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GREATER NEW ORLEANS ECONOMIC DATA CENTER

Prepared by Dr. Raymond J. Brady, Systems Solutions Consulting

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R&D EXPENDITURES: LOUISIANA AND COMPARATIVE SOUTHERN STATES 2017-2021

DEFINITIONS:

- **Gross output** is a measure of sales/revenue generated from production and includes the value of goods and services purchased by industries for use in production (intermediate inputs) and the value of goods and services purchased by final users, including industries' own-account investment. This measure of output double-counts industry output because it includes output that is purchased by other industries for use as intermediate inputs.

- **Value added** is the difference between gross output and intermediate inputs and largely represents the value of labor and capital in the production of gross output. The sum of value added across all industries equals GDP.

- **R&D value added** consists of the value that an industry generates as part of R&D production after it has accounted for its costs of energy, materials, and services used up in R&D production.

- **R&D employment** consists of all full-time, part-time, and temporary wage and salary jobs in which workers are engaged in the production of R&D. Self-employed individuals are not included. R&D workers include researchers, R&D technicians, and other R&D support staff.

The measures of R&D value added and employment above account for both the R&D that is performed in-house for internal use (own-account R&D) and the R&D performed for and funded by others**. The definition of research and experimental development (R&D) encompasses basic research, applied research and experimental development.**

THE IMPORTANT OF R&D IN STATE GDP GROWTH

Why report R&D employment, value added, and value added per employee or researcher in each select state in the South? R&D is a critical underpinning of a high growth economy. It spurs innovation and improves efficiency in terms of the delivery of outcomes. This working paper does not present any conclusions, but as working papers 1 through 3, lays out the data as presented. However, the specific purpose of this working paper, as are the other working papers in this series, is to focus on Louisiana, and its progress or lack thereof in economic development.

OVERVIEW

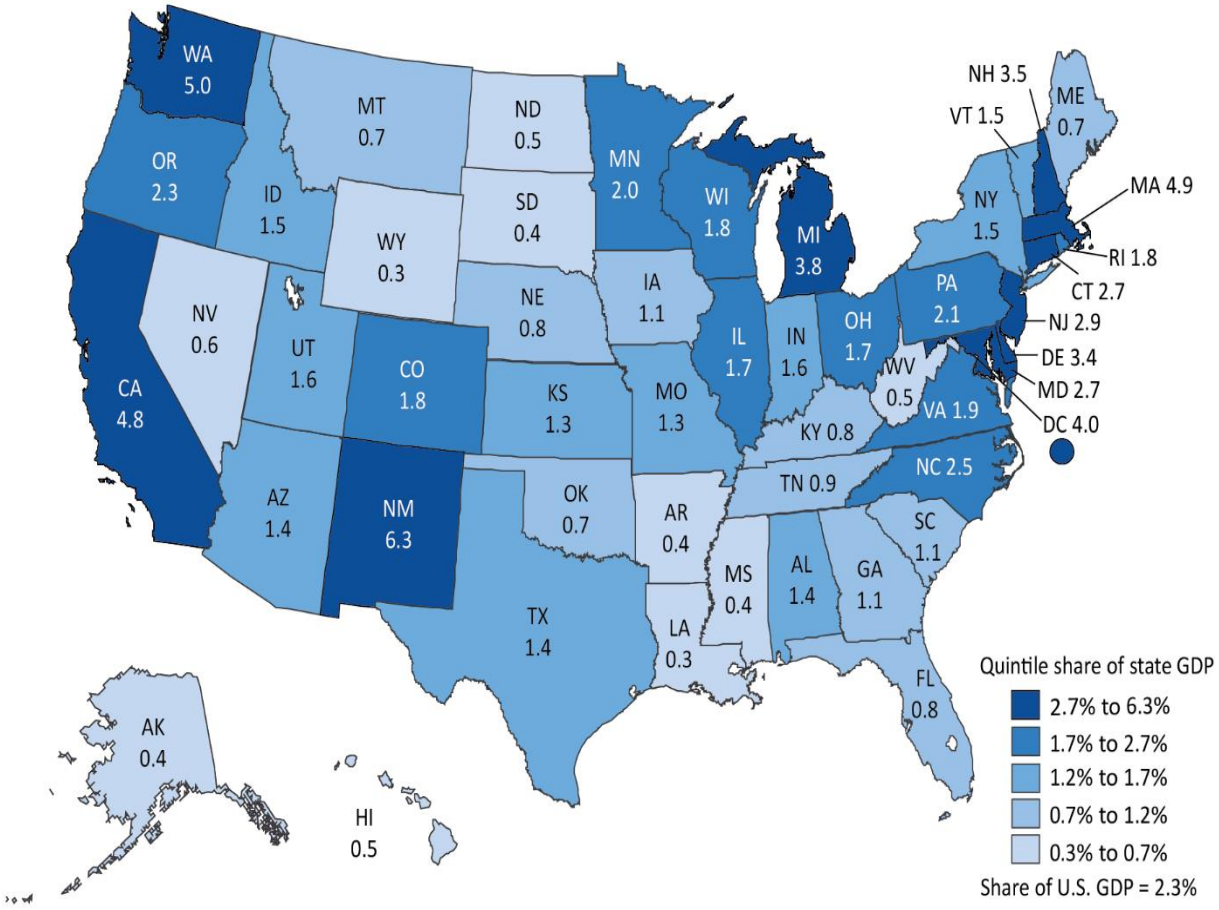
This data is produced by the Bureau of Economic Analysis (BEA) Research Division. The most current data series covers the period 2017 to 2021 (released May 9, 2024). The data covers eleven Southern states. The appendix contains a detailed discussion of sources and assignments of research and development dollar values. BEA Satellite Account Program created a structure of eight categories of R&D, as a place set for data presentation. Table 1 identifies these categories.

Values are presented in the context of total employment, valued added in current dollars and value added per employee or researcher. Rankings, created by *Systems* Solutions Consulting, are presented in the context of each subject area.

Chart 1 presents the 2021 R&D valued-added share fraction of state GDP for the year 2021. Just as a note of caution, the share values can be heavily influenced by the presence of major Federal Government research facilities. For example, New Mexico has the highest fraction of all states in the union primarily because of the importance of U.S. Department of Energy research facilities distributed throughout the state. Hence, 86% of the total R&D expenditures in the state are in professional, scientific and technical services, heavily influenced by the U.S. Department of Energy research facilities.

Chart 1

Research and Development Value Added: Share of State GDP, 2021



U.S. Bureau of Economic Analysis

Where possible, the author will attempt to identify these potential anomalies when looking at the Southern states.

Table 1

RESEARCH AND DEVELOPMENT[1]
Private
Business
Manufacturing
Nonmanufacturing
Universities and colleges[2]
Other nonprofit institutions
Higher education institutions[3]
1. Research and development (R&D) activity is measured by location of R&D production (performance), which is not necessarily the location of the R&D funder.
2. Consists of private universities and colleges only.
3. Consists of public and private nonprofit universities and colleges. Private for-profit universities and colleges are included in business.

Source: Bureau of Economic Analysis, Satellite Account Program

Table 2 identifies the total number of jobs in R&D by state for the year 2021 and ranking in terms of the number of jobs. Texas's rank illustrates the concentration of oil and gas research facilities, the importance of high tech and finance in the state. Virginia, on the other hand, is heavily influenced by the presence of defense industries. Louisiana, Arkansas and Mississippi simply drop off the scale in relative terms with respect to R&D jobs. In the state economies, Alabama is heavily influenced by the NASA and other research facilities in Huntsville.

Table 2

2021 Research and Development Jobs by State and Rank in Thousands of Jobs	
Texas	183.7
Virginia	121.1
North Carolina	89.6
Florida	88.9
Georgia	54.2
Tennessee	37.1
Alabama	32.0
South Carolina	22.0
Louisiana	**8.6**
Arkansas	7.7
Mississippi	7.2

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking, *Systems* Solution Consulting

Table 3 looks at the importance of Research and Development expenditures as a fraction of the GDP in 2021 and in each select state. In 2021 and in Texas, R&D expenditures contributed 1.4% to the state GDP in current dollars. For North Carolina, that fraction was 2.5%, and in Louisiana, R&D expenditures contributed 0.03% to the state GDP.

Table 3

Research and Development 2021 Value Added in Millions of Dollars by Rank	
Texas	29,887.8
North Carolina	16,349.4
Virginia	11,900.2
Florida	10,447.7
Georgia	7,479.9
Tennessee	3,816.4
Alabama	3,625.3
South Carolina	2,872.9
Louisiana	**906.0**
Arkansas	635.4
Mississippi	544.8

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking, *Systems* Solution Consulting

Table 4 ranks the percentage and absolute value change in R&D value added per employee or researcher over all components found in Table 1 in the states within the survey area.

Table 4

Ranking of Research and Development Value Added per Employee Growth in Current Dollars			
2017-2021			
	% Change		Value-Added Increase
North Carolina	23.3%	North Carolina	$34,463
South Carolina	19.1%	South Carolina	$20,926
Virginia	16.8%	Texas	$20,589
Mississippi	16.1%	Alabama	$15,682
Alabama	16.1%	Florida	$14,587
Texas	14.5%	Virginia	$14,140
Florida	14.2%	Tennessee	$11,486
Tennessee	12.6%	Mississippi	$10,487
Louisiana	**8.7%**	Georgia	$9,201
Georgia	7.1%	**Louisiana**	**$8,456**
Arkansas	4.0%	Arkansas	$3,191

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking, *Systems* Solution Consulting

Table 4 provides insight into the structure of each state's economy since R&D value added growth focuses on the process of generating new knowledge to create a novel product, service, or method. For example, comparing Norh Carolina and Louisiana real growth (2017 chained $) in Professional, Scientific and Technical Services shows that Louisiana's Professional, Scientific and Technical Services **contracted by 3.9% over** the 2017 to 2021 period. Whereas in North Carolina, the sector's real (inflation adjusted) growth **increased** by 39.7%.

As a result of this difference, the 2021 real dollar value of output in Professional, Scientific and Technical Services in North Carolina was 4.1 times greater than in Louisiana. One might hypothesize that Louisiana's economy has (overall) evolved during this short period of time into a less scientific economy and into more of a service economy structure producing less value added and wealth. As a note of caution, any statistic that deals with change is heavily influenced by the base value, and a closer look at more details further on in this working paper might not support this generalization.

Table 5

2021			
	Total R&D Total Value-Added per Employee	**Total Business Value Added per Employee**	
North Carolina	$182,471	North Carolina	$209,094
Texas	$162,699	Texas	$182,835
Georgia	$138,006	Virginia	$157,900
South Carolina	$130,586	Georgia	$157,823
Florida	$117,522	South Carolina	$145,945
Alabama	$113,291	Florida	$139,471
Louisiana	**$105,349**	Tennessee	$132,981
Tennessee	$102,868	Alabama	$125,145
Virginia	$98,268	**Louisiana**	**$122,200**
Arkansas	$82,519	Arkansas	$96,053
Mississippi	$75,667	Mississippi	$89,667

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking by *Systems* Solution Consulting

Table 6 is also an insightful table with respect to R&D in manufacturing (Total Business) because it indirectly highlights the overall type of manufacturing activity by state. States with high R&D value added in manufacturing per employee (such as North Carolina) contain industries with high innovation, market adaptability and high productivity (for example, pharmaceuticals). Louisiana's manufacturing is dominated by petrochemicals or other types of manufacturing which primarily serve produce outputs that serve as inputs to higher value-added industries.

Table 6

Rank of Research and Development Value Added Expenditures in Manufacturing in Millions of Dollars in 2021 by State	
Texas	9,848.4
North Carolina	4,007.7
Florida	2,971.1
Georgia	1,782.0
Virginia	1,572.1
Alabama	920.7
South Carolina	601.9
Tennessee	372.5
Louisiana	**194.9**
Arkansas	162.0
Mississippi	95.0

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking by *Systems* Solution Consulting

As Table 7 illustrates, even Louisiana's chemical industry structure primarily functions *as feedstock* to other industries requiring R&D value-added to the product output. On the other hand, the chemical industry in North Carolina produces an R&D value added that is 33 times greater than Louisiana. The chemical manufacturing industry in North Carolina encompasses an array of companies, such as pharmaceuticals, IT, construction materials and food processing. Many of these companies produce *end products* that require high R&D expenditures linked to high value-added outputs.

Table 7

Rank of Research and Development Value Added Expenditures in Chemical Manufacturing in Millions of Dollars in 2021	
North Carolina	1,783.0
Texas	1,293.8
Florida	495.4
Georgia	419.9
Virginia	287.9
South Carolina	170.8
Alabama	99.6
Tennessee	80.4
Louisiana	**54.0**
Arkansas	37.8

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking by *Systems* Solution Consulting

Table 8 focuses on private and public universities that contribute to R&D value added in selected states.

Table 8

Rank of Public and Private Higher Education Institutions by R&D Value Added in Millions of Dollars in 2021		Rank of Private Higher Education Institutions by R&D Value Added in Millions of Dollars in 2021	
Texas	3,401.5	North Carolina	605.4
North Carolina	1,565.3	Texas	504.5
Georgia	1,498.7	Georgia	447.7
Florida	1,493.3	Tennessee	348.8
Virginia	897.4	Florida	209.7
Tennessee	703.1	**Louisiana**	**85.3**
Alabama	636.3	Virginia	83.2
South Carolina	415.9	Alabama	(L)
Louisiana	**378.7**	Arkansas	(L)
Mississippi	267.4	Mississippi	(L)
Arkansas	218.6	South Carolina	(L)

Source: Satellite Account Program, Bureau of Economic Analysis; Ranking by *Systems* Solution Consulting

(L) Less than $20 million for value added, less than $20 million for compensation, and less than 500 jobs for employment.

Universities are a major contributor to statewide level of R&D value added and can significantly affect the economic development of an area. Just focusing on Louisiana, Public Higher Education is the sum of all public and private higher education institutions. Private higher education almost totally focuses on Tulane University.

Appendix

(This paper is produced by BEA)

Regional R&D Satellite Account: Concepts, Data, and Methods for Preparing Preliminary R&D Production by State Statistics

May 2023

Introduction

The U.S. Bureau of Economic Analysis (BEA), in partnership with the National Science Foundation's (NSF's) National Center for Science and Engineering Statistics (NCSES), is developing a new satellite account to track the regional distribution of research and development (R&D) production and investment and the contribution of the R&D sector to regional economies. This account represents a continuation of both agencies' efforts to expand and improve measures of economic activity related to R&D. This document outlines relevant concepts, data and methods used to prepare an initial set of R&D production by state statistics for this account.

BEA's satellite accounts are supplemental accounts that, while linked to BEA's core accounts, expand their analytical capability by exploring new concepts and methodologies and providing enhanced, complementary statistics that focus on a particular aspect of the economy. Satellite accounts provide additional data for more in-depth analyses of key sectors of the U.S. economy and are particularly useful to measure economic activity that is spread across multiple industries as defined by the standard industry classification system—the North American Industry Classification System (NAICS)—which is used for BEA's official statistics. BEA publishes several satellite accounts, including two satellite accounts—arts and culture production and outdoor recreation—that have a regional component.

The regional R&D satellite account measures the economic activity associated with R&D production and investment in each state. It presents national statistics on R&D value added, compensation, and employment by R&D performing sector and provides new state-level statistics on each of these measures.[1] These statistics can be used to show the contribution of individual industries to R&D production and the contribution of the R&D sector to the national economy and each state's economy. With this satellite account, BEA will also refine and improve its measures of R&D investment by state that are incorporated in GDP by state.[2]

Like other satellite accounts, the statistics developed in this account do not change the official U.S. economic statistics that BEA produces, because the R&D economic activity is already captured in BEA's core statistics, including national and regional data on GDP, employment, and compensation.

[1] The national R&D production statistics represent a rearrangement of existing data in the supply-use tables that isolates production of the R&D commodity by the scientific R&D services industry (NAICS 5417) and all other industries that perform R&D.

[2] BEA prepares but does not currently publish R&D investment by state statistics. These statistics are incorporated in the estimation of GDP by state and rely on a choice of assumptions, particularly about the location of the industries that purchase R&D output (see "GDP by State Estimation Methodology" for more details). This satellite account will revisit these assumptions and publish estimates of R&D investment by state.

For this purpose, all data elements associated with R&D activity in the core accounts are rearranged and combined using the framework used to estimate GDP.

The advantage of constructing an R&D account within this framework is that the overall R&D activity can be compared to GDP for the nation and for each state both in terms of levels (i.e., R&D as a percentage of GDP) as well as change (i.e., whether GDP for the R&D sector is increasing faster or slower than the overall national or state economy). R&D economic activity can also be directly compared to the economic activity of NAICS-defined sectors such as mining, construction, utilities, chemical manufacturing, accommodation, and food services. Another important advantage of this framework is that the contribution of the R&D sector is also measured in terms of the number of jobs supported by R&D activities and the compensation for R&D-related work.

BEA's First R&D Satellite Account

The regional R&D satellite account builds on nearly two decades of collaborative work between BEA and NSF that laid out the foundation for BEA to expand its asset boundary within its core accounts by recognizing R&D expenditures as investment. This work began with a satellite account that served as a testing ground for R&D investment as a new concept—R&D expenditures were initially treated as a current expense and not included in GDP—and provided a means to explore the effect of this change and a framework to examine various methodological and conceptual issues, such as how to measure R&D output and investment or changes in R&D prices.

BEA published its first R&D satellite account (R&DSA) in 1994.[3] This account provided a set of definitions for what is considered investment under the national income accounting rules and a methodology to estimate GDP that included R&D spending as investment. Work on this account was extended with the 2002 R&DSA, which adjusted the structure of the national accounts to include R&D investment and provided an approach to assess its impact on GDP, gross domestic income (GDI), and savings.[4] The 2006 update of R&DSA extended prior efforts to assess the impact of R&D by varying assumptions about price indexes, depreciation, and rates of return and introduced investment flows and stocks of R&D assets.[5] In 2007 several enhancements were introduced in the R&DSA including initial assessments of the industry, regional, and international aspects of the new treatment of R&D.[6] In 2010, the R&DSA was updated one last time, and most of the improvements related to the estimates of R&D investment by industry.

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[3] See Carol Carson, Carol Moylan, and Bruce Grimm. "A Satellite Account for Research and Development," Survey of Current Business, November 1994: 37–71.

[4] See Fraumeni and Okubo, "R&D in the National Income and Product Accounts: A First Look at Its Effect on GDP," in Measuring Capital in the New Economy, National Bureau of Economic Research, Studies in Income and Wealth, V. 65, edited by Carol Corrado, John Haltiwanger, and Daniel Sichel (Chicago: Un. of Chicago Press, 2005), pp. 275–322.

[5] See Sumiye Okubo, Carol A Robbins, Carol Moylan, Brian K. Sliker, Laura I. Schultz, and Lisa S. Mataloni, "BEA's 2006 Research and Development Satellite Account: Preliminary Estimates of R&D for 1959-2002 Effect on GDP and Other Measures," Survey of Current Business 86 (December 2006): 14–25.

[6] See Carol A. Robbins and Carol E. Moylan, "Research and Development Satellite Account Update: Estimates for

1959-2004, New Estimates for Industry, Regional, and International Accounts," Survey of Current Business 87 (October 2007): 49–92.

These iterations of the R&DSA formed the general framework for how BEA would implement the capitalization of R&D into its core economic accounts following the updated 2008 SNA. BEA changed the treatment of R&D from a current expense to investment as part of the 2013 comprehensive update of the national accounts and the 2014 comprehensive update of the industry and regional accounts. Further improvements were introduced as part of the 2018 comprehensive update to the national accounts, and additional industry detail was added as part of the 2020 annual update to the national accounts. For a detailed review and full references on BEA's collaborative work on R&D, see Carol E. Moylan and Sumiye Okubo, The Evolving Treatment of R&D in the U.S. National Economic Accounts, March 2020, BEA working paper.

Concepts, Definitions, and Geography

This section reviews related concepts and provides definitions of key concepts in the supply-use framework—the framework used for the regional R&D satellite account and several other BEA thematic satellite accounts—and definitions of measures of R&D production included in this account.

Definitions

Gross output is a measure of sales/revenue generated from production and includes the value of goods and services purchased by industries for use in production (intermediate inputs) and the value of goods and services purchased by final users, including industries' own-account investment. This measure of output double-counts industry output because it includes output that is purchased by other industries for use as intermediate inputs.

Value added is the difference between gross output and intermediate inputs and largely represents the value of labor and capital in the production of gross output. The sum of value added across all industries equals GDP.

R&D value added consists of the value that an industry generates as part of R&D production after it has accounted for its costs of energy, materials, and services used up in R&D production.

R&D employment consists of all full-time, part-time, and temporary wage and salary jobs in which workers are engaged in the production of R&D. Self-employed individuals are not included. R&D workers include researchers, R&D technicians, and other R&D support staff.

R&D compensation consists of the pay to employees (including wages and salaries and benefits such as employer contributions to pension and health funds) for their R&D-related work during a given year. Pay to self-employed individuals is not included.

The measures of R&D value added, employment, and compensation above account for both the R&D that is performed in-house for internal use (own-account R&D) and the R&D performed for and funded by others (purchased R&D, also referred to as "for sale R&D").

The Relationship Between R&D Production (R&D Gross Output) in the Supply-Use Tables and R&D Investment in the NIPAs

BEA measures R&D production at the national level in the detailed supply-use tables. The principal measure of production in the supply-use tables is gross output. The supply-use tables show which industries produce the R&D commodity as well as the intermediate and final uses of this commodity. This framework highlights the interdependencies between R&D output and the rest of the economy, as it allows a detailed look at the composition of R&D production and use across industries.

With the 2013 comprehensive revision of the National Income and Product Accounts (NIPAs), BEA changed the treatment of R&D from that of an intermediate input and recognized R&D as a fixed asset that generates future income and product.[7] BEA adjusted all historical U.S. GDP data to reflect the new treatment of R&D as investment (or capitalization of R&D). Prior to the capitalization of R&D in 2013 in the NIPAs, R&D expenditures were treated as intermediate inputs and not included in GDP.

The relationship between total domestic R&D production in BEA's supply-use tables and total domestic R&D investment in BEA's NIPA investment tables is as follows:

$$\textit{Total domestic R\&D supply} = \textit{Total domestic R\&D investment}$$

where total domestic R&D supply is computed from the supply-use tables as follows:

$$\textit{Total domestic R\&D supply} = \textit{Total domestic R\&D gross output} + \textit{R\&D imports} - \textit{R\&D exports}$$

and total R&D investment is the sum of private and government investment (NIPA table 5.6.5 and NIPA table 5.9.5):

$$\textit{Total domestic R\&D investment} = \textit{Private R\&D investment} + \textit{Government R\&D investment}$$

R&D Ownership

The distinction between R&D performers and R&D funders is important in the measurement of R&D production and R&D investment. BEA assigns ownership to the R&D funder for the purpose of measuring R&D investment.[8] This distinction affects the sectoral distribution of measures of R&D production (performance) and R&D investment. For example, the R&D performed by businesses but funded by the federal government would be assigned to the private sector on a performance basis, but to the federal government on an investment (or funding) basis.

BEA considers the funder of R&D to be the owner largely because the funder is typically the direct beneficiary of R&D. In addition, the R&D performer may not be a major financial supporter of the R&D that it is performing. For example, the R&D performance by the nonprofit institutions serving

[7] See Stephanie H. McCulla, Alyssa E. Holdren, and Shelly Smith, Improved Estimates of the National Income and Product Accounts Results of the 2013 Comprehensive Revision, Survey of Current Business, September 2013.

[8] For a more detailed discussion of R&D ownership, see Marissa J. Crawford, Jennifer Lee, John E. Jankowski, and Francisco A. Moris, Measuring R&D in the National Economic Accounting System, Survey of Current Business, November 2014.

households (NPISHs) is much larger than the R&D investment by this sector. Much of the NPISHs R&D performance is funded by the business sector or federal government, which would be classified under business or federal investment, respectively.

The assignment of R&D ownership to measure R&D investment is straightforward for the private sector. However, it is less clear for the public sector. The federal government funds R&D through purchases (contracts) and grants. For example, the federal government may purchase R&D from an academic institution, or it may provide funding for R&D at an academic institution in the form of a grant. With the contract, the federal government usually retains ownership of the outcome of the purchased R&D activity. With the grant, the ownership typically transfers to the grantee; however, both the federal government and the performer can benefit from the outcome of the R&D activity.

BEA treats both R&D federal contracts and grants as R&D investment by the federal sector because the federal government is assumed to receive the primary economic benefit. Most of the R&D that is funded by the federal government regardless of the funding mechanism is performed in support of the missions of the individual funding agencies. This treatment captures the outsized role of the federal government in funding R&D, where the economic benefits to the federal government include the benefits that the government obtains on behalf of the general public.

BEA also treats the R&D performed at federally funded research and development centers (FFRDCs) as investment by the federal government. FFRDCs are research institutions that are funded by the federal government but administered by businesses, universities, and other nonprofit organizations. These public-private partnerships are intended to provide federal agencies with R&D capabilities in support of their mission that cannot be effectively met by the public or the private sector alone.

Geography of R&D

The geography dimension is an important feature of the regional R&D satellite account. R&D can be performed in one state and used in another. In the initial iteration of the regional R&DSA (with results on a production basis), the geography represents the location of R&D performance. For future statistics on R&D investment, in the cases where the location of the R&D funder (owner) is different from the location where the R&D is used in production, the geography will represent the location where the R&D is used as a productive asset. This assignment is consistent with the current measures of R&D investment in GDP by state.

As an example, consider a multiunit pharmaceutical company that performs R&D in its R&D facilities in Massachusetts which is then used in manufacturing of its pharmaceutical products and medical devices in its manufacturing establishment in Michigan. On a production basis, the R&D of this company would be assigned to the scientific R&D services industry in Massachusetts. On an investment basis, the R&D of this company would be assigned to the pharmaceutical manufacturing industry in Michigan where it is used as a productive asset.

Source Data and Methodology

BEA regularly publishes several satellite accounts. Like other satellite accounts, the regional R&DSA is built on BEA's comprehensive supply-use framework. The supply-use tables provide a detailed look at the commodities produced by each industry, the use of the commodities across the U.S. economy, and each industry's contribution to GDP. They serve as both a data source and a framework used to estimate GDP by industry.

The general methodology for the regional R&DSA consists of three main steps: (1) obtain detailed national values for R&D value added, employment, and compensation; (2) identify source data on R&D with state detail from NSF and other sources, aligning definitions and concepts (e.g., own-account R&D vs. purchased R&D); and (3) use the state source data from step 2 to distribute the national values of R&D value added, employment, and compensation from step 1 to states. The last step generates detailed state-level estimates, which are then aggregated and presented by R&D performing sector. The methodology steps are described below in greater detail.

Step 1. National Values in the Regional R&DSA

The first step in preparing estimates for the regional R&DSA is to obtain national values of R&D value added, employment, and compensation by R&D commodity and detailed industry. This involves first determining the scope of the account by identifying the relevant commodities (goods and services) within BEA's supply-use tables, in this case the R&D commodities, and determining whether their output is partially or fully in scope. Since the output of each R&D commodity is fully in scope for the regional R&DSA, this account is more straightforward than other satellite accounts, where additional work is needed to isolate the portion of the commodity output that is in scope.

Because the most detailed data in BEA's supply-use tables are for gross output, the national values of R&D value added, employment, and compensation by R&D commodity ( ) and detailed industry ( ) are based on R&D commodity-to-industry gross output ( ) ratios:

$$\_\quad , = \frac{\quad ,}{\quad}$$

which are applied to value added, employment, and compensation values by detailed industry. For instance, value added by R&D commodity ( ) and detailed industry ( ) is derived as follows:

$$, = \_\quad , \times$$

This step is necessary to align the detail of the national R&D data with the detail of the state source data used to develop allocator series. Note that this step involves a standard proportionality assumption in the supply-use framework: if an industry's R&D gross output is 60 percent of its total gross output, then 60 percent of its value added is deemed R&D value added. The same is true for employment and compensation.

Step 2. State Source Data

Two sets of data are used to estimate the regional R&DSA. The first set is from NSF/NCSES and consists of the annual surveys of R&D expenditures covering all major R&D performing and funding sectors in the United States. These include the Business Enterprise R&D Survey (BERD), the Higher Education R&D Survey (HERD), the Survey of Federal Funds for R&D, the FFRDCs R&D Survey, Nonprofit Research Activities Survey (NPRA), and the Survey of State Government R&D. The NSF surveys are also a principal source for BEA's estimates of national R&D investment.[9]

The BERD survey collects data on industry R&D expenditures and R&D employment, wages and salaries, and benefits on an enterprise basis for for-profit nonfarm businesses with 10 or more employees.[10] The HERD survey collects data from U.S. colleges and universities that expended at least $150,000 in separately accounted for R&D in the fiscal year. The three government surveys—Federal Funds for R&D, State Government R&D, and FFRDCs survey—collect data on R&D activity performed and funded by federal agencies, by departments and agencies in each state, the District of Columbia, and Puerto Rico, and by FFRDCs, respectively. The NPRA survey collects information on R&D performed by 501(c) nonprofit organizations. An additional source is the annual National Patterns of R&D Resources, a report produced by NSF that integrates data from all the R&D surveys.

A challenge with the NSF R&D survey data is that all data on industries are collected by the Census Bureau on an enterprise basis, whereas BEA's industry statistics are on an establishment basis. With an enterprise approach, all of a company's R&D activity is assigned to the company's primary industry. With an establishment-based approach, the R&D activities performed at different establishments within a company are assigned separately. For example, a pharmaceutical company might perform R&D in an establishment whose main activity (its primary industry) is manufacturing and in another establishment whose main activity is R&D services. With the establishment-based approach, the R&D activity from each unit would be allocated to the manufacturing industry and the R&D services industry. In contrast, the NSF source data assign all of a company's R&D activity to the company's primary industry, which is the pharmaceuticals manufacturing industry.

For the national R&D investment estimates, BEA adjusts the NSF data and assigns R&D activity across all of a company's establishments to the appropriate industries. The methodology developed to convert the enterprise data on an establishment basis uses a special tabulation of U.S. Census Bureau employment and payroll data for establishments from the Business Register linked to NSF's industry categories for multiunit companies in the business survey. From this tabulation, ratios of R&D costs by type of establishment to total R&D costs are developed, which are then used to allocate R&D

[9] BEA makes several adjustments to these data for coverage, for scope, and for alignment with NIPA framework and concepts. For more information, see the NIPA Handbook, Chapter 6: Private Fixed Investment.

[10] Data on R&D activities of microbusinesses—businesses with less than 10 employees—are collected by NSF's Annual Business Survey (ABS). The ABS was recently established to collect annual data on microbusiness R&D as well as data on innovation, intellectual property, technology, business owners, and business structure for all businesses located in the United States. While this data was not incorporated in the initial estimates of the regional R&DSA, it will be incorporated in future work on this account.

expenditures to R&D labs and company headquarters. This company-to-establishment adjustment is also made for the state estimates of R&D investment in GDP by state, but the ratios are assumed to be the same as national ratios.

Ongoing research focused on linking establishment data from the Census Bureau's Business Register to the enterprise data from the BERD survey aims to provide state-level ratios that can be used to reallocate the R&D expenditures of companies to establishments that are more likely to perform R&D including corporate offices, R&D labs, and manufacturing plants. An additional benefit of this microdata work is the assignment of the company investment in R&D to the correct state and industry.

The second set of data used to estimate the regional R&D satellite account includes the Census Bureau's Economic Census and American Community Survey (ACS), the Quarterly Census of Employment and Wages (QCEW) from the U.S. Bureau of Labor Statistics (BLS), and BEA's regional data on compensation and employment. The Economic Census, for example, collects and publishes information on the scientific R&D services (NAICS 5417) industry and aggregate R&D expenditures for NAICS 55, the portion of management of companies and enterprises (NAICS 55) undertaking R&D services. Both industries are collected on an establishment basis. The state source data are summarized below by R&D performing sector.

R&D Performing Sector	State Source Data
Business	Own-account business R&D: BERD For sale business R&D: National Patterns of R&D Resources, BERD R&D performed by auxiliary establishments of larger companies: 1997 Census of Auxiliary Establishments, QCEW R&D performed by FFRDCs run by businesses: FFRDC R&D Survey
Nonprofit institutions serving households (NPISHs)	Own-account and for sale R&D performed by private universities and colleges: HERD Own-account and for sale R&D performed by non-academic nonprofits: NPRA (2016) combined with EC/QCEW; EC/QCEW (nonprofit establishments in NAICS 5417 and NAICS 622) R&D performed by FFRDCs run by nonprofits: FFRDC R&D Survey
Government	Federal R&D: Survey of Federal Funds for R&D State and local government: Survey of State Government R&D For sale R&D performed by public universities and colleges: HERD

Step 3. State Methodology

Two primary strategies are used to allocate detailed national R&D values to states. The first is used for the dollar-based measures, value added and compensation. For the R&D sector, these are closely related statistics. From 2012 to 2020 at the national level, between 61 percent and 64 percent of R&D value added went to compensation. For these reasons, the R&D value added and the R&D compensation for a given kind of R&D produced by a given industry are allocated to states based on NSF's state-level

R&D expenditure data. The second primary strategy is used for employment. Employment is allocated differently because of measurement differences and challenges across the different sources (BLS, Census, and NSF), so these sources are combined to form state employment allocators.

R&D Value Added and R&D Compensation

To estimate R&D value added and R&D compensation by state, state allocator series are developed separately for own-account R&D commodities and purchased R&D commodities.

State-level BERD data on "R&D paid for and performed by the company" is used to allocate national own-account R&D, based on the R&D performing industry. Own-account R&D also includes R&D paid for and performed by nonprofits (allocated to states using data from the NPRA survey), and government (allocated to states using HERD data for academic R&D and data from the Survey of Federal Funds and the Survey of State Government R&D for non-academic R&D).

For sale R&D encompasses multiple kinds of R&D, and as such the allocation strategy is more complicated than for own-account R&D. It can be described separately for separate categories of R&D.

- R&D sold on the market to other businesses. State allocators for this category are based on the difference between total R&D performed in a state (from National Patterns of R&D Resources) and the R&D paid for and performed by the company (i.e., own-account R&D) by state (from BERD). This is split between R&D performing industries based on the assumption that the distribution across states of R&D sold on the market is equal to the distribution across states of own-account R&D.
- R&D performed by colleges and universities and funded externally. For this category, R&D is allocated to states based on HERD microdata on source of R&D funding. It is then aggregated into two separate groups following BEA conventions: R&D performed by private universities and colleges (nonprofits) and R&D performed by public universities and colleges (state and local government).
- R&D performed by auxiliary establishments of larger companies. This portion of for sale R&D is not technically sold on the market but it is classified here due to BEA's general establishment-based method of economic measurement. The most recent public state-level data on auxiliary establishments comes from the 1997 Census of Auxiliary Establishments. State-by-industry QCEW data are used to extrapolate these ratios forward. This methodology assumes that auxiliary establishment growth in R&D is equal to R&D establishments payroll growth over this time period.
- R&D performed by nonacademic nonprofits and funded externally. State allocators for this category are either based on 2016 data from the NSF NPRA survey extrapolated by BLS QCEW, or the receipts of nonprofit establishments classified in the scientific R&D services industry (NAICS 5417) from the 2012 and 2017 Economic Censuses, interpolated and extrapolated by QCEW. Receipts of nonprofit hospitals (NAICS 622) are included in the state allocator series as well for pharmaceutical R&D.

R&D Employment

The national estimates of R&D employment by industry are allocated to states, using several different data sources including BLS QCEW, Census ACS, and NSF/NCSES employment data. Total employment for a given state and six-digit industry comes from the QCEW. However, the QCEW does not have R&D- specific data. The next step is to break down the QCEW state-by-industry data into occupations—this is because occupation-level results are more easily divided into R&D and non-R&D than industry results. The ACS has annual employment data on a state-industry-occupation basis, which is used to do this occupation breakdown. Finally, NCSES workforce data from the National Survey of College Graduates (NSCG) on the time spent on R&D by different occupations is used to isolate R&D from other activities performed by employees. This general strategy is modified by using statistics from NCSES Higher Education R&D (HERD) survey on academic R&D personnel in the industries where that is relevant— namely nonprofits (for private universities and colleges) and state and local government (for public universities and colleges).

BEA recently received a special tabulation of R&D employment and R&D compensation by industry and state from the BERD survey. BEA will examine this tabulation and modify the methodology described above for the preliminary R&D employment and compensation estimates to incorporate the data provided in the special tabulation. However, since the employment detail was collected for the first time in 2018, the employment time series developed for the regional R&DSA will still likely rely on a multisource methodology.