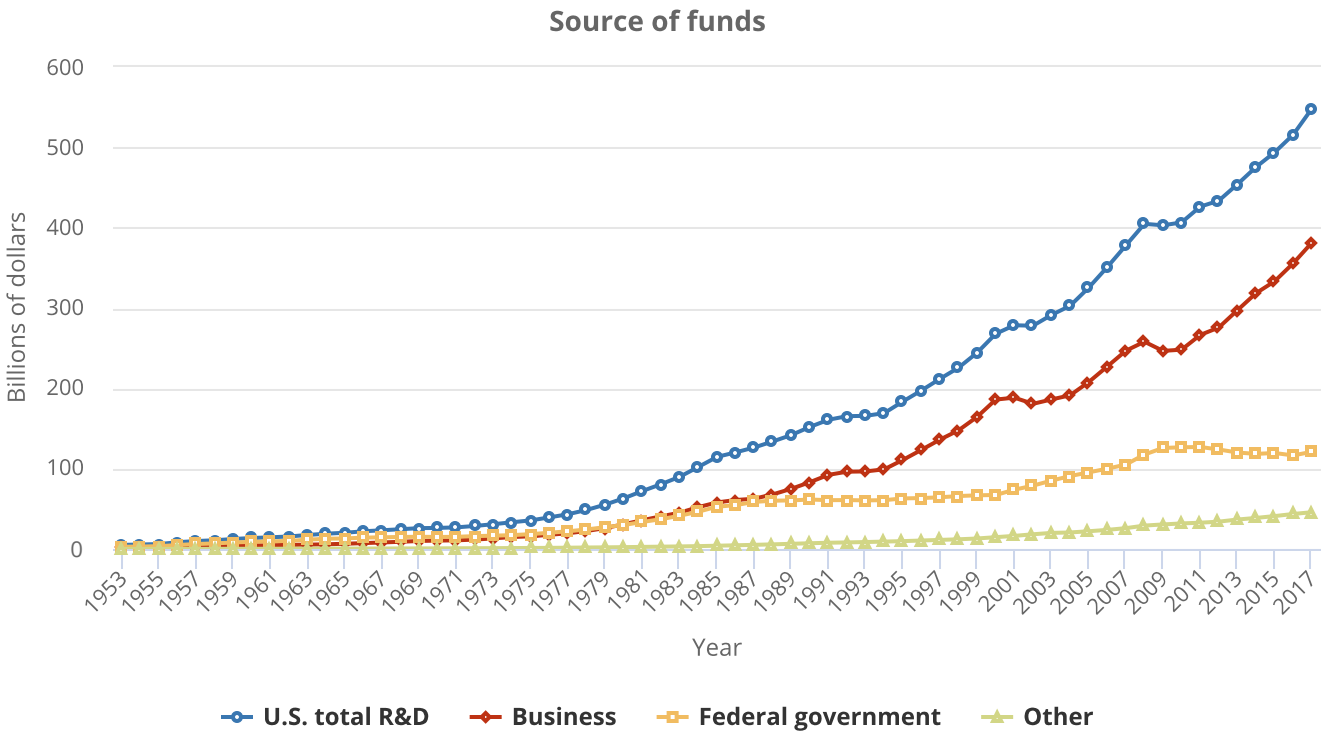
Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series).

Science and Engineering Indicators

FIGURE 4-1

U.S. R&D, by performing sector and source of funds: 1953–2017





Note(s)

Data for 2017 are preliminary and may later be revised. Some components of the R&D performed by other nonprofit organizations are projected and may later be revised. Federal performers of R&D include federal agencies and federally funded R&D centers. Performance by nonfederal government includes state governments (data in this series are not available before 2006). Other funding includes support from higher education, nonfederal (state and local) government, and nonprofit organizations.

Source(s)

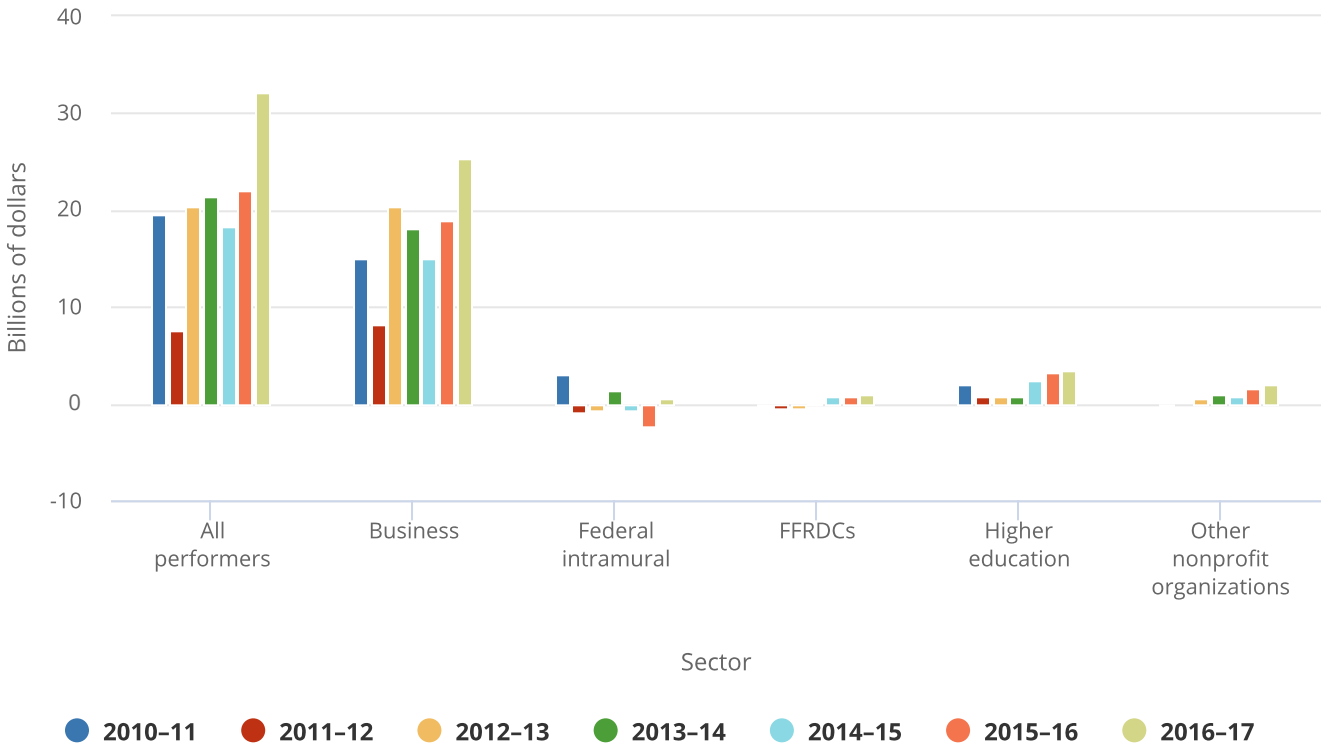
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series).

Science and Engineering Indicators

The 2010–17 period has seen sizable year-over-year increases, averaging $20.2 billion annually—in contrast to essentially no change between 2008 and 2010, a period marked by the impacts of the Great Recession. This pattern of sustained annual increases since 2010 is due mainly to consistently growing levels of business R&D performance (**Figure 4-2**).

FIGURE 4-2

Year-to-year changes in U.S. R&D expenditures, by performing sector: 2010–17



FFRDC = federally funded research and development center.

Note(s)
Data are calculated from R&D expenditure data reported for performers in **Table 4-1**. Expenditures by nonfederal government performers are comparatively negligible, and specific bars for this sector are excluded.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series).

Science and Engineering Indicators

Adjusted for inflation, growth in U.S. total R&D averaged 2.7% annually over the 2010–17 period, moderately faster than the 2.2% average pace of U.S. gross domestic product (GDP) (**Table 4-2**).[2] By comparison, during the prior decade (2000–10, which included the Great Recession), the average annual rate of growth of U.S. total R&D was lower, at 2.1%, although it still outpaced the 1.7% rate of GDP expansion.

TABLE 4-2

Annual rates of change in U.S. R&D expenditures, total and by performing sectors: 1990–2017

(Percent)

Expenditures and gross domestic product	Longer-term trends			Most recent years						
	1990–2000	2000–10	2010–17	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17
	Current $									
Total R&D, all performers	5.8	4.3	4.4	4.8	1.8	4.7	4.7	3.8	4.4	6.3
Business	6.4	3.4	5.3	5.4	2.8	6.7	5.6	4.4	5.3	6.8
Federal government	1.9	5.9	0.5	5.4	-2.6	-2.0	3.1	0.3	-3.1	2.7

TABLE 4-2

Annual rates of change in U.S. R&D expenditures, total and by performing sectors: 1990–2017

(Percent)

Expenditures and gross domestic product	Longer-term trends			Most recent years						
	1990–2000	2000–10	2010–17	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17
Federal intramural[a]	2.1	5.2	0.1	9.3	-2.7	-1.8	4.1	-1.7	-7.1	1.5
FFRDCs	1.7	7.3	1.1	-1.4	-2.4	-2.5	1.3	4.2	4.2	4.6
Nonfederal government[b]	NA	NA	-1.1	0.4	-4.2	-6.8	-5.9	2.0	4.7	2.9
Higher education	5.9	6.9	3.0	3.5	1.3	1.1	1.3	3.6	4.9	5.1
Other nonprofit organizations[c]	8.8	6.6	3.8	-1.5	-0.6	2.9	4.9	3.8	7.8	9.3
Gross domestic product	5.6	3.9	3.8	3.7	4.2	3.6	4.4	4.0	2.7	4.3
Constant 2012 $										
Total R&D, all performers	3.7	2.1	2.7	2.7	-0.2	2.9	2.8	2.8	3.4	4.3
Business	4.3	1.3	3.6	3.3	0.8	4.9	3.7	3.4	4.2	4.8
Federal government	-0.1	3.8	-1.1	3.2	-4.4	-3.7	1.3	-0.7	-4.1	0.8
Federal intramural[a]	0.0	3.0	-1.5	7.1	-4.5	-3.5	2.2	-2.7	-8.1	-0.4
FFRDCs	-0.4	5.1	-0.5	-3.4	-4.2	-4.2	-0.6	3.1	3.1	2.7
Nonfederal government[b]	NA	NA	-2.7	-1.7	-6.0	-8.4	-7.6	0.9	3.6	1.0
Higher education	3.7	4.7	1.3	1.3	-0.6	-0.7	-0.5	2.6	3.8	3.1
Other nonprofit organizations[c]	6.6	4.4	2.1	-3.5	-2.4	1.2	3.0	2.7	6.7	7.3
Gross domestic product	3.4	1.7	2.2	1.6	2.2	1.8	2.5	2.9	1.6	2.4

NA = not available.

FFRDC = federally funded research and development center.

[a] Includes expenditures of federal intramural R&D, as well as costs associated with administering extramural R&D procurements.

[b] Survey data on state intramural R&D performance were not available prior to 2006.

[c] Some components of the R&D performed by other nonprofit organizations are projected and may later be revised.

Note(s)
Longer-term trend rates are calculated as compound annual growth rates. Data for 2017 are preliminary and may later be revised.

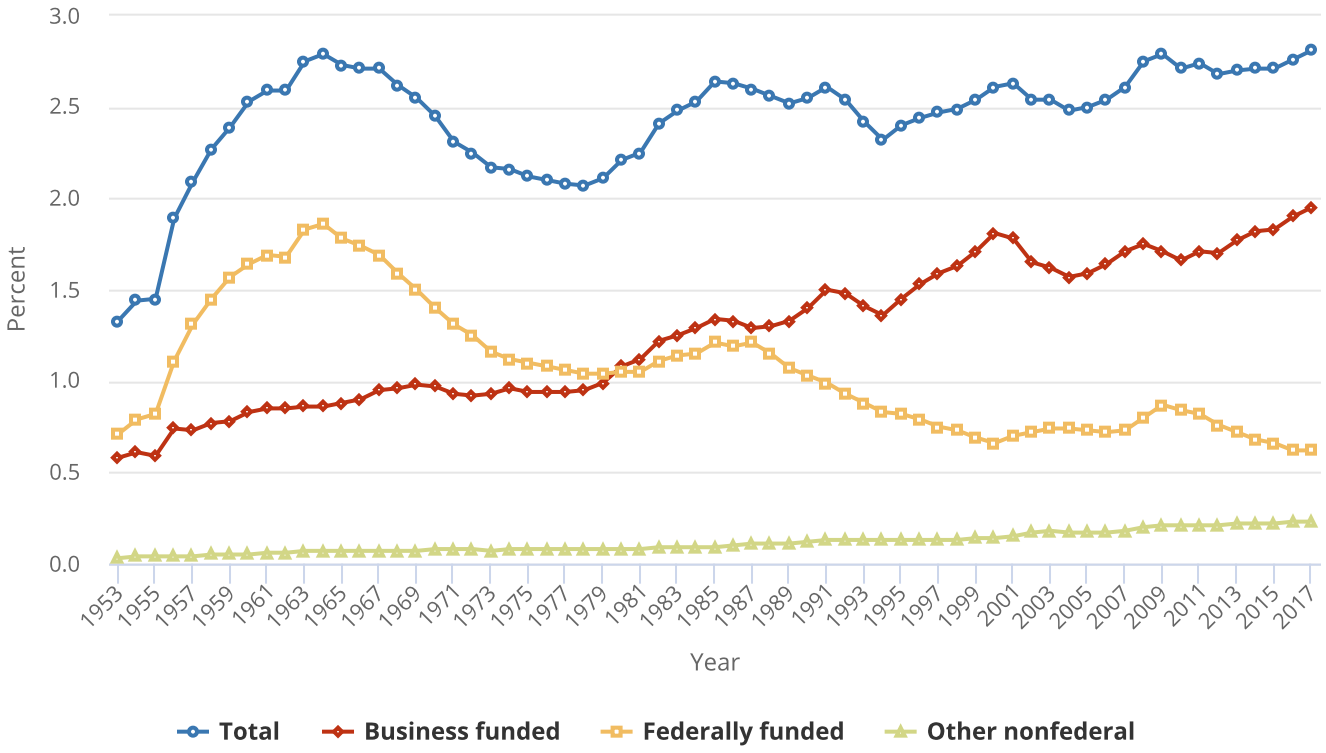
Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series).

Science and Engineering Indicators

Regarding the status of investment in R&D in the national economy, between 2010 and 2017, the ratio of U.S. R&D expenditures to GDP (or R&D intensity)[3] fluctuated within a relatively narrow range (from a low of 2.68% in 2012 to a high of 2.81% in 2017) (**Figure 4-3**). The ratio's 2017 level is the highest it has been since the start of the time series in 1953. (It reached 2.79% in both 1964 and 2009.)

FIGURE 4-3

Ratio of U.S. R&D to gross domestic product, by roles of federal, business, and other nonfederal funding for R&D: 1953–2017



Note(s)

Data for 2017 are preliminary and may later be revised. The federally funded data represent the federal government as a funder of R&D by all performers and similar for the business-funded data. The other nonfederal category includes R&D funded by all other sources—mainly, higher education, nonfederal government, and other nonprofit organizations. The gross domestic product data used reflect the U.S. Bureau of Economic Analysis's comprehensive revisions of the national income and product accounts of July 2018 and the annual update of July 2019.

Source(s)

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

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The broader trend since the mid-1990s has been a rising R&D-to-GDP ratio, albeit with some periods of decline. Most of the rise of this ratio over the past several decades resulted from increases in nonfederal spending on R&D, particularly by the business sector (**Figure 4-3**). This stems from the growing role of business R&D in the national R&D system, which in turn reflects the considerable increase of R&D-dependent goods and services in the national and global economies.

In contrast to the business R&D trend, the ratio of federally funded R&D expenditures to GDP declined from the mid-1980s to the late 1990s, notably from cuts in defense-related R&D. There was a gradual uptick in the ratio through 2009, the result of increased federal spending on biomedical and national security R&D and of the one-time incremental funding for R&D provided by the American Recovery and Reinvestment Act of 2009 (ARRA). Since 2010, the federally funded R&D-to-GDP ratio has returned to a path of decline (**Figure 4-3**).

Performers of R&D

Business Sector

The business sector is by far the largest performer of U.S. R&D. In 2017, domestically performed business R&D accounted for 73% ($400.1 billion) of the national R&D total (**Table 4-1** and **Table 4-3**). The business sector's status as the predominant player in national R&D performance has long been the case, with its annual share ranging between 69% and 73% over the nearly two-decade period of 2000–17 (**Figure 4-1**).

TABLE 4-3

U.S. R&D expenditures, by performing sector, source of funds, and type of work: 2017

(Millions of dollars)

Performing sector and type of work	Total	Business	Federal government	Nonfederal government	Higher education	Other nonprofit organizations	Percent by performer
R&D	547,886	381,137	120,961	4,582	19,723	21,482	100.0
Business	400,101	374,934	24,277	121	*	769	73.0
Federal government	52,553	194	52,174	33	*	152	9.6
Federal intramural	32,231	0	32,231	0	0	0	5.9
FFRDCs	20,322	194	19,943	33	*	152	3.7
Nonfederal government	641	*	258	383	*	*	0.1
Higher education	71,251	4,276	36,034	4,046	19,723	7,173	13.0
Other nonprofit organizations	23,340	1,734	8,218	*	*	13,389	4.3
Percent by funding source	100.0	69.6	22.1	0.8	3.6	3.9	-
Basic research	91,453	26,318	38,653	2,440	12,231	11,811	100.0
Business	24,829	22,942	1,783	14	*	90	27.1
Federal government	10,388	38	10,313	6	*	30	11.4
Federal intramural	6,259	0	6,259	0	0	0	6.8
FFRDCs	4,128	38	4,054	6	*	30	4.5
Nonfederal government	104.0	*	41.8	62.2	*	*	0.1
Higher education	44,302	2,376	23,082	2,357	12,231	4,257	48.4
Other nonprofit organizations	11,830	963	3,434	*	*	7,434	12.9
Percent by funding source	100.0	28.8	42.3	2.7	13.4	12.9	-
Applied research	108,805	58,701	37,620	1,578	5,328	5,578	100.0
Business	62,133	56,904	5,037	26	*	166	57.1
Federal government	18,165	91	17,992	10	*	72	16.7
Federal intramural	10,124	0	10,124	0	0	0	9.3
FFRDCs	8,041	91	7,868	10	*	72	7.4
Nonfederal government	514.4	*	207.0	307.4	*	*	0.5
Higher education	20,009	1,267	10,232	1,234	5,328	1,948	18.4
Other nonprofit organizations	7,984	439	4,152	*	*	3,393	7.3
Percent by funding source	100.0	54.0	34.6	1.5	4.9	5.1	-
Experimental development	347,622	296,118	44,688	559	2,164	4,093	100.0
Business	313,139	295,089	17,457	81	*	513	90.1
Federal government	23,995	64	23,869	11	*	51	6.9
Federal intramural	15,848	0	15,848	0	0	0	4.6
FFRDCs	8,147	64	8,021	11	*	51	2.3

TABLE 4-3

U.S. R&D expenditures, by performing sector, source of funds, and type of work: 2017

(Millions of dollars)

Performing sector and type of work	Total	Business	Federal government	Nonfederal government	Higher education	Other nonprofit organizations	Percent by performer
Nonfederal government	22.1	*	8.9	13.2	*	*	0.0
Higher education	6,941	633	2,721	455	2,164	969	2.0
Other nonprofit organizations	3,526	332	632	*	*	2,562	1.0
Percent by funding source	100.0	85.2	12.9	0.2	0.6	1.2	-

* = small to negligible amount, included as part of the funding provided by other sectors.

FFRDC = federally funded research and development center.

Note(s)
Data for 2017 include some estimates and may later be revised. Some components of R&D performance and funding by other nonprofit organizations are projected and may later be revised.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series).

Science and Engineering Indicators

Adjusted for inflation, growth in business R&D averaged 3.6% annually over the period 2010–17 (**Table 4-2**), well ahead of the 2.7% annual average for total R&D and even further ahead of the 2.2% annual average for GDP.

Higher Education

At $71.3 billion, the higher education sector is a distant second to business in U.S. R&D performance. Universities and colleges annually performed between 11% and 14% of U.S. R&D from 2000 to 2017 (**Figure 4-1** and **Table 4-3**).[4] After adjusting for inflation, growth in this sector's R&D performance averaged 1.3% annually over 2010–17, well behind the pace of both U.S. total R&D (2.7%) and GDP (2.2%).

Federal Agencies and Federally Funded Research and Development Centers

The federal government conducted $52.6 billion, or 10%, of U.S. R&D in 2017 (**Table 4-1** and **Table 4-3**). This amount included $32.2 billion (6% of the U.S. total) for intramural R&D performed by federal agencies in their own research facilities and $20.3 billion (4%) of R&D performed by the 42 federally funded R&D centers (FFRDCs).[5] The federal performance share of U.S R&D has declined slightly since 2000, from around 11% to about 10% in 2017.

Adjusted for inflation, this sector's R&D performance over 2010–17 declined at an annual average rate of 1.1%—providing a sharp contrast to the faster growth in total U.S. R&D (2.7%) and GDP (2.2%) (**Table 4-2**). In the previous decade (2000–10), federal R&D performance grew an average of 3.8% yearly, well ahead of U.S. total R&D (2.1%). This reversal in the 2010–17 period reflects mainly the waning after 2010 of the incremental funding from ARRA and the more challenging environment for federal budget support after 2011.[6]

Other Nonprofit Organizations and Nonfederal Government

R&D performed in the United States by other nonprofit organizations (which exclude universities and FFRDCs) was $23.3 billion in 2017 (**Table 4-1** and **Table 4-3**). This was 4% of U.S. total R&D that year, a share estimated to have increased only slightly since the late 1990s.

NCSES started to track the annual intramural R&D performance of state agencies in 2006. The total for all 50 states and the District of Columbia in 2017 is estimated to be $641 million—a small share (about 0.1%) of the U.S. total (**Table 4-1** and **Table 4-3**).

Sources of R&D Funding

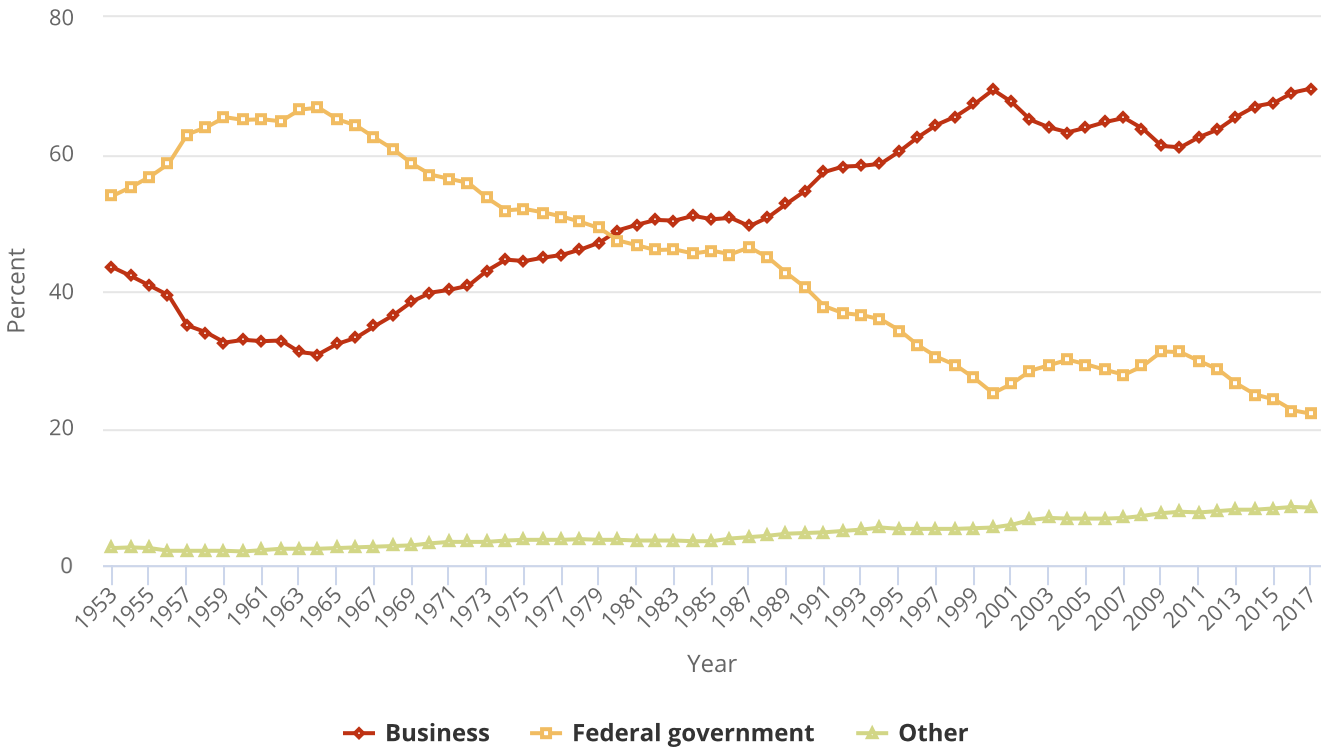
R&D Funding by Business

Mirroring its predominant role in R&D performance, the business sector is also the leading source of funding for R&D performed in the United States. In 2017, business sector funding accounted for $381.1 billion, or 70%, of the total U.S. R&D performance (**Table 4-3**). Nearly all (98%) of the business sector's funding for R&D that year supported business R&D performance—whether performed by the company itself or in support of the R&D performed by other companies.[7] The remainder went to R&D performers in higher education, other nonprofit organizations, and FFRDCs.

The business sector's dominant role in the nation's R&D funding began in the early 1980s, when its support started to exceed 50% of all U.S. R&D funding (**Figure 4-4**). The business sector's share reached 60% in 1995 and has remained above that level since that time.

FIGURE 4-4

U.S. total R&D expenditures, by source of funds: 1953–2017



Note(s)
Data for 2017 are preliminary and may later be revised. The other category includes nonfederal government, higher education, and other nonprofit organizations.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series).

R&D Funding by the Federal Government

The federal government is the second largest source of funding for U.S. R&D, behind the business sector. It is a major resource for most of the U.S. R&D performer sectors, except the business sector, where the federal role, although far from negligible, is overshadowed by business's own funds.

Funds from the federal government accounted for $121.0 billion, or 22%, of U.S. total R&D in 2017 (**Table 4-1**). Federal funding was directed mainly to R&D performance by the federal government, businesses, and higher education (**Table 4-3**). In 2017, federal funding supported about 51% of academic R&D performance; 6% of business R&D performance; 35% of nonprofit R&D performance; and almost all (98%) of FFRDC R&D performance.

Long ago, the federal government was the leading sponsor of the nation's R&D—funding 67% of all U.S. R&D in 1964 (**Figure 4-4**). The federal share decreased to half (49%) of all funding in the late 1970s, to a little over a third (36%) in the mid-1990s, and to a quarter (25%) by the turn of the century. (Once the United States won the race to the moon, funding for space R&D declined sharply—which was a major factor in the overall decrease of federal R&D as share of the national R&D total. At largely the same time the business sector was rapidly expanding its own energy-related R&D in response to the world oil supply crises; see Jankowski [2001].) The share ticked up again after 2000, as changing business conditions and expanded federal funding for health, defense, and counterterrorism R&D (including ARRA funding) pushed the federal funding share to 31% in 2009 and 2010. The federal share, however, again declined in the subsequent years and stands at 22% in 2017. The recent decline reflects chiefly the waning of funding after the 2010 incremental funding from ARRA and the more challenging competition that has prevailed in the federal budgetary process for funding support since 2011.

R&D Funding from Other Sources

The remainder of R&D funding from other sources is a smaller component: $45.8 billion in 2017, or about 8% of all U.S. R&D performance (**Table 4-3**). Of this amount, $19.7 billion was from higher education's own institutional funds, all of which remain in the academic sector; $4.6 billion was from state and local governments, primarily supporting academic research; and $21.5 billion was from other nonprofit organizations, the majority of which funds this sector's own R&D. Of the estimated nonprofit total, some funds ($7.2 billion) support R&D in higher education, and small amounts support business ($0.8 billion) and FFRDC ($0.2 billion) R&D performance.

R&D, by Type of Work

In 2017, basic research activities comprised $91.5 billion (17%) of the total of U.S. R&D expenditures, followed by applied research at $108.8 billion (20%) and $347.6 billion (63%) for experimental development (**Table 4-3** and **Table 4-4**). (For definitions of these terms, see the **Glossary** section.[8])

TABLE 4-4

U.S. R&D expenditures, by type of work: Selected years, 2000–17

(Billions of current and constant 2012 dollars; percent distribution)

Type of work	2000	2010	2012	2013	2014	2015	2016	2017[a]
Current $billions								
All R&D	267.9	406.6	433.6	454.0	475.4	493.7	515.6	547.9
Basic research	42.0	76.0	73.4	78.6	82.1	83.5	88.6	91.5
Applied research	56.5	79.2	87.0	88.2	91.8	97.2	104.8	108.8
Development	169.4	251.4	273.3	287.1	301.5	312.9	322.2	347.6
Constant 2012 $billions								
All R&D	343.2	423.0	433.6	446.1	458.7	471.4	487.4	508.3
Basic research	53.8	79.1	73.4	77.2	79.3	79.8	83.8	84.8
Applied research	72.4	82.4	87.0	86.7	88.6	92.9	99.1	100.9

TABLE 4-4

U.S. R&D expenditures, by type of work: Selected years, 2000–17

(Billions of current and constant 2012 dollars; percent distribution)

Type of work	2000	2010	2012	2013	2014	2015	2016	2017[a]
Development	217.0	261.6	273.3	282.2	290.9	298.8	304.5	322.5
Percent distribution								
All R&D	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Basic research	15.7	18.7	16.9	17.3	17.3	16.9	17.2	16.7
Applied research	21.1	19.5	20.1	19.4	19.3	19.7	20.3	19.9
Development	63.2	61.8	63.0	63.3	63.4	63.4	62.5	63.4

[a] Some data for 2017 are preliminary and may later be revised.

Note(s)

Detail may not add to total because of rounding. Data throughout the time series reported here are consistently based on the Organisation for Economic Co-operation and Development's *Frascati Manual* definitions for basic research, applied research, and experimental development. Prior to 2010, however, some changes were introduced in the questionnaires of the sectoral expenditure surveys to improve the accuracy of respondents' classification of their R&D. Therefore, small percentage changes may not be meaningful when comparing data before 2010 with more recent data.

Source(s)

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

Science and Engineering Indicators

Basic Research

Higher education institutions continued to be the largest performer of U.S. basic research in 2017, while the federal government remained the largest source of funding for basic research. Higher education performed just under half (48%) of basic research, and the federal government funded about 42% of all basic research performed (**Table 4-3**). The business sector was also a substantial performer (27%) and funder (29%) of basic research. The federal government (agency intramural laboratories and FFRDCs) and other nonprofit organizations were smaller performers, accounting, respectively, for 11% and 13% of the U.S basic research performance total in 2017.

Applied Research

The business sector was both the largest performer (57%) and largest funder (54%) of applied research in 2017—accounting for over half of each (**Table 4-3**). Higher education (18%), the federal government (17%), and nonprofit organizations (7%) were the next largest performers of applied research.

The vast majority of business sector funding for applied research remained within the sector (**Table 4-3**). The federal government provided a third of applied research funding, with its funding spread broadly across different sectors; higher education and federal intramural laboratories and FFRDCs received the largest amounts.

Experimental Development

The business sector predominates in experimental development, performing 90% of the R&D in this category in 2017 (**Table 4-3**).[9] The federal government accounted for another 7%, much of it defense related, with the federal government itself the primary user of the results. By contrast, higher education and other nonprofit organizations perform relatively little development (respectively, 2% and 1% of the total in 2017).

The business sector provided 85% of the funding for the experimental development performed in 2017, nearly all of which remained in that sector (**Table 4-3**). Federal funding accounted for about 13% of the development total, with the business sector (especially defense-related industries) and federal intramural laboratories as the largest recipients.

Trend in Shares, by Type of R&D

The shares of basic research, applied research, and experimental development have remained largely the same throughout the 2010–17 period (**Table 4-4**). These shares are also not dramatically different than those estimated in earlier years. Furthermore, adjusted for inflation, and despite occasional year-over-year declines, the overall trend has been substantial increases in the conduct of each of the three types of R&D. (While these key features of the data are noteworthy, care is needed in definitively identifying trends. Various methodological improvements in the R&D performer surveys have been made over time—particularly before 2010, with the net implication that small percentage changes in the reported shares may not be meaningful.[10])

Between 2010 and 2017, the most evident shifts in the relative roles of performers and funders concerned basic research. In 2010, businesses performed 22% of U.S. basic research, but the sector's role rose noticeably to 27% in 2017 (due in part to substantial increases in basic research performed by the pharmaceuticals and medicines industries, as well as the professional, scientific, and technical [PST] services sector). Over the same period, the share of U.S. basic research performed by higher education institutions—historically, the nation's largest basic research performer—declined from 50% in 2010 to 48% in 2017. Businesses funded 23% of U.S. basic research in 2010, rising to 29% in 2017. Over the same period, the federally funded share was 53% in 2010 but has declined each year since that time, falling to 42% in 2017. Further, in 2010, funding from higher education's own funds accounted for 10% of the funding of U.S. basic research performance; in 2017, higher education's funding share had increased to 13%.

Cross-National Comparisons of R&D Performance

Data on R&D expenditures and intensity by country and region provide a broad picture of the current global distribution of R&D capabilities and activities, as well as the changes under way.

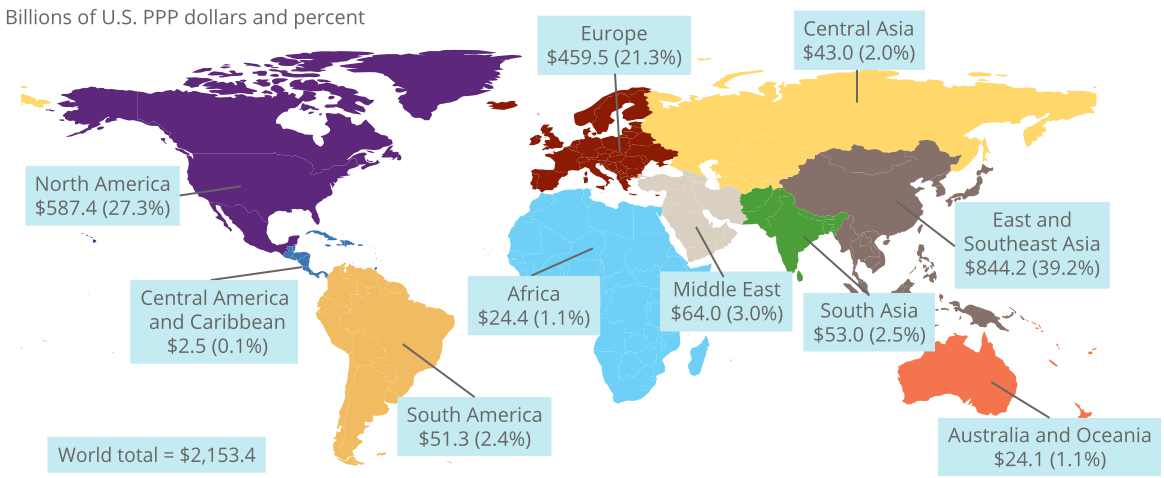
Cross-national comparisons of R&D expenditures and funding require currency conversions. The analysis in this section follows the international convention of converting all foreign currencies into U.S. dollars via purchasing power parity (PPP) exchange rates. For a discussion of this methodology, see the **Technical Appendix** section titled Comparing International R&D Expenditures.

Country and Regional Patterns in Total National R&D

The global total of R&D expenditures continues to rise at a substantial pace.[11] NCSES's latest estimate puts the worldwide total at $2.153 trillion (current PPP dollars) in 2017 (**Figure 4-5**).[12] In 2010, it was estimated at $1.416 trillion, and in 2000, the estimate was $722 billion. The annual increase in total global R&D averaged 7.0% from 2000 to 2010 and averaged 6.2% over the 2010–17 period. This nearly threefold expansion over these 17 years reflects, in part, the escalating knowledge intensity of economic competition among the world's nations—as well their individual desires to harness advances in science and technology to improve their own economies and indicators of their societal well-being.

FIGURE 4-5

Global R&D expenditures, by region: 2017



PPP = purchasing power parity.

Note(s)

Foreign currencies are converted to dollars through PPPs. Some country data are estimated. Countries are grouped according to the regions described by *The World Factbook*.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, estimates as of October 2019. Based on data from the Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1), and the United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre.

Science and Engineering Indicators

R&D performance by the world's countries and economies continues to be concentrated in three geographic regions: North America, Europe, and the combination of South Asia (including India, Pakistan, and other countries) and East-Southeast Asia (including China, Japan, South Korea, Taiwan, and other countries) (**Figure 4-5**).[13] In 2017, the combined regions of South Asia and East-Southeast Asia accounted for the largest share of the world total (42%, or $897 billion).

North America (United States, Canada, and Mexico) had the second largest share (27%, or $587 billion), followed by Europe (21%, or $460 billion), including the European Union (EU) (see the **Glossary** section for a list of the 28 EU member countries). The remaining 10% of global R&D performance comes (in decreasing order) from the regions of the Middle East, South America, Central Asia, Australia and Oceania, Africa, and Central America and the Caribbean.

The geographic concentration of R&D is even more evident when the profiles of specific countries or economies are considered (**Table 4-5** and **Figure 4-6**). The United States continues as the lead performer ($549 billion in 2017), accounting for 25% of the global R&D total. China remains the second largest performer ($496 billion in 2017), accounting for 23% of the global total. Over the last few years, China has moved even closer to the United States (**Figure 4-7**). Japan is third at 8% ($171 billion), and Germany is fourth at 6% ($132 billion). South Korea, also now rapidly rising ($91 billion in 2017), is fifth, accounting for 4% of the global total. France ($65 billion), India ($50 billion), and the United Kingdom ($49 billion) are the next rung down—each accounting for 2%–3%. Russia, Brazil, Taiwan, and Italy make up a fourth tier, with annual R&D expenditures ranging from $34 billion to $42 billion, or around 2% each of the global total. Canada, Spain, Turkey, and Australia each have annual R&D expenditures in the $21 billion–$27 billion range, or about 1% each of the global total.

TABLE 4-5

International comparisons of gross domestic expenditures on R&D and R&D share of gross domestic product, by region, country, or economy: 2017 or most recent year

(PPP millions of dollars and GERD-to-GDP ratio)

Region, country, or economy	GERD (PPP $millions)	GERD-to-GDP ratio (%)
North America		
United States (2017)[a]	548,984.0	2.81
Canada (2017)	27,162.8	1.59
Mexico (2016)	11,259.9	0.49
Central America and Caribbean		
Cuba (2013)	1,113.5	0.47
Ecuador (2014)	808.4	0.44
South America		
Brazil (2016)	39,903.5	1.27
Argentina (2016)	5,024.0	0.54
Colombia (2017)	1,742.0	0.24
Chile (2016)	1,590.8	0.36
Europe		
Germany (2017)	132,004.4	3.04
France (2017)	64,672.1	2.19
United Kingdom (2017)	49,345.3	1.66
Italy (2017)	33,542.9	1.35
Spain (2017)	21,932.0	1.21
Switzerland (2017)	18,900.0	3.37
Netherlands (2017)	18,563.6	1.99
Sweden (2017)	17,561.7	3.40
Belgium (2017)	15,189.0	2.70
Austria (2017)	14,966.4	3.16
Poland (2017)	11,757.8	1.03
Denmark (2017)	9,545.1	3.05
Czechia (2017)	7,213.2	1.79
Finland (2017)	7,038.5	2.76
Norway (2017)	6,869.3	2.09
Portugal (2017)	4,454.1	1.33
Ireland (2016)	3,920.0	1.16
Hungary (2017)	3,801.4	1.35

TABLE 4-5

International comparisons of gross domestic expenditures on R&D and R&D share of gross domestic product, by region, country, or economy: 2017 or most recent year

(PPP millions of dollars and GERD-to-GDP ratio)

Region, country, or economy	GERD (PPP $millions)	GERD-to-GDP ratio (%)
Greece (2017)	3,476.6	1.13
Romania (2017)	2,625.0	0.50
Ukraine (2017)	1,651.6	0.45
Slovakia (2017)	1,554.2	0.88
Slovenia (2017)	1,391.9	1.85
Bulgaria (2017)	1,108.8	0.77
Belarus (2017)	1,052.2	0.59
Serbia (2017)	985.7	0.93
Croatia (2017)	906.9	0.87
Lithuania (2017)	844.7	0.90
Luxembourg (2017)	806.3	1.26
Estonia (2017)	567.8	1.29
Middle East		
Turkey (2017)	21,729.5	0.96
Israel (2017)	15,391.5	4.54
Saudi Arabia (2013)	12,513.3	0.82
United Arab Emirates (2016)	6,522.5	0.96
Iran (2013)	3,317.2	0.25
Africa		
Egypt (2017)	6,846.7	0.61
South Africa (2016)	6,089.8	0.82
Morocco (2010)	1,483.6	0.73
Nigeria (2007)	1,374.8	0.22
Tunisia (2016)	793.9	0.60
Kenya (2010)	788.2	0.79
Ethiopia (2013)	787.3	0.60
Tanzania (2013)	623.8	0.53
Central Asia		
Russia (2017)	41,868.0	1.11
Kazakhstan (2016)	638.0	0.14
South Asia		
India (2015)	49,746.1	0.62
Pakistan (2017)	2,569.7	0.24
East and Southeast Asia		
China (2017)	495,980.9	2.15
Japan (2017)	170,900.7	3.20
South Korea (2017)	90,979.6	4.55
Taiwan (2017)	39,296.0	3.30
Malaysia (2016)	12,412.3	1.44
Singapore (2017)	10,479.7	1.95
Thailand (2016)	9,113.5	0.78
Indonesia (2017)	7,720.0	0.08
Vietnam (2017)	3,408.7	0.53
Philippines (2013)	886.5	0.14
Australia and Oceania		
Australia (2015)	21,151.5	1.88
New Zealand (2017)	2,647.5	1.37
Selected country groups		
European Union (2017)[b]	430,121.0	1.97

TABLE 4-5

International comparisons of gross domestic expenditures on R&D and R&D share of gross domestic product, by region, country, or economy: 2017 or most recent year

(PPP millions of dollars and GERD-to-GDP ratio)

Region, country, or economy	GERD (PPP $millions)	GERD-to-GDP ratio (%)
OECD (2017)	1,360,044.3	2.37
G20 countries (2017)	1,982,070.5	2.00

G20 = Group of Twenty; GDP = gross domestic product; GERD = gross domestic expenditure on R&D; OECD = Organisation for Economic Co-operation and Development; PPP = purchasing power parity.

[a] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D.

[b] Data for the European Union (EU) include the 28 EU member countries.

Note(s)

Year of data is listed in parentheses. Foreign currencies are converted to dollars through PPPs. Countries in this table have an annual GERD of $500 million or more. Countries are grouped according to the regions described by *The World Factbook*. Data for Israel are civilian R&D only. See sources below for GERD statistics on additional countries.

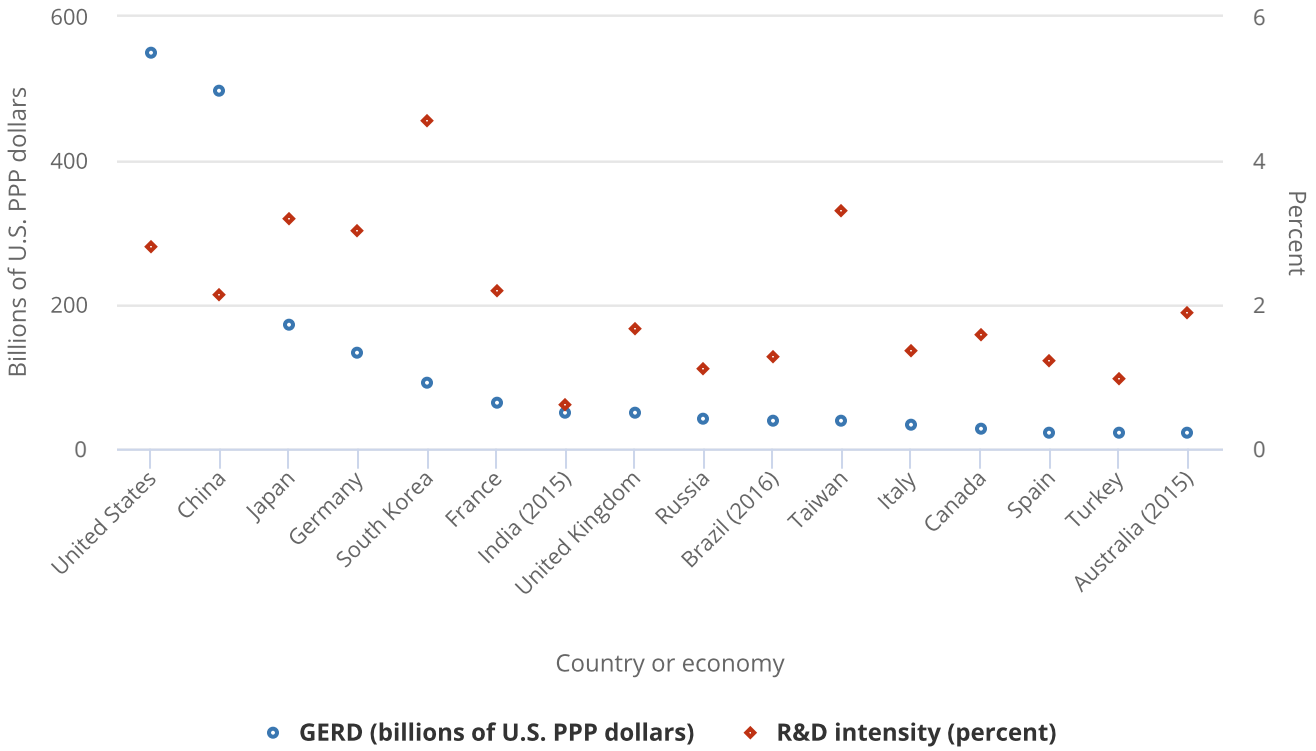
Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre.

Science and Engineering Indicators

FIGURE 4-6

GERD and R&D intensity for world's top 16 R&D performing countries and economies: 2017 or most recent data year



GDP = gross domestic product; GERD = gross domestic expenditure on R&D; PPP = purchasing power parity; R&D intensity = GERD-to-GDP ratio (percent).

Note(s)
Top 16 R&D performing countries or economies (based on annual GERD). Data for most countries are from 2017; data for India, Brazil, and Australia are 1 year or 2 years earlier.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre.

Science and Engineering Indicators

These top 16 countries and economies together accounted for 86% of the global R&D total. As **Table 4-5** indicates, many other countries also conduct R&D, but each has an annual expenditures total well below that of each of this top group of 16 countries and economies.

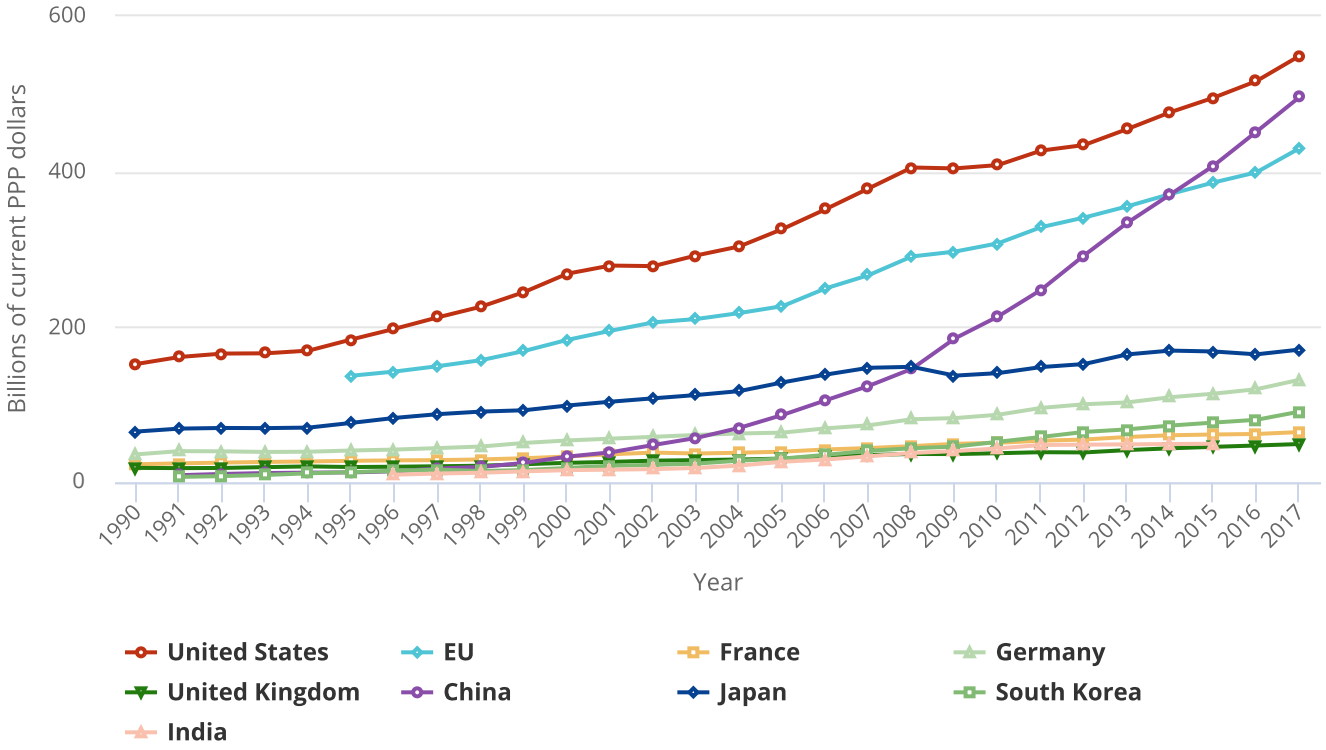
Larger increases in the levels of R&D performance in South Asia and East-Southeast Asia, compared with the other major R&D-performing areas, have resulted in major shifts. R&D performed in the North American region accounted for 40% of the global total in 2000 but had slipped to 27% by 2017. Europe accounted for 27% in 2000 but only 21% in 2017. The regions of East-Southeast Asia and South Asia together comprised 25% of the global total in 2000 but rose to 42% in 2017. Present regional growth trends in R&D performance suggest that the dramatic rise of these areas of Asia in the global R&D arena is unlikely to end soon.

Since 2000, China alone accounted for 32% ($463 billion) of the global increase in R&D, while the United States accounted for 20% ($280 billion), and the EU accounted for 17% ($247 billion). The increases of several other major Asian R&D performers were also noticeable: both Japan and South Korea accounted for 5% of the increase ($72 billion each).

China continues to exhibit the world's most dramatic R&D growth trend (**Figure 4-7**, **Table 4-6**, and Table S4-1). The pace of China's increase in R&D performance has been exceptionally high for numerous years, averaging 20.5% annually over 2000–10 and 12.8% for 2010–17. The expansion in South Korea's R&D has also been quite high, averaging 10.9% annually over 2000–10 and 8.3% for 2010–17. Japan's corresponding increases of R&D have been considerably slower, at 3.6% and 2.8%, respectively.

FIGURE 4-7

Gross domestic expenditures on R&D, by the United States, the EU, and selected other countries: 1990–2017



EU = European Union; PPP = purchasing power parity.

Note(s)

Data are for the top eight R&D-performing countries and the EU. Data are not available for all countries for all years. Data for U.S. gross domestic expenditure on R&D (GERD) differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D. Data for Japan in 1996 onward may not be consistent with earlier data because of changes in methodology. Data for the EU include the 28 EU member countries. Data for Germany for 1981–90 are for West Germany.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre. See Table S4-1.

Science and Engineering Indicators

TABLE 4-6

Comparative growth rates, gross domestic expenditures on R&D and gross domestic product, top R&D-performing countries: 2000–10, 2010–17

(Billions of PPP dollars and percent)

Country	Current measures		Longer-term growth rates			
			GERD		GDP	
	GERD (PPP $billions)	GERD/ GDP (%)	2000–10	2010–17	2000–10	2010–17
United States (2017)[a]	549.0	2.81	4.3	4.3	3.9	3.8
China (2017)	496.0	2.15	20.5	12.8	12.9	9.2
Japan (2017)	170.9	3.21	3.6	2.8	2.8	2.5
Germany (2017)	132.0	3.04	4.9	6.1	3.6	4.4

TABLE 4-6

Comparative growth rates, gross domestic expenditures on R&D and gross domestic product, top R&D-performing countries: 2000–10, 2010–17

(Billions of PPP dollars and percent)

Country	Current measures		Longer-term growth rates			
			GERD		GDP	
	GERD (PPP $billions)	GERD/ GDP (%)	2000–10	2010–17	2000–10	2010–17
South Korea (2017)	91.0	4.55	10.9	8.3	5.9	4.1
France (2017)	64.7	2.19	4.3	3.5	3.9	3.4
India (2015)[b]	49.7	0.62	10.8	2.6	9.7	8.5
United Kingdom (2017)	49.3	1.66	4.1	4.0	3.9	4.0

GDP = gross domestic product; GERD = gross domestic expenditure on R&D; PPP = purchasing power parity.

[a] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D.

[b] Most recent data for India are 2015. The listed growth rates for India for both GERD and GDP are 2010–15.

Note(s)

Table shows the top eight R&D-performing countries in 2017. The growth rates are calculated as compound average annual rates. Year of data is listed in parentheses. By way of comparison, the National Center for Science and Engineering Statistics estimates that the average annual pace of growth of the global total of R&D was 7.0% for 2000–10 and 6.0% for 2010–17.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre.

Science and Engineering Indicators

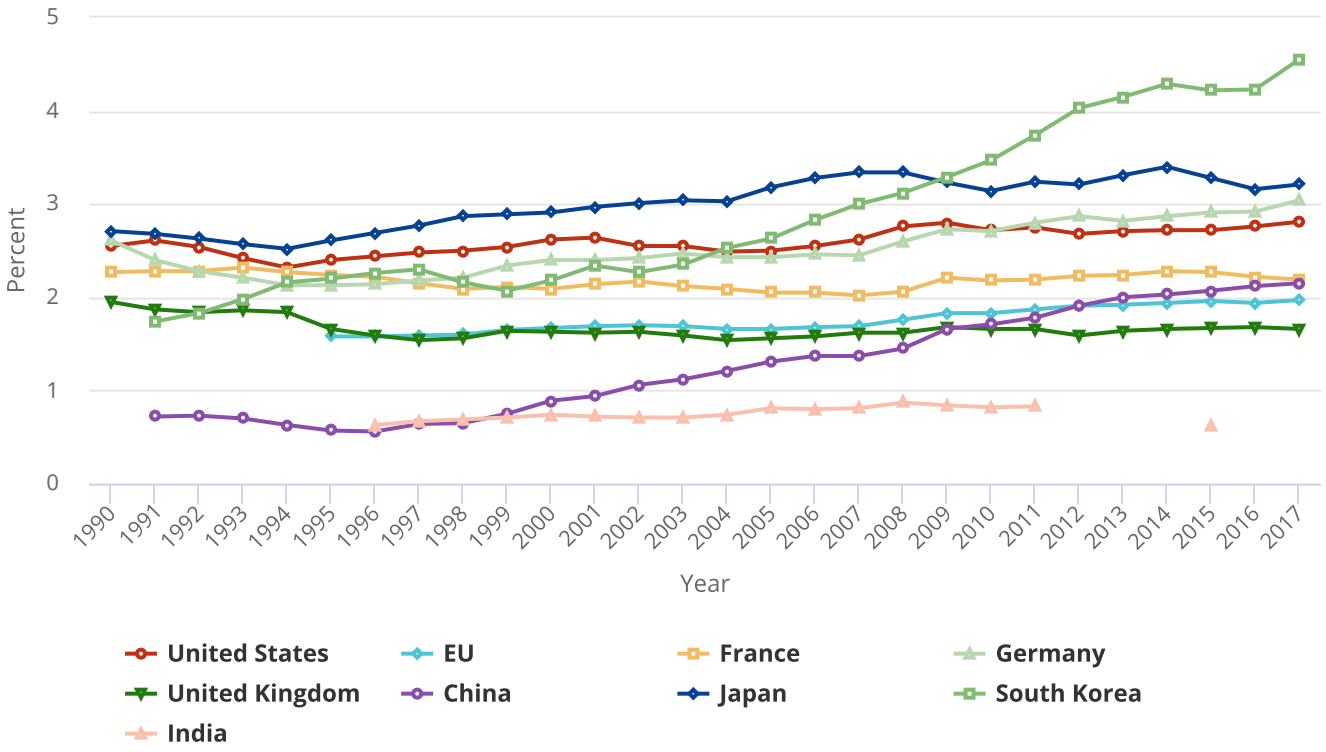
While the United States remains atop the list of the world's R&D-performing nations, its pace of annual expansion in R&D performance has averaged 4.3% over both 2000–10 and 2010–17, and its share of global R&D has declined from 37% in 2000 to 25% in 2017. Total R&D by EU nations has been increasing at an annual average rate of 5.3% in 2000–10 and 4.9% in 2010–17, with Germany at 4.9% and 6.1%, France at 4.3% and 3.5%, and the United Kingdom at 4.1% and 4.0%, respectively.

Country and Regional Patterns in National R&D Intensity

The R&D-to-GDP ratio, a widely reported measure of R&D intensity, provides insight into a country's investments in R&D relative to overall economic activities. For the United States, this ratio has ranged from about 2.6% to 2.8% from 2000 to 2017 (**Figure 4-8** and Table S4-1).

FIGURE 4-8

Gross domestic expenditures on R&D as a share of gross domestic product, by the United States, the EU, and selected other countries: 1990–2017



EU = European Union.

Note(s)

Data are for the top eight R&D-performing countries and the EU. Data are not available for all countries for all years. Data for U.S. gross domestic expenditure on R&D (GERD) differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D. Data for Japan in 1996 onward may not be consistent with earlier data because of changes in methodology. Data for the EU include the 28 EU member countries. Data for Germany for 1981–90 are for West Germany.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre. See Table S4-1.

Science and Engineering Indicators

In 2017, the United States ranked 10th in R&D intensity among the economies tracked by Organisation for Economic Co-Operation and Development (OECD) and United Nations Educational, Scientific and Cultural Organization (UNESCO) data. South Korea and Israel are essentially tied for the top spot, with ratios of 4.6% and 4.5%, respectively (although Israel's data exclude expenditures for defense R&D, while South Korea's data include these values). Israel has long been at the top of the R&D-to-GDP ratio ranking (**Table 4-5**), but South Korea's upward movement has been particularly rapid since the late 1990s (**Figure 4-8**). Furthermore, South Korea is one of the world's largest R&D performers, with annual R&D expenditures many times that of Israel. Sweden and Switzerland are third, at 3.4%, followed by Taiwan at 3.3%. Japan is sixth, at 3.2%. Several smaller countries with comparatively high R&D-to-GDP ratios are Austria (3.2%), Denmark (3.1%), Germany (3.0%), and Finland (2.8%). The R&D intensities of the remaining top R&D performers are as follows: France at 2.2%, China at 2.2%, the United Kingdom at 1.7%, Turkey at 1.0%, and India at 0.6%.

The U.S. rank in this indicator was eighth in 2009, compared to its current ranking of 10th in 2017. The United States was ranked 11th in 2013 and 2015 (NSB 2012, 2014, 2016, 2018). These shifts in the U.S. rank are not surprising, as other countries have been expanding the scope and level of their R&D activities. Even so, this erosion in the U.S. rank has appeared despite generally high U.S. R&D intensity levels (relative to historic levels) over the last 10 years.

The R&D-to-GDP ratio has been rising gradually for the EU as a whole, from about 1.7% in 2000 to nearly 2.0% in 2017 (**Figure 4-8**). For the largest R&D performers among the EU countries, Germany's ratio has gradually risen over that period, from 2.4% to 3.0%, whereas those for France (from 2.1% to 2.2%) and the United Kingdom (from 1.6% to 1.7%) have moved in narrower tracks.

Among the large Asian R&D performers, Japan's R&D-to-GDP ratio has moved mainly upward in recent years, from 2.9% in 2000 to 3.2% in 2017. The high risers—across the eight top R&D-performing countries considered here—have been China and South Korea. China's ratio more than doubled over the period, from just over 0.9% in 2000 to about 2.1% in 2017, suggesting that ample room remains for future increases (Table S4-1). South Korea's ratio has increased considerably in recent years, from 2.2% in 2000 to 4.6% in 2017.

Comparisons of the Composition of Country R&D Performance

Trends in Composition, by Sector

The business sector is the predominant R&D performer in nearly all the top eight R&D-performing nations (**Table 4-7**). In 2017, the sector accounted for approximately three-fourths of R&D performance in the United States (73%) and the leading Asian R&D performers, China (78%), Japan (79%), and South Korea (79%.). Business shares in the European countries were lower, with Germany at 69%, France at 65%, and the United Kingdom at 68%. Older data for India show a share of less than half (44% in 2015).

TABLE 4-7

Gross expenditures on R&D for selected countries, by performing sector and source of funds: 2017 or most recent year

(PPP billions of dollars and percent share)

Country	GERD (PPP $billions)	R&D performance: Share of total (%)				R&D source of funds: Share of total (%)			
		Business	Government	Higher education	Private nonprofit	Business	Government	Other domestic	Rest of the world
United States (2017)[a]	549.0	72.9	9.9	13.0	4.3	62.5	23.1	7.3	7.1
China (2017)	496.0	77.6	15.2	7.2	na	76.5	19.8	NA	0.6
Japan (2017)	170.9	78.8	7.8	12.0	1.4	78.3	15.0	6.1	0.6
Germany (2017)	132.0	69.1	13.5	17.4	na	66.2	27.7	0.4	5.8
South Korea (2017)	91.0	79.4	10.7	8.5	1.4	76.2	21.6	0.9	1.3
France (2016)	62.3	65.0	12.7	20.7	1.7	55.6	32.8	3.9	7.7
India (2015)	49.7	43.6	52.5	3.9	0.0	NA	NA	NA	NA
United Kingdom (2016)	47.4	67.6	6.5	23.7	2.2	51.8	26.3	6.4	15.6

na = not applicable; country does not recognize the category or does not report the data item. NA = not available.

GERD = gross domestic expenditure on R&D; PPP = purchasing power parity.

[a] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D. The data for U.S. funding from the rest of the world include funding for business R&D and academic R&D.

Note(s)
Table shows the top eight R&D-performing countries in 2017. Year of data is listed in parentheses. Percentages may not add to 100% because of rounding. Complete data are not presently available for China and India.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre.

Science and Engineering Indicators

Over half of India's R&D was performed by the government (52%). Government-performed R&D ranged from about 7% to 15% for the remaining top eight countries (**Table 4-7**). The higher education sector accounted for over 20% of R&D performance in France (21%) and the United Kingdom (24%) and for 4%–17% of R&D performance in the remaining top eight countries. At 4%, India had by far the lowest level.

For the most part, the business sector is also the predominant source of R&D funding among the top R&D-performing countries (**Table 4-7**); government is the second largest source. The business sector accounted for 52%–78% of R&D funding, while the government sector accounted for 15%–33% among the top eight countries (**Table 4-7**). (Comparable data on R&D funding sources are not presently available for India.) Funding from the *rest of the world* refers to funding for a country's domestically performed R&D from businesses, universities, governments, nonprofits, and other organizations located outside of the country. Among the top R&D-performing countries, the United Kingdom is the most notable in this category, with about 16% of R&D funding coming from nondomestic sources in 2017. Foreign funding was also significant in France, Germany, and the United States (around 6%–8%), while the rest of the top countries show much lower shares for this funding source. The distributions of R&D performance and funding have been relatively stable for these countries since 2011.

Trends in Composition, by Type of R&D

Comparison of the levels and shares of overall national annual R&D performance devoted to basic research, applied research, and experimental development provides another way to analyze trends among top R&D-performing countries.

France leads the top eight R&D-performing countries in the share of total R&D expenditures on basic research (21% in 2016), although the total spent is relatively low ($13.4 billion) (**Table 4-8**). (The type-of-R&D data are not available for some countries, including Germany and India.) The United States spends the most on basic research ($91.5 billion in 2017), and this accounts for 17% of its total R&D expenditures. China's basic research share is on the low side, at about 6% in 2017; nevertheless, this share still added up to about $27 billion of basic research performance that year, which was higher than France's spending.

TABLE 4-8

Gross expenditures on R&D for selected countries, by type of work: 2017 or most recent year

(PPP billions of dollars and percent share)

Country	GERD (PPP $billions)	Basic	Applied	Experimental development	Capital expenditures nec
			PPP $billions		
United States (2017)[a]	549.0	91.5	108.8	347.6	1.1
China (2017)	496.0	27.5	52.1	416.4	0.0
Japan (2017)	170.9	22.4	31.9	109.2	7.4
Germany (2017)	132.0	NA	NA	NA	NA
South Korea (2017)	91.0	13.2	20.0	57.8	0.0
France (2016)	62.3	13.4	25.6	22.0	1.3
India (2015)	49.7	NA	NA	NA	NA
United Kingdom (2016)	47.4	8.6	20.9	18.0	0.0

TABLE 4-8

Gross expenditures on R&D for selected countries, by type of work: 2017 or most recent year

(PPP billions of dollars and percent share)

Country	GERD (PPP $billions)	Basic	Applied	Experimental development	Capital expenditures nec
		Share of total (%)			
United States (2017)[a]		16.7	19.8	63.3	0.2
China (2017)		5.5	10.5	84.0	0.0
Japan (2017)		13.1	18.7	63.9	4.3
Germany (2017)		NA	NA	NA	NA
South Korea (2017)		14.5	22.0	63.6	0.0
France (2016)		21.5	41.1	35.3	2.1
India (2015)		NA	NA	NA	NA
United Kingdom (2016)		18.1	44.0	37.9	0.0

NA = not available.

GERD = gross domestic expenditure on R&D; nec = not elsewhere classified; PPP = purchasing power parity.

[a] Data for U.S. GERD differ slightly from the U.S. total R&D data tabulated earlier in this report. For better consistency with international standards, U.S. GERD includes federal capital funding for federal intramural and nonprofit R&D, in addition to what is reported as U.S. total R&D.

Note(s)

Table shows the top eight R&D-performing countries in 2017. Year of data is listed in parentheses. Detail may not add to total because of rounding. Complete data are not presently available for Germany or India.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, *Main Science and Technology Indicators* (2019/1); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre.

Science and Engineering Indicators

The United Kingdom has the leading share of R&D expenditures devoted to applied research (44% in 2016) among these countries, spending about $21 billion. Shares for the remaining countries range from 11% (China) to 41% (France), with the U.S. share nearly in the middle, at 20%. Nonetheless, in terms of overall volume, the United States dominates this category, with $108.8 billion of applied research spending in 2017. The overall volume of spending by the second- and third-ranked countries in this category are comparatively far behind: China, at $52.1 billion, and Japan, at $31.9 billion.

Regarding experimental development, China exhibits the highest share by far—84% of its R&D total in 2017, or $416.4 billion of spending in this category. For the United States, the development share that year was 63%, totaling $347.6 billion of spending. Japan and South Korea also have comparatively high shares for development, each around 64% in 2017; however, the dollar amounts of those countries' performances were well below the levels for China and the United States.

Similar statistics on the distributions of R&D performance by type of R&D appear in previous editions of *Science and Engineering Indicators* (**https://www.nsf.gov/statistics/seind/**). The type-of-R&D shares reported by the countries have been stable over the past several years.

U.S. Business R&D

Businesses have been the predominant performers of U.S. R&D dating back to the 1950s. Given its prominent role, year-to-year increases and declines in business R&D performance greatly influence the overall U.S. R&D total (**Figure 4-2**). The U.S. business sector is diverse, with wide differences in the goods and services provided across industries and in the various production inputs required, including for R&D. Historically, companies in manufacturing industries have accounted for two-thirds or more of U.S. business R&D, with the balance accounted for by companies in nonmanufacturing industries. However, most business R&D in the United States currently stems from a relative handful of industries, classified in both the manufacturing and nonmanufacturing sectors.

Key Characteristics of Domestic Business R&D Performance

U.S. business R&D is the R&D performed by companies in the domestic United States, including R&D paid for by the company itself (from company-owned, U.S.-located units or from company subsidiaries located overseas) and R&D paid for by others (such as other companies, domestic or foreign, including foreign parents of U.S. subsidiaries; the federal government; nonfederal government, domestic or foreign; and nonprofit or other organizations, domestic or foreign). NCSES's annual Business R&D and Innovation Survey (BRDIS) and Business Research and Development Survey (BRDS) provide data on for-profit, nonfarm companies that are publicly or privately held in the United States.[14]

Industries That Perform the Most U.S. Business R&D

U.S. businesses performed $400.1 billion of R&D in 2017, 81% of which is accounted for by five business sectors and subsectors ($324.0 billion) (**Table 4-9**).[15]

- Chemicals manufacturing (North American Industry Classification System [NAICS] 325, which includes the pharmaceuticals industry) accounts for 19% of business R&D performance, most of which is from the pharmaceuticals and medicines industry.
- Computer and electronic products manufacturing (NAICS 334) accounts for 20% of business R&D performance.
- Transportation equipment manufacturing (NAICS 336, which includes the automobiles and aerospace industries) accounts for 13% of business R&D performance.
- Information (NAICS 51, which includes the software publishing industry) accounts for about 20% of business R&D performance, two-fifths of which was in software publishing.
- Professional, scientific, and technical (PST) services (NAICS 54, which includes the computer systems design and scientific R&D services industries) accounts for 9% of business R&D performance. About half of PST services is in the scientific R&D services industry, but R&D is also sizable in the computer systems design and related services industry (**Table 4-9**).

TABLE 4-9

Funds spent for business R&D performed in the United States, by source of funds and selected industry: 2017

(Millions of dollars and percent share)

Industry and NAICS code	All R&D[a]	Paid for by the company[b]	Paid for by others				
			Total	Federal	Companies		All other organizations[d]
					Domestic	Foreign[c]	
	$millions						
All industries, 21–33, 42–81[c]	400,100	339,036	61,065	24,277 i	17,494	18,404	890 i
Manufacturing industries, 31–33	257,227	216,155	41,072	18,889 i	6,229	15,434	520 i

TABLE 4-9

Funds spent for business R&D performed in the United States, by source of funds and selected industry: 2017

(Millions of dollars and percent share)

Industry and NAICS code	All R&D[a]	Paid for by the company[b]	Paid for by others				
			Total	Federal	Companies		All other organizations[d]
					Domestic	Foreign[c]	
Chemicals, 325	74,977	63,285	11,692	205	2,696	8,707	84
Pharmaceuticals and medicines, 3254	66,202	55,229	10,973	186	2,685	8,019	83
Other 325	8,775	8,056	719	19	11	688	1
Machinery, 333	13,197	12,257	940	170	130 i	640	0
Computer and electronic products, 334	78,575	69,942	8,633	3,937	s	s	s
Electrical equipment, appliances, and components, 335	4,291	4,110	181	38	65	77 i	1 i
Transportation equipment, 336	53,292	34,629	18,663 i	14,433 i	s	2,219	s
Automobiles, trailers, and parts, 3361–63	23,881	21,137	2,745	s	s	s	s
Aerospace products and parts, 3364	26,383	11,903	14,480 i	s	1209 i	s	s
Other 336	3,028	1,589	1,438	s	s	s	s
Manufacturing nec, other 31–33	32,895	31,932	963 i	106 i	s	s	s
Nonmanufacturing industries, 21–23, 42–81	142,874	122,881	19,993	5,388	11,265 i	2,970	370 i
Information, 51	80,252	78,898	1,354	98	117	1138	1
Software publishers, 5112	34,264	33,201	1,062	62	66	933	1
Other 51	45,988	45,697	292	36	51	205	0
Finance and insurance, 52	7,616	7,565	51	0	* i	0	51
Professional, scientific, and technical services, 54	36,922	18,972	17,951	5,256	10,874 i	1,530	291 i
Computer systems design and related services, 5415	13,327	11,669	1,658	995	339	201	123
Scientific R&D services, 5417	17,321	2,817	14,504	3,200	10,024 i	1,160	120 i
Other 54	6,274	4,486	1,789	1,061	511 i	169	48 i
Nonmanufacturing nec, other 21–23, 42–81	18,084	17,446	637	34	274	302	27
	Percentage of sector or industry totals						
All industries, 21–33, 42–81[c]	100.0	84.7	15.3	6.1	4.4	4.6	0.2
Manufacturing industries, 31–33	100.0	84.0	16.0	7.3	2.4	6.0	0.2
Chemicals, 325	100.0	84.4	15.6	0.3	3.6	11.6	0.1
Pharmaceuticals and medicines, 3254	100.0	83.4	16.6	0.3	4.1	12.1	0.1
Other 325	100.0	91.8	8.2	0.2	0.1	7.8	0.0
Machinery, 333	100.0	92.9	7.1	1.3	1.0	4.8	0.0
Computer and electronic products, 334	100.0	89.0	11.0	5.0	s	s	s
Electrical equipment, appliances, and components, 335	100.0	95.8	4.2	0.9	1.5	1.8	0.0
Transportation equipment, 336	100.0	65.0	35.0	27.1	s	4.2	s
Automobiles, trailers, and parts, 3361–63	100.0	88.5	11.5	s	s	s	s
Aerospace products and parts, 3364	100.0	45.1	54.9	s	4.6	s	s
Other 336	100.0	52.5	47.5	s	s	s	s
Manufacturing nec, other 31–33	100.0	97.1	2.9	0.3	s	s	s
Nonmanufacturing industries, 21–23, 42–81	100.0	86.0	14.0	3.8	7.9	2.1	0.3
Information, 51	100.0	98.3	1.7	0.1	0.1	1.4	0.0
Software publishers, 5112	100.0	96.9	3.1	0.2	0.2	2.7	0.0
Other 51	100.0	99.4	0.6	0.1	0.1	0.4	0.0
Finance and insurance, 52	100.0	99.3	0.7	0.0	*	0.0	0.7
Professional, scientific, and technical services, 54	100.0	51.4	48.6	14.2	29.5	4.1	0.8
Computer systems design and related services, 5415	100.0	87.6	12.4	7.5	2.5	1.5	0.9
Scientific R&D services, 5417	100.0	16.3	83.7	18.5	57.9	6.7	0.7
Other 54	100.0	71.5	28.5	16.9	8.1	2.7	0.8
Nonmanufacturing nec, other 21–23, 42–81	100.0	96.5	3.5	0.2	1.5	1.7	0.1

* = amount < $500,000; i = more than 50% of value imputed; s = suppressed for reasons of confidentiality or reliability.

NAICS = North American Industry Classification System; nec = not elsewhere classified.

[a] All R&D is the cost of domestic R&D paid for by the respondent company and others outside of the company and performed by the company.

[b] Includes foreign subsidiaries of U.S. companies ($19.2 billion).

[c] Includes foreign parent companies of U.S. subsidiaries ($15.4 billion) and unaffiliated companies ($3.0 billion). Excludes funds from foreign subsidiaries to U.S. companies paid for through intercompany transactions ($19.2 billion).

[d] Includes U.S. state government agencies and laboratories ($0.1 billion); U.S. universities, colleges, and academic researchers ($0.1 billion); and all other organizations located inside ($0.5 billion) and outside the United States ($0.2 billion).

Note(s)
Detail may not add to total because of rounding. Statistics are representative of companies located in the United States that performed or funded R&D. Industry classification was based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. This table excludes data for federally funded R&D centers.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, and U.S. Census Bureau, Business Research and Development Survey, 2017.

Science and Engineering Indicators

These sectors and subsectors have R&D intensities that are generally higher than others in the national economy (**Table 4-10**). While the distribution of R&D performance shares among these five sectors or subsectors has been relatively stable since 2008, notable changes include a 4 percentage point drop in the shares for transportation equipment and PST services, as well as a 7 percentage point increase in the share of the information industry.

TABLE 4-10

Sales and R&D intensity for companies that performed or funded R&D, by selected industry: 2017

(Millions of U.S. dollars, percent, and thousands of domestic employees)

Industry and NAICS code	Domestic net sales (US$millions)[a]	R&D intensity (%)[b]	Domestic employment (thousands)[c]	
			Total	R&D[d]
All industries, 21–33, 42–81	9,682,692	4.1	19,893	1,609
Manufacturing industries, 31–33	5,423,997	4.7	9,919	916
Chemicals, 325	901,859	8.3	1,234	174
Pharmaceuticals and medicines, 3254	466,391	14.2	518	127
Other 325	435,468	2.0	716	47
Machinery, 333	323,082	4.1	839	85
Computer and electronic products, 334	697,118	11.3	1,200	258
Electrical equipment, appliances, and components, 335	113,434	3.8	291	29
Transportation equipment, 336	1,173,095	4.5	1,771	172
Automobiles, trailers, and parts, 3361–63	756,472	3.2	852	92
Aerospace products and parts, 3364	350,201	7.5	710	67
Other 336	66,422	4.6	209	13
Manufacturing nec, other 31–33	2,215,409	1.5	4,584	198
Nonmanufacturing industries, 21–23, 42–81	4,258,695	3.4	9,974	693
Information, 51	1,192,143	6.7	1,945	305
Software publishers, 5112	230,197	14.9	572	134
Other 51	961,946	4.8	1,373	171
Finance and insurance, 52	736,468	1.0	1,211	36
Professional, scientific, and technical services, 54	400,375	9.2	1,330	235
Computer systems design and related services, 5415	152,271	8.8	456	78
Scientific R&D services, 5417	69,134	25.1	283	86
Other 54	178,970	3.5	591	71
Nonmanufacturing nec, other 21–23, 42–81	1,929,709	0.9	5,488	117

NAICS = North American Industry Classification System; nec = not elsewhere classified.

[a] Dollar values for goods sold or services rendered by R&D-performing or R&D-funding companies located in the United States to customers outside of the company, including the U.S. federal government, foreign customers, and the company's foreign subsidiaries. Included are revenues from a company's foreign operations and subsidiaries and from discontinued operations. If a respondent company is owned by a foreign parent company, sales to the parent company and to affiliates not owned by the respondent company are included. Excluded are intracompany transfers, returns, allowances, freight charges, and excise, sales, and other revenue-based taxes.

[b] R&D intensity is the cost of domestic R&D paid for by the respondent company and others outside of the company and performed by the company divided by domestic net sales of companies that performed or funded R&D.

[c] Data recorded on 12 March represent employment figures for the year.

[d] Includes researchers, R&D managers, technicians, clerical staff, and others assigned to R&D groups.

Note(s)

Detail may not add to total because of rounding. Sales, R&D intensity, and total domestic employment statistics are representative of companies located in the United States that performed or funded R&D; R&D employment statistics are representative of companies located in the United States that performed R&D. Industry classification was based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. This table excludes data for federally funded R&D centers.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, and U.S. Census Bureau, Business Research and Development Survey, 2017.

Science and Engineering Indicators

Sources of Funding for U.S. Business R&D

Business R&D performance is primarily funded by the companies themselves. In 2017, 85% of U.S. business R&D performance was funded mainly by companies' own funds. The vast majority of these funds came from company units owned and located in the United States (80%), with a small amount (nearly 5%) from companies' foreign subsidiaries (**Table 4-11**). The remainder (15%) came from R&D performed by the company but paid for by others. The federal government is the largest of these sources, funding about 6% of business R&D performance in 2017.

TABLE 4-11

Funds spent for business R&D performed in the United States: Selected years, 2010–17

(Millions of dollars and percent share)

Sector	2010	2012	2014	2015	2016	2017
	$millions					
U.S. total R&D	406,580	433,619	475,418	493,687	515,305	542,222
All business R&D[a]	278,977	302,250	340,728	355,821	374,685	400,100
Paid for by the company	221,706	247,280	282,570	296,677	317,731	339,036
From company-owned, U.S.-located units	218,187	242,674	277,272	289,892	306,611	319,796
From foreign subsidiaries	3,519	4,606	5,298	6,785	11,120	19,240
Paid for by others	57,271	54,970	58,158	59,144	56,954	61,065
Federal	34,199	30,621	26,554	26,990	23,772	24,277
Domestic companies	11,013	11,624	13,227	14,595	14,239	17,494
Foreign companies	11,015	12,093	17,246	16,317	17,692	18,404
Foreign parent[b]	7,102	8,486	13,407	12,579	14,766	15,426
Unaffiliated companies	3,913	3,607	3,839	3,738	2,926	2,978
All other organizations[c]	1,044	632	1,131	1,242	1249	890
Source of funds as a percentage of all business R&D						
All business R&D[a]	100.0	100.0	100.0	100.0	100.0	100.0
Paid for by the company	79.5	81.8	82.9	83.4	84.8	84.7
From company-owned, U.S.-located units	78.2	80.3	81.4	81.5	81.8	79.9
From foreign subsidiaries	1.3	1.5	1.6	1.9	3.0	4.8

TABLE 4-11

Funds spent for business R&D performed in the United States: Selected years, 2010–17

(Millions of dollars and percent share)

Sector	2010	2012	2014	2015	2016	2017
Paid for by others	20.5	18.2	17.1	16.6	15.2	15.3
Federal	12.3	10.1	7.8	7.6	6.3	6.1
Domestic companies	3.9	3.8	3.9	4.1	3.8	4.4
Foreign companies	3.9	4.0	5.1	4.6	4.7	4.6
Foreign parent[b]	2.5	2.8	3.9	3.5	3.9	3.9
Unaffiliated companies	1.4	1.2	1.1	1.1	0.8	0.7
All other organizations[c]	0.4	0.2	0.3	0.3	0.3	0.2

[a] Includes companies located in the United States that performed or funded R&D. Data in this table represent an aggregate of all industries in the North American Industry Classification System codes 21–33 and 42–81.

[b] Includes foreign parent companies of U.S. subsidiaries.

[c] Includes U.S. state government agencies and laboratories, foreign agencies and laboratories, and all other organizations located inside and outside the United States.

Note(s)

Detail may not add to total because of rounding. Industry classification was based on the dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. This table excludes data for federally funded R&D centers.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Business R&D and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS) (annual series).

Science and Engineering Indicators

The most notable change since 2010 is the declining role of federal funding, falling from 12% in 2010 to 6% in 2016 and 2017 (**Table 4-11**). In addition, there are some noteworthy differences when more narrowly defined sectors and industries are considered, particularly for the five top R&D-performing sectors and subsectors previously discussed (see **Table 4-9**).

Company Size and U.S. Business R&D

In 2017, the largest companies (i.e., those with 25,000 or more domestic employees) performed over a third (37%) of U.S. business R&D (**Table 4-12**). Micro companies (5–9 employees) and small companies (10–49 employees) accounted together for about 3%. The remaining 60% was distributed among the size classifications between these extremes. The distribution of business R&D performance by company size has not greatly changed in recent years. Nonetheless, a more extensive NCSES analysis of the Business R&D and Innovation Survey data from 2009–15 concluded that R&D performance by larger-sized companies rebounded from the Great Recession considerably better than small companies and micro companies (see Anderson and Kindlon [2019]).

TABLE 4-12

Funds spent for business R&D performed in the United States, by size of company: Selected years, 2010–17

(Millions of dollars and percent share)

Size of company (number of domestic employees)	Millions of dollars						Percentage of all business R&D					
	2010	2012	2014	2015	2016	2017	2010	2012	2014	2015	2016	2017
All business domestic R&D[a]	278,977	302,250	340,728	355,821	374,685	400,100	100.0	100.0	100.0	100.0	100.0	100.0
Micro companies[b]												
5–9	3,851	2,926 i	3,295 i	2,988 i	1,581 i	NA	1.4	1.0	1.0	0.8	0.4	NA

TABLE 4-12

Funds spent for business R&D performed in the United States, by size of company: Selected years, 2010–17

(Millions of dollars and percent share)

Size of company (number of domestic employees)	Millions of dollars						Percentage of all business R&D					
	2010	2012	2014	2015	2016	2017	2010	2012	2014	2015	2016	2017
Small companies												
10–24[c]	8,722	6,915 i	7,177 i	NA	NA	NA	3.1	2.3	2.1	NA	NA	NA
25–49	8,624	7,195 i	8,428 i	NA	NA	NA	3.1	2.4	2.5	NA	NA	NA
10–19[c]	NA	NA	NA	5,680 i	4,958 i	3,311	NA	NA	NA	1.6	1.3	0.8
20–49[c]	NA	NA	NA	10,249 i	9,662 i	9,435	NA	NA	NA	2.9	2.6	2.4
Medium companies												
50–99	8,855	9,182 i	10,178 i	11,509	9,298	10,141	3.2	3.0	3.0	3.2	2.5	2.5
100–249	11,866	12,480	13,492	13,602	14,875	17,216	4.3	4.1	4.0	3.8	4.0	4.3
Large companies												
250–499	10,283	11,264	12,203	13,553	13,092	14,103	3.7	3.7	3.6	3.8	3.5	3.5
500–999	10,117	11,484	13,262	15,217	14,450	17,871	3.6	3.8	3.9	4.3	3.9	4.5
1,000–4,999	48,228	50,691	57,551	58,094	63,971	65,112	17.3	16.8	16.9	16.3	17.1	16.3
5,000–9,999	27,463	30,483	38,202	38,838	40,633	40,198	9.8	10.1	11.2	10.9	10.8	10.0
10,000–24,999	41,835	49,493	54,445	59,328	65,594	73,485	15.0	16.4	16.0	16.7	17.5	18.4
25,000 or more	99,133	110,138	122,495	126,763	136,571	149,227	35.5	36.4	36.0	35.6	36.4	37.3

i = more than 50% of value imputed; NA = not available.

[a] R&D performed by companies in the domestic United States. Includes industries in NAICS 21–33, 42–81.

[b] Data from the Business R&D and Innovation Survey (BRDIS; 2008–16) do not include companies with fewer than 5 employees. Data from the Business Research and Development Survey (BRDS; 2017) do not include companies with fewer than 10 employees. (Data on companies with 1–9 employees will be collected by the Annual Business Survey.)

[c] Employee size categories have been revised to match international classifications starting in 2015.

Note(s)
Detail may not add to total because of rounding. This table excludes data for federally funded R&D centers.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Business R&D and Innovation Survey (BRDIS), Business Research and Development Survey (BRDS) (annual series).

Science and Engineering Indicators

Cross-National Comparisons of Business R&D

The industries currently predominant in performing business R&D in the other largest R&D-performing countries exhibit both similarities and differences to those in the United States. This section analyzes cross-national comparisons for the United States, France, Germany, the United Kingdom, China, Japan, and South Korea (**Table 4-13**). Corresponding statistics for India are not presently available. The data analyzed come from OECD's Analytical Business Enterprise R&D (ANBERD) database (OECD 2019a). The industry classification used in this section is based on the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4, for all countries (including the United States). The ISIC differs somewhat from NAICS, which is used elsewhere in this report to analyze the U.S. trends.[16] Only those industries with comparatively higher levels of annual R&D performance are included in the following analysis. For a more complete listing of industries, see the OECD ANBERD database. (All amounts and calculations are in current PPP dollars, unless otherwise noted. The text below focuses on comparing the shares of national R&D performed by differing industries within countries; the associated dollar amounts are listed in **Table 4-13**.)

TABLE 4-13

Business expenditures for R&D, by selected countries and top R&D-performing industries: 2016 or most recent year

(PPP millions of current dollars and percent share)

Industry	ISIC Rev.4 Section	ISIC Rev.4 Division	United States (2016)	France (2016)	Germany (2016)	United Kingdom (2016)	China (2016)	Japan (2016)	South Korea (2015)
PPP current $millions									
Total business enterprise	A–U	1–99	374,685	40,495	81,739	31,812	349,685	129,752	59,644
Manufacturing	C	10–33	250,533	20,242	69,422	13,166	304,342	112,766	53,446
Chemicals and chemical products		20	8,947	1,242	5,091	688	26,623	8,275	3,136
Pharmaceuticals, medicinal chemical, and botanical products		21	64,628	1068	5,878	548	14,066	13,168	1,576
Computer, electronic, and optical products		26	77,385	4,836	9,936	1,560	57,494	25,599	29,893
Motor vehicles, trailers, and semi-trailers		29	22,042	2,904	28,478	4,220	30,198	34,042	7,550
Other transport equipment		30	29,233	3,937	2,635	2,595	13,235	1087	1011
Air and spacecraft and related machinery		303	26,645	3,590	2,194	2,369	NA	754	275
Total services	G–U	45–99	120,230	18,897	11,779	18,015	NA	15,310	4,802
Information and communication	J	58–63	86,495	4,926	4,334	4,573	NA	5,706	2,470
Publishing activities		58	33,574	1,407	NA	118	NA	18	1,620
Software publishing		582	33,495	1,383	NA	47	NA	NA	1,589
Computer programming, consultancy, and related activities		62	15,747	2,283	3,669	2,354	NA	2,094	255
Professional, scientific, and technical activities	M	69–75	21,848	10,487	6,524	10,242	NA	8,312	1,391
Scientific R&D		72	14,842	4,712	2,940	7,625	NA	7,641	402
Percentage of total business enterprise									
Total business enterprise	A–U	1–99	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Manufacturing	C	10–33	66.9	50.0	84.9	41.4	87.0	86.9	89.6
Chemicals and chemical products		20	2.4	3.1	6.2	2.2	7.6	6.4	5.3
Pharmaceuticals, medicinal chemical, and botanical products		21	17.2	2.6	7.2	1.7	4.0	10.1	2.6
Computer, electronic, and optical products		26	20.7	11.9	12.2	4.9	16.4	19.7	50.1
Motor vehicles, trailers, and semi-trailers		29	5.9	7.2	34.8	13.3	8.6	26.2	12.7
Other transport equipment		30	7.8	9.7	3.2	8.2	3.8	0.8	1.7
Air and spacecraft and related machinery		303	7.1	8.9	2.7	7.4	NA	0.6	0.5
Total services	G–U	45–99	32.1	46.7	14.4	56.6	NA	11.8	8.1
Information and communication	J	58-63	23.1	12.2	5.3	14.4	NA	4.4	4.1
Publishing activities		58	9.0	3.5	NA	0.4	NA	0.0	2.7
Software publishing		582	8.9	3.4	NA	0.1	NA	NA	2.7
Computer programming, consultancy, and related activities		62	4.2	5.6	4.5	7.4	NA	1.6	0.4
Professional, scientific, and technical activities	M	69–75	5.8	25.9	8.0	32.2	NA	6.4	2.3
Scientific R&D		72	4.0	11.6	3.6	24.0	NA	5.9	0.7

NA = not available.

ISIC Rev.4 = International Standard Industrial Classification of All Economic Activities, Revision 4; PPP = purchasing power parity.

Note(s)
Detail may not add to total because of rounding. Industry classifications for all countries are based on main activity. The U.S. business R&D data are from the U.S. Business R&D and Innovation Survey 2016 (cross-walked to the ISIC Rev. 4 classifications). In general, the table includes industries with annual R&D expenditures of $10 billion or more (i.e., each country's largest R&D performers). See the Organisation for Economic Co-operation and Development's (OECD's) ANalytical Business Enterprise Research and Development (ANBERD) database for a more detailed set of industries by country.

Source(s)
OECD, ANalytical Business Enterprise Research and Development (ANBERD) database.

Science and Engineering Indicators

Overall, the manufacturing sector accounted for a substantially higher share of overall business R&D in Germany, Japan, South Korea, and China (85% to 90%) relative to the United States, France, and the United Kingdom (41% to 67%) (**Table 4-13**). For Germany, within manufacturing, motor vehicles, trailers, and semi-trailers (ISIC 29, 35%) and computer, electronic, and optical products (ISIC 26, 12%) accounted for substantial levels of business R&D. For Japan, motor vehicles, trailers, and semi-trailers (ISIC 29, 26%), computer, electronic, and optical products (ISIC 26, 20%), and pharmaceuticals, medicinal chemical, and botanical products (ISIC 21, 10%) were the three largest R&D-performing sectors in 2016. For South Korea, computer, electronic, and optical products (ISIC 26, 50%) and motor vehicles, trailers, and semi-trailers (ISIC 29, 13%) were important sectors. Most of China's business R&D in 2016 was conducted in manufacturing (87%) but is more diverse among manufacturing industries than the other countries analyzed here. Computer, electronic, and optical products (ISIC 26, 16%), chemicals and chemical products (ISIC 20, 8%), motor vehicles, trailers, and semi-trailers (ISIC 29, 9%), and the other manufacturing industries all played important roles in China.

Based on ISIC, the manufacturing section (ISIC 10–33) accounted for about two-thirds (67%) of the overall business R&D performance in the United States in 2016. The three largest sectors were computer, electronic, and optical products (ISIC 26, 21%); pharmaceuticals, medicinal chemical, and botanical products (ISIC 21, 17%); and the air and spacecraft and related machinery industry (ISIC 303, 7%). These shares are similar to those reported earlier in this report based on the NAICS categories.

In addition to manufacturing, a comprehensive group encompassing all services (ISIC 45–99) accounted for most of the rest of U.S. business R&D in 2016 ($120.2 billion, or 32%) (**Table 4-13**), with information and communication (ISIC 58–63, 23%) and PST activities (ISIC 69–75, 6%) playing important roles.

France and the United Kingdom were exceptions to the manufacturing emphasis, given the large shares of R&D that occurred in services industries (**Table 4-13**). For France, 47% of business R&D came from services, with 26% from PST activities (ISIC 69–75) and 12% from information and communication (ISIC 58–63). For the United Kingdom, 57% of business R&D comprised services: 32% from PST activities (ISIC 69–75), and 14% from information and communication (ISIC 58–63).

Recent Trends in Federal Support for U.S. R&D

One of the federal government's most significant roles in supporting U.S. science and engineering (S&E) is the regular stream of funding it has provided for R&D performed by both federal entities (agency intramural laboratories and facilities and FFRDCs) and external, nonfederal organizations such as businesses and academic institutions. Fifteen federal departments and 17 other agencies perform or provide funding for R&D in the United States (**Table 4-14**). In recent years, the majority of the yearly federal R&D funding total is accounted for by a relatively small group of departments and agencies: the Department of Defense (DOD), Department of Health and Human Services (HHS, including the National Institutes of Health [NIH]), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), Department of Agriculture (USDA), Department of Commerce (DOC), and Department of Transportation (DOT).

The data discussed throughout this section are the obligations of federal agencies for R&D and R&D plant by federal fiscal year. Obligations represent the amounts for orders placed, contracts awarded, services received, and other similar transactions, regardless of when the funds were appropriated and when future payments may be required. Obligations typically provide a better measure of actual agency spending than the budget appropriations granted to agencies by Congress in advance of agency spending actions.

TABLE 4-14

Federal obligations for R&D and R&D plant, by agency: FYs 2008–18

(Millions of dollars)

Agency	2008	2009	2010	2011	2012	2013	2014	2015	2016[a]	2017	2018
All agencies	129,049.5	144,758.1	146,967.8	139,703.3	140,670.2	127,625.5	132,779.0	131,578.3	118,273.8	121,626.6	133,277.5
Department of Defense	71,996.6	75,973.7	73,623.9	75,328.2	73,973.6	63,654.7	65,128.6	61,683.0	44,926.7	45,163.8	53,444.0
Department of Health and Human Services	29,700.7	35,735.9	37,616.9	30,928.0	31,335.8	29,512.8	30,799.1	30,425.5	32,366.8	33,901.8	37,115.8
Department of Energy	8,990.3	11,562.2	11,644.9	10,680.4	10,635.2	10,397.1	11,296.3	12,343.0	13,343.2	13,583.9	14,894.1
National Aeronautics and Space Administration	5,847.1	5,957.6	8,691.3	8,429.0	10,758.3	10,494.3	10,880.6	11,413.1	12,461.7	12,638.1	10,813.9
National Science Foundation	4,506.4	6,924.8	6,073.4	5,536.6	5,705.4	5,328.5	5,800.2	5,989.7	6,022.3	5,945.7	6,358.0
Department of Agriculture	2,246.0	2,344.7	2,615.4	2,376.9	2,187.6	2,031.2	2,269.0	2,352.0	2,380.4	2,575.2	2,522.7
Department of Commerce	1,196.4	1,533.4	1,683.2	1,308.9	1,230.7	1,293.9	1,567.8	1,519.4	1,635.6	1,847.1	1,832.3
Department of Transportation	825.2	846.2	929.2	861.8	936.1	875.8	847.7	884.5	961.5	987.0	1,076.6
Patient-Centered Outcomes Research Trust Fund	na	na	na	41.1	41.1	334.4	282.6	152.1	114.9	883.9	491.7
Department of Homeland Security	1,056.8	983.6	1,131.8	1,127.5	832.2	718.8	943.8	1,645.2	689.2	869.9	913.1
Department of the Interior	645.3	738.8	728.0	716.5	742.7	717.3	762.4	808.7	859.9	868.1	768.6
Department of Veterans Affairs	480.0	510.0	563.0	612.9	614.8	639.0	588.8	661.6	695.2	682.3	1,349.0
Environmental Protection Agency	532.0	552.8	572.3	581.7	581.1	529.7	538.0	520.7	513.3	498.4	492.1
Department of Education	328.1	322.4	362.8	346.1	338.0	309.9	322.0	251.3	244.4	261.8	266.2
Smithsonian Institution	188.0	226.7	213.0	248.7	246.2	240.3	230.9	229.0	235.0	240.5	260.6
Agency for International Development	123.8	160.1	84.3	119.2	77.4	125.5	59.9	212.2	192.8	192.2	166.6
Department of Justice	114.5	103.4	125.4	102.3	85.0	118.7	160.5	149.7	208.0	126.9	106.6
Social Security Administration	54.1	67.9	63.0	53.0	64.9	56.7	59.6	58.9	129.0	109.5	71.6
All other agencies	218.2	213.9	246.0	304.5	284.1	246.9	241.2	278.7	293.9	250.5	334.0

na = not applicable.

[a] Beginning in FY 2016 (and continuing in subsequent years), agency reports of obligations for R&D reflect the application of a definition for development that is narrowed to "experimental development." This revision was introduced to align federal R&D budget formulation to be consistent with the Office of Management and Budget's Circular A-11, Section 84. This change in definition applies to all agencies, but the predominant impact is that the Department of Defense's (DOD's) Operational Systems Development (Budget Activity 7) is no longer included as development. DOD Operational Systems Development was about $24.6 billion in FY 2016, $26.0 billion in FY 2017, and $26.7 billion in FY 2018. Accordingly, the All agencies and DOD R&D obligations totals listed above for FYs 2016–18 are not directly comparable with those for FY 2015 and earlier years.

Note(s)

This table lists all agencies with R&D and R&D plant obligations greater than $100 million in FY 2017. All other agencies include Department of Housing and Urban Development, Department of Labor, Department of State, Department of the Treasury, Administrative Office of the U.S. Courts, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, Library of Congress, National Archives and Records Administration, Nuclear Regulatory Commission, Patient-Centered Outcomes Research Trust Fund, Social Security Administration, Tennessee Valley Authority, and U.S. Postal Service.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Survey of Federal Funds for Research and Development, FYs 2018–19 (Volume 68).

Science and Engineering Indicators

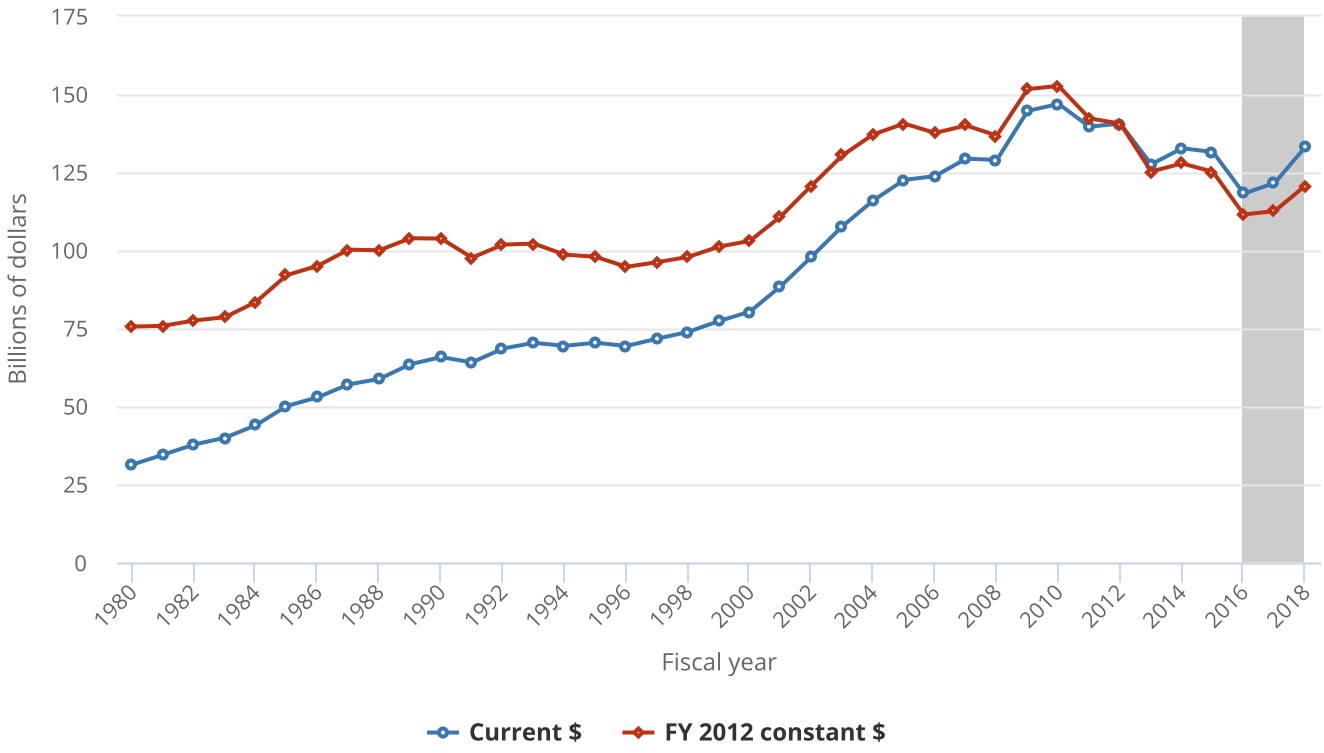
Total of Federal Funding for R&D and for Major Agencies

In FY 2017, eight agencies each obligated near or well above $1 billion (current dollars) annually on R&D and R&D plant: DOD, HHS, DOE, NASA, NSF, USDA, DOC, and DOT (**Table 4-14**). These eight agencies accounted for about 96% of the federal R&D and R&D plant total that year. Another five agencies obligated funding in the $500 million–$900 million range: the Patient-Centered Outcomes Research Trust Fund, Department of Homeland Security, Department of the Interior, Department of Veterans Affairs, and the Environmental Protection Agency.

The level of overall federal support for R&D (including for both R&D conduct and R&D plant) has generally increased each year since the early 1950s (**Figure 4-9** and Table S4-2).[17] The $2 billion–$5 billion obligated to R&D in the mid-1950s increased to around $130 billion in FYs 2007 and 2008. The level moved higher still to historical peaks in FYs 2009 and 2010, largely a result of the $18.7 billion of incremental funding for R&D authorized by ARRA (**Figure 4-9**).

FIGURE 4-9

Federal obligations for R&D and R&D plant, current versus constant dollars: FYs 1980–2018



Note(s)

Data for FYs 2009 and 2010 include obligations from the additional federal R&D funding appropriated by the American Recovery and Reinvestment Act of 2009. Beginning in FY 2016 (and continuing in subsequent years), agency reports of obligations for R&D reflect the application of a definition for development that is narrowed to "experimental development." This revision was introduced to align federal R&D budget formulation consistent with the Office of Management and Budget's Circular A-11, Section 84. This change in definition applies to all agencies, but the predominant impact is that the Department of Defense's (DOD's) Operational Systems Development (Budget Activity 7) is no longer included as development. DOD Operational Systems Development was about $24.6 billion in FY 2016, $26.0 billion in FY 2017, and $26.7 billion in FY 2018. Accordingly, the federal R&D obligations totals listed above for FYs 2016–18 (shaded in the graphic) are not directly comparable with those for FY 2015 and earlier years.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Survey of Federal Funds for Research and Development, FYs 2018–19 (Volume 68).

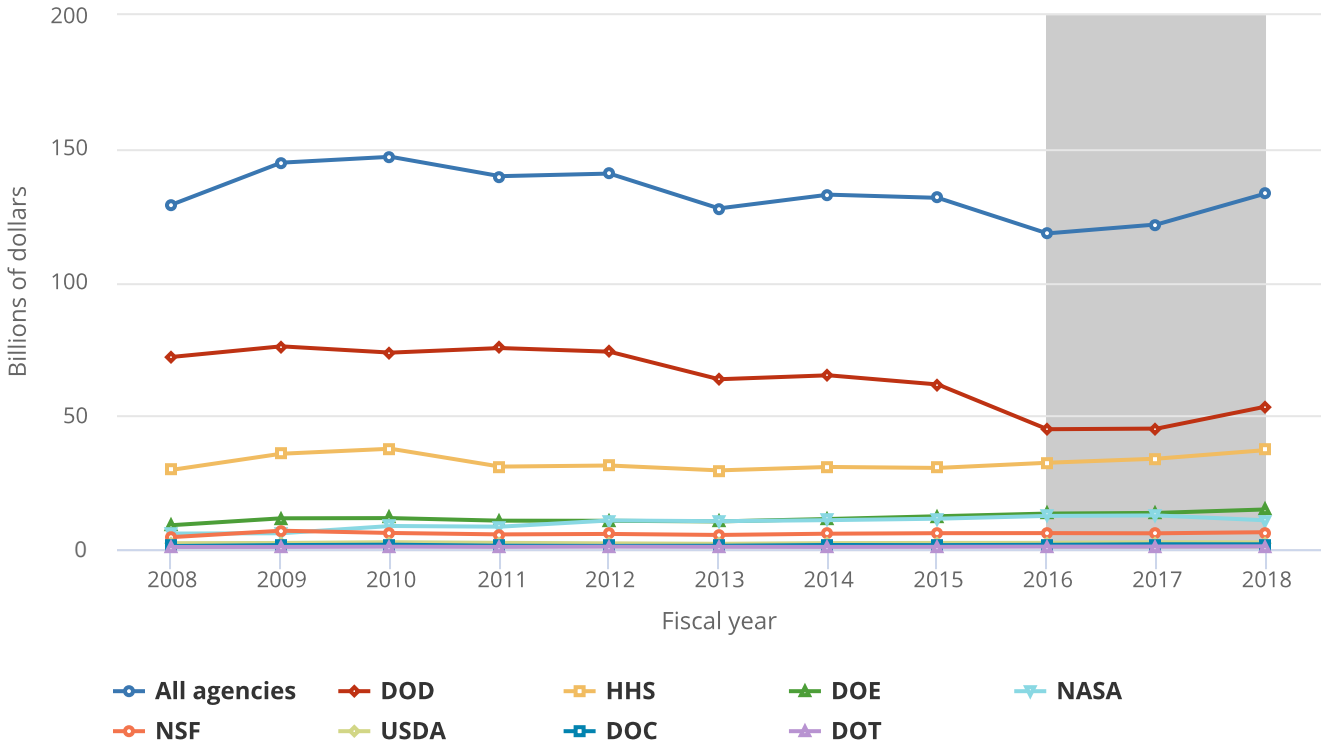
FYs 2011–15, however, exhibited a notably different trend, with federal R&D funding dropping each year (**Figure 4-9**). Adjusted for inflation, the FY 2015 level was 18% below the FY 2010 level. Some of this post–FY 2010 drop in federal R&D funding reflected the waning of the incremental funding provided by ARRA, which showed up as R&D obligations mainly in FYs 2009 and 2010. A portion of the decreased funding can also be attributed to the slow post–Great Recession expansion of the U.S. economy. The downward pressure on discretionary spending and the more challenging policy setting for federal budget decisions that emerged in 2011 and afterward also played roles. These factors all took a toll on the federal funding approved for R&D as part of the larger federal budget picture.[18]

For FYs 2016–18, the agency-reported statistics suggest the post–FY 2010 decline in federal R&D funding has flattened in more recent years (**Figure 4-9** and **Table 4-14**). However, gauging the trend in these recent fiscal years is confounded by an important change in the official data. Beginning in FY 2016, federal agencies reported R&D spending using a narrowed definition of *development* adopted by the Office of Management and Budget (OMB) (and consistent with international standards) (OMB 2018 and OMB 2016). The revised definition affected all agencies; as a practical matter, however, only several agencies experienced noticeable effects: NASA, in a modest way, with a decline in reported development (and, correspondingly, the R&D total) of $2 billion–$3 billion each year, and DOD, which was affected in a rather large way, with some $25 billion–$27 billion of formerly reported development excluded each year. No other agencies reported that the change in the official OMB definition of R&D resulted in any change in their reported R&D totals.

Figure 4-10 charts federal funding for R&D and R&D plant for each of the eight agencies from FY 2008 to FY 2018 (with the above-mentioned change in the official data also reflected in the FYs 2016–18 numbers). The decline in the total federal R&D obligations total in the FYs 2011–15 period was mainly due to a decline in DOD R&D funding—a result intended by the Budget Control Act and related agreements central to the policy debate surrounding the federal spending bills for FYs 2011–15. Against FY 2016 as a reset baseline, we see a rise in total federal R&D funding in FYs 2017 and 2018, particularly from repeated annual increases in DOD R&D and some also for HHS and DOE R&D; the levels for the other non-defense agencies remained more nearly flat.

FIGURE 4-10

Federal obligations for R&D and R&D plant, by selected agencies: FYs 2008–18



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

Note(s)

The departments and agencies included in this figure each had annual R&D obligations of $1 billion or more and together account for the vast majority of the R&D and R&D plant total. Data for FYs 2009 and 2010 include obligations from the additional federal R&D funding appropriated by the American Recovery and Reinvestment Act of 2009. Beginning in FY 2016 (and continuing in subsequent years), agency reports of obligations for R&D reflect the application of a definition for development that is narrowed to "experimental development." This revision was introduced to align federal R&D budget formulation consistent with the Office of Management and Budget's Circular A-11, Section 84. This change in definition applies to all agencies, but the predominant impact is that DOD's Operational Systems Development (Budget Activity 7) is no longer included as development. DOD Operational Systems Development was about $24.6 billion in FY 2016, $26.0 billion in FY 2017, and $26.7 billion in FY 2018. Accordingly, the All agencies and DOD R&D obligations totals listed above for FYs 2016–18 (shaded in the graphic) are not directly comparable with those for FY 2015 and earlier years.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Survey of Federal Funds for Research and Development, FYs 2018–19 (Volume 68).

Science and Engineering Indicators

Distribution of Federal Funding of R&D, by Performer and Type of R&D

Table 4-15 and **Table 4-16** (and Table S4-3) provide breakdowns, by agency, of the $121.6 billion of federal dollars obligated for R&D and R&D plant in FY 2017 according to purpose (R&D conduct, R&D plant), performers funded (intramural, extramural), and type of R&D (basic research, applied research, experimental development).

For all the agencies together, nearly all of the obligated total was for the purpose of R&D conduct ($119.0 billion, 98%) (**Table 4-15** and Table S4-3). Spending on R&D plant was just over 2% of the annual total ($2.7 billion), with most of the obligations in this category coming from a few agencies (mainly DOE, but also NSF, DOD, DOC, USDA, and HHS).

In 2017, the largest share of federal funding was for development (41%), next was applied research (31%), and then basic research (28%) (**Table 4-16**). These proportions vary widely, however, from agency to agency—mainly reflecting differences in agency missions and priorities. For example, basic research's share for NSF in 2017 was 86% and was 49% for HHS, but its share was only 5% for DOD and nearly 0% for DOT.

Corresponding data tables in earlier editions of *Science and Engineering Indicators* (e.g., the 2014, 2016, and 2018 editions, accessible at **https://www.nsf.gov/statistics/seind/**) show largely the same picture for these distributions of federal funding by agency, performer, and type of R&D.

TABLE 4-15

Federal obligations for R&D and R&D plant, by agency and performer: FY 2017

(Millions of dollars and percentage of total performers)

Agency	Total	R&D	R&D plant	Total by performers			
				Intramural and FFRDCs	Percentage of total	Extramural performers	Percentage of total
All agencies	121,626.6	118,974.8	2,651.8	44,469.4	36.6	77,157.2	63.4
Department of Defense	45,163.8	44,872.6	291.2	17,266.1	38.2	27,897.7	61.8
Department of Health and Human Services	33,901.8	33,774.2	127.6	7,921.9	23.4	25,979.9	76.6
National Aeronautics and Space Administration	12,638.1	12,594.6	43.4	3,575.6	28.3	9,062.5	71.7
Department of Energy	13,583.9	12,308.4	1,275.5	9,378.1	69.0	4,205.9	31.0
National Science Foundation	5,945.7	5,517.6	428.1	249.3	4.2	5,696.4	95.8
Department of Agriculture	2,575.2	2,418.5	156.8	1,685.1	65.4	890.2	34.6
Department of Commerce	1,847.1	1,612.5	234.6	1,443.0	78.1	404.1	21.9
Department of Transportation	987.0	948.6	38.4	296.2	30.0	690.8	70.0

TABLE 4-15

Federal obligations for R&D and R&D plant, by agency and performer: FY 2017

(Millions of dollars and percentage of total performers)

Agency	Total	R&D	R&D plant	Total by performers			
				Intramural and FFRDCs	Percentage of total	Extramural performers	Percentage of total
Patient-Centered Outcomes Research Trust Fund	883.9	883.9	0.0	0.0	0.0	883.9	100.0
Department of the Interior	868.1	862.6	5.4	767.2	88.4	100.9	11.6
Department of Homeland Security	869.9	856.6	13.3	489.9	56.3	380.0	43.7
Department of Veterans Affairs	682.3	682.3	0.0	682.3	100.0	0.0	0.0
Environmental Protection Agency	498.4	493.6	4.8	263.4	52.8	235.0	47.2
Department of Education	261.8	261.8	0.0	10.6	4.0	251.3	96.0
Smithsonian Institution	240.5	207.9	32.7	240.5	100.0	0.0	0.0
Agency for International Development	192.2	192.2	0.0	10.9	5.7	181.3	94.3
Department of Justice	126.9	126.9	0.0	11.4	9.0	115.5	91.0
Social Security Administration	109.5	109.5	0.0	31.2	28.5	78.3	71.5
All other agencies	250.4	250.4	0.0	146.8	58.6	103.5	41.4

FFRDC = federally funded research and development center.

Note(s)

This table lists all agencies with R&D obligations greater than $100 million in FY 2017. Detail may not add to total because of rounding. R&D is basic research, applied research, and development and does not include R&D plant. Intramural activities include actual intramural R&D performance and costs associated with the administration of intramural R&D programs and extramural R&D procurements by federal personnel. Extramural performers include federally funded R&D performed in the United States and U.S. territories by businesses, universities and colleges, other nonprofit institutions, state and local governments, and foreign organizations. All other agencies include Department of Housing and Urban Development, Department of Labor, Department of State, Department of the Treasury, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, Library of Congress, National Archives and Records Administration, Nuclear Regulatory Commission, Tennessee Valley Authority, and U.S. Postal Service.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Survey of Federal Funds for Research and Development, FYs 2018–19 (Volume 68).

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TABLE 4-16

Federal obligations for R&D, by agency and type of work: FY 2017

(Millions of dollars and percentage of total R&D)

Agency	Total R&D	Basic research	Applied research	Development	Percentage of total R&D		
					Basic research	Applied research	Development
All agencies	118,974.8	33,271.5	36,599.8	49,103.5	28.0	30.8	41.3
Department of Defense	44,872.6	2,110.1	5,068.0	37,694.6	4.7	11.3	84.0
Department of Health and Human Services	33,774.2	16,700.1	16,977.3	96.8	49.4	50.3	0.3
National Aeronautics and Space Administration	12,594.6	3,425.8	2,319.5	6,849.4	27.2	18.4	54.4
Department of Energy	12,308.4	4,500.3	5,084.2	2,723.9	36.6	41.3	22.1
National Science Foundation	5,517.6	4,739.1	778.6	0.0	85.9	14.1	0.0
Department of Agriculture	2,418.5	965.2	1,251.1	202.1	39.9	51.7	8.4

TABLE 4-16

Federal obligations for R&D, by agency and type of work: FY 2017

(Millions of dollars and percentage of total R&D)

Agency	Total R&D	Basic research	Applied research	Development	Percentage of total R&D		
					Basic research	Applied research	Development
Department of Commerce	1,612.5	246.0	1,056.3	310.2	15.3	65.5	19.2
Department of Transportation	948.6	0.0	695.6	253.0	0.0	73.3	26.7
Patient-Centered Outcomes Research Trust Fund	883.9	0.0	883.9	0.0	0.0	100.0	0.0
Department of the Interior	862.6	54.3	667.5	140.7	6.3	77.4	16.3
Department of Homeland Security	856.6	11.6	264.4	580.6	1.4	30.9	67.8
Department of Veterans Affairs	682.3	274.1	394.7	13.5	40.2	57.8	2.0
Environmental Protection Agency	493.6	0.0	417.5	76.2	0.0	84.6	15.4
Department of Education	261.8	32.7	141.4	87.8	12.5	54.0	33.5
Smithsonian Institution	207.9	207.9	0.0	0.0	100.0	0.0	0.0
Agency for International Development	192.2	0.8	191.5	0.0	0.4	99.6	0.0
Department of Justice	126.9	2.1	84.6	40.2	1.7	66.7	31.7
Social Security Administration	109.5	0.0	109.5	0.0	0.0	100.0	0.0
All other agencies	250.4	1.4	214.3	34.6	0.6	85.6	13.8

Note(s)

This table lists all agencies with R&D obligations greater than $100 million in FY 2017. Detail may not add to total because of rounding. All other agencies include Department of Housing and Urban Development, Department of Labor, Department of State, Department of the Treasury, Appalachian Regional Commission, Consumer Product Safety Commission, Federal Communications Commission, Federal Trade Commission, Library of Congress, National Archives and Records Administration, Nuclear Regulatory Commission, Tennessee Valley Authority, and U.S. Postal Service.

Source(s)

National Center for Science and Engineering Statistics, National Science Foundation, Survey of Federal Funds for Research and Development, FYs 2018–19 (Volume 68).

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Distribution of Federal Funding for Research, by S&E Fields

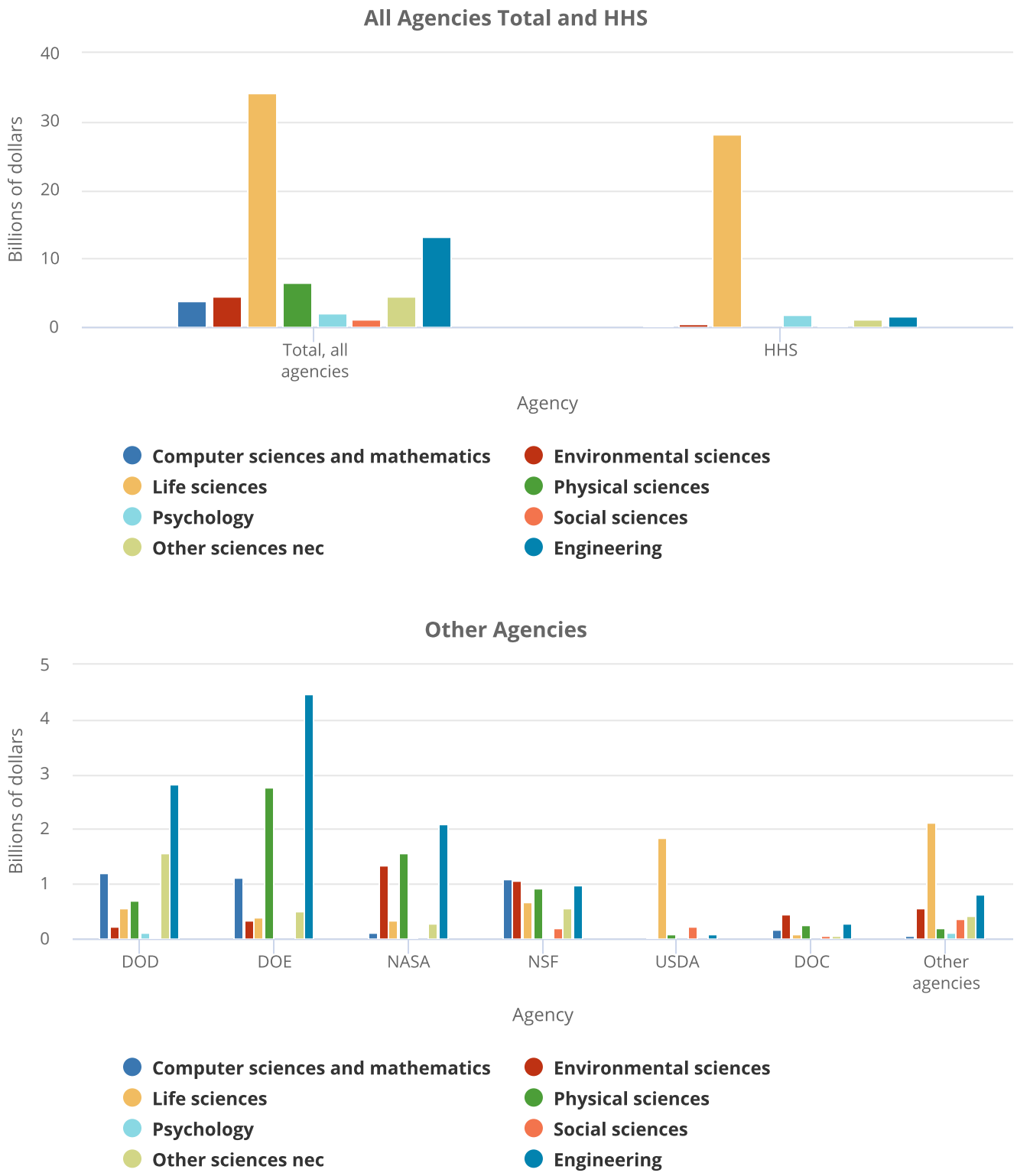
The basic research and applied research conducted or funded by the federal government spans a full range of S&E fields: computer sciences and mathematics, environmental sciences, life sciences, physical sciences, psychology, social sciences, engineering, and other S&E fields. Experimental development cannot easily be classified by S&E field, so the available data cover only research.[19]

In FY 2017, funding for basic and applied research combined accounted for $69.9 billion of the $119.0 billion total of federal obligations for R&D (**Table 4-16**). Nearly half of this amount, $34.1 billion, supported research in life sciences (Table S4-4). The fields with the next largest amounts were engineering ($13.2 billion, 19%) and physical sciences ($6.6 billion, 9%), followed by environmental sciences ($4.5 billion, 6%) and computer sciences and mathematics ($3.9 billion, 6%). The balance of federal obligations for research in FY 2017 supported psychology, social sciences, and all other sciences ($7.6 billion overall, or 11% of the total for research).

The differences in federal funding for research across agencies and fields reflect the differences in agency missions (**Figure 4-11**). HHS accounted for the largest share (48%) of federal obligations for research in FY 2017 (Table S4-4). Most of this amount funded research in life sciences, primarily through NIH. The six next largest federal agencies for research funding that year were DOE (14%), DOD (10%), NASA (8%), NSF (8%), USDA (3%), and DOC (2%).

FIGURE 4-11

Federal obligations for research, by agency and major S&E field: FY 2017



DOC = Department of Commerce; DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; nec = not elsewhere classified; NSF = National Science Foundation; USDA = Department of Agriculture.

Note(s)
The scales differ for Total, all agencies, and HHS compared with the scales for the other agencies listed. Research includes basic and applied research.

Source(s)
National Center for Science and Engineering Statistics, National Science Foundation, Survey of Federal Funds for Research and Development, FYs 2018–19 (Volume 68). See Table S4-4.

Science and Engineering Indicators

DOE primarily funded research in engineering ($4.5 billion), physical sciences ($2.8 billion), and computer sciences and mathematics ($1.1 billion). DOD's research focuses included engineering ($2.8 billion), computer sciences and mathematics ($1.2 billion), physical sciences ($0.7 billion), and life sciences ($0.6 billion). NASA focused primarily on engineering ($2.1 billion), physical sciences ($1.6 billion), and environmental sciences ($1.3 billion).

NSF is charged with "promoting the progress of science." As such, it had a comparatively diverse $5.5 billion research portfolio that allocated about $0.6 billion–$1.1 billion to each of the following fields: environmental sciences, life sciences, computer sciences and mathematics, physical sciences, and engineering. Smaller amounts were allocated to psychology, social sciences, and other sciences. USDA's $2.2 billion was directed primarily at life (agricultural) sciences ($1.8 billion). DOC's $1.3 billion was distributed mainly in the fields of environmental sciences, physical sciences, engineering, and computer sciences and mathematics.

Adjusted for inflation, the total of federal funds obligated for research across all S&E fields grew, on average, by 3.8% annually over 1990–2000 and by 3.0% over 2000–10 (Table S4-5). More recently, however, the research obligations total has slowed noticeably; over the 2010–17 time period, research obligations declined, on average, 0.3% annually, adjusted for inflation.

Cross-National Comparisons of Government R&D Priorities

OECD countries report statistics on government funding of R&D through the "government budget allocations for R&D" (GBARD) indicator, which distinguishes more than a dozen differing socioeconomic objectives.[20] Defense is an objective for government funding of R&D for all the top R&D-performing countries, but the shares vary considerably (**Table 4-17**). Defense accounted for 44% of U.S. federal R&D support in 2017, while the United Kingdom and South Korea were a distant second, with 15% each supporting R&D for defense.[21] The remaining countries' shares were 8% or lower.

TABLE 4-17

Government R&D support by major socioeconomic objectives, for selected countries or regions: Selected years, 2000–17

(Millions of U.S. dollars and percent)

Country or region	Year	GBARD (current PPP US$millions)	Percentage of GBARD		Percentage of nondefense					
			Defense	Nondefense	Economic development programs	Health and environment	Education and society	Civil space	Non-oriented research	General university funds
United States	2000	72,681.0	44.4	55.6	13.4	49.9	1.8	20.9	13.8	na
	2010	119,382.0	46.7	53.3	12.5	56.1	1.6	12.9	16.9	na
	2017	127,306.0	43.6	56.5	11.9	55.7	2.5	14.2	15.7	na
EU	2000	76,676.6	12.6	87.4	22.4	11.6	3.5	6.0	17.8	35.0
	2010	116,371.3	6.5	93.5	22.2	14.1	6.4	5.4	18.2	33.2
	2017	135,160.6	4.7	95.3	22.2	14.0	4.8	4.2	18.0	35.7
France	2000	14,880.1	21.4	78.6	17.7	9.7	1.1	13.2	27.4	28.5
	2010	19,141.6	14.7	85.3	21.1	12.6	5.3	12.7	19.6	27.0
	2017	19,015.4	7.5	92.5	23.3	10.2	2.4	4.5	25.5	25.7
Germany	2000	17,234.0	7.8	92.2	21.6	9.4	3.9	5.1	17.5	42.4
	2010	28,587.1	5.0	95.0	24.4	9.2	4.4	5.0	17.0	40.6

TABLE 4-17

Government R&D support by major socioeconomic objectives, for selected countries or regions: Selected years, 2000–17

(Millions of U.S. dollars and percent)

Country or region	Year	GBARD (current PPP US$millions)	Percentage of GBARD		Percentage of nondefense					
			Defense	Nondefense	Economic development programs	Health and environment	Education and society	Civil space	Non-oriented research	General university funds
	2017	39,992.1	3.8	96.2	21.7	9.9	4.6	4.8	16.7	42.4
United Kingdom	2000	9,492.2	35.7	64.4	14.2	27.7	6.3	3.4	18.3	29.7
	2010	13,315.8	18.2	81.8	8.5	32.3	5.0	2.1	22.0	30.1
	2017	15,700.2	15.2	84.8	22.4	34.1	5.0	1.6	12.6	24.3
Japan	2000	21,227.8	4.1	95.9	33.4	6.6	1.0	5.8	14.6	37.0
	2010	32,140.4	4.8	95.2	27.6	7.4	0.9	7.1	21.0	35.9
	2017	34,027.7	3.5	96.5	26.0	8.0	0.6	6.4	22.0	37.1
South Korea	2000	5,017.8	20.5	79.5	53.4	14.8	3.8	3.1	24.9	**
	2010	16,293.9	13.3	86.7	52.1	13.7	2.4	2.7	29.1	**
	2017	22,519.2	15.0	85.0	49.3	15.4	8.9	3.1	23.3	**

** = included in other categories. na = not applicable; country or region does not use this funding mechanism.

EU = European Union; GBARD = government budget allocations for R&D; PPP = purchasing power parity.

Note(s)

Foreign currencies are converted to dollars through PPPs. The GBARD statistics reported for the United States are federal budget authority data; all years reported in this table reflect the narrowed definition of "development" adopted by the Office of Management and Budget in 2017. GBARD data are not yet available for China or India. The socioeconomic objective categories are aggregates of the 14 categories identified by Eurostat's 2007 Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets. The data are as reported by the Organisation for Economic Co-operation and Development (OECD).

Source(s)

OECD, *Main Science and Technology Indicators* (2019/1).

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Nondefense R&D priorities also vary by country. For the United States and the United Kingdom, health and the environment have been the largest shares of nondefense spending, at 56% and 34%, respectively. These shares have increased markedly since 2000.

South Korea has consistently allocated about half of its nondefense R&D support to economic development programs, which encompass agriculture, energy, fisheries and forestry, industry, transportation, telecommunications, and other infrastructure. The shares devoted by other countries are markedly less.

The civil space objective accounted for about 14% of nondefense federal R&D funding in the United States in 2017. The share was 21% in 2000 and declined to 13% by 2010, but this objective has experienced increases more recently. The corresponding share in France was about 4% for 2017, well down from 13% in both 2000 and 2010. The space share has been well below 10% for the rest of the top R&D-performing countries.

Both the non-oriented research funding and general university funds (GUF) objectives reflect government support for R&D by academic, government, and other performers that is directed chiefly at the “general advancement of knowledge” in the natural sciences, engineering, social sciences, humanities, and related fields. For some of the countries, the sum of these two objectives represents by far the largest part of nondefense GBARD: in 2017, Japan (59%), Germany (59%), France (51%), the United Kingdom (37%), and South Korea (23%). While the corresponding 2017 share for the United States (16%) was substantially smaller, it requires interpretive caution. Cross-national comparisons of these particular indicators can

be difficult because some countries (notably the United States) do not use the GUF mechanism to fund R&D for general advancement of knowledge or do not separately account for GUF (e.g., South Korea); more typically, these countries direct R&D funding to project-specific grants or contracts, which are then assigned to more specific socioeconomic objectives. [22]

Finally, the education and society objective represents a comparatively small component of nondefense government R&D funding for the top R&D-performing countries. This objective comprised 3% of nondefense GBARD in the United States in 2017, compared to a lower share in Japan (1%) and to higher shares in Germany (5%), the United Kingdom (5%), and South Korea (9%).

Conclusion

The U.S. annual total of R&D is now back on a strong expansionary path ($548 billion in 2017) due, particularly, to sizable annual increases in business R&D performance. Adjusted for inflation, the U.S. R&D total over 2010–17 grew modestly faster that U.S. GDP (with average annual growth rates, respectively, of 2.7% and 2.2%).

In 2017, the United States remains the world's top R&D performer (as it long has been), accounting for 25% of the global total. China, however, has closed the gap even further, at $496 billion in 2017 and 23% of the global total, with an average annual growth rate nearly three times as high as that of the United States.

The global concentration of R&D performance continues to shift from the United States and Europe to South Asia and East-Southeast Asia (including China, Japan, South Korea, Taiwan, and other countries or economies). In 2017, this part of Asia accounted for 42% of the global R&D total, up from 25% in 2000. Over the same period, the U.S. share significantly declined, from 37% in 2000 to 25% in 2017. Similarly, Europe accounted for 27% in 2000 but declined to 21% in 2017.

In 2017, the U.S. R&D-to-GDP ratio (2.8%) matches the highest levels evident over the long time-series available for this indicator since the early 1950s. Present U.S. spending for basic research, applied research, and experimental development continues to increase and is at historical highs in these three categories. Nonetheless, the challenges to U.S. R&D leadership from countries abroad, particularly in Asia, continue unabated.

Glossary

Definitions

European Union (EU): The EU comprises 28 member nations: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Unless otherwise noted, data on the EU include all 28 nations.

Gross domestic product (GDP): The market value of goods and services produced within a country. It is one of the main measures in a country's national income and product accounts, which record the value and composition of national output and the distribution of the incomes generated in this production (BEA 2015).

Organisation for Economic Co-operation and Development (OECD): An international organization of 36 countries, headquartered in Paris, France. The member countries are Australia, Austria, Belgium, Canada, Chile, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Among its many activities, the OECD compiles social, economic, and science and technology statistics for all member and selected nonmember countries.

R&D: Research and experimental development comprise creative and systematic 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.

R&D intensity: A measure of R&D expenditures relative to size, production, financial, or other characteristics for a given R&D-performing unit (e.g., country, sector, company). Examples include the R&D-to-GDP and R&D-to-value-added ratios.

R&D plant: Includes both facilities and major equipment necessary for the execution of an R&D program. These include the purchase, construction, manufacture, rehabilitation, or major improvement of physical assets such as land, major fixed equipment, and supporting infrastructure like a sewer line or housing at a remote location. R&D plant also includes the acquisition, design, or production of major movable equipment, such as mass spectrometers, research vessels, DNA sequencers, and other movable major instruments for use in R&D activities.

Key to Acronyms and Abbreviations

ANBERD: Analytical Business Enterprise R&D

ARRA: American Recovery and Reinvestment Act of 2009

DOC: Department of Commerce

DOD: Department of Defense

DOE: Department of Energy

DOT: Department of Transportation

EU: European Union

FFRDC: federally funded research and development center

FY: fiscal year

GBARD: government budget allocations for R&D

GDP: gross domestic product

GUF: general university funds

HHS: Department of Health and Human Services

ISIC: International Standard Industrial Classification of All Economic Activities

NAICS: North American Industry Classification System

NASA: National Aeronautics and Space Administration

NCSES: National Center for Science and Engineering Statistics

NIH: National Institutes of Health

NSF: National Science Foundation

OECD: Organisation for Economic Co-operation and Development

PPP: purchasing power parity

PST: professional, scientific, and technical

R&D: research and experimental development

S&E: science and engineering

UNESCO: United Nations Educational, Scientific and Cultural Organization

USDA: Department of Agriculture

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Notes

1 A **Technical Appendix** to this report provides an overview of the R&D surveys and key methods used in this report. In addition to the data presented in this section's figures and tables, NCSES statistics on U.S. R&D performance go back to 1953 and provide details by R&D performers and funders and by type of R&D. These data time series and additional statistics are part of the NCSES *National Patterns of R&D Resources* series released yearly and can be accessed on the NCSES website at **https://ncses.nsf.gov/pubs/nsf20307/**.

2 In this report, dollars adjusted for inflation (i.e., constant dollars) are based on the GDP implicit price deflator (currently in 2012 dollars) as published by the Department of Commerce, Bureau of Economic Analysis (BEA) (**https://www.bea.gov/iTable/index_nipa.cfm**). Note that GDP deflators are calculated on an economy-wide scale and do not explicitly focus on R&D.

3 The ratio of total national R&D expenditures to GDP is often reported as a measure of the intensity of a nation's overall R&D effort and is widely used as an international benchmark for comparing countries' R&D activities.

4 The data for higher education R&D appearing in this report adjust the academic fiscal year basis of NCSES's Higher Education Research and Development Survey data to calendar year and net out pass-throughs of research funds to remove double-counting in the national totals (see NCSES *National Patterns of R&D Resources*: **https://www.nsf.gov/statistics/natlpatterns/**). Accordingly, the higher education data included in this report differ from those cited in *Indicators 2020* report "Academic Research and Development."

5 FFRDCs are R&D-performing organizations that are exclusively or substantially financed by the federal government. An FFRDC is operated to provide R&D capability to serve agency mission objectives or, in some cases, to provide major facilities at universities for research and associated training purposes. Each FFRDC is administered by an industrial firm, a university, a nonprofit institution, or a consortium. NCSES maintains a current Master Government List of Federally Funded R&D Centers. For information on the current FFRDC count, along with its history, see **https://www.nsf.gov/statistics/ffrdclist/**.

6 An additional factor affecting the reported level of federal intramural R&D performance in 2016 and beyond is OMB's adoption in 2016 of a definition of "development" that narrowed what is counted to "experimental development." The largest effect has been the exclusion of DOD's Activity 6.7 Operational Systems Development from the federal tally of R&D expenditures. As a result, the federal intramural R&D totals reported for 2016 and 2017 (in **Table 4-1**, **Figure 4-2**, and elsewhere in this report) are approximately $5 billion lower than they would have been if tallied in the same way as 2015 and earlier. For a further discussion of this technical development in federal R&D reporting, see section **Recent Trends in Federal Support for U.S. R&D** in this report.

7 R&D funding by business in this section refers to business funding for domestic business R&D performance plus business funding for FFRDCs and U.S. academic and nonprofit R&D performers.

8 R&D encompasses a wide range of activities, ranging from research yielding fundamental knowledge in the physical, life, and social sciences; to research addressing national defense needs and such critical societal issues as global climate change, energy efficiency, and health care; to the development of platform or general-purpose technologies that can enable the creation and commercial application of new and improved goods and services. The most widely applied classification of these activities characterizes R&D as "basic research," "applied research," or "experimental development" (OECD 2015, OMB 2016, and NSF 2018). This longstanding trio of categories has been criticized over the years as reinforcing the idea that creating new knowledge, invention, and innovation is a linear process beginning with basic research, followed by applied research and then development, and ending with the production and diffusion of new technologies and eventually commercially significant innovations. Nonetheless, alternative classifications that provide

measurable distinctions, capture major differences in types of R&D, and are widely accepted as superior have yet to be developed. Despite the recognized limitations of the basic research–applied research–development classification framework, it remains useful in providing indications of differences in the motivation, expected time horizons, outputs, and types of investments associated with R&D projects.

9 The Organisation for Economic Co-Operation and Development notes that in measuring R&D, one source of error is the difficulty of locating the dividing line between experimental development and the further downstream developmental activities needed to realize an innovation (OECD 2015:51–52). Most definitions of R&D set the cutoff at the point when a particular product or process reaches "market readiness." At this point, the defining characteristics of the product or process are substantially set—at least for manufactured goods, if not also for services—and further work is aimed primarily at developing markets, engaging in preproduction planning, and streamlining the production or control system.

10 The arithmetic is straightforward to calculate type-of-R&D shares for past years, based on the time-series data reported annually in the NCSES *National Patterns of R&D Resources* series. Nonetheless, care must be taken in describing the trends for these shares over time. Although NCSES's sectoral surveys of R&D expenditures have long and consistently used the Organisation for Economic Co-Operation and Development *Frascati Manual*'s type-of-R&D definitions, the survey instruments have occasionally been revised to improve the reliability of the responses received, most notably in the academic, business, federal funds, and FFRDC R&D expenditure surveys. Accordingly, some differences observed in the shares directly calculated from the supplemental table time-series data more nearly reflect the effects of these improvements in the type-of-R&D survey questions than changes in the type-of-R&D shares among R&D performers.

11 This report provides new R&D expenditures data relative to what is presented in the previous (2018) edition of *Indicators.* The new data include updated data for 2016 and 2017 and revisions for prior years. Actual 2018 data for all countries will not be available at the time of the report's publication.

12 The figures cited for total global R&D in 2000, 2010, and 2017 are NCSES estimates. R&D expenditures for all countries are denominated in U.S. dollars, based on PPP dollar conversions. These estimates are based on data from the Organisation for Economic Co-Operation and Development's (OECD's) Main Science and Technology Indicators 2019/1 (OECD 2019b) and from R&D statistics for additional countries assembled by the United Nations Educational, Scientific and Cultural Organization's (UNESCO's) Institute for Statistics (as of mid-March 2019). Presently, no database on R&D spending is comprehensive and consistent for all nations performing R&D. The OECD and UNESCO databases together provide R&D performance statistics for 158 countries, although the data are not current or complete for all. NCSES's estimate of total global R&D reflects 106 countries, with reported annual R&D expenditures of $50 million or more, which accounts for most of the current global R&D.

13 The regional groupings of countries reported throughout this section of the report are the classifications of the U.S. Central Intelligence Agency, as described in its *World Factbook* publication (**https://www.cia.gov/library/publications/the-world-factbook/**).

14 Up through 2016, the reference population for the Business R&D and Innovation Survey (BRDIS) did not include companies with fewer than 5 employees in the United States. Starting in 2017, the survey was renamed the Business R&D Survey (BRDS), and the reference population was revised to exclude companies with fewer than 10 employees.

15 The industry-level data presented in this section are obtained by classifying a company's total R&D into a single industry, even if R&D activities occur in multiple lines of business. For example, if a company has $100 million in R&D expenses—$80 million in pharmaceuticals and $20 million in medical devices—the total R&D expense of $100 million is assigned to the pharmaceuticals industry because it is the largest component of the company's total R&D expense (Shackelford 2012). However, most companies performed R&D in only one business activity area. In 2010, 86% of companies reported domestic R&D performed by and paid for by the company related to only one business activity. See Shackelford (2012) for an in-depth analysis of the relationship between business codes and industry codes.

16 ISIC Revision 4 was released by the United Nations Statistics Division in August 2008. For an overview of the classification structure, comparisons with earlier editions, and background, see **https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27**.

17 The analysis in this section focuses primarily on developments in federal R&D priorities and funding support over the course of the last decade. Nevertheless, there is an important and interesting story to tell about how the comparatively minor federal role in the nation's science and research system up until World War II was reconsidered, redirected, and greatly enlarged, starting shortly after the end of the war and moving through the subsequent decades to the present. For a review of the essential elements of this evolving postwar federal role, see Jankowski (2013).

18 For a further account of this recent federal budget history, see Boroush (2015, 2016). Notable among the various interconnected developments over these years were the federal-wide spending reductions imposed by the enacted FY 2011 federal budget: the Budget Control Act of 2011, intended to address the then-ongoing national debt ceiling crisis, which commanded a 10-year schedule of budget caps and spending cuts; the budget sequestration provision, which ultimately took hold in the FY 2013 federal budget; and the Bipartisan Budget Act of 2013, which provided some subsequent relief from the deepening sequestration requirements, but only for the FY 2014 and FY 2015 budgets.

19 Data collected annually by NCSES on federal R&D funding include detail on the distribution of support for research (i.e., basic and applied research) across differing S&E fields.

20 Government R&D funding statistics compiled annually by OECD provide insights into how national government priorities for R&D differ across countries (OECD 2015). Known technically as government budget allocations for R&D (GBARD), this indicator provides data on how a country's overall government funding for R&D splits among a set of socioeconomic categories (e.g., defense, health, space, and general research). GBARD statistics are available for the United States and most of the other top R&D-performing countries discussed earlier in this report's section on Cross-National Comparisons of R&D Performance (however, corresponding GBARD data for China and India are not currently available).

21 Defense received 50% or more of the federal R&D budget in the United States for many years. The defense share was 63% in 1990 as the Cold War period waned but then dropped in subsequent years. It rose again in the first decade of the 2000s—in large part, reflecting post-9/11 security concerns—but it has been declining again in the most recent years. For the other countries, the defense share of government R&D funding has generally declined or remained at a stable, low level.

22 The treatment of GUF is one of the major areas of difficulty in making international R&D comparisons. In many countries, governments support academic research primarily through large block grants that are used at the discretion of each higher education institution to cover administrative, teaching, and research costs. Only the R&D component of GUF is included in national R&D statistics, but problems arise in identifying the amount of the R&D component and the objective of the research. Moreover, government GUF support is in addition to support provided in the form of earmarked, directed, or project-specific grants and contracts (funds that can be assigned to specific socioeconomic categories). In several large European countries (France, Germany, Italy, and the United Kingdom), GUF accounts for 50% or more of total government R&D funding to universities. In Canada, GUF accounts for about 38% of government academic R&D support. Thus, international data on academic R&D reflect not only relative international funding priorities but also funding mechanisms and philosophies regarded as the best methods for financing academic research.

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