



Five States Account for Half of U.S. Business R&D in 2013; New Data for Metropolitan Areas Available

by Brandon Shackelford and Raymond Wolfe¹

Five states—California, Massachusetts, Michigan, Texas, and Washington—accounted for half of the research and development paid for and performed by companies in the United States in 2013, according to estimates from the 2013 Business R&D and Innovation Survey (BRDIS) from the National Science Foundation’s National Center for Science and Engineering Statistics. Companies performed \$265 billion of R&D paid for by their own company expenses in the United States in 2013, of which \$255 billion could be attributed to one of the 50 states or the District of Columbia.² Not included in these figures but discussed at the end of this InfoBrief is R&D performed by companies but paid for by others, such as the federal government and other customers or business partners.

Concentration of Self-Funded Business R&D within States

California alone accounted for 30% (\$77 billion) of all self-funded business R&D performance in the United States in 2013 (table 1). In 2008, California accounted for 25% of such R&D performance (Shackelford 2012). Between 2008 and 2013, the growth of California’s self-funded business R&D

performance outpaced that of the rest of the United States, increasing by 42%, compared to a 7% increase for all other states combined.

Business R&D is geographically concentrated in the United States more so than is either gross domestic product (GDP) or population. The five states with the highest levels of business R&D performance accounted for \$133 billion (52%) of the \$255 billion total. The top five states in terms of both GDP and population accounted for 40% of GDP and 37% of the population in 2013.³ The higher concentration of business R&D among top states is reflected in a high ratio of business R&D to GDP (table 1). The ratio of business R&D to GDP for a region is an indicator of R&D intensity that can be used to compare regions in a way that controls for differences in the size of regions’ economies.

Overall, the ratio of business R&D to GDP was 1.6% in 2013 (table 1). California, Massachusetts, Michigan, and Washington each had an R&D intensity that was at least twice as high as the United States as a whole, indicating that twice as much business R&D was performed in these states relative to the size of their economy. California’s

R&D grew at a faster pace between 2008 and 2013 than its economy as a whole, resulting in its R&D intensity increasing from 2.8% in 2008 to 3.5% in 2013. Two of the top 10 states for business R&D in 2013 had R&D intensities substantially below that of the nation as a whole: Texas and New York. The below-average R&D intensities reflect a higher concentration of industries that are less R&D intensive: oil and gas extraction in Texas, and financial services in New York.⁴

A single industry dominates the business R&D in 4 of the top 10 states (table 2).⁵ Automobile manufacturers accounted for 74% of Michigan’s total, software publishers for 62% of Washington’s total, and the pharmaceutical industry for 53% and 48% of New Jersey’s and Pennsylvania’s totals, respectively. The semiconductor and other electronic components industry (the largest industry in terms of R&D in California) accounted for only 20% of California’s business R&D, but all information and communication technology (ICT) industries combined accounted for 67% of the state’s business R&D.⁶ Mining, extraction, and support activities was the single largest industry in terms of R&D in Texas, but

TABLE 1. Domestic business R&D paid for by the company and performed by the company, GDP, and business R&D-GDP ratio, by state: 2013

(Millions of U.S. dollars)

State	R&D performed and paid for by the company	GDP	Business R&D-GDP ratio (%)	State	R&D performed and paid for by the company	GDP	Business R&D-GDP ratio (%)
All states	264,913	16,549,228	1.6	Montana	73	42,722	0.2
Alabama	802	193,374	0.4	Nebraska	577	107,088	0.5
Alaska	33	57,132	0.1	Nevada	460	128,037	0.4
Arizona	4,036	274,328	1.5	New Hampshire	811	67,485	1.2
Arkansas	252	116,403	0.2	New Jersey	11,955	533,966	2.2
California	76,851	2,215,726	3.5	New Mexico	291	89,110	0.3
Colorado	3,869	286,812	1.3	New York	9,456	1,325,405	0.7
Connecticut	5,789	242,878	2.4	North Carolina	5,690	458,282	1.2
Delaware	1,705 i	60,260	2.8	North Dakota	215	51,866	0.4
District of Columbia	297	111,891	0.3	Ohio	5,582	557,028	1.0
Florida	3,900	799,616	0.5	Oklahoma	450	176,101	0.3
Georgia	3,350	452,897	0.7	Oregon	5,405	204,109	2.6
Hawaii	158 i	74,156	0.2	Pennsylvania	10,001	636,833	1.6
Idaho	908	60,641	1.5	Rhode Island	501	52,555	1.0
Illinois	11,961	715,239	1.7	South Carolina	861	181,345	0.5
Indiana	5,482	307,614	1.8	South Dakota	149	44,653	0.3
Iowa	1,498	164,409	0.9	Tennessee	1,188	286,877	0.4
Kansas	1,321	140,428	0.9	Texas	13,406	1,554,870	0.9
Kentucky	917	181,811	0.5	Utah	2,384	133,909	1.8
Louisiana	275	245,000	0.1	Vermont	363 i	28,635	1.3
Maine	314	53,244	0.6	Virginia	2,465	451,946	0.5
Maryland	2,665	336,365	0.8	Washington	13,996	402,535	3.5
Massachusetts	14,000	437,424	3.2	West Virginia	273	70,078	0.4
Michigan	14,409	431,680	3.3	Wisconsin	3,618	280,669	1.3
Minnesota	6,057	306,593	2.0	Wyoming	21 e	41,570	0.1
Mississippi	183 i	102,822	0.2	Undistributed ^a	10,120	na	na
Missouri	3,570	272,810	1.3				

e = estimated; $\geq 50\%$ of value is modeled—see technical notes of *Business R&D and Innovation: 2013* (<https://www.nsf.gov/statistics/industry/>) i = imputed; $\geq 50\%$ of the estimate is a combination of imputation and reweighting to account for nonresponse. na = not applicable.

GDP = gross domestic product for state.

^a Includes data reported on Form BRDI-1 that were not allocated to a specific state, as well as data reported on Form BRD-1(S) by multi-establishment companies. For single-establishment companies, data reported on Form BRD-1(S) were allocated to the state in the address used to mail the survey form.

NOTES: 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.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, and U.S. Census Bureau, Business R&D and Innovation Survey, 2013; GDP data are from the U.S. Bureau of Economic Analysis.

TABLE 2. Industry profile of top 10 states with the highest level of business R&D performed and paid for by companies from companies' own funds: 2013

State	R&D performed and paid for by the company (\$millions)	Largest R&D industry in region	Largest industry's share of state's R&D (%)	ICT industries' share of state's R&D (%)
United States	264,913	Pharmaceuticals and medicines (NAICS 3254)	17	46
California	76,851	Semiconductor and other electronic components (NAICS 3344)	20	67
Michigan	14,409	Automobiles, bodies, trailers, and parts (NAICS 3361–3363)	74	4
Massachusetts	14,000	Pharmaceuticals and medicines (NAICS 3254)	38	43
Washington	13,996	Software publishers (NAICS 5112)	62	75
Texas	13,406	Mining, extraction, and support activities (NAICS 21)	20	53
Illinois	11,961	Pharmaceuticals and medicines (NAICS 3254)	34	18
New Jersey	11,955	Pharmaceuticals and medicines (NAICS 3254)	53	18
Pennsylvania	10,001	Pharmaceuticals and medicines (NAICS 3254)	48	23
New York	9,456	Software publishers (NAICS 5112)	23	48
Minnesota	6,057	Medical equipment and supplies (NAICS 3391)	39	27

ICT = Information and communications technologies; NAICS = 2007 North American Industry Classification System.

NOTES: State and industry rankings are based on point estimates and do not take into account the variance of the survey sample. Industry classification is 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. Of the U.S. total, \$10,120 million could not be distributed to one of the 50 states or the District of Columbia. ICT manufacturing comprises NAICS 334 (computer and electronic products) and ICT services comprises NAICS 5112 (software publishers), NAICS 517 (telecommunications), NAICS 518 (data processing, hosting, and related services), NAICS 5415 (computer systems design and related services), and the remaining industries within NAICS 51 (information) other than traditional paper publishers.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, and U.S. Census Bureau, Business R&D and Innovation Survey, 2013; GDP data are from the U.S. Bureau of Economic Analysis.

the ICT industries as a group accounted for 53% of the state's R&D.

Due to its size, California is the largest state for many industries' R&D in the United States, including large R&D industries such as pharmaceuticals and medicines, semiconductor and other electronic components, and software publishers (table 3). Not only is the semiconductor and other electronic components industry the single largest in terms of R&D in California, but over half of the R&D performed by semiconductor companies in the United States is carried out in California. Few other industries have their R&D as geographically concentrated as the semiconductor and other electronic components industry. Among them are automobiles, bodies, trailers, and parts manufacturing (Michigan accounting for 76%); mining, extraction, and support activities (Texas accounting for 75%);

and semiconductor machinery (California accounting for 86%) (NSF/NCSES 2016).

Concentration of Self-Funded Business R&D within Metropolitan Areas

Businesses responding to BRDIS tend to concentrate their self-funded R&D performance in one geographic location. This finding is based on data reported by the subset of all BRDIS respondents identified at the time of sampling as having performed at least \$3 million of R&D in the United States in prior years (hereafter referred to as *large-R&D companies*).⁷ In 2013, about half of these large-R&D companies (2,946 of 5,717 companies) responded to questions in BRDIS asking for the address of their largest (primary) R&D location in the United States and the amount of R&D performed at that location. These responding companies accounted

for 72% of all R&D performed in the United States in 2013 that was paid for by the performing companies. Of the large-R&D companies that reported these data, 52% reported performing 100% of their U.S. R&D at their largest location, and 88% reported performing at least 50% at that location (figure 1).⁸ BRDIS also asks companies for information about their second-largest R&D location. Of the 2,849 large-R&D companies with estimated data about their second-largest location, 69% reported performing all of their U.S. R&D at their two largest locations, with 95% reporting performing at least 50% at these two locations (figure 1).

Data reported by large-R&D companies for their largest R&D location further illustrate the regional concentration of business R&D in the United States. The 10 most-frequently reported combined statistical areas (CSAs) or

TABLE 3. Domestic R&D performed and paid for by the companies, by select industry, by state: 2013
(Millions of dollars)

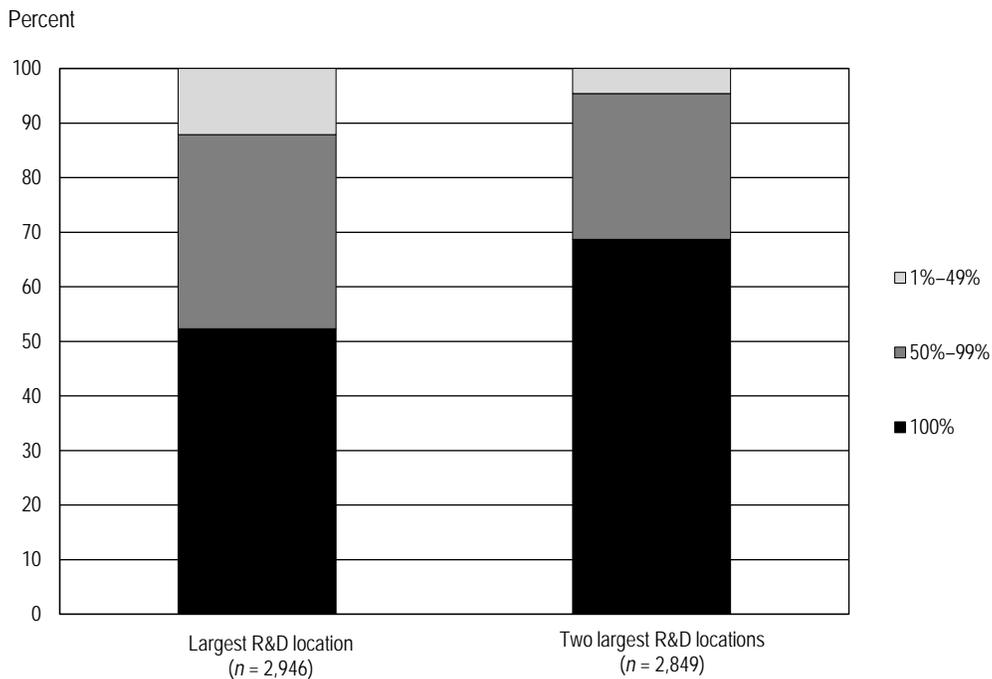
Industry	NAICS code	Total	Largest state for industry	Industry's R&D performed in largest state	
				\$millions	Percent
Aerospace products and parts	3364	10,042	Washington	2,028	20
Automobiles, bodies, trailers, and parts	3361, 3362, 3363	14,081	Michigan	10,708	76
Finance and insurance	52	4,298	Illinois	1,174	27
Food manufacturing	311	4,801	Delaware	1,003	21
Mining, extraction, and support activities	21	3,602	Texas	2,693	75
Other machinery	other 333	6,098	Illinois	1,638	27
Pharmaceuticals and medicines	3254	45,891	California	11,412	25
Semiconductor and other electronic components	3344	28,576	California	15,250	53
Semiconductor machinery	333295	3,097	California	2,658	86
Software publishers	5112	34,296	California	10,258	30

NAICS = 2007 North American Industry Classification System.

NOTES: Industry classification is 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.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, and U.S. Census Bureau, Business R&D and Innovation Survey, 2013.

FIGURE 1. Large-R&D companies, by share of U.S. R&D reported at largest R&D locations: 2013



NOTE: Data are for companies with known R&D activity and an estimated measure of size of at least \$3 million of R&D performed in the United States that reported their largest R&D location (column 1) and that reported their two largest R&D locations (column 2).

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, and U.S. Census Bureau, Business R&D and Innovation Survey, 2013.

metropolitan statistical areas (MSAs) accounted for over half of the primary R&D location reported by large-R&D companies (table 4).⁹

Large-R&D companies performed an estimated \$123 billion of R&D at their primary R&D location alone. Because companies tend to perform most—but not all—of their R&D at one location, the R&D reported at primary R&D location provides lower-bound estimates for business R&D performed in major metropolitan areas. The 26 geographic areas listed in table 4 were each home to the primary R&D location of at least 20 large-R&D companies, 2,205 companies in total. Together, these 26 areas account for over four-fifths of the R&D performed by large-R&D companies at their primary location.

The three geographic areas where the largest amount of R&D was performed by large-R&D companies at their primary R&D location were the San Jose-San Francisco-Oakland, Los Angeles-Long Beach, and Seattle-Tacoma-Olympia CSAs. The largest R&D industries represented in these areas vary, with San Jose-San Francisco-Oakland dominated by computer and electronic products manufacturers and Seattle-Tacoma-Olympia dominated by information technology and aerospace companies. Although the Los Angeles-Long Beach CSA is home to many large-R&D companies, no single industry accounts for a disproportionately large share of its R&D performance.

The San Jose-San Francisco-Oakland CSA, home to Silicon Valley, not only was the site with the highest level of R&D performance among large-R&D companies, but it also was the most commonly reported primary R&D location. The Boston-Worcester-Providence, New York-Newark, and Los Angeles-Long Beach CSAs were the next most commonly reported

TABLE 4. Business R&D performed and paid for by large-R&D companies at their largest R&D location, by geographic area: 2013

Combined statistical area or metropolitan statistical area	Companies reporting largest R&D location (number)	R&D performance at largest location (\$millions)
All locations	2,946	123,278
Atlanta-Athens-Clarke County-Sandy Springs, GA CSA	45	1,020
Austin-Round Rock, TX MSA	33	860
Boston-Worcester-Providence, MA-RI-NH CSA	240	6,108
Chicago-Naperville, IL-IN-WI CSA	115	2,297
Cleveland-Akron-Canton, OH CSA	36	676
Dallas-Fort Worth, TX CSA	44	1,291
Denver-Aurora, CO CSA	54	630
Detroit-Warren-Ann Arbor, MI CSA	93	9,382
Grand Rapids-Wyoming-Muskegon, MI CSA	26	310
Hartford-West Hartford, CT CSA	22	1,426
Houston-The Woodlands, TX CSA	60	1,972
Los Angeles-Long Beach, CA CSA	197	13,505
Miami-Fort Lauderdale-Port St. Lucie, FL CSA	22	684
Milwaukee-Racine-Waukesha, WI CSA	37	679
Minneapolis-St. Paul, MN-WI CSA	90	2,045
New York-Newark, NY-NJ-CT-PA CSA	209	7,913
Philadelphia-Reading-Camden, PA-NJ-DE-MD CSA	73	2,447
Phoenix-Mesa-Scottsdale, AZ MSA	31	1,038
Pittsburgh-New Castle-Weirton, PA-OH-WV CSA	38	462
Portland-Vancouver-Salem, OR-WA MSA	37	3,895
Raleigh-Durham-Chapel Hill, NC CSA	26	984
Salt Lake City-Provo-Orem, UT CSA	49	573
San Diego-Carlsbad, CA MSA	96	4,762
San Jose-San Francisco-Oakland, CA CSA	381	29,547
Seattle-Tacoma-Olympia, WA CSA	72	10,522
Washington-Baltimore-Arlington, DC-MD-VA-WV CSA	79	1,715
All other geographic areas reported as largest location	741	16,534

CSA = combined statistical area; MSA = metropolitan statistical area.

NOTES: R&D data are for companies known to have performed at least \$3 million of R&D in prior years that reported their largest R&D location. Only geographic areas where at least 20 companies report their largest location are listed.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, and U.S. Census Bureau, Business R&D and Innovation Survey, 2013.

areas. Like the Los Angeles-Long Beach CSA, the Boston-Worcester-Providence CSA is not dominated by a single company or industry in terms of R&D. The New York-Newark CSA is dominated by pharmaceutical and chemicals companies. A characteristic common to each of these CSAs, however, is that they are each home to multiple world-renowned research universities. These universities, along with large preexisting companies, may foster the creation of new R&D-performing companies in their locales

through technology transfer programs and the training and education of future company employees.

Business R&D Paid for by Others

BRDIS estimates of business R&D that is not paid for by the performing company itself but by others—such as customers, partners, and foreign affiliates of foreign-owned companies—show that this R&D is also geographically concentrated, although these estimates are less precise than

those for self-funded business R&D. Companies performed \$29 billion of R&D in the United States in 2013 that was funded by the federal government, of which \$25 billion can be attributed by BRDIS to a specific state. The five largest states in terms of federally funded business R&D (California, Connecticut, Maryland, New York, and Virginia) accounted for 55% of the federally funded business R&D that could be attributed by BRDIS to a specific state. Companies performed \$28 billion of R&D in the United States in 2013 that was paid for by other nonfederal organizations, of which \$26 billion can be attributed by BRDIS to a specific state. The five largest states by this measure (California, Massachusetts, New Jersey, North Carolina, and Ohio) accounted for 51% of the business R&D paid for by other nonfederal organizations that could be attributed by BRDIS to a specific state.¹⁰

Data Sources and Limitations

The sample for BRDIS was selected to represent all for-profit, nonfarm companies that are publicly or privately held and have five or more employees in the United States. Estimates produced from the survey and presented in this InfoBrief are restricted to companies that perform or fund R&D, either domestically or abroad. Because the statistics from the survey are based on a sample, they are subject to both sampling and nonsampling errors (see technical notes in the survey's detailed statistical tables at <http://www.nsf.gov/statistics/industry/>).

In this InfoBrief, money amounts are expressed in current U.S. dollars and are not adjusted for inflation. Company is defined as a business organization located in the United States, either U.S. owned or a U.S. affiliate of a foreign parent, of one or more establishments under common ownership or control.

For 2013, a total of 45,089 companies were sampled, representing 1,971,959 companies. The actual numbers of reporting units in the sample that remained within the scope of the survey between sample selection and tabulation were 41,588 for 2013. Reasons for the reduced counts include mergers, acquisitions, and instances where companies had fewer than five paid employees in the United States or had gone out of business in the interim. Of these in-scope reporting units, 73.6% met the 2013 survey response criteria. Industry classification was based on the dominant business activity for domestic R&D performance where available.

In 2013, the following could not be assigned to a specific state location: 4% of U.S. business R&D paid for and performed by the same companies, 14% of U.S. business R&D paid for by the federal government and performed by companies, and 7% of U.S. R&D paid for by nonfederal organizations other than the performing company. Therefore, state R&D data provided here are lower-bound estimates. Data on R&D paid for by others for the state of Missouri, which are withheld to avoid disclosing operations of individual companies, are also included in these undistributed R&D totals. State and industry rankings are based on point estimates and do not take into account the variance of the survey sample. Data presented here for metropolitan areas are from a subset of companies in the survey sample (companies known to have performed \$3 million or more of R&D in the United States in any of the four years preceding 2013) and therefore are lower-bound estimates of the total business R&D in these areas.

BRDIS estimates of federally funded business R&D had an imputation rate of 40% in 2013. Some estimates of federally funded business R&D for

specific states—including California—have imputation rates exceeding 50%.

For this InfoBrief, estimates for R&D at companies' largest locations represent only the amounts for companies responding to the item. No estimation has been made to correct for item nonresponse or for R&D performed at these locations as nonprimary locations. Further, the totals reported here for largest R&D locations do not include R&D performed by these companies that is paid for by others.

The full set of detailed tables from this survey, including R&D estimates for each state by industry, are available in the report *Business R&D and Innovation: 2013* (<http://www.nsf.gov/statistics/industry/>). For further information concerning BRDIS or to request tables with relative standard errors and imputation rates, please see the author endnote for contact information.

Notes

1. Brandon Shackelford is the owner of Twin Ravens Consulting, Austin, TX. For more information on this report, contact Raymond Wolfe, Research and Development Statistics Program, National Center for Science and Engineering Statistics, National Science Foundation, 4201 Wilson Boulevard, Suite 965, Arlington, VA 22230 (rwolfe@nsf.gov; 703-292-7789).

2. R&D reported on Form BRDI-1 that is not allocated to a specific state and R&D reported on Form BRDI-1(S) by multi-establishment companies are reported as undistributed in BRDIS data tables. This undistributed amount is company R&D performed in one of the 50 states or the District of Columbia, but where the specific location is not estimated by BRDIS. This InfoBrief does not include this undistributed amount when calculating state shares of total U.S. R&D.

3. The largest states in 2013 in terms of both GDP and population were California, Florida, Illinois, New York, and Texas. GDP estimates are from the U.S. Bureau of Economic Analysis and population estimates from the U.S. Census Bureau.

4. Industry concentration was determined based on data from the U.S. Census Bureau 2012 Economic Census.

5. For this InfoBrief the term industry may refer to different levels of detail of the North American Industrial Classification System (NAICS). In some cases BRDIS publishes R&D data down to a 6-digit NAICS level (such as for semiconductor equipment manufacturing), but in other cases, no detail is available below a 2-digit NAICS level (such as for mining, extraction, and support).

6. For this InfoBrief the ICT sector is defined as the sum of ICT manufacturing, which comprises NAICS 334 (computer and electronic products), and ICT services, which comprises NAICS 5112 (software publishers), NAICS 517 (telecommunications), NAICS 518 (data processing, hosting, and related services), NAICS 5415 (computer systems design and related services), and the remaining industries within

NAICS 51 (information) other than traditional paper publishers (Shackelford and Jankowski 2016).

7. Based on the likelihood of these companies having R&D, these large-R&D companies were selected with certainty for the 2013 BRDIS sample with sample weights equal to 1. These companies account for the majority of R&D performed by businesses in the United States.

8. This concentration is less pronounced among the very largest R&D performers, but most of these companies still report performing the majority of their U.S. R&D at their primary location.

9. CSAs are defined by the Office of Management and Budget as groups of adjacent core based statistical areas that are linked by commuting ties (<https://www.whitehouse.gov/sites/default/files/omb/bulletins/2015/15-01.pdf>). Some large MSAs—such as San Diego-Carlsbad, Portland-Vancouver-Salem, and Austin-Round Rock—are not part of a defined CSA. For the purpose of this InfoBrief these MSAs are treated as equivalent to a CSA.

10. State-level data for business R&D paid for by organizations other than the

performing company are available in table 22 of *Business R&D and Innovation: 2013* (NSF/NCSES 2016).

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