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The Innovative Pharmaceutical Manufacturing Industry:
Driving Economic Growth

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About the Author

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Led by the pharmaceutical manufacturing industry, IP-intensive manufacturing industries contribute extraordinary economic value to the U.S. economy. Compared to other IP-intensive and non-IP intensive manufacturing industries, the pharmaceutical manufacturing industry had the highest R&D investment over the past decade. Consequently, the pharmaceutical manufacturing industry outperformed other manufacturing industries in all key economic measures, including job creation, wages paid, gross output, net economic contribution, and exports.

The Innovative Pharmaceutical Manufacturing Industry: Driving Economic Growth

This report is a companion report to analysis of the U.S. manufacturing sector that found research and development (R&D) investment is a key driver of innovation, supporting the growth and sustainability of the nation's economy. The report, "Intellectual Property (IP)-Intensive Manufacturing Industries: Driving U.S. Economic Growth," determined that industries that invest more in R&D (defined as "IP-intensive") tend to be more productive, support higher-value jobs and sustain employment better than industries with low levels of R&D spending ("non-IP-intensive").

We use the latest official data to measure innovation and to assess the economic impacts and returns of R&D investment of manufacturing industries in the United States. The dataset covers detailed R&D industry data from 2000 to 2013 and Census economic data from 2000 to 2015. We found that industries that spent more on R&D per worker outperform their counterparts in all aspects. R&D investment creates innovative products that are sold at home and abroad. With higher demand, companies hire more workers. Furthermore, workers in high R&D industries are more productive. To attract and to keep productive workers, innovative industries pay their employees higher wages than their counterparts.

This companion report was developed with support by PhRMA to explore the economic contributions of manufacturing performed by the innovative biopharmaceutical industry versus other IP-intensive industries across a number of key measures.

The pharmaceutical manufacturing industry outperforms all other IP-intensive industries across key economic measures

Led by the pharmaceutical manufacturing industry, IP-intensive manufacturing industries contributed significant economic value to the U.S. economy during the past 15 years, a period covering both economic upturns and downturns. IP-intensive industries are defined in this report as those industries that have a higher research and development (R&D) investment per employee than the average R&D per employee in all manufacturing industries. Adopting and developing new technologies, these manufacturing companies in the U.S. create innovative products and services for consumers both domestically and internationally. With higher demand for their products and services and rising revenues, these companies are able to hire additional workers and pay wage premiums to attract talent and continue to innnovate. Innovation

Key Definitions and Data Sources

R&D: Research and development expenses of a manufacturing sector or subsector used in the production of intellectual property published by the National Science Foundation.

Employment: Total number of employees in a manufacturing sector or subsector published by the U.S. Census Bureau.

Wages: Total wages paid to employees of a manufacturing sector or subsector published by the U.S. Census Bureau.

Gross output: Total sales of a manufacturing sector or subsector published by the U.S. Census Bureau.

Value-added: The economic contributions of a manufacturing sector or subsector as measured by total sales minus intermediate inputs such as the cost of raw materials and services published by the U.S. Census Bureau.

Exports: Total sales abroad of a manufacturing sector or subsector (i.e. total sales minus domestic sales) published by the U.S. International Trade Commission.

of the U.S. pharmaceutical manufacturing is critically tied to its base of high-skilled STEM workers who are involved in every stage of the manufacturing process and seek to bring new treatments and cures to fight our most costly and challenging diseases. Workers in IP-intensive manufacturing industries are shown to have higher economic contributions to the U.S. economy.

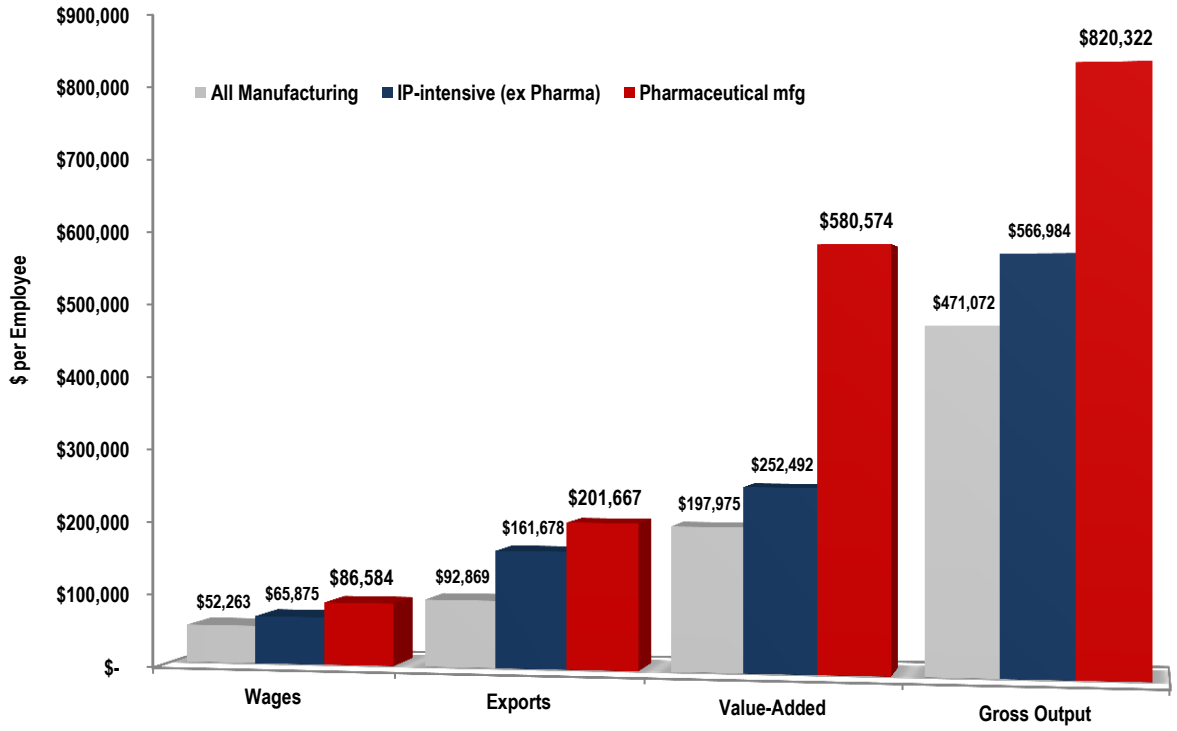
As noted above, this report is based on our comprehensive report that assesses the economic performance of all IP-intensive and non-IP-intensive industries during the period between 2008 and 2015.[1] We use R&D investment as a proxy to measure the innovative intensity across industries and R&D investment per employee to identify IP-intensive (which is defined as R&D per employee above the manufacturing average) and non-IP-intensive manufacturing industries. The matrix of economic performance includes employment, wages, output (revenue/sales), value-added (economic contributions), and exports.

Key highlights of the economic performance of the U.S. pharmaceutical manufacturing industry between 2008 and 2015 are:

- **Highest innovative industry**. R&D investment in the pharmaceutical manufacturing industry accounted for 33% of all R&D investment among IP-intensive industries (Figure 2).
- **Highest R&D investment**. The pharmaceutical manufacturing industry invested more than 6 times in R&D per employee than other IP-intensive manufacturing industries and more than 13 times all IP- and non-IP-intensive manufacturing industries (Figure 3).
- **Highest wages**. A worker in the pharmaceutical manufacturing industry made an average of $86,584 per year, compared to an average of $65,875 in other IP-intensive industries and an average of $52,263 in all manufacturing industries (Figure 1).
- **Highest performance and most productive**. The pharmaceutical manufacturing industry outperformed all manufacturing industries as well as other IP-intensive industries (Figure 1).
    - Gross output in the pharmaceutical manufacturing industry averaged $820,322 per employee, compared to $566,984 in other IP-intensive manufacturing industries and $471,072 in all manufacturing industries.
    - Net economic contributions (value-added) in the pharmaceutical manufacturing industry averaged $580,574 per employee, compared to $252,492 in other IP-intensive manufacturing industries and $197,975 in all manufacturing industries.
    - Exports of the pharmaceutical manufacturing industry averaged $201,667 per employee, compared to $161,678 in other IP-intensive manufacturing industries and $92,869 in all manufacturing industries.

[1] Pham, Nam. 2017. "IP-intensive Manufacturing Industries: Driving U.S. Economic Growth." ndp | analytics.

Figure 1. Economic Performance per Employee, Pharmaceutical versus other Manufacturing Industries, 2008-15



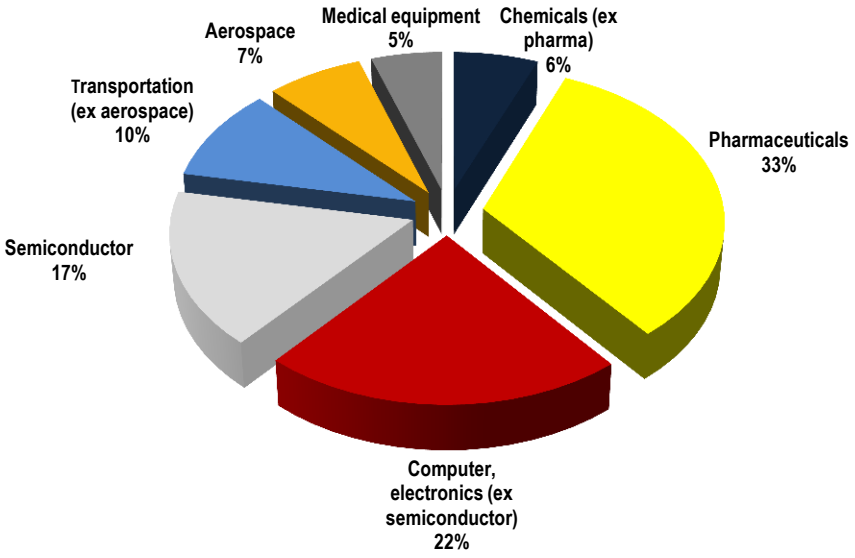
Sources: National Science Foundation: BRDIS Survey; U.S. Census Bureau: Annual Survey of Manufactures, County Business Patterns, and Economic Census; U.S. International Trade Commission: DataWeb.

The pharmaceutical manufacturing industry is highly innovative

Companies invest in research and development (R&D) to create intellectual property and to produce innovative products and services. During the period 2008-13, R&D investment across U.S. manufacturing averaged $177.8 billion per year. IP-intensive industries accounted for over 82% of total R&D investment while the combined R&D investment of all other non-IP-intensive industries was less than 18%. Among the IP-intensive industries, the pharmaceutical manufacturing industry had the highest share (33%) of R&D investment. During this period, the pharmaceutical manufacturing industry invested over $48 billion a year on R&D (Figure 2).

Figure 2. Composition of R&D Investment, 2008-13

The pharmaceutical manufacturing industry accounts for 33% of IP-intensive manufacturing R&D investment in the U.S.

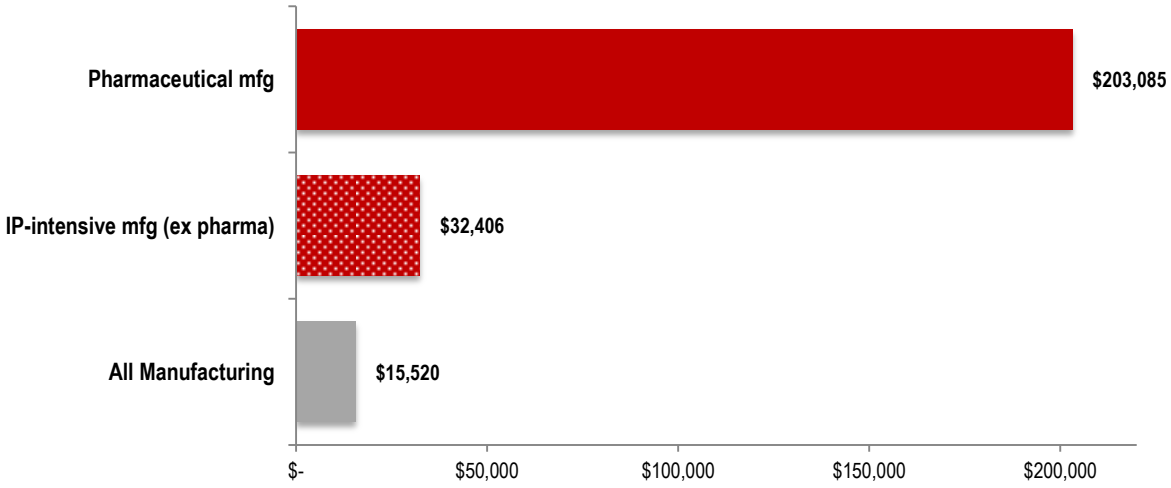


Source: National Science Foundation: BRDIS Survey.

During the period 2008-13, R&D investment in the pharmaceutical manufacturing industry averaged $203,085 per employee compared to an average of $32,406 per employee in other non-IP-intensive industries and $15,520 per employee in all manufacturing industries (Figure 3).

Figure 3. Annual Average R&D Investment per Employee, 2008-13

The pharmaceutical industry invests thirteen times more R&D per employee than all manufacturing industries



Sources: National Science Foundation: BRDIS Survey; U.S. Census Bureau: County Business Patterns.

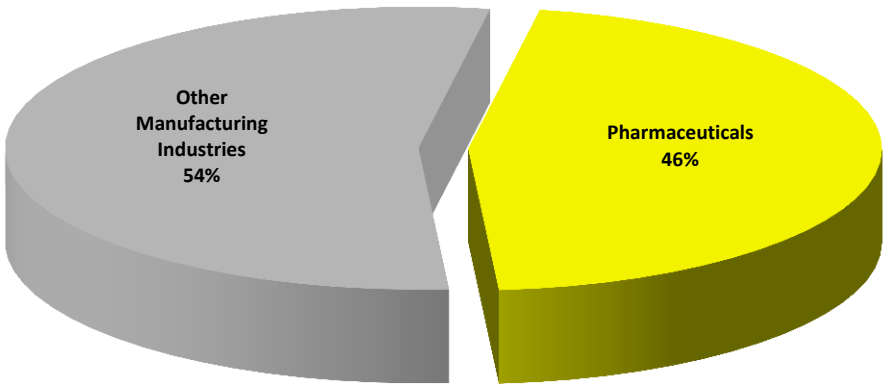
The pharmaceutical manufacturing industry has the highest stock of R&D Assets

In 2013, the Bureau of Economic Analysis began treating R&D expenditures as fixed investment and recorded it in a new investment category as intellectual property products. While annual R&D investment measures the annual flows of R&D investment (i.e., new R&D investment each year), the stock of R&D investment is the total accumulated R&D assets at a point in time. The stock of R&D assets (assets with a useful life greater than a year), are used repeatedly in the production process of other goods and services. The stock of assets is typically used in measuring rates of return on R&D and in analyzing multifactor productivity.[2] In pharmaceuticals, the stock of R&D assets can be thought of as the accumulated scientific knowledge related to disease pathways and methods of treatment discovered through the drug discovery and development process. In this respect, even clinical trials and related R&D expenditures that do not yield an FDA-approved drug product nevertheless contribute to the science and understanding of disease and their treatments.

U.S. manufacturing industries accumulated nearly $1.25 trillion R&D assets by the end of 2015, an increase from $792.9 billion in 2008. As of 2015, the stock of R&D assets of the biopharmaceutical industry ($529.4 billion) accounted for 46% of total stock of R&D assets of all U.S. manufacturing sectors (Figure 4). Furthermore, the stock of R&D assets of the biopharmaceutical industry grew 63% during 2008-15, compared to 45% for all other U.S. manufacturing sectors,

Figure 4. Stock of R&D Assets, as of 2015

The stock of R&D assets of the pharmaceutical industry accounts for 46% of all U.S. manufacturing industries



The pharmaceutical manufacturing industry grew faster than other manufacturing industries

Gross output of the pharmaceutical manufacturing industry during 2008-15, accounting for 10.2% of total output of IP-intensive manufacturing industries, grew faster than other IP-intensive manufacturing industries and all manufacturing industries. R&D investment is the crucial element for companies to be innovative and

[2] BEA. 2016. NIPA Handbook: Concepts and Methods of the U.S. National Income and Product Accounts, Chapter 6: Private Fixed Investment. https://www.bea.gov/national/pdf/chapter6.pdf

to grow. The pharmaceutical manufacturing industry has the highest R&D investment intensity across U.S. manufacturing industries, 25.4% of their gross output compared to 5.9% of other IP-intensive industries and 3.4% of all U.S. manufacturing industries during 2008-15 (Table 1).

Table 1. Annual Average Output, Growth Rates, and Shares of R&D, 2008-15

The pharmaceutical manufacturing industry grew faster than other manufacturing industries

	Annual Gross Output ($ billions)	Annual Growth Rate (%)	R&D as % of Gross Output (%)
All Manufacturing Industries	**5,406.2**	**0.2**	**3.4**
IP-Intensive	***1,912.5***	***1.5***	***7.9***
Pharmaceutical & medicine	194.8	2.1	25.4
Others	1,717.7	1.4	5.9

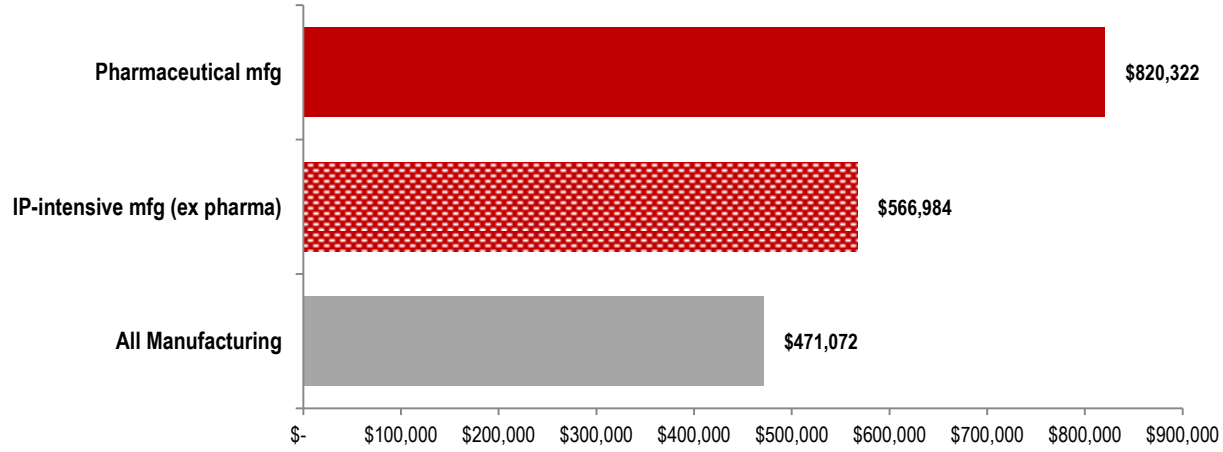
Sources: National Science Foundation: BRDIS Survey; R&D as % of gross output (2008-13); U.S. Census Bureau: Annual Survey of Manufactures, County Business Patterns and Economic Census.

Gross output per employee in the pharmaceutical manufacturing industry was 1.7 times that of all manufacturing industries

During 2008-15, gross output in the pharmaceutical manufacturing industry was $820,322 per employee, compared to the average of $566,984 per employee in other IP-intensive manufacturing industries and $471,072 in all manufacturing industries (Figure 5).

Figure 5. Annual Average Output per Employee, 2008-15

Workers in the pharmaceutical manufacturing industry produce higher levels of output than the average of other manufacturing industries



Sources: U.S. Census Bureau: Annual Survey of Manufactures, County Business Patterns and Economic Census.

The pharmaceutical manufacturing industry is one of the largest contributors to the U.S. economy across all manufacturing industries

While gross output includes values of intermediate materials, the value-added measurement excludes values of intermediate products to measure the net value of economic contributions of the industry to the economy. The value-added of the pharmaceutical manufacturing industry accounted for more than 15% of total value-added of all IP-intensive industries. During the period 2008-2015, the pharmaceutical manufacturing industry grew an average of 1.2% annually. The pharmaceutical manufacturing industry invests 35.5% of its value-added in research and development for its products and innovation, compared to an average of 13.1% of other IP-intensive industries and 8.0% of all manufacturing industries (Table 2).

Table 2. Annual Average Value-Added, Growth Rates, and Shares of R&D, 2008-15

Economic value-added in the pharmaceutical manufacturing industry grew faster than other manufacturing industries

	Annual Value-Added ($ billions)	Annual Growth Rate (%)	R&D as % of Value-Added (%)
All Manufacturing Industries	**2,271.8**	**1.0**	**8.0**
IP-Intensive	***902.6***	***1.1***	***16.5***
Pharmaceutical & medicine	137.9	1.2	35.5
Others	764.7	1.1	13.1

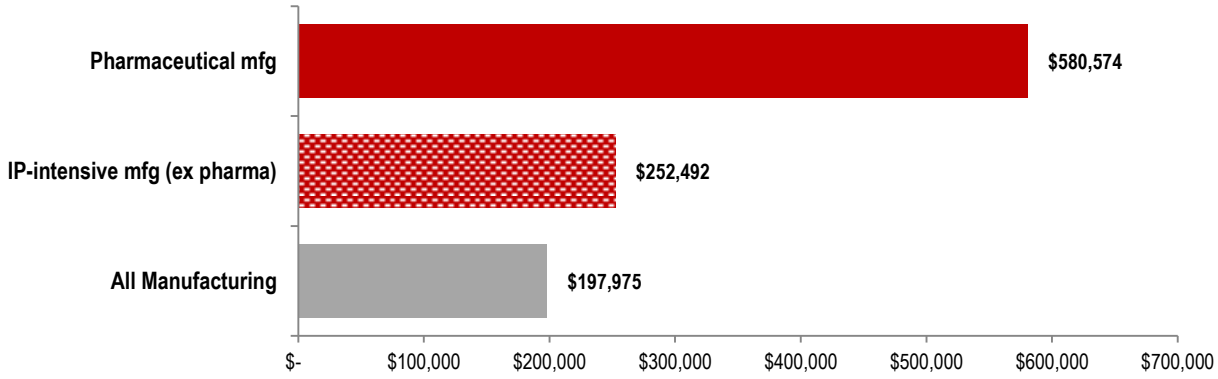
Sources: National Science Foundation: BRDIS Survey; R&D as % of value-added (2008-13); U.S. Census Bureau: Annual Survey of Manufactures, County Business Patterns and Economic Census.

Like gross output, value-added per employee in the pharmaceutical manufacturing industry outpaced other manufacturing industries

During the period 2008-15, net economic contributions (value-added) per employee in the pharmaceutical manufacturing industry averaged $580,574 per year. The economic performance of pharmaceutical industry workers is 2.3 times the average of all other IP-intensive manufacturing industries and nearly three times the average of all manufacturing industries (Figure 6).

Figure 6. Annual Average Value-added per Employee, 2008-15

Economic valued-added of workers in the pharmaceutical manufacturing industry are substantially higher than in other manufacturing industries



Sources: U.S. Census Bureau: Annual Survey of Manufactures, County Business Patterns, and Economic Census.

The pharmaceutical manufacturing industry maintained its employment level over the last decade, covering periods of economic upturn and downturn

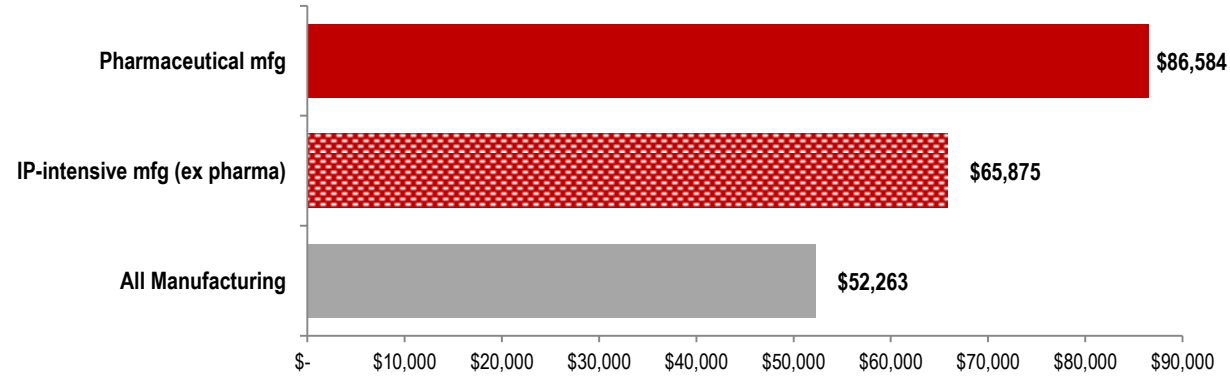
During the past decade, U.S. manufacturing sectors lost nearly 5.3 million jobs and about one-third of total manufacturing jobs. IP-intensive manufacturing industries also suffered job losses, although the effect was smaller. While jobs were lost in all other industries during the economic downturn, overall jobs in the pharmaceutical and medicine manufacturing industry remained unchanged from its 2000 level.

Wages in the pharmaceutical manufacturing industry are higher than other manufacturing industries

Workers in the pharmaceutical manufacturing industry earn higher wages than their counterparts in other IP-intensive and all manufacturing industries. During 2008-15, workers in the pharmaceutical manufacturing industry made an average $86,584 per employee per year compared to $65,875 per employee in other IP-intensive manufacturing industries and $52,263 in all manufacturing industries (Figure 7).

Figure 7. Annual Average Wages per Employee, 2008-15

Workers in the pharmaceutical manufacturing industry earn higher wages than in other industries



Sources: National Science Foundation: BRDIS Survey; U.S. Census Bureau: County Business Patterns and Economic Census.

Pharmaceutical manufacturers increased their exports to surpass $55 billion in 2015

Export sales in the pharmaceutical manufacturing industry increased more than 32% from $41.7 billion in 2008 to $55.1 billion in 2015. R&D investment of the pharmaceutical manufacturing industry is equivalent to 104.6% of the industry's exports, compared to 20.8% of other IP-intensive industries and 17.4% of all manufacturing industries (Table 3).

Table 3. Annual Average Exports, Growth Rates, and Shares of R&D, 2008-15

The pharmaceutical manufacturing industry's exports grew 4.0% annually during 2008 and 2015

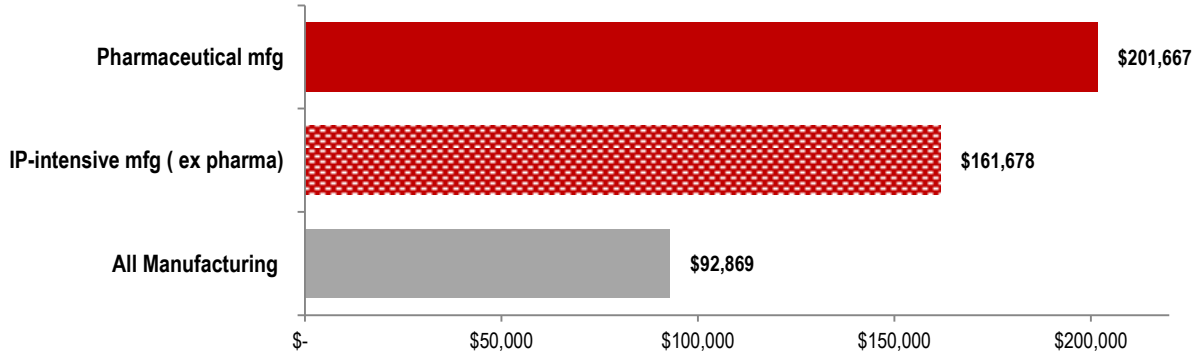
	Annual Exports ($ billions)	Annual Growth Rate (%)	R&D as % of Exports (%)
All Manufacturing Industries	**1,064.2**	**1.6**	**17.4**
IP-Intensive	***537.6***	***1.6***	***28.2***
Pharmaceutical & medicine	47.8	4.0	104.6
Others	489.8	1.4	20.8

Sources: U.S. Census Bureau: County Business Patterns and Economic Census; U.S. International Trade Commission: DataWeb;. R&D as % of exports (2008-13).

During the same period, annual export sales per employee in the pharmaceutical manufacturing industry averaged $201,667 compared to $161,678 in other IP-intensive industries and $92,869 in all manufacturing industries (Figure 8).

Figure 8. Annual Average Exports per Employee in IP-Intensive and All Manufacturing Industries, 2008-15

Exports per employee in the pharmaceutical manufacturing industry are twice that of all manufacturing industries



Sources: U.S. Census Bureau: County Business Patterns and Economic Census; U.S. International Trade Commission: DataWeb.

FINAL REMARKS

This brief report reinforces the importance of research and development (R&D) investment in supporting innovation. As seen in the pharmaceutical manufacturing industry, R&D investment and the activity and output generated is positively correlated with the economic performance of the industry during both economic upturns and downturns.

Recent data reconfirms that IP-intensive manufacturing industries outperformed others and contributed significant value to U.S. economic growth. The pharmaceutical manufacturing industry is leading other industries in terms of R&D investment. Consequently, the economic performance of the pharmaceutical manufacturing industry outpaces others.

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