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Annual Report on the U.S. Manufacturing Economy: 2024

Douglas Thomas

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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
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Annual Report on the U.S. Manufacturing Economy: 2024

Douglas Thomas
Applied Economics Office
Engineering Laboratory

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October 2024

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National Institute of Standards and Technology
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NIST Author ORCID iDs

Douglas Thomas: 0000-0002-8600-4795

Abstract

This report provides a statistical review of the U.S. manufacturing industry. There are three aspects of U.S. manufacturing that are considered: (1) how the U.S. industry compares to other countries, (2) the trends in the domestic industry, and (3) the industry trends compared to those in other countries.

Keywords

manufacturing; economy; supply chain; value added; statistics

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Preface

This study was conducted by the Applied Economics Office (AEO) in the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST). The study provides aggregate manufacturing industry data and industry subsector data to develop a quantitative depiction of the U.S. manufacturing industry.

Acronyms

AM: Additive Manufacturing
ASM: Annual Survey of Manufactures
ATP: Advanced Technology Program
BEA: Bureau of Economic Analysis
BLS: Bureau of Labor Statistics
CAG: Compound Annual Growth
CEO: Chief Executive Officer
DARPA: Defense Advanced Research Projects Agency
GDP: Gross Domestic Product
ISIC: International Standard Industrial Classification
NAICS: North American Industry Classification System
NIST: National Institute of Standards and Technology
OECD: Organization for Economic Cooperation and Development
PPP: Purchasing Power Parity
R&D: Research and Development
SBIR: Small Business Innovation Research Program
SIC: Standard Industrial Classification
STEP: Standard for the Exchange of Product Model Data
USGS: United States Geological Survey
VA: Value Added

Executive Summary

This report provides a statistical review of the U.S. manufacturing industry. There are three aspects of U.S. manufacturing that are considered: (1) how the U.S. industry compares to other countries, (2) the trends in the domestic industry, and (3) the industry trends compared to those in other countries. The U.S. remains a major manufacturing nation; however, other countries are rising rapidly.

Although U.S. manufacturing performs well in many respects, there are opportunities for advancing competitiveness. This will require strategic placement of resources to ensure that U.S. investments have the highest return possible.

Competitiveness – Manufacturing Industry Size: In 2022, there was $15.0 trillion of value added (i.e., GDP) in global manufacturing in constant 2015 dollars, which is 17.5 % of the value added by all industries ($86.1 trillion), according to the United Nations Statistics Division. The U.S. accounted for $2.6 trillion (15.1 %) in manufacturing valued added while China accounted for $5.1 trillion (31.0 %). Direct and indirect (i.e., purchases from other industries) manufacturing accounts for 17.1 % of GDP. Among the ten largest manufacturing countries, the U.S. is the 2nd largest manufacturing value added per capita (see Figure 2.5) and out of all countries the most recent U.S. rank is 16th, as illustrated in Figure 2.6. In 2020, China produced more than the U.S. in 9 of the 11 subsectors shown in Figure 2.7.

Competitiveness – Manufacturing Growth: Compound real (i.e., controlling for inflation) annual growth in the U.S. between 1997 and 2022 (i.e., 25-year growth) was 1.7 %, which places the U.S. below the 50th percentile. The compound annual growth for the U.S. between 2017 and 2022 (i.e., 5-year growth) was 1.5 %. This puts the U.S. just below the 50th percentile, above Canada and Germany among others.

Competitiveness – Productivity: Labor productivity for manufacturing increased by 0.4 % between the second quarter of 2023 and the second quarter of 2024, as illustrated in Figure 4.9. The five-year compound annual growth is 0.4 %. For U.S. manufacturing, total factor productivity decreased 1.3 % from 2021 to 2022 and has a 5-year compound annual growth rate of 0.1 %, as illustrated in Figure 4.10. Productivity in the U.S. is relatively high compared to other countries. As illustrated in Figure 4.11, the U.S. is ranked ninth in output per hour among 142 countries using data from the Conference Board. In recent years, productivity growth has been negative or has come to a plateau in many countries and the U.S. seems to be following this pattern of slow growth. There are competing explanations for why productivity has slowed, such as an aging population, inequality, or other factors. A number of the explanations equate to low levels of capital investment. It is also important to note that productivity is difficult to measure and even more difficult to compare across countries. Moreover, the evidence does not seem to support any particular explanation over another as to why productivity appears to have stalled.

Competitiveness – Economic Environment: There is no agreed upon measure for research, innovation, and other factors for doing business, but there are a number of common measures that are used. The ranking of the U.S. in these measures has mixed results, ranking high in some and lower in others. For instance, the U.S. ranks 4th in patent applications per million people but ranks 18th in researchers per capita and 24th in journal article publications per capita. The IMD World Competitiveness Index, which measures competitiveness for conducting business, ranked the U.S. 12th in competitiveness for conducting business and the World Economic Forum, which assesses the competitiveness in determining productivity, ranked the U.S. 5th. Note that neither of these are specific to manufacturing, though. The Competitive Industrial Performance Index, which measures capacity to produce and export manufactured goods; technological deepening and upgrading; and world impact, ranked the U.S. as 6th.

Domestic Specifics – Types of Goods Produced: The largest manufacturing subsector in the U.S. is chemical manufacturing followed by food, beverage, and tobacco products and then computer and electronic products, as seen in Figure 2.11. Discrete technology products accounted for 39 % of U.S. manufacturing.

Domestic Specifics – Manufacturing Supply Chain Costs: High-cost supply chain industries/activities might pose as opportunities for advancing competitiveness. For discrete technology products, the largest supply chain items, based on NAICS code, include wholesale trade, primary metals, fabricated metals, management of companies and enterprises, and chemical products. For process manufacturing, the largest items were oil and gas extraction; wholesale trade; management of companies and enterprises; and miscellaneous professional, scientific, and technical services.

Domestic Specifics – Manufacturing Safety, Compensation, and Profits: As illustrated in Figure 4.5, employee compensation in manufacturing, which includes benefits, has had a five-year compound annual growth of -1.9 %. In recent years, manufacturing compensation has had a negative trend while that of private industry has had a positive trend. Compensation in manufacturing, which includes benefits, still slightly exceeds that of the total private industry; however, the difference has narrowed significantly. In terms of safety in manufacturing, injuries and the injury rate have generally trended downward since 2002, as seen in Figure 4.2 while fatalities has plateaued or even increased slightly in recent years.

For those that invest in manufacturing, corporate profits have had a five-year compound annual growth of 11.1 %, as illustrated Figure 4.7, and nonfarm proprietors’ income for manufacturing has had a five-year compound annual growth rate of 14.9 %, as illustrated in Figure 4.8.

1. Introduction

1.1. Background

Public entities have a significant role in the U.S. innovation process (Block and Keller 2016). The federal government has had a substantial impact in developing, supporting, and nurturing numerous innovations and industries, including the Internet, telecommunications, aerospace, semiconductors, computers, pharmaceuticals, and nuclear power among others, many of which may not have come to fruition without public support (Wessner and Wolff 2012). Although the Defense Advanced Research Projects Agency (DARPA), Small Business Innovation Research Program (SBIR), and Advanced Technology Program (ATP) have received attention in the scholarly community, there is generally limited awareness of the government's role in U.S. innovation. The vastness and diversity of U.S. federal research and development programs along with their changing nature make them difficult to categorize and evaluate (Block and Keller 2016), but their impact is often significant. For instance, the origins of Google are rooted in a public grant through the National Science Foundation (National Science Foundation 2004; Block and Keller 2016).One objective of public innovation is to enhance economic security and improve our quality of life (National Institute of Standards and Technology 2018), which is achieved in part by advancing efficiency in which resources are consumed or impacted by production. This includes decreasing inputs, which amount to costs, and negative externalities (e.g., environmental impacts) while increasing output, (i.e., the products produced), and the function of the product (e.g., the usefulness or quality of the product), as seen in Figure 1.1. In pursuit of this goal, the National Institute of Standards and Technology (NIST) has expended resources on a number of projects, such as support for the development of the International Standard for the Exchange of Product Model Data (STEP) (Robert D. Niehaus, Inc 2014), which reduces the need for duplicative efforts such as re-entering design data.

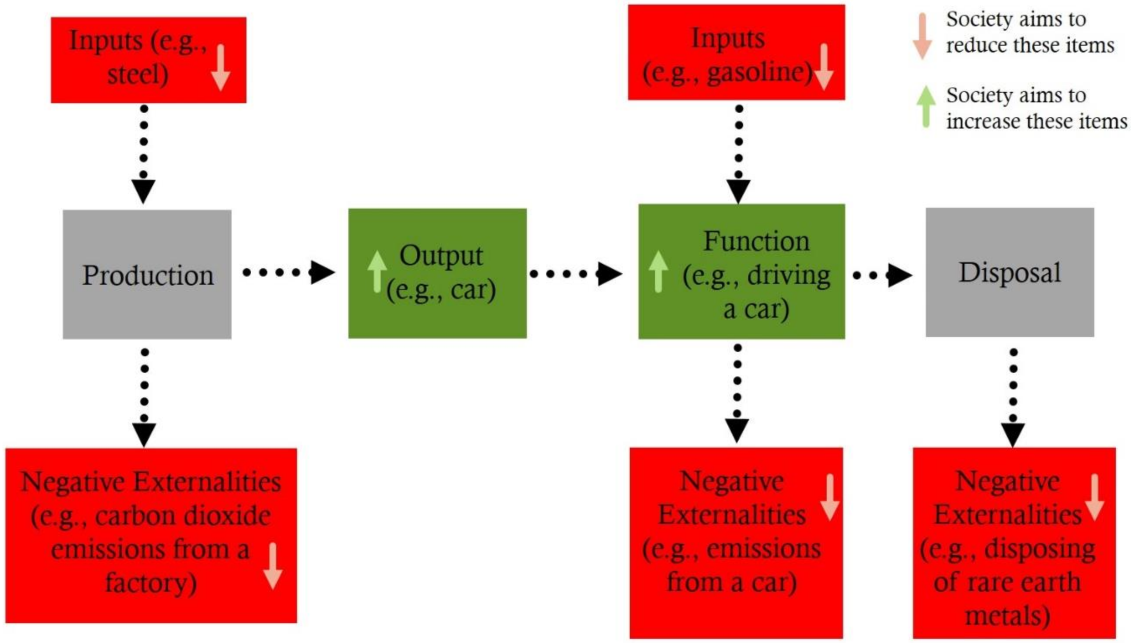


Figure 1.1: Illustration of Objectives – Drive Inputs and Negative Externalities Down while Increasing Production Output and Product Function

1.2. Purpose of this Report

The purpose of this report is to characterize U.S. innovation and industrial competitiveness in manufacturing, as it relates to the objectives illustrated in Figure 1.1. It includes tracking domestic manufacturing activity and its supply chain in order to develop a quantitative depiction of U.S. manufacturing in the context of the domestic economy and global industry. There are five aspects that encapsulate the information discussed in this report:

- **Growth and Size**: The size of the U.S. manufacturing industry and its growth rate as compared to other countries reveals the relative competitiveness of the industry.
    - ***Metrics***: Value added, value added per capita, assets, and compound annual growth

- **Productivity**: It is necessary to use resources efficiently to have a competitive manufacturing industry. Productivity is a major driver of the growth and size of the industry.
    - ***Metrics***: Labor productivity index, total factor productivity index, output per hour

- **Economic Environment**: A number of factors, including research, policies, and societal trends, can affect the productivity and size of the industry.

- *Metrics*: Research and development expenditures as a percent of GDP, journal articles per capita, researchers per capita, competitiveness indices, inflation, patents

- **Stakeholder Impact**: Owners, employees, and other stakeholders invest their resources into manufacturing with the purpose of receiving some benefit. The costs and return that they receive can drive industry productivity and growth. However, data is limited on this topic area.
    - *Metrics*: Number of employees, compensation, safety incidents, profits, exports, hours worked

- **Areas for Advancement**: It is important to identify areas of investment that have the potential to have a high return, which can facilitate productivity and growth in manufacturing.
    - *Metrics*: High-cost supply chain components, country comparison indices

Currently, this annual report discusses items related to inputs for production and outputs from production. It does not discuss negative externalities, the inputs that are used in the function of a product (e.g., gasoline for an automobile), or the function of the product; however, these items might be included in future reports.

Manufacturing metrics can be categorized by stakeholder, scale, and metric type (see Figure 1.2). Stakeholders include the individuals that have an interest in manufacturing. All the metrics in this report relate directly or indirectly to all or a selection of stakeholders. The benefits for some stakeholders are costs for other stakeholders. For

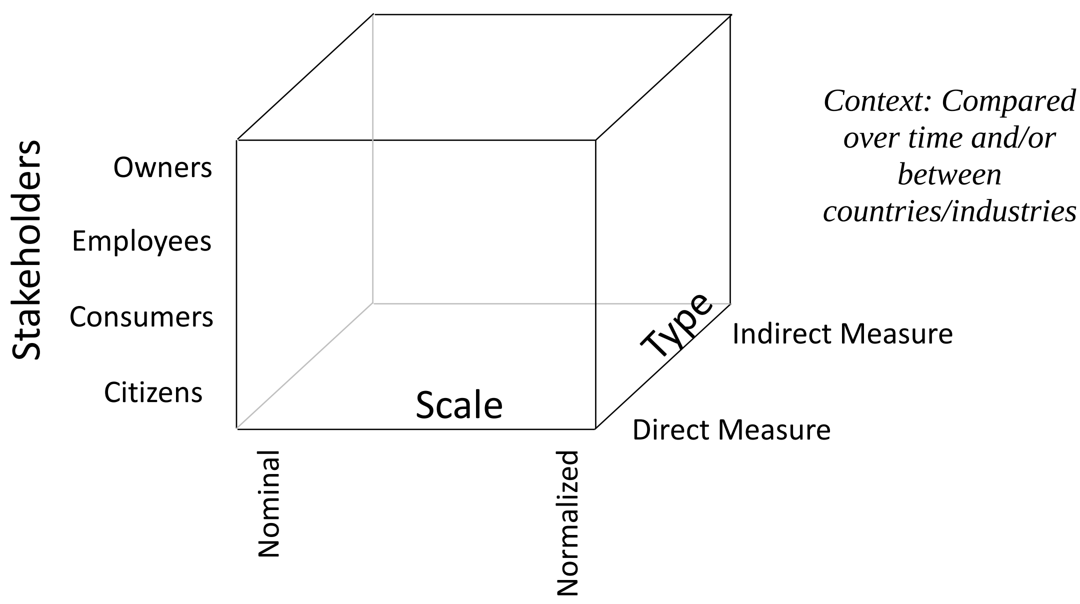


Figure 1.2: Data Categorization for Examining the Economics of Manufacturing

instance, the price of a product is a cost to the consumer but represents compensation and profit for the producers. The scale indicates whether the metric is nominal (e.g., the total U.S. manufacturing revenue) or is adjusted to a notionally common scale (e.g., revenue per capita). The metric type distinguishes whether the metric measures manufacturing activities directly (e.g., total employment) or measures those things that affect manufacturing (e.g., research and development). These metrics are then compared over time and/or between industries to provide context to U.S. manufacturing activities.

1.3. Scope and Approach

There are numerous aspects one could examine in manufacturing. This report discusses a subset of stakeholders and focuses on U.S. manufacturing. Among the many datasets available, it utilizes those that are prominent and are consistent with economic standards. These criteria are further discussed below.

Stakeholders: This report focuses on the employees and the owners/investors, as the data available facilitates examining these entities. Future work may move toward examining other stakeholders in manufacturing, such as the consumers and general public.

Geographic Scope: Many change agents are concerned with a certain group of people or organizations. Since NIST is concerned with "U.S. innovation and competitiveness," this report focuses on activities within national borders. In a world of globalization, this effort is challenging, as some of the parts and materials being used in U.S.-based manufacturing activities are imported. The imported values are a relatively small percentage of total activity, but they are important in regard to a firm's production. NIST, however, promotes U.S. innovation and industrial competitiveness; therefore, consideration of these imported goods and services are outside of the scope of this report.

Standard Data Categorization: Domestic data in the U.S. tends to be organized using NAICS codes, which are the standard used by federal statistical agencies classifying business establishments in the United States. NAICS was jointly developed by the U.S. Economic Classification Policy Committee, Statistics Canada, and Mexico's Instituto Nacional de Estadística y Geografía, and was adopted in 1997. NAICS has several major categories each with subcategories. Historic data and some organizations continue to use the predecessor of NAICS, which is the Standard Industrial Classification system (SIC). NAICS codes are categorized at varying levels of detail. The broadest level of detail is the two-digit NAICS code, which has 20 categories. More detailed data is reported as the number of digits increase; thus, three-digit NAICS provide more detail than the two-digit and the four-digit provides more detail than the three-digit. The maximum is six digits. Sometimes a two, three, four, or five-digit code is followed by zeros, which do not represent categories. They are null or place holders. For example, the code 336000 represents NAICS 336. International data tends to be in the International Standard Industrial Classification (ISIC) version 3.1, a revised United Nations system for classifying economic data. Manufacturing is broken into 23 major categories (ISIC 15 through 37), with additional subcategorization. This data categorization works similar to NAICS in that additional digits represent additional detail.

Data Sources: Thomas (2012) explores a number of data sources for examining U.S. manufacturing activity (Thomas 2012). This report selects from sources that are the most prominent and reveal the most information about the U.S. manufacturing industry. These data include the United Nations Statistics Division's National Accounts Main Aggregates Database and the U.S. Census Bureau's Annual Survey of Manufactures, among others. Because the data sources are scattered across several resources, there are differences in what yearly data is available for a particular category or topic. In each case, the most-up-to-date and available information is provided for the relevant category.

Data Limitations: Like all collections of information, the data on manufacturing has limitations. In general, there are 3 aspects to economic data of this type: 1) breadth of the data, 2) depth of the data, and 3) the timeliness of the data. The breadth of the data refers to the span of items covered, such as the number of countries and years. The depth of the data refers to the number of detailed breakouts, such as value added, expenditures, and industries. In general, breadth and depth are such that when the number of items in each are multiplied together it equals the number of observations in the dataset for a particular time period. For instance, if you have value added data on 5 industries for 20 countries for a single year, then you would have 100 observations (i.e., 5 x 20 = 100). The timeliness of the data refers to how recently the data was released. For instance, is the data 1 year old or 5 years old at release. In general, data can perform well in 2 of these 3 criteria, but it is less common to perform well on all 3 due to feasibility of data collection (see Figure 1.3). Moreover, in this report there is data that is very recent (timeliness) and spans numerous subsectors (depth), but it only represents the United States. On the other hand, there is data that spans multiple countries (breadth) and subsectors of manufacturing (depth); however, this data is from several years ago. Fortunately, industry level trends change slowly; thus, the data may not be from the most recent years, but it is still representative.

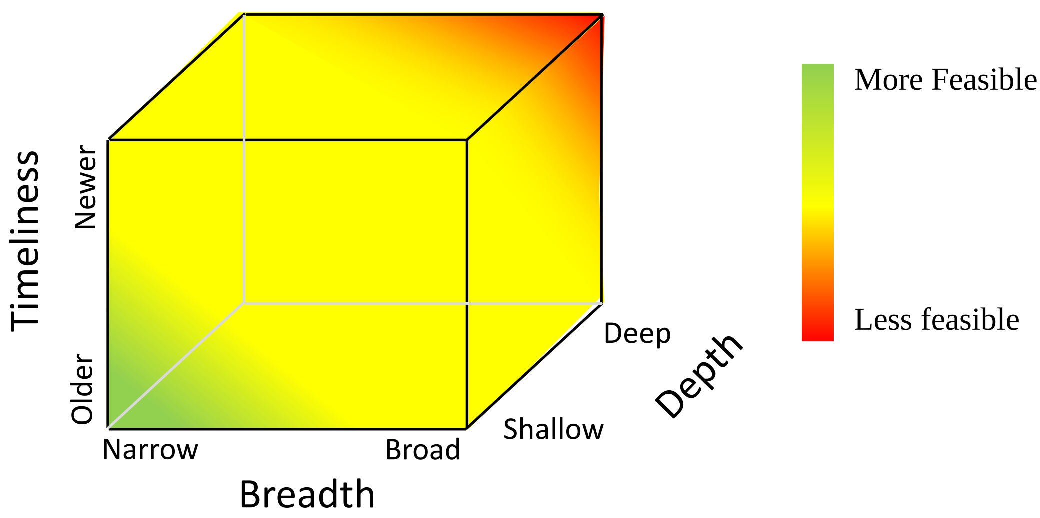


Figure 1.3: Illustration of the Feasibility of Data Collection and Availability

2. Value Added

Value added is the primary metric used to measure economic activity. It is defined as the increase in the value of output at a given stage of production; that is, it is the value of output minus the cost of inputs from other establishments (Dornbusch 2000). The primary elements that remain after subtracting inputs is taxes, compensation to employees, and gross operating surplus; thus, the sum of these also equal value added. Gross operating surplus is used to calculate profit, which is gross operating surplus less the depreciation of capital such as buildings and machinery. The sum of all value added for a country is that nation's Gross Domestic Product (GDP).

2.1. International Comparison

There are a number of sources of international estimates of value added for manufacturing. The United Nations Statistics Division National Accounts Main Aggregates Database has a wide-ranging dataset that covers a large number of countries over a significant period of time. In 2022, there was $15.0 trillion of value added (i.e., GDP) in global manufacturing in constant 2015 dollars, which is 17.5 % of the value added by all industries ($86.1 trillion), according to the United Nations Statistics Division. Since 1970, manufacturing ranged between 13.8 % and 17.5 % of global GDP. The top 10 manufacturing countries accounted for $10.7 trillion or 71.0 % of global manufacturing value added: China (31.0 %), United States (15.1 %), Japan (6.6 %), Germany (4.9 %), South Korea (3.1 %), India (3.1 %), United Kingdom (1.9 %), Italy (1.9 %), Mexico (1.8 %), and France (1.7 %) (United Nations Statistics Division 2024).

As seen in Figure 2.1, U.S. compound real (i.e., controlling for inflation) annual growth between 1997 and 2022 was 1.7 %, which places the U.S. below the 50th percentile. This growth exceeded that of Germany, France, Canada, Japan, and Australia; however, it is slower than that for the world (3.8 %) and that of many emerging economies. It is important to note that emerging economies can employ idle or underutilized resources and adopt technologies that are already proven in other nations to achieve high growth rates. Developed countries are already utilizing resources and are employing advanced technologies; thus, comparing U.S. growth to the high growth rates in China or India has limited meaning. As seen in Figure 2.2, the compound annual growth for the U.S. between 2017 and 2022 was 1.5 %. This puts the U.S. just below the 50th percentile above Canada and Germany among others but still below the world growth of 2.9 %.

As seen in Figure 2.3, among the 10 largest manufacturing nations, U.S. manufacturing value added, as measured in constant 2015 dollars, is the second largest. In current

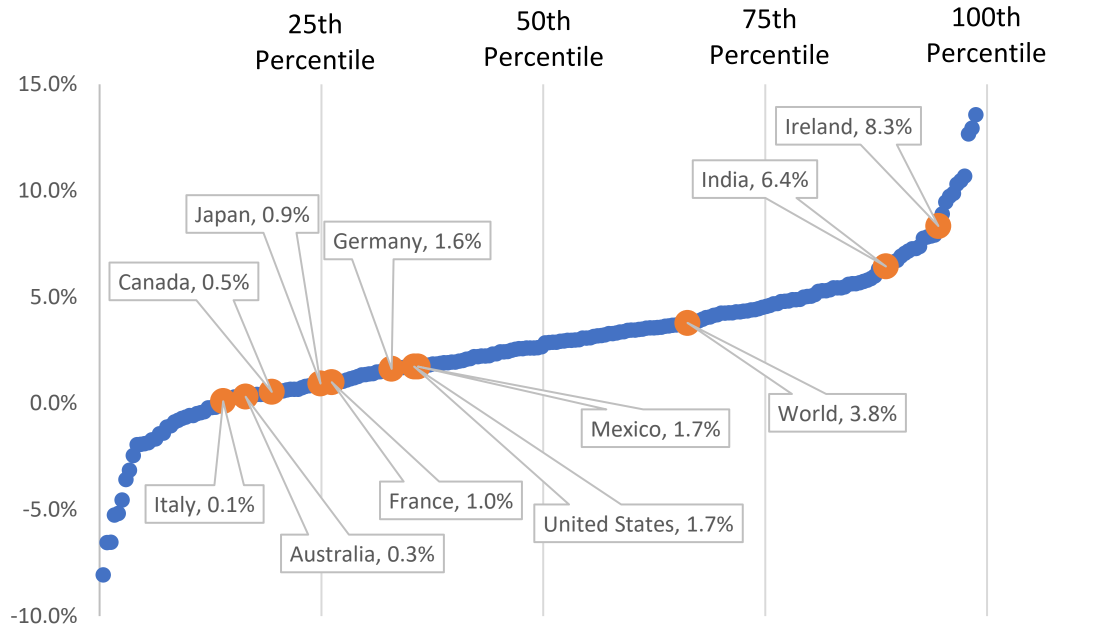


Figure 2.1: National 25-Year Compound Annual Growth, by Country (1997 to 2022): Higher is Better

Data Source: United Nations Statistics Division. (2024). "National Accounts Main Aggregates Database." http://unstats.un.org/unsd/snaama/Introduction.asp

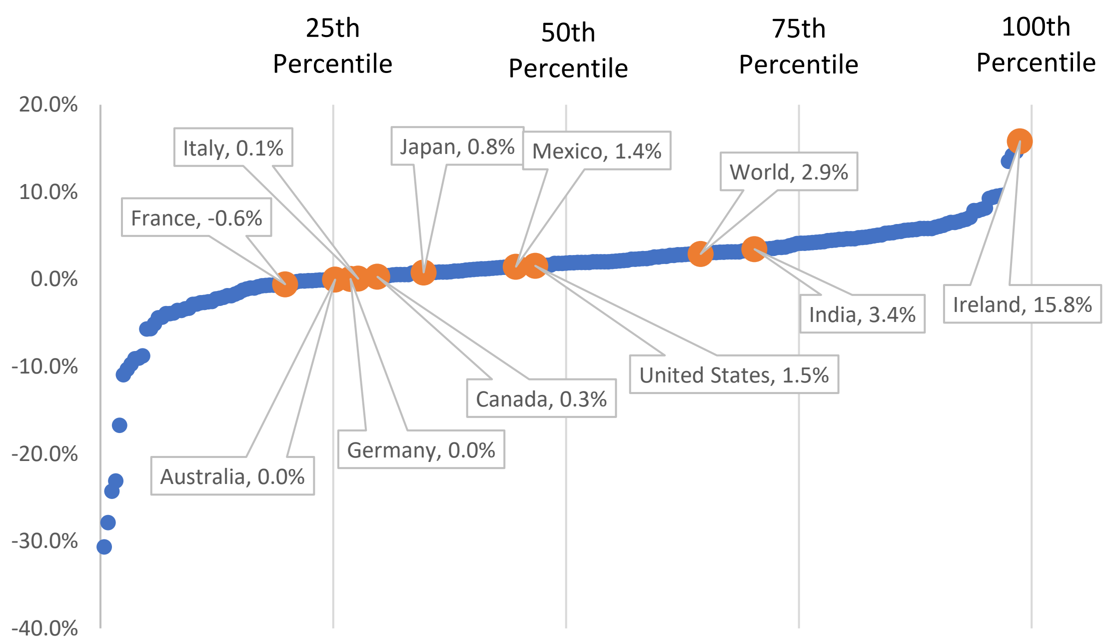
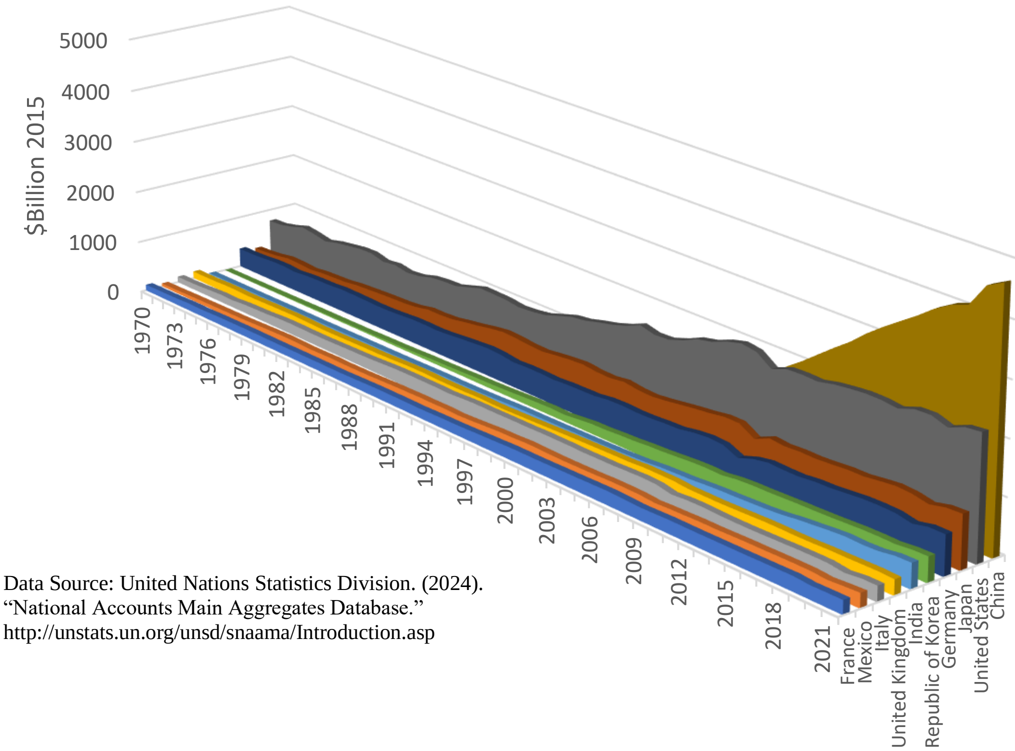


Figure 2.2: National 5-Year Compound Annual Growth, by Country (2017 to 2022): Higher is Better

Data Source: United Nations Statistics Division. (2024). "National Accounts Main Aggregates Database." http://unstats.un.org/unsd/snaama/Introduction.asp)



Data Source: United Nations Statistics Division. (2024).
"National Accounts Main Aggregates Database."
http://unstats.un.org/unsd/snaama/Introduction.asp

Figure 2.3: Manufacturing Value Added, Top 10 Manufacturing Countries (1970 to 2022)

dollars, the U.S. produced $2.6 trillion in manufacturing valued added while China produced $5.1 trillion. As illustrated in Figure 2.4, U.S. manufacturing value added was 10.7 % of national GDP in 2022. In comparison, Germany's manufacturing industry was 22.6 %, China was 28.6 %, and Japan was 22.1 % with the world average being 17.5 %. Although the U.S. is below average, this can be somewhat deceiving, as 2022 U.S. GDP per capita is significantly higher than both Japan and Germany along with most other countries, which makes the denominator disproportionally larger when calculating the proportion of the economy that manufacturing represents. Thus, a more meaningful measure might be manufacturing GDP (i.e., value added) per capita. Among the ten largest manufacturing countries, the U.S. has the 2nd largest manufacturing value added per capita, as seen in Figure 2.5. Out of all countries the U.S. ranks 16th, as seen in Figure 2.6. Since 1970, the U.S. ranking has ranged between 12th and 17th. It is important to note that there are varying means for adjusting data that can change the rankings slightly. The UNSD data uses market exchange rates while others might use purchasing power parity (PPP) exchange rates. PPP is the rate that a currency in one country would have to be converted to purchase the same goods and services in another country. The drawback of PPP is that it is difficult to measure and methodological questions have been raised about some surveys that collect

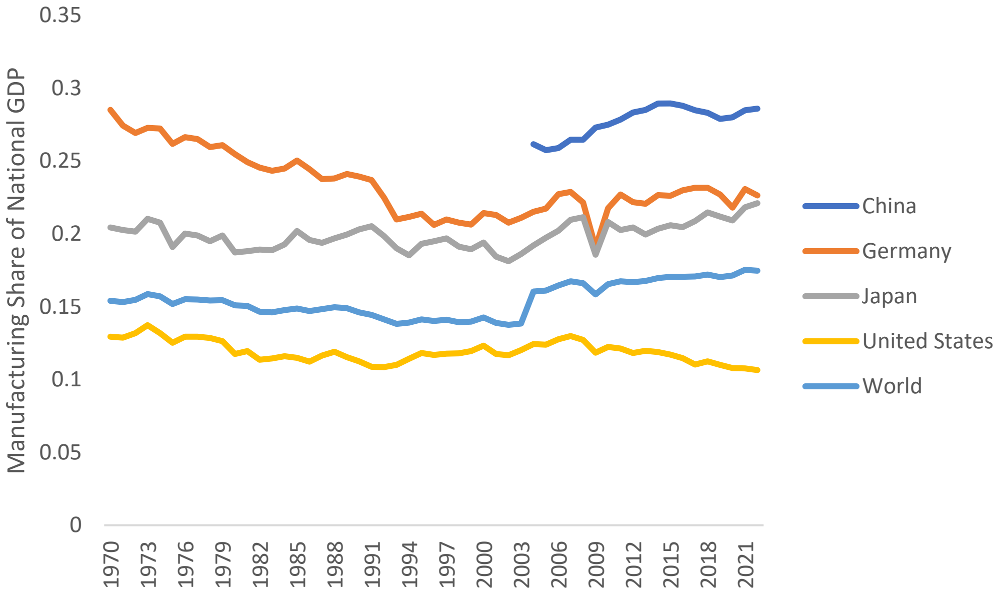
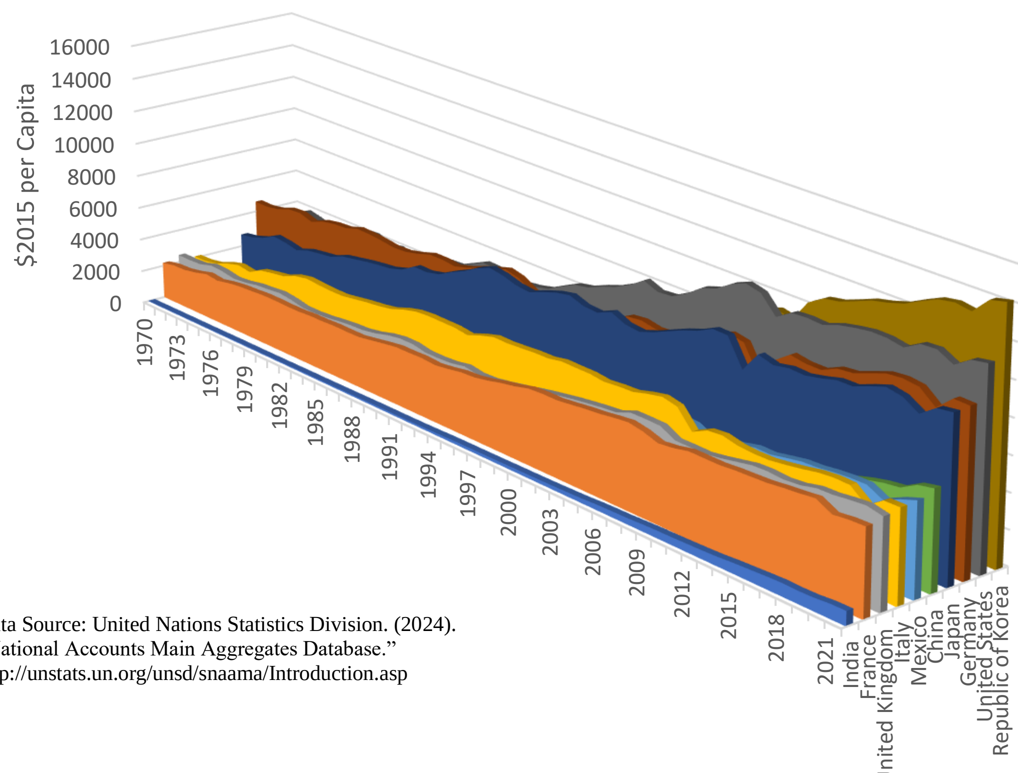


Figure 2.4: Manufacturing's Share of National GDP (Constant 2015 Dollars)

Data Source: United Nations Statistics Division. (2024). "National Accounts Main Aggregates Database." http://unstats.un.org/unsd/snaama/Introduction.asp



Data Source: United Nations Statistics Division. (2024). "National Accounts Main Aggregates Database." http://unstats.un.org/unsd/snaama/Introduction.asp

Figure 2.5: Manufacturing Value Added Per Capita, Top 10 Largest Manufacturing Countries (1970 to 2022): Higher is Better

data for these calculations (Callen 2007). Market based rates tend to be relevant for internationally traded goods (Callen 2007); therefore, this report often utilizes these rates.

In terms of subsectors of manufacturing, China produces more than the U.S. in 9 of the 11 subsectors shown in Figure 2.7. When aggregated together, U.S. and European manufacturing value added exceeds that of Eastern and South-eastern Asia (excluding Japan) for 7 of the 11 subsectors. Computer, electronic, and optical products is among those that Asia produces more value added.

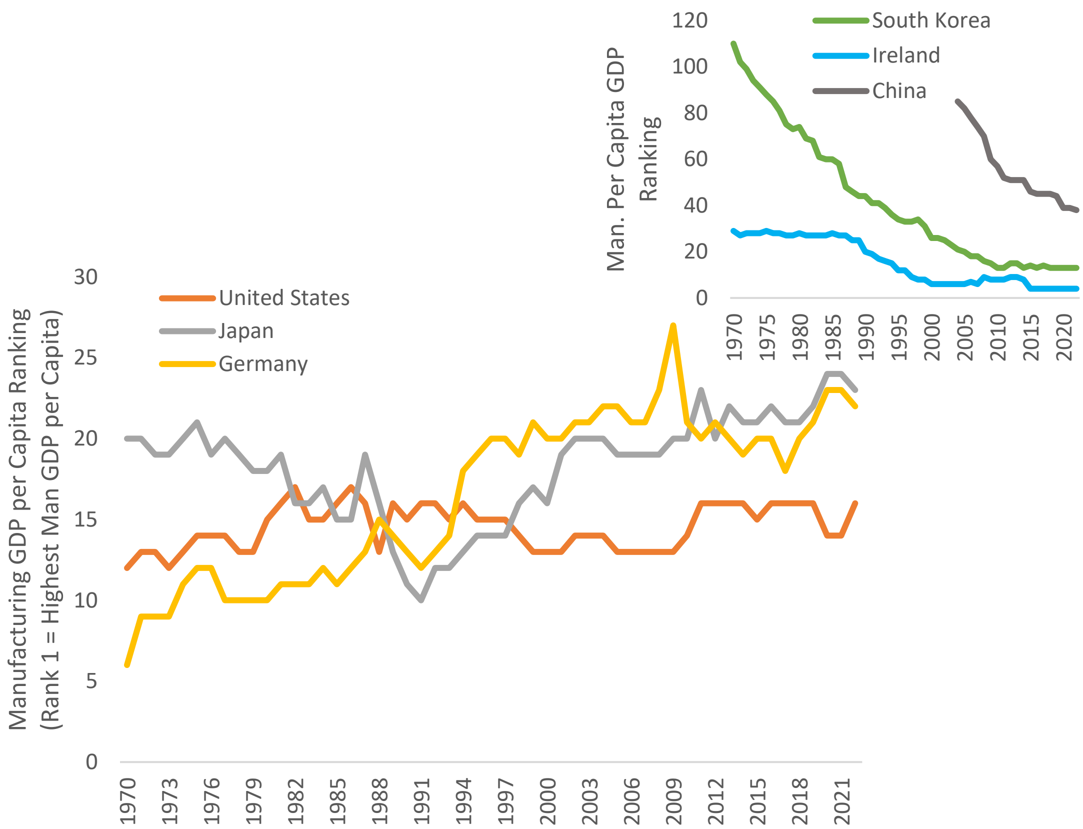


Figure 2.6: Manufacturing Per Capita Ranking, 1970-2022: Lower is Better

Data Source: United Nations Statistics Division. (2024). "National Accounts Main Aggregates Database." http://unstats.un.org/unsd/snaama/Introduction.asp

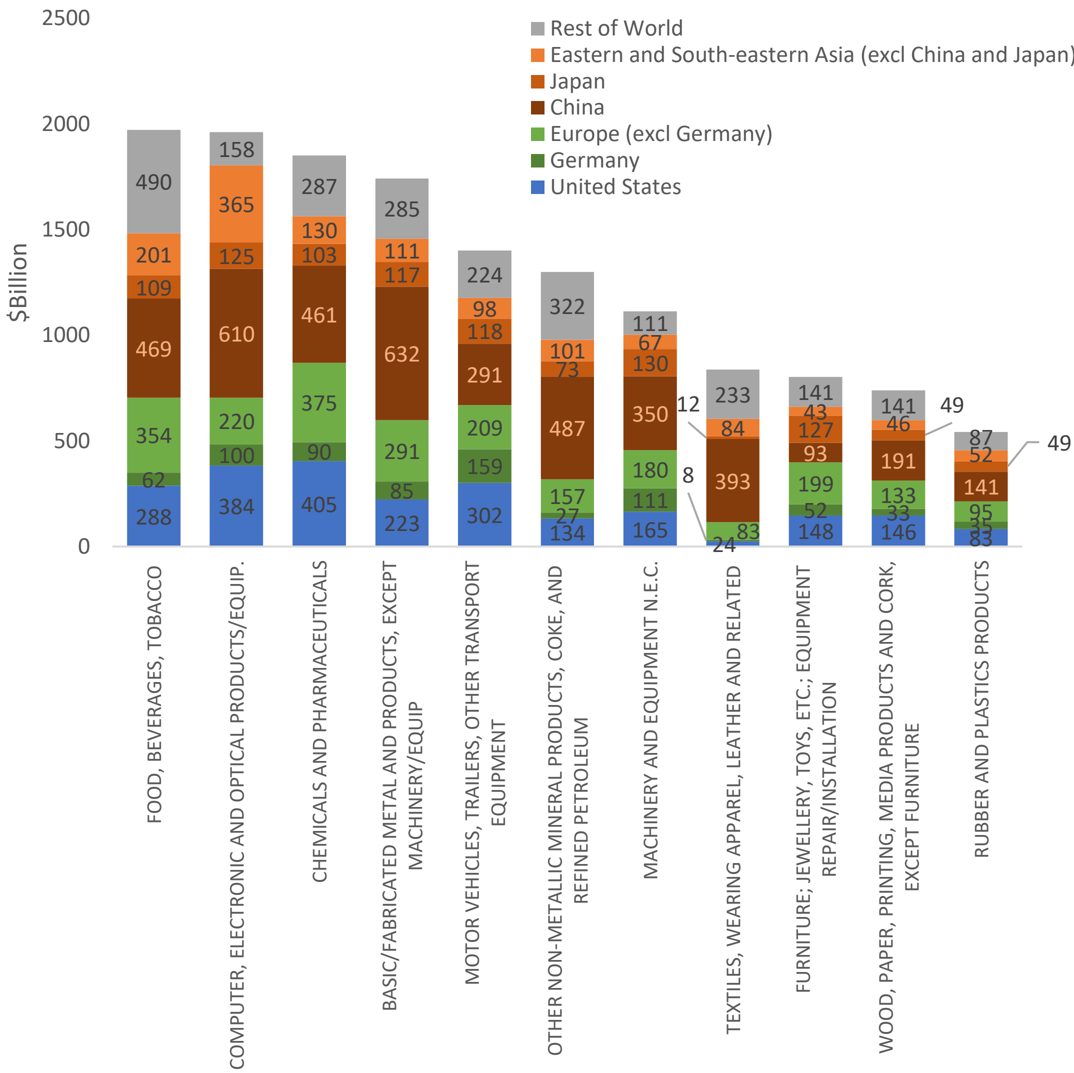


Figure 2.7: Global Manufacturing Value Added by Industry, by Country/Region (2020)

Data Source: OECD. (2024b) . Trade in Value Added (TiVA). https://www.oecd.org/en/tiva.html

2.2. Domestic Details

There are two primary methods for adjusting value added for inflation. The first is using chained dollars, which uses a changing selection of goods to adjust for inflation. The second uses an unchanging selection of goods to adjust for inflation (Dornbusch 2000). There has been some dispute about the accuracy of each for some goods. The values in this section uses chained dollars. Previous versions of this report included both; however, the differences are often minor.

Figure 2.8 shows the cumulative change in manufacturing, durable goods, and nondurable goods manufacturing from 2005 forward. As seen in the figure, U.S.

manufacturing value added dips during the financial crisis in the late 2000's and during the recent pandemic. During the 2005 to 2023 period, durable goods, which was 45.4 % higher than its 2005 value, has had more robust growth than nondurables, which is 0.7 % below its 2005 value.

Manufacturing value added in the U.S. in 2023 was $2.3 trillion in chained 2017 dollars or 10.2 % of GDP (Bureau of Economic Analysis 2024a). Using chained dollars from the BEA shows that manufacturing increased by 0.6 % between 2022 and 2023. Figure 2.9 and Figure 2.10 provide more detailed data on durable and nondurable goods within the manufacturing industry. As seen in Figure 2.9, computer and electronic products along with motor vehicles, bodies and trailers, and parts has grown 42.8 % and 61.0 %, respectively between 2013 and 2023. Primary metals also saw significant growth (59.8 %). Five of the eleven durable goods subsectors decreased in size between 2013 and 2023. As seen in Figure 2.10, in 2022 only two of eight non-durable sectors were above their 2008 value: Chemical products along with food, beverage, and tobacco products. The largest manufacturing subsector in the U.S. is chemical products followed by food, beverage, and tobacco products, as seen in Figure 2.11. Computer and electronic products is third. Note that this is based on chained dollars. Adjustments using other methods or the nominal value can have slightly different results.

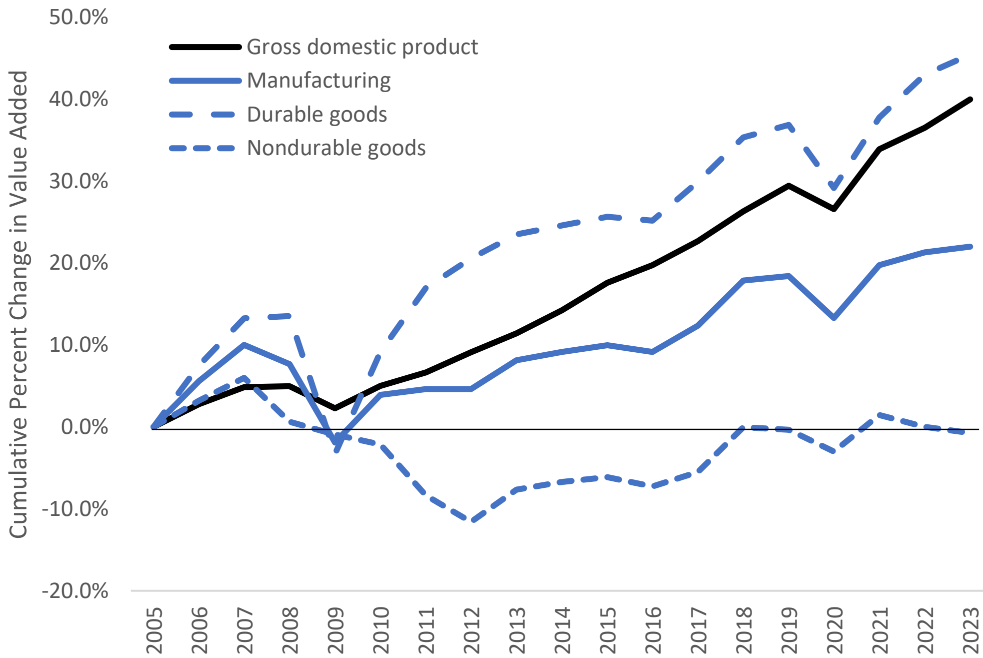
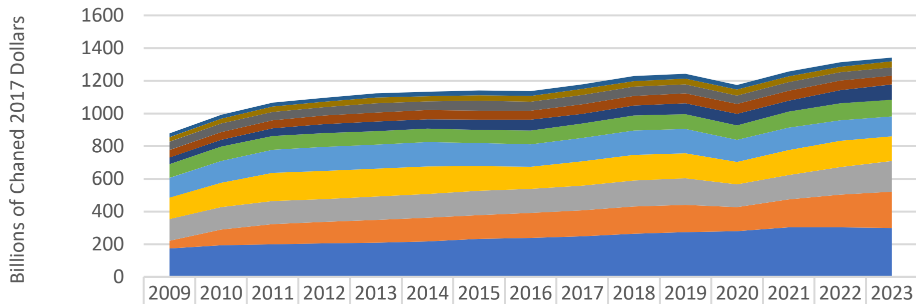


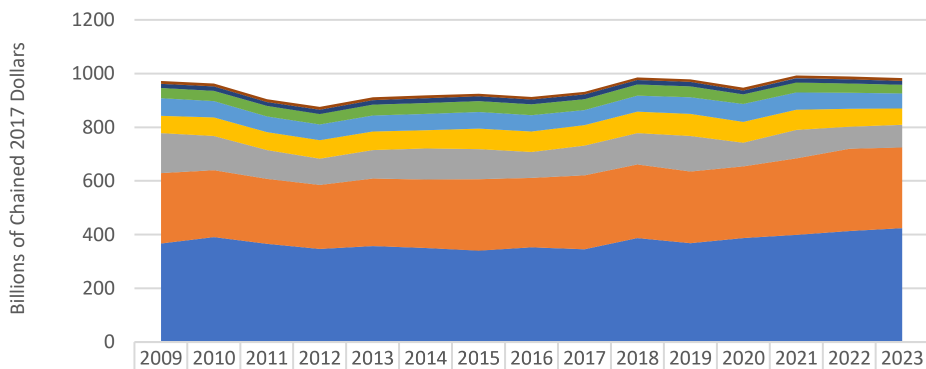
Figure 2.8: Cumulative Percent Change in Value Added (2017 Chained Dollars)
Data Source: Bureau of Economic Analysis. (2024a). "Industry Economic Accounts Data." http://www.bea.gov/iTable/index_industry_gdpIndy.cfm



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Furniture and related products	24	24	24	24	26	27	29	29	29	30	29	27	28	27	23
Wood products	28	30	33	34	34	31	34	35	36	34	35	37	36	34	37
Electrical equip, appliances, and components	51	53	51	52	57	53	60	55	58	58	55	53	53	50	51
Nonmetallic mineral products	47	48	51	53	56	57	57	55	59	58	61	59	61	60	54
Primary metals	40	41	45	54	58	57	63	67	60	60	67	72	66	81	93
Miscellaneous manufacturing	84	88	85	85	82	83	80	84	87	92	89	88	98	103	103
Fabricated metal products	121	134	142	147	147	148	142	137	145	151	149	135	137	126	122
Machinery	131	149	171	173	172	168	150	136	148	156	154	139	154	162	152
Other transportation equipment	133	137	142	140	144	146	151	148	151	159	162	138	150	168	187
Motor vehicles, bodies and trailers, and parts	47	97	123	130	139	145	145	153	159	166	167	148	170	201	223
Computer and electronic products	174	193	200	205	209	218	232	238	249	265	273	279	303	303	299

Figure 2.9: Value Added for Durable Goods by Type (billions of chained dollars), 2009-2023

Data Source: Bureau of Economic Analysis. (2024a) “Industry Economic Accounts Data.”
http://www.bea.gov/iTable/index_industry_gdpIndy.cfm



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Apparel and leather and allied products	10	11	11	11	11	10	10	10	9	9	10	10	10	11	11
Textile mills and textile product mills	16	16	15	16	17	18	18	18	17	16	16	15	16	15	14
Printing and related support activities	38	38	39	39	40	40	40	41	41	42	41	35	37	35	32
Paper products	66	61	59	59	60	61	62	61	56	60	63	68	64	60	56
Plastics and rubber products	64	68	67	69	69	69	76	77	77	80	82	77	75	66	61
Petroleum and coal products	149	127	107	98	107	115	113	97	111	116	133	88	106	82	84
Food and beverage and tobacco products	262	250	243	239	252	255	266	259	275	274	267	268	286	307	301
Chemical products	368	390	366	346	357	351	340	352	345	388	368	387	399	413	424

Figure 2.10: Value Added for Nondurable Goods by Type (billions of chained dollars), 2009-2023

Data Source: Bureau of Economic Analysis. (2024a) “Industry Economic Accounts Data.”
http://www.bea.gov/iTable/index_industry_gdpIndy.cfm

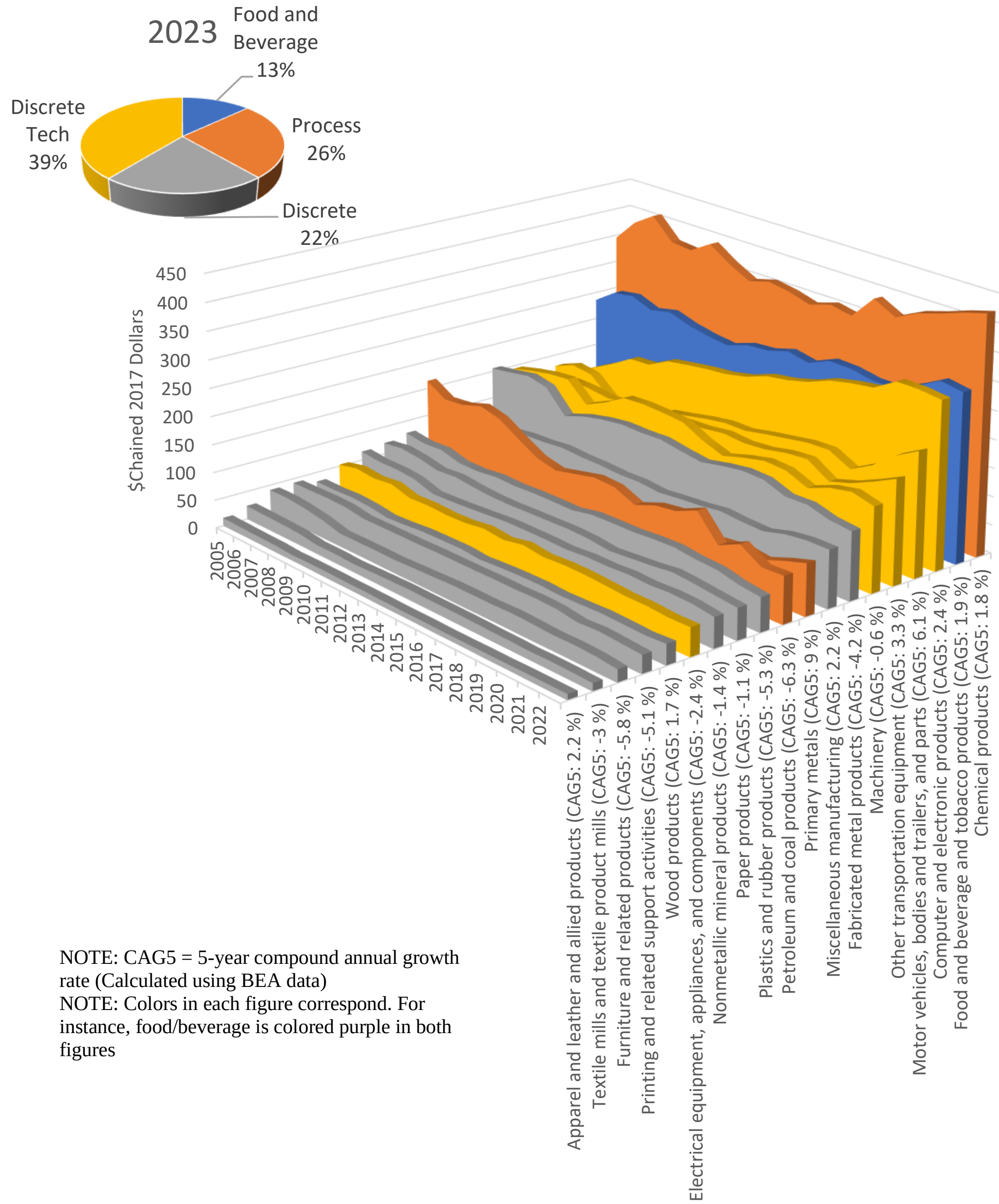


Figure 2.11: Manufacturing Value Added by Subsector (billions of chained dollars), 2005-2022

Data Source: Bureau of Economic Analysis. (2024a) "Industry Economic Accounts Data." http://www.bea.gov/iTable/index_industry_gdpIndy.cfm

In addition to examining manufacturing value added, it is useful to examine the capital stock in manufacturing, as it reflects the investment in machinery, buildings, and intellectual property in the industry (see Figure 2.12, Figure 2.13, Figure 2.14, and Figure 2.15). Discrete technology manufacturing (i.e., computer manufacturing, transportation equipment manufacturing, machinery manufacturing, and electronics manufacturing) accounts for 29 % of all manufacturing equipment and 33 % of structures. The 5-year compound annual growth in computer and electronic manufacturing equipment is 0.5 % while structures is growing at a rate of 4.5 %. Recall that computer and electronic product manufacturing is the largest durable goods manufacturing sector in the U.S., as shown in Figure 2.9. Note that for many subsectors, structures are growing at a five-year compound rate as high as 7.9 %, as seen in Figure 2.13. In terms of intellectual property, chemical products have the highest value, as seen in Figure 2.14. As of 2022, manufacturing net stock is split between intellectual property (33.3 %), structures (34.9 %), and equipment (31.8 %) somewhat evenly.

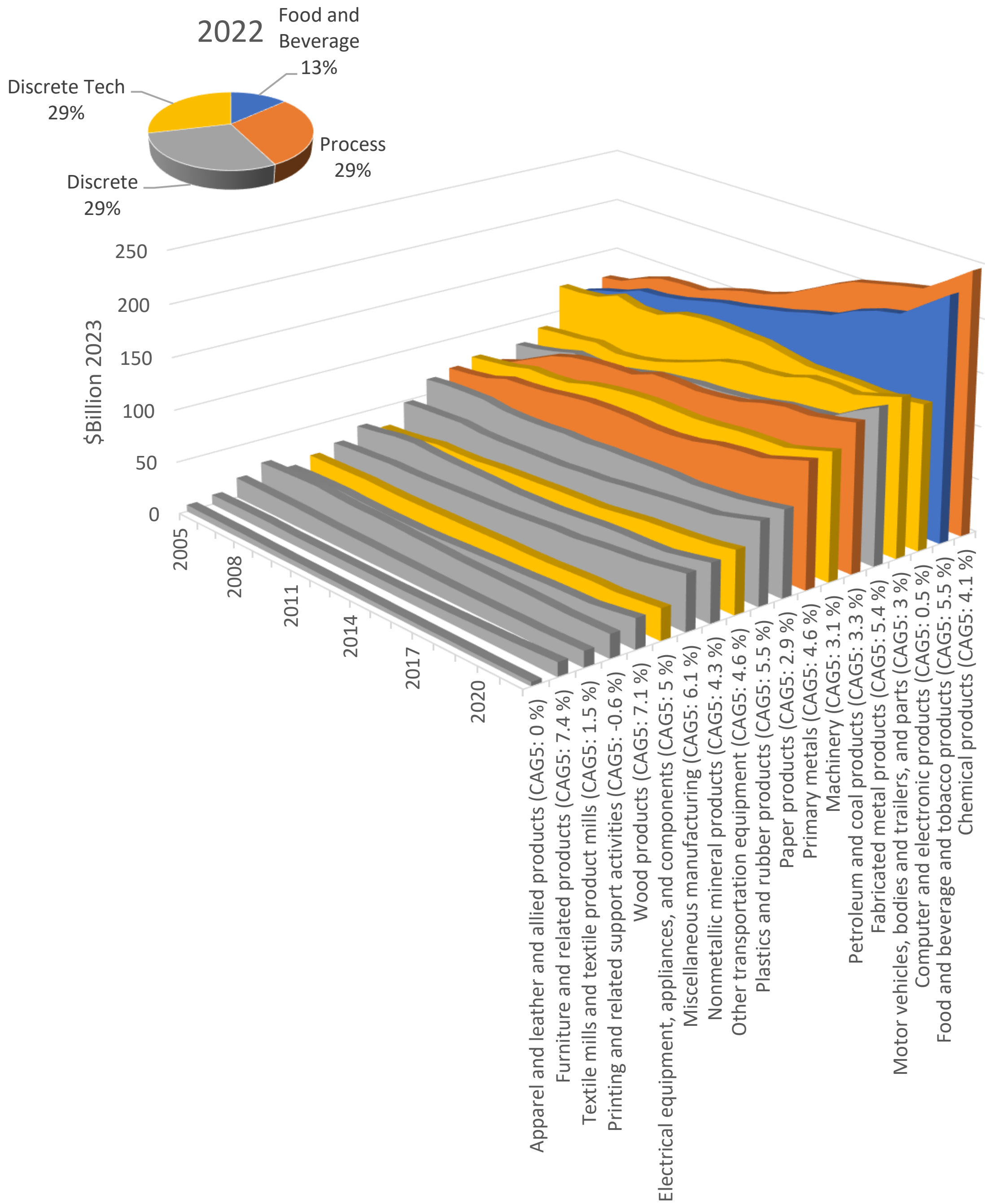


Figure 2.12: Current-Cost Net Stock: Private Equipment, Manufacturing (2005-2022)
NOTE: CAG5 = 5-year compound annual growth rate (Calculated using BEA data)
NOTE: Colors in each figure correspond. For instance, food/beverage is colored purple in both figures
Adjusted using the Consumer Price Index from the Bureau of Labor Statistics
Data Source: Bureau of Economic Analysis. (2024b) "Fixed Assets Accounts Tables."
https://apps.bea.gov/iTable/iTable.cfm?ReqID=10&step=2

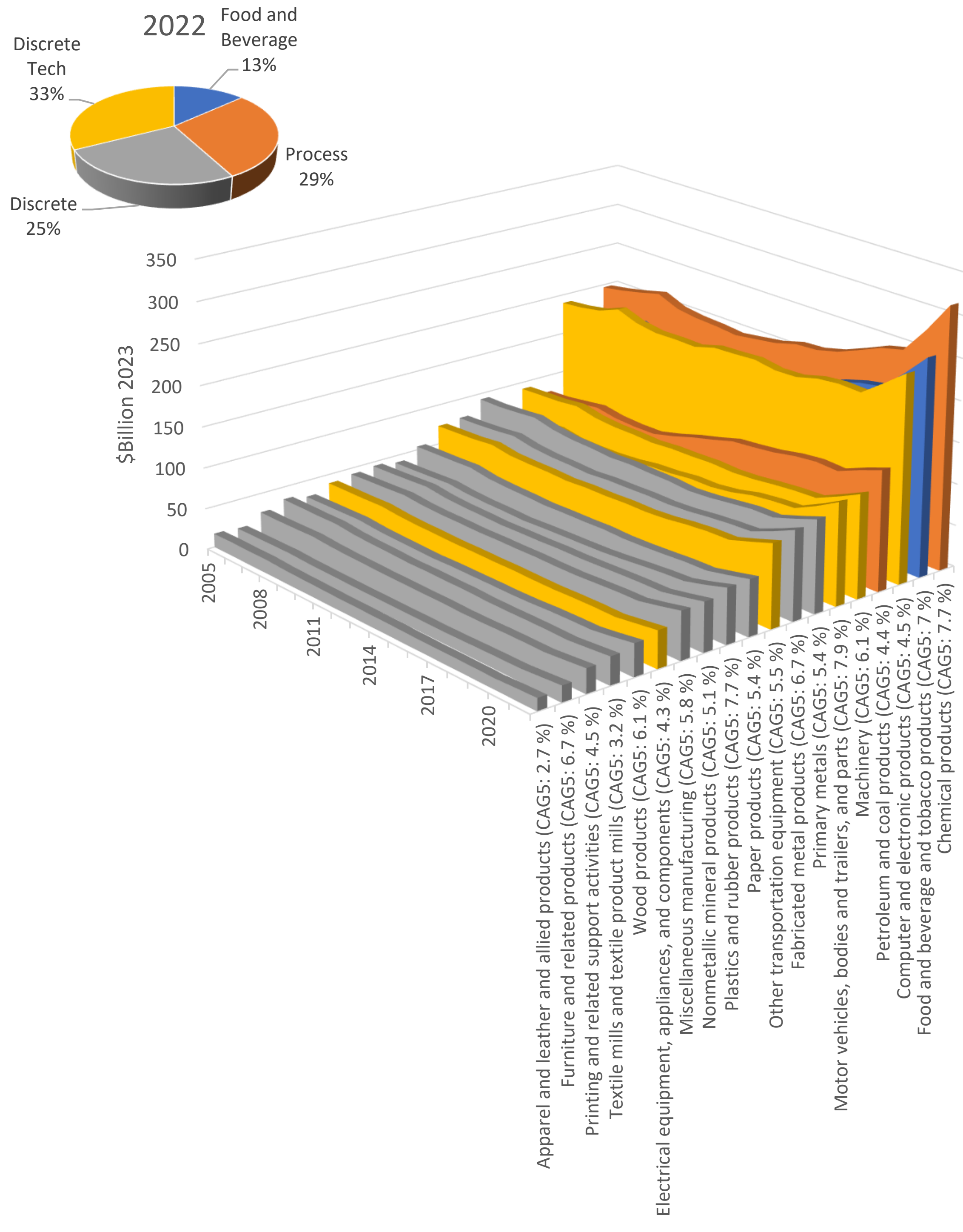


Figure 2.13: Current-Cost Net Stock: Private Structures, Manufacturing (2005-2022)

NOTE: CAG5 = 5-year compound annual growth rate (Calculated using BEA data)
NOTE: Colors in each figure correspond. For instance, food/beverage is colored purple in both figures
Adjusted using the Consumer Price Index from the Bureau of Labor Statistics
Data Source: Bureau of Economic Analysis. (2024b) “Fixed Assets Accounts Tables.” https://apps.bea.gov/iTable/iTable.cfm?ReqID=10&step=2

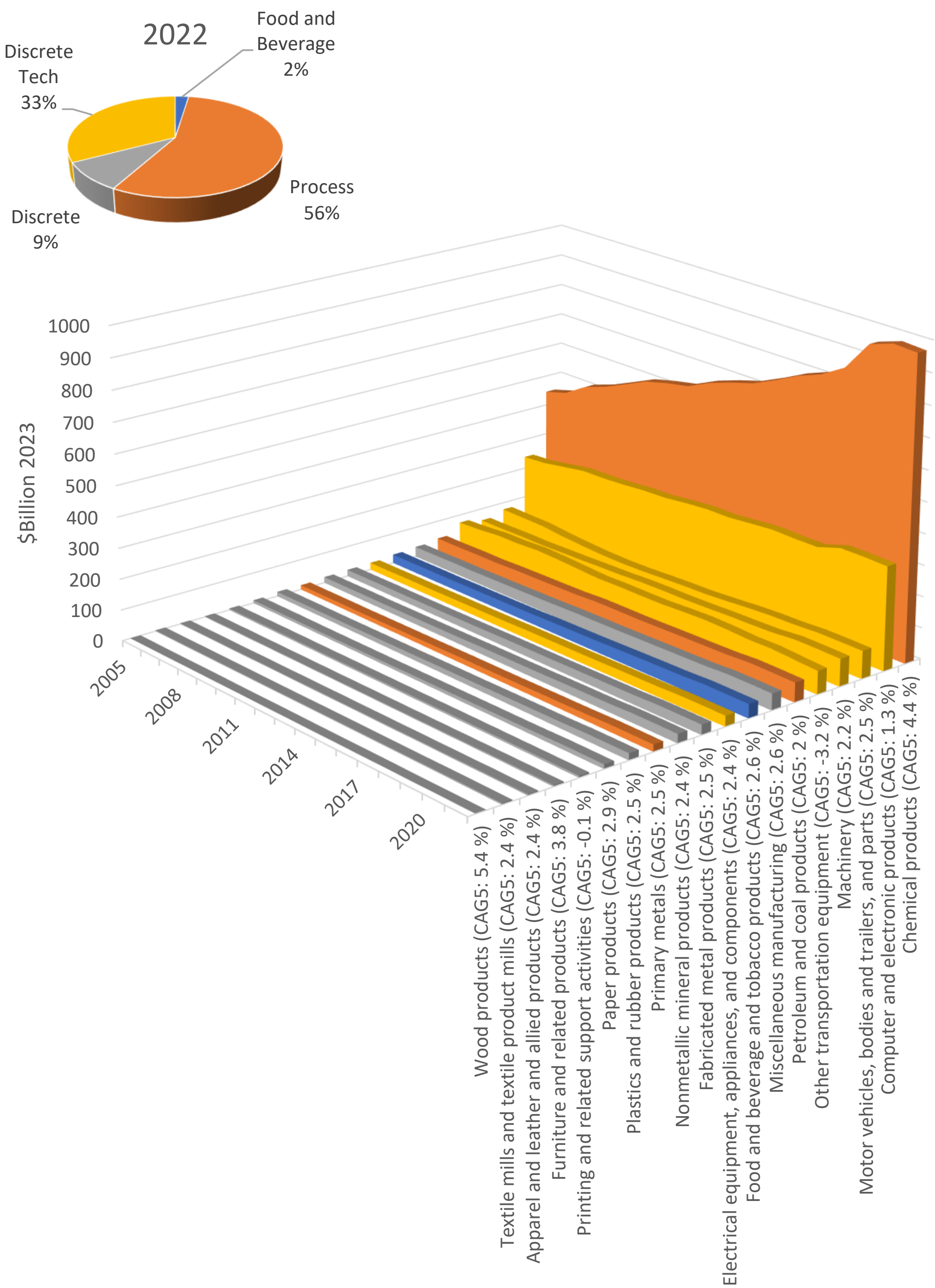


Figure 2.14: Current-Cost Net Stock: Intellectual Property Products, Manufacturing (2005-2022)

NOTE: CAG5 = 5-year compound annual growth rate (Calculated using BEA data)
NOTE: Colors in each figure correspond. For instance, food/beverage is colored blue in both figures
Adjusted using the Consumer Price Index from the Bureau of Labor Statistics
Data Source: Bureau of Economic Analysis. (2024b) “Fixed Assets Accounts Tables.” https://apps.bea.gov/iTable/iTable.cfm?ReqID=10&step=2

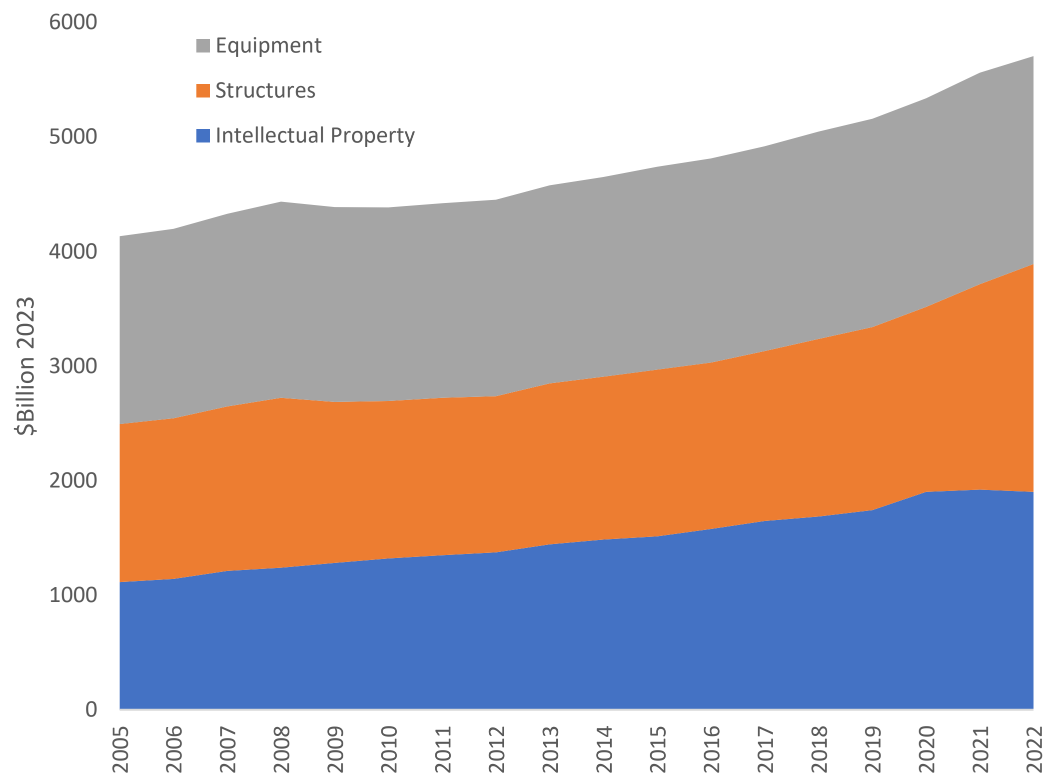


Figure 2.15: Current-Cost Net Stock in Manufacturing, by Type (2005-2022)

Adjusted using the Consumer Price Index from the Bureau of Labor Statistics
Data Source: Bureau of Economic Analysis. (2024b) “Fixed Assets Accounts Tables.” https://apps.bea.gov/iTable/iTable.cfm?ReqID=10&step=2

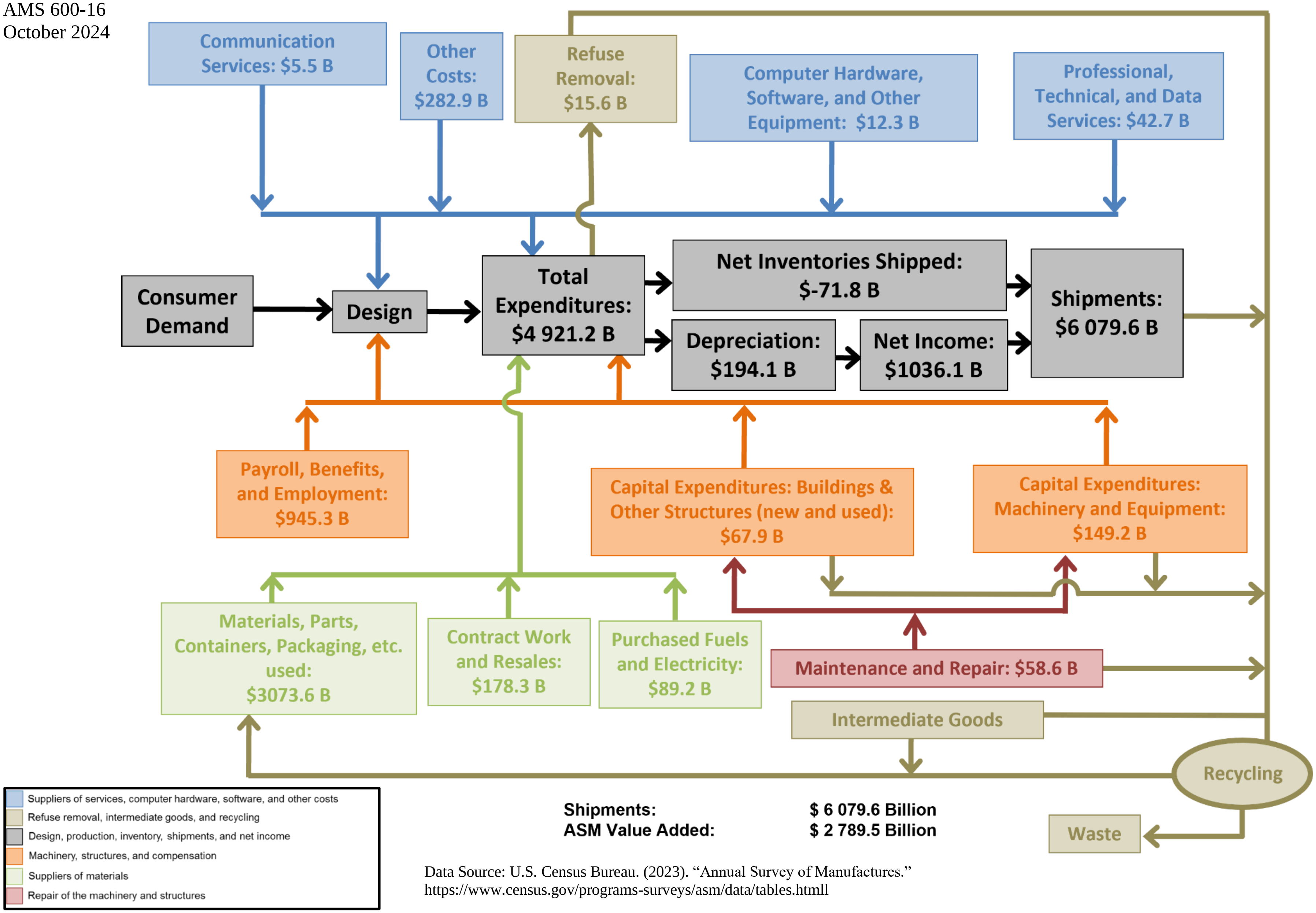
3. US Manufacturing Supply Chain

There are many suppliers of goods and services that have a stake in manufacturing; these include resellers, providers of transportation and warehousing, raw material suppliers, suppliers of intermediate goods, and suppliers of professional services. Using data from the Annual Survey of Manufactures (U.S. Census Bureau 2023), Table 3.1 presents and Figure 3.1 maps the purchases that the manufacturing industry made for production, which is

Table 3.1: Supply Chain Entities and Contributions, Annual Survey of Manufactures, 2021

	2021 ($Billions 2021)
I. Services, Computer Hardware, Software, and Other Expenditures	
a. Communication Services	5.5
b. Computer Hardware, Software, and Other Equipment	12.3
c. Professional, Technical, and Data Services	42.7
d. Other Expenditures	282.9
e. TOTAL	**343.4**
II. Refuse Removal Expenditures	**15.6**
III. Machinery, Structures, and Compensation Expenditures	
a. Payroll, Benefits, and Employment	945.3
b. Capital Expenditures: Structures (including rental)	67.9
c. Capital Expenditures: Machinery/Equipment (including rental)	149.2
d. TOTAL	**1162.4**
IV. Suppliers of Materials Expenditures	
a. Materials, Parts, Containers, Packaging, etc… Used	3073.6
b. Contract Work and Resales	178.3
c. Purchased Fuels and Electricity	89.2
d. TOTAL	**3341.2**
V. Maintenance and Repair Expenditures	**58.6**
VI. Shipments	
a. Expenditures	4921.2
b. Net Inventories Shipped	-71.8
c. Depreciation	194.1
d. Net Income	1036.1
E. TOTAL	**6079.6**
VII. Value Added estimates	
a. Value added calculated VI.E-VI.b-VI.A+III.a	2175.6
b. ASM Value added	2789.5
c. BEA value added	2496.8

Note: Colors correspond with those in Figure 3.1
Source: U.S. Census Bureau. (2023). "Annual Survey of Manufactures." https://www.census.gov/programs-surveys/asm.html



Data Source: U.S. Census Bureau. (2023). "Annual Survey of Manufactures." https://www.census.gov/programs-surveys/asm/data/tables.htmll

Figure 3.1: Manufacturing Supply Chain, 2021

disaggregated into five categories: suppliers of services, computer hardware, software, and other costs (blue); refuse removal (gold); machinery, structures, and compensation (orange); repair of the machinery and structures (red); and suppliers of materials (green). These items all feed into the design and production of manufactured goods which are inventoried and/or shipped (gray). The depreciation of capital and net income is also included in Figure 3.1, which affects the market value of shipments. In addition to the stakeholders, there are also public vested interests, the end users, and financial service providers to be considered.

Direct and Indirect Manufacturing: As previously mentioned, to achieve economy-wide efficiency improvements, researchers have suggested that “the supply chain must become the focus of policy management, in contrast to the traditional emphasis on single technologies/industries” (Tassey 2010). As seen in Table 3.2, there is an estimated $2425 billion in manufacturing value added with an additional $1975 billion in indirect value added from other industries for manufacturing, as calculated using input-output analysis.[1] Direct and indirect manufacturing accounts for 17.1 % of total GDP.

In 2022, the U.S. imported approximately 20.6 % of its intermediate goods, as seen in Table 3.3. As a proportion of output and imports (i.e., a proportion of the total inputs), intermediate imports represented 13.4 %. As can be seen in Table 3.3, these proportions

Table 3.2: Direct and Indirect Manufacturing Value Added, 2022 ($Billion)

		Value Added			
Description	NAICS	Direct	Indirect	Total	Indirect as % of Total GDP
Total U.S. GDP		-	-	25 744.1	-
Total Manufacturing*	31-33	2 424.5	1 975.2	4 399.7	17.1%
Discrete Technology Products	333-336	307.4	639.7	947.1	3.7%
Discrete Products	313-323, 327-332, 337-339	714.5	972.1	1 686.6	6.6%
Process Products	324-326	631.5	735.4	1 366.8	5.3%
Food, Beverage, and Tabaco	311-312	771.1	659.8	1 431.0	5.6%

* The sum of the 3 digit NAICS does not equal total manufacturing due to overlap in supply chains.

Data Source: BEA. (2024c). Input-Output Accounts Data. https://www.bea.gov/industry/input-output-accounts-data
Note: These values are calculated by using the Excel solver to estimate final demand for each set of NAICS codes such that the total requirements table multiplied by the final demand estimate equals the industry output. All other industries are set to zero in the final demand.

[1] These values are calculated by using the Excel solver to estimate final demand for each set of NAICS codes such that the total requirements table multiplied by the final demand estimate equals the industry output. All other industries are set to zero in the final demand.

Table 3.3: Imported Intermediate Manufacturing ($millions)

Year	Intermediate Manufacturing*	Intermediate Imports for Manufacturing**	Total Manufacturing Output	Intermediate Imports as a Percent of Intermediates	Intermediate imports as a Percent of Total Industry Output
2007	3 511 210	732 632	5 217 713	20.9%	14.0%
2012	3 812 996	838 198	5 577 343	22.0%	15.0%
2017	3 523 048	680 102	5 456 958	19.3%	12.5%
2022	4 485 746	926 053	6 910 279	20.6%	13.4%

Source Data: Bureau of Economic Analysis. (2024c). Input-Output Accounts Data. https://www.bea.gov/industry/input-output-accounts-data
* Commodities used by industries
** From the import matrix

have not changed dramatically in recent years. As seen in Table 3.4, Canada is the primary source of imported supply chain items for the U.S. with China being second.

Some of the costs of production are caused by losses due to waste or defects. Unfortunately, there is limited data and information on these losses. The research that does exist is often case studies within various industries and countries, which provide only limited insight to U.S. national trends. Tabikh estimates from survey data in Sweden that the percent of planned production time that is downtime amounts to 13.3 % (Tabikh 2014). According to NIST's Manufacturing Cost Guide, downtime amounts to 8.3 % of planned production time and amounts to $245 billion for discrete manufacturing (i.e., NAICS 321-339 excluding NAICS 324 and 325)(Thomas 2020). In addition to downtime, defects result in additional losses. The Manufacturing Cost Guide estimates that defects amount to between $32.0 billion and $58.6 billion for discrete manufacturing (i.e., NAICS 321-339 excluding NAICS 324 and 325), depending on the method used for estimation (Thomas 2020).

The USGS estimates that 15 % of steel mill products end up as scrap in the manufacturing process (Fenton 2001). Other sources cite that at least 25 % of liquid steel and 40 % of liquid aluminum does not make it into a finished product due primarily to metal quality (25 % of steel loss and 40 % of aluminum loss), the shape produced[2] (10 % to 15 % of loss), and defects in the manufacturing processes (5 % of loss) (Allwood 2012). Material losses mean there is the possibility of producing the same goods using less material, which could have rippling effects up and down the supply chain. There would be reductions in the burden of transportation, material handling, machinery, inventory costs, and energy use along with many other activities associated with handling and altering materials.

Another source of losses can be found in cybercrime where criminals can disrupt production and/or steal intellectual property. The Manufacturing Cost Guide estimates that manufacturers lost between $8.9 billion and $38.6 billion due to cybercrime.

[2] The steel and aluminum industry often produce standard shapes rather than customized shapes tailored to specific products. This results in needing to cut away some portion of material, which ends up as scrap.

Table 3.4: Percent of U.S. Manufacturing Industry Supply Chain, by Country of Origin (2014)

Country	US Manufacturing Supply Chain (percent)
USA	83.0
CAN	3.1
CHN	1.8
MEX	1.5
DEU	0.8
JPN	0.8
GBR	0.5
KOR	0.5
RUS	0.4
ROW	7.6

Data Source: Thomas, Douglas. (2020). Manufacturing Cost Guide. https://www.nist.gov/services-resources/software/manufacturing-cost-guide

Manufacturing costs also accumulate in assets such as buildings, machinery, and inventory. In addition to the estimates provided in Figure 2.12, Figure 2.13, Figure 2.14, and Figure 2.15, data on assets is published periodically in the Economic Census. As seen in Table 3.5, total depreciable assets amount to $3.4 trillion with $2.7 trillion being machinery and equipment. The adoption of new technologies often requires new assets (e.g., machinery). During the 2017 year, 4.9 % of depreciable assets were new with an overall growth of 3.2 % after accounting for retirements. This rate provides some insight into the rate of change for assets.

Table 3.5: Depreciable Assets and the Rate of Change, 2017 ($million 2017)

		Buildings and Structures	Machinery and Equipment	Total
A	Gross value of depreciable assets (acquisition costs), beginning of year	661 841*	2 645 636*	3 307 476
B	Capital Expenditures (added to assets)	33 705	134 733	168 438
C	Retirements (subtracted from assets)	11 597*	46 358*	57 955
D	Gross value of depreciable assets (acquisition costs, end of year) [A + B - C]	683 949	2 734 011	3 417 960
E	Percent of depreciable assets that are new (end of year) [B/D]			4.9%

* Assumes that the proportions of buildings and structures or machinery and equipment are the same as that for capital expenditures.

Data Source: U.S. Census Bureau. (2020) 2017 Economic Census. EC1731BASIC: Manufacturing Summary Statistics. https://www.census.gov/data/tables/2017/econ/economic-census/naics-sector-31-33.html

A frequently invoked axiom suggests that roughly 80 % of a problem is due to 20 % of the cause, a phenomenon referred to as the Pareto principle (Hopp and Spearman 2008). That is, a small portion of the cause accounts for a large portion of the problem. Joseph Juran proposed that the Pareto principle could be applied to an organization's operations (Six Sigma Daily 2018). For instance, 80 % of defects would be the result of 20 % of the causes. Identifying that small portion of the cause (i.e., the 20 %) can facilitate making large efficiency improvements in operations. Manufacturing industry NAICS codes are categories of production activities. A larger industry (i.e., one in the top 20 %) suggests that there is more of a particular type of activity and/or the activities are more costly; thus, an increase in productivity in a larger industry would either reduce a costly activity or reduce an activity that occurs at high frequency. The result is a greater impact than might otherwise be achieved. Additionally, statistical evidence suggests that a dollar of research and development in a large cost supply chain entity has a higher return on investment than a small cost one (Thomas 2018). Table 3.6, Table 3.7, and Table 3.8 provide the supply chain items for all of U.S. manufacturing, U.S. high tech manufacturing, and U.S. process manufacturing, respectively. For all of manufacturing, professional and business services is the largest contributor to manufacturing, excluding manufacturing itself. Mining is the second largest and wholesale trade is third. The high-tech manufacturing industries are greyed out in Table 3.7 while the process industries are greyed out in Table 3.8. Excluding the greyed-out items, wholesale trade is the largest supply chain item for high tech manufacturing while oil and gas extraction is that for process manufacturing.

Table 3.6: Domestic U.S. Manufacturing Supply Chain, 2022 Value Added

Description	$Billion	% of Total
Manufacturing	2424.5	55.1%
Professional and business services	356.9	8.1%
Mining	355.4	8.1%
Wholesale trade	337.4	7.7%
Finance, insurance, real estate, rental, and leasing	264.3	6.0%
Agriculture, forestry, fishing, and hunting	207.5	4.7%
Transportation and warehousing	173.0	3.9%
Utilities	69.2	1.6%
Government	62.8	1.4%
Information	61.2	1.4%
Other services, except government	24.1	0.5%
Construction	23.4	0.5%
Arts, entertainment, recreation, accommodation, and food services	21.1	0.5%
Retail trade	18.3	0.4%
Educational services, health care, and social assistance	0.5	0.0%
TOTAL	4399.7	100.0%

Data Source: Bureau of Economic Analysis. (2024c). Input-Output Accounts Data. https://www.bea.gov/industry/input-output-accounts-data
Note: Calculated using methods described in Table 3.2; however, the BEA industry-by-commodity after redefinitions input-output data with 15 total industries was used.

Table 3.7: 2022 Domestic Supply Chain Entities for Discrete High-Tech Manufacturing (NAICS 333-336), Value Added (VA) ($Billion)

NAICS	Description	VA	% of Total			VA	% of Total
334	*Computer and electronic products*	*246.2*	*17.2%*	482	Rail transportation	4.6	0.3%
333	*Machinery*	*167.2*	*11.7%*	339	Miscellaneous manufacturing	4.1	0.3%
3364OT	*Other transportation equipment*	*155.7*	*10.9%*	GSLE	State and local government enterprises	3.8	0.3%
3361MV	*Motor vehicles, bodies and trailers, and parts*	*143.6*	*10.0%*	324	Petroleum and coal products	3.5	0.2%
42	Wholesale trade	122.0	8.5%	722	Food services and drinking places	3.5	0.2%
331	Primary metals	73.7	5.2%	GFE	Federal government enterprises	2.9	0.2%
335	*Electrical equipment, appliances, and components*	*58.5*	*4.1%*	313TT	Textile mills and textile product mills	2.8	0.2%
332	Fabricated metal products	46.6	3.3%	4A0	Other retail	2.6	0.2%
55	Management of companies and enterprises	34.5	2.4%	562	Waste management and remediation services	2.4	0.2%
325	Chemical products	33.7	2.4%	511	Publishing, except internet (includes software)	2.3	0.2%
5412OP	Misc.professional, scientific, and technical services	32.3	2.3%	481	Air transportation	2.2	0.2%
561	Administrative and support services	27.7	1.9%	113FF	Forestry, fishing, and related activities	1.9	0.1%
521CI	Federal Reserve banks, credit intermediation, and related	19.6	1.4%	721	Accommodation	1.7	0.1%
524	Insurance carriers and related activities	17.9	1.3%	711AS	Performing arts, sports, museums, and related	1.6	0.1%
484	Truck transportation	17.5	1.2%	111CA	Farms	1.5	0.1%
326	Plastics and rubber products	17.0	1.2%	323	Printing and related support activities	1.3	0.1%
22	Utilities	16.9	1.2%	486	Pipeline transportation	0.9	0.1%
532RL	Rental/leasing services and lessors of intangible assets	15.8	1.1%	315AL	Apparel and leather and allied products	0.9	0.1%
ORE	Other real estate	15.4	1.1%	311FT	Food and beverage and tobacco products	0.8	0.1%
514	Data processing and other information services	9.4	0.7%	213	Support activities for mining	0.8	0.1%
487OS	Other transportation and support activities	9.3	0.6%	485	Transit and ground passenger transportation	0.8	0.1%
5415	Computer systems design and related services	8.9	0.6%	512	Motion picture and sound recording industries	0.6	0.0%
327	Nonmetallic mineral products	8.3	0.6%	483	Water transportation	0.4	0.0%
81	Other services, except government	8.3	0.6%	337	Furniture and related products	0.4	0.0%
5411	Legal services	8.0	0.6%	713	Amusements, gambling, and recreation industries	0.4	0.0%
322	Paper products	7.6	0.5%	452	General merchandise stores	0.3	0.0%
212	Mining, except oil and gas	7.4	0.5%	61	Educational services	0.1	0.0%
211	Oil and gas extraction	7.0	0.5%	623	Nursing and residential care facilities	0.0	0.0%
523	Securities, commodity contracts, and investments	6.5	0.5%	445	Food and beverage stores	0.0	0.0%
23	Construction	6.2	0.4%	621	Ambulatory health care services	0.0	0.0%
GFGN	Federal general government (nondefense)	5.9	0.4%	525	Funds, trusts, and other financial vehicles	0.0	0.0%
513	Broadcasting and telecommunications	5.7	0.4%	624	Social assistance	0.0	0.0%
493	Warehousing and storage	5.4	0.4%	622	Hospitals	0.0	0.0%
321	Wood products	5.4	0.4%	HS	Housing	0.0	0.0%
GSLG	State and local general government	5.3	0.4%	GFGD	Federal general government (defense)	0.0	0.0%
441	Motor vehicle and parts dealers	4.8	0.3%				

Note: Calculated using methods described in Table 3.2.
Data Source: Bureau of Economic Analysis. (2024c). Input-Output Accounts Data. https://www.bea.gov/industry/input-output-accounts-data

Table 3.8: 2022 Domestic Supply Chain Entities for Process Manufacturing (NAICS 331, 324-325), Value Added (VA) ($Billion)

NAICS	Description	VA	% of Total
325	*Chemical products*	*439.5*	*26.1%*
211	Oil and gas extraction	305.3	18.1%
324	*Petroleum and coal products*	*185.2*	*11.0%*
42	Wholesale trade	103.2	6.1%
331	*Primary metals*	*89.8*	*5.3%*
55	Management of companies and enterprises	64.9	3.9%
5412OP	Misc professional, scientific, and technical services	37.7	2.2%
22	Utilities	35.6	2.1%
561	Administrative and support services	28.1	1.7%
521CI	Federal Reserve banks, credit intermediation, and related	27.7	1.6%
486	Pipeline transportation	23.9	1.4%
332	Fabricated metal products	21.6	1.3%
532RL	Rental and leasing services and lessors of intangible assets	19.9	1.2%
524	Insurance carriers and related activities	19.4	1.2%
484	Truck transportation	18.5	1.1%
ORE	Other real estate	18.0	1.1%
213	Support activities for mining	15.8	0.9%
212	Mining, except oil and gas	14.4	0.9%
5415	Computer systems design and related services	13.7	0.8%
334	Computer and electronic products	13.3	0.8%
111CA	Farms	13.1	0.8%
333	Machinery	12.0	0.7%
23	Construction	11.0	0.7%
487OS	Other transportation and support activities	10.4	0.6%
GFGN	Federal general government (nondefense)	10.1	0.6%
5411	Legal services	9.1	0.5%
81	Other services, except government	9.0	0.5%
514	Data processing, internet, and other information services	8.4	0.5%
482	Rail transportation	8.0	0.5%
326	Plastics and rubber products	7.1	0.4%
GSLE	State and local government enterprises	7.0	0.4%
GSLG	State and local general government	6.7	0.4%
523	Securities, commodity contracts, and investments	6.5	0.4%
513	Broadcasting and telecommunications	6.2	0.4%
493	Warehousing and storage	6.1	0.4%
322	Paper products	5.7	0.3%
327	Nonmetallic mineral products	5.7	0.3%
311FT	Food and beverage and tobacco products	4.9	0.3%
722	Food services and drinking places	4.0	0.2%
4A0	Other retail	3.9	0.2%
562	Waste management and remediation services	3.9	0.2%
335	Electrical equipment, appliances, and components	3.6	0.2%
GFE	Federal government enterprises	3.5	0.2%
3361MV	Motor vehicles, bodies and trailers, and parts	2.8	0.2%
113FF	Forestry, fishing, and related activities	2.4	0.1%
321	Wood products	2.4	0.1%
511	Publishing, except internet (includes software)	2.2	0.1%
481	Air transportation	2.0	0.1%
711AS	Performing arts, sports, museums, and related	1.9	0.1%
721	Accommodation	1.8	0.1%
313TT	Textile mills and textile product mills	1.7	0.1%
323	Printing and related support activities	1.3	0.1%
441	Motor vehicle and parts dealers	1.2	0.1%
483	Water transportation	1.0	0.1%
339	Miscellaneous manufacturing	0.9	0.1%
485	Transit and ground passenger transportation	0.8	0.0%
512	Motion picture and sound recording industries	0.7	0.0%
3364OT	Other transportation equipment	0.5	0.0%
713	Amusements, gambling, and recreation industries	0.4	0.0%
315AL	Apparel and leather and allied products	0.3	0.0%
337	Furniture and related products	0.2	0.0%
452	General merchandise stores	0.2	0.0%
61	Educational services	0.1	0.0%
623	Nursing and residential care facilities	0.1	0.0%
445	Food and beverage stores	0.1	0.0%
621	Ambulatory health care services	0.1	0.0%
525	Funds, trusts, and other financial vehicles	0.0	0.0%
624	Social assistance	0.0	0.0%
622	Hospitals	0.0	0.0%
HS	Housing	0.0	0.0%
GFGD	Federal general government (defense)	0.0	0.0%

Note: Calculated using methods described in Table 3.2.
Data Source: Bureau of Economic Analysis. (2024c). Input-Output Accounts Data.
https://www.bea.gov/industry/input-output-accounts-data

4. Employment, Compensation, Profits, and Productivity

The Annual Survey of Manufactures estimates that there were 11.2 million employees in the manufacturing industry in 2021, which is the most recent data available (see Table 4.1). The Current Population Survey estimates that there were 15.6 million manufacturing employees in 2023 and the Current Employment Statistics estimates 12.9 million employees in 2023, the most recent data available (see Table 4.2 and Table 4.3). According to data in Table 4.2, manufacturing accounted for 9.7 % of total employment. 36.6 % of manufacturing employment was production workers with an addition 20.0 % being management, business, and financial operations occupations along with 16.6 % being professional and related occupations. As seen in Table 4.3, manufacturing employment has a 5-year compound annual growth rate of 0.8 %, which is less than that for total private employment. The source data for the estimates from Table 4.2 and Table 4.3 each have their own method for how the data was acquired and its own definition of employment. The Current Population Survey considers an employed person to be any individual who did any work for pay or profit during the survey reference week or were absent from their job because they were ill, on vacation, or taking leave for some other reason. It also includes individuals who completed at least 15 hours of unpaid work in a family-owned enterprise operated by someone in their household. In contrast, the Current Employment Statistics specifically exclude proprietors, self-employed, and unpaid family or volunteer workers. Therefore, the estimates from the Current Employment Statistics are lower than the

Table 4.1: Employment, Annual Survey of Manufactures

NAICS	Description	2020	2021
311	Food manufacturing	1 509 076	1 509 329
312	Beverage and tobacco product manufacturing	214 712	224 136
313	Textile mills	78 736	77 854
314	Textile product mills	97 569	96 965
315	Apparel manufacturing	65 696	62 491
316	Leather and allied product manufacturing	25 213	25 055
321	Wood product manufacturing	395 339	398 867
322	Paper manufacturing	328 945	330 425
323	Printing and related support activities	372 745	351 849
324	Petroleum and coal products manufacturing	105 383	100 428
325	Chemical manufacturing	758 902	778 136
326	Plastics and rubber products manufacturing	768 225	773 438
327	Nonmetallic mineral product manufacturing	386 482	384 716
331	Primary metal manufacturing	346 423	317 946
332	Fabricated metal product manufacturing	1 339 334	1 296 417
333	Machinery manufacturing	1 008 247	996 694
334	Computer and electronic product manufacturing	776 220	758 833
335	Electrical equipment, appliance, and component manufacturing	334 391	341 237
336	Transportation equipment manufacturing	1 535 704	1 534 161
337	Furniture and related product manufacturing	347 017	333 078
339	Miscellaneous manufacturing	510 868	513 924
TOTAL		11 305 227	11 205 979

Data Source: U.S. Census Bureau. (2023). "Annual Survey of Manufactures." https://www.census.gov/programs-surveys/asm/data/tables.html

Table 4.2: Employment by Industry, by Occupation (2023): Current Population Survey

Percent of Total Industry Employment

		Management, professional, and related occupations		Service occupations		Sales and office occupations		Natural resources construction, and maintenance occupations			Production, transportation, and material, moving occupations	
	Total employed	Management, business, and financial operations occupations	Professional and related occupations	Protective service occupations	Service occupations, except protective	Sales and related occupations	Office and administrative suppor occupations	Farming, fishing, and forestry occupations	Construction and extraction occupations	Installation, maintenance, and repair occupations	Production occupations	Transportation and material moving occupations
Agriculture and related	2 264	42.1%	3.1%	0.7%	4.6%	1.5%	3.3%	36.9%	0.4%	1.7%	1.0%	4.6%
Mining, quarrying, and oil and gas extraction	590	19.3%	12.9%	0.2%	2.0%	2.7%	7.5%	0.0%	31.9%	5.9%	6.3%	11.4%
Construction	11 896	21.1%	3.2%	0.1%	0.3%	1.3%	4.3%	0.1%	59.6%	5.6%	1.7%	2.8%
Manufacturing	15 570	20.0%	16.6%	0.3%	1.4%	3.8%	6.8%	0.1%	2.1%	4.4%	36.6%	7.8%
Wholesale and retail trade	19 787	9.3%	6.6%	0.5%	3.4%	44.4%	10.3%	0.3%	0.6%	3.5%	3.6%	17.5%
Transportation and utilities	9 949	11.4%	5.3%	0.6%	1.5%	1.3%	22.3%	0.0%	2.3%	5.3%	3.9%	45.9%
Information	2 971	26.3%	43.9%	0.1%	1.9%	6.1%	11.6%	0.0%	0.5%	7.0%	1.3%	1.2%
Financial activities	11 018	45.4%	11.2%	0.5%	2.3%	21.2%	16.0%	0.0%	0.3%	1.6%	0.5%	1.0%
Professional and business services	20 735	28.0%	34.8%	3.1%	14.4%	3.1%	10.0%	0.1%	0.8%	1.5%	1.4%	2.8%
Education and health services	36 378	11.8%	56.9%	0.6%	19.1%	0.4%	8.9%	0.0%	0.2%	0.6%	0.4%	1.2%
Leisure and hospitality	14 288	16.6%	7.7%	1.3%	58.0%	6.1%	5.7%	0.0%	0.2%	0.9%	1.0%	2.4%
Other services	7 605	11.6%	13.0%	0.2%	37.5%	5.0%	7.6%	0.1%	0.5%	14.3%	5.9%	4.3%
Public administration	7 984	21.6%	28.2%	22.1%	5.9%	0.6%	15.1%	0.4%	1.6%	1.7%	1.1%	1.7%
TOTAL	161 037											

Note: Shading aids in identifying high/low percentages where green is high and red is low.
Source: Bureau of Labor Statistics. (2024a) Current Population Survey. "Table 17: Employed Persons by Industry, Sex, Race, and Occupation." <http://www.bls.gov/cps>

Current Population Survey estimates. Additionally, the Current Employment Statistics include temporary and intermittent employees. The Annual Survey of Manufactures considers an employee to include all full-time and part-time employees on the payrolls of operating establishments during any part of the pay period being surveyed excluding temporary staffing obtained through a staffing service. It also excludes proprietors along with partners of unincorporated businesses.

Between January 2005 and January 2010, manufacturing employment declined by 19.6 %, as seen in Figure 4.1. As of August 2024, employment was still 9.3 % below its 2005 level. In times of financial difficulty, large purchases are often delayed or determined to be unnecessary. Thus, as would be expected, during the late 2000's recession durable goods declined more than nondurable goods. The other major decline in manufacturing employment was during the pandemic. Between January 2019 and April of 2020, manufacturing employment declined 10 percentage points to be 19.9 % below its 2005 level. By September 2021, manufacturing employment had risen to 12.8 % below its 2005 level. However, at that time there were a substantial number of job openings in manufacturing as seen in Figure 4.1.

The employees that work in manufacturing offer their time and, in some cases, risk their personal safety in return for compensation. In terms of safety, the number of fatal injuries increased 5.5 % between 2021 and 2022 (see Table 4.4). Nonfatal injuries increased; however, the injury rate decreased (see Table 4.5). The incident rate for nonfatal injuries in manufacturing remains higher than that for all private industry. As illustrated in Figure 4.2, fatalities, injuries, and the injury rate have a five-year compound growth rate of 5.9 %, -1.5 %, and -1.8 % respectively.

Table 4.3: Manufacturing Employment (Thousands): Current Employment Statistics

	Total Private	Manufacturing	Durable Goods	Nondurable Goods
2017	124 257	12 439	7 741	4 699
2018	126 454	12 688	7 946	4 742
2019	128 291	12 817	8 039	4 778
2020	120 200	12 167	7 573	4 594
2021	124 311	12 354	7 681	4 673
2022	130 329	12 812	7 968	4 844
2023	133 269	12 940	8 102	4 838
5-Year Compound Annual Growth	1.4%	0.8%	0.9%	0.6%

Source: Bureau of Labor Statistics. (2024b) Current Employment Statistics. http://www.bls.gov/ces/home.htm

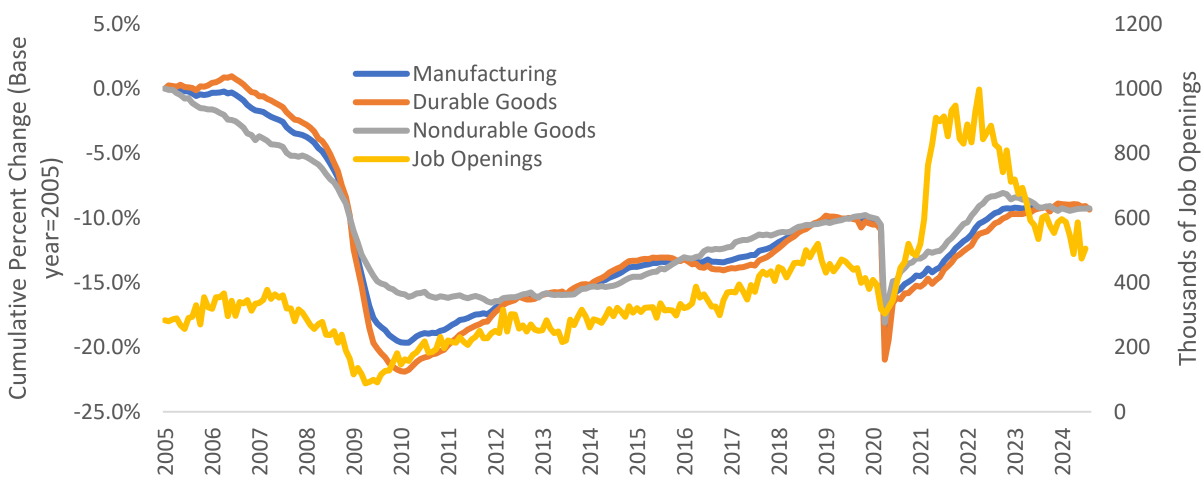


Figure 4.1: Cumulative Change in Percent in Manufacturing Employment (Seasonally Adjusted) and Number of Job Openings (seasonally Adjusted), 2005-2023

Source: Bureau of Labor Statistics. (2024b) Current Employment Statistics. http://www.bls.gov/ces/ and Bureau of Labor Statistics. (2023c) Job Openings and Labor Turnover Survey. https://www.bls.gov/jlt/
Source: Bureau of Labor Statistics. (2024c). Job Openings and Labor Turnover Survey. https://www.bls.gov/jlt/

Table 4.4: Fatal Occupational Injuries by Event or Exposure

		Total	Violence and other injuries by persons or animals	Transportation Incidents	fires and explosions	Falls, slips, trips	exposure to harmful substances or environments	Contact with objects and equipment
2021	Total	5190	761	1982	76	850	798	705
	Manufacturing	383	36	84	10	55	82	115
2022	Total	5486	849	2066	107	865	839	738
	Manufacturing	404	44	98	19	45	79	118
Percent Change	Total	5.7%	11.6%	4.2%	40.8%	1.8%	5.1%	4.7%
	Manufacturing	5.5%	22.2%	16.7%	90.0%	-18.2%	-3.7%	2.6%

Source: Bureau of Labor Statistics. Census of Fatal Occupational Injuries. "Industry by Event or Exposure."
<http://stats.bls.gov/iif/oshcfoi1.htm>

Table 4.5: Total Recordable Cases of Nonfatal Injuries and Illnesses

		2021	2022	Percent Change
Manu-facturing	Incident Rate per 100 full time workers*	3.3	3.2	-3.0%
	Total Recordable Cases (thousands)	385.1	396.8	3.0%
Private Industry	Incident Rate per 100 full time workers	2.7	2.7	0.0%
	Total Recordable Cases (thousands)	2607.9	2804.2	7.5%

Source: Bureau of Labor Statistics. (2024e). Injuries, Illness, and Fatalities Program.
http://www.bls.gov/iif/

* The incidence rates represent the number of injuries and illnesses per 100 full-time workers and were calculated as: (N/EH) x 200,000, where

N = number of injuries and illnesses

EH = total hours worked by all employees during the calendar year
200,000 = base for 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year)

During the late 2000s recession, the average number of hours worked per week declined, as seen in Figure 4.3. Unlike employment, however, the number of hours worked per week returned to its pre-recession levels or slightly higher. Average wages increased significantly during the late 2000's recession and 2020 decline of GDP, as can be seen in Figure 4.4. This is likely because low wage earners are disproportionately impacted by employment reductions, which suggests that high wage earners not only receive more pay, but also have more job security. Average hours also dropped during the pandemic and has largely returned to pre-recession levels. Like the late 2000's recession, during the pandemic wages increased while hours and employment decreased.

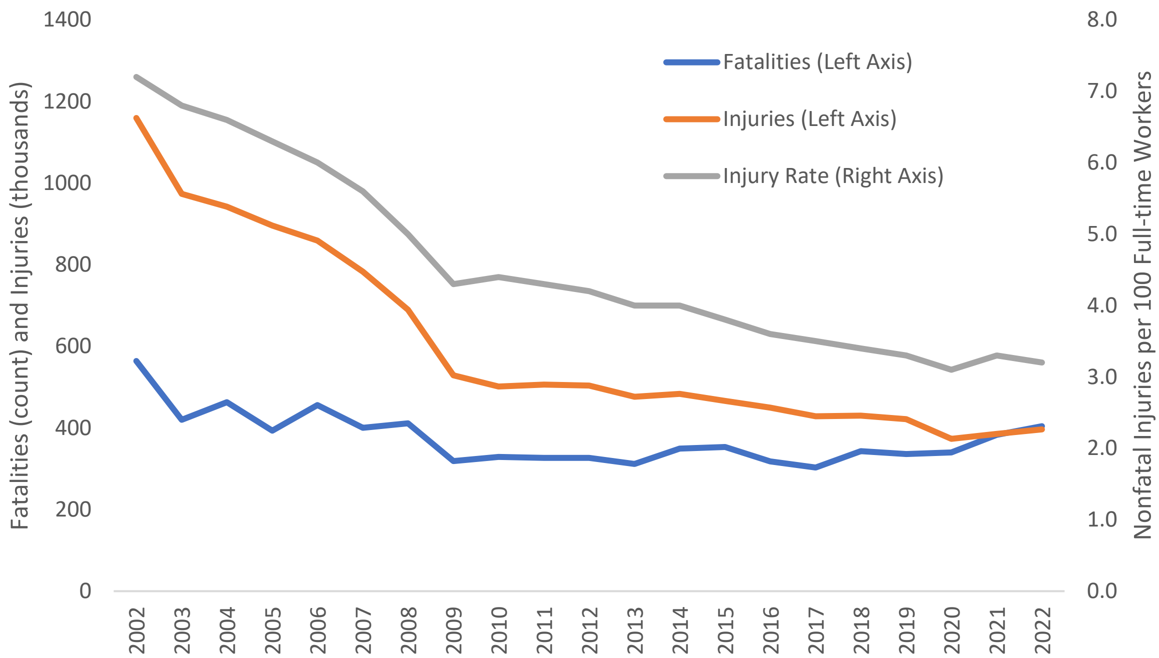


Figure 4.2: Manufacturing Fatalities and Injuries

Source: Bureau of Labor Statistics. (2024e). Injuries, Illness, and Fatalities Program. http://www.bls.gov/iif/
Source: Bureau of Labor Statistics. (2024d) Census of Fatal Occupational Injuries. "Industry by Event or Exposure."
<http://stats.bls.gov/iif/oshcfoi1.htm>

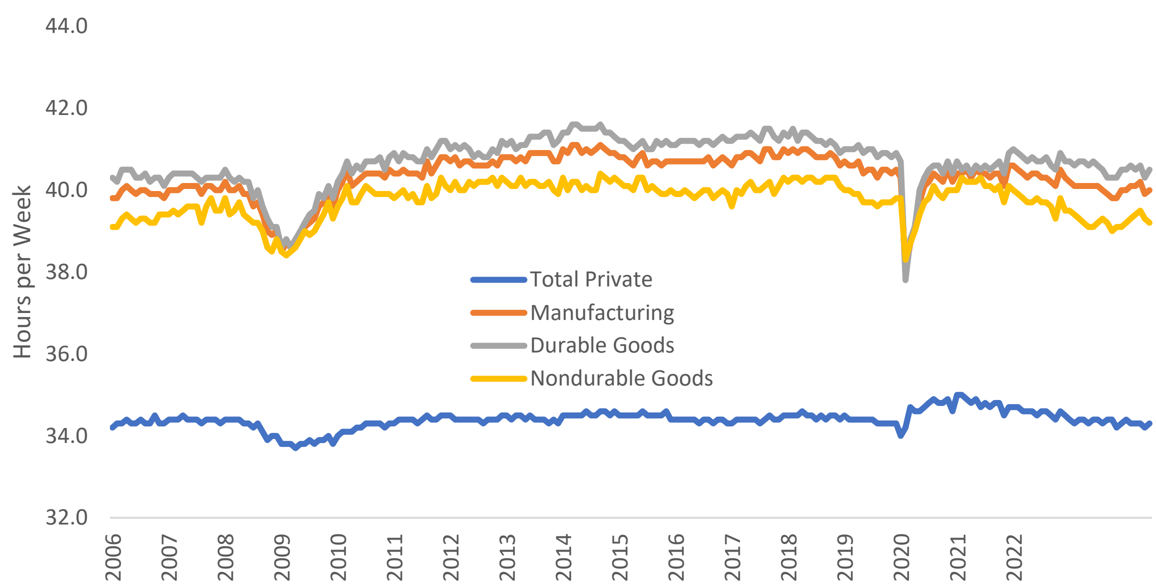


Figure 4.3: Average Weekly Hours for All Employees (Seasonally Adjusted)

Source: Bureau of Labor Statistics. (2024b) Current Employment Statistics. http://www.bls.gov/ces/home.htm

The compound annual growth rate in real dollars for private sector wages was 0.4 % between July 2019 and July 2024 and was 0.1 % for manufacturing. As illustrated in Figure 4.5, employee compensation in manufacturing, which includes benefits, has had a five-year compound annual growth of -1.9 %. In recent years, manufacturing compensation has had a negative trend while that of private industry has had a positive trend. The result is that compensation for manufacturing is only slightly higher than that of total private industry. Hourly compensation in manufacturing, which includes benefits, still exceeds that of the total private industry; however, the difference has narrowed significantly. In the first quarter of 2007, hourly compensation in manufacturing was 17.2 % higher than the private sector; however, in the second quarter of 2024 it was only 0.5 % higher.

As illustrated in Figure 4.6, the prices received by producers for all manufacturing between July 2020 and July 2022 has increased 33.4 % while in the fifteen years prior to that (i.e., June 2005 to June 2020) it only increased 27.1 % total. The 5-year compound annual growth in manufacturing prices is 4.8 %.

For those that invest in manufacturing, corporate profits have had a five-year compound annual growth of 11.1 %, as illustrated Figure 4.7, and nonfarm proprietors' income for manufacturing has had a five-year compound annual growth rate of 14.9 %, as illustrated in Figure 4.8.

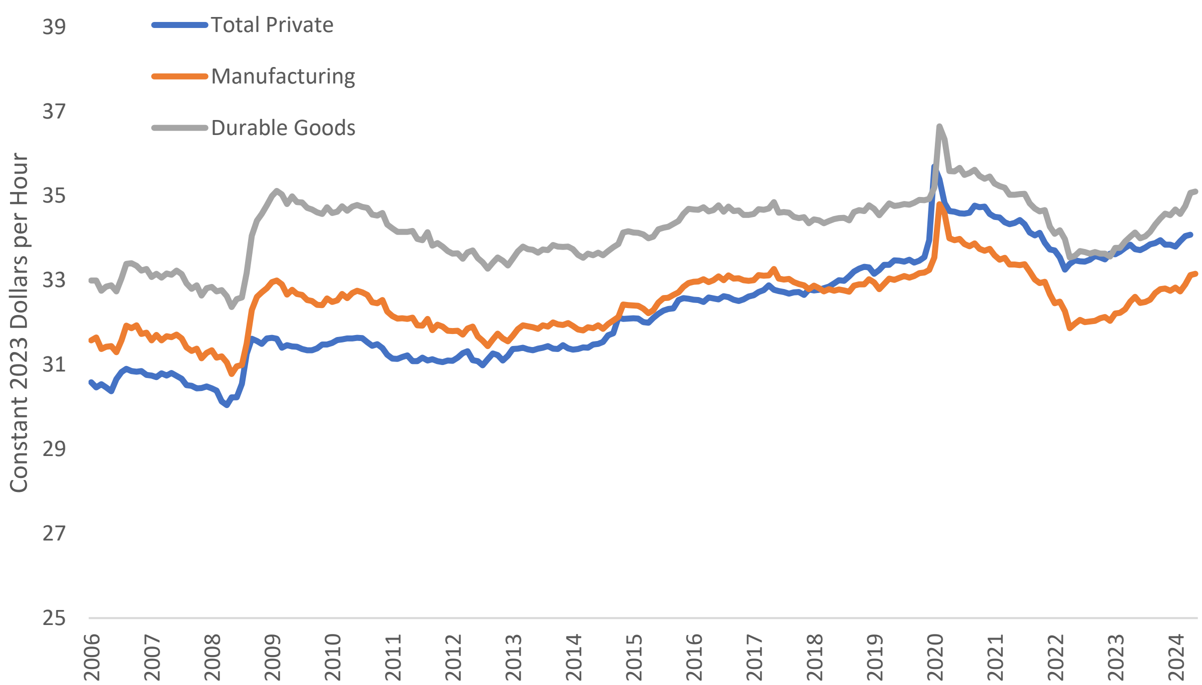


Figure 4.4: Average Hourly Wages for Manufacturing and Private Industry (Seasonally Adjusted)

Source: Bureau of Labor Statistics. (2024b) Current Employment Statistics. http://www.bls.gov/ces/home.htm
Adjusted using the CPI for all consumers. Bureau of Labor Statistics. (2024i). Consumer Price Index. https://www.bls.gov/cpi/data.htm

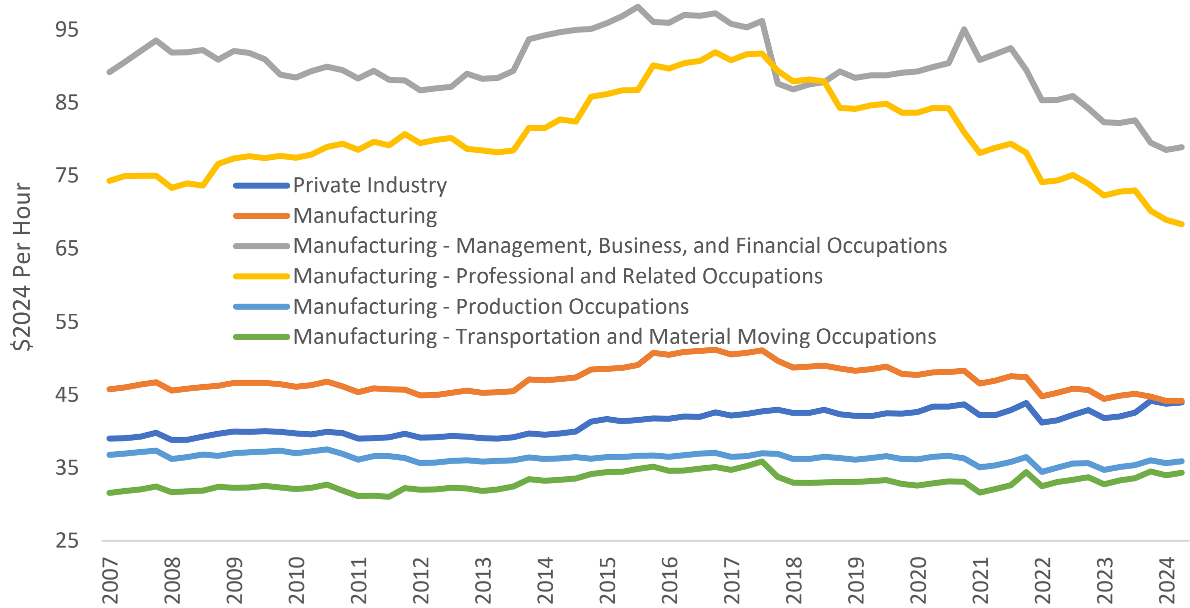


Figure 4.5: Employee Compensation (Hourly)

Source: Bureau of Labor Statistics. (2024f) National Compensation Survey. http://www.bls.gov/ncs/
Adjusted using the Consumer Price Index for all consumers from the Bureau of Labor Statistics.

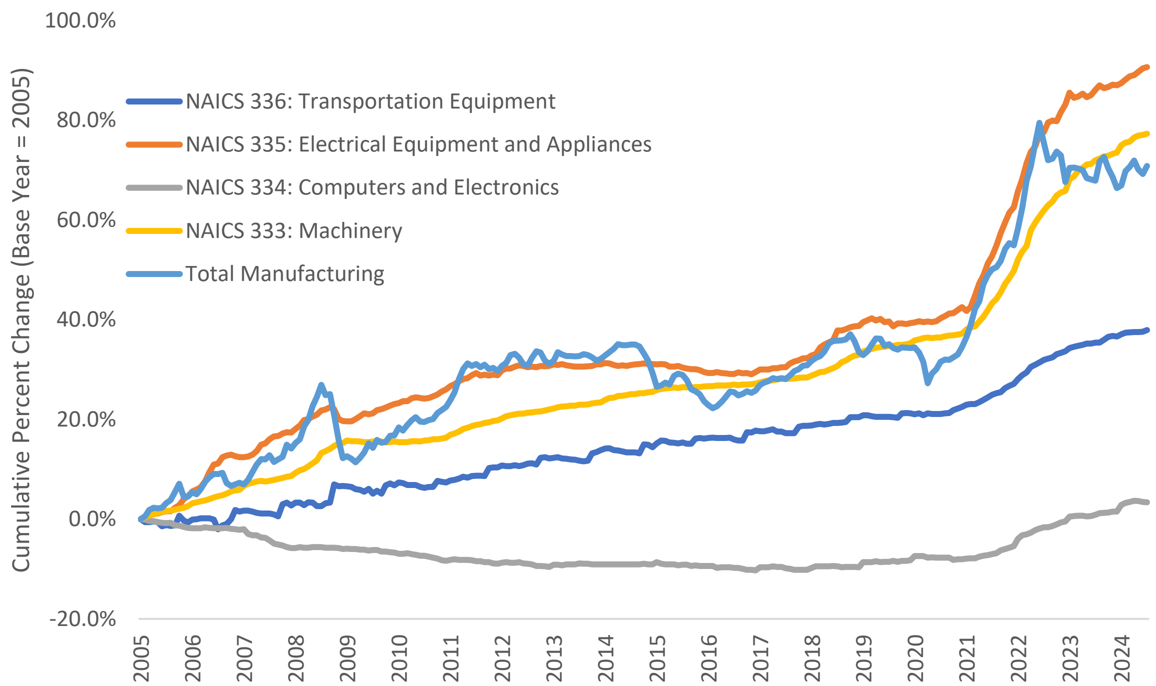


Figure 4.6: Inflation - Cumulative Percent Change in the Producer Price Index (Selling Price Received), 2005-2024

Source: Bureau of Labor Statistics. (2024h). Producer Price Index. https://stats.bls.gov/ppi/databases/

An important aspect of manufacturing is the efficiency and productivity with which resources are used. The Bureau of Labor Statistics provides an index of labor productivity and total factor productivity. Labor productivity for manufacturing increased by 0.4 % between the second quarter of 2023 and the second quarter of 2024, as illustrated in Figure 4.9. The five-year compound annual growth is 0.4 %. The Bureau of Labor Statistics total factor productivity metric measures “the efficiency at which combined inputs are used to produce output of goods and services” (Bureau of Labor Statistics 2023). For U.S. manufacturing, total factor productivity decreased 1.3 % from 2021 to 2022 and has a 5-year compound annual growth rate of less than 0.1 %, as illustrated in Figure 4.10. In general, productivity in the U.S. is relatively high compared to other countries. As illustrated in Figure 4.11, the U.S. is ranked ninth in output per hour for all goods and services among 142 countries using data from the Conference Board (2023).

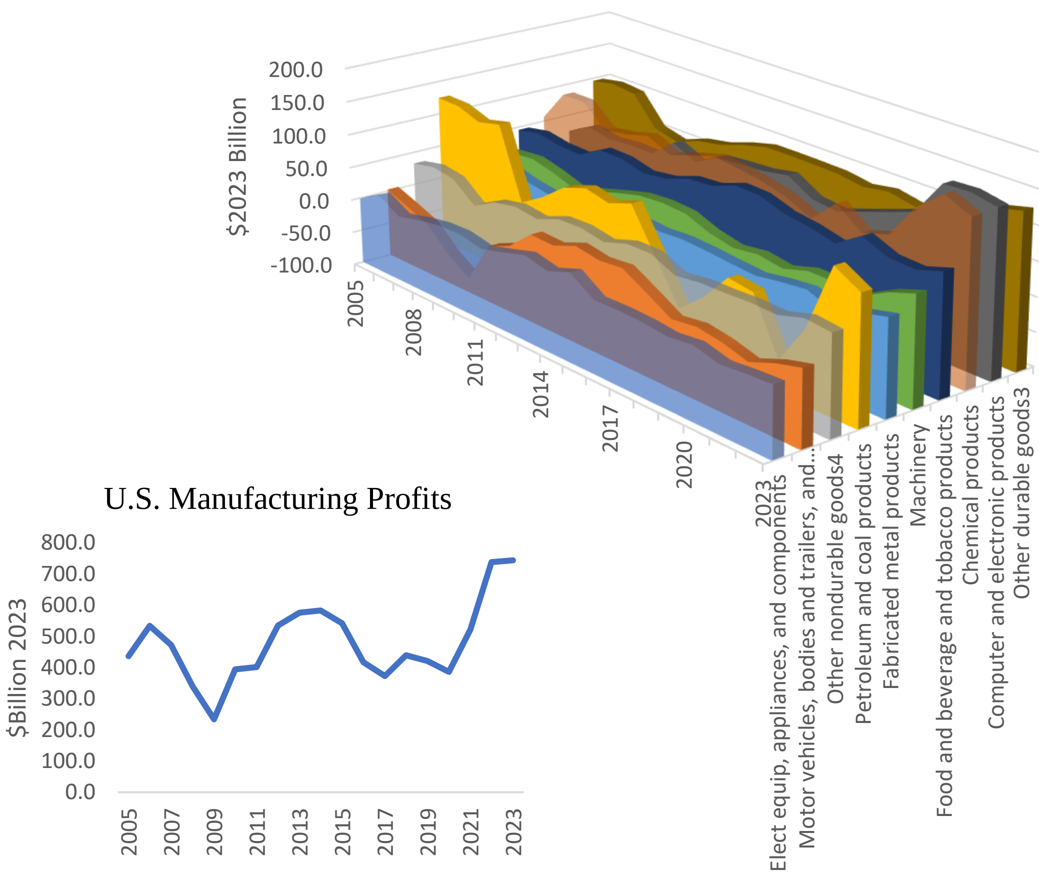


Figure 4.7: Profits for Corporations

Source: Bureau of Economic Analysis. (2024d) Income and Employment by Industry. Table 6.16D. Corporate Profits by Industry. https://apps.bea.gov/iTable/index_nipa.cfm.

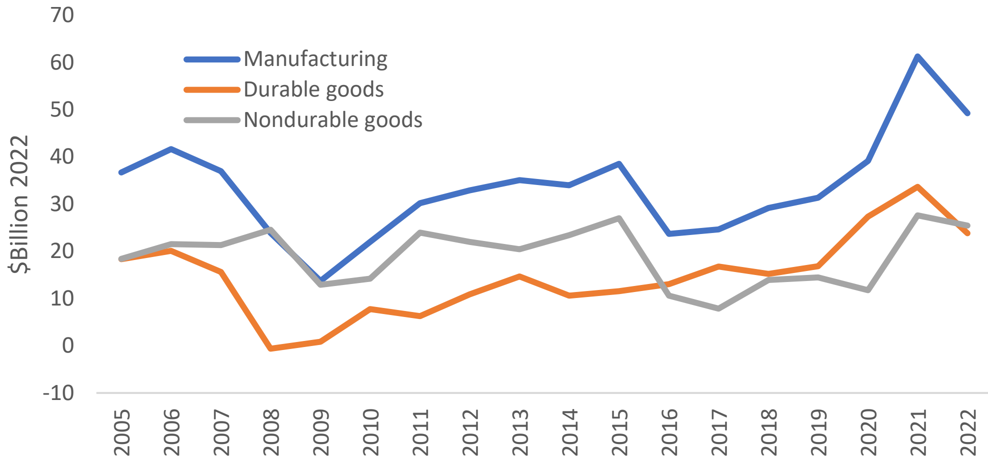


Figure 4.8: Nonfarm Proprietor's Income

Source: Bureau of Economic Analysis. (2023d) Income and Employment by Industry. Table 6.12D. Nonfarm Proprietors' Income. https://apps.bea.gov/iTable/index_nipa.cfm.

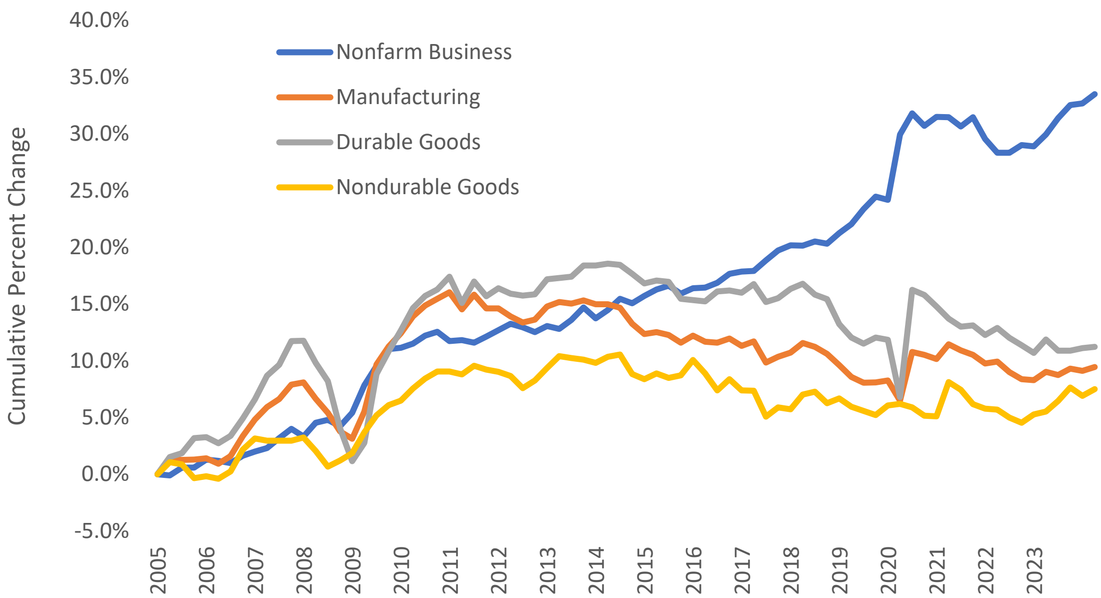


Figure 4.9: Manufacturing Labor Productivity Index (2017 Base Year = 100)

Source: Bureau of Labor Statistics. (2024g) Productivity. https://www.bls.gov/mfp/

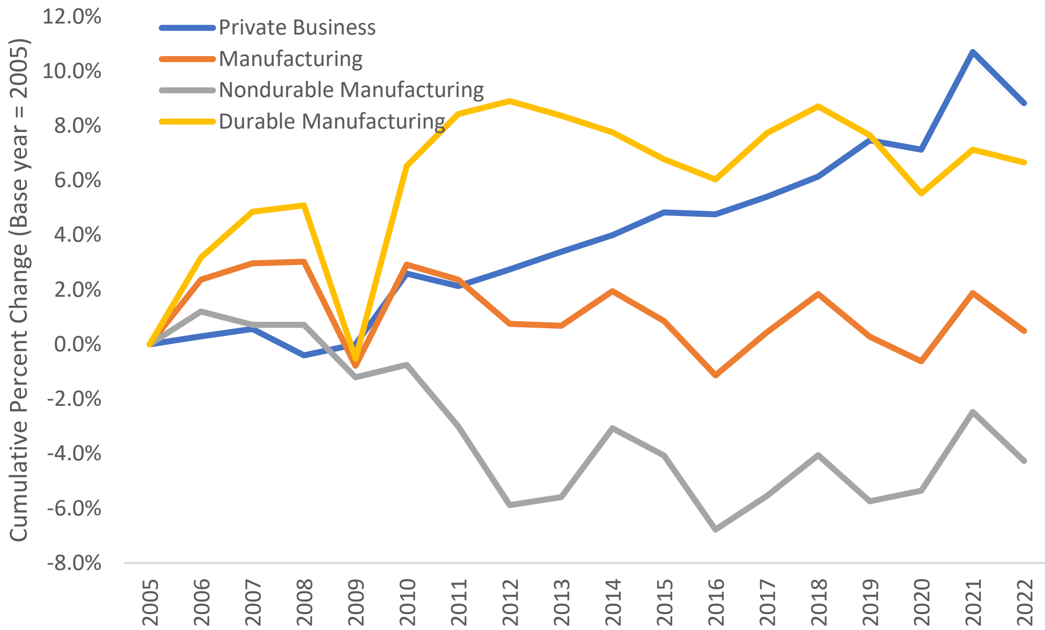


Figure 4.10: Manufacturing Total Factor Productivity Index

Source: Bureau of Labor Statistics. (2024g) Productivity. https://www.bls.gov/mfp/

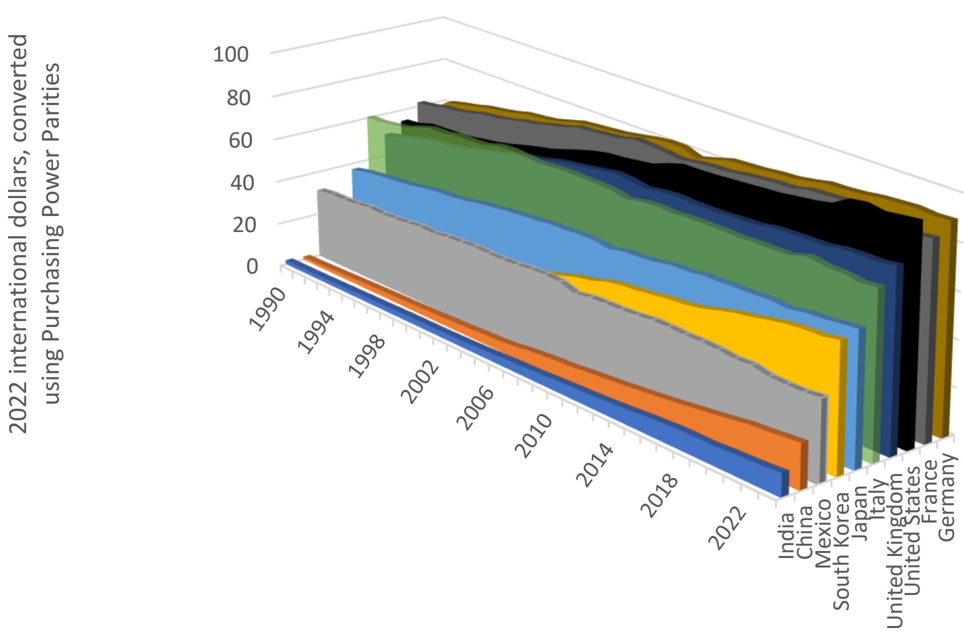


Figure 4.11: Output per Labor Hour (Top Ten Largest Manufacturing Countries from Figure 2.3)

Source: Conference Board. (2023) Total Economy Database: Output, Labor and Labor Productivity. https://www.conference-board.org/data/economydatabase/index.cfm?id=27762

5. Research, Innovation, and Factors for Doing Business

Manufacturing goods involves not only physical production, but also design and innovation. Measuring and comparing innovation between countries is problematic, as there is no standard metric for measuring this activity. Four measures are often discussed regarding innovation: number of patent applications, research and development expenditures, number of researchers, and number of published journal articles. As seen in Figure 5.1, the U.S. ranked 4th in 2021 in resident patent applications per million people, which puts it above the 95th percentile among 113 countries. Using patent applications as a metric can be problematic though, as not all innovations are patented and some patents might not be considered innovation. The U.S. ranked 3rd in research and development expenditures as a percent of GDP in 2021, which puts it above the 95th percentile (see Figure 5.2) among 79 nations. As seen in Figure 5.3, U.S. enterprise research and development expenditures in manufacturing increased 3.9 % between 2020 and 2021, has a 5-year compound annual growth rate of 3.9 % (not shown), and the 2021 value amounts to 13.4 % of manufacturing value added. Despite an increasing trend in researchers per million people, the U.S. rank decreased to 18th in 2020, putting it just above the 75th percentile (see Figure 5.4) out of 76 countries. In journal articles per million people it ranked 24th in 2020 out of 197 countries, and China had more articles than the U.S. (see Figure 5.5) (World Bank 2024). Germany, Japan,

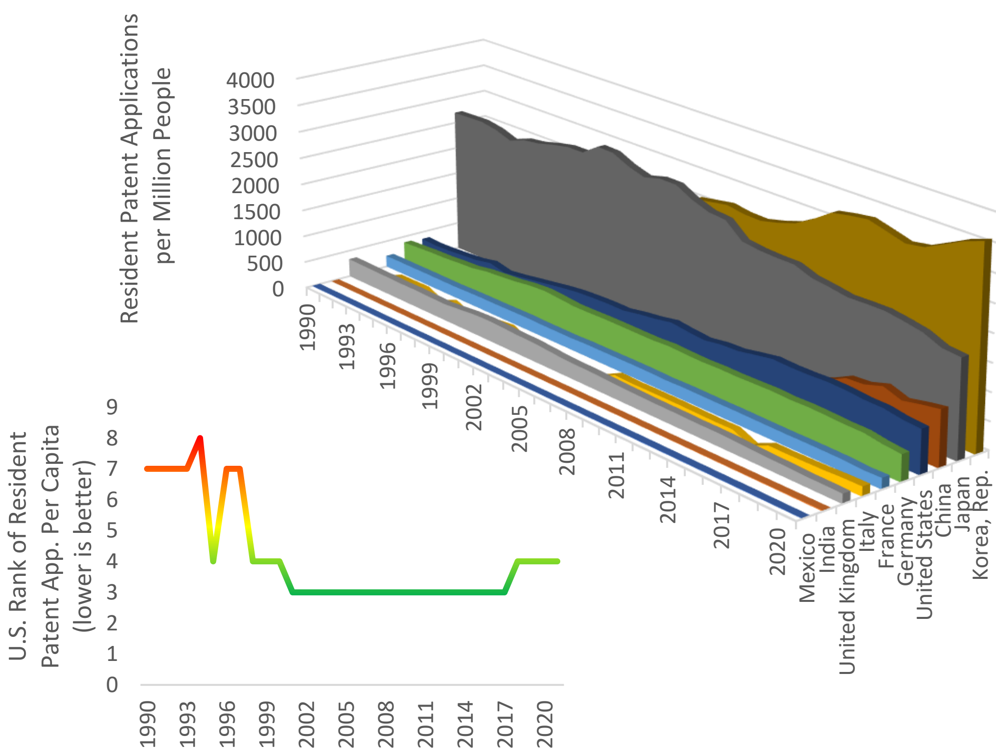


Figure 5.1: Patent Applications (Residents) per Million People, Top Ten Largest Manufacturing Countries (1990-2020)

World Bank. 2024. World Development Indicators. https://data.worldbank.org/products/wdi

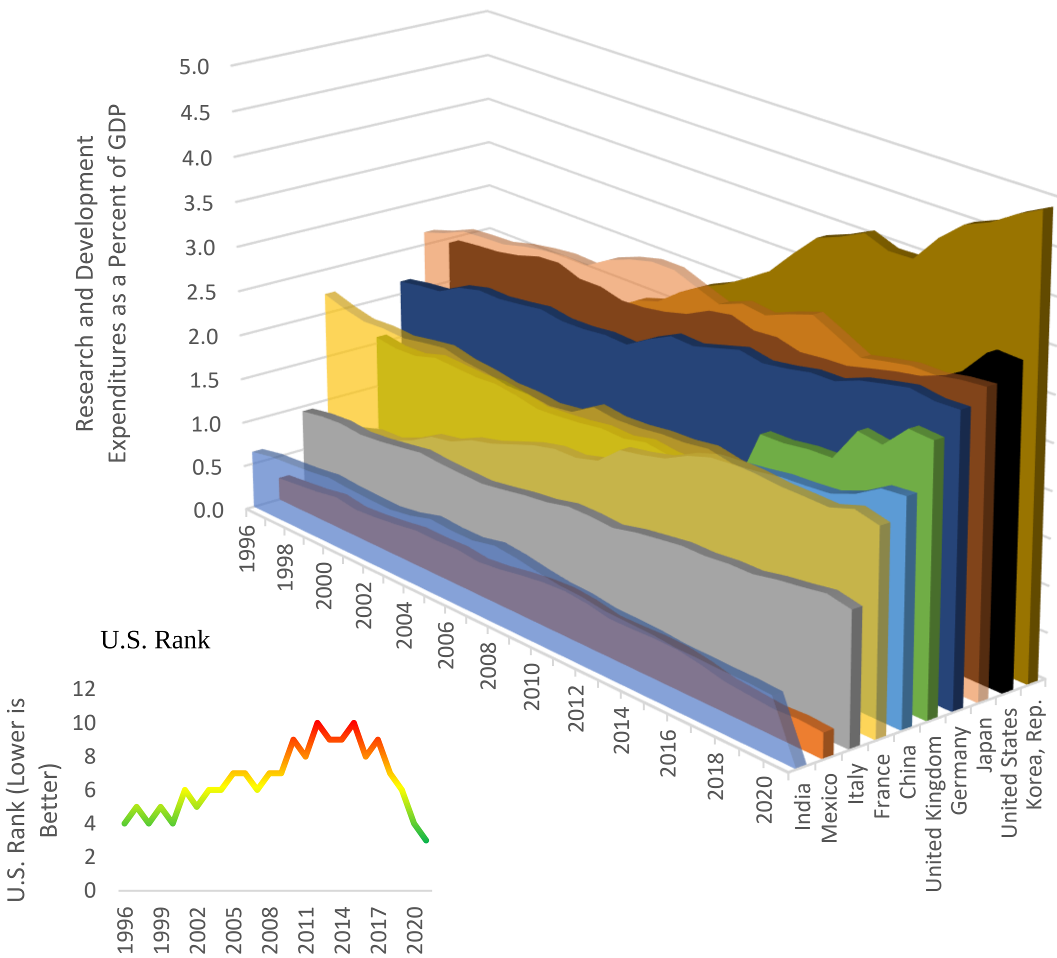


Figure 5.2: Research and Development Expenditures as a Percent of GDP, Top Ten Largest Manufacturing Countries

Source: World Bank. 2024. World Development Indicators. https://data.worldbank.org/products/wdi
* Missing data was interpolated

South Korea, and China ranked 26th, 38th, 22nd, and 54th, respectively (not shown). Exports are also frequently seen as a measure of competitiveness. The U.S. was the second largest exporter in 2023, as illustrated in Figure 5.6.

In addition to some of the previously mentioned metrics, a number of indices have been developed to assess national competitiveness. The IMD World Competitiveness Index provides insight into the U.S. innovation landscape. Figure 5.7 provides the U.S. ranking for 20 measures of competitiveness. This provides some indicators to identify opportunities for improvement in U.S. economic activity. In 2023, the U.S. ranked low in prices, public finance, societal framework, and international trade among other things. Overall, the U.S. ranked 12th in competitiveness for conducting business while Germany, Japan, and China ranked 24th, 38th, and 14th, respectively (IMD 2024). Between 2016 and 2024, 80 % or 16 of the 20 rankings went down for the U.S.

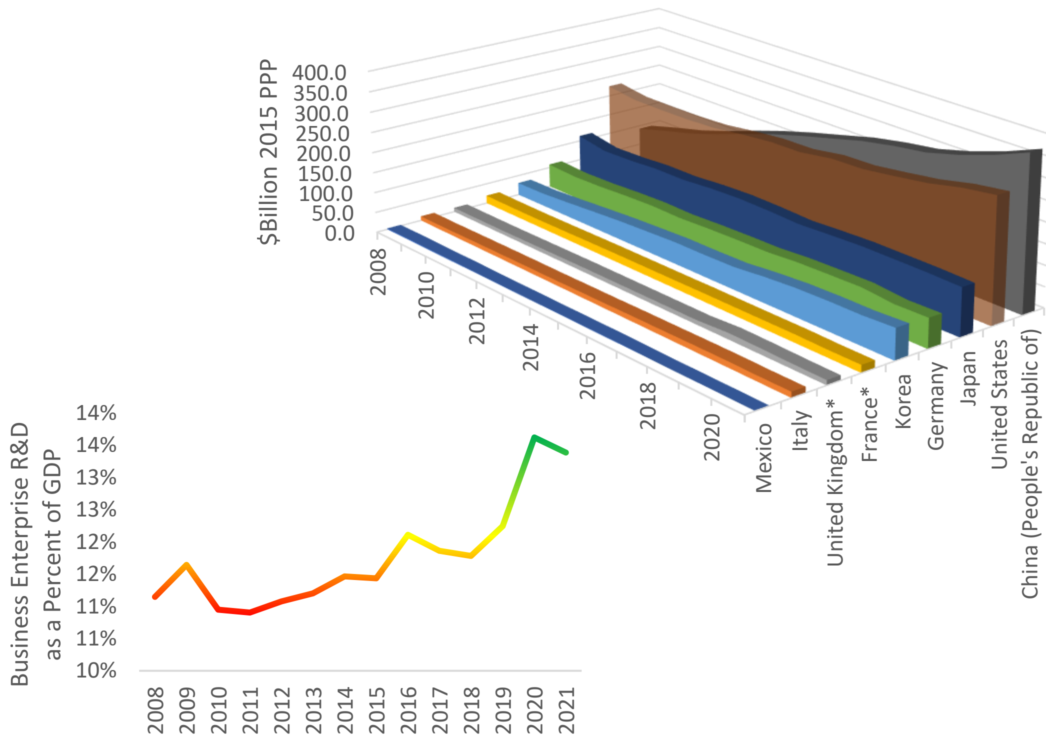


Figure 5.3: Manufacturing Enterprise Research and Development Expenditures (PPP Converted $Billion 2015), Top 10 Largest Manufacturing Countries

Source: OECD. (2024a) Business Enterprise R-D Expenditure by Industry (ISIC 4). http://stats.oecd.org/#
Bureau of Economic Analysis. (2024a) "Industry Economic Accounts Data." http://www.bea.gov/iTable/index_industry_gdpIndy.cfm
*Missing values were interpolated

The 2016 Deloitte Global Manufacturing Competitiveness Index uses a survey of CEOs to rank countries based on their perception. The U.S. was ranked 2nd out 40 nations with China being ranked 1st. High-cost labor, high corporate tax rates, and increasing investments outside of the U.S. were identified as challenges to the U.S. industry. Manufacturers indicated that companies were building high-tech factories in the U.S. due to rising labor costs in China, shipping costs, and low-cost shale gas (Deloitte 2016). According to the Deloitte Global Manufacturing Competitiveness Index, advantages to U.S. manufacturers included its technological prowess and size, productivity, and research support. China was ranked 1st with advantages in raw material supply, advanced electronics, and increased research and development spending. China has challenges in innovation, slowing economic growth, productivity, and regulatory inefficiency.

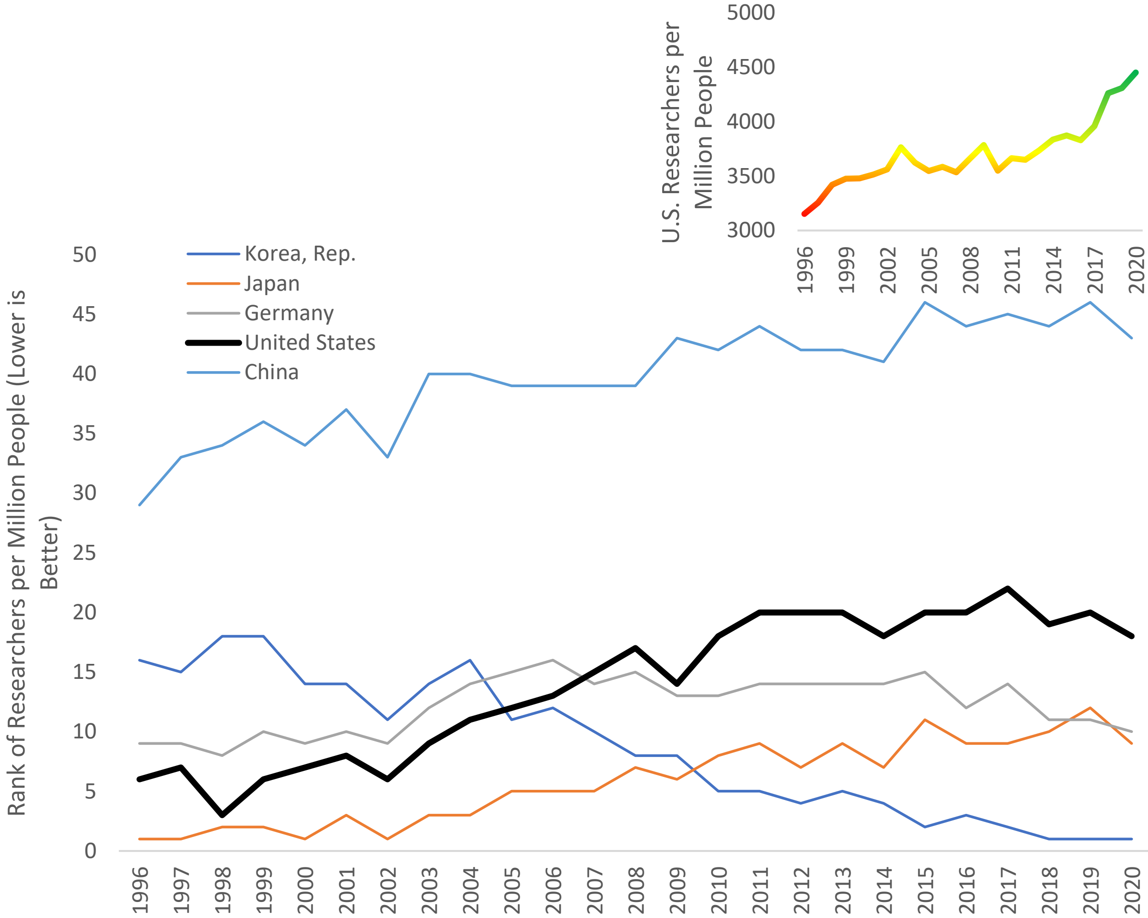


Figure 5.4: Researchers per Million People, Ranking

World Bank. 2024. World Development Indicators. https://data.worldbank.org/products/wdi

The World Economic Forum's Global Competitiveness Report uses 12 items to assess the competitiveness of a number of economies, which includes the set of "institutions, policies and factors that determine a country's level of productivity." The U.S. was ranked 5th overall with various rankings in the 12 "pillars" that underly the ranking. The U.S. rankings for each of the pillars was not readily available; however, the 2019 rankings are illustrated in Figure 5.8. Within the 12 "pillars," there were lower rankings in health, macroeconomic stability, and information/communication technology adoption (World Economic Forum 2020). The index uses a set of 90 factors to produce the 12 items in Figure 5.8. A selection of those that are relevant to standards, technology, and information dissemination are presented in Table 5.1. Those that have poorer rankings might be opportunities for improvement.

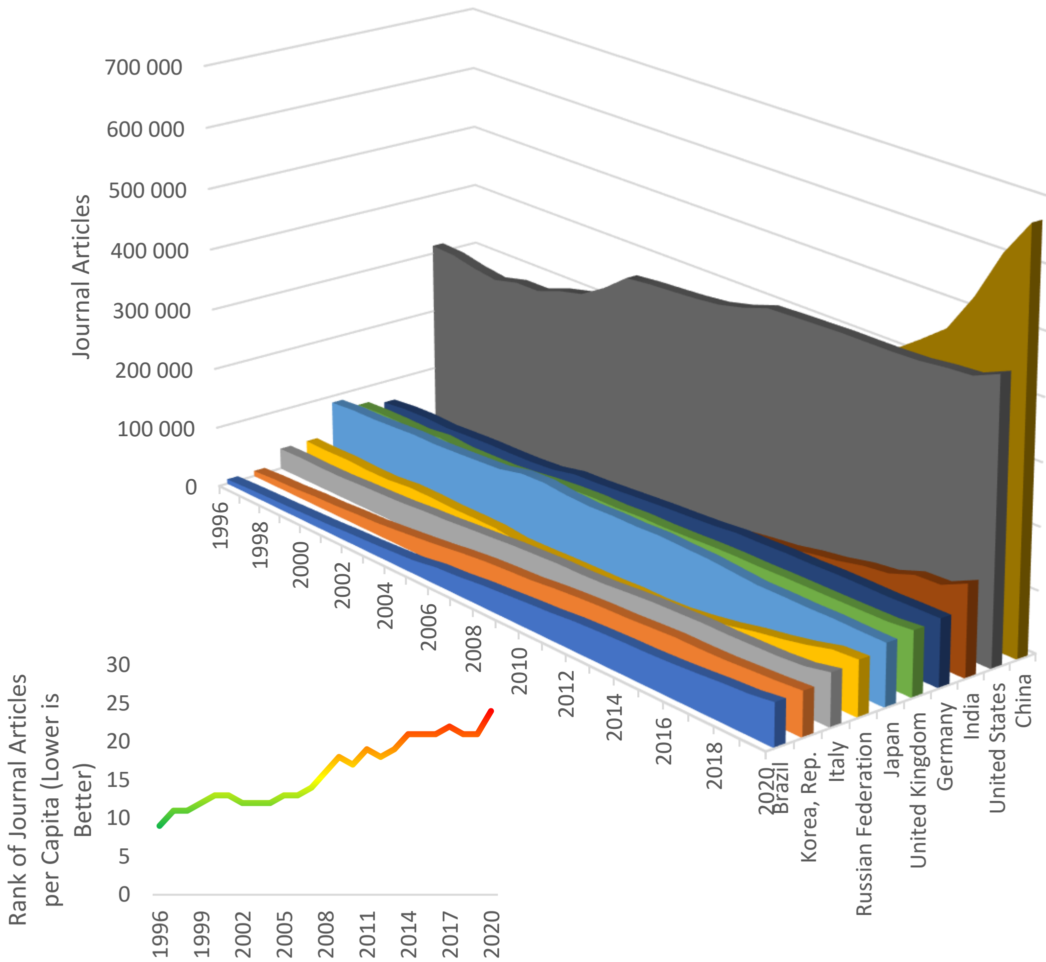


Figure 5.5: Journal Articles, Top 10 Countries

World Bank. 2024. World Development Indicators. https://data.worldbank.org/products/wdi

Among those selected in Table 5.1, the U.S. ranks below the 90th percentile in both of the *crime* items, 2 of the 8 *transport* items, 6 of the 9 *utility* items, *labor-health*, 2 of the 9 *human capital* items, both *barrier to entry* items, and 2 of the 10 *innovation* items.

The Competitive Industrial Performance Index, published by the United Nations Industrial Development Organization, ranks countries based on 3 dimensions: 1) capacity to produce and

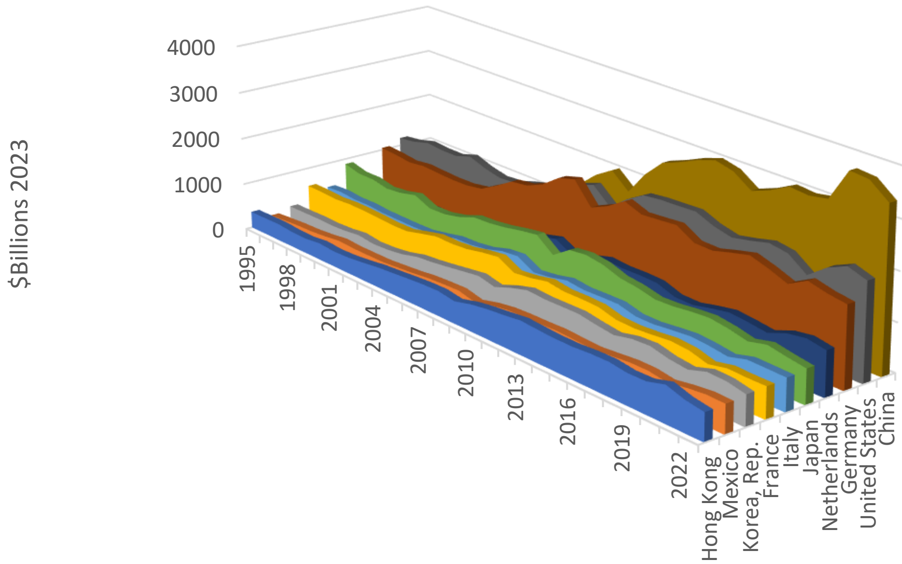


Figure 5.6: Merchandise Exports, Top Ten Exporters

World Bank. 2024. World Development Indicators. https://data.worldbank.org/products/wdi
NOTE: Adjusted using the Consumer Price Index for all consumers from the Bureau of Labor Statistics.

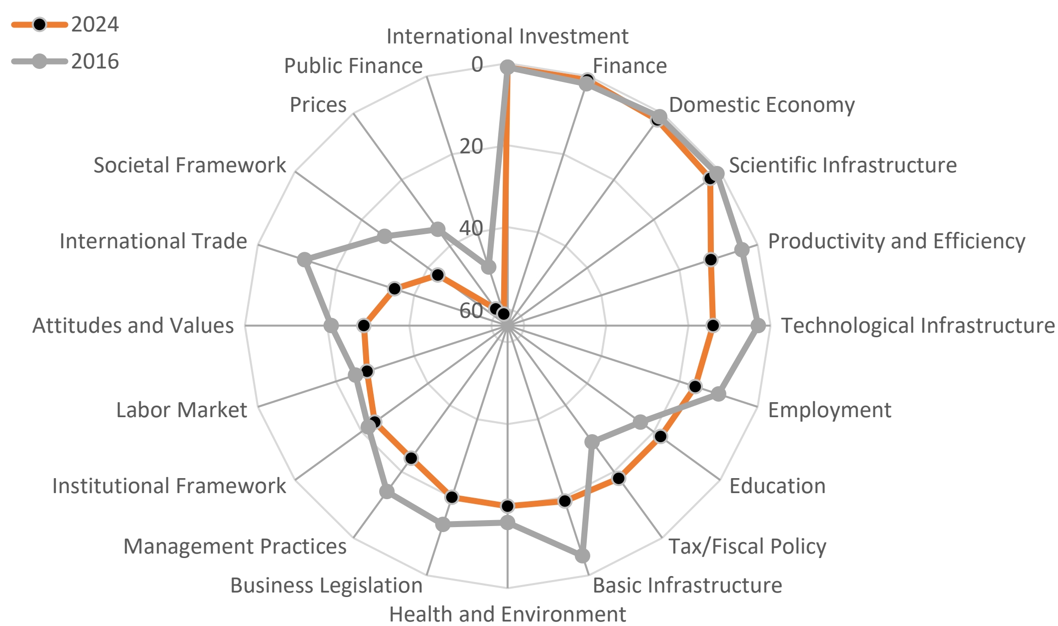


Figure 5.7: IMD World Competitiveness Rankings for the US: Lower is Better (i.e., a Rank of 1 is Better than a Rank of 67) – 67 countries ranked

Source: IMD. (2024). IMD World Competitiveness Country Profile: U.S. https://worldcompetitiveness.imd.org/countryprofile/US

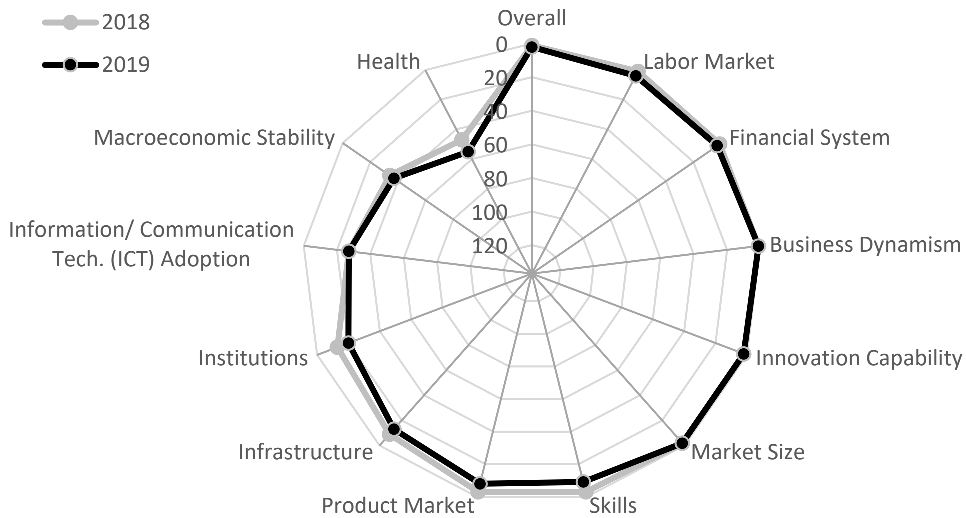


Figure 5.8: World Economic Forum 2019 Global Competitiveness Index: U.S. Pillar Rankings: Lower is Better

Source: World Economic Forum. (2020). The Global Competitiveness Report 2019. https://www.weforum.org/publications/the-global-competitiveness-report-2020/

export manufactured goods; 2) technological deepening and upgrading; and 3) world impact (United Nations Industrial Development Organization. 2020). The U.S. ranked 6th overall, as seen in Figure 5.9. Germany ranked first followed by China.

The Annual Survey of Entrepreneurs makes inquiries on U.S. entrepreneurs concerning the negative impacts of eight items:

- Access to financial capital
- Cost of financial capital
- Finding qualified labor
- Taxes
- Slow business or lost sales
- Late or nonpayment from customers
- Unpredictability of business conditions
- Changes or updates in technology
- Other

Table 5.1: World Economic Forum Competitiveness Index Indicators – Selection of those Relevant to Standards, Technology, and Information Dissemination Solutions, Rankings Out of 141 Countries (Lower is Better)

Pillar	Component	US Rank	Application
1	Organized crime	69	Crime
1	Terrorism incidence	83.3	Crime
1	Intellectual property protection	12	IP Protection
2	Road connectivity index	1	Transport
2	Quality of roads	17	Transport
2	Railroad density (km of roads/square km)	48	Transport
2	Efficiency of train service	12	Transport
2	Airport connectivity	1	Transport
2	Efficiency of air transport services	10	Transport
2	Liner shipping connectivity index	8	Transport
2	Efficiency of seaport services	10	Transport
2	Electrification rate (% of population)	2	Utilities
2	Electric power transmission and distribution losses (% output)	23	Utilities
2	Exposure to unsafe drinking water (% of population)	14	Utilities
2	Reliability of water supply	30	Utilities
3	Mobile-cellular telephone subscriptions (per 100 people)	54	Utilities
3	Mobile-broadband subscriptions (per 100 people)	7	Utilities
3	Fixed-broadband internet subscriptions (per 100 people)	18	Utilities
3	Fibre internet subscriptions (per 100 people)	45	Utilities
3	Internet users (% of population)	26	Utilities
5	Healthy life expectancy	54	Labor - Health
6	Mean years of schooling	7	Human Capital
6	Extent of staff training	6	Human Capital
6	Quality of vocational training	8	Human Capital
6	Skillset of graduates	5	Human Capital
6	Digital skills among population	12	Human Capital
6	Ease of finding skilled employees	1	Human Capital
6	School life expectancy (expected years of schooling)	30	Human Capital
6	Critical thinking in teaching	9	Human Capital
6	Pupil-to-teacher ratio in primary education	45	Human Capital
11	Cost of starting a business (% GNI per capita)	24	Barriers to Entry
11	Time to start a business (days)	31	Barriers to Entry
11	Companies embracing disruptive ideas	2	Innovation
12	State of cluster development	2	Innovation
12	International co-inventions (applications/million people)	19	Innovation
12	Multi-stakeholder collaboration	2	Innovation
12	Scientific publications (H index)	1	Innovation
12	Patent applications (per million people)	13	Innovation
12	R&D expenditures (% of GDP)	11	Innovation
12	Quality of research institutions	1	Innovation
12	Buyer sophistication	4	Innovation
12	Trademark applications (per million people)	32	Innovation

Pillars: 1) Institutions, 2) Infrastructure, 3) Information and communication technology adoption, 4) macroeconomic policy, 5) Health, 6) Skills, 7) Product market, 8) Labor market, 9) Financial system, 10) Market size, 11) Business dynamism, and 12) Innovation capability.
Applications: The application categories were developed for this report in order to identify items that might be relevant to manufacturing

As seen in Figure 5.10, there are four items where more than a 25 % of the firms indicated negative impacts, including taxes, slow business or lost sales, unpredictability of business conditions, and finding qualified labor (: U.S. Census Bureau and National Center for Science and Engineering Statistics 2023).

Countries are sometimes compared to or alluded to as brands. According to a survey on country reputation of products published by Statista (see Figure 5.11), the U.S. ranks 10th among 49 total countries. Another ranking from Ipsos (see Figure 5.12), the U.S. ranks 6th. The high ranking of the U.S. supports the idea that manufacturers in the U.S. tend to compete based on differentiation rather than cost competition.

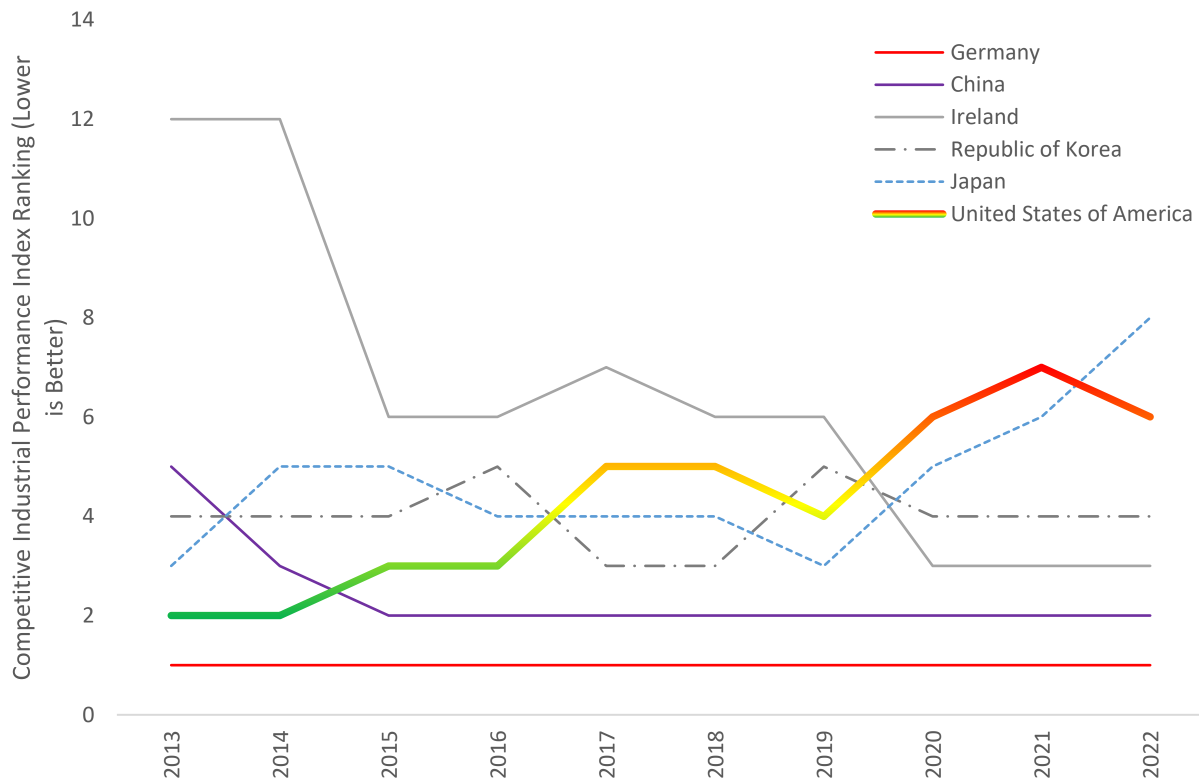


Figure 5.9: Rankings from the Competitive Industrial Performance Index 2024, 150 Total Countries

Source: United Nations Industrial Development Organization. (2024). Competitive Industrial Performance Index. https://stat.unido.org/analytical-tools/country-analytics?country=840&codes=IND_%2CHI_IND

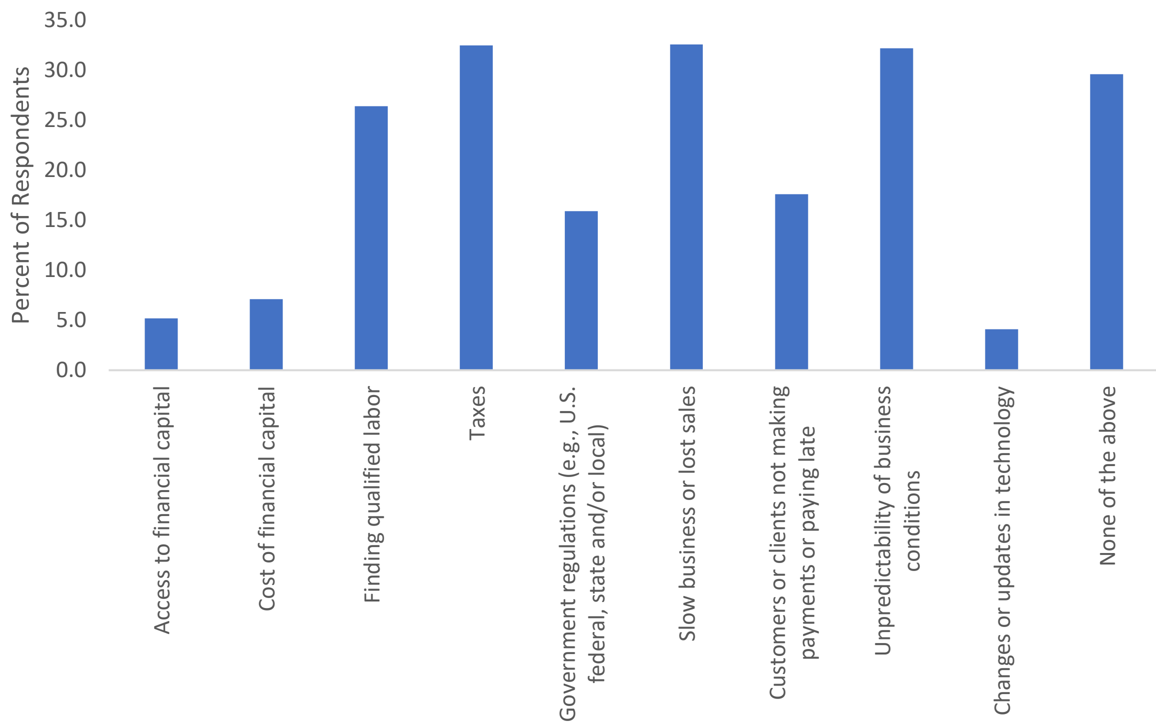


Figure 5.10: Factors Impacting U.S. Business (Annual Survey of Entrepreneurs), 2022

Source: U.S. Census Bureau and National Center for Science and Engineering Statistics, 2023 Annual Business Survey. https://www.test.census.gov/programs-surveys/abs/data/tables.html

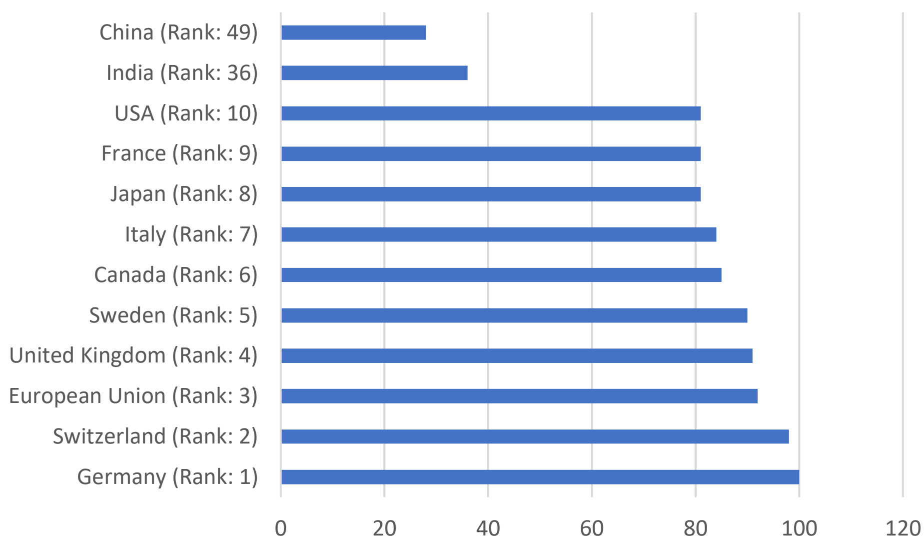


Figure 5.11: Made-in-Country Index, 2017

Source: Loose, Nicolas. (2017). "Made-in-Country Index 2017." https://www.statista.com/page/Made-In-Country-Index

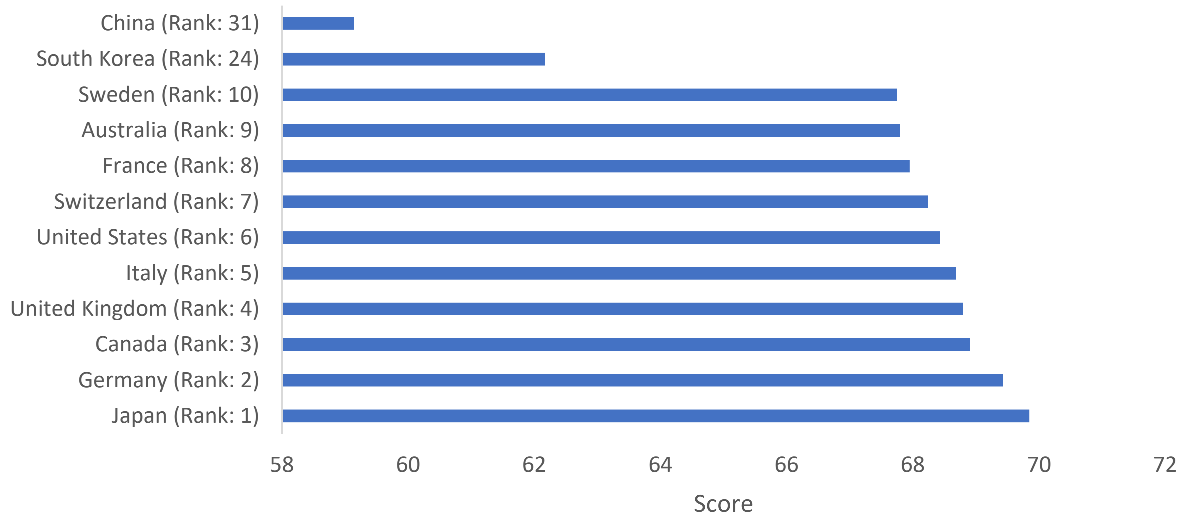


Figure 5.12: Ipsos National Brands Index, 2023

Source: Ipsos. (2023). “Nation Brands Index 2023.” https://www.ipsos.com/en-us/nation-brands-index-2023

6. Discussion

This report provides an overview of the U.S. manufacturing industry. There are 3 aspects of U.S. manufacturing that are considered: (1) how the U.S. industry compares to other countries, (2) the trends in the domestic industry, and (3) the industry trends compared to those in other countries. The U.S. remains a major manufacturing nation; however, other countries are rising rapidly. Manufacturing in the U.S. was significantly impacted by the 2000's recession and the 2020 economy.

The U.S. is a major contributor to global manufacturing, accounting for 15.1 %, making it the second largest, according to the United Nations Statistics Division National Accounts Main Aggregates Database, as seen in Table 6.1. U.S. compound real (i.e., controlling for inflation) annual growth between 1997 and 2022 was 1.7 %, which places the U.S. below the 50^{th} percentile. This growth exceeded that of Germany, France, Canada, Japan, and Australia; however, it is slower than that for the world (3.8 %) and that of many emerging economies. It should be expected that the growth in emerging economies will continue to outpace those in developed economies, as they can use underutilized resources to achieve high growth rates.

The largest subsectors of U.S. manufacturing are chemical products; food and beverage, and tobacco products; computer and electronic products; and motor vehicles, bodies/trailers, and parts. China produces more of all of these except for the category that includes motor vehicles. China produces more than the U.S. in 9 of 11 subsectors for manufacturing. China's manufacturing value added is on an upward trajectory with little signs of slowing. On a per person basis, the U.S. significantly outperforms China; however, China's populations is more than four times that of the U.S. When aggregated together, U.S. and European manufacturing value added exceeds that of Eastern and South-eastern Asia (excluding Japan) for 7 of the 11 subsectors. Computer, electronic, and optical products is among those that Asia produces more value added. For a country such as the U.S. to maintain significant influence in manufacturing, it would likely need to rely in part on allying with other nations.

As suggested by the types of products produced, ranking as a national brand, and research activities (see Table 6.1), the U.S. tends to have strength as a differentiator rather than a cost competitor; that is, evidence suggests the U.S. tends to produce products that require more advanced technology that perform at higher levels, which is probably driven in part by higher education levels. As shown in Table 6.1, Germany, Japan, and to some extent South Korea tend to be differentiators as well; however, South Korea ranks lower as a national brand. There might be some concern regarding U.S. rankings in some measures of research and innovation. Although the U.S. ranks 3^{rd} in research and development expenditures as a percent of GDP, it ranks 18^{th} in researchers per million people, 24^{th} in journal articles per capita, and does not rank first in any item. It is important to note that other countries in Table 6.1, which rank high in various metrics, also rank lower in journal articles per capita. Moreover, journal articles per capita may not be a strong measure of manufacturing innovation and/or competitiveness. The ranking of U.S. researchers per million might be more concerning.

An estimated 26.4 % of businesses indicated that finding qualified labor was having a negative impact on their business. In the World Economic Forum's Competitiveness Index, the U.S.

ranked low in the expected years of schooling (30th) and pupil-to-teacher ratio in primary education (45th). Moreover, some indicators raise concern regarding human capital.

Between 2016 and 2024, 80 % or 16 of the 20 ranked items from the IMD World Competitiveness Country rankings went down for the U.S. Additionally, the U.S. ranks 10th in the made-in-country index and 6th in the Ipsos National Brands Index, suggesting that U.S. products are seen positively, but is not among the very top, such as the top 3 or top 5. Germany performs quite well as it ranks 1st in the Made-in-country index and 2nd in the Ipsos National Brands index. For the last 9 years, it has also ranked 1st for in the Competitive Industrial Performance Index.

Table 6.1: Rankings for a Selection of Metrics and Countries (Lower is Better)

Metric	U.S.	Germany	Japan	South Korea	China
Made-in-Country Index	10	1	8	-	49
Ipsos National Brands Index	6	2	1	24	31
Competitive Industrial Performance Index	6	1	8	4	2
IMD Competitiveness Index	12	24	38	20	14
Patent applications per million people	4	5	2	1	3
R&D Expenditures as % of GDP*	3	10	8	2	20
Researchers per million	18	10	9	1	43
Journal articles	2	4	6	9	1
Journal articles per capita	24	26	38	22	54
Merchandise Exporters	2	3	5	8	1
Manufacturing value added	2	4	3	6	1
Rank in 5-year compound annual growth in manufacturing value added*	127	175	156	100	35
Manufacturing value added per capita (among top ten manufacturing nations)	2	3	4	1	5

Note: Shading is to aid in identifying high/low values.
* Rankings are not shown elsewhere.

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Appendix A. U.S. Semiconductor Manufacturing

U.S. semiconductor manufacturing value added was $34.4 billion in 2021 and was 26.1 % larger in 2021 than it was in 2008, as illustrated in Figure A 1. The industry value added has had a 5-year compound annual growth rate of 7.4 %. The U.S. has a significant presence in the semiconductor manufacturing industry with an estimated 12 % of the global production capacity in 2020 (see Table A 1). As shown in both Table A 1 and Figure A 1, while U.S. semiconductor employment has been relatively flat, manufacturing value added has generally grown; however, global growth has been faster, as seen in Table A 1. The result is that the U.S. share of the industry went from 37 % in 1990 to 12 % in 2020.

As seen in Table A 2, the U.S. has 43 % of the 10 nm to 22 nm process technology market. Generally, the lower the number, the greater the performance and the more technologically advanced the technology because it represents the space for features on a chip.[3] The U.S. has little to no capacity for the most advanced technology, which is at the 10 nm or less process technology. U.S. owned firms, which own facilities around the world, have a commanding position in terms of the design of semiconductors, as seen in Table A 3. Additionally, U.S. firms held significant proportions of national markets, including 53.1 % of the Chinese market, and

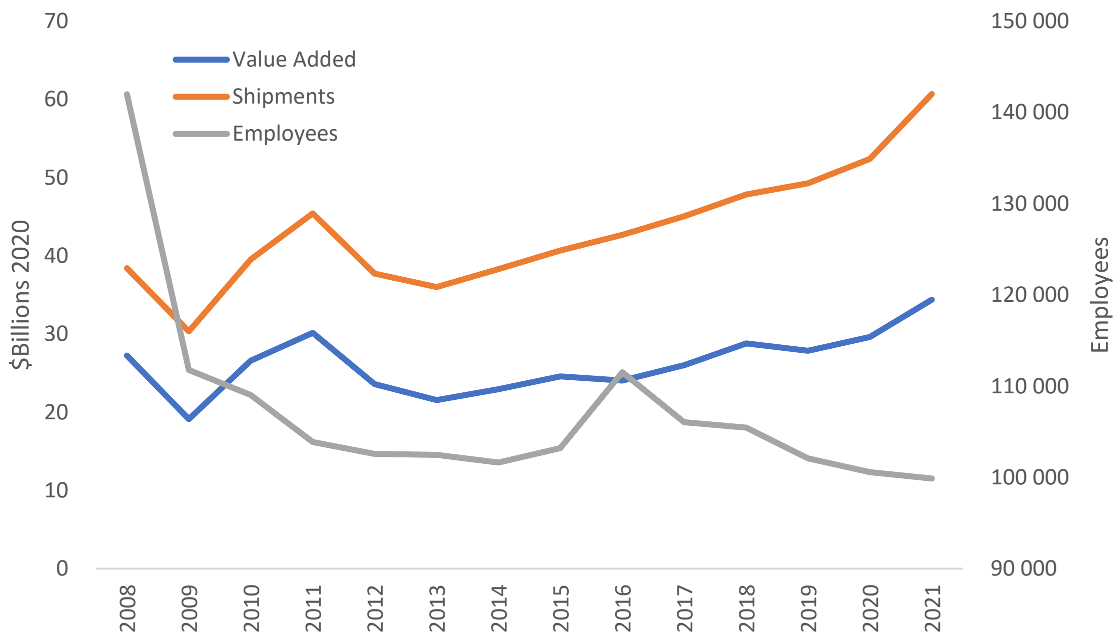

Figure A 1: Semiconductor Shipments, Value Added, and Employment, 2008-2021

Source: U.S. Census Bureau. Annual Survey of Manufactures. 2023. https://www.census.gov/programs-surveys/asm/data.html
Note: Adjusted using the PPI for "semiconductors and related device mfg" from the Bureau of Labor Statistics
Note: 2017 Value Added was interpolated

[3] Congressional Research Service. 2020. "Semiconductors: U.S. Industry, Global Competition, and Federal Policy." https://crsreports.congress.gov/product/pdf/R/R46581

48.3 % of the Asia/other market (see Table A 4). As illustrated in Figure A 2, U.S. productivity between 2016 and 2021 grew significantly with a 6.9 % 5-year compound annual growth in total factor productivity. Between 2018 and 2023, labor productivity had a 1.5 % compound annual growth for labor productivity.

Table A 1: U.S. Share and Growth of Production Capacity

	U.S. Share of Global Capacity	CAGR U.S.	CAGR World
1990	37%		
2000	19%	12.8%	20.20%
2010	13%	5.0%	9.60%
2020	12%	4.0%	4.90%
2030 (Projected)	10%	3.0%	4.60%

Source: Semiconductor Industry Association. 2020a. "Government Incentives and US Competitiveness in Semiconductor Manufacturing." https://www.semiconductors.org/wp-content/uploads/2020/09/Government-Incentives-and-US-Competitiveness-in-Semiconductor-Manufacturing-Sep-2020.pdf

Table A 2: 2019 National Share of Global Process Technology and Value of Subsidies, 2019

		U.S.	China	Taiwan	South Korea	Japan	Europe	Other	TOTAL
Process Technology (lower is more technologically advanced)	< 10 nm	0%	0%	92%	8%	0%	0%	0%	100%
	10-22 nm	43%	3%	28%	5%	0%	12%	9%	100%
	28-45 nm	6%	19%	47%	6%	5%	4%	13%	100%
	> 45 nm	9%	23%	31%	10%	13%	6%	7%	100%
Subsidies 2000-2020 (billions)*		$0	~$50	$0.5+	$7-10	$5-7+	$2.5+	-	
Tax Incentives (2000-2020)**		No	Yes	Yes	Yes	Yes	Yes		
Other Government Incentives (2000-2020)		No	Yes	Yes	Yes	Yes	Yes	-	

Source: Semiconductor Industry Association. "2021 State of the U.S. Semiconductor Industry." https://www.semiconductors.org/wp-content/uploads/2021/09/2021-SIA-State-of-the-Industry-Report.pdf
Source: Semiconductor Industry Association. 2020b. U.S. Needs Greater Semiconductor Manufacturing Incentives. https://www.semiconductors.org/wp-content/uploads/2020/07/U.S.-Needs-Greater-Semiconductor-Manufacturing-Incentives-Infographic1.pdf?utm_source=morning_brew
* Estimates based on SIA analysis of national-level direct funding to companies
** Industry-specific tax incentives

Table A 3: U.S. Company Semiconductor Value Added Occurring Globally, 2019

Category	U.S. Share of Value Added	Category Share of Value Added (Global)*
R&D Intensive		
Electronic Design Automation and Core IP	74%	3%
Logic	67%	30%
Discrete, Analog, and Other	37%	17%
Memory Semiconductors	29%	9%
Manufacturing Equipment	41%	12%
Capital Intensive		
Materials	11%	5%
Wafer Fabrication	12%	19%
Assembly, Packaging, and Testing	2%	6%
TOTAL	38%	100%

* Sum may not equal total due to rounding
Source: Semiconductor Industry Association. "2021 State of the U.S. Semiconductor Industry." https://www.semiconductors.org/wp-content/uploads/2021/09/2021-SIA-State-of-the-Industry-Report.pdf

Table A 4: U.S. Firms Share of National Semiconductor Markets

Region	$Billion	Share that from U.S. Based Firms
Japan	46.8	42.0%
Europe	55.8	48.8%
America	134.4	52.2%
Asia/Other	137.7	48.3%
China	154.3	53.1%
TOTAL	529.0	50.2%

Source: Semiconductor Industry Association. 2024. 2024 Factbook. https://www.semiconductors.org/wp-content/uploads/2024/05/SIA-2024-Factbook.pdf

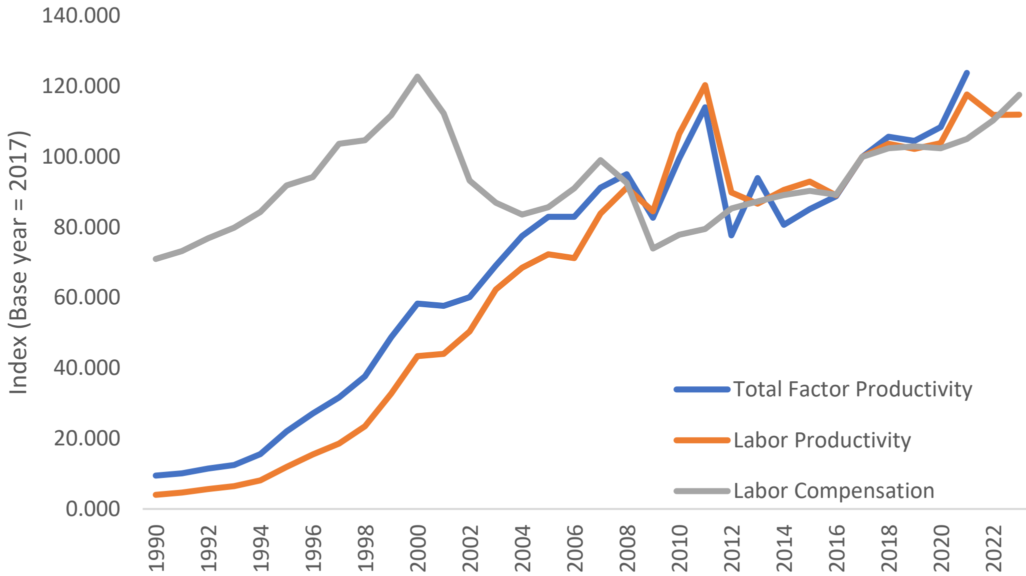

Figure A 2: Semiconductor Industry Productivity Indices, 1990-2021

Source: Bureau of Labor Statistics. 2024g. Productivity. https://www.bls.gov/productivity/data.htm

Appendix B. Additive Manufacturing

Table B.6.2 provides an approximation of the shipments and value added of the goods produced using additive manufacturing in the United States. For this report, this is referred to as the additive manufacturing industry. The estimates below were not revised from the previous year's report. There are other associated activities such as the production of the additive manufacturing machinery and materials. These are costs/inputs of the additive manufacturing industry. The approximated shipments of goods produced using additive manufacturing in the U.S. is $2.8 billion with value added being $1.4 billion. These represent a small proportion of the manufacturing industry; however, it should not be concluded that this technology is not important or impactful, as it is often an input in the production of other goods. For instance, in 2022 utilities were only 1.4 % of GDP, but where would the economy be without electricity. Nuts and bolts are a small proportion of the value of a car, but how would be assemble an automobile without them. Additive manufacturing facilitates rapid prototyping to produce products in a shorter period of time, weight/material reduction, and lower cost production for small batches and customized products, including parts for products that are no longer produced. Moreover, the size of the industry does not represent the economic impact of the technology.

Table B.6.2: Approximation of U.S. Shipments and Value Added of Goods Produced using Additive Manufacturing

Category	Relevant NAICS Codes	Shipments of US Made AM Products ($millions, 2021)*	Total US Shipments ($millions, 2021)	AM Share of Industry Shipments	Total Value Added ($millions, 2021)*	AM Value Added ($millions, 2021)
Motor vehicles	NAICS 3361, 3362, 3363	433.48	620 402	0.07%	180 836	126
Aerospace	NAICS 336411, 336412, 336413	498.80	152 113	0.33%	75 339	247
Medical/dental	NAICS 3391	463.17	94 889	0.49%	62 293	304
Government/military	NAICS 336414, 336415, 336419, 336992	178.14	40 502	0.44%	14 821	65
Architectural	NAICS 3323	133.61	113 646	0.12%	58 817	69
Consumer products/electronics, academic, and other	All other within NAICS 332 through 339	1 054.01	954 970	0.11%	527 054	582
TOTAL	NAICS 332 through 339	2761.2	1 976 521	0.14%	919 160	1 394

* These values are calculated assuming that the percent of total additive manufacturing made products for each industry is the same for the US as it is globally. It is also assumed that the US share of AM systems installed is equal to the share of revenue for AM products

Note: Numbers may not add up to total due to rounding