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IP-Intensive Manufacturing Industries:
Driving U.S. Economic Growth

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About the Author

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Abstract

Recent R&D and economic data across industries once again confirm the crucial role of innovation on long-term economic productivity and growth.

IP-intensive industries outperformed non-IP intensive industries across key economic measures. Workers in innovative industries disproportionately create more economic value and earn higher wages than their counterparts in other manufacturing industries. IP-intensive industries cut less jobs during the economic downturn and added more jobs during the economic recovery than their counterparts non-IP-intensive industries.

Given intellectual property (IP) rights and protections foster innovation, public policies should focus on ensuring robust IP rights and protections.

Highlights of the Report

Innovative industries in the United States owe much of their success to economic returns resulting from their high levels of research and development (R&D) or intellectual capital investment. Intellectual property (IP)-intensive manufacturing industries are defined in our research as those industries that have a higher rate of R&D investment per employee than the average R&D per employee across all manufacturing industries. Our research findings show that IP-intensive manufacturing industries have outperformed non-IP-intensive manufacturing industries in all key economic measures since the turn of the century. The outperformance of the IP-intensive industries during economic downturns reflects the sustainability of these industries. IP-intensive manufacturing industries invest heavily to research and develop new products and services as well as invest in incremental advances by improving or transforming existing products. With higher demand for their products and services and increased revenues based on the high value of these products and services, these IP-intensive companies are able to build new facilities and hire additional high-wage workers in both science, technology, engineering, and mathematics (STEM) and non-STEM fields. Workers in IP-intensive manufacturing industries in turn are more productive and contribute higher economic value to the U.S. economy compared to workers in non-IP intensive industries.

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. Our dataset covers detailed R&D data from 2000 to 2013 published by the National Science Foundation 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.

Highlights of the economic performance of IP-intensive manufacturing industries during the period 2008-15 are (Table 1 and Figure 1):

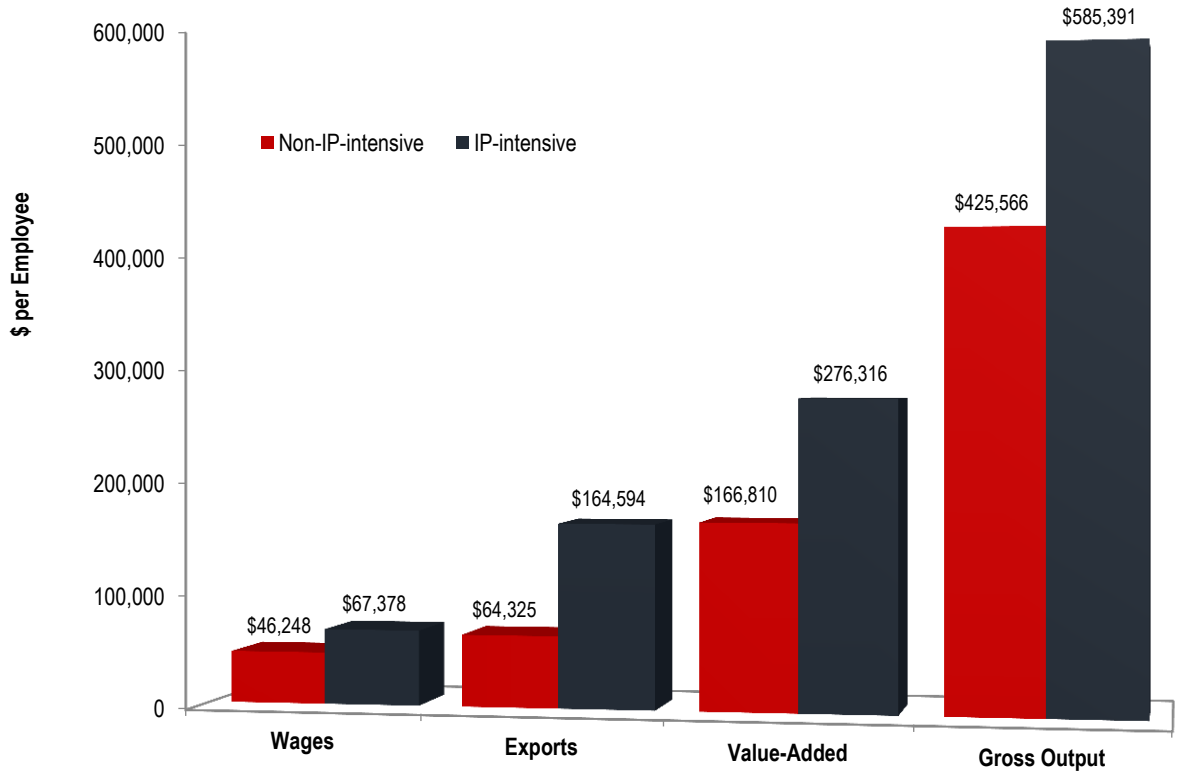
- **Higher R&D investment**. IP-intensive manufacturing industries invest 11.5 times more R&D per employee than non-IP-intensive manufacturing industries ($44,799 compared to $3,887 per employee annually).
- **Higher job creation**. IP-intensive manufacturing industries added more jobs during the most recent economic recovery period.
- **Higher wages**. IP-intensive manufacturing industries pay 45.7% higher wages than non-IP-intensive manufacturing industries (approximately $67,378 compared to $46,248 per employee annually).
- **Higher sales**. While IP-intensive manufacturing industries employ approximately 28% of American manufacturing workers, they account for over 35% of gross output (total sales) of manufacturing industries. Gross output per employee in IP-intensive manufacturing industries is 1.4 times that of their counterparts in non-IP-intensive manufacturing industries (approximately $585,391 compared to $425,566 per employee annually).
- **Higher productivity**. Net economic contribution (gross sales minus intermediate products or value added) per employee in IP-intensive manufacturing industries is also 1.7 times that of their

counterparts in non-IP-intensive manufacturing industries ($276,316 compared to $166,810 per employee annually).

- **Higher exports**. Annual exports per employee in IP-intensive manufacturing industries are 2.6 times greater than exports per employee in non-IP-intensive manufacturing industries ($164,594 compared to $64,325 per employee annually).

R&D investment produces innovative products to sell at home and abroad and has positive economic returns in all key economic measures. Figure 1 below illustrates the economic outperformance of IP-intensive manufacturing industries compared to other non-IP-intensive manufacturing industries. During the period between 2008 and 2015, gross output (total sales), value-added (net economic contribution), exports, and wages per employee in IP-intensive manufacturing industries were all higher than that of other non-IP-intensive manufacturing industries. Overall, industries that invest more on R&D per employee have higher economic returns and contribute more to the U.S. economy.

Figure 1. Economic Performance per Employee, IP-Intensive and Non-IP-Intensive Industries, 2008-15



IP-intensive Manufacturing Industries: Driving U.S. Economic Growth

INTRODUCTION

Continued innovation is imperative for long-term sustainable economic growth. The research and development (R&D) process requires substantial time, effort, and resources. R&D investment enables companies to research and develop new or improved products, services, and processes that advance quality of life around the world and enable economies to grow. With advanced knowledge, innovative companies have comparative advantages to compete domestically and globally. Much of the post-World War II economic growth in the United States can be explained by increases in productivity due to technological advancement, increases in knowledge, and increased investment in human capital and R&D.[1]

Empirical studies have found evidence to support the linkage between innovation and economic growth. R&D activities help innovative companies and industries grow, which leads to employment and economic growth across the country. Indeed, innovative industries support over 57.6 million American jobs, 20 million directly and another 37.6 million indirectly through robust supply chain activities. Workers in innovative industries are highly productive, reflecting the high-skilled labor required and relative capital intensity of innovative work.[2]

Over the past fifty years, annual R&D investment in the United States has fluctuated with gross domestic product (GDP) growth, with significant drops during the two most recent recessions in 2000 and 2008. Approximately two-thirds of private R&D investment is spent on human capital in the form of salaries and wages, benefits, stock-based compensation, and temporary staffing, while the remaining one-third is spent on equipment, materials and supplies, lease and rental payments, and depreciation.[3] Figure 2 below tracks annual growth rates of aggregate R&D investment, GDP, and employment, in the United States since 1960.

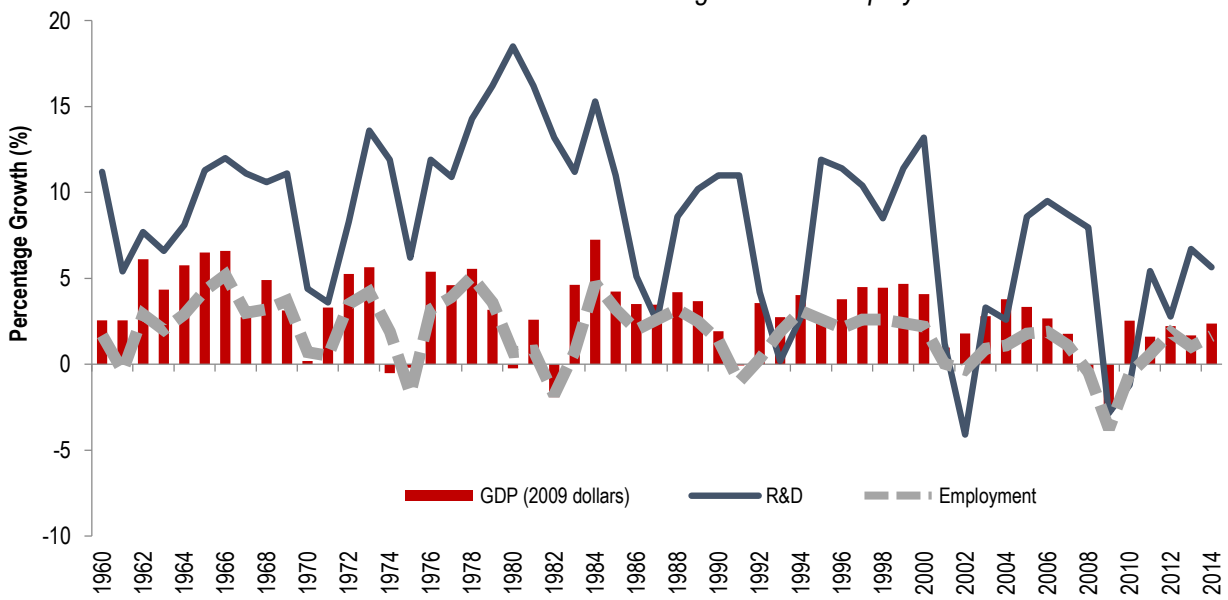
In July 2013, the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce took a historic step to recognize private and public R&D investment as tangible assets. The BEA now records R&D investment figures in a category called "intellectual property products" within nonresidential gross investment. The new method recognizes "R&D" as assets used in the production process over a given time period. The revision has significant implications domestically as well as internationally. R&D activities now are recognized in a more tangible form in the national income accounts with market values that reflect the potential for generation of future income (Figure 6).

Source: Bureau of Economic Analysis, U.S. Department of Commerce.

[1] Hasan, Iftekhar, and Christopher L. Tucci. 2010. "The Innovation–Economic Growth Nexus: Global Evidence."
[2] Pham, Nam. 2015. "IP-Intensive Manufacturing Industries: Driving U.S. Economic Growth." ndp | analytics; Pham, Nam. 2012. "IP Creates Jobs for America." ndp | analytics; U.S. Department of Commerce. 2012. "Intellectual Property and the U.S. Economy: Industries in Focus."
[3] National Science Foundation: BRDIS Survey. "2008 Data Tables. Table 1, Survey item aggregates."

Figure 2. R&D, GDP, and Employment, Annual Growth Rates, 1960-2014

R&D investment correlates with GDP growth and employment



Sources: National Science Foundation: BRDIS Survey; U.S. Bureau of Economic Analysis: National Economic Accounts; U.S. Bureau of Labor Statistics: Current Population Survey.

Evidence of the positive correlation between innovation and economic growth can be seen in economies around the world. Research has shown that countries with higher levels of patenting activity, meaning those that file a higher number of patents which is an indicator of innovation, tend to have higher economic growth rates, and that growth accelerates over time as patenting levels increase. Researchers measuring innovation across 49 developed and developing economies find a recurrent micro-level relationship between expenditures in R&D and innovation output measured by patents granted.[4] The European Patent Office found that innovative industries accounted for more than 56 million jobs, which translates to 26% of total employment in the European Union (EU). These jobs support a network of suppliers and service industry jobs that total another 20 million jobs. In total, innovative industries directly and indirectly support 76.6 million jobs, or more than 35% of total employment in the EU. These jobs pay more than 40% higher wages than non-IP-intensive manufacturing industries.[5] The success and growth of developed and developing economies hinges on the protection of proprietary research, development processes, and safeguards to the innovative ecosystem.

This report uses the official R&D and economic data to measure the innovation and to assess the economic impacts of R&D investments in U.S. manufacturing sectors. We use National Science Foundation's R&D data (2000-2013) and Census's economic data (2000-2015) of manufacturing industries.. We use R&D investments 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

[4] Bosch, Mariano, Daniel Lederman, and William Maloney. 2005. "Patenting and Research and Development: A Global View." World Bank Policy Research Working Paper 3739.

[5] European Patent Office. 2013. "IPR-Intensive Industries: Contribution to Economic Performance and Employment in the European Union."

average) and non-IP-intensive manufacturing industries. The matrix of economic performance includes employment, wages, outputs/sales, value-added/economic contributions, and exports. The data time frame covers both economic upturn and downturn periods.

METHODOLOGY

Innovation can be measured by an input matrix, an output matrix, or a combination of input and output matrices. The input matrix, leading with R&D investment, provides the level of effort needed to produce innovation while the output matrix measures the outcomes of innovation. Depending on the type of innovation, the input and output matrices have their advantages and disadvantages as proxies of innovation. Three tangible IP outputs that are commonly used and recognized legally are patents, trademarks, and copyrights. The economic value of IP outputs depends heavily on the value of products and services that were created by the innovation process.

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.

Measuring innovation by its inputs has several advantages. R&D investments are tangible and direct inputs to produce IP. Since R&D investments are recorded in terms of expenditures, they are widely used to measure the intensity of IP across industries and countries. In fact, empirical evidence shows that R&D investment is a reliable indicator of innovative capacity and is positively correlated with all measures of innovation outputs.[6] Studies also show that R&D spending is highly correlated with the number of patents in both large and small firms.[7] Evidence shows previous R&D expenditures affect subsequent R&D inputs of companies in the high-tech industries. Furthermore, successful R&D projects at previous stages tend to increase the commitments of future R&D efforts. Consequently, R&D activities positively affect innovative performance of a company, which leads to new products.[8]

Measuring IP-Intensity across U.S. Manufacturing Industries

We follow the methodology developed in our previous reports to identify IP-intensive manufacturing industries and to quantify the economic benefits of innovation to the U.S. economy.[9] We use R&D

[6] Mairesse, Jacques and Pierre Mohnen. 2004. "The Importance of R&D for Innovation: A Reassessment Using French Survey Data." NBER Working Paper No. 10897; Steinberg, Rolf and Olaf Arndt. 2001. "What Determines the Innovation Behavior of European Firms?" Economic Geography.
[7] For example, Chakrabarti, Alok K. and Michael R. Halperin. 1990. "Technical Performance and Firm Size: Analysis of Patents and Publications of U.S. Firms," Small Business Economics, Vol. 2, No. 3, pp. 183-190.
[8] Hagedoorn, John, and Myriam Cloodt. 2003. "Measuring Innovative Performance: Is There An Advantage In Using Multiple Indicators?" *Research Policy*, 32(8): 1365-1379.

investment as an indicator to measure the level of innovation and R&D per employee to measure the IP intensity across manufacturing industries. We define IP-intensive manufacturing industries are those industries that have a higher R&D investment per employee than the average R&D per employee in all manufacturing sectors. Similarly, non-IP-intensive manufacturing industries are those industries that have R&D per employee below the average manufacturing sector level.

We obtain annual detailed R&D data by industry from 2000 to 2013 by industry (2-, 3-, and 4-digit NAICS) published by the National Science Foundation (NSF) and annual economic data from 2000 to 2015 by industry published by the U.S. Census Bureau. The annual 2014 R&D industry data is only available at the aggregated level but not at the industry level. To be consistent with other economic performance per employee (i.e., output, value added, wage, and exports), we use the employment data published by the U.S. Census Bureau to calculate the R&D per employee by manufacturing industry. Note that the Census Bureau publishes employment data by industry at the establishment level and therefore is expected to be lower than the employment data at the company level compiled by the NSF. To assess the robustness of our IP classifications, we also use the employment number at the company level published by the NSF to calculate the R&D per employee. Although the level of R&D investment per employee is different, the IP-industry classification remains unchanged.

We categorize IP-intensity and non-IP-intensity industries by comparing R&D per employee of each subsector to the manufacturing average. Among 21 subsectors (3-digit NAICS) that make up the U.S. manufacturing sectors (2-digit NAICS), four manufacturing subsectors (chemical products, computer and electronic products, transportation equipment, and medical equipment) had higher R&D investment than the manufacturing sector average throughout the entire period between 2000 and 2013.[10] R&D per employee in the petroleum and coal products manufacturing subsector (NAICS 324) however was higher than the manufacturing sector average during 2000 and 2007 but then dropped below the manufacturing sector average since 2008. As a result, IP-intensive industries in our analysis include five manufacturing subsectors (petroleum and oil products, chemical products, computer and electronic products, transportation equipment, and medical equipment) during 2000 to 2007 but only four manufacturing subsectors (chemical products, computer and electronic products, transportation equipment, and medical equipment) during 2008 to 2013.

We further calculate R&D investment per employee of disaggregated industries (4-digit NAICS) within the three largest manufacturing subsectors (3-digit NAICS) by R&D investment which are also IP-intensive industries. R&D investment per employee of the largest industry (4-digit NAICS) within each of the three IP-intensive subsectors (chemical products, computer and electronic products, and transportation equipment) is also higher than the manufacturing sector level, reflecting its IP-intensity.

Annual R&D investment of U.S. manufacturing sectors increased more than 155% from $6,870 per employee in 2000 to $17,583 per employee in 2013, averaging $11,844 per employee. During this period, R&D per employee of IP-intensive industries was about twelve times R&D per employee of non-IP-intensive industries. As shown in Figure 3 below, the three industries (4-digit NAICS) with the highest

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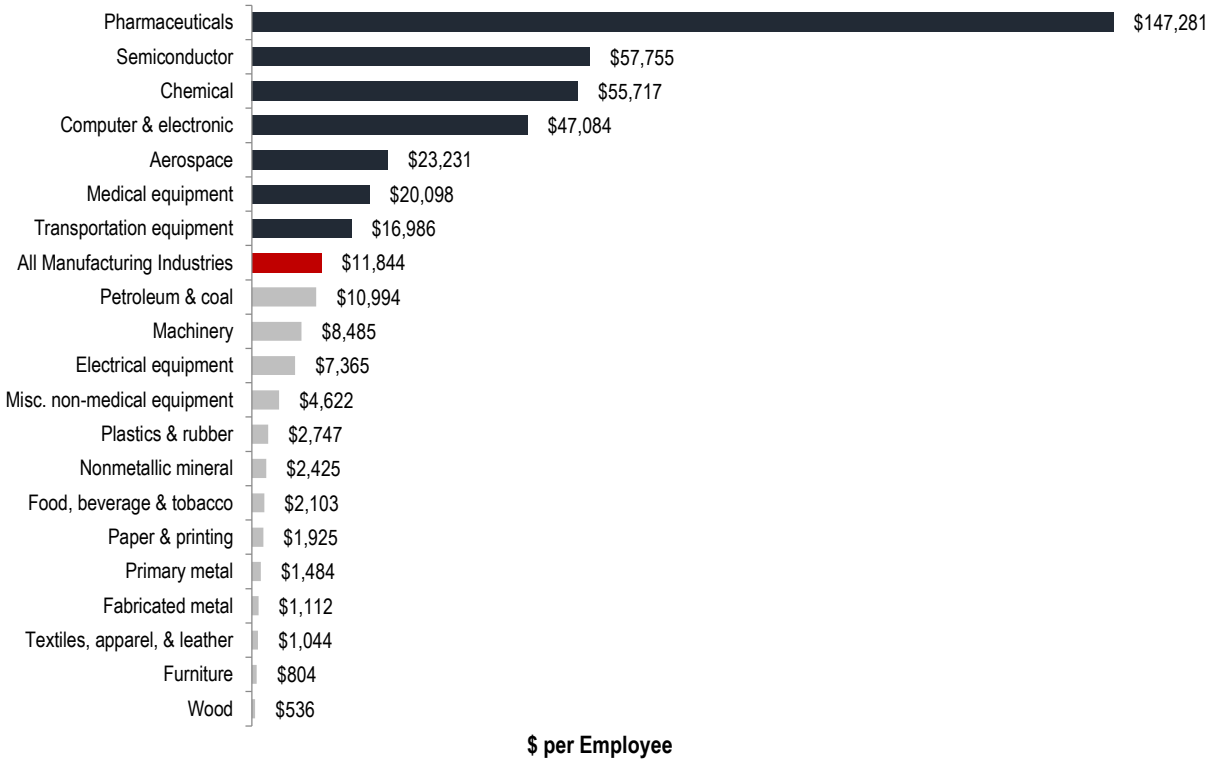
[9] Pham, Nam. 2010. "The Impact of Innovation and the Role of Intellectual Property Rights on U.S. Productivity, Competitiveness, Jobs, Wages, and Exports." ndp | analytics; Pham, Nam. 2015. "IP-Intensive Manufacturing Industries: Driving U.S. Economic Growth." ndp | analytics.

[10] NAICS refers to the North American Industry Classification System (NAICS). The system uses the term sector for 2-digit NAICS, subsector for 3-digit, and 4-digit for industry.

amount of R&D investment per employee were pharmaceutical and medicine manufacturing, semiconductor manufacturing, and aerospace manufacturing. Note that other sections in this report use the term industry and subsector interchangeably.

Figure 3. Annual Average R&D Investment per Employee, by Selected Industries, 2000-13

IP-intensive industries, led by the pharmaceutical industry, invest twelve times more R&D per employee than non-IP-intensive industries

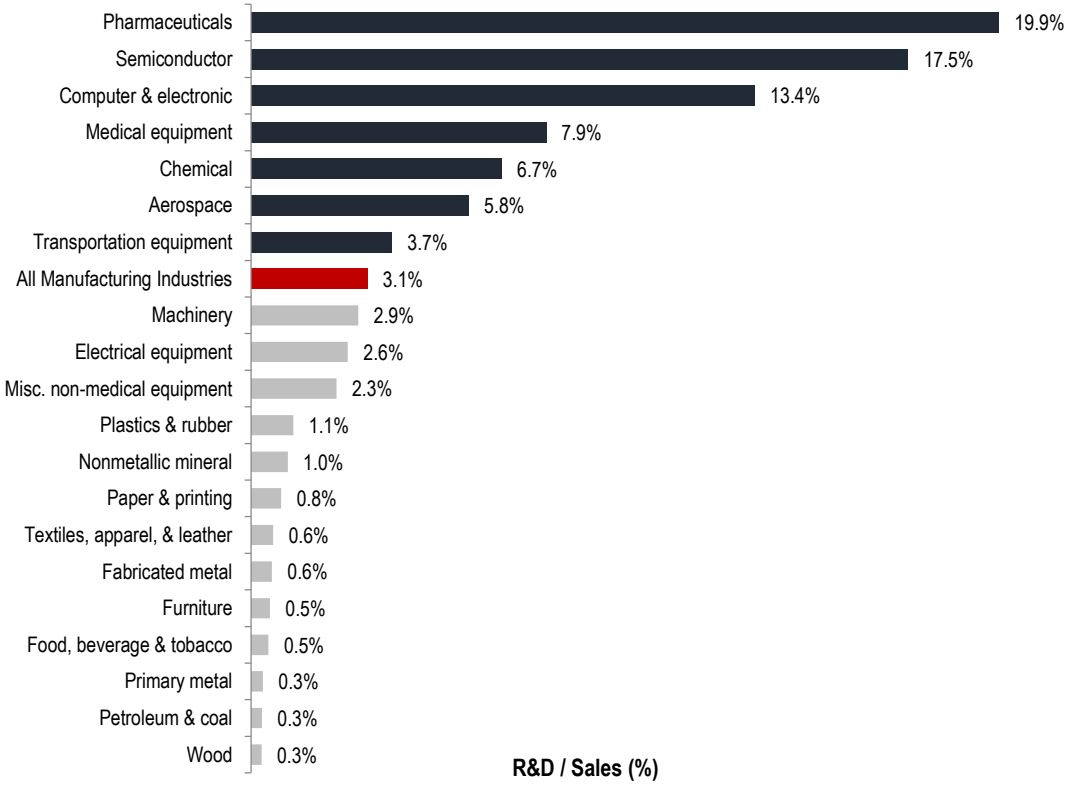


Sources: National Science Foundation: BRDIS Survey; U.S. Census Bureau: County Business Patterns.

R&D investments of the U.S. manufacturing sectors increased from 2.7% of manufacturing sales in 2000 to 3.4% in 2013, averaging 3.1% from 2000 to 2013. During this period, IP-intensive industries invested about 6.4% of its sales on R&D compared to 0.9% in the non-IP-intensive industries. Pharmaceuticals companies invested an average of over $35 billion a year, the equivalent of 20% of their sales, on R&D to discover new drugs (Figure 4).

Figure 4. Annual Average R&D Investment as Share of Sales, by Selected Industries, 2000-13

R&D investment in the pharmaceutical industry accounts for nearly 20% of total sales, compared to 3.1% manufacturing average



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

Assessing Economic Performance between IP-Intensive and non-IP-Intensive Manufacturing Industries

Our analysis uses annual data of employment, wages, gross output, value added (net economic contribution), and exports by manufacturing industry from the U.S. Census Bureau and the U.S. International Trade Commission. Our economic dataset covers the period from 2000 to 2015, which includes economic upturn and downturn periods. We calculate output, value added, wage, and export per employee in order to compare the economic performance across IP-intensive and non-IP-intensive manufacturing industries. Our previous reports analyzed the economic performance of innovation and intellectual properties prior to 2008 when the petroleum and oil products manufacturing industry was one of the IP-intensive industries. This report updates the R&D per employee and reclassifies the petroleum and oil products manufacturing industry from 2008. The analysis therefore focuses on the economic performance from 2008 to the current time.

ECONOMIC IMPACTS OF INTELLECTUAL PROPERTY PRODUCTS ON U.S. MANUFACTURING INDUSTRIES

IP-intensive manufacturing industries consistently outperform non-IP-intensive manufacturing industries

IP-intensive manufacturing industries outperformed non-IP-intensive manufacturing industries in all key economic measures. IP-intensive industries invest heavily in R&D to produce and improve their products and services. Adopting new technology from their R&D activities, these U.S. companies create innovative products and services at home to offer to 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. Workers in IP-intensive manufacturing industries are shown to have higher economic contributions to the U.S. economy.

Key economic measurements are summarized in Table 1 below along with the IP-intensive multiple showing the factor by which IP-intensive industries exceeds non-IP intensive industries across each key measurement.

Table 1. Economic Performance per Employee
IP-Intensive versus Non-IP-Intensive Manufacturing Industries, 2008-15

	IP-intensive industries ($)	Non-IP-intensive industries ($)	Difference ($)	IP intensive multiple
R&D Investment	44,799	3,887	40,912	11.5
Wages	67,378	46,248	21,131	1.5
Exports	164,594	64,325	100,269	2.6
Value-Added	276,316	166,810	109,506	1.7
Gross Output	585,391	425,566	159,825	1.4

Sources: National Science Foundation: BRDIS Survey; R&D investment (2008-13); U.S. Census Bureau: Annual Survey of Manufactures, County Business Patterns, and Economic Census; U.S. International Trade Commission: DataWeb.

Measuring R&D Investment

Expenditures to produce intellectual property have become important and significant enough to be a separate item on the national accounts. After launching R&D satellite accounts to explore investment in R&D and its larger economic effects, the Bureau of Economic Analysis (BEA) in 2013 expanded its coverage of intellectual property products in the measurement of U.S. national accounts. The BEA has been working in conjunction with the National Science Foundation to measure innovative activity and the Bureau of Labor Statistics to construct a deflator for R&D to estimate real investment in R&D. Starting July 31, 2013, the BEA recorded expenditures of R&D, software, entertainment, literacy, and artistic originals as

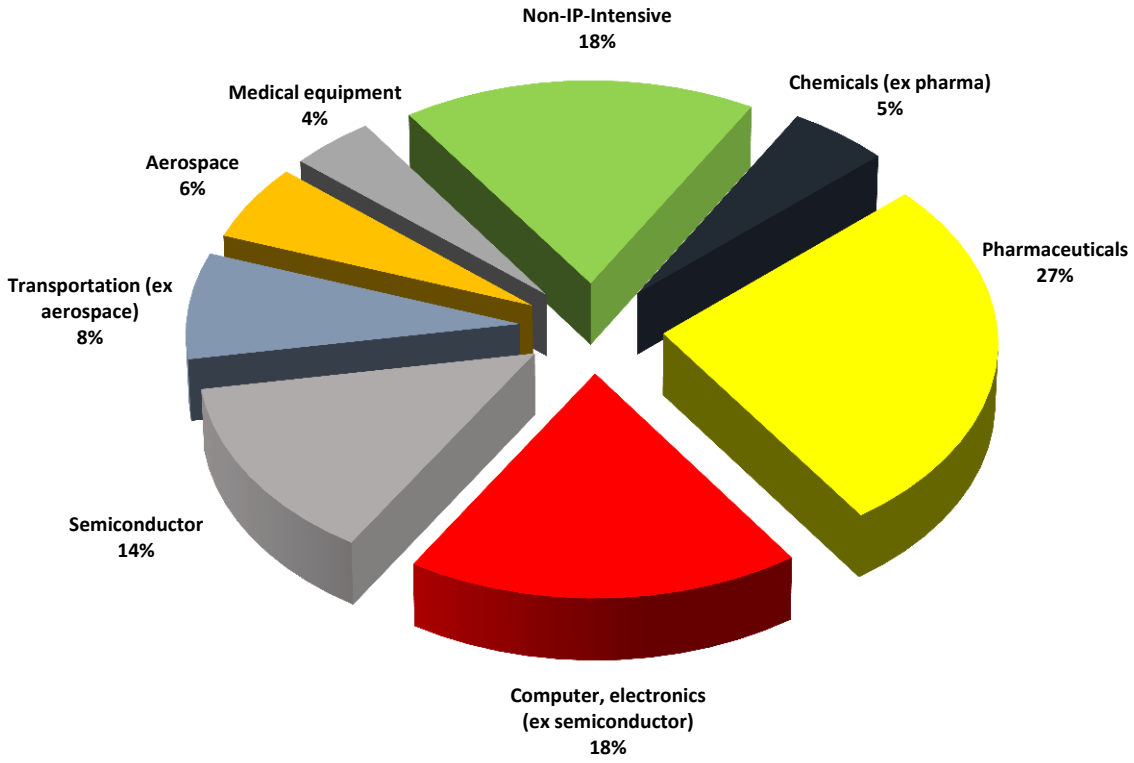
fixed investment in the national accounts. The BEA estimates that intellectual property expenditures accounted for one-third of nonresidential fixed investment in 2013.[11]

82% of R&D Investment in the U.S. during 2008-13 was in IP-Intensive Industries

During the period 2008-13, R&D investment in U.S. manufacturing sectors averaged $177.8 billion per year. The four IP-intensive subsectors accounted for over 82% of total R&D investment while a combined R&D investment of all other non-IP-intensive industries was less than 18%. At the 3-digit NAICS level, the chemical manufacturing and the computer and electronic manufacturing subsectors accounted for approximately 64% of total R&D investment. At the 4-digit NAICS level, the pharmaceutical industry of the chemical subsector had the highest share (27.0%) of total R&D investment followed by the semiconductor industry of the computer and electronic subsector (13.6%) as shown in Figure 5.

Figure 5. Composition of R&D Investment, by Selected Industries, 2008-13

IP-intensive manufacturing industries account for over 82% of manufacturing R&D investment in the U.S.



Source: National Science Foundation: BRDIS Survey.

Annual R&D investment in IP-intensive industries averaged more than 4.5 times that of non-IP-intensive industries during 2008-13

During the period between 2008 and 2013, manufacturing R&D investment averaged $177.8 billion a year, mostly in IP-intensive industries. IP-intensive industries invested 4.6 times more than non-IP-intensive

[11] Aizcorbe, Anna M., Carol E. Moylan, and Carol A. Robbins. 2009. "Toward Better Measurement of Innovation and Intangibles." BEA Briefing, Survey of Current Business; Bureau of Economic Analysis. 2013. "Preview of the 2013 Comprehensive Revision of the National Income and Product Accounts – Changes in Definitions and Presentations."

industries, $145.9 billion a year compared to 31.8 billion a year. Recognizing the crucial role of innovation on long-term growth, several non-IP-intensive industries such as food and beverage and plastic and rubber industries have increased their investment on R&D by about 15% a year since 2008 (Table 2).

Table 2. R&D Investment and Growth Rates, by Selected Industries, 2008-13

	R&D ($ millions) 2008-13	Annual Growth Rate (%)
All Manufacturing Industries	**177,768.0**	**2.8**
IP-Intensive	***145,964.2***	***2.5***
Chemical	57,047.5	1.1
Pharmaceutical & medicine	48,047.3	1.7
Computer & electronic	56,771.5	2.2
Semiconductor & other	24,164.3	7.3
Transportation equipment	24,617.0	2.8
Aerospace	10,275.8	-0.4
Medical equipment & supplies (misc.)	7,528.2	15.6
Non-IP-Intensive	***31,803.8***	***4.1***
Petroleum & coal	789.8	-27.5
Food, beverage, & tobacco	4,481.0	15.2
Textiles, apparel, & leather	584.7	-4.2
Wood	316.3	-4.3
Paper, printing, & support activities	1,337.0	-4.6
Plastics & rubber	2,614.2	14.9
Nonmetallic mineral	1,269.5	-2.7
Primary metal	682.7	-2.3
Fabricated metal	1,948.3	-2.3
Machinery	11,523.0	4.5
Electrical equipment & appliances	3,337.8	5.6
Furniture	381.0	-4.7
Misc. non-medical equipment	2,128.0	4.1

Source: National Science Foundation: BRDIS Survey.

R&D investment per employee in IP-intensive manufacturing industries averaged more than 11.5 times that of non-IP-intensive manufacturing industries during 2008-13

We calculate R&D investment per employee to estimate and to compare the IP-intensity across manufacturing industries. During the period between 2008 and 2013, annual R&D investment in manufacturing sectors averaged $15,520 per employee. Annual R&D investment per employee in IP-intensive manufacturing industries was more than 11.5 times that of non-IP-intensive manufacturing industries, $44,799 compared to $3,887. The pharmaceutical manufacturing industry invested $203,085 per employee, the highest level among all manufacturing industries. In contrast, the wood product manufacturing industry spent only $850 per employee during the same period (Table 3).

Table 3. Annual Average R&D Investment per Employee, by Selected Industries, 2008-13

	R&D ($ millions)	Employment (persons)	Annual Average R&D per Employee ($)
All Manufacturing Industries	**177,768.0**	**11,507,466**	**15,520**
IP-Intensive	***145,964.2***	***3,268,793***	***44,799***
Chemical	57,047.5	749,583	76,219
Pharmaceutical & medicine	48,047.3	237,002	203,085
Computer & electronic	56,771.5	904,776	63,225
Semiconductor & other	24,164.3	292,419	84,122
Transportation equipment	24,617.0	1,320,316	18,709
Aerospace	10,275.8	394,484	25,989
Medical equipment & supplies (misc.)	7,528.2	294,119	25,709
Non-IP-Intensive	***31,803.8***	***8,238,673***	***3,887***
Petroleum & coal	789.8	99,650	7,895
Food, beverage, & tobacco	4,481.0	1,581,907	2,839
Textiles, apparel, & leather	584.7	390,152	1,500
Wood	316.3	377,476	850
Paper, printing, & support activities	1,337.0	887,197	1,508
Plastics & rubber	2,614.2	712,070	3,706
Nonmetallic mineral	1,269.5	368,979	3,456
Primary metal	682.7	387,462	1,766
Fabricated metal	1,948.3	1,396,127	1,390
Machinery	11,523.0	1,030,146	11,251
Electrical equipment & appliances	3,337.8	349,497	9,635
Furniture	381.0	373,871	1,022
Misc. non-medical equipment	2,128.0	284,139	7,564

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

The stock of IP assets of IP-intensive manufacturing industries accounted for 81% of all U.S. manufacturing industries

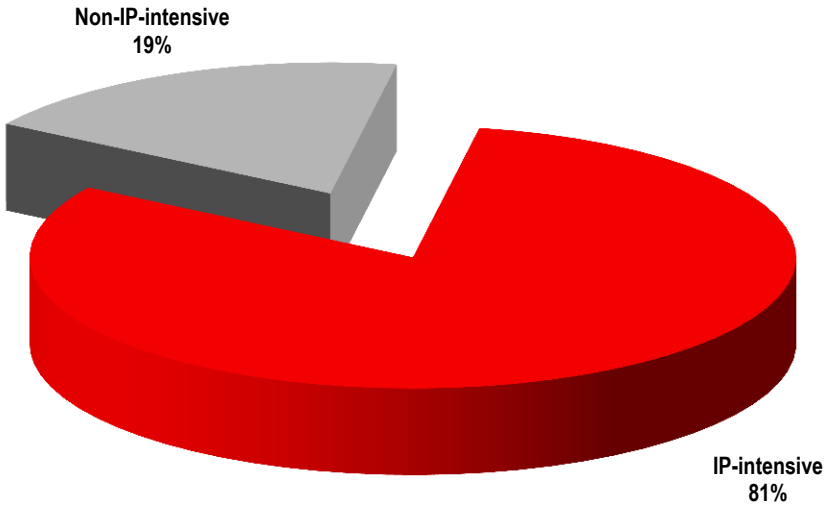
In 2013, the Bureau of Economic Analysis began treating R&D expenditures as fixed investment and recorded it in a new investment category as intellectual property products, also known as IP assets. While annual R&D investment measures the annual flows of R&D investment (i.e., new R&D investment each 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.[12]

[12] 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

U.S. manufacturing industries accumulated over $1.2 trillion IP assets by the end of 2015, an increase from $867.9 billion in 2008. As of 2015, the stock of IP assets of the IP-intensive industries ($999.2 billion) accounted for 81% of the total stock of IP assets of all U.S. manufacturing industries (Figure 6). Furthermore, the stock of IP assets of the IP-intensive industries grew faster than non-IP-intensive industries, 43.9% compared to 34.0%, during 2008-15.

Figure 6. Stock of IP Assets of U.S. Manufacturing Sectors, as of 2015

The stock of IP assets of IP-intensive industry accounts for 81% of all U.S. manufacturing industries

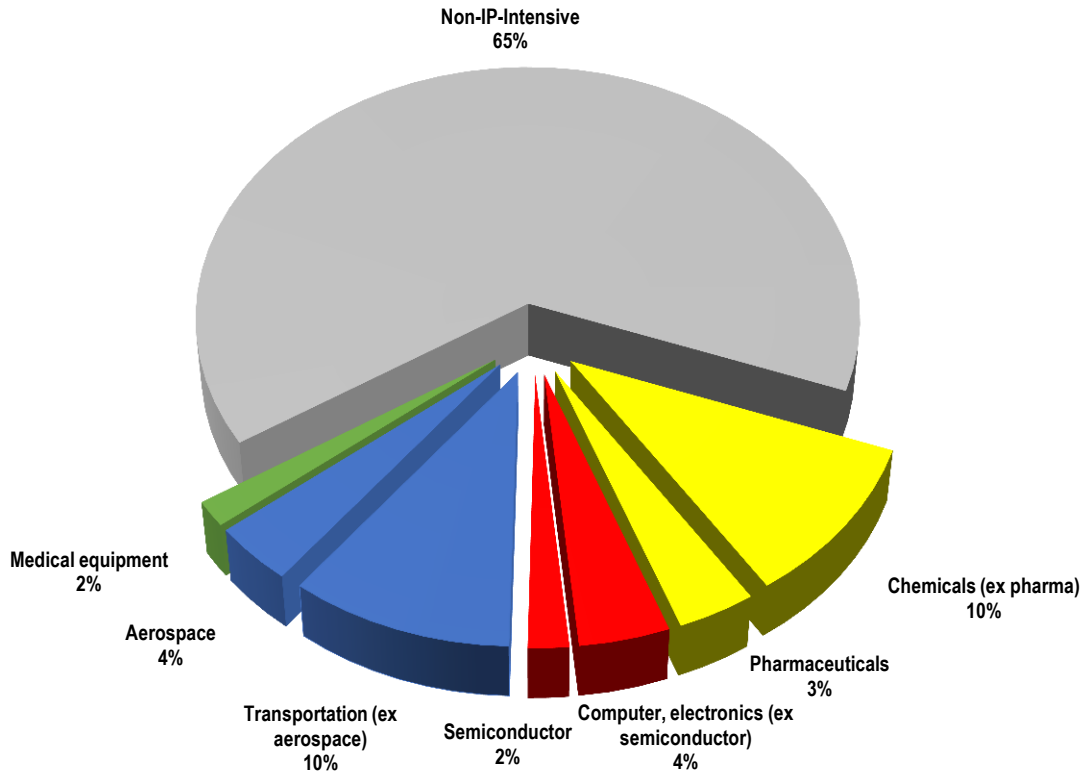


Gross output of IP-intensive manufacturing industries continues to grow

Gross output (gross revenues or total sales) of U.S. manufacturing industries remained unchanged at around $5.5 trillion a year between 2008 and 2015. During this period, gross output of IP-intensive industries increased by more than 11% while gross output of non-IP-intensive industries declined by 3.6%. The share of IP-intensive manufacturing industries accounted for more than 35% of gross output of U.S. manufacturing sectors during this period, even though IP-intensive manufacturing industries represent only 28.4% of U.S. manufacturing employment (Figure 7).

Figure 7. Composition of Gross Output, by Selected Industries, 2008-15

Although accounting for 28% of manufacturing employment, IP-intensive manufacturing industries account for 35% of manufacturing output



Sources: U.S. Census Bureau: Annual Survey of Manufactures and Economic Census.

Gross output per employee in IP-intensive manufacturing industries was 1.4 times that of non-IP-intensive manufacturing industries during 2008-15

During 2008-15, gross output of IP-intensive manufacturing industries averaged $585,391 per employee per year compared to $425,566 per employee in non-IP-intensive manufacturing industries. With one exception of an extremely high sales per employee figure in the petroleum and coal manufacturing industry (nearly $7.2 million per year), the chemical manufacturing industry including pharmaceuticals has the highest gross output per employee in the U.S. manufacturing sectors ($992,513 per person per year) (Table 4).

R&D investment is the crucial element for company innovation. The U.S. manufacturing sectors invested an average 3.4% of their gross output in R&D during 2008-15. R&D investment accounted for 7.9% of their gross output per employee in IP-intensive manufacturing industries while a mere 0.9% per employee in non-IP-intensive manufacturing industries. The pharmaceutical and medicine industry has the highest R&D investment intensity across U.S. manufacturing sectors, accounting for 25.4% of their gross output per employee (Table 4).

Table 4. Annual Average Output per Employee and Shares of R&D, by Selected Industries, 2008-15

	Gross Output ($ billions)	Output per Employee ($)	R&D as % of Gross Output (%)
All Manufacturing Industries	**5,406.2**	**471,072**	**3.4**
IP-Intensive	***1,912.5***	***585,391***	***7.9***
Chemical	744.0	992,513	7.8
Pharmaceutical & medicine	194.8	820,322	25.4
Computer & electronic	325.7	370,171	17.1
Semiconductor & other	101.1	354,176	23.8
Transportation equipment	754.0	556,699	3.6
Aerospace	203.7	512,569	5.4
Medical equipment & supplies (misc.)	88.7	306,073	8.4
Non-IP-Intensive	***3,493.7***	***425,566***	***0.9***
Petroleum & coal	716.2	7,158,105	0.1
Food, beverage, & tobacco	851.7	533,463	0.5
Textiles, apparel, & leather	72.2	191,630	0.8
Wood	81.5	218,640	0.4
Paper, printing, & support activities	262.8	305,384	0.5
Plastics & rubber	210.4	294,023	1.3
Nonmetallic mineral	103.2	281,489	1.3
Primary metal	248.8	638,376	0.3
Fabricated metal	331.8	236,123	0.6
Machinery	363.9	350,225	3.2
Electrical equipment & appliances	120.8	349,053	2.8
Furniture	67.5	183,876	0.6
Misc. non-medical equipment	62.8	226,954	3.4

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

Output per employee in IP-intensive manufacturing industries grew more than two times faster than that of non-IP-intensive manufacturing industries during 2008-2015

The growth rate of output per employee in IP-intensive industries outpaced the growth rate of non-IP-intensive manufacturing industries. During 2008-15, output per employee grew an averaged 3.0% per year in IP-intensive manufacturing industries compared to 1.3% per year in non-IP-intensive manufacturing industries (Table 5).

Table 5. Average Annual Output per Employee and Growth Rates, 2008-15

	Average Annual Output per employee ($)	Average Annual Growth Rate per Employee (%)
All Manufacturing Industries	**471,072**	**1.9**
IP-Intensive	***585,391***	***3.0***
Non-IP-Intensive	***425,566***	***1.3***

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

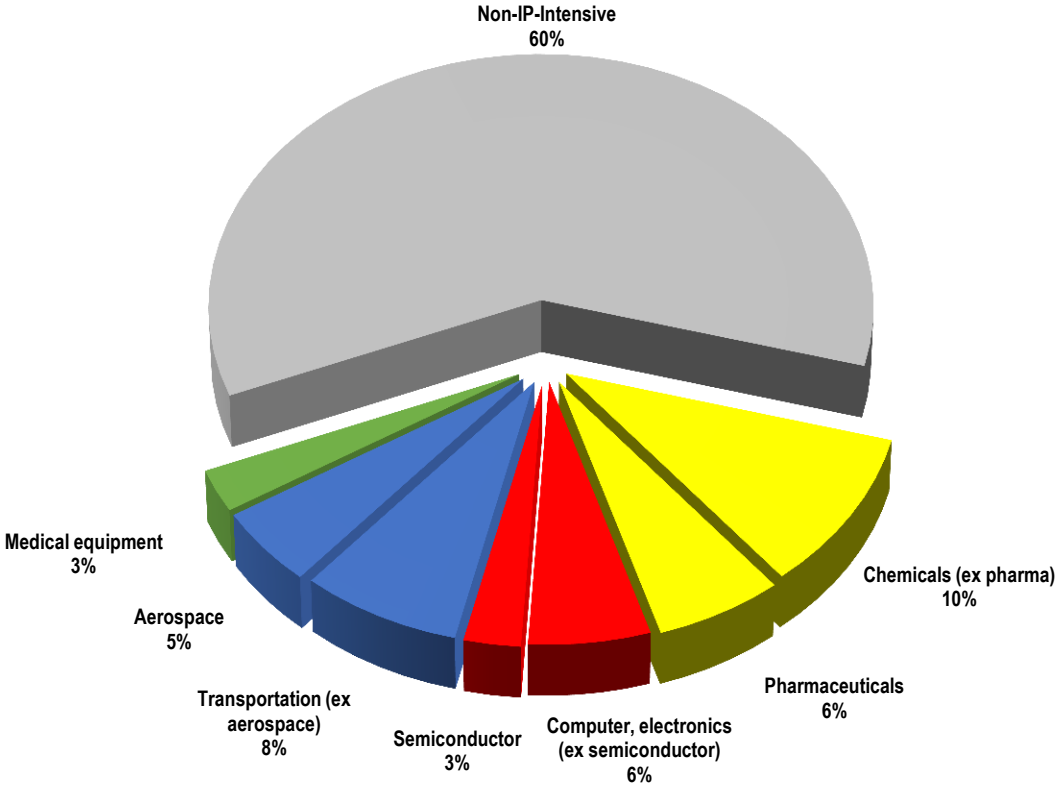
IP-intensive manufacturing industries accounted for 40% of net value of economic contributions of the manufacturing sectors to the U.S economy

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 net value of economic contributions, commonly referred to as value-added, is calculated as gross output minus intermediate products. The net value of economic contributions of U.S. manufacturing sectors increased 7.2% from less than $2.3 trillion in 2008 to over $2.4 trillion in 2015, averaging $2.3 trillion per year during 2008-15.

IP-intensive manufacturing industries accounted for about 40% of net value of economic contributions of the manufacturing sectors to the U.S economy. The chemical manufacturing industry, including the pharmaceutical and medicine manufacturing industry, is the largest contributor to the U.S. economy across manufacturing sectors. During the period 2008-15, the chemical subsector (including the pharmaceutical industry) accounted for 16% of manufacturing contributions. The transportation equipment subsector (including the aerospace industry) and computer subsector (including the semiconductor industry) accounted for 12.5% and 8.5%, respectively. The medical equipment industry added another 2.7% (Figure 8).

Figure 8. Composition of Value-Added (Net Economic Contributions), by Selected Industries, 2008-15

IP-intensive industries employ 28% of manufacturing workers, who account for 40% of the economic value added of manufacturing



Sources: U.S. Census Bureau: Annual Survey of Manufactures and Economic Census.

The value added per employee in IP-intensive manufacturing industries is more than 1.6 times that of non-IP-intensive manufacturing industries

During 2008-15, manufacturing workers contributed an average $197,975 per employee annually to the U.S. economy. Workers in IP-intensive manufacturing industries contributed $276,316 per employee annually, compared to $166,810 per employee in non-IP-intensive manufacturing industries. The petroleum manufacturing industry and the pharmaceutical manufacturing industry have the largest net economic contributions per employee (Table 6).

R&D investment averaged 8.0% of value-added of the U.S. manufacturing sectors, 16.5% in IP-intensive manufacturing industries and only 2.4% in non-IP-intensive manufacturing industries. Semiconductor and pharmaceutical manufacturing industries have the largest R&D investment compared to the industry's net economic contributions (Table 6).

Table 6. Annual Average Value-Added and Share of R&D, by Selected Industries, 2008-15

	Value-Added ($ billions)	Value-Added per Employee ($)	R&D as % of Value-Added (%)
All Manufacturing Industries	**2,271.8**	**197,975**	**8.0**
IP-Intensive	***902.6***	***276,316***	***16.5***
Chemical	364.9	486,668	16.0
Pharmaceutical & medicine	137.9	580,574	35.5
Computer & electronic	192.1	218,140	28.9
Semiconductor & other	61.3	213,756	39.8
Transportation equipment	284.5	210,758	9.2
Aerospace	111.9	281,847	9.8
Medical equipment & supplies (misc.)	61.2	210,798	12.2
Non-IP-Intensive	***1,369.2***	***166,810***	***2.4***
Petroleum & coal	105.5	1,055,960	0.8
Food, beverage, & tobacco	346.9	217,260	1.3
Textiles, apparel, & leather	31.6	83,927	1.8
Wood	33.5	89,944	1.1
Paper, printing, & support activities	132.4	153,841	1.0
Plastics & rubber	97.3	135,981	2.8
Nonmetallic mineral	56.9	155,387	2.3
Primary metal	83.6	214,783	0.9
Fabricated metal	176.2	125,382	1.1
Machinery	175.0	168,466	6.8
Electrical equipment & appliances	58.4	168,820	5.8
Furniture	35.8	97,499	1.1
Misc. non-medical equipment	36.1	130,505	6.0

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.

Over 28% of manufacturing jobs, or 3.3 million jobs, are employed in IP-intensive manufacturing industries

U.S. manufacturing sectors employ nearly 11.5 million persons across all industries. Over 28% of manufacturing jobs, or 3.3 million jobs, are employed in IP-intensive manufacturing industries. The allocation of jobs in the IP-intensive manufacturing industries is: 11.7% in the transportation equipment subsector (including the aerospace industry), 7.7% the computer and electronics subsector (including the semiconductor industry), 6.5% in the chemical subsector (including the pharmaceutical industry), and 2.5% in the medical equipment industry. For industry comparison purposes, this report uses employment data published by the Census Bureau that is based on establishments. As discussed earlier, the employment numbers of establishments are substantially lower than the employment numbers of the whole company.

After a decade of declines, jobs are added to IP-intensive manufacturing industries

After a decade of job declines, U.S. manufacturing sectors started adding new jobs in the summer of 2010. From 2000 to 2010, U.S. manufacturing sectors lost more than 5.6 million jobs and over one-third of total manufacturing jobs. Manufacturing jobs in non-IP-intensive industries such as textile, furniture, electrical equipment, wood products, and paper products were hit hardest. IP-intensive manufacturing industries also suffered job losses, although with a smaller effect. Since 2010, 742,663 jobs have been added to the U.S. manufacturing sectors. During 2010-15, jobs in IP-intensive industries increased by 7.2%, compared to 6.7% job growth in the non-IP-intensive industries.

Wages of workers in IP-intensive manufacturing industries are more than 45% higher than those in non-IP-intensive manufacturing industries

Workers in IP-intensive manufacturing industries earn higher wages than their counterparts in non-IP-intensive manufacturing industries. During 2008-15, American manufacturing workers made an average $52,263 per year. Among them, workers in IP-intensive manufacturing industries made $67,378 per year. Their annual wages were over 45% higher than wages of workers in non-IP-intensive manufacturing industries. IP-intensive manufacturing industries with the highest wages were pharmaceutical and medicine industry ($86,584 per employee) and aerospace industry ($81,152 per employee). In contrast, the textile and wood product industries had the lowest pay, $32,064 and $36,016 per employee per year, respectively (Table 8).

R&D investment is positively correlated with wages. During 2008-2013, R&D investment averaged 30.4% of wages in the U.S. manufacturing sectors. R&D investment was more than 68% of total wages paid in IP-intensive manufacturing industries, led by 243.0% of wages paid in the pharmaceutical and medicine industry. During the same period, R&D investment was only 8.6% of total wages paid in non-IP-intensive manufacturing industries and merely 2.5% of total wages paid in the wood products industry (Table 7).

Table 7. Annual Average Wages per Employee and Shares of R&D, by Selected Industries, 2008-15

	Wages ($ billions)	Wages per Employee ($)	R&D as % of Wages (%)
All Manufacturing Industries	**600.5**	**52,263**	**30.4**
IP-Intensive	***220.3***	***67,378***	***68.2***
Chemical	54.3	72,431	108.7
Pharmaceutical & medicine	20.6	86,584	243.0
Computer & electronic	65.7	74,989	86.7
Semiconductor & other	18.5	64,965	135.2
Transportation equipment	83.2	61,518	31.2
Aerospace	32.2	81,152	33.3
Medical equipment & supplies (misc.)	17.1	58,853	44.4
Non-IP-Intensive	***380.2***	***46,248***	***8.6***
Petroleum & coal	9.2	91,661	9.1
Food, beverage, & tobacco	63.8	39,952	7.2
Textiles, apparel, & leather	12.1	32,064	4.8
Wood	13.6	36,016	2.5
Paper, printing, & support activities	41.3	47,809	3.2
Plastics & rubber	31.3	43,658	8.6
Nonmetallic mineral	17.4	47,308	7.5
Primary metal	22.4	57,488	3.2
Fabricated metal	67.3	47,885	3.0
Machinery	58.2	55,965	20.4
Electrical equipment & appliances	18.1	52,361	19.0
Furniture	13.6	37,036	2.8
Misc. non-medical equipment	12.1	43,764	17.7

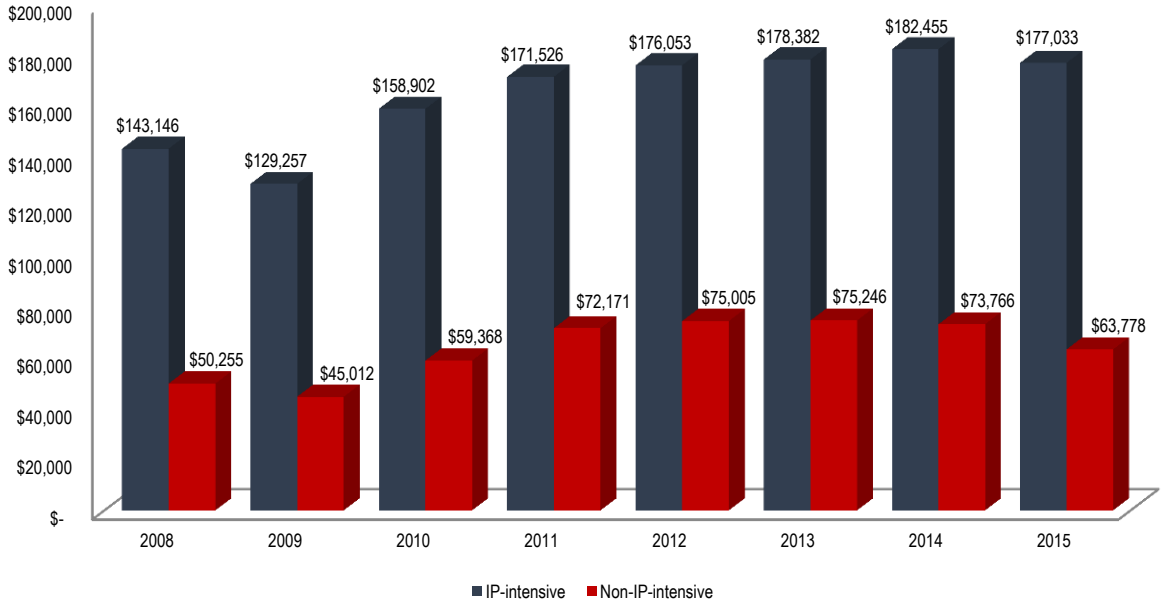
Source: National Science Foundation: BRDIS Survey. R&D as % of wages (2008-13); U.S. Census Bureau: County Business Patterns and Economic Census.

IP-intensive manufacturing industries accounted for more than half of total manufacturing exports between 2008 and 2015

Across U.S. manufacturing sectors, more than $1 trillion in goods and services was exported a year between 2008 and 2015. IP-intensive manufacturing industries accounted for more than half of total manufacturing exports. The top exporters across IP-intensive industries were transportation equipment manufacturing (20%) including the aerospace industry, chemical manufacturing including the pharmaceutical industry (16.7%), computer and electronic manufacturing including the semiconductor industry (11.6%), and medical equipment manufacturing (2.2%).

Export sales in IP-intensive manufacturing industries have continued to rise over the years. Exports averaged $164,594 per employee in IP-intensive manufacturing industries during 2008-15, 2.6 times the average $64,325 per employee in non-IP-intensive manufacturing industries (Figure 10).

Figure 10. Annual Average Exports per Employee in IP- and Non-IP-Intensive Industries, 2008-15
Exports per employee in IP-intensive manufacturing industries were 2.6 times than that in the non-IP-intensive industries



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

CONCLUSION

Recent R&D and economic data confirm the significant contributions of IP-intensive industries to the U.S. economy. IP-intensive manufacturing industries consistently outperform non-IP-intensive manufacturing industries in all key economic measures. Both gross output per employee and net value of economic contribution per employee in the IP-intensive manufacturing industries was 1.5 times that of non-IP-intensive manufacturing industries. Workers in IP-intensive manufacturing industries earn approximately 45% higher wages than their counterparts in non-IP-intensive manufacturing industries. After a decade of job losses, U.S. manufacturing sectors started adding new jobs in the summer of 2010. While non-IP-intensive industries cut more jobs during the economic downturn, IP-intensive industries added more jobs during the economic recovery. By the end of 2015, IP-intensive industries have already added 7.2% of its 2010 job level while non-IP-intensive industries added 6.7% of its 2010 job level. Recognizing the important role of innovation on long-term sustainable growth, a number of non-IP-intensive industries have increased their allocation of resources on R&D investment in the past several years. These findings reinforce the importance of ensuring public policies continue to support robust IP rights and protections to foster innovation and the economic contributions resulting from IP-intensive industries.

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APPENDIX

Table A.1. Economic Performance per Employee in 24 IP-Intensive and Non-IP-Intensive Industries, 2008-15

	R&D Investment /1	Wages	Exports	Value-Added	Gross Output
IP-Intensive	•	•	•	•	•
Chemical	•	•	•	•	•
Basic chemical	•	•	•	•	•
Pharmaceutical & medicine	•	•	•	•	•
Computer & electronic	•	•	•	•	
Communications equipment	•	•	•	•	
Semiconductor & other	•	•	•	•	
Navigational, measure, electromed	•	•	•	•	
Transportation equipment	•	•	•	•	•
Motor vehicles, trailers	•	•	•		•
Aerospace product	•	•	•	•	•
Medical equipment & supplies (miscellaneous)	•	•		•	
Non-IP-Intensive					
Petroleum & coal		•	•	•	•
Food, beverage & tobacco				•	•
Textiles, apparel, & leather					
Wood					
Paper, printing, & support					
Plastics & rubber					
Nonmetallic mineral					
Primary metal		•	•	•	•
Fabricated metal					
Machinery		•	•		
Electrical equipment & appliances		•	•		
Furniture					
Misc non-medical equipment					

"•" indicates that performance is above the average of all sub-sectors and industries
1/ Data only available from 2008-13

Table A.2. Industrial R&D Investment, by Selected Industries, 2008-13 ($ millions)

	2008	2009	2010	2011	2012	2013
All Manufacturing Industries	**172,542.0**	**166,102.0**	**169,717.0**	**176,406.0**	**184,070.0**	**197,771.0**
IP-Intensive	***143,665.0***	***137,185.0***	***140,897.0***	***142,284.0***	***149,220.0***	***162,534.0***
Chemical	58,038.0	53,100.0	57,858.0	55,175.0	56,846.0	61,268.0
Basic chemical	4,040.0	1,976.0	1,718.0	3,720.0	2,630.0	2,495.0
Pharmaceutical & medicine	47,982.0	44,811.0	49,316.0	45,870.0	48,084.0	52,221.0
Computer & electronic	55,770.0	51,181.0	53,901.0	57,477.0	60,092.0	62,208.0
Communications equip	11,590.0	12,730.0	12,445.0	11,869.0	13,182.0	14,786.0
Semiconductor & other	21,588.0	19,868.0	21,752.0	23,841.0	27,239.0	30,698.0
Navigational, measure, electromed	11,799.0	10,523.0	10,624.0	11,279.0	11,905.0	10,206.0
Transportation equipment	24,581.0	25,231.0	22,633.0	23,073.0	24,015.0	28,169.0
Motor vehicles, trailers	12,234.0	10,853.0	10,098.0	13,449.0	14,993.0	16,418.0
Aerospace product	11,020.0	12,980.0	10,787.0	8,177.0	7,890.0	10,801.0
Medical equipment & supplies (misc.)	5,276.0	7,673.0	6,505.0	6,559.0	8,267.0	10,889.0
Non-IP-Intensive	***28,877.0***	***28,917.0***	***28,820.0***	***34,122.0***	***34,850.0***	***35,237.0***
Petroleum & coal	1,207.0	273.0	1,104.0	1,025.0	889.0	241.0
Food, beverage & tobacco	2,878.0	4,116.0	4,376.0	4,909.0	4,767.0	5,840.0
Textiles, apparel, & leather	806.0	423.0	478.0	600.0	552.0	649.0
Wood	273.0	512.0	236.0	205.0	453.0	219.0
Paper, printing, & support	1,473.0	1,429.0	1,452.0	1,497.0	1,005.0	1,166.0
Plastics & rubber	1,812.0	2,441.0	2,034.0	2,270.0	3,492.0	3,636.0
Nonmetallic mineral	1,522.0	1,077.0	1,246.0	1,146.0	1,301.0	1,325.0
Primary metal	685.0	824.0	613.0	634.0	731.0	609.0
Fabricated metal	2,403.0	2,015.0	1,588.0	1,738.0	1,812.0	2,134.0
Machinery	10,038.0	8,982.0	9,842.0	14,001.0	13,764.0	12,511.0
Electrical equipment & appliances	3,047.0	3,226.0	3,195.0	3,515.0	3,042.0	4,002.0
Furniture	477.0	396.0	372.0	319.0	348.0	374.0
Misc. non-medical equipment	2,068.0	2,329.0	1,802.0	1,883.0	2,156.0	2,530.0

Source: National Science Foundation: BRDIS Survey.

Table A.3. Gross Output, by Selected Industries, 2008-15 ($ billions)

	2008	2009	2010	2011	2012	2013	2014	2015
All Manufacturing Industries	**5,468.1**	**4,436.2**	**4,905.4**	**5,498.6**	**5,696.7**	**5,809.7**	**5,887.6**	**5,547.0**
IP-Intensive	***1,879.8***	***1,586.5***	***1,753.4***	***1,894.6***	***1,975.5***	***2,030.5***	***2,090.5***	***2,089.3***
Chemical	738.7	628.9	697.8	776.8	785.3	785.6	787.4	751.6
Basic chemical	242.1	175.4	226.1	267.4	276.0	276.6	259.9	217.8
Pharmaceutical & medicine	192.1	191.4	182.0	195.7	189.0	186.0	199.3	222.7
Computer & electronic	383.9	328.0	331.3	337.9	313.6	308.5	302.0	300.5
Communications equip	53.9	45.2	42.8	44.6	43.6	44.5	39.3	36.1
Semiconductor & other	118.5	96.5	115.1	123.5	90.4	86.8	87.8	90.1
Navigational, measure, electromed	133.1	125.1	129.8	135.3	143.7	142.2	141.7	142.1
Transportation equipment	672.8	545.0	636.8	690.4	785.7	841.0	912.2	948.2
Motor vehicles, trailers	413.2	301.7	400.7	445.3	508.2	546.0	600.2	636.6
Aerospace product	183.9	178.9	174.9	183.3	209.6	223.6	238.5	236.9
Medical equipment & supplies (misc.)	84.4	84.6	87.4	89.5	90.9	95.4	88.8	89.0
Non-IP-Intensive	***3,588.3***	***2,849.7***	***3,152.1***	***3,604.0***	***3,721.3***	***3,779.2***	***3,797.1***	***3,457.7***
Petroleum & coal	769.7	497.9	627.1	836.8	851.1	852.8	786.3	507.9
Food, beverage & tobacco	775.0	748.4	779.9	847.3	881.5	909.9	940.8	931.2
Textiles, apparel, & leather	83.2	66.6	68.6	72.0	69.6	71.6	73.1	72.8
Wood	87.8	65.4	69.6	70.6	78.1	88.6	94.9	97.2
Paper, printing, & support	277.9	245.7	252.5	258.6	263.1	268.3	268.6	268.2
Plastics & rubber	203.7	171.2	188.8	204.5	218.6	225.8	234.4	236.4
Nonmetallic mineral	115.5	90.4	90.1	93.0	99.0	106.2	113.2	118.0
Primary metal	282.6	168.3	232.8	280.2	269.5	263.2	265.4	228.3
Fabricated metal	358.3	281.3	293.9	326.8	339.9	347.1	357.5	350.0
Machinery	355.6	287.6	317.7	365.7	402.2	393.5	403.8	384.6
Electrical equipment & appliances	130.3	106.7	110.0	120.0	123.6	123.5	126.4	126.0
Furniture	79.8	60.8	59.0	62.0	66.7	68.2	69.7	73.5
Misc. non-medical equipment	69.0	59.4	62.1	66.6	58.3	60.5	62.9	63.8

Sources: U.S. Census Bureau: Annual Survey of Manufactures and Economic Census.

Table A.4. Value-Added, by Selected Industries, 2008-15 ($ billions)

	2008	2009	2010	2011	2012	2013	2014	2015
All Manufacturing Industries	**2,266.4**	**1,978.0**	**2,160.7**	**2,295.2**	**2,300.7**	**2,356.0**	**2,387.2**	**2,430.1**
IP-Intensive	***899.8***	***812.0***	***883.7***	***909.4***	***890.5***	***916.4***	***939.5***	***969.7***
Chemical	352.4	328.9	349.9	374.9	364.8	371.2	380.3	396.5
Basic chemical	82.8	66.7	89.3	100.3	100.0	100.6	99.6	95.6
Pharmaceutical & medicine	141.5	140.6	131.8	139.8	129.5	130.2	136.1	153.7
Computer & electronic	228.4	193.2	200.5	208.0	180.1	178.4	173.0	175.1
Communications equip	29.8	24.9	20.9	21.2	20.8	23.4	20.6	20.5
Semiconductor & other	74.8	58.4	77.3	86.1	50.7	46.2	47.6	49.2
Navigational, measure, electromed	81.8	79.4	81.2	84.5	90.9	90.9	88.1	89.5
Transportation equipment	258.3	229.6	270.9	264.5	284.6	303.2	326.8	338.3
Motor vehicles, trailers	124.6	100.4	137.1	126.8	140.4	151.8	163.4	174.1
Aerospace product	99.4	99.2	104.0	105.5	111.3	116.4	129.6	130.1
Medical equipment & supplies (misc.)	60.6	60.2	62.5	61.9	61.1	63.7	59.4	59.9
Non-IP-Intensive	***1,366.6***	***1,166.0***	***1,277.0***	***1,385.9***	***1,410.2***	***1,439.6***	***1,447.7***	***1,460.4***
Petroleum & coal	89.7	78.6	94.0	126.2	131.5	130.0	92.0	102.3
Food, beverage & tobacco	322.8	329.6	340.0	348.0	343.5	352.7	361.5	376.8
Textiles, apparel, & leather	36.3	29.4	31.1	31.9	30.3	31.2	31.3	31.5
Wood	34.5	25.9	28.9	28.7	31.8	37.0	40.3	40.8
Paper, printing, & support	139.1	127.0	128.3	130.5	132.8	134.5	132.9	134.4
Plastics & rubber	90.9	82.3	89.3	91.7	100.2	104.3	107.7	111.5
Nonmetallic mineral	61.8	48.9	49.2	50.9	54.3	59.3	63.5	67.4
Primary metal	91.7	48.2	83.8	97.9	86.6	88.1	91.4	81.1
Fabricated metal	189.1	146.9	156.9	173.0	179.8	185.7	191.0	187.3
Machinery	167.3	133.1	154.5	177.5	189.7	186.5	201.4	189.8
Electrical equipment & appliances	60.8	50.5	54.7	58.5	60.3	59.6	61.3	61.3
Furniture	43.5	32.2	31.1	32.7	35.6	35.6	36.6	39.3
Misc. non-medical equipment	39.0	33.5	35.2	38.3	33.8	35.2	36.8	37.0

Sources: U.S. Census Bureau: Annual Survey of Manufactures and Economic Census.

Table A.5. Exports, by Selected Industries, 2008-15 ($ millions)

	2008	2009	2010	2011	2012	2013	2014	2015
All Manufacturing Industries	**998,331.0**	**801,821.0**	**952,261.0**	**1,103,115.0**	**1,162,604.0**	**1,182,537.0**	**1,198,205.0**	**1,115,052.0**
IP-Intensive	***524,221.0***	***426,842.0***	***490,678.0***	***535,802.0***	***563,001.0***	***577,736.0***	***596,745.0***	***585,983.0***
Chemical	165,805.0	145,526.0	170,992.0	187,138.0	188,107.0	189,214.0	191,444.0	183,705.0
Basic chemical	55,887.0	44,302.0	56,355.0	65,317.0	64,108.0	64,337.0	62,499.0	56,209.0
Pharmaceutical & medicine	41,726.0	45,983.0	46,580.0	45,164.0	48,451.0	48,103.0	51,594.0	55,081.0
Computer & electronic	136,443.0	107,077.0	121,586.0	124,277.0	123,874.0	123,138.0	123,998.0	121,104.0
Communications equip	17,896.0	13,962.0	14,659.0	15,509.0	15,787.0	16,757.0	17,768.0	18,322.0
Semiconductor & other	47,867.0	34,819.0	42,525.0	40,697.0	37,977.0	37,736.0	39,498.0	39,044.0
Navigational, measure, electromed	38,522.0	33,544.0	37,893.0	41,589.0	43,112.0	42,976.0	40,884.0	38,912.0
Transportation equipment	201,986.0	154,057.0	176,326.0	201,093.0	226,521.0	240,306.0	255,378.0	255,155.0
Motor vehicles, trailers	102,176.0	68,308.0	93,167.0	109,461.0	120,235.0	125,562.0	130,684.0	125,793.0
Aerospace product	91,035.0	79,401.0	76,003.0	84,038.0	97,323.0	106,391.0	116,023.0	121,186.0
Medical equipment & supplies (misc.)	19,987.0	20,182.0	21,774.0	23,294.0	24,499.0	25,078.0	25,925.0	26,019.0
Non-IP-Intensive	***474,110.0***	***374,979.0***	***461,583.0***	***567,313.0***	***599,603.0***	***604,801.0***	***601,460.0***	***529,069.0***
Petroleum & coal	58,273.0	41,551.0	61,010.0	100,863.0	110,286.0	118,429.0	116,230.0	77,556.0
Food, beverage & tobacco	53,282.0	48,277.0	56,272.0	64,978.0	70,421.0	75,527.0	77,388.0	70,301.0
Textiles, apparel, & leather	16,146.0	13,341.0	15,875.0	17,841.0	17,554.0	18,248.0	18,736.0	17,811.0
Wood	5,036.0	3,977.0	5,075.0	5,579.0	5,952.0	6,493.0	7,223.0	6,805.0
Paper, printing, & support	28,152.0	24,758.0	28,847.0	30,717.0	30,340.0	30,562.0	30,360.0	29,342.0
Plastics & rubber	23,764.0	20,545.0	24,538.0	27,496.0	28,881.0	29,249.0	30,371.0	29,233.0
Nonmetallic mineral	9,095.0	7,469.0	9,226.0	10,076.0	10,144.0	10,395.0	11,001.0	10,650.0
Primary metal	54,733.0	38,228.0	49,773.0	71,996.0	74,283.0	69,482.0	58,860.0	51,952.0
Fabricated metal	32,459.0	27,730.0	32,690.0	37,038.0	40,176.0	42,845.0	45,042.0	43,419.0
Machinery	133,699.0	103,326.0	124,792.0	141,998.0	149,361.0	141,002.0	141,742.0	128,129.0
Electrical equipment & appliances	34,649.0	27,339.0	32,280.0	35,658.0	38,265.0	39,482.0	41,027.0	40,489.0
Furniture	3,986.0	3,137.0	3,560.0	3,892.0	4,411.0	4,489.0	4,628.0	4,445.0
Misc. non-medical equipment	20,836.0	15,299.0	17,645.0	19,180.0	19,529.0	18,597.0	18,854.0	18,937.0

Source: U.S. International Trade Commission: DataWeb.

Table A.6. Employment, by Selected Industries, 2008-15 (thousands)

	2008	2009	2010	2011	2012	2013	2014	2015
All Manufacturing Industries	**13,096.2**	**11,633.0**	**10,862.8**	**10,984.4**	**11,192.0**	**11,276.4**	**11,424.3**	**11,605.5**
IP-Intensive	**3,662.2**	**3,302.3**	**3,087.9**	**3,123.7**	**3,197.9**	**3,238.8**	**3,270.6**	**3,310.0**
Chemical	810.8	759.3	722.5	725.3	738.6	741.0	750.0	758.8
Basic chemical	164.9	151.1	147.0	153.0	155.0	159.3	160.0	160.2
Pharmaceutical & medicine	253.3	242.8	231.0	227.9	235.6	231.4	236.0	242.3
Computer & electronic	1,014.5	965.2	878.3	877.5	850.3	842.8	820.0	795.7
Communications equip	120.5	143.2	113.6	115.7	98.9	103.4	98.4	93.0
Semiconductor & other	351.2	299.0	283.1	283.9	274.2	263.1	271.4	258.6
Navigational, measure, electromed	410.8	397.2	383.0	387.5	386.3	389.3	385.8	383.0
Transportation equipment	1,526.9	1,273.2	1,202.0	1,235.0	1,315.5	1,369.3	1,418.9	1,477.6
Motor vehicles, trailers	879.4	662.1	627.6	667.3	727.1	769.7	811.1	865.6
Aerospace product	415.3	401.2	383.6	379.0	388.0	399.9	406.4	404.3
Medical equipment & supplies (misc.)	309.9	304.6	285.1	285.9	293.5	285.6	281.7	277.9
Non-IP-Intensive	***9,434.0***	***8,330.7***	***7,774.9***	***7,860.6***	***7,994.1***	***8,037.7***	***8,153.6***	***8,295.5***
Petroleum & coal	103.9	100.4	99.7	98.4	98.0	97.5	101.9	102.5
Food, beverage & tobacco	1,624.5	1,581.1	1,572.4	1,573.8	1,565.0	1,574.8	1,610.2	1,670.2
Textiles, apparel, & leather	494.0	401.5	368.3	364.2	357.0	355.8	349.1	347.9
Wood	491.3	385.8	350.3	344.3	341.0	352.1	365.4	378.5
Paper, printing, & support	1,039.5	931.0	864.7	843.5	827.3	817.2	810.8	798.7
Plastics & rubber	822.1	693.5	667.6	684.0	697.8	707.4	723.6	739.7
Nonmetallic mineral	456.1	380.3	344.0	338.8	344.9	349.8	359.4	369.9
Primary metal	432.0	378.3	352.3	372.9	396.0	393.3	394.4	398.6
Fabricated metal	1,588.1	1,401.5	1,275.8	1,332.1	1,379.3	1,400.0	1,425.9	1,446.8
Machinery	1,149.7	1,034.0	928.7	966.9	1,044.2	1,057.5	1,062.7	1,078.4
Electrical equipment & appliances	403.9	363.2	329.2	331.7	336.8	332.2	336.5	344.7
Furniture	489.2	388.3	348.7	334.9	341.1	341.0	354.5	359.1
Misc. non-medical equipment	339.8	292.0	273.2	275.1	265.7	259.0	259.3	260.7

Sources: U.S. Census Bureau: County Business Patterns and Economic Census.

Table A.7. Employment Wages, by Selected Industries, 2008-15 ($ billions)

	2008	2009	2010	2011	2012	2013	2014	2015
All Manufacturing Industries	**622.3**	**549.6**	**550.4**	**574.8**	**598.6**	**611.8**	**639.9**	**656.8**
IP-Intensive	***223.1***	***202.5***	***202.1***	***211.3***	***220.1***	***225.6***	***236.7***	***241.2***
Chemical	53.0	49.7	49.8	51.8	54.8	55.9	58.9	60.8
Basic chemical	11.7	10.5	10.8	11.9	12.2	12.9	13.7	13.9
Pharmaceutical & medicine	19.6	19.2	18.7	19.0	21.1	21.1	22.5	23.2
Computer & electronic	69.7	65.1	63.2	66.1	64.6	64.7	66.9	65.4
Communications equip	9.0	11.1	9.2	10.2	8.4	9.4	8.9	8.4
Semiconductor & other	21.3	16.6	18.0	18.8	17.1	16.8	20.3	18.9
Navigational, measure, electromed	30.3	28.9	29.5	31.0	32.2	32.3	32.8	33.5
Transportation equipment	83.6	71.4	73.1	76.8	82.9	87.4	93.4	97.1
Motor vehicles, trailers	42.4	31.7	33.3	35.5	39.5	42.2	45.9	49.7
Aerospace product	30.0	29.2	29.7	30.9	32.3	34.1	36.0	35.6
Medical equipment & supplies (misc.)	16.8	16.3	16.2	16.5	17.7	17.6	17.5	17.8
Non-IP-Intensive	***399.2***	***347.2***	***348.2***	***363.5***	***378.5***	***386.3***	***403.2***	***415.6***
Petroleum & coal	8.4	8.3	8.4	8.8	9.3	9.8	10.1	10.4
Food, beverage & tobacco	60.4	60.2	61.0	61.8	62.6	64.7	67.8	72.0
Textiles, apparel, & leather	14.5	11.8	11.5	11.7	11.6	11.6	11.9	12.3
Wood	15.8	12.4	12.0	12.1	12.5	13.4	14.4	15.2
Paper, printing, & support	46.5	40.6	39.9	39.8	40.1	40.4	41.1	41.7
Plastics & rubber	32.0	27.7	28.7	29.9	31.2	32.0	33.6	35.1
Nonmetallic mineral	19.7	16.3	15.7	15.9	16.4	17.2	18.3	19.2
Primary metal	23.0	18.5	20.1	21.9	23.5	23.6	24.4	24.2
Fabricated metal	70.7	59.6	59.7	64.4	68.0	69.2	73.0	73.7
Machinery	59.1	50.5	50.9	55.6	60.4	61.1	63.4	64.6
Electrical equipment & appliances	18.9	16.7	16.6	17.3	18.1	18.3	19.1	20.0
Furniture	16.6	13.0	12.2	12.3	13.0	13.2	14.0	14.7
Misc. non-medical equipment	13.6	11.6	11.6	12.1	11.9	11.7	12.0	12.4

Sources: U.S. Census Bureau: County Business Patterns and Economic Census.

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