

TOP R&D-PERFORMING STATES DISPLAY DIVERSE R&D PATTERNS IN 2000

by Brandon Shackelford

Although research and development (R&D) expenditures are concentrated in relatively few states, patterns of R&D activities vary considerably among the top R&D-performing locations. In 2000, total U.S. R&D expenditures were \$265 billion, of which \$247 billion could be attributed to expenditures within individual states with the remainder falling under an undistributed “other/unknown” category. The statistics and discussion in this InfoBrief refer to state R&D levels in relation to the distributed total of \$247 billion. These totals include R&D performed by industry, universities, federal agencies, and nonprofit organizations.¹

Distribution of R&D Expenditures Among States

In 2000, the 20 highest ranking states in R&D expenditures accounted for 87 percent of the U.S. total, while the lowest ranking 20 states accounted for only 4 percent. The six states with the highest levels of R&D expenditures—California, Michigan, New York, New Jersey, Massachusetts, and Illinois (in decreasing order of magnitude)—accounted for one-half of the entire national effort. Adding (in descending order) Texas, Washington, Pennsylvania, and Maryland, the top 10 states accounted for two-thirds (table 1). As in prior years, California had the highest level of R&D expenditures in the Nation (\$55 billion); it alone accounted for over one-fifth of the \$247 billion U.S. R&D total. California’s R&D effort exceeded by nearly a factor of three that of the next highest state, Michigan, with

¹R&D performance refers to the sector that does the work regardless of the funding source, as distinguished from the sector that funds the R&D activity.

nearly \$19 billion in R&D expenditures. After Michigan, R&D levels for the top 10 states declined incrementally to \$8.6 billion for Maryland.²

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Ratio of R&D to Gross State Product

States vary significantly in the size of their economies, owing to differences in population, land area, infrastructure, natural resources, and history. Consequently, variations in the R&D expenditure levels of states may simply reflect differences in economic size or the nature of their R&D efforts. One way of controlling for the size of each state’s economy is to measure each state’s R&D level as a percentage of its gross state product (GSP).³ That percentage is referred to as R&D intensity or concentration.

²Reliability of the estimates of industry R&D varies by state because the sample for the NSF Survey of Research and Development in Industry was not based on geography. Rankings do not take into account the margin of error of estimates from sample surveys.

³GSP is often considered the state counterpart of the nation’s GDP (gross domestic product). GSP is estimated by summing the “value added” of each industry in a state. Value added for an industry is equivalent to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other U.S. industries or imported). (Source: <http://www.bea.gov/bea/newsrel/gspnewsrelease.htm>).



Table 1. Leading states in total R&D performance, R&D by sector, and R&D as a percentage of gross state product: 2000

Rank	Top 10 states in total R&D performance ¹		Top 10 states in size of R&D, by type of performer			Top 10 states in R&D intensity (states with the highest R&D/GSP ratio)		
	State	Total R&D (millions of current dollars)	Industry ²	Universities & colleges ³	Federal Government ⁴	State	R&D/GSP (percent)	GSP (billions of current dollars)
1	California	55,093	California	California	Maryland	Michigan	5.81	325.4
2	Michigan	18,892	Michigan	New York	District of Columbia	New Mexico	5.68	54.4
3	New York	13,556	New Jersey	Texas	California	Washington	4.78	219.9
4	New Jersey	13,133	Illinois	Pennsylvania	Virginia	Maryland	4.64	186.1
5	Massachusetts	13,004	New York	Maryland	Alabama	Massachusetts	4.56	284.9
6	Illinois	12,767	Massachusetts	Massachusetts	Ohio	Delaware	4.22	36.3
7	Texas	11,552	Washington	Illinois	Florida	Rhode Island	4.12	36.5
8	Washington	10,516	Texas	North Carolina	Texas	California	4.10	1,344.6
9	Pennsylvania	9,842	Pennsylvania	Michigan	New Jersey	Idaho	3.87	37.0
10	Maryland	8,634	Ohio	Georgia	New Mexico	District of Columbia	3.87	59.4

¹Includes in-state total R&D performance of industry, universities, Federal agencies, FFRDCs, and federally financed nonprofit R&D.

²Includes R&D activities of industry-administered FFRDCs located within these states.

³Excludes R&D activities of university-administered FFRDCs located within these states.

⁴Includes costs associated with the administration of intramural and extramural programs by Federal personnel as well as actual intramural performance.

KEY: R&D = research and development; GSP = gross state product; FFRDC = federally funded research and development center.

NOTES: Reliability of the estimates of industry R&D varies by state because the sample allocation was not based on geography. Rankings do not take into account the margin of error of estimates from sample surveys.

SOURCE: National Science Foundation/Division of Science Resources Statistics, *National Patterns of R&D Resources*, annual series; GSP data are from the U.S. Bureau of Economic Analysis.

Overall, the Nation's ratio of total R&D to gross domestic product was 2.69 percent in 2000. The top 10 rankings for state R&D intensity in 2000 were, in descending order, Michigan (5.81 percent), New Mexico, Washington, Maryland, Massachusetts, Delaware, Rhode Island, California, Idaho, and the District of Columbia (3.87 percent). Each of the 10 states with the highest R&D intensity levels in 2000 was also among the top 10 states in R&D intensity in 1998 and 1999. New Mexico's high R&D intensity is largely attributable to Federal (specifically Department of Energy) support of two federally funded research and development centers (FFRDCs), Los Alamos National Laboratory and Sandia National Laboratories.

According to the U.S. Bureau of Economic Analysis, real GSP for the nation⁴ grew at an annual rate of 4.5

⁴GSP for the nation is the sum of all the states' GSPs. GSP for the nation differs from GDP, however, in part because GSP excludes and GDP includes the compensation of federal civilian and military personnel stationed abroad and government consumption of fixed capital for military structures located abroad and for military equipment, except office equipment. (Source: <http://www.bea.gov/beat/newsrel/gspnewsrelease.htm>).

percent from 1999 to 2000. Six of the 10 states with the fastest growth in real GSP from 1999 to 2000 also rank among the top 10 in either total R&D performance (California, New York, Massachusetts, and New Jersey) or R&D intensity (Massachusetts, Rhode Island, California, and Idaho) for 2000.

Sector Distribution of R&D Performance by State

Although leading states in total R&D tend to be well represented in each of the major R&D-performing sectors, the relative shares of each state's R&D performed by these sectors varies. States that are national leaders in total R&D performance are also usually leaders in terms of R&D performance by the industrial sector, which is not surprising because industry-performed R&D accounts for 77 percent of the distributed U.S. total. Thus, 9 of the top 10 states for total R&D (all but Maryland) were among the leading industrial R&D-performing states; Ohio rounded out the list of top 10 industrial R&D states in 2000. Although university-performed R&D accounts for only 12 percent of the U.S. total, it is also highly

correlated with the total R&D performance in a state (table 2). The top 10 states in university-performed R&D include the top 10 states in total R&D except that North Carolina and Georgia replace New Jersey and Washington.

There was less overlap between the top 10 states for total R&D and those states with the most Federal-performed R&D.⁵ Only four states are in both top 10 lists: Maryland, California, Texas, and New Jersey. The six additions to the Federal intramural top 10, in descending order of Federal R&D performance, were the District of Columbia, Virginia, Alabama, Ohio, Florida, and New Mexico. Maryland ranked first in Federal R&D performance, followed by the District of Columbia, California, and Virginia. The inclusion of Maryland, Virginia, and the District of Columbia in the top-four ranking reflects the concentration of Federal facilities and administrative offices within the national

capital area. Alabama, Florida, and New Mexico rank among the highest in Federal R&D because of their relatively high shares of Federal space- and defense-related R&D.

Industry R&D in Top States

The types of companies that carry out R&D vary considerably among the 10 leading states in industry-performed R&D (table 3). Nationally, 62 percent of total industry R&D is performed in manufacturing industries. Michigan has a higher share of its industry R&D accounted for by manufacturing industries (89 percent), which can largely be attributed to the state's high concentration of automotive design and manufacturing. The transportation equipment industry accounts for 15 percent of the nation's total industry R&D but accounts for 73 percent of the industry R&D in Michigan. Washington has less of its industry R&D concentrated in manufacturing industries than the nation as a whole with a manufacturing share of 33 percent. Companies in Washington performed over \$6 billion of nonmanufacturing R&D in 2000, a large portion of which can be attributed to software research and development.

At a more detailed level, clusters of industrial R&D activity are apparent in the top 10 states in industry R&D. The computer and electronic products industry accounts for 23 percent of the nation's total industry R&D but accounts for a larger share of the industry R&D in California (36 percent), Massachusetts (43 percent), and Texas (42 percent). These three states have clearly defined regional centers of high-technology research and manufacturing: Silicon Valley in California, Route 128 in Massachusetts, and the Silicon Hills of Austin in Texas. The chemicals industry accounts for 10 percent of the nation's total industry R&D but accounts for much more of the industry R&D in New Jersey (25 percent) and Pennsylvania (33 percent). Chemicals is the largest single manufacturing industry in both New Jersey and Pennsylvania, and both of these states are home to a number of large pharmaceutical and chemical-manufacturing companies.

Variation among the top 10 states in industry R&D is also evident in terms of the relative R&D performance of small and large companies in the state. For the purpose of this analysis a small company is defined as

Table 2. Correlations coefficients among state R&D components: 2000

Component	Total R&D ¹	Federal intramural R&D ²	Total industry R&D ³	Total university R&D ⁴
Total R&D	1.0000	0.3343	0.9923	0.8937
Federal intramural R&D	0.3343	1.0000	0.2284	0.4042
Total industry R&D	0.9923	0.2284	1.0000	0.8569
Total university R&D	0.8937	0.4042	0.8569	1.0000

¹Includes in-state total R&D performance of industry, universities, Federal agencies, FFRDCs, and federally financed nonprofit R&D.

²Includes costs associated with the administration of intramural and extramural programs by Federal personnel as well as actual intramural performance.

³Includes R&D activities of industry-administered FFRDCs located within states.

⁴Excludes R&D activities of university-administered FFRDCs located within states.

KEY: FFRDC = federally funded research and development center; R&D = research and development.

NOTES: Reliability of the estimates of industry R&D varies by state because the sample allocation was not based on geography.

SOURCE: National Science Foundation/Division of Science Resources Statistics, *National Patterns of R&D Resources*, annual series.

⁵Federal-performed R&D includes costs associated with the administration of intramural and extramural programs by Federal personnel as well as actual intramural performance.

Table 3. Leading states in Industry R&D performance, shares of R&D by select industry and size of company: 2000

Rank	Top 10 states in industry R&D performance		Share of total industry-performed R&D in state						
	State	Industry-performed R&D (millions of current dollars) ¹	Manufacturing industries				Professional, scientific, and technical services	Size of company	
			Total	Computer and electronic products	Transportation equipment	Chemicals		5-499 employees	500 or more employees
			(Percent)						
	U.S. Total	199,539	62.2	22.6	15.1	10.5	11.3	17.9	82.1
1	California	45,769	54.1	36.0	7.0	2.9	18.0	27.0	73.0
2	Michigan	17,640	88.9	2.0	73.4	6.5	4.7	8.7	91.3
3	New Jersey	12,062	61.9	27.6	1.0	25.1	5.6	25.8	74.2
4	Illinois	10,661	59.8	26.6	2.5	17.0	2.7	4.0	96.0
5	New York	10,539	65.6	16.4	14.7	18.7	3.7	12.6	87.4
6	Massachusetts	9,863	59.7	43.5	(D)	7.7	21.0	20.9	79.1
7	Washington	9,265	32.9	5.7	(D)	(D)	11.4	9.1	90.9
8	Texas	8,961	58.3	42.2	1.5	5.3	7.0	14.9	85.1
9	Pennsylvania	7,873	68.5	14.6	4.5	32.9	7.2	13.4	86.6
10	Ohio	5,962	65.6	3.0	7.9	(D)	20.1	16.6	83.4
	All other states	60,946	64.7	17.1	14.5	12.0	10.9	17.4	82.6

¹Includes company and federally financed R&D activities and R&D activities of industry-administered FFRDCs located within these states.

KEY: FFRDC = federally funded research and development center.
(D) = Data have been withheld to avoid disclosing operations of individual companies.

NOTES: Reliability of the estimates of industry R&D varies by state because the sample allocation was not based on geography. Rankings do not take into account the margin of error of estimates from sample surveys.

SOURCE: National Science Foundation/Division of Science Resources Statistics, Survey of Industrial Research and Development: 2000

having from 5 to 499 employees.⁶ Nationally these small companies perform 18 percent of the nation’s total industry R&D, but in three of the top 10 states small companies perform a much greater share of industry R&D. Small companies perform 27 percent of California’s, 26 percent of New Jersey’s, and 21 percent of Massachusetts’s industrial R&D. In contrast with these states, small companies perform a much smaller share of industry R&D in Michigan (9 percent), Illinois (4 percent), and Washington (9 percent).

⁶For most manufacturing industries, the U.S. Small Business Association has established a size standard of 500 employees. The NSF Survey of Research and Development in Industry does not sample companies with fewer than five employees due to concerns over respondent burden.

User Notes

NSF’s Division of Science Resources Statistics (SRS) collects and analyzes statistics on the geographic distribution of R&D expenditures in the United States among the 50 states, the District of Columbia, and Puerto Rico. The data are categorized by type of performer (industry, Federal Government, academia, FFRDCs, and other nonprofit organizations) and by source of funds (industry and Federal Government, and for university performers only, state government, academia, and other nonprofit organizations).⁷ The amounts of R&D funding from specific Federal agencies are also provided.

⁷Data on industry R&D—and therefore on total R&D—performance are not available for Puerto Rico.

In addition to these state R&D statistics, SRS collects state-specific data in its surveys of science and engineering (S&E) personnel and institutions. These data and those assembled from non-SRS sources (e.g., data on population, patents, and GSP) are included in a set of 52 one-page S&E state profiles available at <http://www.nsf.gov/sbe/srs/sepro/start.htm>.

Data on U.S. and state R&D expenditures were assembled from ongoing NSF surveys. For information

on U.S. and state R&D, please contact—

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