The Economic Performance of IP-Intensive Manufacturing and Service Industries in the United States, 2012-22

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KEY FINDINGS OF THE REPORT

Intellectual property (IP) protections, particularly patents, enable significant investments in research and development (R&D), leading to the creation of new and improved products, processes, and services across the economy. In this way, IP serves as one of the most potent economic force multipliers known, even surpassing compounded interest. Since World War II, IP-protected, R&D-derived inventions have been responsible for much of the economic growth experienced by both the U.S. and the world. Strong IP protections, a science-based regulatory framework, and market incentives constitute the "magic elixir" that fuels the economic growth desired by policymakers worldwide. Nations that have acquired and harnessed this elixir—often through many years of challenging trial-and-error—have enjoyed its advantages. It would be utterly foolish to abandon this formula. This report presents data showcasing the importance of IP to U.S. competitiveness and urges policymakers to uphold America's well-established system of IP protections.

All sectors of the economy use IP to one degree or another. In this report, IP-intensive industries are defined as those that use or invest in IP more than the average for their respective sector – manufacturing or service. It should be noted that most economic activity – in terms of jobs, the number of firms, and contributions to gross domestic product (GDP) – occurs in non-IP-intensive sectors. IP tends to become highly specialized with fewer actors concentrated in a particular specialty. Although IP-intensive activity is a smaller portion of the overall economy, it is a catalyst to provide most of the growth impetus. The intertwined contributions of IP and non-IP-intensive sectors are vital for a functioning economy.

IP and R&D are correlated as R&D is typically spent inventing or developing the technologies described in new patents. Over the past decade (most recent data through 2022), U.S. companies have increased their R&D investments by 155%, rising from $258.7 billion in 2012 to $658 billion in 2022. The number of patents issued has remained relatively stable, fluctuating between 82,178 and 115,953 annually. Patent awards to manufacturing industries accounted for over two-thirds of the total patents granted during this period. The pharmaceutical sector showed the highest R&D investment per employee, exceeding 13 times the average for all manufacturing industries. In the service sector, the information industry led in R&D investment per employee, nearly 18 times the average for all service industries. The number of patents awarded was disproportionate to the amount of R&D investment. More than 58% of patents issued within the service sector were granted to the information industry. In comparison, only 8% of patents issued to the manufacturing sector were attributed to the pharmaceutical industry.

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[1] Nam D. Pham is Managing Partner at ndp | analytics. Marc Dupont, Stephanie Barello, and Ilma Fadhil provided research assistance. Pharmaceutical Research and Manufacturers of America (PhRMA) provided financial support to conduct this study. The opinions and views expressed in this report are solely those of the author.

Recent official R&D and economic statistics once again confirm the importance of innovation to the U.S. economy. Over 2012-22, Intellectual Property (IP)-intensive manufacturing industries – those that invest more R&D per employee and engage in more patenting activity than the overall manufacturing sector – outperformed non-IP-intensive manufacturing industries across all key economic metrics. Compared to their non-IP-intensive counterparts over this period, IP-intensive manufacturing industries:

1. Invested 13 times more in R&D per employee.
2. Published over three times more patents, with a patent intensity (patents per employee) eight times greater.
3. Paid their employees 44% higher wages.
4. Exported 152% more goods per employee.
5. Contributed 53% more to GDP per employee.
6. Produced 37% higher output per worker.

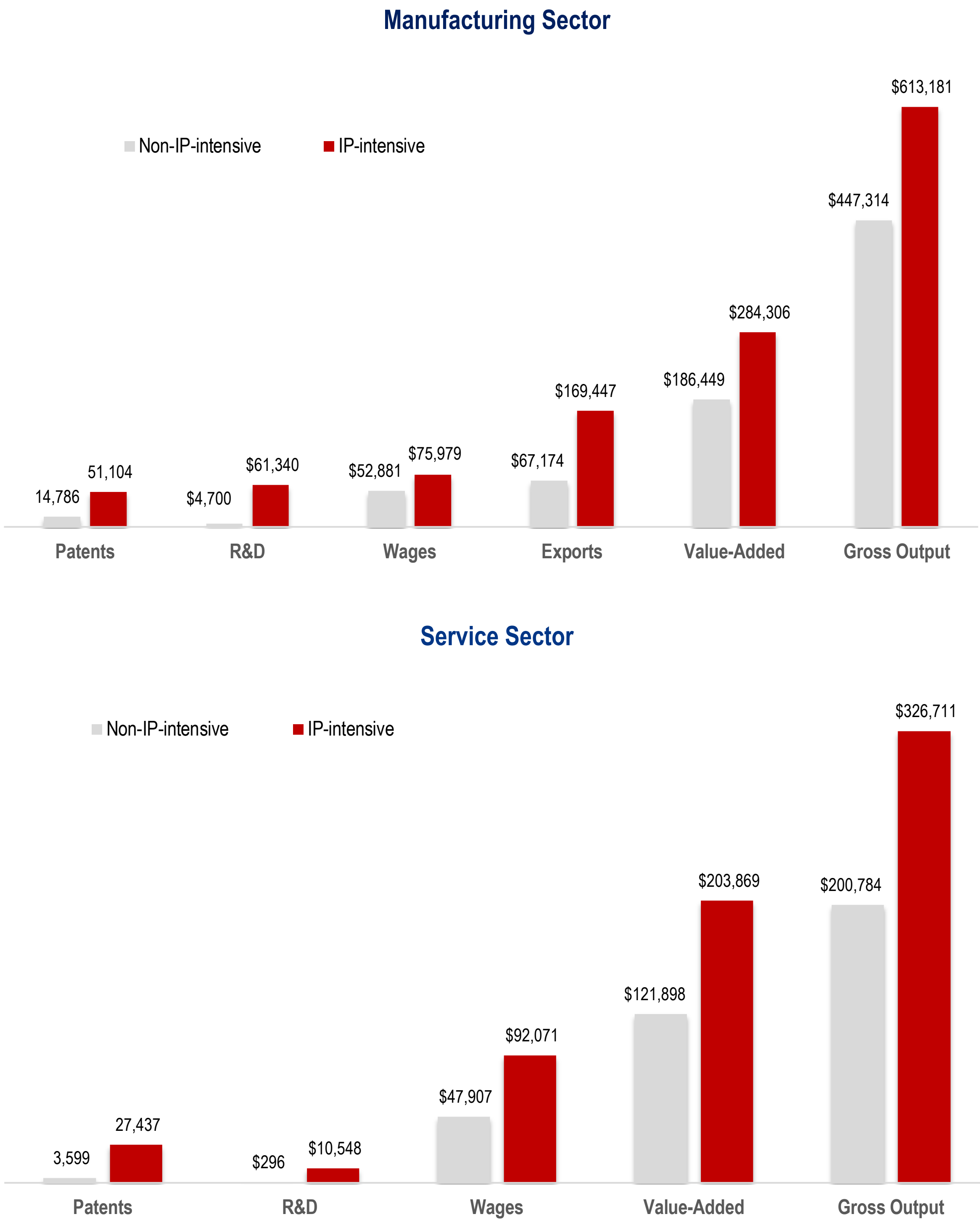
Harnessing IP drives significantly higher economic performance in the U.S. service sector as well. The economic multiples between IP-intensive and non-IP-intensive service industries were even more pronounced than among manufacturers over this period. Compared to non-IP-intensive services industries during 2012-22, IP-intensive services industries:

1. Invested 36 times more in R&D per employee.
2. Published seven times more patents, with a patent intensity (patent per employee) 56 times greater.
3. Paid their employees 92% higher wages.
4. Contributed 67% more to GDP per worker.
5. Produced 63% higher output per worker.

Companies allocate resources to develop IP for their competitive advantage. Given the considerable resources of time, capital, and effort it takes to develop both IP and any resulting products based on the IP, performers and funders must protect their IP through patents, trademarks, copyrights, or trade secrets. According to the latest National Science Foundation survey, IP types and protection methods vary significantly across industries. Companies across all manufacturing and service industries indicated that protecting trade secrets is “very important” to their operations. A higher number of IP-intensive manufacturing companies reported that utility and design patent protections are crucial to their business, while more service companies noted that copyright protections are essential.

Policymakers must maintain supportive IP policies that sustain the innovation ecosystem, fostering continued economic growth and strengthening U.S. competitiveness.

Figure 1.
Economic Performance per Employee (except Patent Data), 2012-22



Patents represent average patents issued per year during 2012-22.
Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

INTRODUCTION

Intellectual property (IP) is defined as creations such as inventions, designs, symbols, names, or images that are protected by law.[2] There are four main types of IP: patents, trademarks, copyrights, and trade secrets.[3] A patent is an exclusive right granted for an invention that allows its owner to decide how or whether others can utilize it. A trademark is a sign that allows individuals or firms to differentiate between their respective goods or services. A copyright gives a person rights over their literary or artistic works. A trade secret is a practice that safeguards confidential information, which may then be sold or licensed broadly.[4] Although each IP has a different type of protection, this report focuses on patents since they provide descriptions and directly protect new technologies and inventions to produce new products.

IP rights, especially patents, are crucial for fostering creativity, innovation, and investment by giving inventors and creators exclusive rights to their work. Intellectual property rights incentivize inventors to make risky investments and provide an opportunity to recover or earn a return on their research and development costs.[5] This, in turn, encourages them to continue innovating and creating new products and services, further spurring economic growth and helping them maintain a competitive edge in their respective industries.[6]

Specifically, patents stimulate economic and technological development and promote economic competition by establishing financial motivation for an invention in return for public disclosure.[7] This distribution of patent information is a valuable and comprehensive way to create a source of technical, commercial, and legal information that can be used directly for scientific and experimental purposes. Patents can also be used to adapt and improve the technology described in patent documents immediately after publication.[8] Furthermore, patents enable the separation of innovation discovery from commercialization, which can lead to innovation specialization. This allows patent holders to focus on research and development while selling their ideas or products to others.[9]

These positive returns to IP are key reasons why governments around the globe strive to provide robust legal frameworks for IP protection. As the U.S. Chamber of Commerce has identified, many developed nations score high ratings on their International IP Index, which seeks to evaluate IP systems across the world's top 55 economies.[10] These scores demonstrate a strong worldwide commitment to enforcing IP protection to strengthen innovation.

The economic significance of innovation is well documented in the United States and the global market. In the U.S., innovation is crucial in promoting domestic economic growth and protecting the nation's comparative advantage internationally.[11] IP-intensive industries, defined as those that spent more on R&D per employee

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[2] World Intellectual Property Organization. "What Is Intellectual Property?"
[3] Columbia Law School. 2021. "The Four Types of Intellectual Property."
[4] World Intellectual Property Organization. "What Is Intellectual Property?"
[5] Vidal, Kathi. 2024. "Quality U.S. Patents Drive Our Economic and Solve World Problems." United States Patent and Trademark Office.
[6] Deel, Gary L. 2023. "What Is Intellectual Property Law? And Why Does It Matter?" American Public University.
[7] World Intellectual Property Organization. "R&D, Innovation and Patents."
[8] Ibid.
[9] World Intellectual Property Organization. 2022. "World Intellectual Property Report 2022: The Direction of Innovation."
[10] U.S. Chamber of Commerce. 2024. "2024 International IP Index."
[11] Akhtar, Shayerah I. and Liana Wong. 2025. "Intellectual Property Rights (IPR) and U.S. Trade Policy." Congressional Research Service.

than the average of all industries, in the U.S. accounted for a significant percentage of domestic economic activity, output, and employment. Many of these jobs were also directly supported by IP-intensive industries while a considerable portion were indirectly supported by supplying intermediate goods and services to IP-intensive industries from non-IP-intensive industries. Furthermore, research has shown that workers in these IP-intensive industries are more likely to earn higher wages, work at large companies, and have insurance and retirement plans than their non-IP-intensive counterparts.[12]

According to U.S. Bureau of Economic Analysis data, IP licensing and use fees accounted for 13% of U.S. service exports and 6% of U.S. service imports in 2023.[13] Additionally, the U.S. is the largest exporter of IP and historically has also been the top patent filer under the Patent Cooperation Treaty (PCT) system, administered by the World Intellectual Property Organization (WIPO).[14]

In the European Union, on average, firms that own IP perform significantly better than those without it, generating 23.8% higher revenue per employee and 22.1% higher wages measured over a 10-year period from 2013-2022. In particular, patent owners delivered 28.7% higher revenue per employee while paying the highest salaries – 43.3% higher than firms without patent ownership. Controlling for various factors, such as a firm's country of origin, size, and sector of activity, the positive association between IP and the revenue generated grows, as IP-owning firms deliver 41% higher revenue per employee than non-owners.[15]

IP ownership in Singapore has also contributed to a 5.9% increase in revenue per invested capital per year, a 4.9% increase in revenue per employee per year, a 20.8% increase in profit per invested capital per year, and a 21.7% increase in profit per employee per year at the firm level.[16] Similarly, small and medium-sized enterprises (SMEs) in Australia that file for IP rights have been shown to employ more workers. After filing for an IP right, they are 16% more likely to experience high employment growth and more than two times more likely to achieve high turnover growth than SMEs with no recent filings. SMEs that own IP rights also deliver higher wages, paying a median annual salary of $53,755 compared to $43,304 for their non-IP counterparts.[17]

Investing in research and development (R&D) is crucial for innovation. Firms that invest in R&D enhance supply processes by developing new production methods while delivering new and improved products and services. These improvements increase job creation and additional value-added activity in other industries and regions, boosting employment and economic growth. As Figure 2 illustrates below, changes in R&D investment, GDP, and employment have historically moved in unison, highlighting the link between R&D spending and economic growth in the U.S. Overall, the strong connection that IP and R&D have to the growth of these broad economic measures should be a key focus for policymakers aiming to bolster the U.S. economy.

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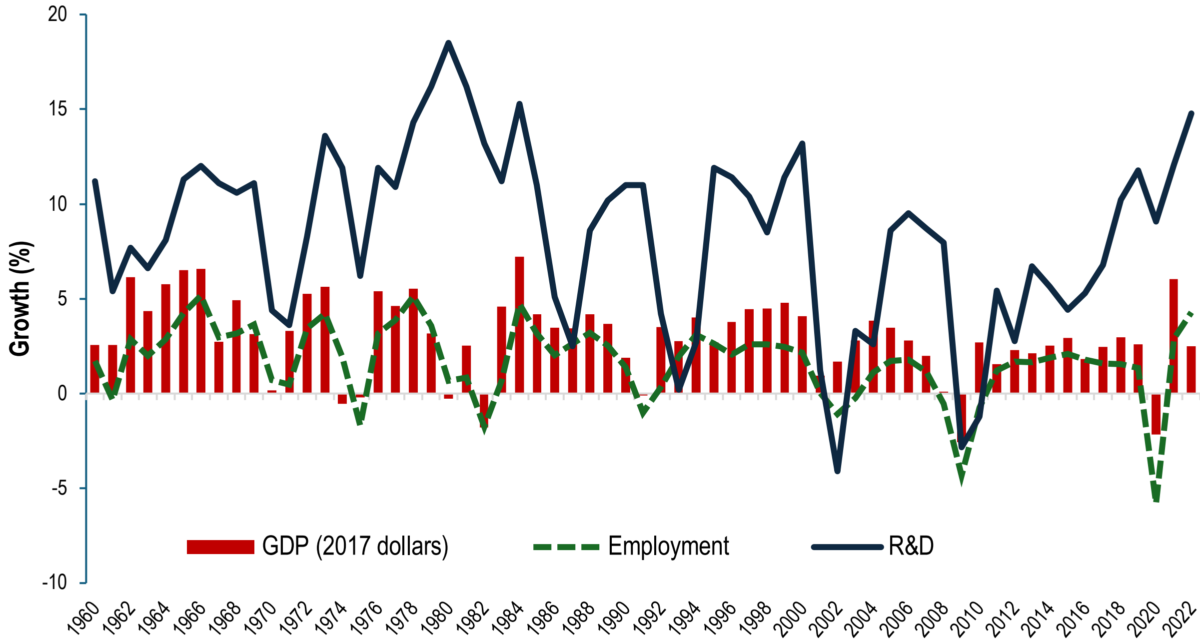
[12] Miller, Richard D., Nicholas Rada, and Toole, Andrew A. 2022. "Intellectual Property and the U.S. Economy: Third Edition." United States Patent and Trademark Office.
[13] Akhtar, Shayerah I. and Liana Wong. 2025. "Intellectual Property Rights (IPR) and U.S. Trade Policy." Congressional Research Service.
[14] Miller, Richard D., Nicholas Rada, and Andrew A. Toole. 2022. "Intellectual Property and the U.S. Economy: Third Edition." United States Patent and Trademark Office.
[15] European Patent Office and European Union Intellectual Property Office. 2025. "Intellectual Property Rights and Firm Performance in the European Union."
[16] Intellectual Property Office of Singapore. 2024. "Singapore IP and Firms' Performance Study."
[17] Zhang, Haiyang. 2021. "Intellectual Property Rights and Enterprise Growth: The Role of IP Rights in the Growth of SMEs." IP Australia.

Figure 2.
Annual Growth Rates of R&D, GDP, and Employment, 1960-2022



Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

MEASURING IP-INTENSITY

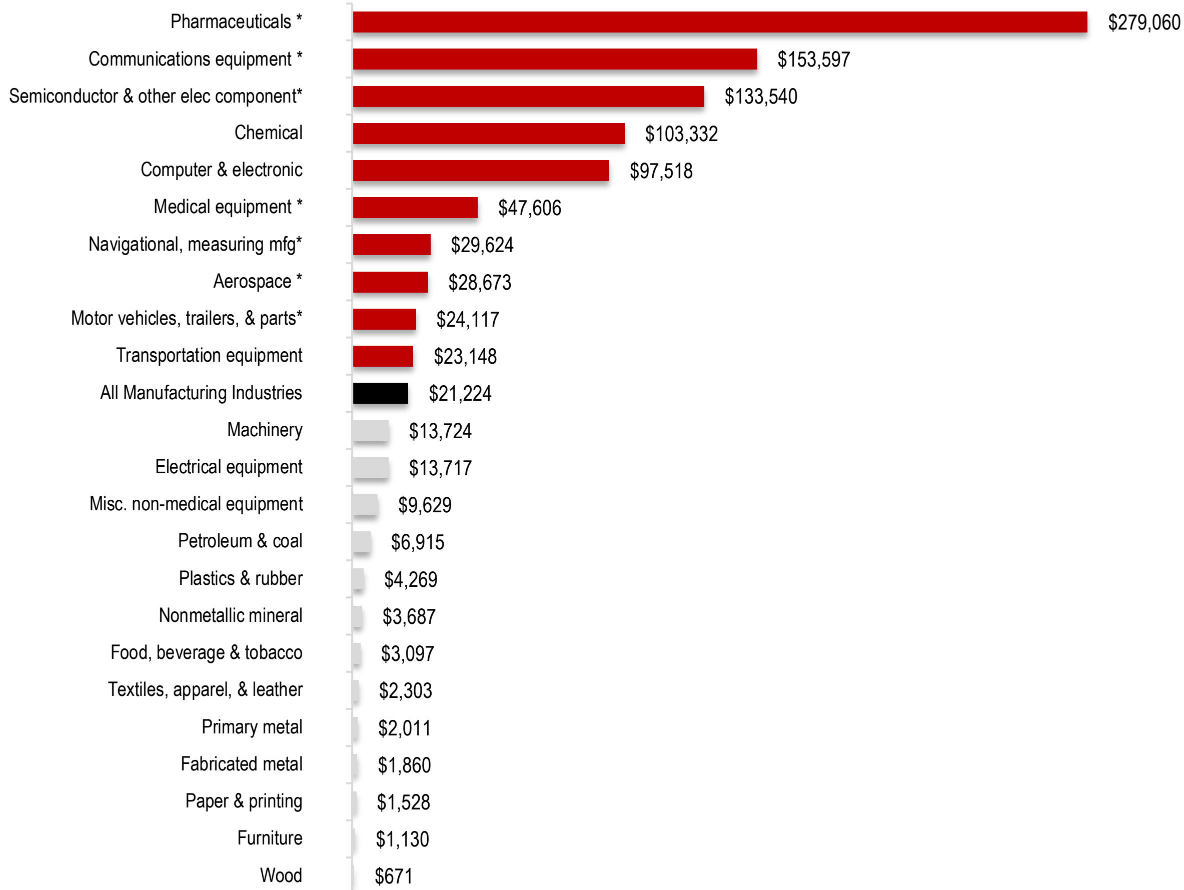
This report uses both R&D investment and patenting activity to determine intellectual property (IP) intensity. We calculated R&D per employee in each industry and compared it to the average R&D per employee of the aggregated manufacturing sector. An IP-intensive manufacturing industry is defined as one where its R&D per employee exceeds the average R&D per employee of the overall manufacturing sector. Similarly, an IP-intensive service industry is one where R&D per employee surpasses the average R&D per employee of the overall service sector. Additionally, we categorized patenting activity among industries and calculated patent intensity as patents per employee. Similarly to the R&D measure, an IP-intensive industry of either sector is one where the patenting ratio is higher than the average for their respective sector.[18]

Based on official statistics from 2012 to 2022, we identified three manufacturing industries (3-digit NAICS level) – chemical products, computer and electronic products, and transportation equipment – along with their sub-industries (4-digit NAICS level) such as pharmaceuticals, communications equipment, and aerospace, which meet the definitions of IP-intensive. Additionally, we found that the medical device manufacturing sub-industry (4-digit NAICS level) within the miscellaneous manufacturing industry (3-digit NAICS level) meets

[18] R&D investment is an input to the creation of intellectual property, which includes patents, trademarks, copyrights, and trade secrets.

this definition. All other manufacturing industries and their sub-industries are classified as non-IP-intensive. (Figure 3)[19]

Figure 3.
Annual Average R&D Investment per Manufacturing Employee, 2012-22



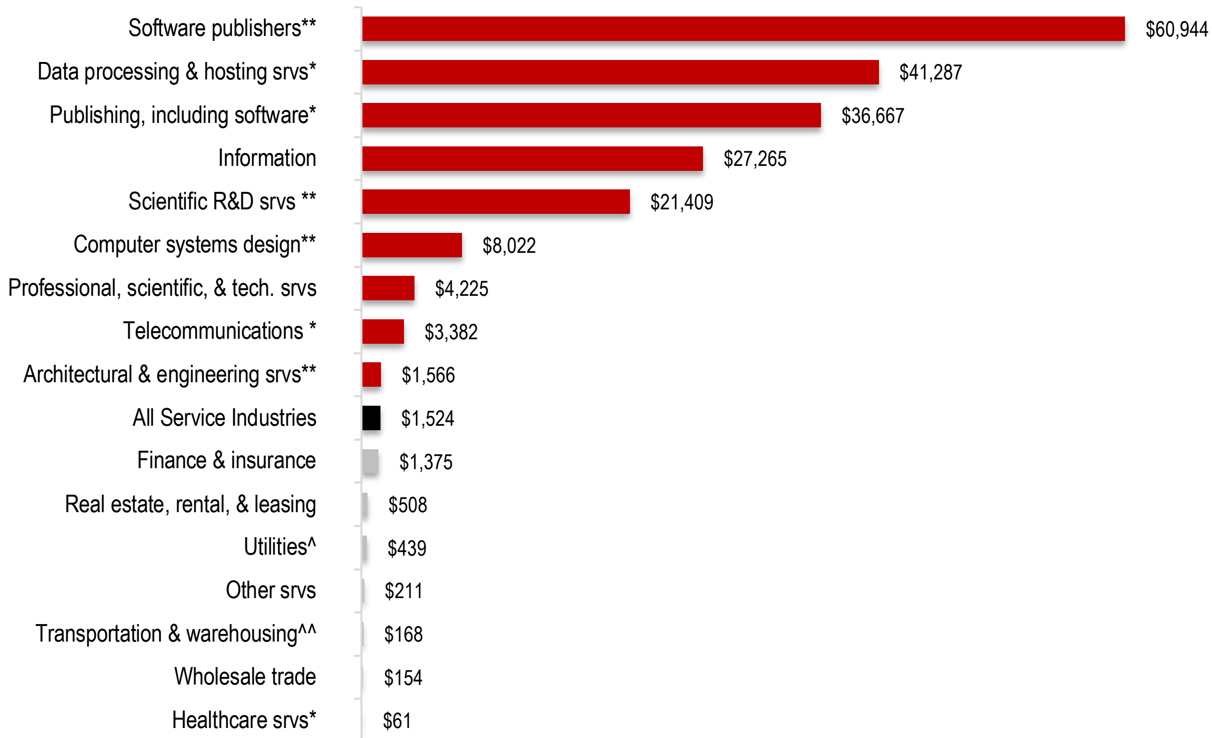
(*) indicates 4-digit NAICS while all others are 3-digit NAICS.
Sources: U.S. Census Bureau; National Science Foundation.

Based on official statistics from 2012 to 2022, we identified two service industries at the 2-digit NAICS level—information and professional, scientific, and technical services—along with their sub-industries, including data processing and hosting services, telecommunications (3-digit NAICS level), software publishers, scientific R&D services, computer systems design services, and architectural and engineering services (4-digit NAICS level), which meet the definition of IP-intensive. All other service industries and their sub-industries are classified as non-IP-intensive. (Figure 4)

Table A.1 in the Appendix provides a full list of industry classifications.

[19] The differences in the listed industries in the figures and tables throughout the report arise from the data availability for the indicators in those figures and tables.

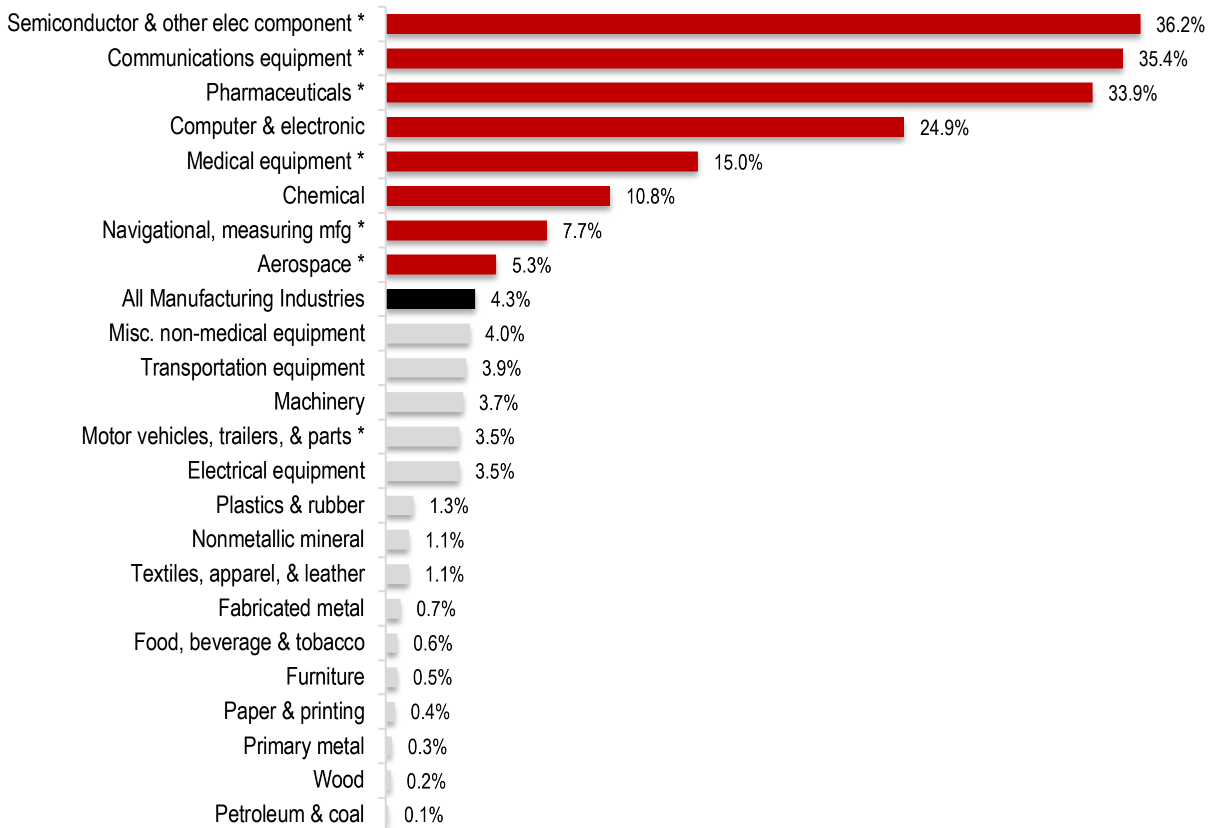
Figure 4.
Annual Average R&D Investment per Service Employee, 2012-22



(*) and (**) are 3-digit and 4-digit NAICS, respectively, while all others are 2-digit NAICS.
(^) and (^^) are 2012-20 data and 2012-21 data, respectively.
Sources: U.S. Census Bureau; National Science Foundation.

R&D investment in the U.S. manufacturing sector rose from 3.2% of sales in 2012 to 4.9% in 2022, averaging 4.3% across the manufacturing sector over these 11 years. However, there were notable distinctions between the two groups of industries. IP-intensive industries allocated 10.0% of sales to R&D, while non-IP-intensive industries invested only 1.0%. Notably, pharmaceutical manufacturers and communication equipment manufacturers — two of the most innovative industries—invested an average of nearly $74 billion a year in R&D (33.9% of their annual sales) and over $13 billion a year in R&D (35% of their annual sales), respectively. This measure of IP-intensity illustrates the concentration of effort these industries dedicate to discovering and developing new products and services, a key input for innovation and economic performance. (Figure 5)

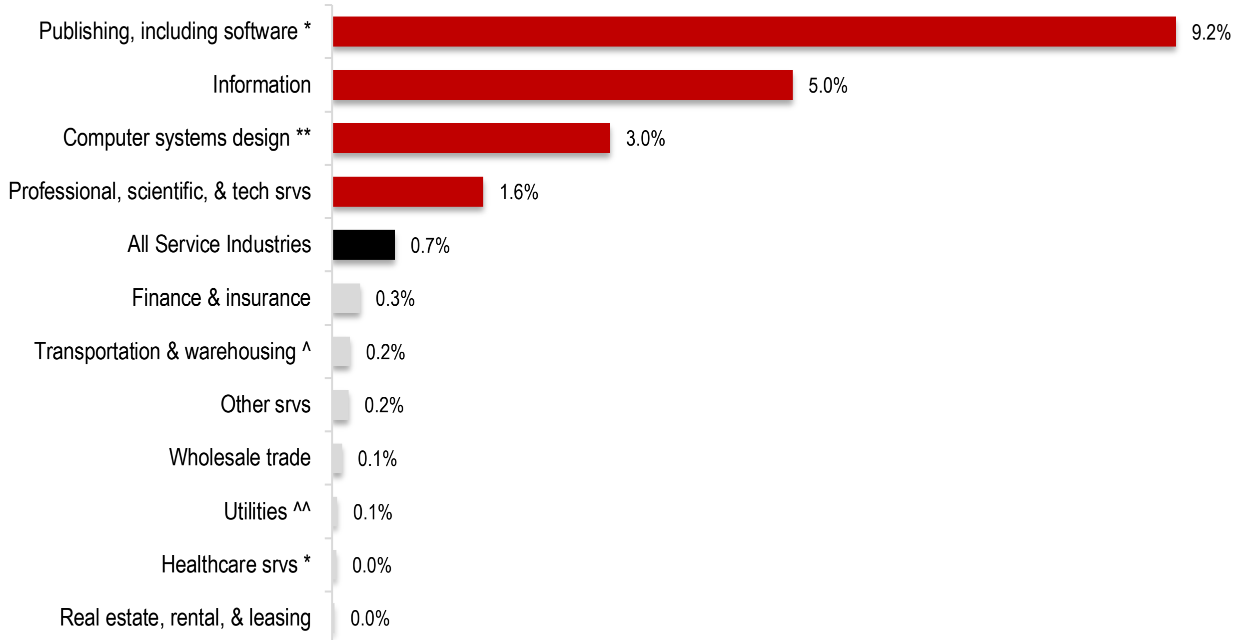
Figure 5.
Annual Average R&D Investment per Sales, Manufacturing Sector, 2012-22



(*) indicates 4-digit NAICS while all others are 3-digit NAICS.
Sources: U.S. Census Bureau; National Science Foundation.

During the same period, R&D investment in the U.S. service sector more than doubled from 0.4% of sales in 2012 to 1.0% in 2022, averaging 0.7% for the entire service sector over those 11 years. The disparities between the IP-intensive and non-IP-intensive groups were even more pronounced. IP-intensive service industries invested an average of $134 billion per year (3.1% of sales), while non-IP-intensive service industries invested less than $28 billion annually (0.1% of sales). The information industry, led by software publishers, invested an average of $95 billion per year, accounting for 5.0% of sales. Unlike manufacturing industries, annual sales data of service industries are not available for 3- and 4-digit NAICS level. (Figure 6)

Figure 6.
Annual Average R&D Investment per Sales, Service Sector, 2012-22



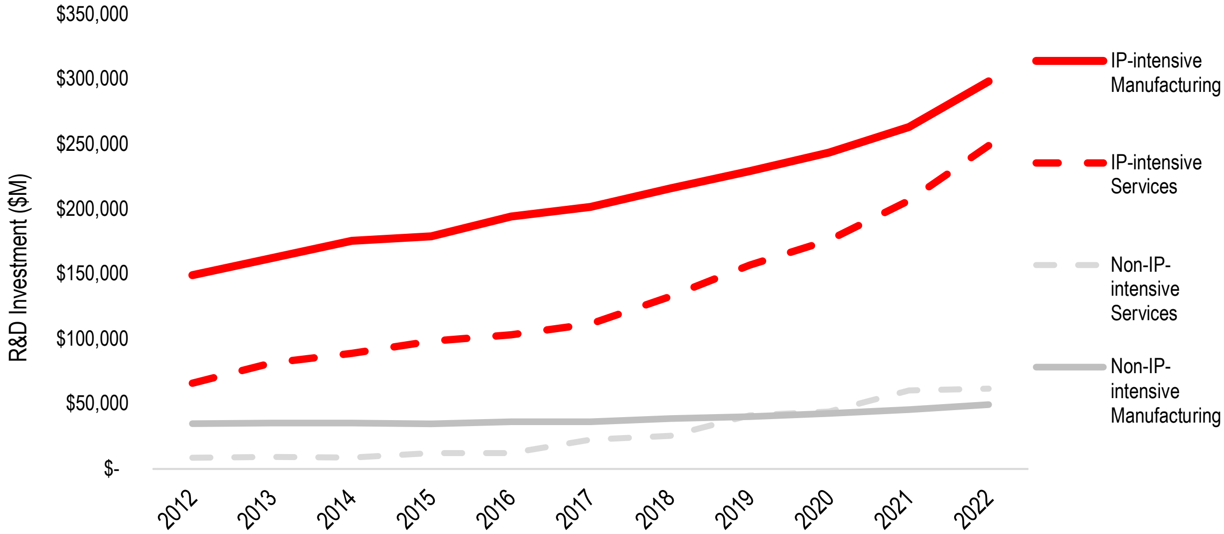
(*) and (**) indicate 3-digit NAICS and 4-digit NAICS, respectively, while all others are 2-digit NAICS.
(^) and (^^) 2012-2021 and 2012-2020, respectively.
Sources: U.S. Bureau of Economic Analysis; National Science Foundation.

INVESTING IN INTELLECTUAL PROPERTY

IP-intensive manufacturing industries doubled their nominal R&D investment from $149 billion in 2012 to $298 billion in 2022. From 2012 to 2022, R&D investment in non-IP-intensive manufacturing industries varied between $35 billion and $50 billion per year. (Figure 7)

U.S. service industries have significantly increased their R&D investment since 2012. IP-intensive service industries boosted their R&D investment by 277%, rising from $66 billion in 2012 to $249 billion in 2022. Notably, non-IP-intensive service industries raised their R&D investment from under $9 billion in 2012 to nearly $62 billion in 2022, marking a 617% increase. (Figure 7)

Figure 7.
Trends of R&D Investment by Sector and IP-Intensity, 2012-22



Sources: National Science Foundation.

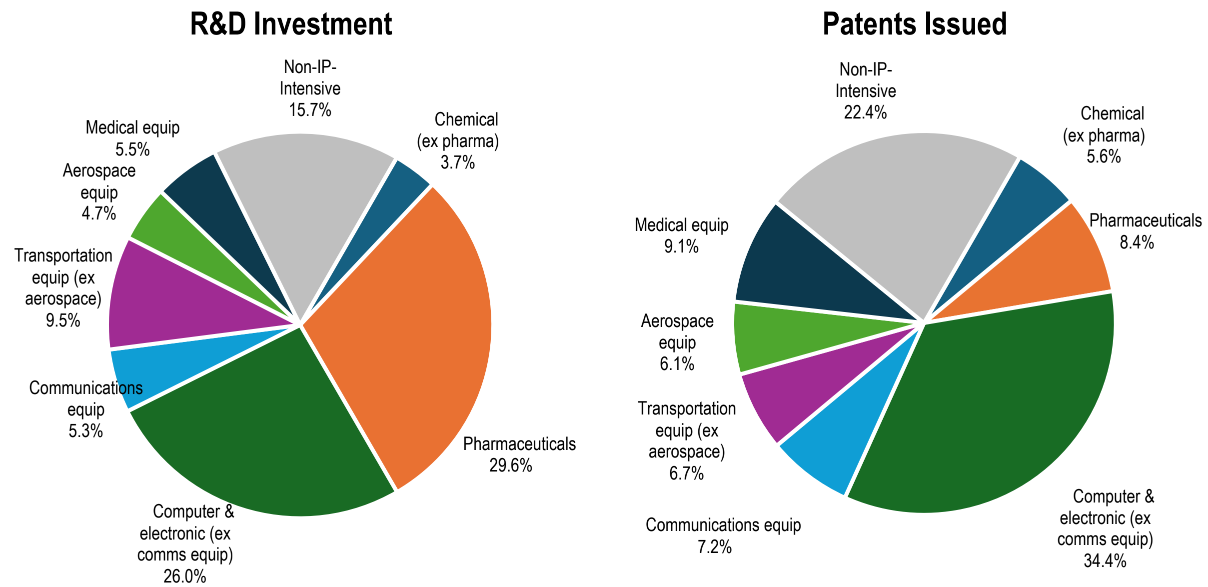
From 2012 to 2022, R&D investment in the aggregate U.S. manufacturing sector averaged $250 billion annually. IP-intensive industries accounted for over 84% of total manufacturing R&D investment. At the 3-digit NAICS level, the chemical and computer & electronic manufacturing industries comprised approximately 65% of total R&D investment. At the 4-digit NAICS level, the pharmaceutical industry, a subset of chemical manufacturing, held the highest share (29.6%) of total R&D investment. (Figure 8)

During the same period, the USPTO issued an average of 65,890 patents to manufacturing companies per year. IP-intensive industries accounted for nearly 78% of total patents issued. At the 3-digt NAICS level, the chemical and computer & electronic manufacturing industries received 56% of patents issued. (Figure 8)

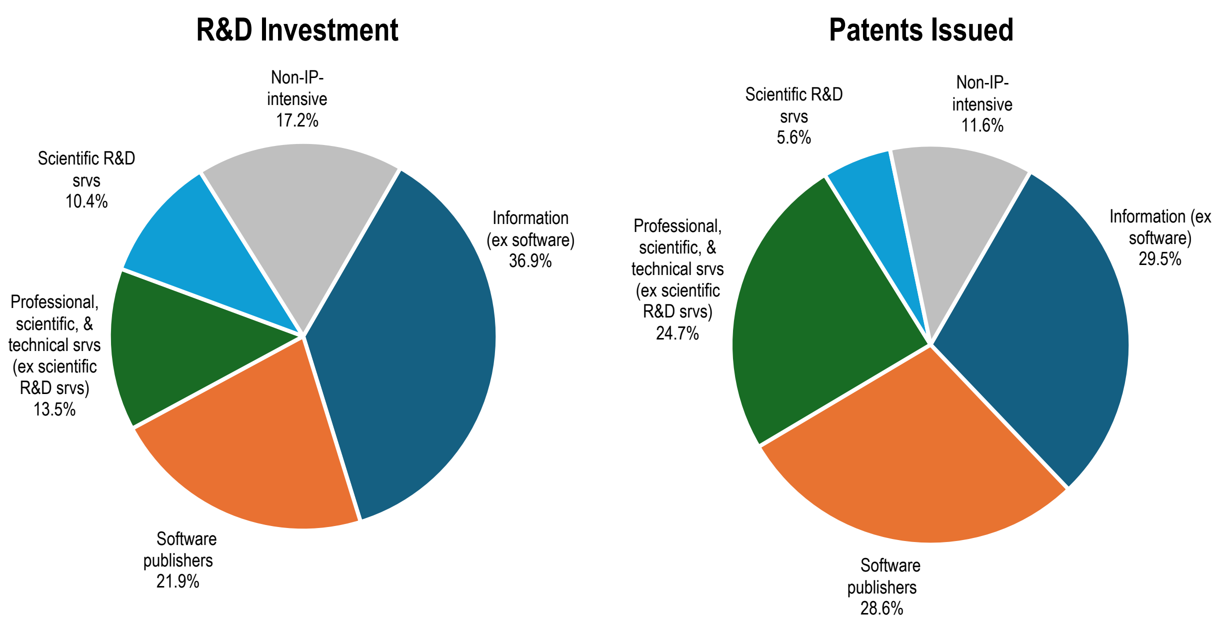
The U.S. service sector invested $162 billion annually during the same period. IP-intensive service industries represented over 82% of total services R&D investment. At the 4-digit NAICS level, the software publishing industry captured the highest share (21.9%) of total investment. The USPTO issued an average of 31,036 patents to service companies per year, with 88% to IP-intensive service industries. (Figure 8)

Figure 8.

Composition of R&D Investment by Selected Manufacturing Industries, 2012-22



Composition of R&D Investment by Selected Service Industries, 2012-22



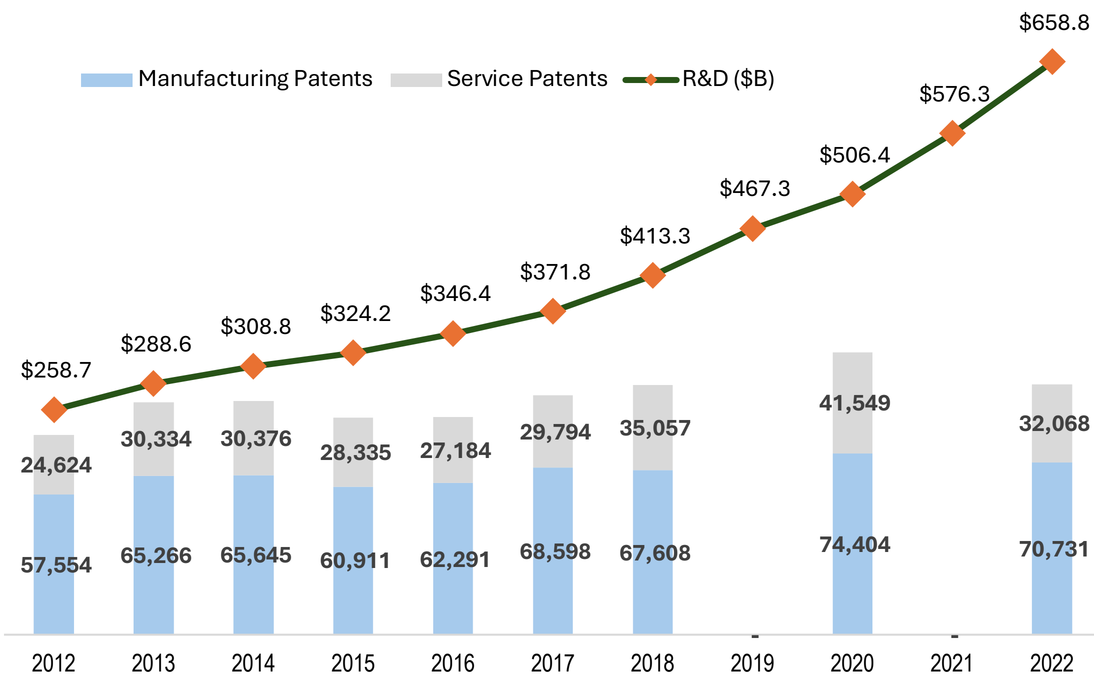
Sources: National Science Foundation.

OUTCOMES OF IP INVESTMENTS

Annual R&D investment grew 155% while patents issued remained relatively unchanged.

In the past decade, U.S. manufacturing and service companies increased their R&D investments by 155%, rising from $258.7 billion in 2012 to $658.8 billion in 2022. During this time, the annual number of patents issued by the U.S. Patent Trademark Office (USPTO) remained relatively stable, fluctuating between 82,178 in 2012 and 115,953 in 2020, according to data compiled by the National Science Foundation. U.S. companies in the manufacturing sector accounted for more than two-thirds of the patents issued, while those in the service sector represented one-third of the total. (Figure 9)

Figure 9.
Trends of R&D Investment and Patents Issued, 2012-22

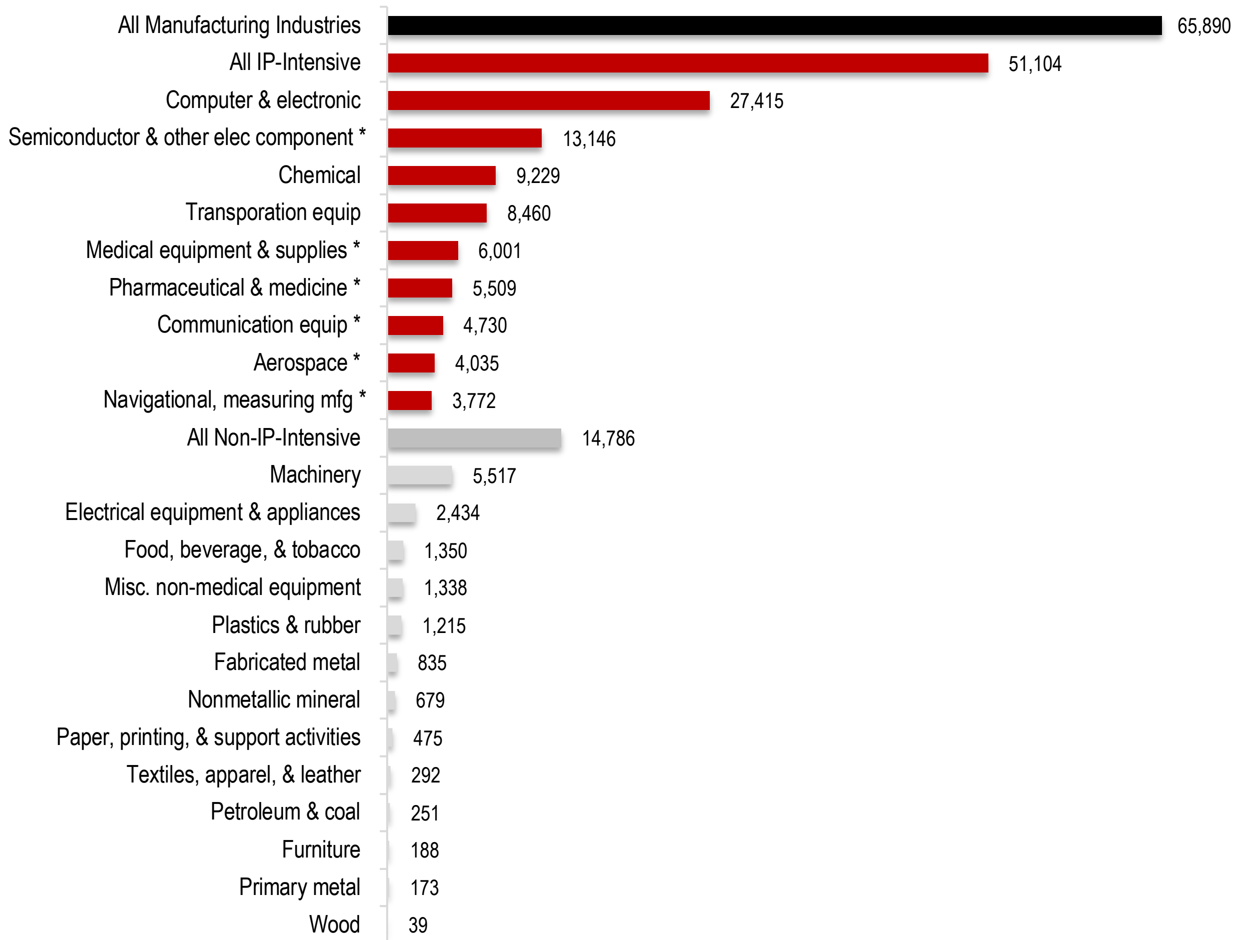


Sources: National Science Foundation; Patent data for 2019 and 2021 are unavailable.

IP-intensive industries accounted for more than two-thirds of patents issued.

From 2012 to 2022, more than 77% of patents granted within the manufacturing sector were to IP-intensive manufacturing industries. The computer and electronics industry represented about 54% of all patents issued in these IP-intensive industries, followed by the chemical sector at 18% and the transportation sector at 17%. The pharmaceutical industry, classified at the 4-digit NAICS level, received an average of 5,509 patent awards annually, comprising 11% of patents granted to IP-intensive industries and 8% of all patents granted to the manufacturing sector. (Figure 10)

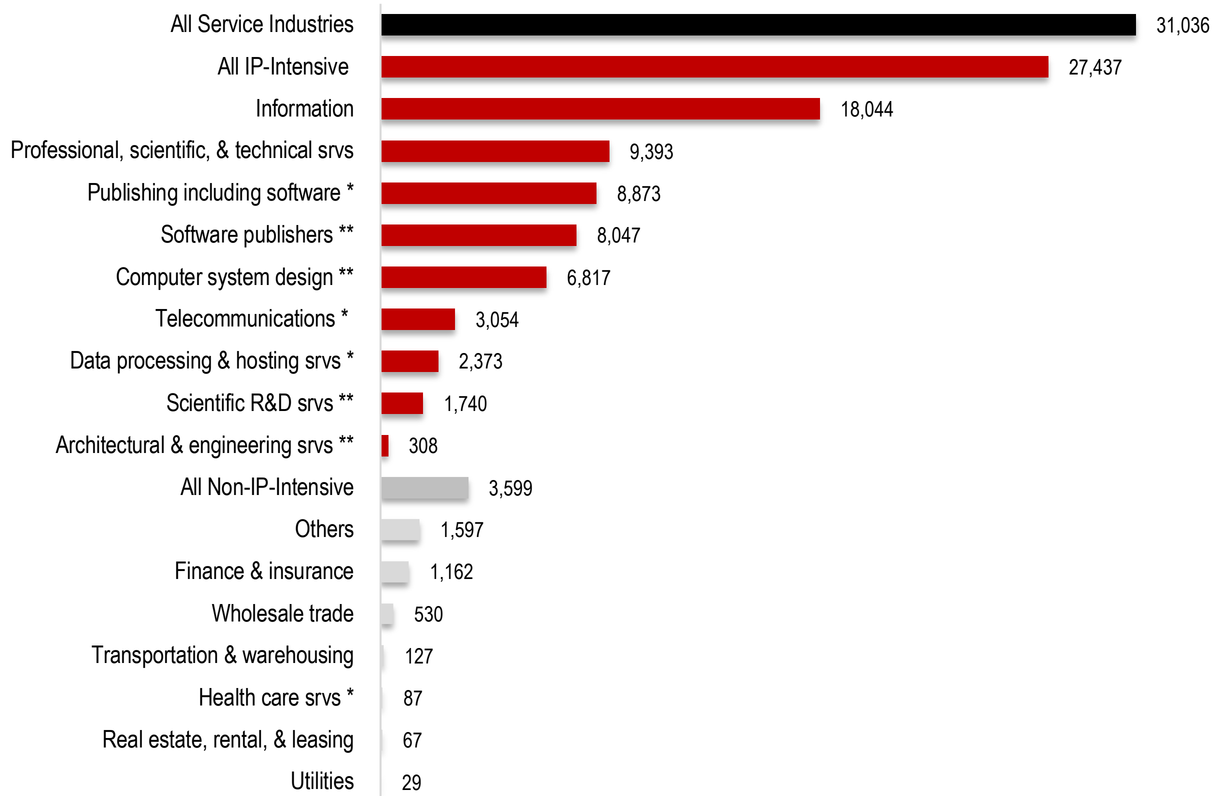
Figure 10.
Average Annual Patents Issued by Selected Manufacturing Industries, 2012-22



(*) indicates 4-digit NAICS while all others are 3-digit NAICS.
Sources: National Science Foundation.

Likewise, over 88% of patents granted within the service sector were awarded to IP-intensive service industries. Software publishers and computer systems designers represented more than half of the patents granted to these IP-intensive service industries. (Figure 11)

Figure 11.
Average Annual Patents Issued by Selected Service Industries, 2012-22

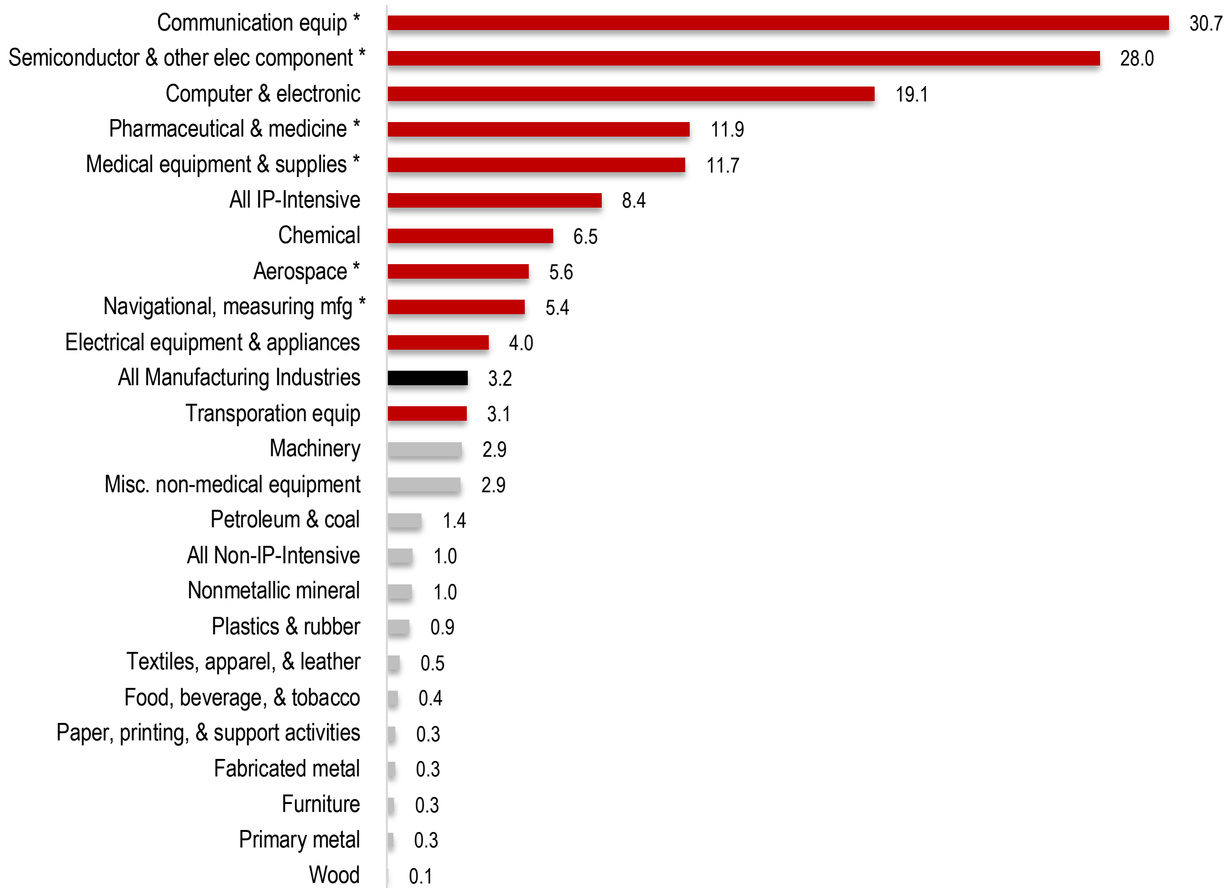


(*) and (**) are 3-digit and 4-digit NAICS, respectively, while all others are 2-digit NAICS.
Sources: National Science Foundation.

Patents per employee in IP-intensive manufacturing industries were 8 times those in non-IP-intensive manufacturing industries.

Between 2012 and 2022, patents per employee (patent intensity) in IP-intensive manufacturing industries were 8.4 times higher than in non-IP-intensive manufacturing industries. Patent intensity was highest in the communication equipment manufacturing industry, 30.7 times that of all non-IP-intensive industries. (Figure 12)

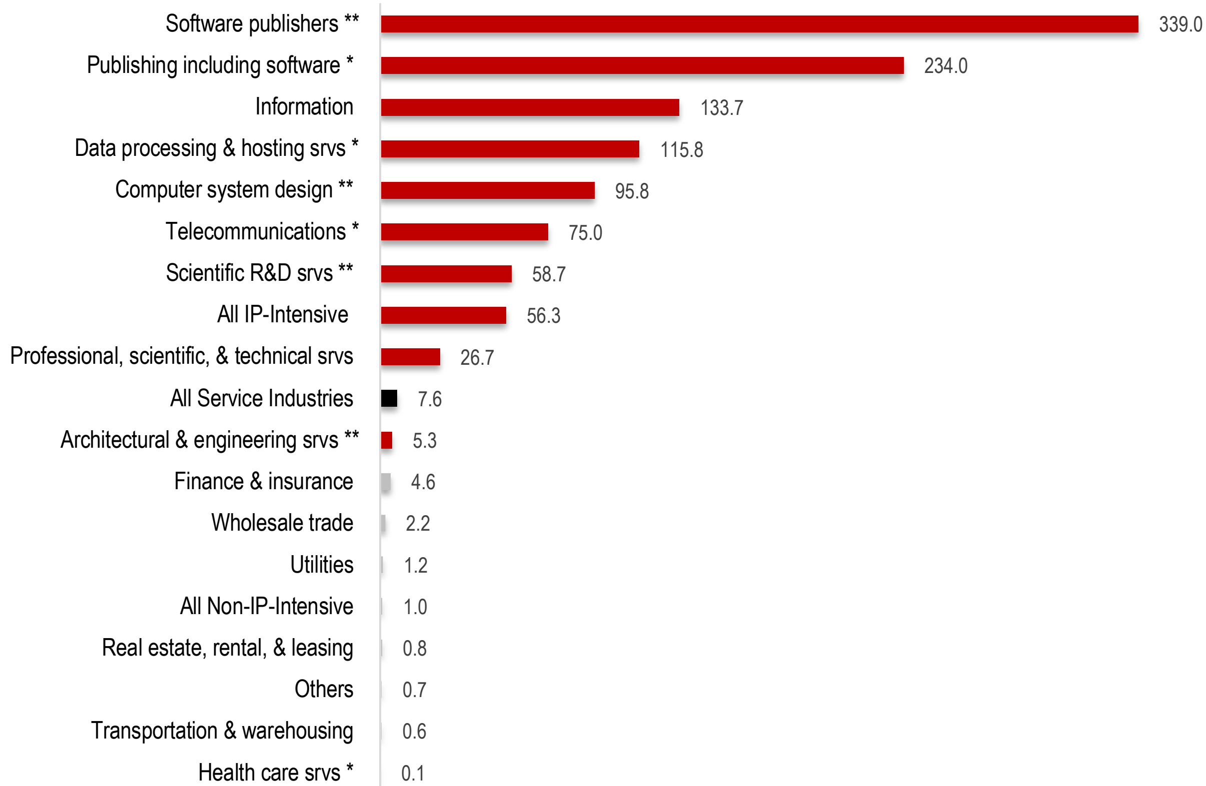
Figure 12.
Average Annual Patents per Employee by Selected Manufacturing Industries, 2012-22
(All non-IP-intensive = 1.0)



(*) indicates 4-digit NAICS while all others are 3-digit NAICS.
Sources: National Science Foundation; U.S. Census Bureau.

The patent-intensity differentials were more substantial between IP-intensive and non-IP-intensive service industries. The patent-intensity of the publishing including software industry was 234 times higher than non-IP-intensive service industries. (Figure 13)

Figure 13.
Average Annual Patents per Employee by Selected Service Industries, 2012-22 (All non-IP-intensive = 1.0)

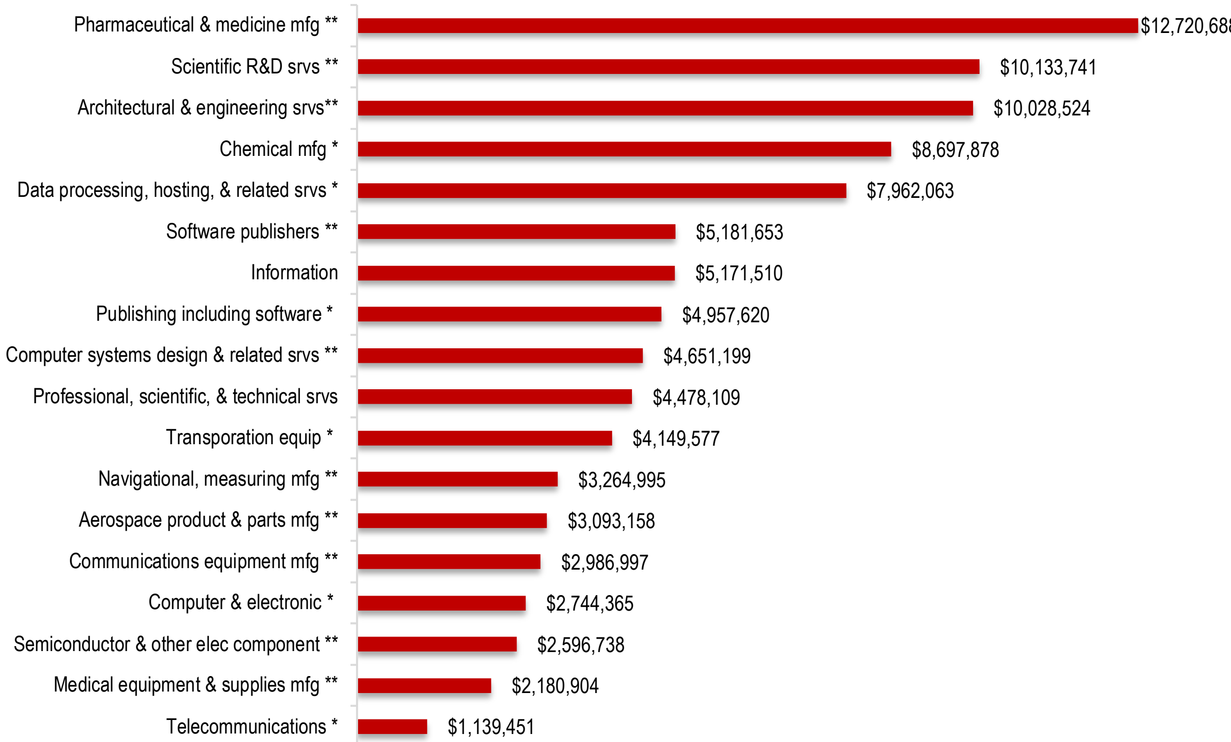


(*) and (**) are 3-digit and 4-digit NAICS, respectively, while all others are 2-digit NAICS.
Sources: National Science Foundation; U.S. Census Bureau.

The pharmaceutical industry invests more in R&D per patent than any other IP-intensive industry, but the financial return on patents is comparable to that of other industries.

Operating under different, highly specialized business models, the time, effort, and capital required to develop new ideas and innovations vary significantly across industries. We calculated the annual R&D investment and the number of patents awarded each year in each IP-intensive industry (for both service and manufacturing) as a proxy for measuring the cost of developing a patent. During 2012-22, companies in the pharmaceutical industry invested an average of $12.7 million per patent – the most of any sector. In contrast, companies in the telecommunications industry invested an average of $1.1 million per patent. (Figure 14) For the pharmaceutical sector, R&D occurs on both sides of the patent grant date, but the preponderance occurs during the clinical trial phase after that date.

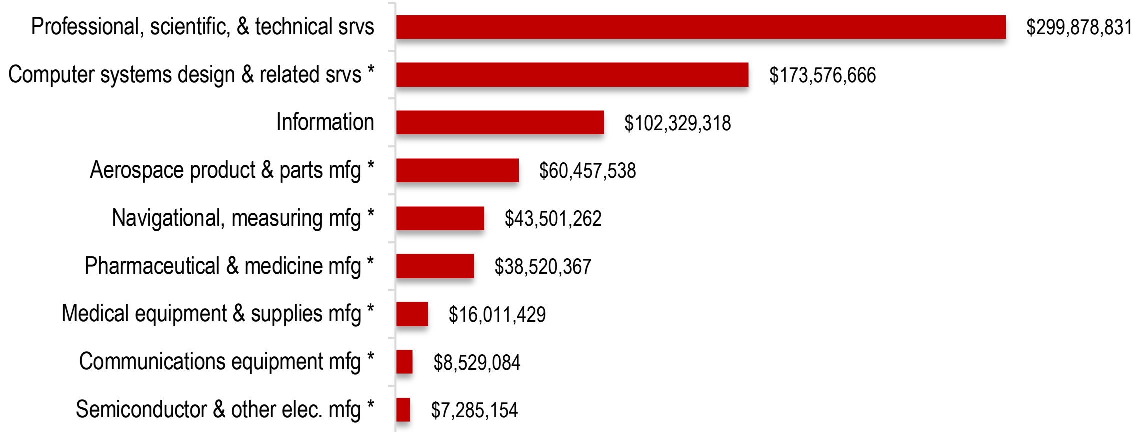
Figure 14.
Average Annual R&D Investment per Patent Issued by Selected IP-intensive Manufacturing and Service Industries, 2012-22



(*) and (**) are 3-digit and 4-digit NAICS, respectively, while all others are 2-digit NAICS.
Sources: National Science Foundation.

R&D investment per patent indicates the cost of developing a patent. Sales per patent reflect the financial return generated by those patents. While the pharmaceutical industry invests the most in R&D to develop patents, pharmaceutical sales per patent tended to be in the mid-range compared to other IP-intensive industries. The IP-intensive service industries (at the 2-digit NAICS level) professional, scientific, and technical services and information (including software), as well as computer systems design and some high-IP manufacturing sectors, all had higher sales per patent. (Figure 15)

Figure 15.
Average Sales per Patent Issued by Selected IP-intensive Manufacturing and Service Industries, 2012-22



(*) indicates 4-digit NAICS while all others are 2-digit NAICS.
Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

ECONOMIC IMPACTS OF INTELLECTUAL PROPERTY

IP-intensive manufacturing and service industries accounted for over 83% of total R&D investment in the U.S. during 2012-22. IP-intensive industries accounted for the majority of patents granted in the U.S., nearly 78% of total patents granted to manufacturing industries and over 88% of total patents granted in service industries.

IP-intensive industries employed a smaller share of the labor force, 29% in the manufacturing sector and 12% in the service sector. However, their economic contributions to the U.S. economy are disproportionally larger. Across all key economic metrics, there is an associated IP-multiplier. (Table 1)

Table 1.
Shares of IP-intensive and non-IP-intensive Industries

Manufacturing Industries

	IP-intensive Manufacturing Industries	Non-IP-intensive Manufacturing Industries	All Manufacturing Industries
R&D Investment	84.3%	15.7%	100.0%
Patents Issued	77.6%	22.4%	100.0%
Output	36.0%	64.0%	100.0%
Value-added	38.5%	61.5%	100.0%
Exports	50.9%	49.1%	100.0%
Wages	37.1%	62.9%	100.0%
Employment	29.1%	70.9%	100.0%

Service Industries

	IP-intensive Service Industries	Non-IP-intensive Service Industries	All Service Industries
R&D Investment	82.8%	17.2%	100.0%
Patents Issued	88.4%	11.6%	100.0%
Output	18.1%	81.9%	100.0%
Value-added	18.5%	81.5%	100.0%
Wages	20.7%	79.3%	100.0%
Employment	11.9%	88.1%	100.0%

Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

That IP is an economic force multiplier is amply demonstrated by the fact that IP-intensive industries have consistently outperformed non-IP-intensive industries across all key economic metrics. The average investment in R&D in IP-intensive manufacturing industries is $61,340 per employee per year, compared to just $4,700 in non-IP-intensive manufacturing industries. The USPTO granted an average of 51,104 patents per year to manufacturing companies in the IP-intensive industries and 14,786 patents in the non-IP-intensive industries. The patent intensity (patents per employee) in the IP-intensive manufacturing industries is eight times greater than in non-IP-intensive industries.

Employees in IP-intensive manufacturing earn an average salary of $75,979 per year, which is 44% higher than workers in non-IP-intensive manufacturing industries. Furthermore, IP-intensive manufacturing sectors export 152% more than their non-IP-intensive counterparts, amounting to $169,447 per employee per year compared to $67,174 per employee in non-IP-intensive industries.

Each worker in IP-intensive manufacturing contributes $284,306 to the GDP annually, which is 53% higher than workers in non-IP-intensive manufacturing. On average, IP-intensive manufacturing workers generate $613,181 in production value per year, which is 37% higher than the production value of non-IP-intensive manufacturing workers. (Table 2)

The economic weight of IP is particularly pronounced in the service sector. IP-intensive service industries invested nearly 36 times more than their non-intensive counterparts, with an expenditure of $10,548 per employee per year compared to just $296. The USPTO granted an average of 27,437 patents per year to service companies in the IP-intensive service industries and 3,599 patents per year in the non-IP-intensive industries. The patent intensity in the IP-intensive service industries was more than 56 times greater than in the non-IP-intensive industries.

Employees in IP-intensive service industries earned 92% more than those in non-IP-intensive service industries, with annual salaries of $92,071 compared to $47,907. Additionally, the contributions to GDP by workers in IP-intensive service industries were 67% higher than those in non-IP-intensive industries, at $203,869 versus $121,898. Output per worker in IP-intensive service industries was also 63% greater than in non-IP-intensive service industries, $326,711 compared to $200,784. (Table 2)

Table 2.
Patents Issued and Economic Performance per Employee Per Year, 2012-22

IP-intensive versus non-IP-intensive Manufacturing Industries

	IP-intensive Industries	Non-IP-intensive Industries	Difference	IP intensive multiple
Patents Issued (*)	15,007	1,782	13,225	8.4
R&D	$61,340	$4,700	$56,640	13.0
Wages	$75,979	$52,881	$23,097	1.4
Exports	$169,447	$67,174	$102,273	2.5
Value-Added	$284,306	$186,449	$97,857	1.5
Gross Output	$613,181	$447,314	$165,868	1.4

IP-intensive versus non-IP-intensive Service Industries

	IP-intensive Industries	Non-IP-intensive Industries	Difference	IP intensive multiple
Patents Issued (*)	2,204	39	2,165	56.3
R&D	$10,548	$296	$10,252	35.7
Wages	$92,071	$47,907	$44,165	1.9
Value-Added	$203,869	$121,898	$81,971	1.7
Gross Output	$326,711	$200,784	$125,926	1.6

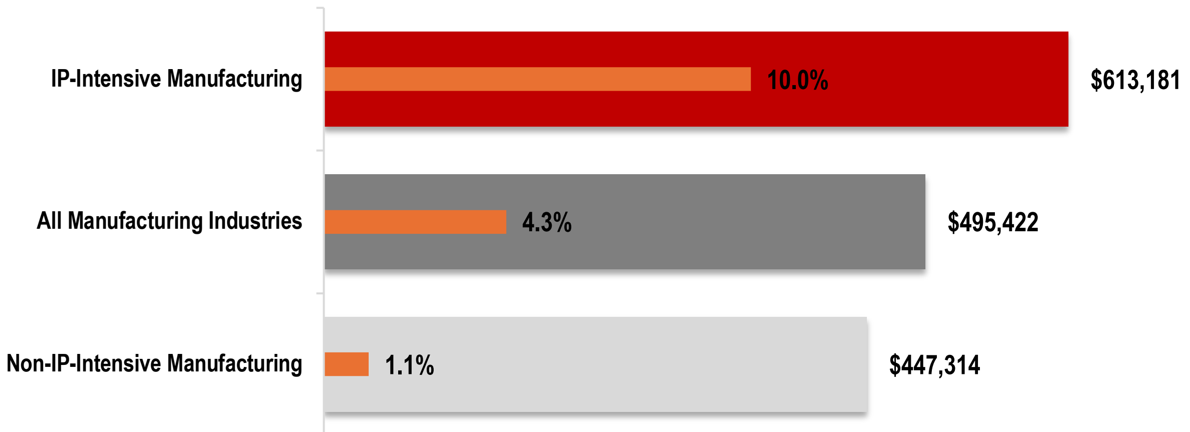
(*) patents issued per 1 million employees.
Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

Gross Sales (output) per employee in IP-intensive industries surpassed those in non-IP-intensive industries.

Worker productivity (measured as total output or gross sales per employee) is a crucial indicator of an industry's outlook and sustainability and is closely tied to invention and capital investment. This is especially so for process invention or the development of new and improved manufacturing methods or providing services. Process inventions are also often patent-protected and have fueled the decades-long trend of steady growth in worker productivity. From 2012 to 2022, output per employee in manufacturing industries averaged $495,422. In IP-intensive manufacturing industries, output per employee was 37% higher than in non-IP-intensive counterparts, averaging $613,181 and $447,314, respectively. With the exception of the petroleum and coal manufacturing industry, the chemical manufacturing sector—including pharmaceuticals—boasts the highest sales per employee in the U.S. manufacturing sector at $971,035 per employee annually.

Worker productivity is amplified by R&D and closely correlates with R&D intensity—the extent to which a firm or industry focuses its efforts on R&D. During 2012-22, annual R&D investment in the U.S. manufacturing sector averaged 4.3% of sales (gross output). R&D investment accounted for 10.0% of sales in IP-intensive industries, while the corresponding figure for non-IP-intensive manufacturing industries was 1.0%. During this period, the industry with the highest sales per employee, the pharmaceuticals industry, invested nearly 34.0% of sales in R&D. (Figure 16 and Table A.5 in Appendix)

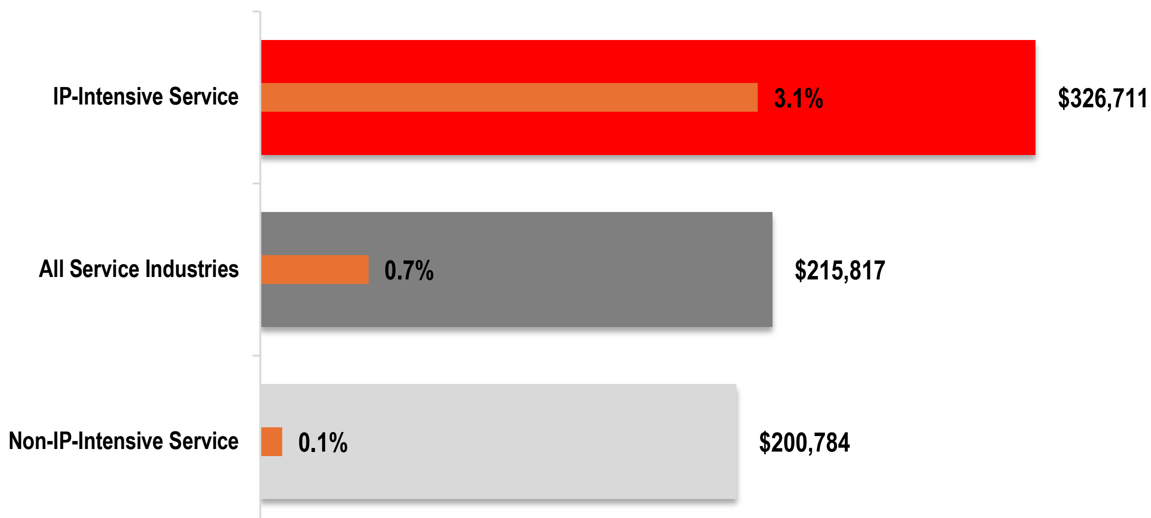
Figure 16.
Annual Average Output per Manufacturing Employee and R&D as % of Output, 2012-22



Sources: U.S. Census Bureau; National Science Foundation.

The positive effects of R&D investment are also evident in the service industries. From 2012 to 2022, output per employee in IP-intensive service industries ($326,711) was 63% higher than that of non-IP-intensive service industries ($200,784). R&D investment represented 3.1% of sales in IP-intensive service industries, compared to 0.1% in non-IP-intensive service industries. (Figure 17 and Table A.5 in the Appendix)

Figure 17.
Annual Average Output per Service Employee and R&D as % of Output, 2012-2022



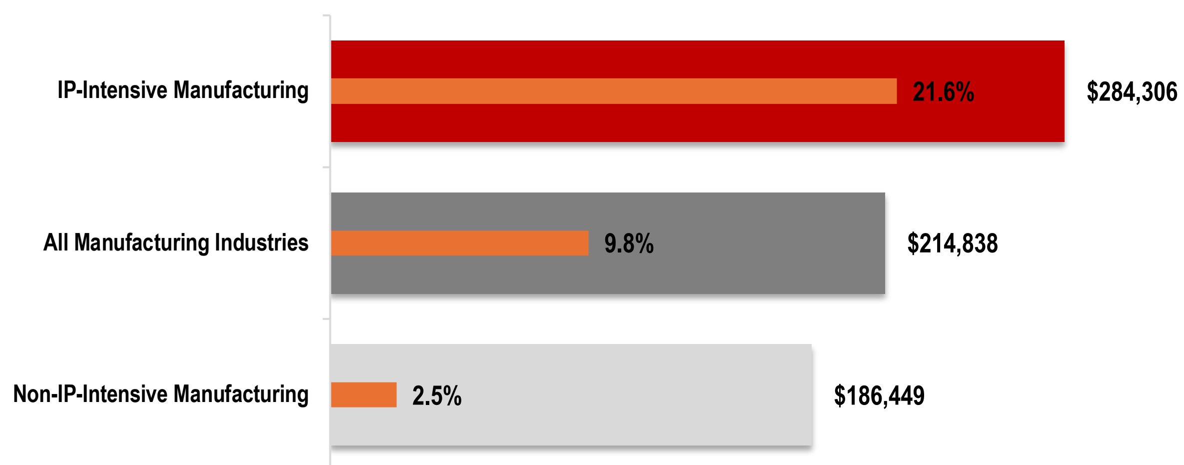
Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

The contribution to GDP (value-added) per employee in IP-intensive industries was higher than in non-IP-intensive industries.

Industry sales (or gross output) of a product or service encompass the value of intermediate goods plus the value added to those goods. The net value, or "value-added," signifies the industry's contribution to GDP. Between 2012 and 2022, IP-intensive manufacturing industries represented approximately 38% of the manufacturing sector's contribution to the U.S. economy. The chemical industry (including pharmaceuticals), the transportation equipment sector (including aerospace), and the computer industry (including semiconductors) accounted for 16%, 13%, and 7% of the manufacturing sector's contribution, respectively. The medical device manufacturing sector contributed an additional 2%.

During 2012-22, a manufacturing worker contributed an annual average of $214,838 in value-added to the U.S. economy. The value added per worker in IP-intensive sectors was 52% higher than in non-IP-intensive industries, with averages of $284,306 compared to $186,449, respectively. The greater contribution to GDP of workers in IP-intensive industries reflects the value of IP as an economic force multiplier. During this period, R&D investment in the U.S. manufacturing sector averaged 9.8% of value-added, while in IP-intensive manufacturing industries, R&D investment was 21.6% of value-added, compared to 2.5% in non-IP-intensive manufacturing sectors. (Figure 18 and Table A.6 in Appendix)

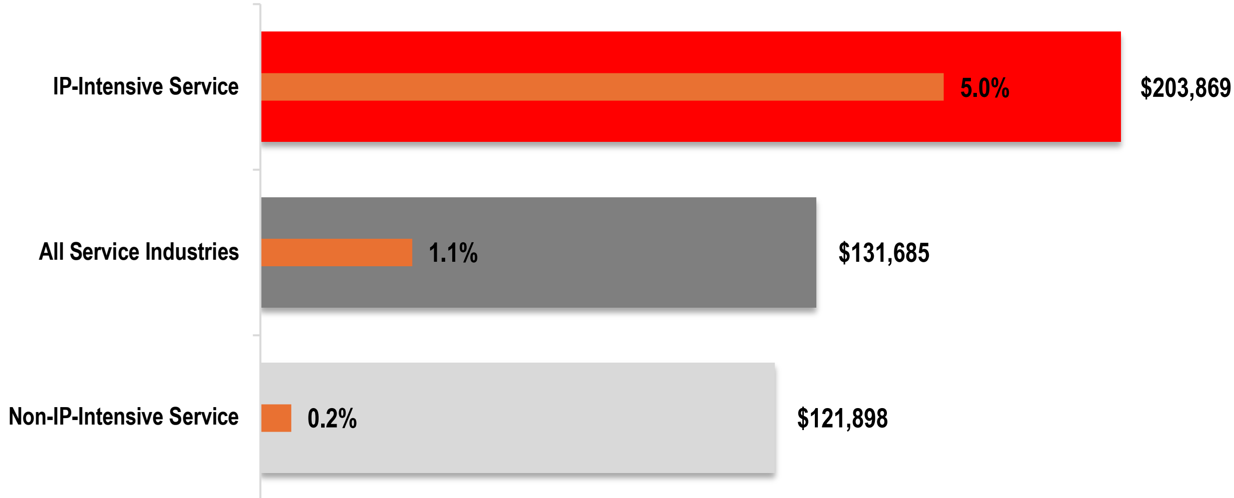
Figure 18.
Annual Average Value-added per Manufacturing Employee and R&D as % of Value-added, 2012-2022



Sources: U.S. Census Bureau; National Science Foundation

In contrast, IP-intensive service industries comprised less than 19% of the service sector's contribution to the U.S. economy. Nevertheless, the value added per worker in IP-intensive service industries was 67% higher than in non-IP-intensive service industries, at $203,869 compared to $121,898. R&D investment represented 5.0% of value added in IP-intensive service industries, whereas it was only 0.2% in non-IP-intensive service industries. (Figure 19 and Table A.6 in Appendix)

Figure 19.
Annual Average Value-added per Service Employee and R&D as % of Value-added, 2012-2022

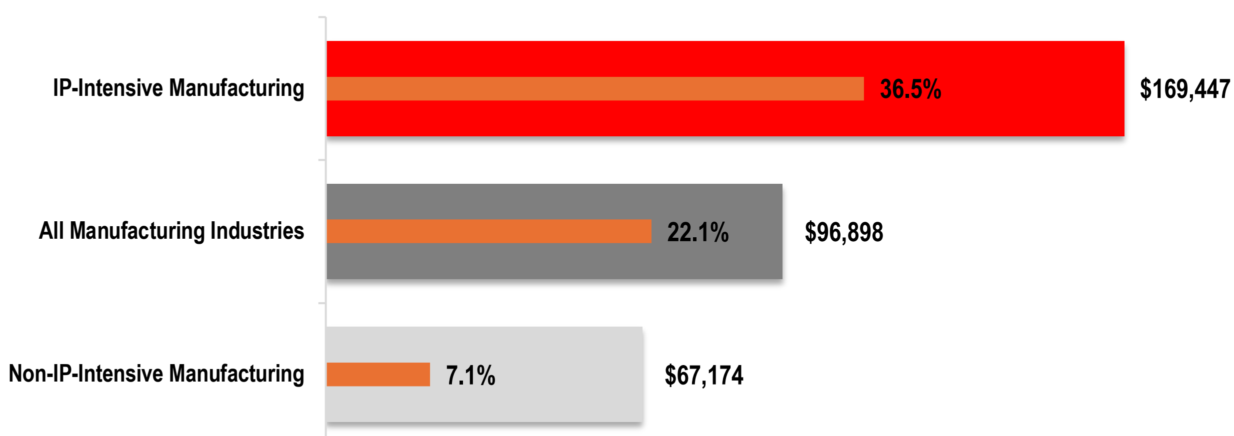


Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

IP-intensive manufacturing industries accounted for more than half of total manufacturing exports between 2012 and 2022.

From 2012 to 2022, IP-intensive manufacturing industries represented over half of the $1.1 trillion in exported goods each year within the manufacturing sector. Among these industries, the leading exporters included transportation equipment manufacturers, such as aerospace (20.7%); chemical manufacturers, including pharmaceuticals (17.4%); computer and electronics manufacturers, which encompassed communications equipment (10.4%); and medical device manufacturers (2.3%). Exports from IP-intensive manufacturing industries have increased steadily over the years. Between 2012 and 2022, the average IP-intensive export value was $169,447 per employee, which is 2.5 times higher than the average of $67,174 per employee in non-IP-intensive manufacturing industries. (Figure 20 and Table A.7 in Appendix)

Figure 20.
Annual Average Exports per Manufacturing Employee and R&D as % of Exports, 2012-2022



Sources: U.S. Census Bureau; National Science Foundation.

We do not analyze exports of the service sector since most service industries such as healthcare services are non-tradeable. For several service industries such as information, exports data are limited.

Wages in IP-intensive industries were higher than in non-IP-intensive industries.

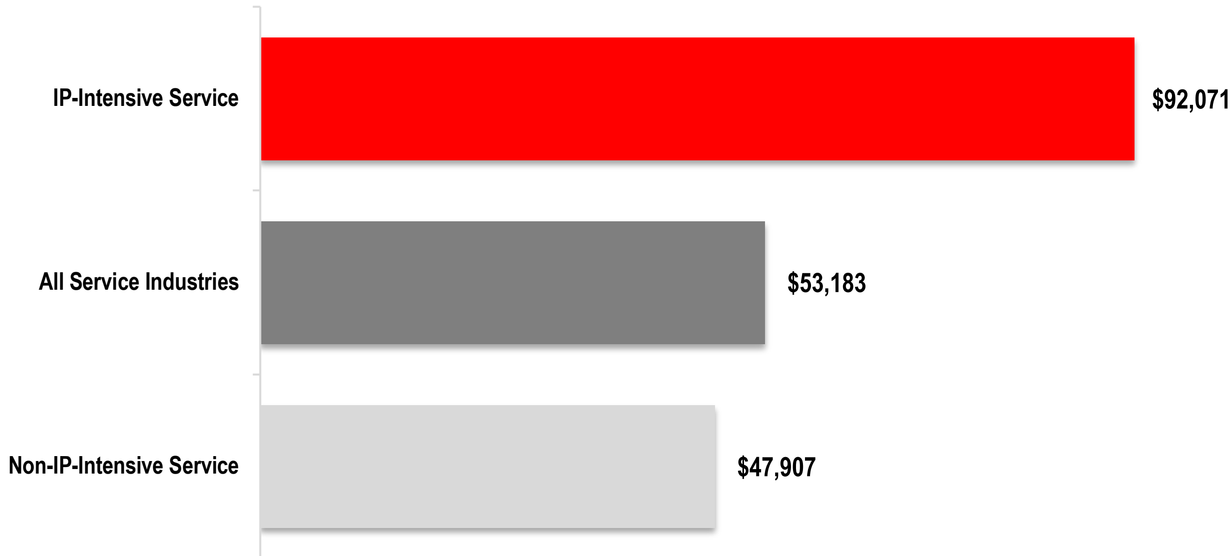
Wages reflect the productivity of workers; the greater the productivity, the higher the wages. R&D investment is positively correlated with wages – R&D includes the development of new and improved working and production processes, which increase worker productivity and thus wages. Employees in IP-intensive manufacturing industries earn higher wages than those in non-IP-intensive manufacturing industries. Between 2012 and 2022, manufacturing workers earned an average of $59,605 per year. Among them, employees in IP-intensive manufacturing industries earned $75,979 per year, which is over 44% higher than the wages of those in non-IP-intensive manufacturing industries. The IP-intensive manufacturing industry with the highest wages was the pharmaceutical manufacturing sector, with an average of $98,112 per employee. In contrast, the textile, apparel, and leather manufacturing industry offered the lowest pay at $37,406 per employee annually. (Figure 21 and Table A.8 in Appendix)

Figure 21.
Annual Average Wage per Manufacturing Employee, 2012-2022

Sources: U.S. Census Bureau; National Science Foundation.

Workers in IP-intensive service industries earn higher wages than those in non-IP-intensive service industries. From 2012 to 2022, employees in IP-intensive sectors made an average of $92,071 per year, almost twice as high as the wages of their counterparts in non-IP-intensive sectors. (Figure 22 and Table A.8 in Appendix)

Figure 22.
Annual Average Wage per Service Employee, 2012-2022



Sources: U.S. Census Bureau; National Science Foundation.

IP-intensive industries added more jobs than non-IP-intensive industries.

After reaching an all-time low in 2010-11, U.S. manufacturing employment is gradually rebounding. By 2019, prior to the COVID-19 pandemic, U.S. manufacturing jobs exceeded 12 million, compared to 10.9 million in 2010-11 and 19.4 million in the late 1970s. The recovery of manufacturing jobs paused in 2020-21 during the COVID-19 pandemic but began to surpass 12 million again in 2022.

Since the manufacturing job recovery started in 2012, employment in this sector has increased by 8.9%, averaging 11.7 million jobs. IP-intensive manufacturing employment rose by 14.2%, while non-IP-intensive manufacturing growth was 6.8%. From 2012 to 2019, IP-intensive manufacturing jobs grew by 10.8%, and non-IP-intensive jobs rose by 7.2%. Following the COVID-19 pandemic, IP-intensive manufacturing employment increased by 3.1%, whereas non-IP-intensive employment declined by 0.4%.

The positive influence of IP on job creation is also clear in the service sector. From 2012 to 2022, employment in the service sector increased by 17.5%, 23.6% in IP-intensive service industries and 16.7% in non-IP-intensive industries. Before the COVID-19 pandemic, job growth in IP-intensive service industries was slightly higher than in their non-IP-intensive counterparts, at 15.3% and 14.8%, respectively. However, since the COVID-19 pandemic, employment in IP-intensive service industries has risen by 7.2%, while non-IP-intensive service industries saw an increase of only 1.7%. (Table 3)

Table 3.
Average Employment and Percentage Changes, 2012-22

	Average Employment 2012-22	Change in Employment (%)		
		2012-22	2012-19	2019-22
All Manufacturing Industries	**11,702,862**	**8.9%**	**8.2%**	**0.6%**
IP-intensive	3,405,281	14.2%	10.8%	3.1%
Non-IP-intensive	8,297,581	6.8%	7.2%	-0.4%
All Service industries	**104,391,624**	**17.5%**	**14.8%**	**2.3%**
IP-intensive	12,451,386	23.6%	15.3%	7.2%
Non-IP-intensive	91,940,238	16.7%	14.8%	1.7%

Sources: U.S. Census Bureau

IMPORTANCE OF IP PROTECTIONS TO COMPANIES

Companies allocate resources to create intellectual property (IP) for their competitive advantage through patents, trademarks, copyrights, or trade secrets. Since developing IP requires time, effort, and capital, performers and funders must safeguard their intellectual property. The National Science Foundation conducts surveys of U.S. businesses that have engaged in or funded R&D regarding the importance of IP protection for their operations. In 2022, 45.5% of U.S. companies in the manufacturing and service sectors stated that protecting trade secrets was “very important” to their businesses, followed by trademarks (36% of respondents), utility patents (28%), copyrights (26%), and design patents (17%).

While IP protection is crucial for all manufacturing and service companies, the types of IP and the means of protection vary significantly across industries, depending on the nature of their business model and their IP intensity. More companies, with a few exceptions (such as food, beverage, textile, and petroleum products), in every industry indicated that protecting trade secrets is very important. As expected, more IP-intensive manufacturing companies, led by pharmaceutical companies, reported that utility and design patent protections are vital to their operations. Similarly, more IP-intensive service companies, led by software publishers, noted that copyright protections are essential to their businesses. (Table 4)

Table 4.
Importance of IP Protections to U.S. Companies in 2022 (% of companies stated that IP protection is “Very Important” to their business)

	Utility patents	Design patents	Trademarks	Copyrights	Trade secrets
Manufacturing & Service Industries	**28.1**	**17.2**	**36.0**	**26.1**	**45.5**
All Manufacturing Industries	**32.0**	**22.3**	**38.2**	**23.4**	**47.6**
IP-Intensive					
Chemicals	47.3	18.7	40.8	20.3	62.3
Basic chemicals	53.3	20.7	40.0	17.9	69.0

Pharmaceuticals and medicines	59.2	20.6	41.2	21.6	64.7
Computer and electronic products	37.0	24.3	50.7	37.2	56.3
Communications equipment	40.6	29.0	46.9	35.5	60.6
Semiconductor and other electronic	31.1	23.9	37.0	24.4	48.9
Navigational, measuring, & control	36.2	23.4	45.3	28.4	57.4
Transportation equipment	33.3	31.1	38.6	31.1	45.5
Motor vehicles, trailers, & parts	33.9	33.3	31.6	25.0	35.1
Aerospace products and parts	32.0	24.0	44.0	36.0	60.9
Medical equipment and supplies	44.7	35.5	50.0	28.9	57.9
Non-IP-Intensive					
Food	14.0	10.5	44.2	18.6	42.5
Beverage and tobacco products	14.3	14.3	50.0	20.0	42.9
Textile, apparel, and leather products	24.0	20.0	34.6	19.2	32.0
Wood products	20.0	10.0	30.0	20.0	40.0
Paper	22.2	22.2	33.3	20.0	44.4
Printing and related support activities	13.3	14.3	21.4	14.3	26.7
Petroleum and coal products	37.5	25.0	66.7	37.5	62.5
Plastics and rubber products	24.7	18.5	32.9	18.5	41.3
Nonmetallic mineral products	15.4	8.3	23.1	11.5	38.5
Primary metals	19.2	11.5	18.5	11.5	60.0
Fabricated metal products	15.7	13.8	16.7	9.3	31.2
Machinery	37.9	28.4	34.2	23.9	43.4
Electrical equipment, appliances	41.7	31.3	43.8	35.4	55.3
Furniture and related products	18.2	23.8	38.1	18.2	23.8
Other miscellaneous manufacturing	35.4	37.5	51.1	31.3	46.8
Service Industries	**23.6**	**13.3**	**32.9**	**25.6**	**43.4**
IP-Intensive					
Information	20.2	10.1	44.1	36.0	46.7
Publishing	16.3	6.7	50.4	43.4	44.0
Software publishers	16.2	7.0	51.5	43.8	45.0
Telecommunications	22.2	19.2	26.9	23.1	61.5
Data processing, hosting, related srvs	25.0	12.4	40.6	30.7	47.8
Other information	15.4	7.7	44.4	40.7	40.7
Professional, scientific, & technical srvs	23.5	12.3	26.4	26.6	39.9
Architectural, engineering, & srvs	23.4	14.1	22.5	19.7	36.7
Computer systems design & srvs	17.7	10.9	27.9	23.9	40.4
Scientific R&D srvs	46.6	18.9	27.8	18.9	55.6
R&D in nanotechnology	40.0	20.0	20.0	10.0	60.0

R&D in biotech (exc nanobiotech)	56.3	16.1	32.3	18.8	53.1
Other R&D in physical, eng, & life	43.6	19.6	27.2	19.4	55.3
Non-IP-Intensive					
Utilities	28.6	16.7	28.6	16.7	33.3
Wholesale trade	27.8	28.5	43.4	20.8	41.7
Transportation and warehousing	28.6	16.7	33.3	33.3	33.3
Newspaper, periodical, book publishers	14.3	16.7	33.3	28.6	16.7
Finance and insurance	5.9	3.9	11.8	7.8	80.4
Real estate & rental & leasing	16.7	14.3	42.9	33.3	42.9
Health care services	21.4	10.7	20.7	14.3	25.0

Sources: National Science Foundation:

CONCLUSION

Innovation is essential for sustainable economic growth and competitiveness. Recent official statistics reaffirm the significance of intellectual property (IP) to the U.S. economy. Between 2012 and 2022, employment in IP-intensive manufacturing and services industries grew faster than in non-IP-intensive industries before and after the COVID-19 pandemic. Workers in IP-intensive industries earned higher wages, produced higher output, and contributed more to GDP growth than their counterparts in non-IP-intensive sectors. Additionally, these IP-intensive manufacturing industries accounted for most U.S. manufacturing exports.

Intellectual property protection is a vital investment in high-risk projects that lead to new innovations. Without this protection, inventors and investors would struggle to recoup the time, effort, and funds spent on new and groundbreaking ideas. IP takes various forms and is utilized differently to generate value through innovative goods and services.

Policymakers must maintain policies to support the innovation ecosystem to create, protect, and utilize IP, fostering stronger and more sustainable economic growth and strengthening U.S. competitiveness.

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APPENDIX 1

METHODOLOGY

Innovation can be measured by inputs, outputs, or a combination of both. Inputs, starting with R&D investment, are the effort needed to produce innovation, while outputs measure the fruits of innovation. In some cases, inputs tell us more about innovation and, in others, outputs are more revealing.

Three observable and measurable outputs are the number and value of patents, trademarks, and copyrights. The "number" of these IP protections is a straightforward metric, but it is important to keep in mind that there are patents, trademarks, and copyrights that never get commercialized. Sometimes the economic value of IP outputs, which is determined by the value of the products and services created by the innovation process, is a more useful measure.

However, there are advantages to measuring innovation by its inputs. R&D investment, a direct input to IP output, is observable and widely used to measure IP intensity. R&D is a reliable indicator of innovative capacity and is positively correlated with IP outputs.[20] These outputs are just as important to start-ups as they are to multinational corporations; investments in R&D and patents allow companies of all sizes to create, manufacture, and market their products.[21] Furthermore, the evidence from high-tech industries reveals a

Definitions and Data Sources

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

Employment: Total number of employees in a manufacturing or service sector, subsector, or industry published by the Census Bureau.

Wages: Total wages paid to employees of a manufacturing or service sector, subsector, or industry published by the Census Bureau.

Gross output: Total sales or revenues of a manufacturing or service sector, subsector, or industry published by the Census Bureau or Bureau of Economic Analysis.

Value added: The economic contributions of a manufacturing or service sector, subsector, or industry as measured by total sales minus intermediate inputs such as the cost of raw materials and services published by the Census Bureau or Bureau of Economic Analysis.

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

Patents Issued: Number of U.S. patents issued by USPTO to companies located in the U.S. that performed or funded R&D published by the National Science Foundation.

Importance of IP Protections: A survey by the National Science Foundation on the importance of IP protections for U.S. companies that conducted or funded R&D in the U.S.

[20] For example, National Science Board. 2020. "Invention, Knowledge Transfer, and Innovation." National Science Foundation. January 15; 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.

[21] For example, McDole, Jaci and Stephen Enzell. 2021. "Ten Ways IP Has Enabled Innovations That Have Helped Sustain the World Through the Pandemic." Information Technology & Innovation Foundation. April 29; 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.

relationship between past and prospective R&D spending: success at earlier stages in the R&D process tends to increase the value of future R&D commitments, which means that R&D success breeds more innovation, leads to new life-enhancing products, raises our living standards, and makes us more efficient and productive.

We evaluate the R&D, patents, and economic data at the 2-, 3-, and 4-digit NAICS levels. Based on its classification system, the 2-digit NAICS level refers to the economic sector (e.g., manufacturing sector), the 3-digit NAICS level refers to the economic subsector (e.g., chemical manufacturing subsector), and the 4-digit NAICS level refers to the economic industry (e.g., pharmaceutical manufacturing industry). For consistency with other "per employee" economic performance metrics (i.e., output, value-added, wages, and exports), we use the Census employment data to calculate R&D per employee by manufacturing and service industry.[22] To assess the robustness of our IP classifications, we also use the NSF employment figures (at the company level) to calculate R&D per employee.[23]

IP-intensive Manufacturing and Service Industries

We define IP-intensive manufacturing industries by comparing the R&D per employee in each manufacturing industry to the aggregated manufacturing sector. IP-intensive manufacturing industries are those that have the average R&D per employee during 2012-22 above the average R&D per employee of the aggregated manufacturing sector during the same period.

For the service sector, we use the BLS classification of the service-providing sectors (https://www.bls.gov/iag/tgs/iag07.htm). Similarly, we calculated and compared R&D per employee in each service industry to the aggregated service-providing sectors. IP-intensive service industries are those that have the average R&D per employee during 2012-22 above the average R&D per employee of the aggregated service-producing sectors during the same period. Public administration/government is one of the service-providing industries in the BLS classification. Since NSF data does not have R&D investment for the public sector, we exclude the public administration industry from our analysis.

[22] Note that the Census Bureau publishes employment data by industry at the "establishment level," which tends to be slightly different from the "company level" employment data published by the NSF.
[23] Although the value of R&D investment per employee differs, the IP-industry classification remains unchanged.

APPENDIX 2

INDUSTRY CLASSIFICATIONS

Table A.1.
IP-Intensity

IP-Intensive and Non-IP-Intensive Manufacturing Industries

	IP-Intensive Manufacturing Industries
325	Chemical manufacturing
3254	Pharmaceutical & medicine manufacturing
334	Computer & electronic product manufacturing
3342	Communications equipment manufacturing
3344	Semiconductor & other electronic component manufacturing
3345	Navigational, measuring, medical, & control instruments manufacturing
336	Transportation equipment manufacturing
3361-3363	Motor vehicles, trailers, & parts
3364	Aerospace product & parts manufacturing
3391	Medical equipment & supplies manufacturing
	Non-IP-Intensive Industries
311	Food manufacturing
312	Beverage & tobacco product manufacturing
313–16	Textile, apparel, & leather products
321	Wood product manufacturing
322	Paper manufacturing
323	Printing & related support activities
324	Petroleum & coal products manufacturing
326	Plastics & rubber products manufacturing
327	Nonmetallic mineral product manufacturing
331	Primary metal manufacturing
332	Fabricated metal product manufacturing
333	Machinery manufacturing
335	Electrical equipment, appliance, & component manufacturing
337	Furniture & related product manufacturing
3399	Other miscellaneous manufacturing

IP-Intensive and Non-IP-Intensive Service Industries

	IP-Intensive Service Industries
51	Information
511	Publishing, including software publishers
5112	Software publishers
517	Telecommunications
518	Data processing, hosting, & related services
54	Professional, scientific, & technical services
5413	Architectural, engineering, & related services
5415	Computer systems design & related services
5417	Scientific R&D services
	Non-IP-Intensive Service Industries
22	Utilities
42	Wholesale trade
44-45	Retail trade
48-49	Transportation & warehousing
52	Finance and insurance
53	Real estate, rental, & leasing
55	Management of companies & enterprises
56	Administrative, waste management, & remediation services
621-623	Health care services
624	Social assistance
71	Arts, entertainment, & recreation
72	Accommodation & food services
81	Other services

APPENDIX 3

ECONOMIC PERFORMANCE

Table A.2.
Economic Performance per Employee Compared to the Manufacturing Sector Average, 2012-2022

	R&D Investment	Wages	Exports	Value-added	Gross Output
IP-Intensive	Ÿ	Ÿ	Ÿ	Ÿ	Ÿ
Chemical	Ÿ	Ÿ	Ÿ	Ÿ	Ÿ
Pharmaceutical & medicine	Ÿ	Ÿ	Ÿ	Ÿ	Ÿ
Computer & electronic	Ÿ	Ÿ	Ÿ	Ÿ	
Communication equip	Ÿ	Ÿ	Ÿ	Ÿ	
Semiconductor & other elec component	•	•	•		
Navigational, measuring mfg	•	•	•	•	
Transportation equip	Ÿ	Ÿ	Ÿ		Ÿ
Motor vehicles, trailers, & parts	•		Ÿ		Ÿ
Aerospace	Ÿ	Ÿ	Ÿ	Ÿ	Ÿ
Medical equipment & supplies	Ÿ	Ÿ			
Non-IP-Intensive					
Petroleum & coal		Ÿ	Ÿ	Ÿ	Ÿ
Food, beverage, & tobacco				Ÿ	Ÿ
Textiles, apparel, & leather					
Wood					
Paper, printing, & support activities					
Plastics & rubber					
Nonmetallic mineral					
Primary metal		Ÿ	Ÿ	Ÿ	Ÿ
Fabricated metal					
Machinery		Ÿ	Ÿ		
Electrical equipment & appliances		Ÿ	Ÿ		
Furniture					
Misc. non-medical equipment					

Ÿ indicates that performance is above the average of the U.S. manufacturing sector during the relevant period

Economic Performance per Employee Compared to the Service Sector Average, 2012-2022

	R&D Investment	Wages	Value-added	Gross Output
IP-Intensive	Ÿ	Ÿ	Ÿ	Ÿ
Information	Ÿ	Ÿ	Ÿ	Ÿ
Publishing including software	Ÿ	Ÿ	Ÿ	Ÿ
Software publishers	Ÿ	Ÿ	○	○
Telecommunications	Ÿ	Ÿ	○	○
Data processing & hosting srvs	Ÿ	Ÿ	○	○
Professional, scientific, & technical srvs	Ÿ	Ÿ	Ÿ	Ÿ
Architectural & engineering srvs	Ÿ	Ÿ	○	○
Computer systems design	Ÿ	Ÿ	Ÿ	Ÿ
Scientific R&D srvs	Ÿ	Ÿ	○	○
Non-IP-Intensive				
Utilities		Ÿ	Ÿ	Ÿ
Wholesale trade		Ÿ	Ÿ	Ÿ
Transportation & warehousing				Ÿ
Finance & insurance		Ÿ	Ÿ	Ÿ
Real estate, rental, & leasing		Ÿ	Ÿ	Ÿ
Health care srvs		Ÿ		
Others				

Ÿ indicates that performance is above the average of the U.S. service sector during the relevant period.
○ indicates that data is not available for those economic categories.

Table A.3.
Total and Average Annual Patents Issued, R&D per Patent, and Sales per Patent, 2012-22 (*)

IP-intensive versus Non-IP-intensive Manufacturing Industries

	Total Patents Issued	Average Annual Patents Issued	Patents per One Million Employee	R&D per Patent ($M)	Sales per Patent ($M)
All Manufacturing Industries	**593,008**	**65,890**	**5,630**	**$3.6**	**$88.0**
IP-Intensive	**459,937**	**51,104**	**15,007**	**$3.9**	**$41.0**
Chemical	83,057	9,229	11,616	$8.7	$84.3
Pharmaceutical & medicine	49,580	5,509	21,177	$12.7	$38.5
Computer & electronic	246,735	27,415	34,109	$2.7	$11.5
Communication equip	42,567	4,730	54,694	$3.0	$8.5
Semiconductor & other comp.	118,313	13,146	49,862	$2.6	$7.3
Navigational, measuring mfg	33,945	3,772	9,650	$3.3	$43.5
Transportation equip	76,136	8,460	5,567	$4.1	$109.7
Motor vehicles, trailers, & parts	--	--	--	--	--
Aerospace	36,317	4,035	9,909	$3.1	$60.5

Medical equipment & supplies	54,009	6,001	20,871	$2.2	$16.0
Non-IP-Intensive	**133,071**	**14,786**	**1,782**	**$2.6**	**$254.2**
Petroleum & coal	2,262	251	2,431	$3.0	$5,392.1
Food, beverage, & tobacco	12,146	1,350	772	$4.0	$729.6
Textiles, apparel, & leather	2,628	292	907	$3.5	$317.0
Wood	351	39	99	$7.2	$3,453.9
Paper, printing, & supports	4,274	475	607	$2.9	$686.9
Plastics & rubber	10,937	1,215	1,598	$3.3	$265.6
Nonmetallic mineral	6,108	679	1,776	$2.2	$191.9
Primary metal	1,554	173	458	$5.9	$1,912.7
Fabricated metal	7,511	835	590	$3.3	$488.6
Machinery	49,653	5,517	5,245	$2.6	$73.5
Electrical equip & appliances	21,910	2,434	7,114	$1.9	$54.7
Furniture	1,694	188	524	$2.5	$475.5
Misc. non-medical equipment	12,043	1,338	5,168	$2.1	$53.9

IP-intensive versus Non-IP-intensive Service Industries

	Total Patents Issued	Average Annual Patents Issued	Patents per One Million Employee	R&D per Patent ($M)	Sales per Patent ($M)
All Service industries	**279,321**	**31,036**	**297**	**$4.6**	**$711.0**
IP-Intensive	**246,932**	**27,437**	**2,204**	**$4.5**	**$144.9**
Information	162,393	18,044	5,235	$5.2	$102.3
Publishing including software	79,860	8,873	9,160	$5.0	$54.1
Software publishers	72,422	8,047	13,271	$5.2	n/a
Telecommunications	27,484	3,054	2,935	$1.1	n/a
Data processing & hosting srvs	21,354	2,373	4,532	$8.0	n/a
Professional, scientific, & tech srvs	84,539	9,393	1,043	$4.5	$299.9
Architectural & engineering srvs	2,775	308	206	$10.0	n/a
Computer systems design	61,353	6,817	3,750	$4.7	$173.6
Scientific R&D srvs	15,658	1,740	2,296	$10.1	n/a
Non-IP-Intensive	**32,389**	**3,599**	**39**	**$5.7**	**$5,440.5**
Utilities	264	29	46	$12.1	$15,713.3
Wholesale trade	4,771	530	88	$6.2	$11,789.5
Transportation & warehousing	1,142	127	25	$9.0	$15,352.0
Finance & insurance	10,455	1,162	182	$7.7	$3,265.5
Real estate, rental, & leasing	600	67	31	$14.9	$66,101.4
Health care srvs	782	87	5	$11.5	$35,419.3
Others	14,375	1,597	29	$5.9	$35,446.2

(*) 2019 and 2021patent data are not available.
Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

Table A.4.
Annual Average R&D per employee, 2012-2022

IP-intensive versus Non-IP-intensive Manufacturing Industries

	R&D ($ billions)	R&D per Employee
All Manufacturing Industries	**$249.3**	**$21,224**
IP-Intensive	**$210.2**	**$61,340**
Chemical	$83.0	$103,332
Pharmaceutical & medicine	$73.8	$279,060
Computer & electronic	$78.1	$97,518
Communication equip	$13.3	$153,597
Semiconductor & other elec component	$35.2	$133,540
Navigational, measuring mfg	$11.6	$29,624
Transportation equip	$35.4	$23,148
Motor vehicles, trailers, & parts	$22.2	$24,117
Aerospace	$11.7	$28,673
Medical equipment & supplies	$13.7	$47,606
Non-IP-Intensive	**$39.0**	**$4,700**
Petroleum & coal	$0.7	$6,915
Food, beverage, & tobacco	$5.4	$3,097
Textiles, apparel, & leather	$0.7	$2,303
Wood	$0.3	$671
Paper, printing, & support activities	$1.2	$1,528
Plastics & rubber	$3.2	$4,269
Nonmetallic mineral	$1.4	$3,687
Primary metal	$0.8	$2,011
Fabricated metal	$2.6	$1,860
Machinery	$14.4	$13,724
Electrical equipment & appliances	$4.7	$13,717
Furniture	$0.4	$1,130
Misc. non-medical equipment	$2.5	$9,629

IP-intensive versus Non-IP-intensive Service Industries

	R&D ($ billions)	R&D per Employee
All Service industries	**$161.7**	**$1,524**
IP-Intensive	**$133.8**	**$10,548**
Information	$95.0	$27,265
Publishing including software	$35.5	$36,667
Software publishers	$35.4	$60,944
Telecommunications	$3.5	$3,382

Data processing & hosting srvs	$22.4	$41,287
Professional, scientific, & technical srvs	$38.7	$4,225
Architectural & engineering srvs	$2.4	$1,566
Computer systems design	$14.8	$8,022
Scientific R&D srvs	$16.9	$21,409
Non-IP-Intensive	**$27.9**	**$296**
Utilities	$0.3	$439
Wholesale trade	$1.8	$154
Transportation & warehousing	$7.2	$168
Finance & insurance	$9.0	$1,375
Real estate, rental, & leasing	$1.1	$508
Health care srvs	$1.0	$61
Others	$12.0	$211

Sources: U.S. Census Bureau; National Science Foundation.

Table A.5.

Annual Average Output per Employee, 2012-22

IP-intensive versus Non-IP-intensive Manufacturing Industries

	Gross Output ($ billions)	Output per Employee	R&D as % of Output (%)
All Manufacturing Industries	**$5,797.6**	**$495,422**	**4.29**
IP-Intensive	**$2,086.8**	**$613,181**	**10.04**
Chemical	$770.0	$971,035	10.77
Pharmaceutical & medicine	$214.8	$827,797	33.92
Computer & electronic	$312.8	$389,581	24.88
Communication equip	$37.7	$439,133	35.38
Semiconductor & other elec component	$96.4	$366,119	36.21
Navigational, measuring mfg	$150.0	$383,594	7.74
Transportation equip	$912.4	$601,661	3.86
Motor vehicles, trailers, & parts	$620.7	$685,017	3.54
Aerospace	$220.5	$542,874	5.31
Medical equipment & supplies	$91.5	$318,491	0.05
Non-IP-Intensive	**$3,710.8**	**$447,314**	**1.05**
Petroleum & coal	$645.1	$6,299,047	0.12
Food, beverage, & tobacco	$970.5	$555,649	0.56
Textiles, apparel, & leather	$66.7	$207,974	1.12
Wood	$112.2	$281,356	0.25
Paper, printing, & support activities	$271.9	$348,429	0.44
Plastics & rubber	$245.4	$322,296	1.33
Nonmetallic mineral	$126.5	$329,724	1.13

Primary metal	$250.1	$666,018	0.30
Fabricated metal	$366.0	$258,827	0.71
Machinery	$388.2	$369,064	3.72
Electrical equipment & appliances	$132.1	$385,668	3.54
Furniture	$74.2	$206,334	0.55
Misc. non-medical equipment	$61.9	$239,393	4.02

IP-intensive versus Non-IP-intensive Service Industries

	Gross Output ($ billions)	Output per Employee	R&D as % of Output (%)
All Service industries	**$22,631.7**	**$215,817**	**0.68**
IP-Intensive	**$4,093.8**	**$326,711**	**3.14**
Information	$1,815.1	$524,457	5.02
Publishing including software	$392.7	$401,873	9.20
Professional, scientific, & technical srvs	$2,278.7	$251,358	1.65
Computer systems design	$482.9	$263,042	3.03
Non-IP-Intensive	**$18,537.9**	**$200,784**	**0.14**
Utilities	$520.5	$812,583	0.06
Wholesale trade	$2,100.4	$346,958	0.11
Transportation & warehousing	$1,264.3	$251,603	0.20
Finance & insurance	$2,805.7	$437,086	0.30
Real estate, rental, & leasing	$3,783.5	$1,761,005	0.03
Health care srvs	$2,164.8	$128,652	0.05
Others	$5,898.7	$106,908	0.18

Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

Table A.6.
Annual Average Value-added per Employee, 2012-22

IP-intensive versus Non-IP-intensive Manufacturing Industries

	Value-added ($ billions)	Value-added per Employee	R&D as % of Value-added (%)
All Manufacturing Industries	**$2,516.2**	**$214,838**	**9.84**
IP-Intensive	**$968.1**	**$284,306**	**21.60**
Chemical	$405.8	$510,230	20.22
Pharmaceutical & medicine	$154.4	$593,241	47.03
Computer & electronic	$178.6	$222,375	43.63
Communication equip	$19.6	$228,316	67.84
Semiconductor & other elec component	$51.1	$194,065	68.45
Navigational, measuring mfg	$94.1	$240,762	12.32
Transportation equip	$323.1	$213,278	10.94

Motor vehicles, trailers, & parts	$174.1	$191,842	12.61
Aerospace	$115.4	$284,189	10.31
Medical equipment & supplies	$60.6	$210,853	22.67
Non-IP-Intensive	**$1,548.0**	**$186,449**	**2.52**
Petroleum & coal	$118.4	$1,153,689	0.66
Food, beverage, & tobacco	$399.9	$228,432	1.37
Textiles, apparel, & leather	$30.3	$94,906	2.45
Wood	$50.4	$125,724	0.56
Paper, printing, & support activities	$135.4	$173,446	0.88
Plastics & rubber	$119.7	$156,943	2.74
Nonmetallic mineral	$71.2	$185,477	2.00
Primary metal	$92.8	$248,169	0.81
Fabricated metal	$198.3	$140,229	1.31
Machinery	$190.0	$180,649	7.59
Electrical equipment & appliances	$65.5	$191,264	7.13
Furniture	$40.0	$111,244	1.02
Misc. non-medical equipment	$36.1	$139,590	6.90

IP-intensive versus Non-IP-intensive Service industries

	Value-added ($ billions)	Value-added per Employee	R&D as % of Value-added (%)
All Service industries	**$13,806.8**	**$131,685**	**1.12**
IP-Intensive	**$2,554.5**	**$203,869**	**5.04**
Information	$1,035.3	$299,118	8.80
Publishing including software	$253.8	$259,220	14.38
Professional, scientific, & technical srvs	$1,519.2	$167,600	2.47
Computer systems design	$338.8	$263,042	4.32
Non-IP-Intensive	**$11,252.3**	**$121,898**	**0.23**
Utilities	$328.8	$513,439	0.09
Wholesale trade	$1,221.0	$201,730	0.08
Transportation & warehousing	$640.4	$127,031	0.38
Finance & insurance	$1,521.1	$236,766	0.55
Real estate, rental, & leasing	$2,629.0	$1,224,712	0.04
Health care srvs	$1,349.9	$80,204	0.07
Others	$3,562.1	$64,601	0.30

Sources: U.S. Bureau of Economic Analysis; U.S. Census Bureau; National Science Foundation.

Table A.7.
Annual Average Exports per Employee, 2012-22

IP-intensive versus Non-IP-intensive Manufacturing Industries

	Exports ($ billions)	Exports per Employee	R&D as % of Exports (%)
All Manufacturing Industries	**$1,133.1**	**$96,898**	**22.09**
IP-Intensive	**$576.3**	**$169,447**	**36.52**
Chemical	$197.5	$248,074	41.72
Pharmaceutical & medicine	$58.1	$221,853	125.45
Computer & electronic	$117.4	$146,043	66.91
Communication equip	$16.1	$186,140	82.79
Semiconductor & other elec component	$36.1	$137,148	96.76
Navigational, measuring mfg	$39.9	$102,095	29.14
Transportation equip	$234.8	$155,504	15.27
Motor vehicles, trailers, & parts	$117.5	$130,705	18.85
Aerospace	$108.4	$266,925	11.02
Medical equipment & supplies	$26.6	$92,577	51.23
Non-IP-Intensive	**$556.8**	**$67,174**	**7.07**
Petroleum & coal	$97.5	$950,042	0.80
Food, beverage, & tobacco	$75.0	$43,010	7.28
Textiles, apparel, & leather	$17.0	$53,101	4.40
Wood	$7.1	$17,877	3.74
Paper, printing, & support activities	$28.6	$36,573	4.19
Plastics & rubber	$30.6	$40,272	10.59
Nonmetallic mineral	$10.7	$28,101	13.20
Primary metal	$56.8	$150,911	1.34
Fabricated metal	$40.8	$28,815	6.48
Machinery	$125.5	$119,316	11.59
Electrical equipment & appliances	$44.6	$130,400	10.57
Furniture	$4.6	$12,852	8.95
Misc. non-medical equipment	$18.1	$69,781	13.92

Sources: U.S. Census Bureau; National Science Foundation.

Table A.8.
Annual Average Wage per Employee, 2012-22

IP-intensive versus Non-IP-intensive Manufacturing Industries

	Wages ($ billions)	Wages per Employee
All Manufacturing Industries	**$698.8**	**$59,605**
IP-Intensive	**$259.4**	**$75,979**
Chemical	$66.2	$82,960
Pharmaceutical & medicine	$25.7	$98,112
Computer & electronic	$69.6	$86,769
Communication equip	$8.2	$95,948
Semiconductor & other elec component	$20.8	$79,042
Navigational, measuring mfg	$35.6	$90,909
Transportation equip	$104.0	$68,187
Motor vehicles, trailers, & parts	$54.3	$59,372
Aerospace	$37.4	$91,653
Medical equipment & supplies	$19.6	$68,203
Non-IP-Intensive	**$439.3**	**$52,881**
Petroleum & coal	$10.9	$105,539
Food, beverage, & tobacco	$80.5	$45,802
Textiles, apparel, & leather	$11.9	$37,406
Wood	$17.3	$43,391
Paper, printing, & support activities	$42.4	$54,414
Plastics & rubber	$38.0	$49,763
Nonmetallic mineral	$21.0	$54,634
Primary metal	$24.5	$65,072
Fabricated metal	$76.5	$54,047
Machinery	$67.0	$63,671
Electrical equipment & appliances	$21.0	$61,307
Furniture	$15.4	$42,828
Misc. non-medical equipment	$12.9	$50,087

IP-intensive versus Non-IP-intensive Service industries

	Wages ($ billions)	Wages per Employee
All Service industries	**$5,577.0**	**$53,183**
IP-Intensive	**$1,154.9**	**$92,071**
Information	$368.6	$106,341
Publishing including software	$125.5	$127,221
Software publishers	$102.7	$164,198
Telecommunications	$81.3	$78,347
Data processing & hosting srvs	$57.6	$108,858

Professional, scientific, & technical srvs	$786.3	$86,706
Architectural & engineering srvs	$130.5	$86,726
Computer systems design	$187.7	$102,114
Scientific R&D srvs	$97.3	$126,490
Non-IP-Intensive	**$4,422.1**	**$47,907**
Utilities	$67.9	$106,006
Wholesale trade	$441.7	$72,990
Transportation & warehousing	$253.0	$50,067
Finance & insurance	$661.2	$102,948
Real estate, rental, & leasing	$118.8	$55,243
Health care srvs	$927.7	$55,104
Others	$1,951.9	$35,397

Sources: U.S. Census Bureau; National Science Foundation.

About the Author

Nam D. Pham, Ph.D. is Managing Partner of ndp | analytics, a strategic research firm that specializes in economic analysis of public policy and legal issues. Prior to founding ndp | analytics in 2000, Dr. Pham was Vice President at Scudder Kemper Investments in Boston. Before that, he was Chief Economist of the Asia Region for Standard & Poor's DRI; an economist at the World Bank; and a consultant to both the Department of Commerce and the Federal Trade Commission.

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