

The U.S. Biopharmaceuticals Sector:

Economic Contribution to the Nation

Prepared by Battelle Technology Partnership Practice

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of America (PhRMA)

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◆ Introduction

The United States' biopharmaceutical industry produces products that save, sustain and improve lives. Biopharmaceuticals is also well recognized as a dynamic and innovative business sector generating high quality jobs and powering economic output and exports for the U.S. economy. This report quantifies this economic impact of the biopharmaceutical sector on the U.S. economy and jobs. Using input/output analysis, this report measures the direct and indirect impacts of the biopharmaceutical sector, and quantifies the economic impacts that would occur if biopharmaceutical revenues increase or decrease from significant changes in the business operating environment.

Identifying High Value Sectors for Future U.S. Economic Growth

If we were to imagine an “ideal” industry for economic growth and sustainability in the U.S., it would have several important characteristics. It should grow in output and employment even in tough economic times. It should provide high wage, good quality jobs. It should be innovative and deploy high-technology to generate comparative advantage for U.S. companies. It should generate significant exports. It should have a strong supply chain that drives further economic growth across the economy through “multiplier effects.” It should build on our nation’s long-standing strengths and investment in fundamental and applied research. It should encourage capital flows to sustain growth, and it should be profitable to provide funds for reinvestment into the research and development (R&D) cycle and generate federal, state and local taxes and other economic contributions that support public services. These characteristics are a collective challenge, but let’s add further to them to make the bar even higher for our “ideal” industry. It should be sustainable and not a major drain on global resources. It should be geographically dispersed, providing opportunities for job creation and economic growth across many areas of the nation, not just a few selected places. As icing on the cake, it should also produce a product of value to society, something to improve the quality of life for humankind.

The biopharmaceutical sector has all of the above characteristics and more. Fundamental to major progress in human longevity, reducing the marginalization of individuals from disease and disability, and generally improving our quality-of-life, biopharmaceuticals are a unique contributor to societal and individual well-being. Furthermore, the biopharmaceutical sector has been an American economic success story.

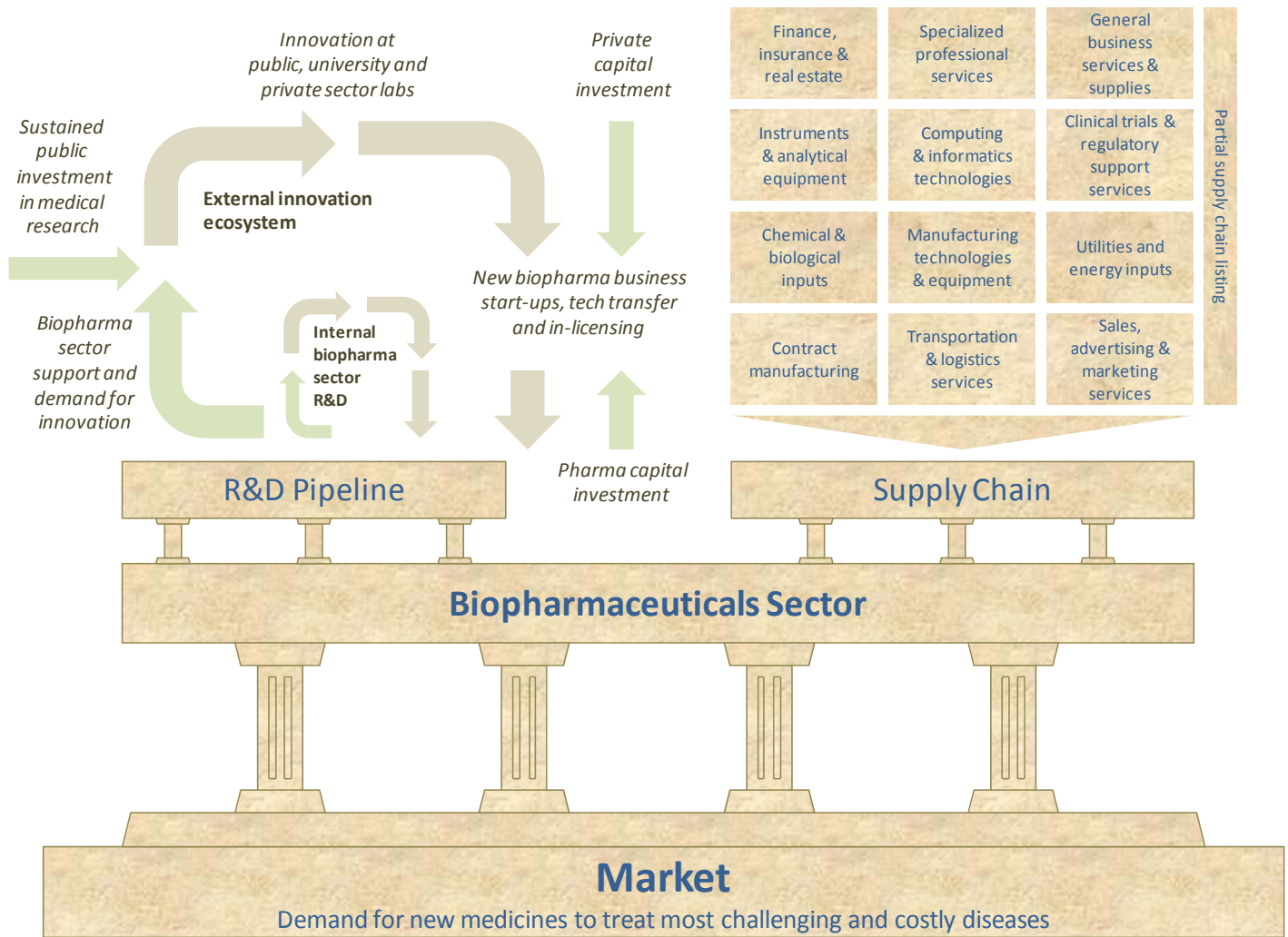
The Biopharmaceutical Sector – An American Success Story

The biopharmaceutical industry stands as one of our nation’s leading industries in high quality job creation, innovation and global competitiveness. More than 674,000 workers were employed in the biopharmaceutical industry in 2009 providing high-wage and high-quality jobs and contributing to the development of vibrant regional economies across the U.S.¹ However, beyond direct employment in biopharmaceutical companies, the biopharmaceutical sector is the foundation upon which one of the United States’ most dynamic innovation and business ecosystems is built. A large part of the modern biomedical economy is built upon a robust foundation of biopharmaceutical companies that perform and support advanced biomedical and technological R&D, and act as the funnel and distribution engine for getting life-saving and quality-of-life-sustaining therapeutics to the marketplace. In accomplishing the mission of bringing new medical treatments to the market, the biopharmaceutical sector sustains a

very large-scale supply chain—both in R&D and in support of the production and distribution of biopharmaceutical and biotechnological products.

As Figure 1 illustrates, the innovative biopharmaceutical industry, which develops both large and small molecule drugs, is a foundational component of a broader biomedical ecosystem that includes such sectors as diagnostics and medical devices. Providing R&D impetus and funding, capital resources, technology licensing opportunities, and a sophisticated market access and distribution system, the biopharmaceutical sector is of central importance to the much broader biomedical and life sciences economy.

Figure 1: The Biopharmaceutical Sector – The Foundation of a Dynamic U.S. Innovation and Business Ecosystem



Biopharmaceutical production is a successful industry in the U.S. It stands out in its total economic impacts because of its broad supply chain linkages across the economy as well as the impacts of its high wages on consumer spending in communities across nation. Furthermore, in a 21st Century economy in which economic leadership is synonymous with leadership in technology and innovation, the biopharmaceutical sector is on the front lines in leveraging America’s exceptional base of public and private R&D activity. Fueled by private investment capital, venture capital investments, and public/private collaborations, and enabled by the U.S. open market system, the nation has been able to

advance biomedical innovation, which in turn has led to new start-up companies, business growth and exports across the world.

Measuring the Impacts of the U.S. Biopharmaceutical Sector

Recognizing the importance of the biopharmaceutical sector and the need for high-quality economic and social analysis to inform public policy discussions, the Pharmaceutical Research and Manufacturers of America (PhRMA) engaged Battelle Memorial Institute to provide an independent evaluation of biopharmaceutical impacts. Battelle's Technology Partnership Practice (TPP) contains significant expertise in the analysis of industry sector economic, social and functional impacts and impacts relating to health and life sciences. TPP has an established reputation in state-by-state assessment of the biopharmaceutical sector, and has recently undertaken major impact assessment projects for the Human Genome Project, the nation's biotechnology sector, and major bioscience organizations such as Mayo Clinic. TPP has also been active in provision of analysis to industry organizations, including the Council for American Medical Innovation, PhRMA and BIO-the Biotechnology Industry Organization.

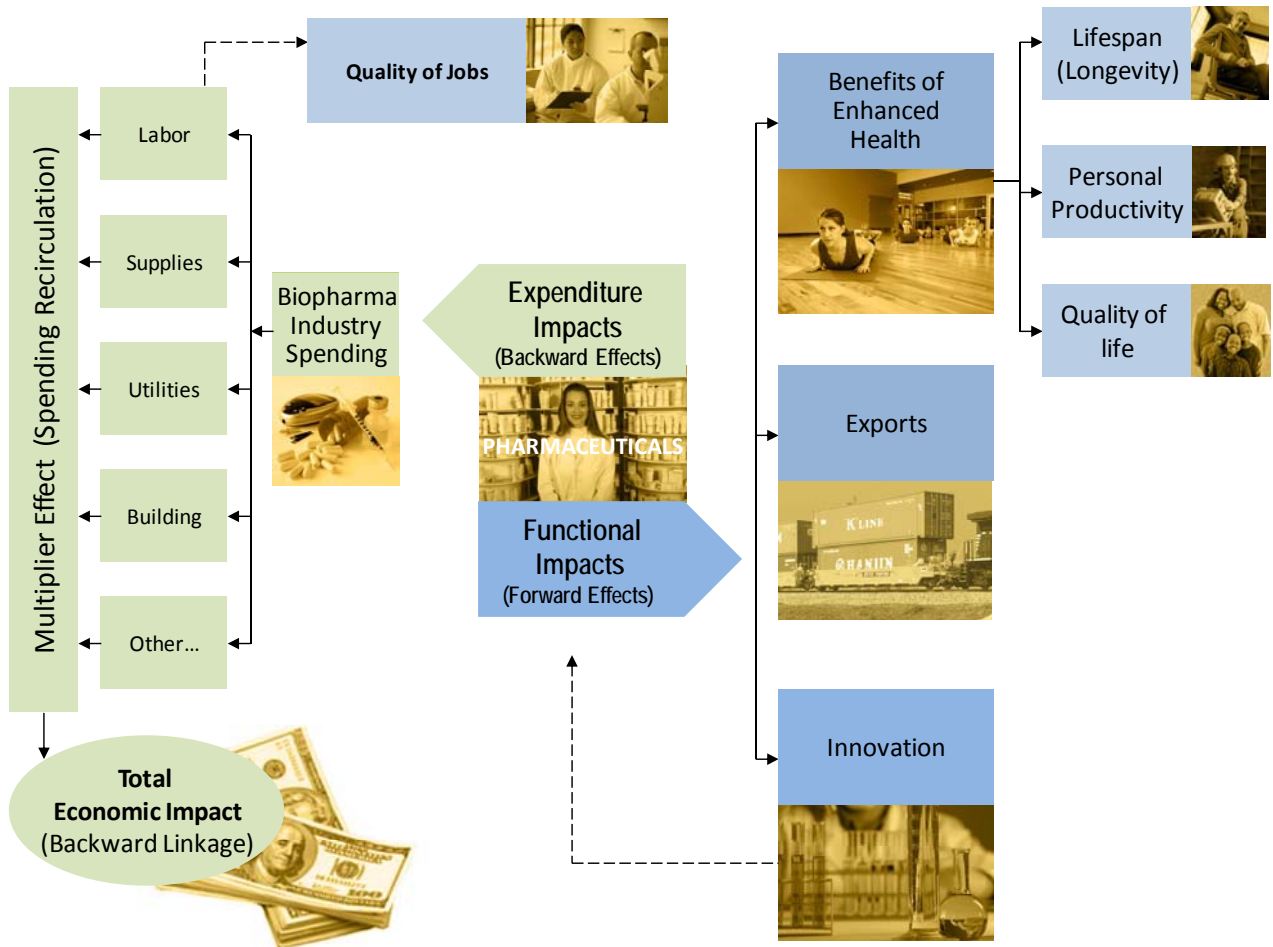
The Structure of Biopharmaceutical Sector Impacts

The importance of the biopharmaceutical sector is such that a well-rounded approach must be used in evaluating and presenting its diverse impacts. Certainly the **economic impacts** are of importance for many observers, and are quantified within this report. but equally important are the **functional impacts** generated by biopharmaceutical products—improved health, enhanced personal capabilities and productivity, and an enhanced quality-of-life through our ability to treat medical diseases and disorders. Impacts may thus be logically segmented into the “expenditure impacts” (also known as backward-linkage economic impacts) and “functional impacts” (sometimes referred to as forward-linkage impacts).

Backward-linkage expenditure impacts of the biopharmaceutical sector are the impacts typically measured in an economic impact study, quantifying direct and indirect job creation, associated personal incomes, business output, and associated revenues to federal, state and local taxing jurisdictions. These impacts are measured using the well-established regional economic analysis technique of Input/Output Analysis (I/O) which tracks the revenues of a sector and the related economic activity of suppliers to the sector and its personnel. Forward-linkage functional impacts are what make a sector unique. The biopharmaceutical sector exists to make useful, and in many cases crucial life-saving, new medicines for patients. The output of the biopharmaceutical sector is highly valued by society because the sector develops and manufactures a broad-range of unique products to treat disorders and diseases that, were they to go untreated, can ruin individual quality of life, personal abilities and productivity. In many instances, biopharmaceuticals are central to helping to prevent and treat a range of public health issues, address pandemic risk and thereby support national economic security.

Taking backward and forward linkages into account, Battelle's considers the impact areas illustrated in Figure 2 as key components of biopharmaceutical sector impacts in this report:

Figure 2: The Impact of Biopharmaceuticals – Economic and Functional Impacts



Battelle’s analysis thus quantifies, using input/output (I/O) analysis, the economic impacts of the biopharmaceutical sector on output in the U.S. economy, on jobs, personal income, and federal, state and local tax revenues. We also highlight some of the functional impacts of the sector—the wide-ranging benefits provided through the biopharmaceutical sector’s contributions to enhancing human health, improving life spans and sustaining the high quality-of-life that Americans enjoy—and assess the contributions of the biopharmaceutical sector to key areas of importance to our economy—innovation, product exports and quality of jobs produced. One measure that is not included in the analysis is the impact that the biopharmaceutical industry has on productivity in other industry sectors. Productivity increases will occur but their quantification is beyond the scope of this study.

◆ Expenditure Impacts of the Biopharmaceutical Sector

Direct, Indirect and Induced Impacts of the Biopharmaceutical Sector

The Battelle impact analysis for the U.S. biopharmaceutical sector makes use of a custom economic I/O model quantifying the interrelationships between economic sectors in the economy of the United States. I/O data matrices track the flow of commodities to industries from producers and institutional consumers within the nation. The data also show consumption activities by workers, owners of capital, and imports. These trade flows built into the model permit estimating the impacts of one sector on all other sectors with which it interacts.

Impacts consist of three general types: **direct impacts** (the specific impact of biopharmaceutical sector expenditures in the first round of spending), **indirect impacts** (the impact of expenditures by suppliers to the biopharmaceutical sector), and **induced impacts** (the additional economic impact of the spending of biopharmaceutical sector employees and suppliers' employees in the overall economy that can be attributed to the direct biopharmaceutical industry expenditures). In other words, I/O analysis models the flow of funds that originate from direct biopharmaceutical sector expenditures in the economy and the ongoing ripple (multiplier) effect of these expenditures. I/O analysis represents the generally accepted standard for measurement of economic impacts.

The current estimated impacts of the biopharmaceutical sector were calculated using 2009 U.S. specific I/O models generated by the IMPLAN Group (one of two major developers of regionally and nationally specific I/O tables). IMPLAN provides a specialized software system for impact analysis and highly detailed data tables at the national and individual state levels. Battelle acquired the necessary data files for use with the IMPLAN system and developed a customized model to quantify the direct, indirect and induced impacts of the biopharmaceutical sector. The model incorporates detail of the biopharmaceutical sector and its interrelationships with more than 430 other individual sectors that cover the entire national economy. With these data, the analysis is able to show not only the overall impact on the U.S. economy, but impacts on specific sub-sectors of the economy that are strongly dependent on economic activity generated by the biopharmaceutical sector.

U.S. Economic Impacts of Biopharmaceutical Sector Spending

Table 1 presents the findings from Battelle's I/O analysis of the U.S. biopharmaceutical sector for 2009 (the most current year for which complete I/O tables are available).² The overall economic impact of the biopharmaceutical sector on the U.S. economy (as measured by "output") totals more than \$917 billion on an annual basis. This impact comprises \$382 billion in direct impact of biopharmaceutical businesses and \$535 billion in indirect and induced impacts (an output multiplier of 2.4—meaning that every \$1 dollar in output generated by the biopharmaceutical sector generates another \$1.4 in output in other sectors of the economy). This significant multiplier is due to the high value-added nature of the sector, its extensive supply chain relationships, and high wage paying jobs.

The biopharmaceutical sector is responsible for supporting more than four million jobs in the U.S. economy (674,000 direct jobs and an additional 3.4 million indirect and induced jobs) in 2009.

Together, this biopharmaceutical sector-related workforce received **\$258 billion in wages and benefits in 2009**. In addition, the biopharmaceutical sector is also an important generator of government

revenues for the federal government and state and local jurisdictions. The analysis shows that the biopharmaceutical sector, directly and through the multiplier effect, **generated nearly \$33 billion in state and local tax revenue and more than \$52 billion in federal tax revenues in 2009.**

Table 1: Economic Impacts of the U.S. Biopharmaceutical Sector, 2009 (\$ in billions)

Impact	Employment	Personal Income	Value Added	Output	State/Local Tax Revenue	Federal Tax Revenue
Direct Effect	674,192	\$80.0	\$130.7	\$382.4	\$4.4	\$15.4
Indirect Impacts	1,403,511	\$92.1	\$142.3	\$261.6	\$12.4	\$18.6
Induced Impacts	1,935,738	\$85.9	\$152.9	\$273.8	\$15.8	\$18.5
Total Impact	4,013,441	\$258.0	\$425.9	\$917.8	\$32.6	\$52.5
Impact Multiplier	5.95	3.22	3.26	2.40	7.43	3.40

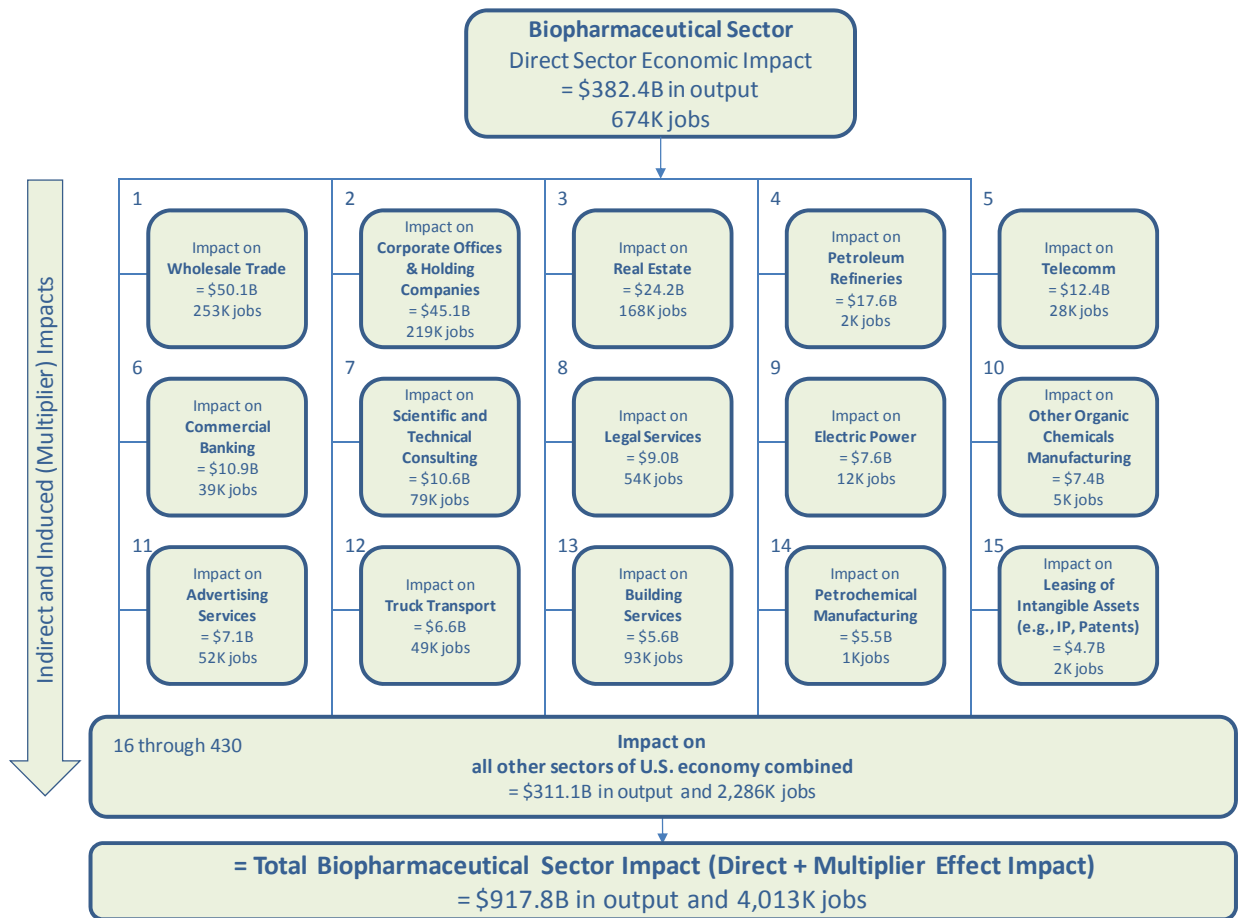
Personal Income: Measures cash, benefits and non-cash payments received by individuals in the economy.

Value-Added: The difference between an industry's or an establishments total output and the cost of its intermediate inputs.

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

The multiplier effects of the biopharmaceutical sector (indirect and induced impacts) are of benefit to a broad range of U.S. economic sectors. The I/O analysis allows the impact of the biopharmaceutical sector on every other sector in the economy to be measured, and the analysis shows that the following sectors benefit from particularly robust biopharmaceutical sector dependencies:

Figure 3: Total Biopharmaceutical Impacts and Indirect/Induced Impacts on Key Biopharmaceutical Supplier Sectors and on the Rest of the U.S. Economy (The top box indicates direct expenditure impacts of the Biopharmaceutical sector, the remaining boxes illustrate the indirect and induced impacts on the other sectors of the economy derived from the direct biopharmaceutical sector impacts)



As Figure 3 shows, gains or losses in biopharmaceutical sector revenues will be reflected in gains and losses across a broad range of additionally important U.S. economic sectors that have robust supply chain relationships with the biopharmaceutical sector.

Comparing Biopharmaceutical Sector Spending to a Consumer Spending Benchmark

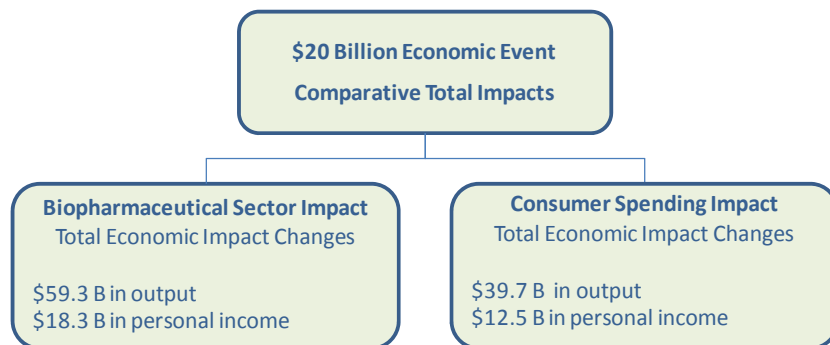
The biopharmaceutical sector currently has a large and significant economic impact, affecting many other key areas of the U.S. economy. The scale of this impact is subject to increases and decreases (as are all sectors) stemming from changes in the final demand and revenue derived from overall biopharmaceutical sales (output). These potential revenue changes can come from a number of sources; examples include increasing or decreasing foreign competition to the U.S. biopharmaceutical sector, significant revenue declines due to key patent expirations, and from changes in federal and state healthcare reimbursement policies.

But is the scale of these changes in the biopharmaceutical sector’s impact on the U.S. economy more (e.g., larger or smaller) than the impact of other sectors? To look at the relative impact of the biopharmaceutical sector, Battelle compared the economic impact of the biopharmaceutical sector to the impact of general consumer spending.

To accomplish this, Battelle TPP ran a comparative impact analysis for a hypothetical \$20 billion biopharmaceutical sector output “economic event” versus \$20 billion of direct consumer spending “event” (spread among income groups based upon 2009 U.S. Census estimates).³ This economic event can be interpreted as “absolute values”—while we show the impacts of a positive \$20 billion economic event, a negative \$20 billion economic event will have the same numerical results though *in the negative direction*. The impacts are linear, and thus a different value for the economic event would produce impacts proportional to the size of the event.

The results are illustrated on Figure 4, showing that the total impact of a \$20 billion event on the biopharmaceutical sector under this scenario would be \$59.3 billion compared to \$39.7 billion for a similar event on consumer spending—indicating that a \$20 billion change in revenue to the biopharmaceutical sector would cause an overall economic impact change of nearly \$60 billion (either positive or negative depending on the direction of the revenue change).

Figure 4: Comparative Effect of \$20 Billion Economic Event on Biopharmaceuticals and Consumer Spending on U.S. Economy



Thus, it is evident that the biopharmaceutical sector provides high returns for the U.S. economy. This is a result of the industry’s high overall multiplier effect, the biopharmaceutical sector generates far higher impacts in the U.S. economy than would a similar amount of general consumer spending.

Functional Impacts of the Biopharmaceutical Sector

Impacts of the Biopharmaceutical Sector on Health, Well-being and Selected Economic Indicators

The U.S. economy stays ahead of international competition by using advanced R&D and innovation to drive the growth of high value-added industries. By leveraging investment in federal lab, university and industry R&D, our nation is able to produce high-value, typically technologically advanced products that the rest of the world values highly. In recent decades, life sciences have come to the fore as a leading driver of U.S. technological innovation and competitive advantage, and as Figure 1 illustrates, the biopharmaceutical sector is a key foundation of the life sciences innovation ecosystem.

When examined closely, it is clear that the biopharmaceutical sector is an innovation engine for the U.S. producing high value-added products that boost exports and provide the good quality jobs our economy needs. And, it is producing products of critical importance to human health and quality-of-life. While the economic impacts of biopharmaceutical sector spending are substantial and of great importance to the U.S. economy, it is also important to keep in mind that the biopharmaceutical sector benefits society in many additional ways.

In the following section, Battelle discusses the functional impacts of the biopharmaceutical sector on the following aspects of U.S. economic and societal life:

- High quality job generation and high multiplier effect
- Exports to boost the U.S. economy
- Contributions to the innovation economy and American technological leadership
- Impact on health and well-being for individuals and society, including:
 - Improved life spans (personal longevity)
 - Improved productivity resulting from prevention and effective management of disease and chronic conditions
 - Improved quality of life for the American public
 - Reductions in unnecessary hospitalizations resulting in potential cost-offsets elsewhere in the health care system.

Biopharmaceuticals and High Quality Job Creation

The biopharmaceutical sector, whether in its R&D, manufacturing or sales and distribution functions, is a generator of high quality jobs for Americans. Comparatively high levels of wages and salaries are provided within the industry, as are family-sustaining benefits packages—helping to sustain a high quality of life for more than 674,000 persons directly employed in the industry. The following statistics on jobs and associated incomes in the U.S. biopharmaceutical sector speak for themselves:

Table 2: Job Creation and Quality in the U.S. Biopharmaceutical Sector, 2009

	Value	Notes
Number of biopharmaceutical sector direct Jobs	674,192	Including biopharmaceutical, biotech, bioscience R&D and associated jobs.
Average total compensation per worker	\$118,690	This is more than two times the U.S. private sector wage average.

Source: Battelle calculations using IMPLAN I/O modeling

The quality of biopharmaceutical industry jobs is part of what makes the sector such a key driver within the U.S. economy. The annual average personal income of a biopharmaceutical worker was \$118,690 in 2009 as compared to \$64,278 in the overall economy. Across all occupations involved in the biopharmaceutical sector from scientist to technician to production worker, the average salary is higher in the biopharmaceutical industry than the average across all private sector industries.⁴ This is because the biopharmaceutical sector is R&D intensive, and a high value-added sector, which creates a highly-complex and technologically-advanced product. Such production requires a workforce with specialized technical skills and education (at all levels, from those with entry level technical training to graduate engineers and PhD scientists).

Biopharmaceuticals and U.S. Exports

The U.S. biopharmaceutical industry is a major export generator for the U.S. economy, generating valuable foreign trade and income for the nation.

In the six year period 2005–2010, the United States exported more than \$232 billion in biopharmaceuticals. Moreover, despite the recession, U.S. biopharmaceutical exports have continued to rise for each of the six years, with volume exported increasing from \$29.1 billion in 2005 to \$46.7 billion in 2010 (a strong 60.5 percent increase over six years).⁵

Table 3: U.S. Biopharmaceutical Export Volume (Goods) 2005–2010 (Billions \$)

2005	2006	2007	2008	2009	2010	Six-Year Total
29.1	32.2	36.7	41.7	46.0	46.7	232.4

To put this export volume into perspective, 2010’s total biopharmaceutical exports of \$46.7 billion compares favorably to other major U.S. exports including: automobiles (\$38.4 billion in 2010 exports); plastics and rubber products (\$25.9 billion); communications equipment (\$27 billion) and computers (\$12.5 billion).

It should also be noted that these product exports from the U.S. are contributing to the health and well-being of countless people across the globe. U.S. biopharmaceuticals are a technological global ambassador, built upon a foundation of U.S. innovation and benefiting people worldwide.

Biopharmaceuticals and the U.S. Innovation Economy

Biopharmaceutical development is crucial to saving and improving lives, but it requires significant investment by the industry to discover and develop new prescription drugs. The biopharmaceutical industry spent \$67.4 billion on R&D in 2010, and the U.S. Congressional Budget Office notes that: “the pharmaceutical industry is one of the most research-intensive industries in the United States. Pharmaceutical firms invest as much as five times more in research and development, relative to their sales, than the average U.S. manufacturing firm.” Biopharmaceutical R&D is also a high risk business endeavor, and out of thousands of screened compounds, only 250 ever enter preclinical testing, just five make it to human clinical trials, and only one on average will be approved by the FDA.⁶

Despite the challenges, the biopharmaceutical sector is highly innovative. Giving testimony to innovation within the biopharmaceutical sector is the fact that it has been the leading U.S. technology class in terms of patent generation for the past five years. Data from the United States Patent Office show that the pharmaceutical patent class “drug, bio-affecting and body treating compositions (class 424)” led the nation, with a combined total of 15,969 patents generated between 2006 and 2010.⁷

At over \$105,000 in biopharmaceutical R&D per employee, the sector is way ahead of the average across all U.S. manufacturing which stands at about \$10,000 per employee—and is far ahead of the second and third ranked sectors of “communications equipment” and “semiconductors, which respectively spend \$63,000 and \$40,000 per employee in R&D annually.

This success in generating innovations and associated patents does not occur by serendipity—rather it results from intensive investments by the biopharmaceutical sector in research and development. The extensive degree of activity in the biopharmaceutical innovation and development pipeline is illustrated by the fact that the biopharmaceutical sector expends more per employee on R&D than any other U.S. sector. At over \$105,000 in biopharmaceutical R&D per employee, the sector is way ahead of the average across all U.S. manufacturing which stands at about \$10,000 per employee—and is far ahead of the second and third ranked sectors of “communications equipment” and “semiconductors, which respectively spend \$63,000 and \$40,000 per employee in R&D annually.⁸

The Impact of Biopharmaceuticals on the Health and Well-being of Individuals and Society in the U.S.

Biopharmaceuticals are the central tool in modern medicine but not the most costly.

74 percent of patient visits to physicians' offices result in prescribed drug therapies. However, prescriptions only represent 10 percent of the nation's healthcare expenditures.

“There is a highly statistically significant relationship between the number of new molecular entities [drugs] approved by the FDA and increased longevity.”

Biopharmaceuticals and the Longevity of Americans

Innovation in the biopharmaceutical sector, combined with the diagnostic and treatment skills of U.S. healthcare professionals, has contributed to a lengthening of the average life span of Americans. In 1900, the expected life span of an American at birth was just 47.3 years. With the advent of more modern medicines and advanced medical knowledge, life expectancy at birth has seen a steady increase rising to 69.7 years in 1960, and 77.9 years in 2007. Multiple researchers have shown that new medicines have played a key role in life expectancy gains in the last several decades.⁹

Of course, multiple advancements have contributed to increased life expectancy over time (safer motor vehicles, improved diagnostics technologies, product safety laws, etc.). However, the National Bureau of Economic Research reports that “there is a highly statistically significant relationship between the number of new molecular entities [drugs] approved by the FDA and increased longevity.”¹⁰ Furthermore, Lichtenberg found in a study of FDA data that “approval of priority-review drugs—those considered by the FDA to offer significant improvements in the treatment, diagnosis, or prevention of a disease—has a significant positive impact on longevity.”¹¹ Of note is the fact that in the past 10 years more than 300 new medicines have been approved for use by the FDA.

Americans are enjoying longer lives, in large part, because of the innovation taking place in the biopharmaceutical sector, plus data indicate they are able to enjoy more rewarding and productive lives because of the sector's products.

Biopharmaceuticals and Improved Personal Functionality and Productivity

Ill people are likely to be less productive people. Whether afflicted with a common cold or allergies, or suffering from debilitating diseases such as multiple-sclerosis, arthritis or chronic obstructive pulmonary disease, one's ability to function, to achieve daily life tasks, and to be productive in work and play is impaired. Over the course of a year the CDC reports that 83 percent of adults and 91.5 percent of children will have contact with a healthcare professional and 956 million physician office visits will occur. The demand for treatment for illness is immense.

The American Hospital Association (AHA) notes that “advances in medicine contribute to national economic growth by helping Americans recover more quickly from injury and illness, avoid lost or ineffective work time due to flare-ups of chronic conditions, and live longer with higher quality of life.”¹² Inability to work, or reduced productivity due to illness, has both personal and social costs. Those who experience an inability to work see their capacity to support themselves and their families reduced, while lost or unproductive work days are a clear drain on the economy. In an analysis of the sickness-to-productivity-loss issue, The Commonwealth Fund found that:¹³

In 2003, an estimated 18 million adults ages 19 to 64 were not working and had a disability or chronic disease, or were not working because of health reasons. Sixty-nine million workers reported missing days due to illness, for a total of 407 million days of lost time at work. Fifty-five million workers reported a time when they were unable to concentrate at work because of their own illness or that of a family member, accounting for another 478 million days. Together, labor time lost due to health reasons represents lost economic output totaling \$260 billion per year. Workers without paid time off to see a physician are more likely to report missing work or being unable to concentrate at their job.

Without effective medicines and treatments for illnesses, injuries, pain and chronic conditions, the productivity of the U.S. economy would clearly be greatly impaired. Biopharmaceuticals are a key contributor to a more productive and healthy America and U.S. economy. The impact of just one disease, Alzheimer's, illustrates the significant benefits that would attach to an effective treatment for just this one disease in the U.S. A recent report by the Alzheimer's Association notes that the development of a new treatment that would delay the onset of Alzheimer's by just five years could reduce Medicare and Medicaid spending on patients by more than \$100 billion annually by 2030.¹⁴

Biopharmaceuticals and Improved Quality-of-Life for the American Public

"Life, Liberty and the Pursuit of Happiness," enshrined in the Declaration of Independence, represents the core of American aspirations. Each of these three attributes is, however, denuded by illnesses. Obviously, disease is the leading cause of loss of "life" in the United States, but likewise illness takes away the liberty to pursue daily functions, to enjoy life and be happy. Depression, cardiovascular disease, cancer, arthritis, Alzheimer's disease, etc.—the list is long for diseases and disorders afflicting Americans and reducing quality-of-life. R&D to produce new biopharmaceuticals is of central importance to sustaining and improving quality-of-life.

Into the Future

The demand for new medicines and for innovations and solutions within the biopharmaceutical sector is not going to abate. Emerging infectious diseases continue to present new challenges, while a substantial volume of long-standing diseases such as cancer, diabetes, neurodegenerative diseases, psychiatric diseases, immunological diseases, etc. continue to demand novel treatments and improved therapeutics. There are millions of people suffering from diseases and disorders for which a therapy has yet to be found. The need for ongoing biopharmaceutical research and development is simply enormous.

Helping to lead progress in biopharmaceutical development are major advancements in our understanding of molecular biology together with the large-scale information generated through the sequencing of the human genome and sequencing of model organisms. Subsequent genomics advancements are opening new pathways for biopharmaceutical discovery and a new era of rational drug design and personalized medicine is approaching (and indeed, has already arrived in some frontier areas such as cancer therapeutics). Synthetic biology may allow new classes of drugs to be built from the ground up, while the personalized medicine revolution will mandate new approaches to producing small batches of customized drug formulations. The opportunities and needs are large, but so too, are the challenges.

For the U.S. to continue to benefit from a robust biopharmaceutical industry, companies must have a business and innovation environment that fosters and sustains continued R&D investment. We are in an era of intense global competition with other countries increasingly seeking to attract technologically-sophisticated, R&D-intensive companies, such as those in the biopharmaceutical

A \$10 billion change in biopharmaceutical revenues would have the following effect on the U.S. economy:

- **\$29.7 billion in total output**
- **130,000 total jobs**
- **\$9.2 billion in personal income**

sector. The upside for the U.S. is that having a strong business environment for the biopharmaceutical sector pays significant economic dividends. As the economic impact analysis reported herein shows, every \$20 billion in biopharmaceutical revenues produces ,through the multiplier effect, an additional \$39 billion of U.S. economic activity, 260,000 total jobs and federal tax revenues of nearly \$3.4 billion. Operating environments are dynamic, however, and changes in policies or operating conditions can have negative ramifications for business. Just as a \$20 billion increase in biopharmaceutical revenues would generate the benefits shown above, a shift in the environment that would cause a \$20 billion decline in revenues would have the reverse effect—reducing U.S. economic activity by a substantial \$59 billion and causing 260,000 job losses. For important, innovation-based, high multiplier-effect sectors of the U.S. economy, such as the biopharmamaceutical sector, actions and policy changes that impact the operating environment have to be considered very carefully.

ENDNOTES

¹ Bureau of Labor Statistics Quarterly Census of Employment and Wages data, with Battelle calculations.

² This 2009 analysis (the latest year available for the IMPLAN model) is built upon, updated and estimated using as a starting point the 2008 employment data developed by Archstone Consulting, A Hackett Group Company for PhRMA in their report, *The Biopharmaceutical Sector's Impact on the Economy of the United States*, 2010.

³ Note: the consumer spending is modeled as direct consumer spending of \$20 billion as opposed to income of \$20 B. A \$20 billion income event would result in lower economic impacts resulting from local, state, and federal income tax reductions to the \$20 billion event.

⁴ Wage data by occupation is based on data developed by the US Bureau of Labor Statistics based on an occupational survey. There are significant differences in the coverage, scope, and meaning between average wage data by industry and occupation. Average wages for a specific industry span all types of workers within that industry. Average wages for the biopharmaceutical sector are based on all the individuals employed by the industry, including the CEO, administrative staff, professional positions, janitors, etc. On the other hand, average wages for a specific occupation are confined only to that occupation or type of worker. Each type of wage analysis is useful but in different contexts—industry wage data will give you a broad perspective on wages for an entire sector, while occupational wage data will allow you to examine the wages and effective supply and demand for certain types of workers or skill sets.

⁵ U.S. International Trade Commission Trade Data database

⁶ PhRMA. "Key Industry Facts About PhRMA".

⁷ Patenting by Geographic Region, Breakout by Patent Class. U.S. Patent Office. Accessed online at: http://www.uspto.gov/web/offices/ac/ido/oeip/taf/clsstc/usastccl_gd.htm

⁸ Pham, N. "The Impact of Innovation and the Role of Intellectual Property Rights on U.S. Productivity, Competitiveness, Jobs, Wages, and Exports." NDP Consulting, April 2010.

⁹ See, for example, Centers for Disease Control and Prevention, "National Center for Health Statistics, Health, United States, 2006 with Chartbook on Trends in Health of Americans and E. Sun, et al., "The Determinants of Recent Gains in Cancer Survival: An Analysis of the Surveillance, Epidemiology, and End Results Database, *Journal of Clinical Oncology*, May 2008 Suppl (Abstract 6616).

¹⁰ Frank R. Lichtenberg. "New Drugs: Health and Economic Impacts." National Bureau of Economic Research. NBER Reporter: Winter 2003.

¹¹ Ibid

¹² American Hospital Association. "Healthy People are the Foundation for a Productive America." AHA Trendwatch.

¹³ Davis, K. et al. (2005). "Health and Productivity Among U.S. Workers." New York, NY. The Commonwealth Fund.

¹⁴ Alzheimer's Association, "Changing the Trajectory of Alzheimer's Disease: A National Imperative." (2010).