The Economic Impact of the U.S. Biopharmaceutical Industry:

National and State Estimates

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The Pharmaceutical Research and Manufacturers of America (PhRMA) represents the country's leading innovative pharmaceutical research and biotechnology companies, which are devoted to developing medicines that allow patients to live longer, healthier, and more productive lives. PhRMA companies are leading the way in the search for new treatments and cures.

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Prepared by TEConomy Partners, LLC
Prepared for the Pharmaceutical Research and Manufacturers of America

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Summary

At a time when the economic competitiveness at the national and state level 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 life-saving and quality-of-life-improving therapeutics to patients.

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 nearly 854,000 individuals in 2014. This industry also supported more than 3.5 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 supported more than 4.4 million U.S. jobs in 2014, leading to a significant industry employment multiplier of 5.21.
- The overall economic impact of the biopharmaceutical industry on the U.S. economy is substantial. The biopharmaceutical industry accounted for more than $1.2 trillion in economic output, representing 3.8 percent of total U.S. output in 2014. This total economic impact includes $558 billion in revenues from biopharmaceutical businesses and $659 billion from suppliers and worker spending.
- In 2014, the direct biopharmaceutical jobs generated $105.1 billion in total wages and benefits—averaging $123,107 per worker. This annual average compensation was more than twice the U.S. private sector average of $57,149, which is an indication of the high-quality jobs the biopharmaceutical industry provides to U.S. workers.
- Fully one-third of the U.S. biopharmaceutical industry's workers are in key science, technology, engineering, and math (STEM) occupations based upon 2014 estimates.
- The biopharmaceutical industry is also an important generator of government tax revenues through the wages and benefits provided to its employees. The analysis shows that the incomes of workers whose employment is supported by the biopharmaceutical industry—directly and through its suppliers or other affected sectors—generated more than $67 billion in federal, state, and local personal tax revenues in 2014.

Biopharmaceuticals—A Leader in U.S. Industry 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] The Congressional Budget Office's economic projections echoe the NRC, finding that nearly half of U.S. projected growth in the 2014-2024 period is estimated to be linked to rising productivity from innovation.[2] The Brookings Institution identified fifty advanced industries in the U.S.—defined by their deep investment in R&D and high share of science, technology, engineering, and math (STEM) workers—as anchors of American economic well-being by "…. encompass[ing] the nation's highest-value economic activity. As such, these industries are the country's best shot at innovative, inclusive, and sustainable growth."[3]

Not only is innovation a critical driver of the nation's economic growth, it is a key differentiator among state and regional economies. Across the U.S., there is compelling evidence of the importance of innovation to economic growth and rising living standards. According to the Information Technology Foundation's State New Economy Index, there is a strong relationship between state capacities in innovation and per capita income.[4] Economists at the Federal Reserve Bank of Cleveland found that increased innovation, as evidenced by growing levels of patent activities, stood out as one of the significant factors for explaining a state's level of per capita income, along with its level of educational attainment. Together, innovation and talent, which are highly correlated, surpassed other factors of economic growth, such as tax burdens, public infrastructure, the size of private financial markets, rates of business failure, and industry structure.[5]

"The role of innovation has been critical to economic development as the U.S. has evolved over the decades. There is a clear statistical link between innovation and gains in the standard of living."

— **Abby Joseph Cohen**
Senior Investment Strategist and President of the Global Markets Institute of Goldman Sachs, "Innovation and Economic Growth," Private Wealth Forum, Goldman Sachs.

Among U.S. industries, the biopharmaceutical industry stands out as a leader in innovation-led development (***see text box***). The comparative data can be striking. For example, the Brookings Institution in its report on advanced industries found that the biopharmaceutical industry has the highest R&D spending per worker far exceeding the next highest industry, communications equipment, by more than 57 percent.[6]

An important characteristic of the U.S. biopharmaceutical industry is that these innovation activities take place across the nation. R&D investments of established and emerging biopharmaceutical companies are geographically dispersed, with a high share of industry-sponsored clinical trial activities and patent activity found across the U.S. In 2014 alone, 21 states had more than 500 biopharmaceutical-related patents issued, and 13 of these had more than 1,000 patents issued. These activities reflect the substantial R&D activity taking place in these states.[7]

Across the country, the biopharmaceutical industry is also one of the largest sources of private business funding of research at universities and academic medical centers, and these collaborative efforts are often focused on the nation's most critical scientific and technological health challenges. In 2014, industry funding for medical science research, which comes primarily from biopharmaceutical companies, accounted for 41 percent of all private sector funding to universities. In 27 states, industry funding for medical science research accounted for at least one-third of all industry funding to university-based research.[8]

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.

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.[9]

- The biopharmaceutical industry's domestic R&D performance of $56.9 billion accounts for 17.6 percent of all domestic U.S. R&D in 2013.[10]
- The biopharmaceutical industry has one of the largest percentage of net sales devoted to R&D among all industries at 10.7 percent, and is more than four times larger than the U.S. industry average.
- The biopharmaceutical industry devotes 19.1 percent of its total domestic employment to R&D, more than 2.5 times larger than the U.S. industry average.
- The biopharmaceutical industry invests more than $114,000 per employee in R&D, the largest among key U.S. industrial sectors. This figure is more than six times larger than the R&D per employee average for all U.S. industries and more than four times larger than the manufacturing sector as a whole.
- Biopharmaceutical internal investment in domestic R&D reached $47 billion in 2013, which is 65 percent higher than the semiconductor industry, and exceeds the automotive industry by 235 percent and the aerospace industry by 370 percent.

The biopharmaceutical industry also stands out on other measures of innovation:

- **PATENTS:** The biopharmaceutical industry stands second to the semiconductor industry in U.S. patents issued, with 7,004 in 2013.
- **VENTURE CAPITAL:** The biopharmaceutical industry significantly outpaces the aerospace, automotive, and semiconductor industries in venture capital deals and funding, with 288 deals and $3.8 billion in investments for 2014. The next closest is semiconductors with 16 deals and $1.2 billion in investments.[11]
- **EMPLOYING R&D TALENT:** The biopharmaceutical industry, at 208,000 domestic R&D employees has the largest number of R&D workers compared to the aerospace, automotive and semiconductor industries.[12]

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.[13] This report provides estimates for 2014—the most recent year for which full data are available—of the total number of biopharmaceutical industry jobs in the U.S. This size estimation relies primarily on publicly-available data from the U.S. federal government. This report employs refinements to the data and methodology used to develop prior estimates to accommodate changes in the underlying data sources used in earlier analyses. The report also provides a number of economic impact measures of the U.S. biopharmaceutical industry, including total economic output, wages and benefits, and taxes. Estimates are provided for the U.S., each of the fifty states, the District of Columbia, and Puerto Rico. Estimates include both 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 economic activity of its workforce. The economic impact assessment is developed using proprietary models from the IMPLAN Group, LLC.[14]

The Broad Scope and Scale of the Biopharmaceutical Industry

The U.S. biopharmaceutical industry maintains a dynamic and integrated structure ranging from R&D to clinical testing to production of goods and services to final distribution. This structure continues to evolve, shaped by technological and scientific advancements and innovations that open up new opportunities.

Defining the Biopharmaceutical Industry

The U.S. biopharmaceutical industry is a diverse collection of establishments that together discover, develop, produce, and distribute prescription medicines. 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 product approved by the Food and Drug Administration; service companies, such as clinical research organizations (CRO) that conduct or manage clinical trials ; manufacturers that produce medicines under contract for other companies; and wholesalers and distributors specializing in prescription medicines.

A hallmark of the industry is its dynamic nature, both of its constituent companies and of the relationships among them. 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 CRO to advance a specific technology or product in development through a clinical trial, or a biopharmaceutical company may license or contract with another company to manufacture or market a medicine. Many biopharmaceutical companies also have corporate venture capital arms that provide early stage funding to a start-up with a promising project.

The core activities that define the biopharmaceutical industry nevertheless remain straightforward—biopharmaceutical R&D, biopharmaceutical manufacturing, and biopharmaceutical distribution—and it is these activities that were used to produce estimates of the size and structure of the U.S. biopharmaceutical industry. The three 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, also captures some standalone corporate headquarters 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.

The Biopharmaceutical Industry – A Generator of High-Quality Jobs

Direct employment in the biopharmaceutical industry reached 853,818 jobs across the U.S. in 2014 (TABLE 1).
Not surprising based on the importance of innovation in driving the biopharmaceutical industry, R&D employment represents 40 percent of the total direct employement of the sector. This is closely followed by employment in biopharmaceutical manufacturing, with 35 percent of the total employment base.

Direct employment in the biopharmaceutical industry reached 853,818 jobs across the U.S. in 2014.

TABLE 1: **Biopharmaceutical Industry Direct Employment by Subsector, 2014**

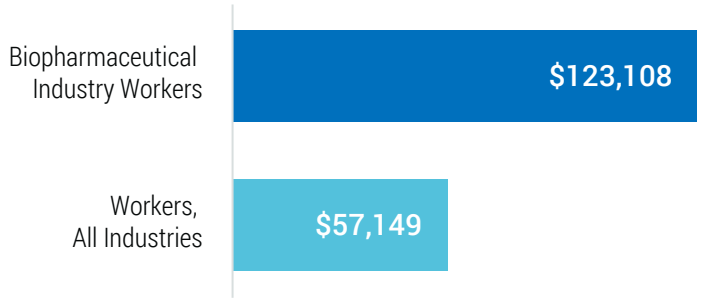
SUBSECTOR	Estimated Biopharmaceutical Subsector Employment	Share of Total Biopharmaceutical Industry Employment
Biopharmaceutical R&D	342,808	40.2%
Pharmaceutical Manufacturing	295,664	34.6%
Biopharmaceutical Distribution	181,623	21.3%
Biopharmaceutical Corporate Offices	33,723	3.9%
Total	**853,818**	**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: 2014 BLS QCEW and CPS Employment Data; TEConomy Partners analysis, calculations and estimations. Data include the 50 States, the District of Columbia, and Puerto Rico.

The biopharmaceutical industry, whether in its R&D, manufacturing, distribution, or corporate headquarters functions, is a generator of high-quality jobs. For 2014, the more than 850,000 direct biopharmaceutical industry jobs generated more than $105 billion in personal income (including both wages and benefits)—**averaging $123,108 in personal income per worker** (FIGURE 1). This is more than twice the national average of $57,149, 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 43 states having an industry wage premium 50 percent higher than the state's private sector average, and for 24 states, this premium exceeds 75 percent.

FIGURE 1: **Average Annual Employee Compensation, Biopharmeceutical Industry and Alll Industries Average**



Source: 2014 U.S. IMPLAN Model and TEConomy Partners estimations of Total Labor Income.

The Biopharmaceutical Industry Demands Highly-Skilled Talent

The 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 college degrees such as advanced manufacturing jobs to blue collar positions such as highly-skilled technicians and other production personnel. Using occupational information for the four subsectors, a composite occupational profile was developed for the U.S. biopharmaceutical industry. FIGURE 2 compares this occupational profile against the overall biophmaraceutical subsector-based employment developed for this analysis.[15] ***Details of key occupational shares, by state, are provided in Appendix B.***

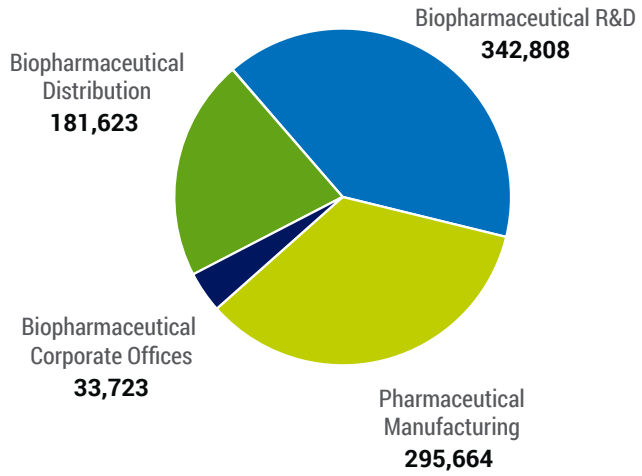
Within the occupational structure of the biopharmaceutical industry, approximately one out of every six workers (17 percent) are in the life, physical and social science occupations, a significantly higher proportion than overall private sector employment. In fact, one-third (33 percent) of the biopharmaceutical industry's workers are in key STEM occupations (i.e., life, physical and social sciences; architecture and engineering; and computer and mathematical)—more than five times higher than the all private employment share of 5.5 percent.

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 20 percent of the employment. Office and administrative workers spread across the industry account for 13 percent of the workforce. Production occupations, occurring primarily within the biopharmaceutical manufacturing subsector, also account for 13 percent of the biopharmaceutical industry's total employment. Transportation and material moving occupations related to receiving supplier inputs and shipping finished products account for 4 percent of total employment.

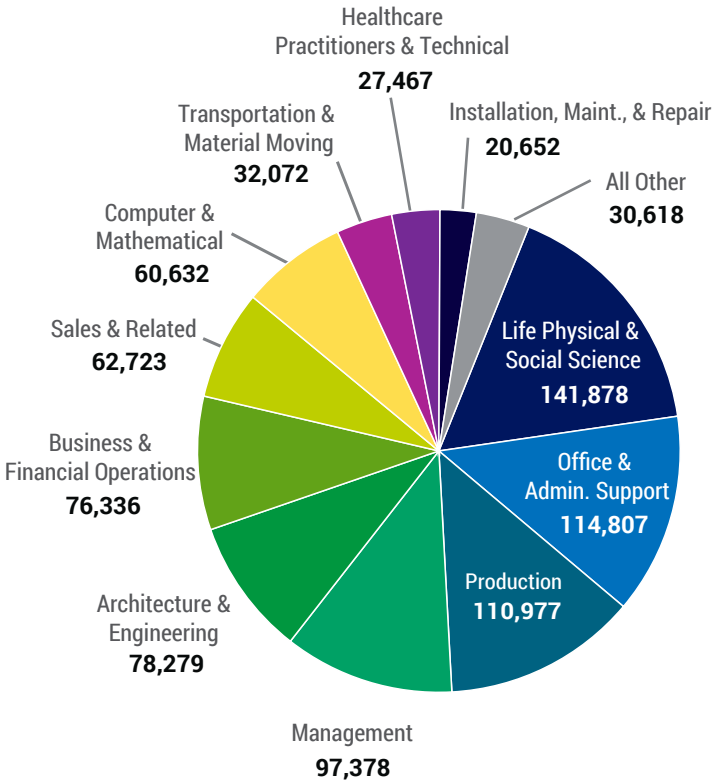
FIGURE 3 provides for additional comparison between the occupational structure of the U.S. biopharmaceutical industry and the overall U.S. average private sector occupational profile.

FIGURE 2: **Employment Profiles of the U.S. Biopharmaceutical Industry: Subsector-based and Occupational-based Employment, 2014**

NAICS-Based Employment Distribution

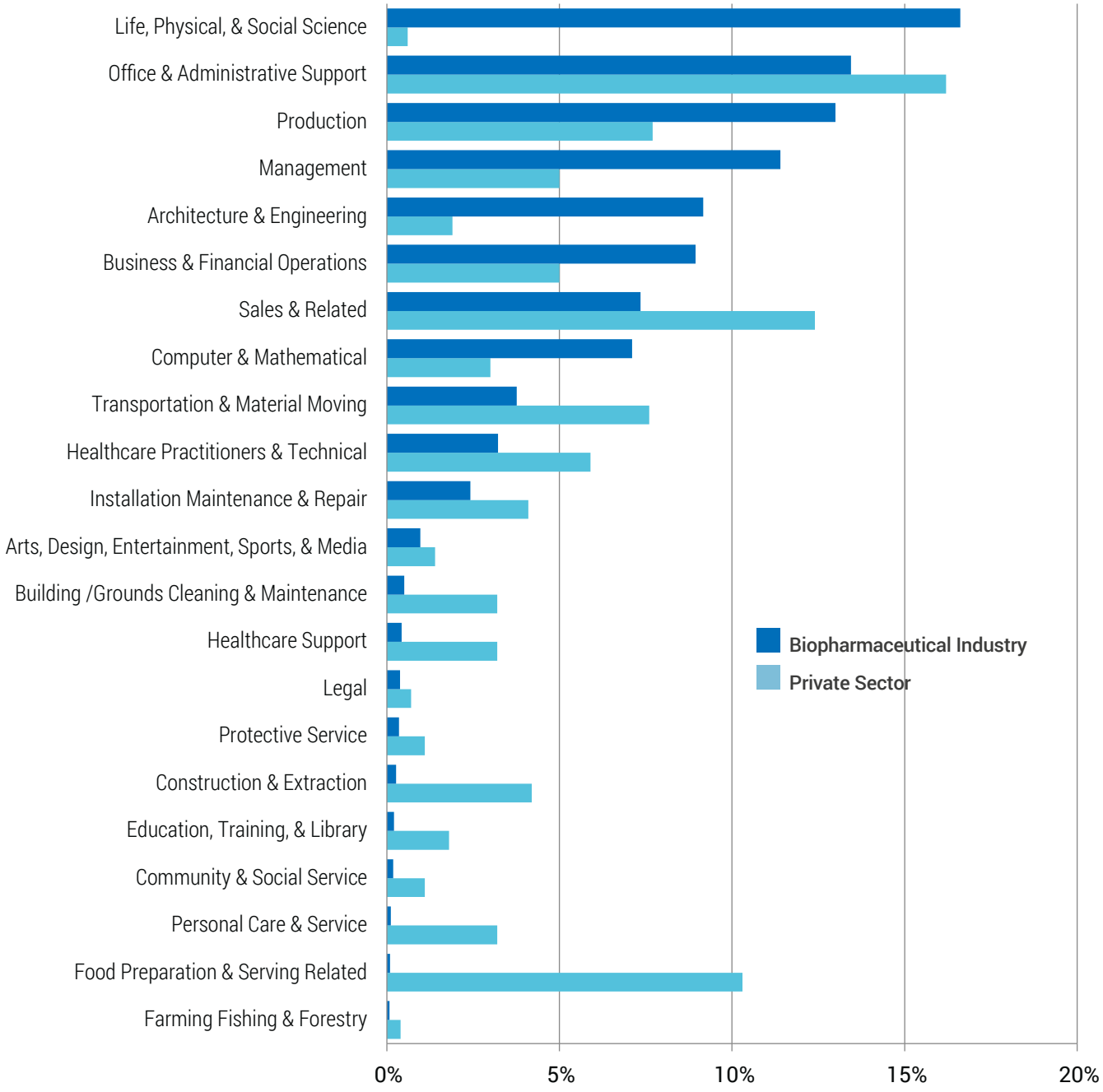


Occupational-Based Employment Distribution



Source: U.S. Bureau of Labor Statistics (BLS) QCEW and Occupational Employment by Industry for the U.S., 2014, and TEConomy Partners estimations.

FIGURE 3: **Occupational Profiles of the U.S. Biopharmaceutical Industry and Total Private Sector Employment (Percent of Jobs), 2014**

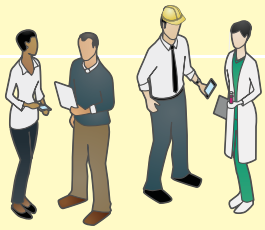


Source: U.S. Bureau of Labor Statistics (BLS) Occupational Employment by Industry for the U.S., 2014, and TEConomy Partners estimations.

From a state industry perspective, life, physical, and social scientists account for at least 15 percent of the biopharmaceutical workforce in 33 states, production workers account for at least 15 percent of the biopharmaceutical workforce in 19 states, and management (administrative and production) accounts for 10 percent or more in 49 states. ***Details of key occupational shares, by state, are provided in Appendix B.***

FIGURE 4 provides a sampling of the wide range of positions required to bring medicines to patients, from drug discovery through to distribution. Sample job titles are shown by the three core functions of the biopharmaceutical industry, and illustrate how the science of manufacturing processes begins at the earliest stages of drug development, long before a product is approved.

FIGURE 4: **Illustrative Jobs Across the Biopharmaceutical Industry by Key Function**

	DISCOVERY & DEVELOPMENT	PROCESS DEVELOPMENT & MANUFACTURING	SALES & DISTRIBUTION
Drug Discovery & Pre-Clinical R&D	• Discovery/R&D Leader • University Medical Science Liaison • Molecular Biologist • Preclinical Chemist • R&D Quality Assurance Manager • Toxicologist	• Formulator Scientist • Pharmaceutical Development Technician	
Clinical Trials	• Clinical Research Budget Manager • Clinical Research Coordinator • Clinical Research Associate • Biostatistician • Clinical Safety Scientist	• Pharmaceutical Biologics Engineer • Processing Technician 	• Pharmaceutical Transport Specialists
FDA Approval	• Regulatory Affairs Specialist • Clinical Compliance Manager		• Technical Writer
Process & Production Scale-up	• Pharmaceutical Chemical Engineer 	• Capital Projects Cost Control Lead • CGMP Project Manager • Functional Safety Engineer • Processing Engineer • Manufacturing Technician	
Manufacturing & Quality Control		• Facilities Director • Pharmaceutical Manufacturing Operator • Production Technician • Qualtiy Control Analyst • Compliance Specialist	• Procurement Lead • Purchasing Agent Pharmaceutical • Chemical/Material Handler • Packaging Operator
Logistics & Shipping			• Supply Chain Analyst • Inventory Specialist • Pharmacy Distribution Manager 
Doctor/Patient Awareness & Patient Use	• Drug Safety Associate • Medical Information Specialist 		• Account Manager • Sales Representative • Digital Marketing Specialist • Medical Writer

STEM: Building a 21st Century Workforce to Develop Tomorrow's New Medicines

The U.S. innovative biopharmaceutical industry relies on a workforce with education and skills in science, technology, engineering, and math (STEM). However, relative declines in achievement and interest in STEM fields in the U.S. has resulted in an inadequate supply of workers with STEM skills and education, while the demand for STEM talent has continued to increase.

STEM workers have been shown to be key drivers of innovation and, thus, contribute significantly to economic productivity. STEM jobs fuel economic growth in many ways including through higher wages and a higher employment multiplier—meaning STEM-based industries generally support a greater number of additional jobs across the economy compared with other industries.

Around the world, an increasing number of countries have recognized the economic benefits of a robust STEM-skilled workforce. Countries like China and Singapore have developed and implemented strategies specifically aimed at gaining a competitive edge in STEM fields, making major investments in improving the state of STEM education in an effort to increase the number of scientists, engineers, and other STEM graduates overall. As a result of their investments, they have the highest rates of science and math literacy among Organization for Economic Cooperation and Development (OECD) countries, while the U.S. now ranks among the bottom half. There is increasing concern that the U.S. will lose its competitive edge in STEM talent, which in turn will result in a loss of innovative capacity and related economic contributions, and eventually lead U.S. businesses to look to other countries for needed STEM talent.

Recognizing the need to improve the pipeline of STEM workers in the U.S., the innovative biopharmaceutical industry has demonstrated a commitment to finding new ways to improve the quality of STEM education starting at K-12 and continuing beyond college. Companies are partnering with schools, investing in STEM education, and bringing their expertise and resources to bear to improve STEM education in the U.S.

- **Innovative biopharmaceutical companies and their corporate foundations are making significant contributions to U.S. STEM education through a broad range of local, state, and national level programs and initiatives aimed at elementary through post-secondary education.**

  From 2009-2013, the 24 PhRMA member companies that voluntarily reported information funded more than 90 individual initiatives focused on students and/or teachers in STEM-related fields and spanning multiple grade levels.

- **Over the last five years, PhRMA member-company STEM programs have impacted over 1.6 million students and 17,500 teachers across the U.S.**

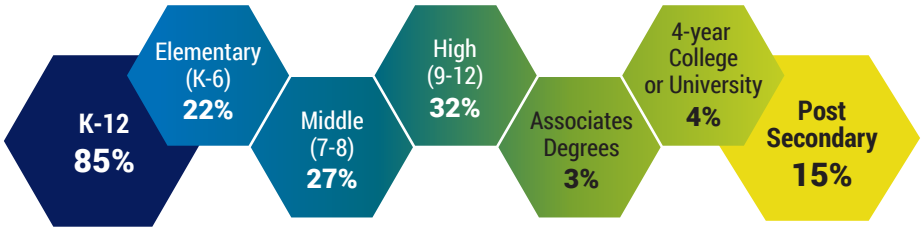
  On a current annual basis, about 500,000 students and 8,000 teachers participate in STEM education programs supported by PhRMA members.

- **PhRMA member-company programs are impacting students and teachers across the country, through 14 national-level programs that range from funding third-party STEM education initiatives to supporting scholarships in STEM-related fields to sponsoring STEM-related competitions to foster interest in STEM careers.**

  Additional STEM activities are being supported in 26 states, Washington D.C., and Puerto Rico, with a larger concentration of activities in states with a deeper industry presence.

- **Over 30 PhRMA member programs are focusing on increasing diversity in STEM fields by providing students of all backgrounds, particularly women and minorities, experience with hands-on, inquiry-based scientific learning opportunities.**

PhRMA Members' Support for All Levels of the STEM Education Talent Pipeline



Note: Many programs span multiple grade levels. K-12 detail will not sum to 85% due to some survey responses reporting age groups that span K-12 grade levels. Programs by grade level include both those focused on students as well as teachers.

Source: *STEM: Building a 21st Century Workforce to Develoop Tomorrow's New Medicines,* Battelle Technology Partnership Practice, January 2014.

The U.S. Biopharmaceutical Industry's Economic Impacts Drive National Growth

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

The economic impacts, or more precisely the revenue and expenditure impacts, of the biopharmaceutical industry are typically measured by 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. This analysis uses a custom IMPLAN I/O model 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 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 $1.2 trillion in 2014.[16] This total impact includes $558 billion in direct effects of biopharmaceutical businesses sales and $659 billion in indirect and induced effects—meaning that every $1.00 in output generated by the biopharmaceutical industry generated an additional $1.18 in output in other sectors of the economy (TABLE 3). This significant output multiplier of 2.18 is due to the high value-added nature of the industry, its extensive

The overall output impact, typically referred to as the "total economic impact" of the biopharmaceutical industry on the U.S. economy, totalled more than $1.2 trillion in 2014.

TABLE 3: **Economic Impacts of the U.S. Biopharmaceutical Industry, 2014 ($ in millions)**

IMPACT TYPE	Employment	Labor Income	Value Added	Output	State/Local Personal Tax Revenue	Federal Personal Tax Revenue
Direct Effect	853,818	$105,111.7	$247,918.4	$558,372.1	$3,190.7	$20,400.7
Indirect Effect	1,710,333	$112,847.3	$184,319.8	$363,617.8	$3,097.2	$20,711.0
Induced Effect	1,882,213	$92,684.3	$161,925.5	$295,551.1	$2,558.0	$17,164.9
Total Impacts	**4,446,365**	**$310,643.2**	**$594,163.7**	**$1,217,541.0**	**$8,845.9**	**$58,276.6**
Multiplier	*5.21*	*2.96*	*2.40*	*2.18*		

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 U.S. model.

supply chain relationships, and the industry's higher wage jobs. This total economic impact represented more than 3.8 percent of total U.S. output.[17]

The revenues of the biopharmaceutical industry are responsible for supporting more than 4.4 million jobs throughout the U.S. economy. These jobs consist of the nearly 854,000 jobs directly in the industry and an additional 3.6 million indirect and induced jobs in 2014. For every one biopharmaceutical industry job, the industry supports an additional 4.21 jobs, for a total employment multiplier of 5.21. Together, the biopharmaceutical industry and the workforce of its suppliers and other impacted segments of the economy received $311 billion in wages and benefits in 2014.

The biopharmaceutical industry also is an important generator of federal, state, and local government 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 $67 billion in personal tax revenues—nearly $9 billion in state and local personal tax revenue and more than $58 billion in federal personal tax revenues in 2014.

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. FIGURE 5 identifies the top 30 supplier sectors to the U.S. biopharmaceutical industry as determined by the size of the indirect output effects. For example, the biopharmaceutical industry purchased $57 billion in output from the non-biopharmaceutical wholesale trade sector (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 more than 237,000 wholesale trade jobs. Together, these thirty supplier sectors account for 69 percent of all the indirect output effects and 61 percent of all the indirect employment effects of the biopharmaceutical industry.

FIGURE 5: **Principal (Top 30) Supplier Sectors to the U.S. Biopharmaceutical Industry, 2014**

Biopharmaceutical Industry

Direct Economics Effects	=	$558.4 B in output	854K jobs

Indirect Economics Effects (Supply Chain)

1	Non-Biopharmaceutical Wholesale Trade	$57.0 B	237K jobs
2	Petrochemical Manufacturing	$19.7 B	2K jobs
3	Real Estate	$19.5 B	99K jobs
4	Other Basic Organic Chemicals Manufacturing	$14.5 B	7K jobs
5	Management Consulting Services	$14.1 B	108K jobs
6	Advertising & PR Services	$9.5 B	42K jobs
7	Legal Services	$8.8 B	48K jobs
8	Petroleum Refineries	$8.5 B	1K jobs
9	Non-Biopharma Management & Administration	$8.0 B	34K jobs
10	Truck Transportation	$6.3 B	40K jobs
11	Electric Utilities	$6.0 B	4K jobs
12	Maintenance & Repair Construction	$5.9 B	36K jobs
13	Employment Services	$5.7 B	86K jobs
14	Non-Biopharma Scientific R&D Services	$5.2 B	20K jobs
15	Internet Services	$5.0 B	7K jobs
16	Commercial Banking	$5.0 B	18K jobs
17	Natural Gas & Oil Production	$4.6 B	10K jobs
18	Architectural & Engineering Services	$4.6 B	29K jobs
19	Television & Radio Broadcasting	$4.3 B	13K jobs
20	Market Research & Other Professional Services	$4.3 B	55K jobs
21	Printing	$4.2 B	29K jobs
22	Wireless (Cellular) Telecommunications	$4.1 B	2K jobs
23	IP Management & Licensing	$3.7 B	3K jobs
24	Internet & Cable Telecommunications	$3.5 B	8K jobs
25	Warehousing & Storage	$3.3 B	33K jobs
26	Insurance	$3.3 B	8K jobs
27	Other Plastics Product Mfg.	$3.3 B	12K jobs
28	Accounting & Payroll Services	$3.1 B	31K jobs
29	Waste Management Services	$3.0 B	14K jobs
30	Data Processing & Related Services	$2.9 B	9K jobs
31-535	Other Indirect Effects Remaining sectors of U.S. economy combined	$113 B in output	668K jobs

Induced Effects	=	$295.65 B in output	1,882K jobs

Total Impact of Biopharmaceutical Industry on U.S. economy	=	$1,217.5 B in output	4,446K jobs

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 U.S. model.

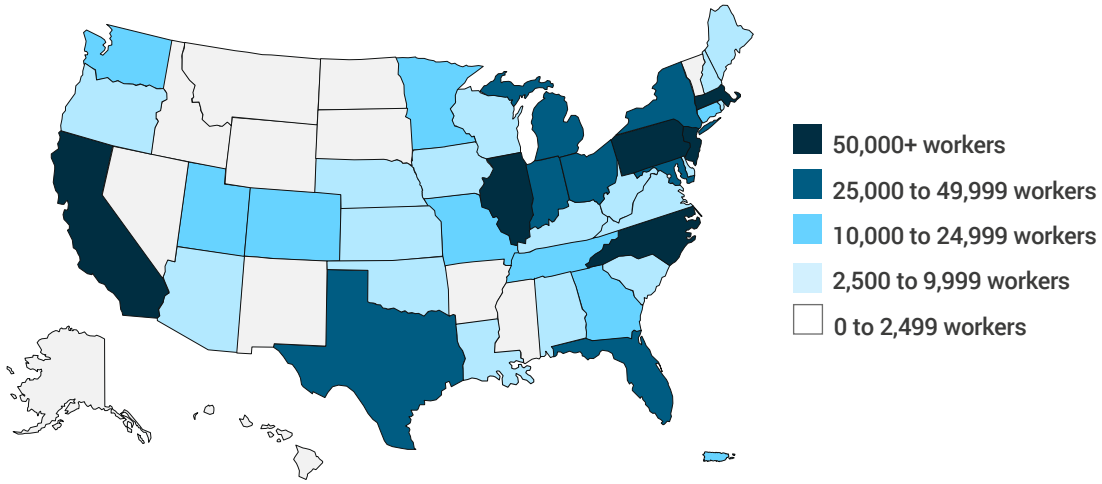
The Economic Impact of the U.S. Biopharmaceutical Industry on Individual States

As with all industries, 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. This geographic diversity, though strongly related to historical industrial location, is also driven by key locational factors such as a strong R&D and STEM workforce, access and robustness of private funding of R&D, number of early stage and emerging biopharmaceutical companies, presence of a robust manufacturing employment base, and competitive state-level incentives.[18] ***Appendix B provides detailed economic impact estimates by state, while broad geographic patterns are described below.***

FIGURE 6 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, 25 states, including Puerto Rico, have more than 10,000 biopharmaceutical industry workers, with six more states having between 5,000 and 10,000 industry jobs.

FIGURE 7: **Geographic Distribution of U.S. Biopharmaceutical Industry Total Employment Impacts, 2014**

The biopharmaceutical industry supports more than 250,000 jobs in six states—California, New Jersey, Illinois, Massachusetts, North Carolina, and Pennsylvania

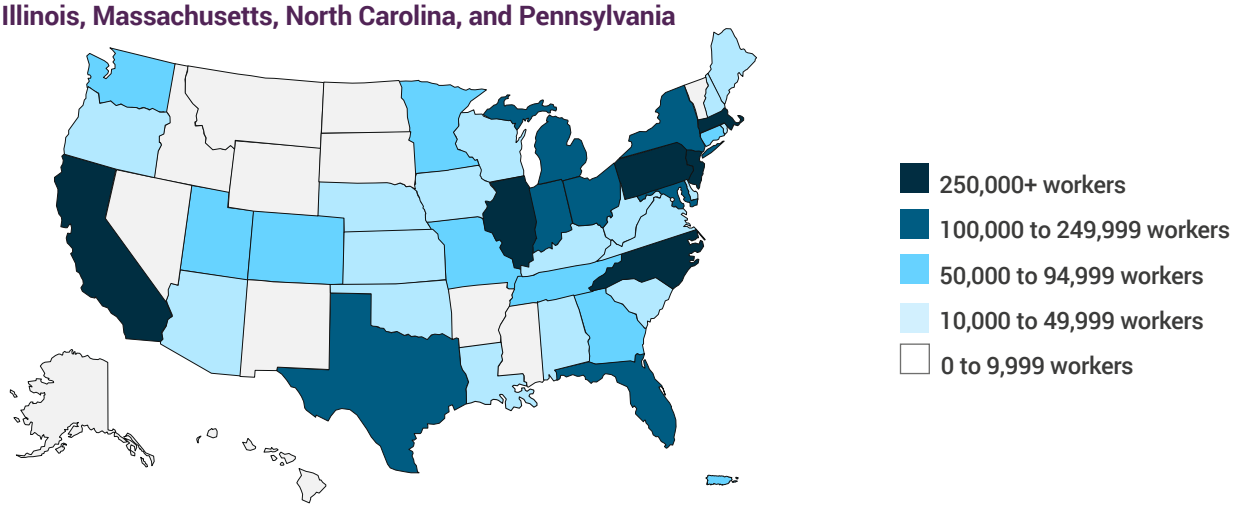


Source: TEConomy Partners data, calculations and analysis.

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 eleven 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 six states—California, New Jersey, Illinois, Massachusetts, North Carolina, and Pennsylvania, 50,000 jobs in 22 states, and more than 20,000 jobs in a total of 31 states (FIGURE 7).

FIGURE 7: **Geographic Distribution of U.S. Biopharmaceutical Industry Total Employment Impacts, 2014**

The biopharmaceutical industry supports more than 250,000 jobs in six states—California, New Jersey, Illinois, Massachusetts, North Carolina, and Pennsylvania

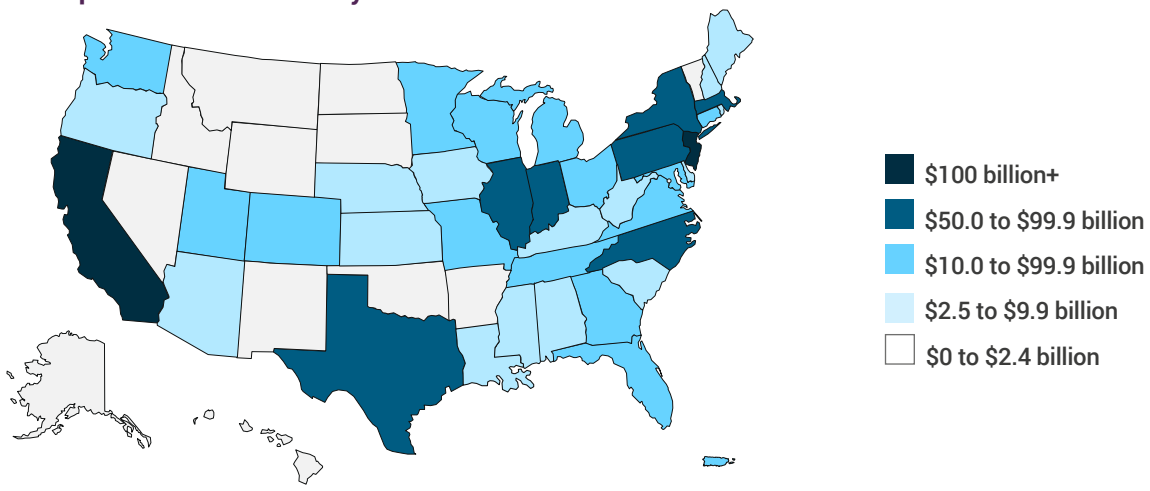


Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 U.S. model.

The total economic impacts (direct, indirect, and induced output combined) are shown in FIGURE 8. The map shows a geographic distribution very similar to the total employment impacts. Two states, California and New Jersey, exceed $100 billion in economic impacts stemming from the U.S. biopharmaceutical industry. A total of nine states have total biopharmaceutical industry impacts of more than $50 billion, with an additional 15 states reaching impact levels of $10-49 billion. Fully 46 states, including the District of Columbia and Puerto Rico, exceed $1 billion in economic impact.

FIGURE 8: **Geographic Distribution of U.S. Biopharmaceutical Industry Total Economic Impacts, 2014**

Two states, California and New Jersey, exceed $100 billion in economic impacts stemming from the U.S. biopharmaceutical industry



Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 U.S. model.

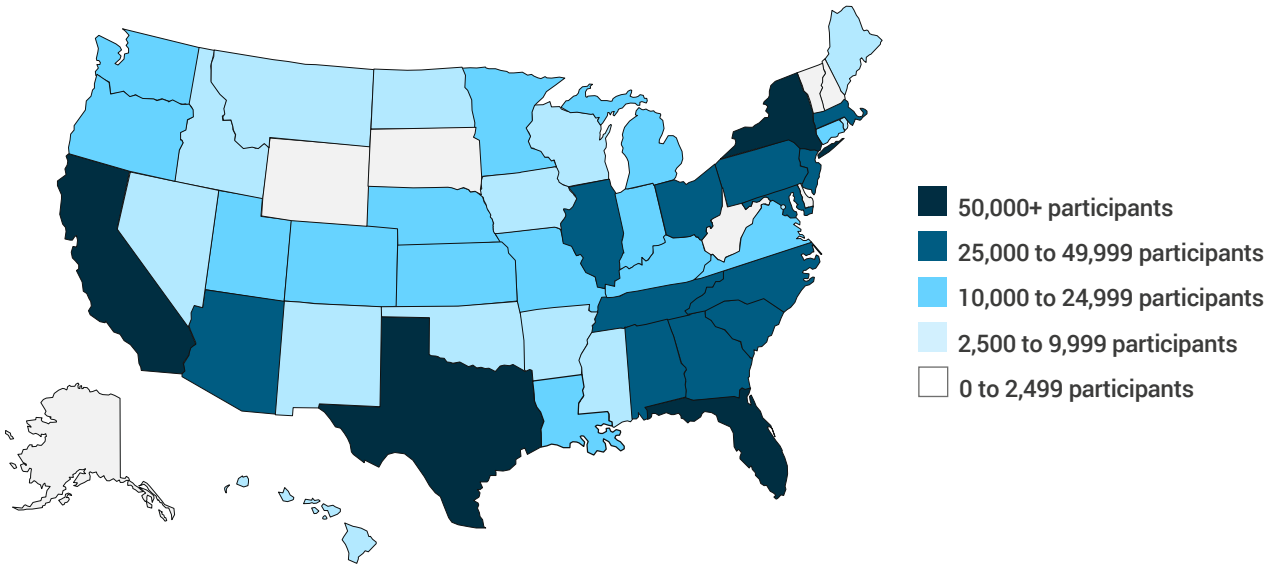
Biopharmaceutical Industry-Sponsored Clinical Trial Activity Across the Country

Developing a new medicine is a long and complex process. The R&D process extends from basic science to pre-clinical and clinical research to approval of new treatments for patients. This development process is shared across a robust R&D ecosystem of industry, government, academia, non-profit organizations, patient advocacy groups, health care providers, and others playing complementary roles in bringing new medical advances to patients. Within this ecosystem, the innovative biopharmaceutical industry makes significant investments every year in supporting these clinical trial activities throughout the U.S. In 2013, nearly 6,200 industry-sponsored clinical trials were supported through investments of $10 billion—involving 1.1 million volunteer participants in these trials. Clinical trial sites are operating in all 50 states and the District of Columbia reflecting the broad reach of the biopharmaceutical industry as well as the substantial unmet medical needs across the nation. Only seven states plus the District of Columbia had fewer than 200 clinical trial sites. Industry-sponsored clinical trial investments were distributed throughout the 50 states, with sizable spending in some states not typically associated with a large biopharmaceutical industry presence, e.g., Ohio and Tennessee.

Clinical trials provide significant benefits to state and local economies through activities such as the development of clinical trial protocols; selection of clinical trial sites; implementation of the trials, including the recruitment of staff, contractors, vendors, and patient volunteers; manufacture of small batches for testing; care to patients, including lab tests and ongoing health monitoring; and analysis of the enormous amount of data generated by the trials–just to name some of the activities occurring at particular trial sites that require significant expenditures by biopharmaceutical companies and their vendors and contractors. The figure illustrates the estimated numbers of participants at clinical trial sites across the U.S.

Geographic Distribution of Biopharmaceutical Industry-Sponsored Clincial Trial Partipants, 2013

In 2013, nearly 6,200 industry-sponsored clinical trials were supported through investments of $10 billion—involving 1.1 million volunteer participants in these trials.



Source: *Biopharmaceutical Industry-Sponsored Clinical Trials: Impact on State Economies,* Battelle Technology Partnership Practice, March 2015. Note: Puerto Rico was not included in this analysis.

Discussion

The U.S. biopharmaceutical industry is a robust and vibrant component of the nation's economy, with a varied occupational base and extensive supply chain that yields significant impacts. What sustains the success of the biopharmaceutical industry is its broad innovation ecosystem. Led by by both small and large innovation-led 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 clinical research organizations, 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 nearly 854,000 workers and a substantial employment multiplier of 5.21, the U.S. biopharmaceutical industry supported approximately 3.6 million additional U.S. jobs for a total of **4.4 million jobs in 2014**.

With **average annual wages and benefits of more than $123,000**—more than twice the U.S. average across all industries—biopharmaceutical industry jobs are both high-wage and high-quality.

The biopharmaceutical industry exceeded **$558 billion in direct output in 2014**, and with the ripple effect of this production throughout the U.S. economy, an additional $659 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 $1.2 trillion—**representing 3.8 percent of the total U.S.** (including the District of Columbia and Puerto Rico) **output in 2014**.

The U.S. biopharmaceutical industry is clearly a major economic driver. However, by the nature of its activities, is is also a truly innovative industry positioned for medical advances and enormous societal impact into the future. To realize these future impacts, the U.S. biopharmaceutical industry must be supported by robust innovation policies starting with strong protections of intellectual property, research and development incentives, a progressive, national technology transfer mechanism, coverage and payment policies that recognize the value of new medicines, and a science-based regulatory system to bring new medicines forward.

To continue to sustain and grow this important U.S. industry and ensure its continued contributions to the U.S. economy, a robust policy framework is needed to support the long, costly, and risky investments vital to to meeting U.S. patient needs. Fostering an environment that will improve the private sectors' ability to harness research innovations to meet health challenges and continue to create high-wage, high-skill jobs is critical to ensuring that the economic impact of the biopharmaceutical industry continues to be realized at the national and state levels. Continued innovation is fundamental to U.S. economic well-being. 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. Charles W. Wessner and Alan Wm. Wolff, Eds. "Rising to the Challenge: U.S. Innovation Policy for the Global Economy." 2012. The National Academies Press, Washington, DC., page xiii.
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3. Brookings Institution, "America's Advanced Industries: What They Are, Where They Are, And Why They Matter." February 2015.
4. Rob Atkinson and Adams Nager, "The State New Economy Index" The Information Technology Foundation, 2014. Similarly, The Milken Institute finds states that invest in innovation strategies emerged stronger out of the 2010 recession. See Kevin Klowden, Kristen Keough, and Jason Barrett, "2014 State Tech and Science Index." The Milken Institute, 2014.
5. Bauer, Schweitzer and Shane, "Knowledge Matters: The Long-Run Determinants of State Income Growth," Journal of Regional Science, 52(2), 240-255.
6. Brookings Institution, "America's Advanced Industries."
7. TEConomy Partners analysis of Thomson Innovation patent database.
8. NSF, Higher Education R&D (HERD) Survey – 2014 and TEConomy Partners calculations.
9. National Science Foundation (NSF), Business R&D and Innovation Survey (BRDIS) - 2013, Tables 2, 20, 47 and 53, and TEConomy Partners calculations combining both pharmaceutical manufacturing and biotechnology.
10. NSF BRDIS - 2013, Table 60, and TEConomy Partners calculations.
11. Thomson Reuters Thomson One Venture Capital database.
12. NSF BRDIS - 2013, Table 53, and TEConomy Partners calculations.
13. The principals of TEConomy Partners, LLC performed the previous economic impact analysis of the biopharmaceutical industry for PhRMA while with the Battelle Technology Partnership Practice.
14. See Appendix B for a detailed discussion of data sources and methodology.
15. Using U.S. Bureau of Labor Statistics 2014 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.
16. 2014 is the most current year available for the IMPLAN I/O tables.
17. Total U.S. output as estimated by the 2014 U.S. IMPLAN model.
18. Battelle Technology Partnership Practice, "The U.S. Biopharmaceutical Industry: Perspectives on Future Growth and The Factors That Will Drive It," April 2014.

Appendix A – Methodology

The following narrative provides an overview of the approach used to develop the 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.

2014 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 2014. QCEW data are captured at the state-level 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. biopharmaceutical industry employment was 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.

2014 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 to reflect the inclusion of these self-employed workers.

2007 and 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. These efforts include data collection for 2007 and, most recently, 2012. Due to the time requirements to process these substantial data sets, only the 2007 Economic Census was fully available at the time

of this analysis (January 2016). Component data of the 2012 Economic Census are being released on a rolling basis, with national level data released first. For the 2014 estimates of biopharmaceutical industry employment in this report, state and U.S. level data from the 2007 Economic Census were combined with U.S. level data from the 2012 Economic Census to develop 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.

2014 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 a custom I/O models from IMPLAN Group, LLC. 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 model's data matrices track the flow of commodities to industries from producers and institutional consumers within the nation. 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.

The Structure of the U.S. Biopharmaceutical Industry

The wide range of activities in which the biopharmaceutical industry engages is spread across numerous NAICS industries within the U.S. economy as defined by the federal government. For purposes of this analysis, these NAICS categories can be collapsed into four sectors: biopharmaceutical manufacturing, biopharmaceutical R&D, biopharmaceutical corporate offices, and biopharmaceutical distribution (TABLE A1).

TABLE A1 **NAICS Structure Relevant to Biopharmaceutical Industry**

NAICS Codes Related to Biopharmaceutical Sectors

Biopharmaceutical Manufacturing	Biopharmaceutical R&D
325411 Medicinal and botanical manufacturing	541711 R&D in biotechnology
325412 Pharmaceutical preparation manufacturing	541712 R&D in the physical, engineering, and life sciences (except biotech)*
325413 In-vitro diagnostic substance manufacturing	541720 R&D in the social sciences and humanities*
325414 Biological product (except diagnostic) manufacturing	
Biopharmaceutical Distribution	**Biopharmaceutical Corporate Offices**
424210 Drugs and druggists' sundries merchant wholesalers*	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 was defined to include 100 percent of the employment within NAICS 325411 through 325414. 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, and the vast majority of the manufacturing captured in these codes is related to these activities.

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.

From NAICS 4242 (Drugs and druggists' sundries merchant wholesalers), non-biopharmaceutical activities were eliminated, e.g., "druggist sundries", miscellaneous medical equipment, and other retail distribution contained within this NAICS code. The resulting estimates of biopharmaceutical distribution employment represented 89.2 percent of this NAICS category.

Biopharmaceutical R&D

Biopharmaceutical R&D was defined to include all of one NAICS code and a portion of two others.

NAICS 541711 (R&D in biotechnology) 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.

The share of jobs in NAICS 541712 (R&D in the physical, engineering, and life sciences [except biotechnology]) specific to the biopharmaceutical industry was estimated by applying information derived from Economic Census data for NAICS 541712. Table A2 shows Economic Census data at the NAICS-level data within the broader NAICS 5417 (Scientific R&D services). TABLE A3 shows Economic Census data at the level of "product code" for NAICS 541712 for non-tax exempt (i.e., for-profit, private sector) entities. The adjustment assumed that the product codes in the Economic Census most relevant to the biopharmaceutical industry were 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.

A small share of the employment in NAICS 54172 (R&D in the social sciences and humanities) was also included as biopharmaceutical industry employment. Modifications in the 2012 Economic Census (compared to the 2007 Economic Census used previously) made it is possible to identify slightly more biopharmaceutical-related R&D employment, because the "biotech R&D" product code within scientific R&D is now also captured within the social science industry code NAICS 54172. This added approximately 5,800 U.S. biopharmaceutical R&D jobs to the estimate. These 2012 national level industry shares were then used to adjust the state-level shares that were based upon the previous 2007 Economic Census on a proportional basis.

Combining the three components of Scientific R&D services, this procedure estimates that 52 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.

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 **2012 Economic Census Data for Key R&D-related Product Codes for NAICS 541712 (Non-Tax Exempt)**

Key Product Codes and Descriptions (Major and Subcategories)		Estabs., 2012	Receipts 2012 ($1,000)
30000	Industry total	10,292	75,161,462
39020	Testing services (physical/product), excluding medical & veterinary services	253	698,780
39170	Basic/applied research in biotechnology	244	689,532
39180	Basic/applied research in the life sciences, excluding biotechnology	4,314	26,696,538
39181	*Basic/applied research life sciences, excluding biotech - Pharma science*	1,947	12,379,957
39182	*Basic/applied research in the life sciences - Med/health sciences*	1,807	7,844,204
39183	*Basic/applied research in the life sciences - Biological science*	369	2,864,108
39184	*Basic/applied research life sciences, excluding biotech - Ag, forestry*	216	261,102
39185	*Basic/applied research - Animal production, fisheries, & veterinary science*	87	148,373
39186	*Basic/applied research in the life sciences - Other life science*	223	1,670,197
39190	Basic/applied research in the social sciences & humanities	64	23,436
39210	Development services for goods	857	3,541,127
39220	Development services for processes, systems, or methods	688	3,435,292
39250	Outright sale of original works of intellectual property	204	897,581
39260	Advisory & consulting services for research & development activities	361	350,684
39280	Engineering services	219	1,604,779
39400	Licensing of rights to use intellectual property	704	9,977,910
39600	Resale of merchandise	199	206,721
39700	All other operating receipts	472	3,739,005

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

Notes: Establishments can be counted in more than one product code. Not all product codes are shown in this table. Receipts within subcategories sum to the Major Product Code.

Biopharmaceutical Corporate Offices

A meaningful share of biopharmaceutical industry employment, based within headquarters and other administrative or management offices, is not captured by the traditional biopharmaceutical manufacturing, biopharmaceutical R&D, or biopharmaceutical distribution sectors' NAICS codes, and special estimation efforts were required to assess these locations' impacts. With specific corporate examples 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 – Management of companies and enterprises 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 was 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 employment in U.S. establishments that are classified as corporate offices, this approach estimates that 1.5 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 were used to adjust the employment estimates to reflect the inclusion of self-employed workers. The CPS provided 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 ranged from 0.2 percent in biopharmaceutical manufacturing to 2.6 percent in biopharmaceutical R&D. The ratio was then applied to the QCEW-based biopharmaceutical sector employment to arrive at a final biopharmaceutical sector employment estimate. Biopharmaceutical headquarters employment was 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, the estimated share of employment within that sector that is attributed to the biopharmaceutical industry, the ultimate employment estimate, and the subsector's share of total biopharmaceutical industry employment are provided in TABLE A4.

TABLE A4 **Final Biopharmaceutical Industry Sector Estimates, 2014**

Biopharmaceutical Sector	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	295,664	100.0%	295,664	34.6%
Biopharmaceutical Distribution	4242 Drug and druggist sundries wholesale	181,623	89.2%	181,623	21.3%
Biopharmaceutical R&D	5417 Scientific research and development (R&D)	655,999	52.3%	342,808	40.2%
Biopharmaceutical Corporate Offices	5511 Management of companies and enterprises	2,302,263	1.5%	33,723	3.9%
Total U.S. Biopharmaceutical Industry				**853,818**	**100.0%**

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

Notes: Establishments can be counted in more than one product code. Not all product codes are shown in this table. Receipts within subcategories sum to the Major Product Code.

Differences from Previous Estimates of Direct Biopharmaceutical Employment

Previous employment estimates for PhRMA (by Archstone Consulting and continued by Battelle used the base IMPLAN model employment data to create the direct jobs estimate across the various biopharmaceutical subsectors, as these data included IMPLAN's estimates of self-employed and sole proprietor employment. However, as a result of the federal government changing its approach to capturing R&D expenses within the National Income Product Accounts (a key input to the IMPLAN models), these base employment figures directly established within the IMPLAN model through linkages to output/worker ratios now dramatically overestimate R&D employment as R&D workers from within all IMPLAN sectors are now counted only within the IMPLAN R&D sector. For example, computer and electronics R&D workers are now captured within the scientific R&D IMPLAN sector, overestimating the "employment" for this sector and underestimating employment for the various computer and electronics-related IMPLAN model sectors.

For this reason, the BLS QCEW series, with the described additional enhancements based upon the CPS to account for self-employed workers and sole proprietors, is now used. The QCEW data are widely used and accepted for measuring national and state-level employment.

Total Economic Impact of the Biopharmaceutical Industry

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 a custom I/O model from IMPLAN. The IMPLAN model's data matrices track the flow of commodities to industries from producers and institutional consumers within the nation. 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.

The biopharmaceutical industry employment estimates described above serve as the inputs to the I/O model. The model's outputs, which are the impacts typically measured in an economic impact study, are the expenditure impacts of the biopharmaceutical industry. They quantify direct and indirect 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, 2014**

	Direct Effects	Indirect Effects	Induced Effects	**Total Impacts**
U.S. Total (incl. District of Columbia and Puerto Rico)	853,818	1,710,333	1,882,213	**4,446,365**

	EMPLOYMENT			
State	Direct Effects	Indirect Effects	Induced Effects	**Total Impacts**
Alabama	5,444	9,927	7,599	**22,970**
Alaska	385	327	323	**1,035**
Arizona	8,457	17,373	17,054	**42,885**
Arkansas	1,437	2,025	1,585	**5,047**
California	145,880	317,738	387,945	**851,563**
Colorado	11,629	24,095	26,351	**62,075**
Connecticut	12,573	21,147	27,717	**61,437**
Delaware	11,205	11,240	17,863	**40,308**
Dist. of Columbia	2,416	2,055	1,259	**5,730**
Florida	29,875	59,244	59,330	**148,449**
Georgia	10,386	20,268	21,183	**51,837**
Hawaii	1,401	1,619	1,558	**4,578**
Idaho	2,073	2,304	2,284	**6,661**
Illinois	45,561	109,301	138,460	**293,322**
Indiana	23,782	65,253	65,879	**154,914**
Iowa	5,563	7,651	9,282	**22,496**
Kansas	5,717	11,485	9,442	**26,645**
Kentucky	5,462	7,274	6,950	**19,686**
Louisiana	3,179	3,985	4,291	**11,455**
Maine	4,137	7,880	7,935	**19,951**
Maryland	25,817	35,595	46,168	**107,579**
Massachusetts	55,184	90,026	119,451	**264,661**
Michigan	27,616	59,128	60,674	**147,418**
Minnesota	11,524	18,940	23,403	**53,866**
Mississippi	1,899	4,219	2,521	**8,639**
Missouri	13,800	26,326	28,470	**68,596**

	EMPLOYMENT			
State	Direct Effects	Indirect Effects	Induced Effects	**Total Impacts**
Montana	1,114	1,672	1,357	**4,142**
Nebraska	3,443	6,660	5,984	**16,088**
Nevada	2,154	4,444	3,229	**9,827**
New Hampshire	2,277	4,244	4,440	**10,961**
New Jersey	65,783	138,578	174,364	**378,726**
New Mexico	1,837	2,544	2,283	**6,664**
New York	54,752	97,156	89,632	**241,540**
North Carolina	42,496	112,771	104,536	**259,803**
North Dakota	387	331	312	**1,029**
Ohio	23,438	42,086	47,690	**113,213**
Oklahoma	2,690	4,019	3,529	**10,238**
Oregon	3,757	6,300	6,044	**16,101**
Pennsylvania	46,202	92,750	115,233	**254,184**
Puerto Rico	17,823	34,422	15,512	**67,756**
Rhode Island	2,288	6,479	6,204	**14,972**
South Carolina	5,349	13,195	9,452	**27,997**
South Dakota	746	660	697	**2,103**
Tennessee	12,645	19,464	20,580	**52,689**
Texas	36,485	78,455	79,096	**194,036**
Utah	12,010	34,860	25,967	**72,837**
Vermont	1,429	2,872	2,335	**6,635**
Virginia	11,962	17,742	19,962	**49,665**
Washington	15,140	20,950	21,622	**57,712**
West Virginia	4,464	11,364	8,252	**24,080**
Wisconsin	10,460	19,210	18,604	**48,273**
Wyoming	286	681	323	**1,290**

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 models.

TABLE B2 **U.S. and State Output: Direct, Indirect, and Induced Effects and Total Impacts, 2014**

	Direct Effects	Indirect Effects	Induced Effects	**Total Impacts**
U.S. Total (incl. District of Columbia and Puerto Rico)	$558,372.1	$363,617.8	$295,551.1	**$1,217,541.0**

	OUTPUT			
State	Direct Effects	Indirect Effects	Induced Effects	**Total Impacts**
Alabama	$2,819.4	$1,735.2	$1,077.4	**$5,632.1**
Alaska	$90.6	$64.6	$52.5	**$207.7**
Arizona	$3,721.7	$3,164.9	$2,535.3	**$9,421.9**
Arkansas	$521.7	$349.8	$218.6	**$1,090.1**
California	$105,131.1	$72,461.0	$66,220.0	**$243,812.1**
Colorado	$5,569.0	$4,816.9	$4,078.7	**$14,464.6**
Connecticut	$8,198.0	$5,221.4	$4,616.1	**$18,035.6**
Delaware	$3,394.8	$2,306.5	$2,728.3	**$8,429.6**
Dist. of Columbia	$728.1	$534.3	$222.5	**$1,484.9**
Florida	$11,937.5	$10,617.0	$8,703.0	**$31,257.5**
Georgia	$4,983.9	$4,016.9	$3,151.1	**$12,151.9**
Hawaii	$360.3	$277.7	$242.3	**$880.3**
Idaho	$569.0	$364.8	$299.8	**$1,233.5**
Illinois	$34,117.2	$24,990.5	$21,978.1	**$81,085.9**
Indiana	$36,122.7	$12,788.0	$9,245.8	**$58,156.4**
Iowa	$2,952.7	$1,447.0	$1,271.3	**$5,671.0**
Kansas	$3,103.4	$2,246.8	$1,376.0	**$6,726.1**
Kentucky	$2,160.4	$1,247.6	$967.2	**$4,375.2**
Louisiana	$1,351.8	$757.6	$609.7	**$2,719.1**
Maine	$2,081.4	$1,410.0	$1,102.5	**$4,593.9**
Maryland	$11,623.9	$7,222.1	$7,162.0	**$26,007.9**
Massachusetts	$28,045.6	$20,409.6	$19,345.5	**$67,800.7**
Michigan	$14,471.9	$11,345.6	$8,752.7	**$34,570.2**
Minnesota	$4,404.6	$3,829.8	$3,626.7	**$11,861.1**
Mississippi	$1,459.9	$746.5	$338.7	**$2,545.1**
Missouri	$7,939.6	$5,261.1	$4,123.3	**$17,324.0**

	OUTPUT			
State	Direct Effects	Indirect Effects	Induced Effects	**Total Impacts**
Montana	$369.6	$274.1	$177.2	**$821.0**
Nebraska	$2,594.5	$1,299.0	$827.2	**$4,720.8**
Nevada	$1,099.5	$802.1	$481.4	**$2,383.1**
New Hampshire	$1,079.6	$843.8	$649.3	**$2,572.6**
New Jersey	$47,550.2	$32,381.5	$28,774.1	**$108,705.8**
New Mexico	$774.0	$452.3	$317.6	**$1,543.9**
New York	$34,109.9	$24,736.0	$15,223.6	**$74,069.4**
North Carolina	$40,867.1	$21,806.8	$14,945.2	**$77,619.1**
North Dakota	$91.7	$59.8	$46.0	**$197.5**
Ohio	$11,039.7	$8,361.1	$7,149.2	**$26,550.1**
Oklahoma	$1,103.2	$735.1	$521.4	**$2,359.7**
Oregon	$1,661.1	$1,136.6	$831.8	**$3,629.5**
Pennsylvania	$30,892.9	$20,386.4	$17,639.3	**$68,918.6**
Puerto Rico	$24,931.1	$4,347.6	$1,193.3	**$30,471.9**
Rhode Island	$2,091.2	$1,368.2	$937.9	**$4,397.3**
South Carolina	$3,498.4	$2,394.2	$1,308.7	**$7,201.3**
South Dakota	$162.5	$110.7	$98.1	**$371.2**
Tennessee	$5,085.7	$3,537.3	$3,056.5	**$11,679.5**
Texas	$22,431.0	$17,488.1	$12,680.1	**$52,599.2**
Utah	$7,356.7	$6,833.6	$3,835.1	**$18,025.3**
Vermont	$810.6	$524.5	$319.1	**$1,654.2**
Virginia	$5,884.3	$3,649.5	$3,045.9	**$12,579.7**
Washington	$5,097.6	$4,445.4	$3,608.2	**$13,151.2**
West Virginia	$4,427.6	$2,146.0	$1,101.9	**$7,675.5**
Wisconsin	$5,229.7	$3,721.0	$2,691.0	**$11,641.7**
Wyoming	$272.5	$144.1	$46.9	**$463.5**

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 models.

TABLE B3 **U.S. and State Occupational Share Estimates, 2014**

	Life, Physical, and Social Science	Architecture and Engineering	Computer and Mathematical	Management	Business and Financial Operations	Office and Administrative Support	Production	Sales and Related Support	Transportation and Material Moving	All Other Occupational Categories
U.S. Total (incl. District of Columbia and Puerto Rico)	17%	9%	7%	11%	9%	13%	13%	7%	4%	26%

State	Life, Physical, and Social Science	Architecture and Engineering	Computer and Mathematical	Management	Business and Financial Operations	Office and Administrative Support	Production	Sales and Related Support	Transportation and Material Moving	All Other Occupational Categories
Alabama	14%	8%	6%	11%	8%	15%	12%	11%	5%	24%
Alaska	17%	10%	8%	11%	8%	16%	3%	12%	5%	27%
Arizona	13%	7%	6%	10%	8%	17%	10%	14%	6%	23%
Arkansas	15%	9%	7%	11%	8%	15%	9%	12%	5%	25%
California	18%	10%	8%	12%	9%	12%	12%	6%	3%	28%
Colorado	18%	10%	8%	11%	8%	13%	10%	8%	4%	27%
Connecticut	14%	8%	7%	12%	10%	15%	15%	7%	4%	23%
Delaware	14%	9%	10%	15%	13%	17%	4%	6%	3%	23%
Dist. of Columbia	24%	15%	11%	12%	9%	10%	4%	3%	1%	33%
Florida	12%	7%	6%	10%	8%	18%	8%	16%	6%	22%
Georgia	13%	7%	6%	10%	8%	16%	12%	13%	6%	23%
Hawaii	17%	10%	8%	11%	8%	16%	5%	12%	5%	26%
Idaho	8%	4%	4%	9%	7%	20%	9%	20%	8%	18%
Illinois	15%	8%	6%	11%	9%	14%	15%	8%	4%	24%
Indiana	16%	7%	5%	11%	9%	11%	24%	4%	4%	24%
Iowa	17%	8%	6%	11%	8%	12%	19%	6%	4%	26%
Kansas	17%	9%	7%	11%	8%	13%	15%	7%	4%	26%
Kentucky	10%	5%	5%	10%	8%	19%	10%	16%	7%	20%
Louisiana	9%	4%	4%	9%	7%	20%	8%	19%	8%	19%
Maine	17%	9%	7%	11%	8%	13%	15%	7%	4%	26%
Maryland	22%	13%	9%	12%	9%	11%	11%	3%	2%	31%
Massachusetts	22%	14%	10%	12%	9%	11%	8%	3%	2%	31%
Michigan	16%	9%	7%	12%	9%	14%	12%	7%	4%	26%
Minnesota	19%	11%	8%	11%	9%	13%	11%	7%	3%	28%
Mississippi	12%	5%	4%	10%	8%	15%	18%	12%	6%	22%
Missouri	17%	9%	7%	11%	8%	13%	14%	8%	4%	26%

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 models.

TABLE B3 **U.S. and State Occupational Share Estimates, 2014 (continued)**

State	Life, Physical, and Social Science	Architecture and Engineering	Computer and Mathematical	Management	Business and Financial Operations	Office and Administrative Support	Production	Sales and Related Support	Transportation and Material Moving	All Other Occupational Categories
Montana	19%	10%	8%	11%	9%	12%	13%	6%	3%	28%
Nebraska	17%	8%	6%	11%	8%	12%	18%	7%	4%	26%
Nevada	18%	10%	7%	11%	8%	13%	14%	7%	4%	27%
New Hampshire	18%	10%	7%	11%	9%	11%	18%	5%	3%	27%
New Jersey	14%	8%	6%	12%	9%	14%	15%	8%	4%	24%
New Mexico	17%	10%	7%	11%	8%	14%	12%	8%	4%	26%
New York	16%	9%	7%	12%	10%	14%	13%	7%	4%	25%
North Carolina	17%	9%	6%	11%	9%	12%	18%	5%	3%	26%
North Dakota	17%	10%	8%	11%	8%	16%	4%	12%	4%	27%
Ohio	14%	8%	7%	12%	10%	16%	9%	9%	4%	24%
Oklahoma	13%	7%	6%	10%	8%	17%	9%	14%	6%	23%
Oregon	17%	10%	8%	11%	8%	14%	9%	10%	4%	26%
Pennsylvania	17%	10%	7%	12%	9%	13%	14%	6%	3%	26%
Puerto Rico	14%	5%	4%	11%	8%	12%	26%	7%	5%	22%
Rhode Island	15%	7%	5%	11%	8%	12%	22%	6%	4%	24%
South Carolina	15%	8%	6%	11%	8%	14%	16%	9%	5%	24%
South Dakota	14%	9%	7%	10%	8%	17%	4%	15%	6%	24%
Tennessee	13%	7%	6%	10%	8%	17%	7%	14%	6%	23%
Texas	14%	8%	6%	11%	8%	15%	12%	11%	5%	24%
Utah	15%	8%	6%	11%	8%	13%	17%	8%	4%	25%
Vermont	11%	5%	4%	10%	8%	17%	16%	14%	7%	20%
Virginia	18%	11%	8%	11%	8%	13%	9%	8%	4%	27%
Washington	20%	12%	9%	11%	9%	12%	7%	6%	3%	30%
West Virginia	16%	7%	5%	11%	8%	11%	23%	5%	4%	25%
Wisconsin	17%	9%	7%	11%	8%	13%	15%	7%	4%	26%
Wyoming	12%	5%	3%	10%	8%	14%	23%	10%	6%	21%

Source: TEConomy Partners data, calculations and analysis; IMPLAN 2014 models.


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