THE ECONOMIC IMPACT OF THE U.S. BIOPHARMACEUTICAL INDUSTRY:

2017 National and State Estimates

DECEMBER 2019

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EXECUTIVE SUMMARY

At a time when economic competitiveness at the national and state levels is recognized to be strongly rooted in the capacity to advance innovation-based industries, the U.S. biopharmaceutical industry stands out as a leading research and development (R&D) and advanced manufacturing industry. Over the past 30 years, the U.S. has solidified its place as the preeminent nation in biopharmaceutical innovation world-wide. Today, that global leadership is built upon a robust foundation of innovation-led U.S. companies that perform and support advanced R&D and sustain a diverse and large-scale supply chain for the development, production, and distribution of biopharmaceuticals.

The innovation-led biopharmaceutical industry and its closely-integrated supply chain represents a significant geographic footprint across the nation. To measure the economic contributions that the biopharmaceutical industry is making, the Pharmaceutical Research and Manufacturers of America (PhRMA) engaged TEConomy Partners, LLC, to develop an independent estimate of the current size and structure of the U.S. biopharmaceutical industry and its total economic impact on the U.S. economy—including the 50 states, the District of Columbia, and Puerto Rico. This examination fully examines the broad value-chain of the biopharmaceutical industry from R&D to clinical testing to manufacturing of biopharmaceuticals to final distribution.

Key findings from this examination of the broad biopharmaceutical value-chain include the following:

- The U.S. biopharmaceutical industry contributes substantially to national, state, and local economies by employing more than 811,000 individuals in 2017. This industry also supports approximately 3.2 million additional U.S. jobs through its varied supply base and from the additional economic impacts stemming from industry and worker spending. Altogether, the U.S. biopharmaceutical industry directly and indirectly supports more than 4.0 million U.S. jobs in 2017, leading to a significant industry employment multiplier of 4.98.
- The overall economic impact of the biopharmaceutical industry on the U.S. economy is substantial. The biopharmaceutical industry reached $560 billion in direct output in 2017, and with the ripple effect of this production throughout the U.S. economy, an additional $589 billion in output was generated by suppliers and other sectors of the economy. Combined, the total economic output supported by the U.S. biopharmaceutical industry was more than $1.1 trillion (including the District of Columbia and Puerto Rico) in 2017.
- The overall value added of the U.S. biopharmaceutical industry, or its contribution to U.S. GDP, is also substantial, with a total value added impact exceeding $625 billion, accounting for 3.2 percent of U.S. gross domestic product (GDP).
- Wages and benefits per direct biopharmaceutical job averaged $126,587 per worker in 2017. This annual average compensation was more than twice the U.S. private sector average of $60,705, which is an indication of the high-quality jobs the biopharmaceutical industry provides to U.S. workers.
- Biopharmaceutical industry workers paid a total of $22.9 billion in personal taxes at federal, state, and local levels in 2017. When tax revenues generated from all the additional jobs supported by the industry are also included, these total personal tax revenues reach $66.6 billion.
- The U.S. biopharmaceutical industry is a key employer of workers from science, technology, engineering, and math (STEM) occupations, with these STEM occupations accounting for 37 percent of all biopharmaceutical industry jobs based upon 2017 estimates.

INTRODUCTION: AN INDUSTRY DEFINED BY INNOVATION

Our nation's economic competitiveness is recognized to be strongly rooted in the capacity to advance innovation-based industries. The National Research Council (NRC) cites the capability to innovate as the most important determinant of economic growth and a nation's ability to compete and prosper in the 21st century global economy.1 Not only is innovation a critical driver of the nation's economic growth, it is a key differentiator among state and regional economies. As this study documents, while some states have significant employment in the biopharmaceutical industry, every U.S. state, the District of Columbia, and Puerto Rico has some level of industry employment. There is compelling evidence of the importance of innovation to economic growth and rising living standards. According to the Information Technology and Innovation Foundation's State New Economy Index, there is a strong relationship between state capacities in innovation and per capita income. Among U.S. industries, the biopharmaceutical industry stands out as a leader in innovation-led development (see text box).

Biopharmaceuticals—A Leader in Innovation-led Development

The biopharmaceutical industry is a major component of the U.S. innovation-driven industrial base, which also includes industries such as aerospace, automotive, and semiconductors. Across a wide range of measures, the biopharmaceutical industry shows a strong leadership position in private-sector R&D.

The domestic biopharmaceutical industry is a leader in U.S. R&D activities and investments.

- The U.S. biopharmaceutical industry invested an estimated $102 billion into R&D in 2018.
- The biopharmaceutical industry accounts for 17.7 percent of all domestic U.S. business R&D in 2017.
- The biopharmaceutical industry, at 146,000 domestic R&D employees in 2017 has the largest number of R&D workers of any U.S. industry, including the aerospace, automotive and semiconductor industries.
- The biopharmaceutical industry devotes 22.8 percent of its total domestic employment to R&D, nearly three times larger than the U.S. industry average.
- Biopharmaceutical internal investment in domestic R&D in 2017 was twice that of the semiconductor industry, and exceeded the automotive industry by 165 percent and the aerospace industry by 371 percent.

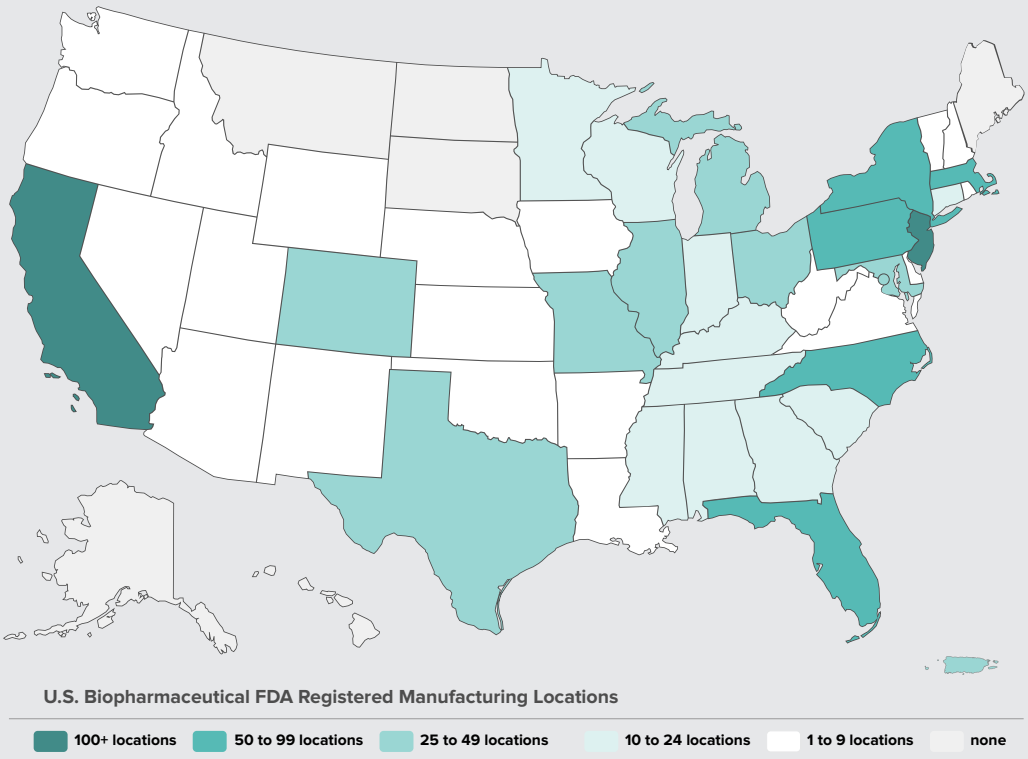
Source: *National Center for Science and Engineering Statistics, National Science Foundation, 2017 Business R&D and Innovation Survey; Research!America, U.S. Investments in Medical and Health Research and Development, Fall 2019, TEConomy Partners analysis.*

Additionally, the biopharmaceutical industry is also one of the largest sources of private business funding of research at universities and academic medical centers across the country, and these collaborative efforts are often focused on the nation's most critical scientific and technological health challenges. In 2017, industry funding for health science research, which comes primarily from biopharmaceutical companies, accounted for 47 percent of all private sector funding to universities. In 27 states, industry funding for health science research accounted for at least one-third of all industry funding to university-based research, and accounted for one-half or more in 19 states.[1]

With its broad geographic footprint and high levels of investment in R&D, the biopharmaceutical industry provides significant economic and wealth generation opportunities for both the U.S. overall and its individual states—making the industry a key component of nearly every state's economic development strategy.

To measure the extent of this geographic footprint, PhRMA engaged TEConomy Partners, LLC, to develop an independent estimate of the size of the U.S. biopharmaceutical industry and its total economic impacts on the U.S. and individual state economies (including the District of Columbia and Puerto Rico). The report provides estimates of the total number of biopharmaceutical industry jobs in the U.S. in 2017—the most recent year for which complete employment data and IMPLAN model data are available. The report also develops a number of economic impact measures of the U.S. biopharmaceutical industry, including total economic output, wages and benefits, and taxes. These measures capture the direct economic impacts of biopharmaceutical industry and the indirect economic impacts of other sectors of the economy that are supported by the biopharmaceutical industry through its broad supply chain and the induced economic activity of its workforce. The economic impact assessment is developed using proprietary models from IMPLAN.[2]

Nearly All States are Involved in the Manufacturing of FDA-Approved Medicines



Currently 1,193 facilities in the US are manufacturing FDA-approved products under current Good Manufacturing Practice regulations.

- These facilities are spread across 44 states, the District of Columbia and Puerto Rico
- 37 states and Puerto Rico have 5+ facilities manufacturing FDA- approved medicines

Source: NDP Analytics for PhRMA. Unpublished analysis of the U.S. Food and Drug Administration's Drug Establishments Current Registration Sites. April 2018.

THE BROAD SCOPE AND SCALE OF THE BIOPHARMACEUTICAL INDUSTRY

Defining the Biopharmaceutical Industry

A hallmark of the biopharmaceutical industry is its dynamic nature, both of its constituent companies and of the relationships among them. Companies in the industry include, for example, large, vertically integrated biopharmaceutical companies with their own research and manufacturing facilities; small and start-up companies that have not yet had a medicine approved by the Food and Drug Administration; clinical development and management and research organizations that provide a range of services to support drug development and manufacturing; and distributors who provide logistics support to deliver prescription medicines.

Just as biopharmaceutical companies collaborate and partner with academic and other public and private institutions to advance the science and develop new treatments, companies also partner with each other in a variety of innovative ways. For example, a larger company may collaborate with a contract research organization (CRO) to advance a specific technology or medicine in development through a clinical trial, or a biopharmaceutical company may license from another company or an academic medical researcher a particular technology such as a novel assay or a promising compound. Many biopharmaceutical companies also have corporate venture capital arms that provide early and late stage funding to a start-up or emerging company with a promising project or technology, such as a promising digital health application.

The core activities that define the biopharmaceutical industry nevertheless remain straightforward—biopharmaceutical discovery, research, development, manufacturing, and distribution—and it is these activities that were used to produce estimates of the size and structure of the U.S. biopharmaceutical industry. These activities are found in U.S. federal data sources within all or parts of three "sectors" of the U.S. economy as defined by the federal government in the North American Industrial Classification System (NAICS). A fourth sector, biopharmaceutical corporate offices, captures standalone corporate operations not captured in the other sectors. Estimates were developed by carefully identifying the share of each of the sectors attributable to the biopharmaceutical industry. Appendix A provides the specific NAICS codes used to define the industry sector, and describes the data and methods used to produce all the U.S. and state-level estimates included in this report.

Direct employment in the biopharmaceutical industry reached 811,153 jobs across the U.S. in 2017 **(Table 1)**. Biopharmaceutical manufacturing accounts for 38 percent of the total employment, with biopharmaceutical R&D of a similar size at 36 percent.

Table 1. U.S. Biopharmaceutical Industry Employment by Subsector, 2017

Sector	Estimated Biopharmaceutical Sector Employment	Share of Total Biopharmaceutical Industry Employment
Biopharmaceutical Manufacturing	307,585	37.9%
Biopharmaceutical R&D	292,947	36.2%
Biopharmaceutical Distribution	180,499	22.3%
Biopharmaceutical Corporate Offices	29,643	3.7%
Total	811,153	100.0%

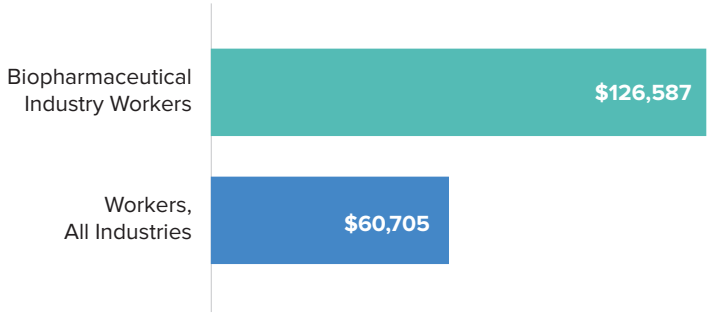
Note: *"Subsector" is based on the NAICS category assigned to the establishment (i.e., the business location) captured in the BLS data, and is assigned based on the predominant activity at that location. Because all jobs within an establishment are assigned to the establishment's NAICS, sector-based job counts may over- or under-state job functions to the extent multiple activities occur at a single establishment (e.g, co-located R&D and manufacturing). The total employment estimate is not affected, however.*

Source: *2017 BLS QCEW and CPS Employment Data; TEConomy Partners analysis, calculations, and estimations. Data include the 50 States, the District of Columbia, and Puerto Rico.*

High-Quality Jobs

The biopharmaceutical industry, whether in its R&D, manufacturing, distribution, or corporate headquarters functions, is a generator of high-quality jobs. For 2017, the 811,000 direct biopharmaceutical industry jobs generated nearly $103 billion in personal income (including both wages and benefits or total compensation)—averaging $126,587 in personal income per worker (**Figure 1**). This is more than twice the national average of $60,705, a strong indication of the quality of jobs that the biopharmaceutical industry provides to U.S. workers, and of the high value-added activities within the industry. This biopharmaceutical wage and benefit premium extends across the U.S., with 38 states (including Puerto Rico) having an industry wage and benefit premium at least 50 percent higher than the state's all industries' average, and for 24 states (including Puerto Rico), this total compensation premium exceeds 75 percent.

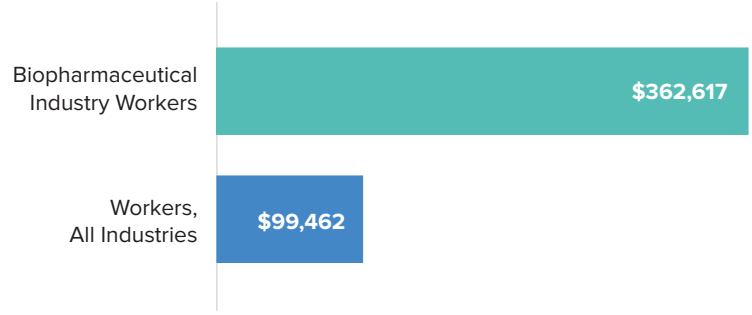
Figure 1. Average Annual Employee Compensation, U.S. Biopharmaceutical Industry and All Industries, 2017



Source: *2017 U.S. IMPLAN Model and TEConomy Partners estimations of Employment and Total Labor Income.*

The high value-added nature of U.S. biopharmaceutical industry is also reflected in an extremely high productivity measure for the industry, exceeding $360,000 in value added per worker, compared to a value-added of less than $100,000 per worker across all U.S. industries (**Figure 2**).[3]

Figure 2. Average Productivity, U.S. Biopharmaceutical Industry and All Industries, 2017



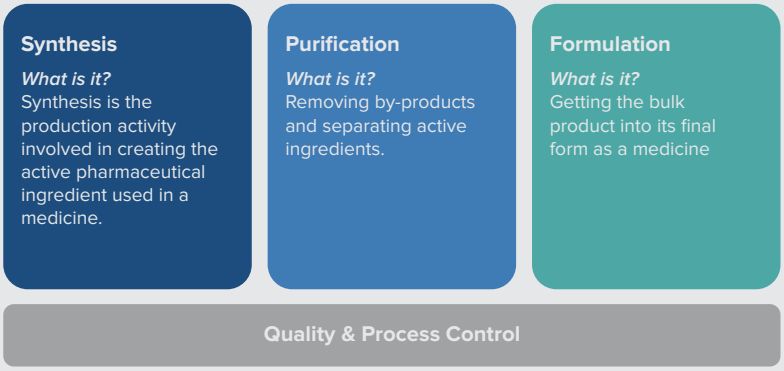
Source: *2017 U.S. IMPLAN Model and TEConomy Partners estimations of Employment and Value Added.*

Complex Biopharmaceutical Manufacturing Approaches Driven by Science

Biopharmaceutical manufacturing provides the critical link between the research and development of a medicine and its availability to a patient to meet an unmet medical need.

Reflecting its close connection to scientific discovery, the processes involved in biopharmaceutical manufacturing are complex and evolving. While the overall process of producing a medicine has common elements, biopharmaceutical manufacturing is further complicated by having two broad manufacturing platforms reflecting the two broad classes of medicines that existing – one based in chemistry and the other in biology.

Biopharmaceutical manufacturing involves many complex steps requiring an extensive knowledge of scientific and engineering principles using high technology equipment consisting of large, tanks surrounded by a maze of pipes, pumps and computer-controlled hardware.



While the manufacturing of biopharmaceuticals involves a set of common production steps, a closer examination reveals two manufacturing platforms that reflect the different ways medicines are developed. One type of medicine is small-molecule pharmaceuticals that are manufactured using chemical synthesis. The other type of medicine is known as large-molecule biologics manufactured using living cells.

	SYNTHESIS/ENGINEERING	PURIFICATION	FORMULATION	QUALITY & PROCESS CONTROL
Small Molecule, Chemistry-based Production Platform	Use of chemical synthesis that assembles the required chemical structure through well-defined and replicable steps	Able to utilize highly advanced analytical tools to guide the isolation and concentrate the active pharmaceutical ingredient from other chemicals left over from the synthesis reactions	Able to blend active ingredients with other chemical-based fillers into highly stable tablets or capsules forms that can be packaged and not require specialized handling	Highly replicable process to be monitored through use of analytical tools ensuring production of unique, though well-defined molecular structure
Large Molecule, Biology-based Production Platform	Involves living entities such as cells and tissues being isolated from a variety of natural resources and may be produced by biotechnology methods and other cutting-edge technologies.	Involves use of filtration approaches that require ongoing optimization due to variability from batch to batch in order to separate living cells from cellular nutrients and byproducts	Remains in a liquid or frozen forms and delivered through injection or infusion and so must be kept sterile and is highly sensitive to temperature conditions	Given complexity of the molecular structure and inherent variability of scaling up living cells, quality control requires focus on comparability of biological activity.

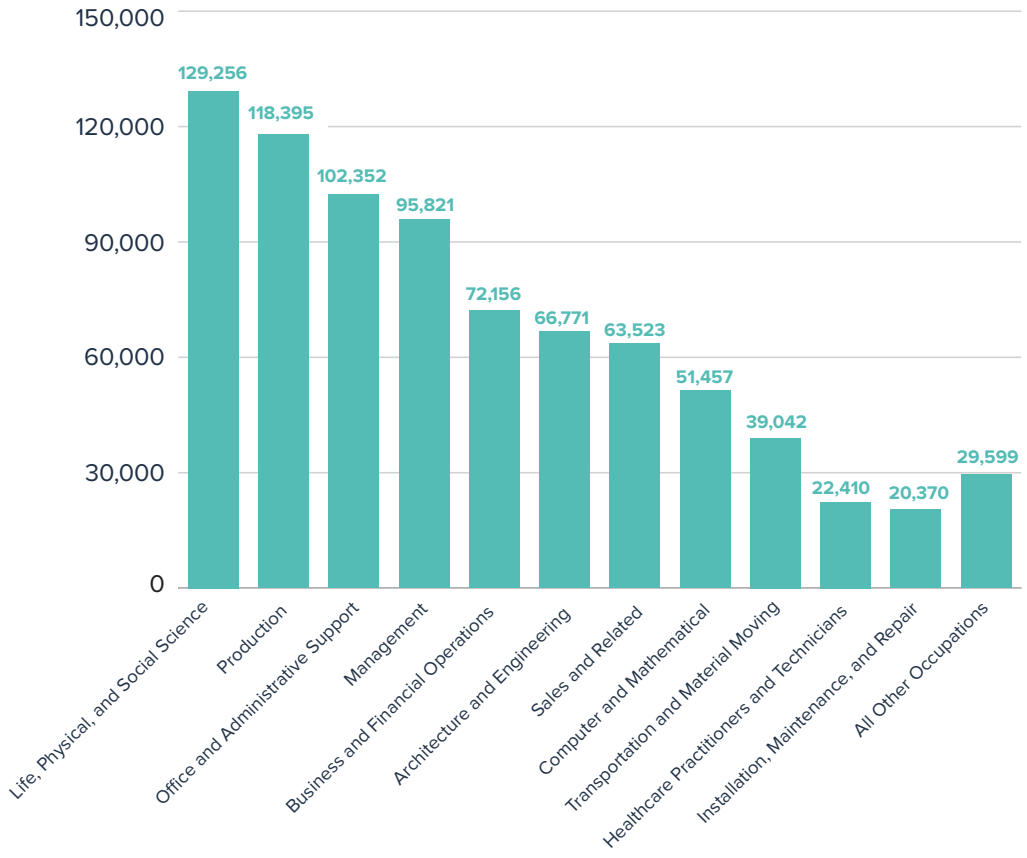
The biopharmaceutical pipeline reflects increasing therapeutic competition, expansion in the number of personalized medicines, and a growing focus on large molecule therapies including cell and gene therapies. These trends have resulted in increasingly complex highly specific manufacturing requirements and a focus on improving the efficiency and effectiveness of the manufacturing process, which in turn is spurring innovation in the technologies and processes needed to support advanced biopharmaceutical manufacturing.

Source: *Biopharmaceutical Manufacturing in the U.S.: Making Cutting-Edge Medicines Today and Leading the Way on Medicines of Tomorrow, TEConomy Partners for Pharmaceutical Research and Manufacturers of America (PhRMA), March 2019.*

Highly Skilled Talent

The U.S. biopharmaceutical industry relies on highly-skilled talent across a range of occupational categories and educational levels, including those with skills, education, and training in science, technology, engineering, and math (STEM). An array of STEM-related jobs are required by this industry and can range from those requiring an advanced college degrees such as positions in R&D to jobs in blue collar positions such as manufacturing technicians and other production and logistics personnel. Using occupational information for the four subectors, a composite occupational profile was developed for the U.S. biopharmaceutical industry. **Figure 3** shows the estimated biopharmaceutical industry employment across key occupational categories.[4] Details of key occupational shares, by state, are provided in Appendix B.

Figure 3. U.S. Occupational Profiles - Biopharmaceutical Industry and Total Employment (Percent of Jobs), 2017

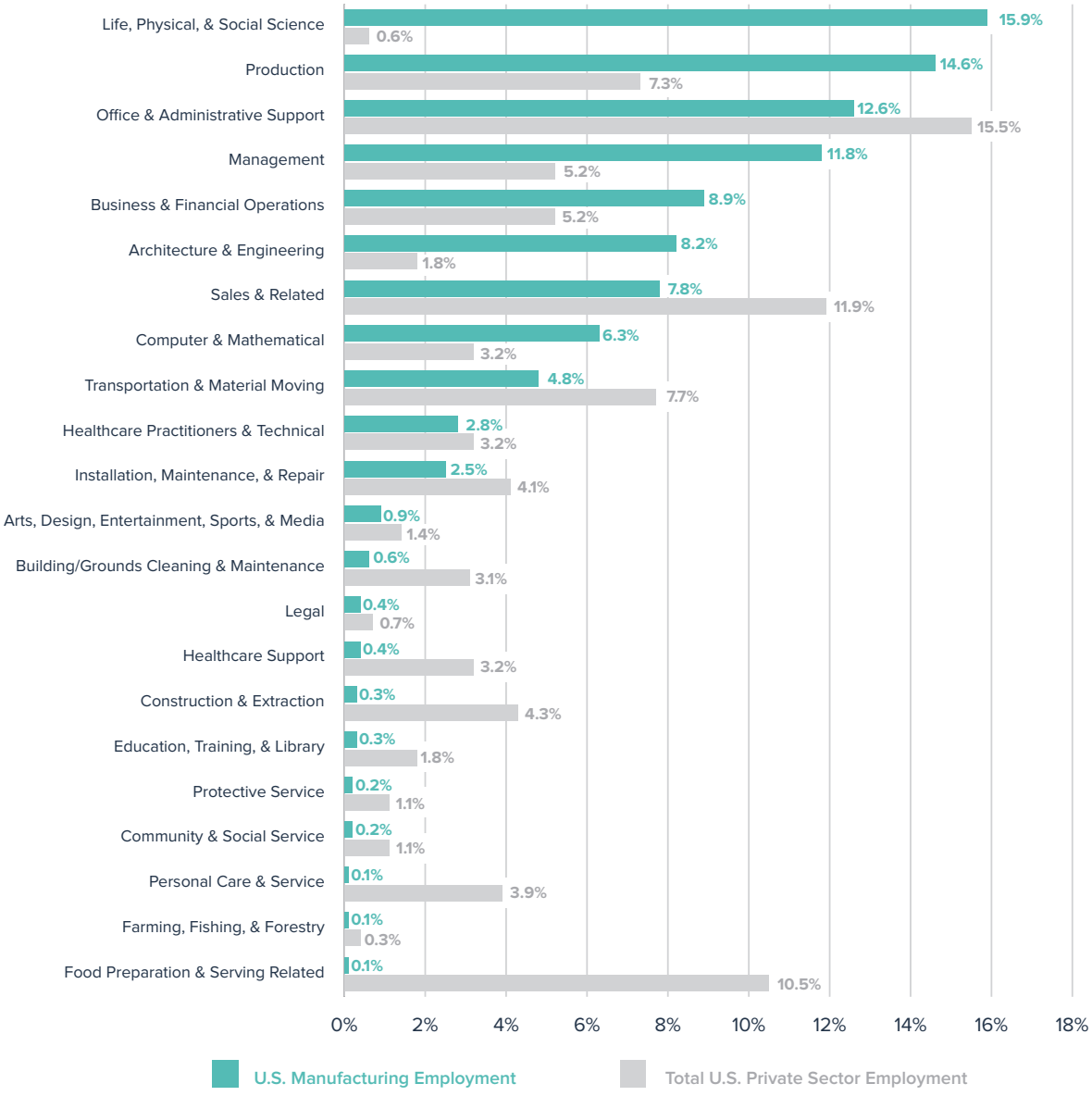


Source: *U.S. Bureau of Labor Statistics (BLS) Occupational Employment by Industry, 2017, and TEConomy Partners estimations.*

Nearly 16 percent of biopharmaceutical industry employment is in the life, physical and social science occupations, a significantly higher proportion than overall private sector employment (**Figure 4**). In fact, STEM-related occupations, as defined by the U.S. Bureau of Labor statistics, account for 37 percent of the biopharmaceutical industry's workers (i.e., life, physical and social sciences; architecture and engineering; and computer and mathematical occupations and STEM-related occupations within the management (e.g., science managers) and sales and related (e.g., techical/scientific sales))—more than six times higher than the private sector average. The biopharmaceutical industry also provides significant employment in other broad areas with diverse educational and skill requirements. Management and financial-related occupations are spread throughout the four subsectors and account for 21 percent of the biopharmaceutical industry's employment.

Production occupations, occurring primarily within the biopharmaceutical manufacturing subsector, account for 15 percent of the biopharmaceutical industry's total employment. Office and administrative workers spread across the industry account for 13 percent of the workforce. Transportation and material moving occupations related to receiving supplier inputs and shipping finished products account for 5 percent of total employment.

Figure 4. U.S. Occupational Profiles - Biopharmaceutical Industry and Total Employment (Percent of Jobs), 2017



Source: *U.S. Bureau of Labor Statistics (BLS) Occupational Employment by Industry, 2017, and TEConomy Partners estimations.*

From a state industry perspective, life, physical, and social scientists account for at least 15 percent of the biopharmaceutical workforce in 25 states, production workers account for at least 15 percent of the biopharmaceutical workforce in 26 states and Puerto Rico, and management occupations accounts for 10 percent or more of biopharmaceutical industry employment in every state and Puerto Rico except Alaska. Details of key occupational shares, by state, are provided in Appendix B.

DRIVER OF U.S. ECONOMIC GROWTH

The U.S. biopharmaceutical industry is not only a world leader in the development of new medicines, vaccines, and diagnostics and one of the nation's top performing industry innovation drivers, but is also a highly valuable industry in terms of its economic contributions and overall impacts.

The economic impacts, or more precisely the revenue and expenditure impacts, of the biopharmaceutical industry can be measured using the well-established regional economic analysis technique of input/output (I/O) analysis, which tracks the revenues of a sector and the related economic activity of suppliers to the sector and its personnel. For this analysis a customized IMPLAN I/O model is used to quantify the interrelationships between the U.S. biopharmaceutical industry and the remaining sectors of the U.S. economy.

Economic impacts consist of three types: ***direct effects*** (the specific impact of biopharmaceutical industry expenditures in the first round of spending), ***indirect effects*** (the impact of expenditures by suppliers to the biopharmaceutical industry), and ***induced effects*** (the additional economic impact of the spending of biopharmaceutical industry employees and suppliers' employees in the overall economy that can be attributed to the direct biopharmaceutical industry expenditures). Taken together, these three impact effects combine to form the ***total impacts***. In other words, the I/O analysis models the "ripple effect" that originates from direct biopharmaceutical industry expenditures in the economy, flows through industry suppliers as they buy additional inputs, and through industry and supplier workers who spend their wages.

Definition of Impact Variables

Employment: The number of individuals whose employment is due, totally (direct employment) or in part (indirect or induced employment) to the economic effects of the industry.

Labor (Personal) Income: Salaries, wages, and the full cost of benefits including non-cash payments received by individuals in the economy. Includes employee compensation and sole proprietor income.

Value-Added: The difference between an industry's total output and the cost of its intermediate inputs; sometimes referred to as the industry's "Contribution to GDP".

Output: The dollar value of production (i.e., sales).

Personal Tax Revenue: The dollar value of taxes generated due to the creation of personal income; includes company paid portion of social security taxes.

The Economic Impact of the U.S. Biopharmaceutical Industry on the Nation

The overall output impact, typically referred to as the "total economic impact" of the biopharmaceutical industry on the U.S. economy, totalled more than $1.1 trillion in 2017.[5] This total impact includes $561 billion in direct effects of biopharmaceutical businesses sales and $589 billion in indirect and induced effects. These values generate a biopharmaceutical industry output multiplier of 2.05—meaning that every $1.00 in output generated by the biopharmaceutical industry generates an additional $1.05 in output in other sectors of the economy **(Table 2)**. This total biopharmaceutical industry economic impact represented 3.4 percent of total U.S. output.[6] The total value added, also considered to be the contribution to U.S. Gross Domestic Product (GDP), of the biopharmaceutical industry exceeds $625 billion and accounts for 3.2 percent of U.S. GDP.

Table 2. Economic Impacts of the U.S. Biopharmaceutical Industry, 2017 ($ in billions)

Impact Type	Employment	Labor Income	Value Added	Output	State/Local Personal Tax Revenue	Federal Personal Tax Revenue
Direct Effect	811,153	$102.7	$294.1	$560.9	$3.0	$19.9
Indirect Effect	1,421,891	$111.1	$167.3	$295.7	$2.9	$20.7
Induced Effect	1,805,928	$94.0	$165.3	$292.9	$2.5	$17.6
Total Impacts	4,038,972	$307.8	$626.7	$1,149.5	$8.5	$58.1
Multiplier	4.98	3.00	2.13	2.05		

Source: *TEConomy Partners data, calculations and analysis; IMPLAN 2017 U.S. model.*

The operations and sales revenue of the biopharmaceutical industry is responsible for supporting more than 4.0 million jobs throughout the U.S. economy. These jobs consist of the more than 811,000 jobs directly in the industry and the more than 3.2 million indirect and induced jobs in 2017. For every one biopharmaceutical industry job, the industry supports an additional 3.98 jobs, for a total employment multiplier of 4.98. Together, the biopharmaceutical industry and the workforce of its suppliers and other impacted segments of the economy received $308 billion in wages and benefits in 2017.

The biopharmaceutical industry also is an important generator of federal, state, and local government tax revenues through the wages and benefits provided to its employees. The impact analysis shows that the incomes of biopharmaceutical industry workers, directly and through the multiplier effect, generated nearly $67 billion in personal tax revenues—more than $8 billion in state and local personal tax revenue and more than $58 billion in federal personal tax revenues in 2017.

The Biopharmaceutical Industry Supply Chain and Breadth of Impacts

The multiplier effects of the biopharmaceutical industry (indirect and induced impacts) are of benefit to, and interrelated with, a broad range of U.S. economic sectors. The I/O analysis assesses the impact of the biopharmaceutical industry on every other sector in the economy and provides industry-specific impact estimates for the principal suppliers to the biopharmaceutical industry. **Table 3** characterizes the major supply chain inputs (using grouped IMPLAN industry sectors) to the U.S. biopharmaceutical industry as determined by the size of the indirect output effects. For example, the biopharmaceutical industry purchased more than $95 billion in wholesale and purchased goods inputs (which includes a wide variety of products and services that serve as inputs to biopharmaceutical R&D, production, and distribution). These purchases also generate an indirect employment impact of nearly 390,000 jobs.

Table 3. Supply Chain Inputs to the U.S. Biopharmaceutical Industry, 2017

Biopharmaceutical Industry Supply Chain Components	Supplier Employment (Indirect)	Supplier Output in $Millions (Indirect)
Wholesale & Purchased Goods Inputs	389,535	$95,049
Marketing & Communications	126,606	$24,574
Organic/Inorganic Chemical Inputs	16,614	$23,399
Technical Services & Consulting	154,895	$21,200
Legal & Business Services	184,306	$20,992
Real Estate Services	83,162	$17,356
Financial Services	54,399	$14,538
Information Technology	47,334	$14,265
Transportation & Logistics	90,278	$12,686
Utilities	8,530	$8,928
Packaging	24,882	$7,792
Production Equipment/Components	23,153	$5,505
Facility & Operational Services	64,133	$4,831
Intellectual Property Management & Licensing	2,848	$3,519
Maintenance & Repair Construction	20,966	$3,407
Printing	17,089	$2,816
All Other Suppliers	113,162	$14,807
Total Indirect (Supply Chain) Impacts	1,421,891	$295,663

Source: *TEConomy Partners data, calculations and analysis; IMPLAN 2017 U.S. model.*

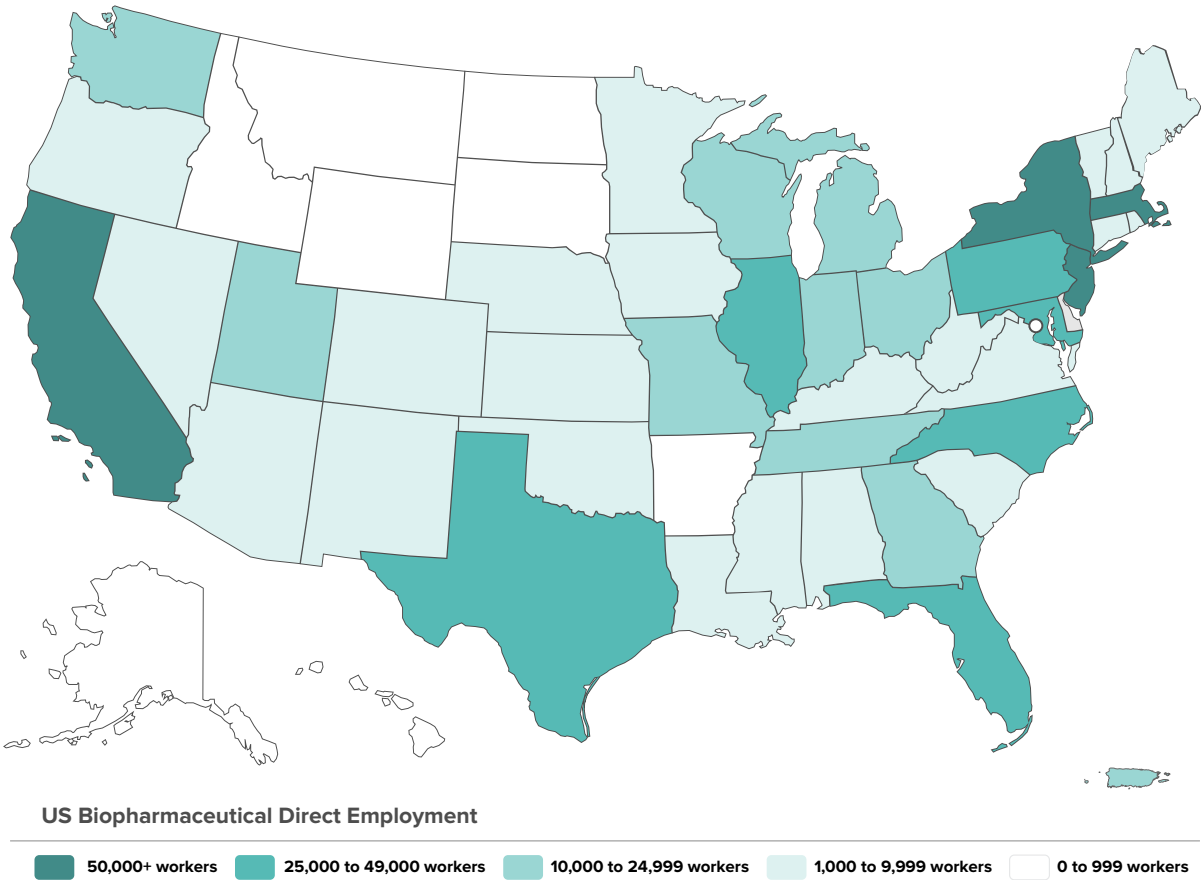
Economic Impact in Individual States

As with every industry, the biopharmaceutical industry has certain leading states with significant employment levels (e.g., California and New Jersey). However, the industry is also diverse in geographic representation, with every state, the District of Columbia, and Puerto Rico having some direct biopharmaceutical industry employment and experiencing some level of economic impact from the industry. Appendix B provides detailed economic impact estimates by state, while broad geographic patterns are described below.

Figure 5 illustrates direct biopharmaceutical industry employment across all 50 states, the District of Columbia, and Puerto Rico. Four states—California, New Jersey, Massachusetts, and New York—each have more than 50,000 biopharmaceutical industry workers. In total, 19 states and Puerto Rico, have more than 10,000 biopharmaceutical industry workers, with nine more states having between 5,000 and 10,000 industry jobs.

Within this distribution of states the importance, as measured by the size of the state's biopharmaceutical industry as a share of total private sector employment, can vary dramatically. For example, the biopharmaceutical industry accounts for 2.7 percent of all of Puerto Rico's private sector employment, the largest share across the U.S. While sizeable and important within the state of California, the state's nearly 140 thousand direct biopharmaceutical industry jobs accounts for only 1 percent of total private sector employment. Whereas in Delaware the state's nearly 5,000 biopharmaceutical industry jobs account for 1.3 percent of its total private sector employment.

Figure 5. Geographic Distribution of U.S. Biopharmaceutical Industry Direct Employment, 2017



Source: *TEConomy Partners data, calculations and analysis.*

An examination of the geographic distribution of the biopharmaceutical industry's total employment impacts shows that the industry has a large-scale, geographically-dispersed, supply chain. For suppliers (indirect employment), there are eight states where the industry supports at least 50,000 jobs, and another nine states with at least 20,000 supplier jobs. Combining direct, indirect, and induced employment, the biopharmaceutical industry supports more than 250,000 jobs in five states—California, New Jersey, Massachusetts, Pennsylvania, and North Carolina, supports at least 100,000 jobs in an additional six states, and at least 50,000 jobs in eight additional states. Overall, across the country 30 states each have more than 20,000 jobs supported by the biopharmaceutical industry.

In terms of total economic impacts (direct, indirect, and induced output combined) California is by far the largest source of U.S. biopharmaceutical economic impact accounting for more than $230 billion, or 20 percent of the U.S. total output impacts. Additionally, eight states, New Jersey, North Carolina, Illinois, Massachusetts, Pennsylvania, New York, Indiana, Texas, and Puerto Rico, have total biopharmaceutical industry impacts of more than $50 billion, with an additional 11 states exceeding $10 billion in total economic impact. Fully 43 states, and Puerto Rico, exceed $1 billion in economic impact.

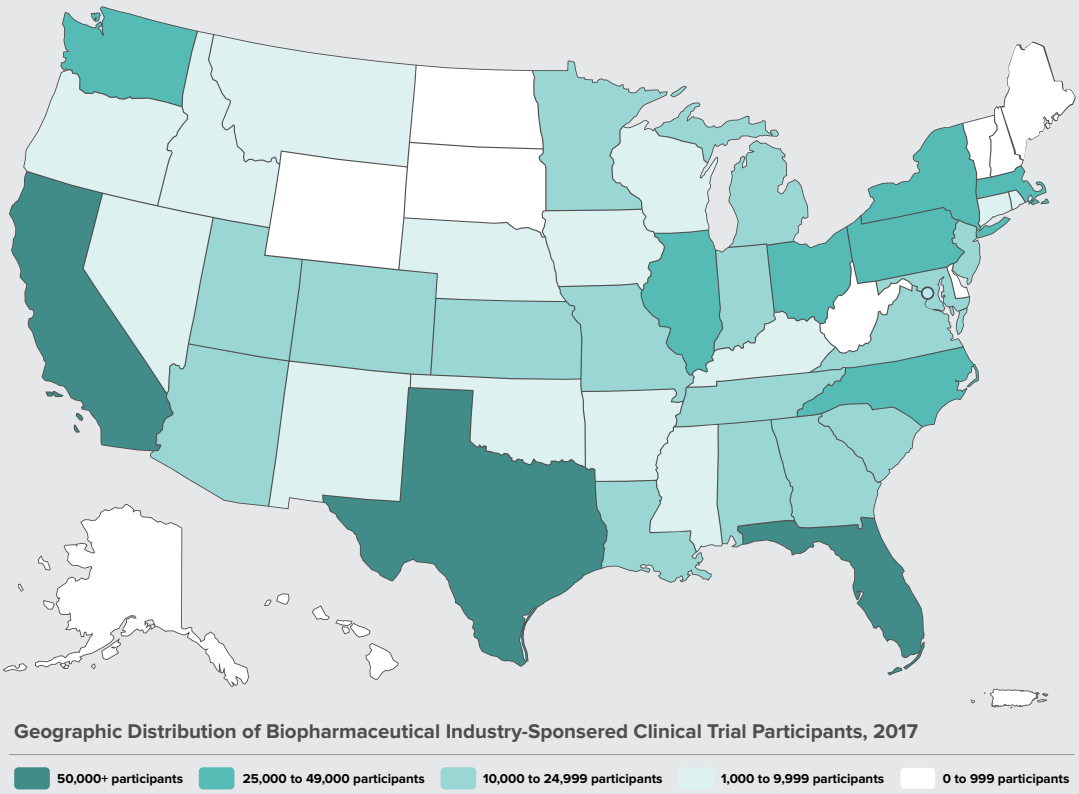
All States Impacted by Biopharmaceutical Industry-Sponsored Clinical Trials

Developing a new prescription medicine is a long and complex process, where most drug candidates fail, and those that succeed can take 10 to 15 years to reach FDA approval. ***The report Biopharmaceutical Industry-Sponsored Clinical Trials: Growing State Economies*** sheds light on the investments and economic activity generated specifically by clinical trials, the most time-consuming and expensive part of the drug development process.

The report estimates the impact of industry-sponsored clinical trials active in the U.S. at some point in 2017, the most recent year for which data were available. The report focuses solely on investments at clinical trial sites, which are only a portion of the full R&D enterprise supported by the U.S. biopharmaceutical industry.

Key findings from this report include:

- America's biopharmaceutical companies sponsored more than 4,500 clinical trials in 2017 alone.
- These sponsored trials involved more than 920,000 participants, with active trial sites in all 50 states, the District of Columbia, and Puerto Rico.
- The biopharmaceutical industry invested more than $15 billion in 2017 on site-based clinical research activities at trial sites across the U.S.. Yet, these resources represent just a portion of overall R&D costs.
- Including the ripple effect of expenditures by clinical research organizations, vendors, contractors, and employees, biopharmaceutical industry investments at U.S. clinical trial sites supported more than $42 billion in economic activity in communities throughout the U.S.



Geographic Distribution of Biopharmaceutical Industry-Sponsered Clinical Trial Participants, 2017

Source: *Biopharmaceutical Industry-Sponsored Clinical Trials: Growing State Economies, TEConomy Partners for Pharmaceutical Research and Manufacturers of America (PhRMA), April 2019.*

DISCUSSION

The U.S. biopharmaceutical industry is a significant and innovative component of the nation's economy, with a varied occupational base and extensive research, manufacturing, and distribution infrastructure that yields significant impacts on economies across the country. What drives and sustains the success of the biopharmaceutical industry is its broad innovation ecosystem. Led by by both small and large R&D-intensive companies, this innovation ecosystem also draws upon a rich network of collaborators, including but not limited to: venture and other forms of private capital; health care providers; public and private sector researchers, including academic medical researchers and private research institutes, and many other sectors supporting the discovery, development, and delivery of new medicines to patients.

The strength of the U.S. biopharmaceutical innovation ecosystem and innovation-based policies has resulted in the nation being the global leader in biopharmaceutical innovation. This global position in turn has resulted in the U.S. biopharmaceutical industry generating the following economic impacts:

- With more than 811,000 workers and a substantial employment multiplier of 4.98, the U.S. biopharmaceutical industry supported approximately 3.2 million additional U.S. jobs for a total of more than 4.0 million jobs in 2017.
- With average annual wages and benefits of more than $126,500—more than twice the U.S. average across all industries—biopharmaceutical industry jobs are both high-wage and high-quality.
- The biopharmaceutical industry reached $560 billion in direct output in 2017, and with the ripple effect of this production throughout the U.S. economy, an additional $589 billion in output was generated by suppliers and other sectors of the economy.
- Combined, the total output impact of the U.S. biopharmaceutical industry was more than $1.1 trillion—representing 3.4 percent of the total U.S. (including the District of Columbia and Puerto Rico) output in 2017.

The nation's biopharmaceutical industry is clearly a major U.S. economic driver. By the nature of its activities, it is also one of the nation's most innovative industries—positioned for breakthroughs yielding enormous societal benefits and economic impacts into the future. To realize this future, the U.S. biopharmaceutical industry must be supported by robust innovation policies starting with strong intellectual property protections, a well functioning and evidence-based regulatory system, research and development incentives,and coverage and payment policies that recognize the value of medical innovation.

To continue to sustain and grow this important U.S. industry and ensure its continued contributions to the U.S. economy, this robust policy framework is needed to support the long, costly, and risky investments vital to meeting U.S. patient needs. Fostering an environment that will improve the private sectors' ability to harness scientific discoveries and translate those into new medical advances to meet the needs of patients while continuing to create and sustain high-wage, high-skill jobs is critical to ensuring that the substantial economic impacts of the biopharmaceutical industry continue to be realized at the national and state levels. A long-term commitment to science, technology, and innovation is vital to enabling U.S. biopharmaceutical companies to improve health outcomes and establish the foundation for economic growth and jobs of the future. The challenges are large, but so too are the opportunities.

Endnotes

1 *National Center for Science and Engineering Statistics, National Science Foundation, 2017 Higher Education Research and Development Survey.*

2 *See Appendix B for a detailed discussion of data sources and methodology.*

3 *It should be noted that pharmaceutical manufacturing, part of a broader chemicals manufacturing sector drives this higher value-added per employee. Overall chemical manufacturing's productivity is $435,000 per worker, with pharmaceutical manufacturing, by itself, reaching more than $640,000 per worker.*

4 *Using U.S. Bureau of Labor Statistics 2017 Occupational Employment by Industry data and the individual biopharmaceutical subsector employment totals, weighted shares of U.S. total sector occupational employment are developed for this analysis.*

5 *2017 is the most current year available for the IMPLAN I/O tables.*

6 *Total U.S. output and value-added as estimated by the 2017 U.S. IMPLAN model. Output does not correspond to U.S. GDP.*


BALL VALVE
MEDICINE
POWER
EMERGENCY
MIXER
RPM METER
SPEED
ON
OFF

APPENDIX A: METHODOLOGY

The following narrative provides an overview of the approach used to develop the 2017 biopharmaceutical industry employment and economic impact estimates at the national and state levels.

Data Sources

Estimates of biopharmaceutical industry employment were derived by combining several widely used public and private data sources.

2017 Quarterly Census of Employment and Wages: Employment data for all relevant components of the biopharmaceutical industry were obtained from the U.S. Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) for 2017. QCEW establishment, employment, and wage data is captured by each state as part of corporate unemployment insurance data collection efforts and reported nationally to the BLS. QCEW employment data are categorized into industry sectors and subsectors using the North American Industrial Classification System (NAICS), which is the standard used by Federal statistical agencies to classify business establishments.

A single company in the biopharmaceutical industry can have many establishments (locations) throughout the U.S., and that company's establishments can be classified into different NAICS categories. For example, a biopharmaceutical company may have a manufacturing facility in one location, an R&D facility in another location, and corporate offices in a third location. At the same time, companies often have these functions co-located, for example R&D and manufacturing in the same location. In these co-location cases the establishment is generally assigned to the NAICS category associated with the primary activity at that location.

U.S. and state-level (including the District of Columbia and Puerto Rico) biopharmaceutical industry employment is estimated by aggregating employment across all establishments determined to belong to the biopharmaceutical industry based on their NAICS classification, with refinements, using the approach described later in this Appendix.

2017 Current Population Survey: The BLS Current Population Survey (CPS) is a national-level survey that estimates the total employment spectrum of the U.S. including public and private sector wage and salary employees, corporate and self-employed workers, and unpaid family workers. While the QCEW data captures nearly all industry employment (approximately 98 percent of all U.S. jobs), it does not capture sole proprietors, consultants, contract employees, representatives, and other "non-corporate" or "self-employed" private sector employment. CPS data were used to adjust the QCEW data to estimate the full spectrum of biopharmaceutical industry employment.

2012 Economic Census: Some NAICS categories include a combination of biopharmaceutical industry jobs and non-biopharmaceutical industry jobs. To determine the share of these sectors attributable to the biopharmaceutical industry, U.S. and state-level data from U.S. Economic Census were used to estimate the share of biopharmaceutical-relevant economic activity within these NAICS codes.

Every five years the U.S. Census Bureau performs the national economic census to examine the detailed economic activities of U.S. industry, with the most recent survey occurring in 2012. Due to the extensive time requirements to process these substantial data sets, state-level 2012 Economic Census were only fully released at the end of 2016, and are therefore the most recent available for use in estimating some aspects of 2017 industry employment. For the 2017 estimates of biopharmaceutical industry employment in this report, state and U.S. level data from the 2012 Economic Census were used for the product code-level detail necessary to refine the QCEW employment data where necessary.

Dun & Bradstreet: With specific corporate examples to work from, individual biopharmaceutical-related Dun & Bradstreet (D&B) establishment records identified as "headquarters" were examined. For those establishments that appeared to be dedicated to management activities only, additional work was performed including examination of corporate websites for additional location and employment information for these administrative locations. Based upon this analysis, employment was estimated for a number of key establishments and locations, for inclusion as part of the overall biopharmaceutical industry.

2017 IMPLAN Models: The wider economic impact of the biopharmaceutical industry was estimated using the well-established regional economic analysis technique of input/output analysis (I/O), using custom I/O models from IMPLAN. The I/O analysis produces estimates of the economic impacts of the biopharmaceutical industry on output in the U.S. economy, on jobs, personal income, and federal, state, and local taxes.

The IMPLAN models' data matrices track the flow of commodities to industries from producers and institutional consumers within the nation or within individual states. The data also model consumption activities by workers, owners of capital, and imports. The inter-industry trade flows built into the model permit estimating the impacts of one sector on all other sectors with which it interacts within the specified geography.

The Structure of the U.S. Biopharmaceutical Industry

The biopharmaceutical industry's wide range of activities is spread across a set of distinct NAICS industries within the U.S. economy. For purposes of this analysis, these NAICS categories can be collapsed into four subsectors: biopharmaceutical manufacturing, biopharmaceutical distribution, biopharmaceutical R&D, and biopharmaceutical corporate offices (**Table A1**).

Table A1. NAICS Structure Relevant to Biopharmaceutical Industry

2017 NAICS Codes Related to Biopharmaceutical Subsectors
Biopharmaceutical Manufacturing
325411 Medicinal and botanical manufacturing
325412 Pharmaceutical preparation manufacturing
325413 In-vitro diagnostic substance manufacturing
325414 Biological product (except diagnostic) manufacturing
Biopharmaceutical Distribution
424210 Drugs and druggists' sundries merchant wholesalers*
Biopharmaceutical R&D
541714 R&D in biotechnology (except nanobiotechnology)
541715 R&D in the physical, engineering, and life sciences (except nanotech and biotech)*
541720 R&D in the social sciences and humanities*
Biopharmaceutical Corporate Offices
551114 Corporate, subsidiary, and regional managing offices*

**Indicate NAICS categories that include both biopharmaceutical and non-biopharmaceutical employment, and which additional refinement is therefore necessary.*

Biopharmaceutical Manufacturing

Biopharmaceutical manufacturing is defined to include 100 percent of the employment within NAICS 3254. While a very small portion of the manufacturing activity of companies falling into these codes may be for products not considered drugs or pharmaceuticals, the intent of these codes is to capture the manufacturers of medicines, vaccines, diagnostics, and related-biopharmaceuticals.

Biopharmaceutical Distribution

The increasing importance of firms involved in the logistics and distribution of biopharmaceutical products, both in managing large and complex supply chains and as a source for industry innovation is acknowledged through their inclusion in this value-chain approach to estimating the size and impacts of the biopharmaceutical industry.

To more succinctly specify biopharmaceutical industry-related estimate from NAICS 4242 (Drugs and druggists' sundries merchant wholesalers), estimates are made of the size of these non-biopharmaceutical activities (e.g., "druggist sundries", miscellaneous medical equipment, and other retail product distribution) using data from the 2012 Economic Census. The size of this non-biopharmaceutical share across the states ranges from less than 1 percent to 80 percent with the U.S. average being 12 percent. The resulting estimate of biopharmaceutical distribution employment for all of the U.S. represents 86.8 percent of this four-digit NAICS.

Biopharmaceutical R&D

Biopharmaceutical R&D was defined to include all of one NAICS code and a portion of two others. For these data additional considerations had to be made to use the 2012 Economic Census data (provided using a 2012 NAICS basis) with the 2017 NAICS-based employment data.

For 2017 NAICS 541714 (R&D in biotechnology except nanobiotechnology) is included in its entirety, as the vast majority of work in this sector is of a biomedical nature or directly applicable to biopharmaceutical development, and therefore did not require any data sharing procedures.

The share of jobs in NAICS 541715 (R&D in the physical, engineering, and life sciences [except nanotechnology and biotechnology]) specific to the biopharmaceutical industry was estimated by applying information derived from 2012 Economic Census data for NAICS 541712 and applying that share to the 2017 employment from NAICS 541715. **Table A2** shows 2012 Economic Census data at the NAICS-level data within the broader NAICS 5417 (Scientific R&D services) hierarchy.

Table A2. Overview of NAICS-level detail within Economic Census, Total Establishments, and Receipts, 2012

NAICS Code and Description		Industry Total Estabs., 2012	Industry Total Receipts 2012 ($1000)
5417	Scientific R&D services	14,125	93,467,639
54171	Physical, engineering, and biological research	13,053	91,509,528
541711	R&D in biotechnology	2,761	16,348,066
541712	R&D in physical, engineering, & life sciences [except biotech]	10,292	75,161,462
54172	R&D in the social sciences and humanities	1,072	1,958,111

Source: *U.S. Bureau of the Census, Economic Census 2012*

Table A3 provides Economic Census the "product code" structure for NAICS 541712. The adjustments made assume the product codes most relevant to capturing the size of the biopharmaceutical R&D sector are the basic and applied research performed in the biotechnology product code (39170), the basic and applied research performed in pharmaceutical science product code (39181), and a share of the basic and applied research performed in the medical/health product code (39182). The determination of this combined share of R&D to be considered "biopharmaceutical-related" were also applied to other receipt based product codes (e.g., 39400, licensing of rights to use intellectual property), to capture a portion of these receipts as related to the biopharmaceutical R&D function. This overall value was then used to capture a share of NAICS 54172 to be then applied to the 2017 employment. Though using a financial share to estimate an employment share has limitations, the high-cost nature of biopharmaceutical R&D increases the acceptability of this estimation procedure.

Table A3. 2012 Economic Census Key Biopharmaceutical R&D-related Product Codes for NAICS 541712

Key Product Codes and Descriptions (Major and Subcategories)	
30000	Industry total
39020	Testing services (physical/product), excluding medical & veterinary services
39170	Basic/applied research in biotechnology
39180	Basic/applied research in the life sciences, excluding biotechnology
39181	Basic/applied research life sciences, excluding biotech - Pharma science
39182	Basic/applied research in the life sciences - Med/health sciences
39183	Basic/applied research in the life sciences - Biological science
39184	Basic/applied research life sciences, excluding biotech - Ag, forestry
39185	Basic/applied research - Animal production, fisheries, & veterinary science
39186	Basic/applied research in the life sciences - Other life science
39190	Basic/applied research in the social sciences & humanities
39210	Development services for goods
39220	Development services for processes, systems, or methods
39250	Outright sale of original works of intellectual property
39260	Advisory & consulting services for research & development activities
39280	Engineering services
39400	Licensing of rights to use intellectual property
39600	Resale of merchandise
39700	All other operating receipts

Notes: *Establishments can be counted in more than one product code. Not all product codes are shown in this table.*

Source: *U.S. Bureau of the Census, Economic Census 2012*

Usinga similar procedure, a very small share of the employment in NAICS 54172 (R&D in the social sciences and humanities) was also included as biopharmaceutical industry employment due to the inclusion of biopharmaceutical-related product code details in this NAICS. For the U.S. overall and for key, large biopharmaceutical states, the 2012 Economic Census include the “biotech R&D” product code within social science industry code NAICS 54172. This procedure added approximately 3,200 biopharmaceutical R&D jobs to the U.S. estimate.

Combining the three components of Scientific R&D services, this procedure estimates that 44 percent of NAICS 5417 Scientific R&D services should be classified as belonging to the biopharmaceutical industry. This percentage captures employment involved in biotechnology activities, pharmaceutical sciences research including CRO activities, and other medical and health related R&D.

Biopharmaceutical Corporate Offices

A characteristic at the core of the NAICS classification scheme is to allow for the classification of individual establishments based upon the functions occurring within a particular establishment. As with all large, multinational industries such as automotive and aerospace, a meaningful share of biopharmaceutical industry employment is captured within Management of Companies and Enterprises (NAICS 5511). To assess the level of this biopharmaceuetical industry employment a special estimation efforts were required to assess these locations' impacts. With specific corporate information to work from, individual biopharmaceutical-related Dun & Bradstreet (D&B) establishment records identified as biopharmaceutical "headquarters" were examined to ascertain whether any significant manufacturing or R&D activities were occurring within these establishments that would allow these locations to be classified by public sector data collection agencies as either NAICS 3254 – Pharmaceutical and medicine manufacturing; or NAICS 5417 – Scientific research and development (R&D) services. For those establishments that appeared to be dedicated to management activities only, additional work was performed including examination of corporate websites for additional location information to determine if this employment would most likely be classified in NAICS 5511 by public sector data collection agencies. Based upon this analysis, employment was estimated for a number of key establishments and locations, for inclusion as part of the overall biopharmaceutical industry. Headquarters employment for key firms in the biopharmaceutical distribution sector is also estimated in this fashion, consistent with the value chain approach used in this report to estimate the size of the biopharmaceutical industry. Of the total 2017 employment in U.S. establishments that are classified as corporate offices, this approach estimates that 1.3 percent should be considered biopharmaceutical industry employment.

It is important to recognize that these four defined "sectors" are based on establishment-level data where a single NAICS code is assigned to the establishment (i.e., the physical business location). The specific NAICS code is determined by the predominant or primary business activity occurring within the location, and is typically determined by factors such as relative share of production costs, revenue, value of shipments, and in some instances employment. Since within the BLS QCEW data all jobs within an establishment are assigned to the establishment's single NAICS code, sector-based job counts may over- or under-state actual employment by function to the extent multiple activities occur at a single establishment (e.g., collocated R&D and manufacturing). The total employment estimate is not affected, however.

Additional Refinements

For three of the four biopharmaceutical sectors – biopharmaceutical manufacturing, biopharmaceutical distribution, and biopharmaceutical R&D – CPS data are used to adjust the employment estimates to reflect the inclusion of self-employed workers. The CPS provides an estimate of the ratio of "self-employed" workers to the number of "private sector wage and salary workers" or corporate employment for each biopharmaceutical sector's grouping of NAICS codes. This share ranges from 0.4 percent in biopharmaceutical manufacturing to 1.7 percent in biopharmaceutical distribution in 2017. This share ratio is applied to the QCEW-based biopharmaceutical sector employment to arrive at a final biopharmaceutical sector employment estimate. Biopharmaceutical headquarters employment is not adjusted because CPS survey respondents identify their employment based upon more traditional industry sectors (e.g., process consultants would identify with the biopharmaceutical manufacturing sector, not corporate headquarters).

Final Biopharmaceutical Employment Estimates

A summary of the NAICS-based employment for the components of the biopharmaceutical industry are provided in **Table A4**. The data entries show the estimated share of employment within that sector (four-digit NAICS code) that is attributed to the biopharmaceutical industry, the 2017 employment estimate, and the subsector's share of total biopharmaceutical industry employment.

Table A4. Final U.S. Biopharmaceutical Industry Subsector Estimates, 2017

Biopharmaceutical Subector	NAICS Codes (4 Digit)	U.S. NAICS Total Employment	Biopharma Share of Sector	Biopharma-Related Sector Employment	Share of Total Biopharma Employment
Biopharmaceutical Manufacturing	3254 Pharmaceutical and medicine manufacturing	307,585	100.0%	307,585	37.9%
Biopharmaceutical Distribution	4242 Drug and druggist sundries wholesale	207,933	86.8%	180,499	22.3%
Biopharmaceutical R&D	5417 Scientific research and development (R&D)	667,087	44.0%	293,426	36.2%
Biopharmaceutical Corporate Offices	5511 Management of companies and enterprises	2,291,629	1.3%	29,643	3.7%
Total U.S. Biopharmaceutical Industry				**811,153**	**100.0%**

Source: *TEConomy Partners analysis, calculations and estimations using 2017 BLS QCEW and CPS Employment Data. Data include the 50 States, the District of Columbia, and Puerto Rico.*

Total Economic Impact of the Biopharmaceutical Industry

The wider economic impact of the biopharmaceutical industry was estimated using the well-established economic analysis technique of input/output analysis (I/O), using custom I/O models from IMPLAN for each state, the District of Columbia, and Puerto Rico, as well as a U.S. national model. The IMPLAN models' data matrices track the flow of commodities to industries from producers and institutional consumers within the specific region. The data also model consumption activities by workers, owners of capital, and imports. The inter-industry trade flows built into the models permit estimating the impacts of one sector on all other sectors with which it interacts.

The biopharmaceutical industry employment estimates described above serve as the inputs to the I/O model. The models' results, which include the impacts typically measured in an economic impact study, are the expenditure impacts of the biopharmaceutical industry. They quantify direct, indirect, and induced job creation, associated personal incomes, business output, and associated revenues to federal, state and local taxing jurisdictions.

APPENDIX B: STATE-LEVEL ESTIMATES

Table B1. U.S. and State Employment: Direct, Indirect, and Induced Effects and Total Impacts, 2017

State	Employment				
	Direct Effects	Indirect Effects	Induced Effects	Total Impacts	Multiplier
U.S. Total (incl. District of Columbia and Puerto Rico)	**811,153**	**1,421,891**	**1,805,928**	**4,038,972**	**4.98**
Alabama	3,507	5,660	5,221	14,388	4.10
Alaska	160	91	109	360	2.25
Arizona	8,408	15,855	17,270	41,533	4.94
Arkansas	822	1,695	1,309	3,827	4.66
California	139,650	260,758	359,360	759,768	5.44
Colorado	8,621	16,560	20,551	45,732	5.30
Connecticut	8,963	8,310	18,160	35,433	3.95
Delaware	4,963	4,186	8,027	17,176	3.46
District of Columbia	637	450	397	1,485	2.33
Florida	25,757	49,564	55,582	130,903	5.08
Georgia	11,611	20,204	25,167	56,982	4.91
Hawaii	903	793	890	2,586	2.86
Idaho	938	1,493	1,435	3,866	4.12
Illinois	40,764	81,259	124,726	246,749	6.05
Indiana	24,658	48,323	66,964	139,944	5.68
Iowa	5,590	7,144	9,081	21,815	3.90
Kansas	5,805	11,565	10,224	27,593	4.75

State	Employment				
	Direct Effects	Indirect Effects	Induced Effects	Total Impacts	Multiplier
Kentucky	5,284	6,567	7,358	19,208	3.64
Louisiana	2,751	3,112	3,461	9,324	3.39
Maine	4,543	8,634	9,958	23,135	5.09
Maryland	30,550	40,577	58,661	129,787	4.25
Massachusetts	60,738	85,451	138,170	284,359	4.68
Michigan	15,982	32,372	38,131	86,485	5.41
Minnesota	7,600	13,206	19,305	40,111	5.28
Mississippi	1,800	3,686	2,520	8,006	4.45
Missouri	12,270	24,010	29,776	66,055	5.38
Montana	846	988	980	2,814	3.33
Nebraska	3,119	5,636	5,878	14,633	4.69
Nevada	2,145	4,242	3,494	9,881	4.61
New Hampshire	2,404	3,877	4,947	11,227	4.67
New Jersey	60,715	97,145	147,397	305,258	5.03
New Mexico	3,575	4,051	4,858	12,484	3.49
New York	55,163	85,093	90,565	230,821	4.18
North Carolina	44,969	97,907	108,177	251,053	5.58
North Dakota	283	241	290	814	2.88
Ohio	20,892	32,717	37,207	90,816	4.35
Oklahoma	2,772	4,236	3,880	10,888	3.93
Oregon	4,183	6,295	6,828	17,306	4.14
Pennsylvania	46,830	82,903	124,143	253,876	5.42
Puerto Rico	17,902	42,691	17,410	78,003	4.36
Rhode Island	1,929	5,238	6,088	13,254	6.87

State	Employment				
	Direct Effects	Indirect Effects	Induced Effects	Total Impacts	Multiplier
South Carolina	5,137	10,519	9,029	24,685	4.81
South Dakota	320	268	398	986	3.08
Tennessee	12,142	16,208	18,084	46,435	3.82
Texas	38,039	72,242	85,974	196,255	5.16
Utah	12,332	33,465	27,425	73,222	5.94
Vermont	1,157	1,666	1,867	4,690	4.05
Virginia	9,706	14,138	16,773	40,617	4.18
Washington	15,398	19,575	22,046	57,018	3.70
West Virginia	4,685	9,329	8,696	22,709	4.85
Wisconsin	10,931	19,197	21,393	51,521	4.71
Wyoming	304	500	290	1,094	3.60

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2017 models.

Table B2. U.S. and State Output: Direct, Indirect, and Induced Effects and Total Impacts, 2017

State	Output ($ Millions)				
	Direct Effects	Indirect Effects	Induced Effects	Total Impacts	Multiplier
U.S. Total (incl. District of Columbia and Puerto Rico)	**$560,931.2**	**$295,662.6**	**$292,913.1**	**$1,149,506.9**	**2.05**
Alabama	$2,296.2	$996.5	$746.1	$4,038.8	1.76
Alaska	$39.7	$17.1	$17.8	$74.5	1.88
Arizona	$3,542.5	$2,889.2	$2,708.7	$9,140.4	2.58
Arkansas	$497.0	$335.6	$184.3	$1,016.9	2.05
California	$106,521.0	$58,945.9	$64,948.1	$230,415.0	2.16
Colorado	$4,373.3	$3,522.8	$3,322.4	$11,218.5	2.57
Connecticut	$4,275.9	$1,712.6	$3,023.8	$9,012.3	2.11
Delaware	$1,745.7	$831.2	$1,245.3	$3,822.2	2.19
District of Columbia	$252.3	$114.5	$70.6	$437.4	1.73
Florida	$11,607.1	$8,929.7	$8,489.7	$29,026.6	2.50
Georgia	$5,624.1	$3,917.6	$3,806.5	$13,348.1	2.37
Hawaii	$199.9	$134.2	$149.4	$483.5	2.42
Idaho	$454.4	$256.8	$198.5	$909.7	2.00
Illinois	$34,354.7	$18,407.6	$20,233.0	$72,995.3	2.12
Indiana	$36,380.9	$9,489.2	$9,750.9	$55,620.9	1.53
Iowa	$3,266.7	$1,344.2	$1,281.8	$5,892.7	1.80
Kansas	$3,190.7	$2,214.0	$1,511.6	$6,916.3	2.17
Kentucky	$2,223.6	$1,125.2	$1,041.0	$4,389.8	1.97
Louisiana	$1,066.8	$546.2	$497.4	$2,110.5	1.98
Maine	$2,235.8	$1,526.1	$1,399.2	$5,161.1	2.31
Maryland	$16,167.4	$7,930.9	$9,712.2	$33,810.5	2.09

State	Output ($ Millions)				
	Direct Effects	Indirect Effects	Induced Effects	Total Impacts	Multiplier
Massachusetts	$29,615.2	$18,272.0	$23,010.3	$70,897.5	2.39
Michigan	$10,606.3	$6,528.1	$5,649.2	$22,783.6	2.15
Minnesota	$3,829.0	$2,888.9	$3,071.1	$9,789.1	2.56
Mississippi	$1,261.8	$655.2	$347.3	$2,264.3	1.79
Missouri	$7,067.4	$4,757.0	$4,316.8	$16,141.2	2.28
Montana	$285.4	$157.7	$130.8	$573.9	2.01
Nebraska	$2,131.6	$1,165.4	$854.0	$4,151.0	1.95
Nevada	$1,042.4	$796.8	$555.2	$2,394.4	2.30
New Hampshire	$1,181.0	$776.0	$751.7	$2,708.7	2.29
New Jersey	$37,289.2	$21,171.0	$24,979.1	$83,439.3	2.24
New Mexico	$1,263.3	$665.1	$684.2	$2,612.7	2.07
New York	$30,844.5	$20,646.6	$15,615.4	$67,106.5	2.18
North Carolina	$39,180.9	$19,038.0	$16,244.1	$74,463.0	1.90
North Dakota	$117.8	$44.7	$43.9	$206.5	1.75
Ohio	$10,482.0	$6,122.4	$5,461.0	$22,065.4	2.11
Oklahoma	$1,238.2	$747.7	$571.1	$2,557.1	2.07
Oregon	$1,673.6	$1,158.1	$1,023.0	$3,854.6	2.30
Pennsylvania	$30,203.4	$18,087.2	$19,018.2	$67,308.7	2.23
Puerto Rico	$48,485.9	$7,182.7	$1,975.0	$57,643.6	1.19
Rhode Island	$1,592.9	$1,126.5	$933.9	$3,653.3	2.29
South Carolina	$3,689.8	$1,869.5	$1,260.8	$6,820.2	1.85
South Dakota	$79.3	$43.4	$57.1	$179.7	2.27
Tennessee	$4,706.4	$2,902.6	$2,842.7	$10,451.7	2.22

State	Output ($ Millions)				
	Direct Effects	Indirect Effects	Induced Effects	Total Impacts	Multiplier
Texas	$25,168.8	$14,795.5	$13,832.6	$53,796.9	2.14
Utah	$7,034.6	$6,125.3	$4,156.0	$17,315.9	2.46
Vermont	$571.7	$300.0	$258.3	$1,130.1	1.98
Virginia	$4,352.0	$2,904.9	$2,644.9	$9,901.7	2.28
Washington	$5,545.8	$4,025.8	$3,920.4	$13,491.9	2.43
West Virginia	$4,640.6	$1,722.2	$1,167.9	$7,530.7	1.62
Wisconsin	$5,176.4	$3,704.5	$3,156.4	$12,037.3	2.33
Wyoming	$258.1	$94.7	$42.6	$395.4	1.53

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2017 models.

Table B3. U.S. and State Occupational Share Estimates, 2017

State	Life, Physical, and Social Science	Production	Office and Administrative Support	Management	Business and Financial Operations	Architecture and Engineering	Sales and Related Support	Computer and Mathematical	Transportation and Material Moving	All Other Occupational Categories
U.S. Total (incl. District of Columbia and Puerto Rico)	16%	15%	13%	12%	9%	8%	8%	6%	5%	9%
Alabama	12%	17%	15%	11%	8%	6%	12%	4%	8%	9%
Alaska	4%	8%	22%	9%	7%	2%	22%	2%	14%	9%
Arizona	11%	14%	16%	11%	8%	6%	14%	4%	8%	9%
Arkansas	16%	21%	11%	11%	8%	7%	7%	5%	5%	8%
California	17%	14%	12%	12%	9%	9%	7%	7%	4%	9%
Colorado	12%	17%	14%	11%	8%	6%	12%	4%	7%	9%
Connecticut	12%	13%	15%	13%	11%	7%	9%	7%	5%	9%
Delaware	8%	5%	20%	16%	17%	6%	6%	10%	3%	10%
District of Columbia	17%	8%	14%	12%	9%	10%	9%	7%	5%	9%
Florida	11%	12%	17%	10%	8%	6%	15%	4%	9%	9%
Georgia	13%	13%	15%	11%	8%	7%	12%	5%	7%	9%
Hawaii	14%	5%	16%	11%	8%	8%	13%	6%	8%	10%
Idaho	14%	23%	12%	11%	8%	6%	8%	4%	5%	8%
Illinois	12%	18%	14%	12%	9%	6%	10%	5%	6%	9%
Indiana	16%	25%	10%	12%	9%	7%	5%	5%	3%	8%
Iowa	17%	21%	10%	12%	8%	8%	6%	6%	4%	8%
Kansas	19%	18%	10%	12%	9%	10%	5%	7%	3%	9%
Kentucky	11%	14%	16%	11%	8%	6%	14%	4%	8%	9%

State	Life, Physical, and Social Science	Production	Office and Administrative Support	Management	Business and Financial Operations	Architecture and Engineering	Sales and Related Support	Computer and Mathematical	Transportation and Material Moving	All Other Occupational Categories
Louisiana	8%	10%	19%	10%	7%	4%	18%	4%	11%	9%
Maine	17%	17%	11%	12%	8%	8%	7%	6%	4%	9%
Maryland	22%	11%	10%	13%	9%	12%	4%	9%	2%	9%
Massachusetts	22%	7%	10%	13%	10%	13%	4%	10%	2%	10%
Michigan	12%	19%	14%	12%	9%	6%	10%	5%	6%	9%
Minnesota	13%	19%	13%	11%	8%	6%	10%	4%	6%	9%
Mississippi	13%	22%	12%	11%	8%	6%	9%	4%	6%	8%
Missouri	15%	18%	12%	11%	8%	7%	9%	5%	6%	9%
Montana	16%	19%	11%	11%	8%	8%	7%	6%	4%	9%
Nebraska	14%	20%	12%	11%	8%	6%	9%	5%	6%	8%
Nevada	15%	17%	13%	11%	8%	7%	9%	5%	6%	9%
New Hampshire	17%	20%	11%	12%	8%	8%	7%	6%	4%	8%
New Jersey	15%	14%	13%	12%	10%	8%	8%	7%	5%	9%
New Mexico	22%	8%	10%	13%	9%	13%	4%	9%	2%	9%
New York	16%	14%	12%	12%	10%	9%	6%	7%	4%	9%
North Carolina	18%	17%	11%	12%	9%	9%	6%	6%	4%	9%
North Dakota	12%	10%	16%	11%	8%	7%	14%	5%	8%	9%
Ohio	12%	11%	16%	12%	10%	7%	10%	6%	6%	9%
Oklahoma	13%	12%	15%	11%	8%	7%	12%	5%	7%	9%
Oregon	17%	10%	13%	12%	9%	10%	8%	7%	5%	9%
Pennsylvania	17%	15%	12%	12%	9%	9%	7%	7%	4%	9%

State	Life, Physical, and Social Science	Production	Office and Administrative Support	Management	Business and Financial Operations	Architecture and Engineering	Sales and Related Support	Computer and Mathematical	Transportation and Material Moving	All Other Occupational Categories
Puerto Rico	15%	25%	11%	11%	8%	6%	7%	4%	5%	8%
Rhode Island	12%	20%	14%	11%	8%	5%	12%	4%	7%	8%
South Carolina	16%	5%	15%	11%	8%	9%	11%	7%	7%	10%
South Dakota	12%	10%	16%	11%	8%	7%	14%	5%	8%	9%
Tennessee	13%	14%	15%	11%	8%	7%	12%	5%	7%	9%
Texas	16%	20%	11%	11%	8%	7%	8%	5%	5%	8%
Utah	9%	18%	16%	10%	7%	4%	15%	3%	9%	9%
Vermont	16%	11%	14%	11%	8%	9%	10%	6%	6%	9%
Virginia	20%	9%	12%	12%	9%	11%	7%	8%	4%	9%
Washington	12%	25%	12%	11%	8%	5%	10%	3%	6%	8%
West Virginia	17%	16%	12%	12%	8%	8%	7%	6%	5%	9%
Wisconsin	12%	24%	13%	11%	8%	5%	10%	3%	7%	8%
Wyoming	14%	27%	11%	11%	8%	5%	7%	3%	5%	8%

Source: U.S. Bureau of Labor Statistics 2017 Occupational Employment Survey data; TEConomy Partners data, calculations, and analysis.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