NIST Technical Note 1935

Annual Manufacturing Review

Douglas S. Thomas

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National Institute of Standards and Technology
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Applied Economics Office
Engineering Laboratory

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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.

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At the Paint Shop in Chrysler Group's Sterling Heights (Mich.) Assembly Plant, a 2015 Chrysler 200 moves through the Underbody Sealing and Underbody Coating station, flipping the vehicle body completely upside down to seal all appropriate seams and compartments. (2014). This image was used in accordance with Fiat Chrysler Automobile's editorial use policy.

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List of Acronyms

ASM: Annual Survey of Manufactures
BEA: Bureau of Economic Analysis
GDP: Gross Domestic Product
IBRD: International Bank for Reconstruction and Development
IDA: International Development Association
ISIC: International Standard Industrial Classification
MAPI: Manufacturers Alliance for Productivity and Innovation
NAICS: North American Industry Classification System
NIST: National Institute of Standards and Technology
PPP: Purchasing Power Parity
SIC: Standard Industrial Classification
UNSD: United Nations Statistics Division

Executive Summary

The purpose of this report is to track 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. This depiction provides change agents, such as public entities and trade groups that invest in advancing the current state of manufacturing, insight into the current state and recent trends in US manufacturing. The report further identifies areas of manufacturing that can have large impacts on costs.

The US remains a major manufacturing nation; however, production and innovation is increasing rapidly in other countries. US manufacturing was significantly impacted by the previous recession and has not returned to pre-recession levels of production or employment. However, between March of 2014 and March of 2015, construction of manufacturing facilities increased significantly, suggesting a rapid increase in investment in US manufacturing that slightly exceeds pre-recession levels.

The US has advantages in technological prowess, innovation, productivity, and research and development; however, education was ranked low in two indices (i.e., IMD World Competitiveness Index and the World Economic Forum's Global Competitiveness Index) and ranked high as being a problematic factor for doing business, which could negatively impact US advantages in the future. Institutions and institutional framework, which include crime, regulatory frameworks, country credit rating, and government spending among other things, was ranked low in two indices. A number of costs were identified as challenges to US manufacturing, including high labor costs.

An input-output analysis of US manufacturing reveals that management is a significant cost along with a number of other non-production costs such as wholesale trade. The number of injuries and the injury rate in US manufacturing has a general downward trend, benefiting employees; however, manufacturing employee compensation has only grown slowly in recent years.

International Comparison – Manufacturing Growth: As seen in Figure 2.1, US compound real (controlling for inflation) annual growth between 1989 and 2014 (i.e., 25-year growth) was 2.2 %, which places the US in the 47th percentile of all countries. This growth exceeded that of Germany, France, Canada, Japan, and Australia; however, it is slower than the global average (3 %) and that of many emerging economies. As seen in Figure 2.2, the compound annual growth for the US between 2009 and 2014 (i.e., 5-year growth) was 0.4 %. This puts the US at the 29th percentile below Japan and Germany.

International Comparison – Manufacturing Industry Size: As seen in Figure 2.3, US manufacturing value added, as measured in constant 2005 dollars, is the second largest just behind that of China. In current dollars, the US produced $1.8 trillion in manufacturing valued added while China produced $1.9 trillion. Among the ten largest manufacturing countries, the US is the 3rd largest manufacturing value added per capita, as seen in Figure 2.4. Out of all countries the US ranks 17th, as seen in Figure 2.5.

International Comparison – Innovation and Competitiveness: As seen in Table 5-1, the US ranked 3rd in 2014 in patent applications per million people, which puts it above the 90th percentile. The US ranked 10th in research and development as a percent of GDP in 2012, which puts at the 90th percentile. In terms of researchers per million people, the US ranked 20th, putting it at the 75th percentile. In journal articles per million people it ranked 21st putting it at the 91st percentile.

The IMD Competitiveness Index ranks the US as 3rd among 60 countries in competitiveness for conducting business. The US ranks low in public finance, prices, and fiscal policy, as seen in Figure 5.1.

The Competitive Industrial Performance Index, published by the United Nations Industrial Development Organization, ranked the US 3rd in its economic performance in 2014. This index assesses an economy's ability to competitively produce and export manufactured goods.

The Deloitte Global Manufacturing Competitiveness Index uses a survey of CEOs to rank countries based on managerial perception. The US was ranked 2nd out of 40 nations. High-cost labor, high corporate tax rates, and increasing investments outside of the US were identified as challenges to US industry. Manufacturers indicated that companies were building high-tech factories in the US due to rising labor costs in China, shipping costs, and low cost shale gas in the US.

The World Economic Forum's 2015-2016 Global Competitiveness Report uses 12 items to assess the competitiveness of 140 economies. As seen in Figure 5.2, the US was ranked 3rd with low rankings in macroeconomic environment, health and primary education, and institutions.

Domestic Focus – Types of Goods Produced: The largest manufacturing subsector in the US is chemical manufacturing followed by computer/electronic products followed by food, beverage, and tobacco products, as seen in Figure 2.12. The compound annual growth rate, calculated using the PPI, for these sectors are 0.7 %, 3.6 %, and -0.6 %, respectively.

Domestic Focus – Economic Recovery: As illustrated in Figure 2.6, manufacturing declined significantly in 2008 and has nearly returned to its peak level occurring in 2007. Manufacturing value added declined more than total US GDP, creating a persistent gap. The result is that first quarter GDP is 10.2 % above its pre-recession peak level while manufacturing is at 1.1 % below its peak level. Moreover, manufacturing value added has not returned to pre-recession levels. However, between March of 2014 and March of 2015, manufacturing construction increased 53 %, suggesting a rapid increase in investment in US manufacturing. This growth is largely due to construction of chemical manufacturing facilities, but may have reached a plateau, as July 2016 manufacturing construction is down 6 % from July of the previous year (see Figure 2.13).

Between January of 2006 and January of 2010, manufacturing employment declined by 19.4 %, as seen in Figure 4.1. As of July 2016, employment in manufacturing is still 13.4 % below its 2006 level. Moreover, manufacturing employment has not returned to pre-recession levels.

Domestic Focus – Manufacturing Supply Chain Costs: As seen in Table 3-4, wholesale trade, the management of companies and enterprises, and oil and gas extraction is a major supply chain cost for manufacturing as a whole and among selected subsectors. As seen in Table 3-5, management occupations, business and financial operations, top executives, operations specialties managers, and business operations specialists occupations are major labor costs for manufacturing as a whole and among selected subsectors. In 2014, the US imported approximately 23.1 % of its intermediate imports, as seen in Table 3-3. As a proportion of output and imports (i.e., a proportion of the total inputs), intermediate imports represented 13.0 %.

Domestic Focus – Manufacturing Safety and Compensation: As seen in Figure 4.2, fatalities, injuries, and the injury rate have had an overall downward trend since 2000. Nonfatal injuries per 100 full-time workers has declined from 9.0 in 2000 to 4.0 in 2014. As seen in Figure 4.5, employee compensation, which includes benefits, has had a 5-year compound annual growth of 1 %.

1 Introduction

1.1 Background

Public entities have a significant role in the US innovation system.[1] 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.[2] 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 US innovation. The vastness and diversity of US federal research and development programs along with their changing nature make them difficult to categorize and appreciate,[3] but even the origins of Google are rooted in a public grant through the National Science Foundation.[4, 5] One objective of public innovation is to enhance economic security and improve our quality of life[6], which is achieved in part by advancing efficiency in which resources are consumed or impacted by production. For example, the National Institute of Standards and Technology (NIST) has expended resources in supporting the development of the International Standard for the Exchange of Product Model Data (STEP),[7] which reduces the need for duplicative efforts such as re-entering design data. Another effort to advance efficiency is the development of the Core Manufacturing Simulation Data (CMSD) specification, which enables data exchange for manufacturing simulations.[8]

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

[1] Block, Fred L and Matthew R. Keller. State of Innovation: The US Government's Role in Technology Development. New York, NY; Taylor & Francis; 2016.
[2] Wessner CW and Wolff AW. Rising to the Challenge: US Innovation Policy for the Global Economy. National Research Council (US) Committee on Comparative National Innovation Policies: Best Practice for the 21st Century. Washington (DC): National Academies Press (US). 2012. <http://www.ncbi.nlm.nih.gov/books/NBK100307/>
[3] Block at 27.
[4] National Science Foundation. "On the Origins of Google." <https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=100660>
[5] Block, Fred L and Matthew R. Keller. State of Innovation: The US Government's Role in Technology Development. New York, NY; Taylor & Francis; 2016: 23.
[6] National Institute of Standards and Technology. "NIST General Information." <http://www.nist.gov/public_affairs/general_information.cfm>
[7] Robert D. Niehaus, Inc. Reassessing the Economic Impacts of the International Standard for the Exchange of Product Model Data (STEP) on the US Transportation Equipment Manufacturing Industry. November 26, 2014. Contract SB1341-12-CN-0084.
[8] Lee, Yung-Tsun Tina, Frank H. Riddick, and Björn Johan Ingemar Hohansson (2011). "Core Manufacturing Simulation Data – A Manufacturing Simulation Integration Standard: Overview and Case Studies." International Journal of Computer Integrated Manufacturing. vol 24 issue 8: 689-709.

emphasis on single technologies/industries."[9] System-level inefficiencies can result from companies working independently from one another. For instance, the "bullwhip effect" is an example where variations in demand are magnified through a supply chain.[10, 11] Another issue lies in the location of supply chain entities. Manufacturers individually decide on the location of production; however, individual decisions may not result in an efficient national supply chain arrangement. Firm level analyses of data can be a source of inefficiencies, as this can hide the economy-wide impacts. For example, a firm might conclude that their transportation cost represents a small portion of their total; however, it is reasonable to expect that they would not consider their suppliers' transportation costs included in material purchases. The result is that the true cost of transportation through the manufacturing life-cycle may not be examined at the firm level.

1.2 Purpose

The purpose of this report is to track 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. This depiction provides change agents, such as public entities and trade groups that invest in advancing the current state of manufacturing, insight into the current state and recent trends in US manufacturing. The report further identifies areas of manufacturing that can have large impacts on costs.

1.3 Scope and Approach

There are numerous aspects one could examine in manufacturing. This report discusses a subset of stakeholders and focuses on US manufacturing. Among the many datasets available, it utilizes those that are prominent and are consistent with economic standards. These boundaries 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 "US innovation and competitiveness," this report focuses on activities within the national borders. In a world of globalization, this effort is challenging, as some of the parts and materials being used in US manufacturing activities are imported. The imported values are a relatively small percentage of the total activity. The U.S. imported 10.8 % of its supply chain, as measured in terms of 2009 imported value added (i.e., supply chain value added used by a nation's manufacturing industry as a percent of all value added associated with that nation's manufacturing

[9] Tassey Gregory. (2010) "Rationales and Mechanisms for Revitalizing US Manufacturing R&D Strategies." *Journal of Technology Transfer*. 35. 283-333.
[10] Lee, H. L., P. Padmanabhan, and S. Whang. The Bullwhip Effect in Supply Chains. Sloan Management Review. 38 (1997) 93-102.
[11] Bray, Robert L. and Haim Mendelson. Management Science. "Information Transmission and the Bullwhip Effect: An Empirical Investigation." March 2012. 860-875: <http://dx.doi.org/10.1287/mnsc.1110.1467>

industry).[12] These imports have environmental impacts, require natural resources, and utilize labor; thus, they are important in regards to a firm's production. NIST, however, promotes US innovation and industrial competitiveness; therefore, the imported goods and services are outside of the scope of this report.

Standard Data Categorization: US domestic data tends to be organized using the NAICS, which is the standard used by federal statistical agencies classifying business establishments in the United States. NAICS was jointly developed by the US 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 digits 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 subcategories. 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 US manufacturing activity.[13] This report selects from sources that are the most prominent and reveal the most information about the US manufacturing industry. These data include the United Nations Statistics Division's National Accounts Main Aggregates Database and the US Census Bureau's Annual Survey of Manufactures, among others.[14] 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.

[12] Thomas, Douglas S. The US Manufacturing Value Chain: An International Perspective. February 2014. NIST Technical Note 1810. <http://www.nist.gov/customcf/get_pdf.cfm?pub_id=914022>
[13] Thomas, Douglas S. The Current State and Recent Trends of the US Manufacturing Industry. NIST Special Publication 1142. <http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1142.pdf>
[14] See <http://unstats.un.org/unsd/snaama/dnlList.asp> and <http://www.census.gov/manufacturing/asm/>

2 Value Added

Value added is the primary metric used to measure economic activity. It is 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 firms.[15] 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 very complete dataset that covers a large number of countries over a significant period of time. In 2014, there was $9.8 trillion in value added (i.e., GDP) by global manufacturing, which is 18 % of the value added by all industries ($55.1 trillion), according to the United Nations Statistics Division. The top 5 manufacturing countries accounted for $5.7 trillion or 58.3 % of manufacturing value added: China (19.1 %), United States (18.4 %), Japan (10.2 %), Germany (6.9 %), and South Korea (3.7 %).[16]

As seen in Figure 2.1, US compound real (controlling for inflation) annual growth between 1989 and 2014 was 2.2 %, which places the US in the 47th percentile of all countries. This growth exceeded that of Germany, France, Canada, Japan, and Australia; however, it is slower than the global average (3 %) 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 US 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 US between 2009 and 2014 was 0.4 %. This puts the US at the 29th percentile below Japan and Germany.

As see in Figure 2.3, US manufacturing value added, as measured in constant 2005 dollars, is the second largest just behind that of China. In current dollars, the US produced $1.8 trillion in manufacturing valued added while China produced $1.9 trillion. Among the ten largest manufacturing countries, the US is the 3rd largest manufacturing value added per capita, as seen in Figure 2.4. Out of all countries the US ranks 17th, as seen in Figure 2.5. This ranking is improved from the early 1990's where it was ranked as low as the 21st largest, but it is down since 2010 where it was ranked 14th. It is important to note that there are varying means for adjusting data that can change the rankings. The

[15] Dornbusch, Rudiger, Stanley Fischer, adn Richard Startz. 2000. Macroeconomics. 8th ed. London, UK: McGraw-Hill.

[16] United Nations Statistics Division. "National Accounts Main Aggregates Database." <http://unstats.un.org/unsd/snaama/Introduction.asp>

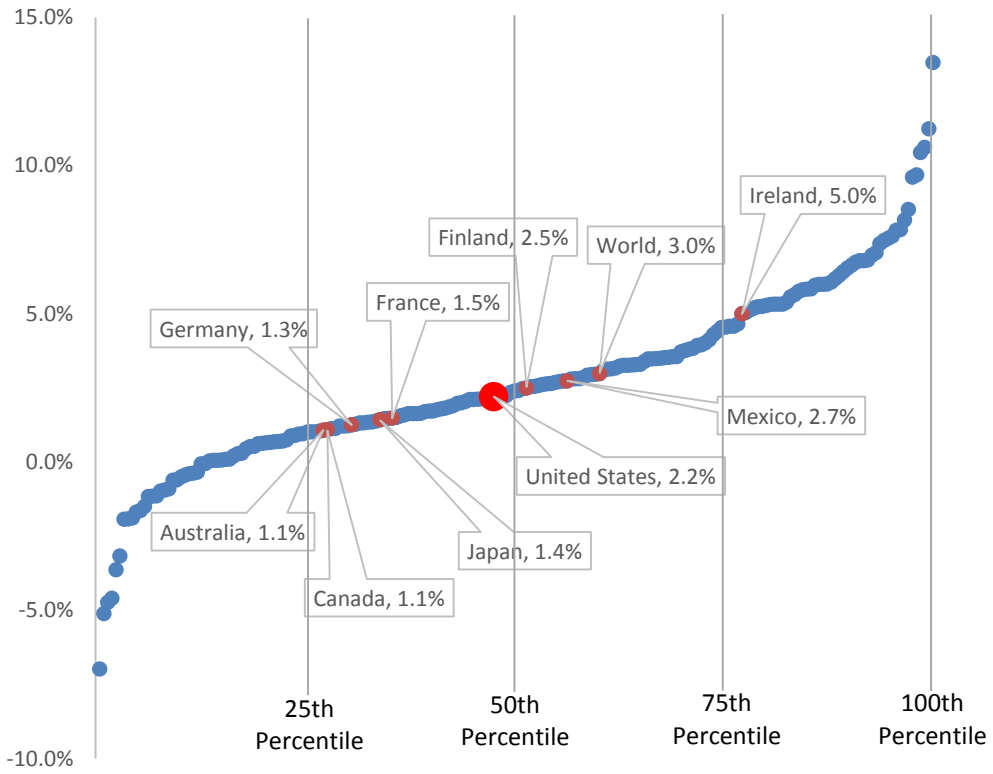


Figure 2.1: National 25 Year Compound Annual Growth, by Country (1989 to 2014)

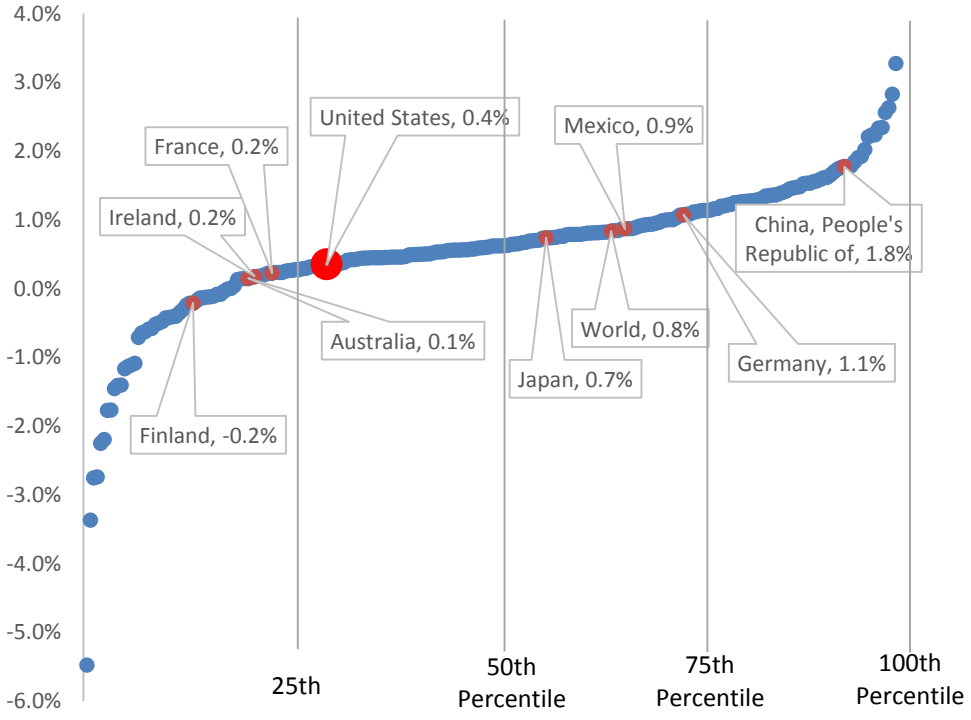


Figure 2.2: National 5 Year Compound Annual Growth, by Country (2009 to 2014)

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 data for these calculations.[17] Market based rates tend to be relevant for internationally traded goods;[18] therefore, this report utilizes these rates.

2.2 Domestic Details

Annual Survey of Manufactures: According to the 2014 Annual Survey of Manufactures (ASM) data shown in Table 2-1, the manufacturing sector produced $2400 billion in value added in 2014, up 1.2 % from $2356 billion in 2013.[19] Value added in machinery manufacturing (NAICS 333), computer and electronic product manufacturing (NAICS 334), electrical equipment (NAICS 335), and transportation equipment (NAICS 336)

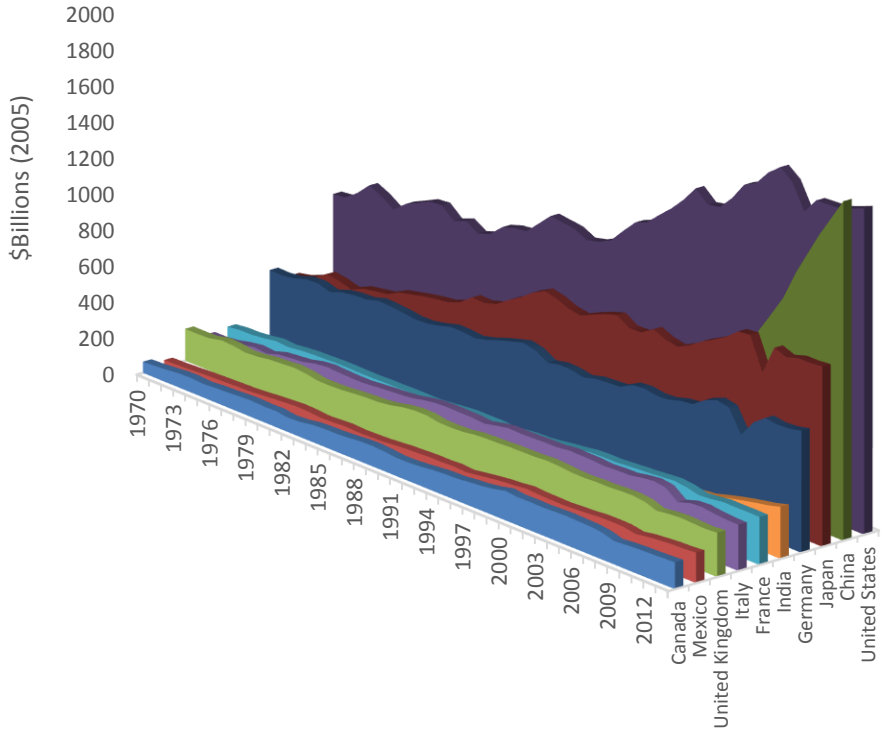


Figure 2.3: Manufacturing Value Added, Top 10 Manufacturing Countries (1970 to 2014)

[17] Callen, Tim. March 2007. PPP Versus the Market: Which Weight Matters? Finance and Development. Vol 44 number 1. <http://www.imf.org/external/pubs/ft/fandd/2007/03/basics.htm>
[18] Ibid.
[19] Census Bureau. "Annual Survey of Manufactures." February 2015. Accessed from the American FactFinder. <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml> and Census Bureau. "Economic Census." March 2015. Accessed from the American FactFinder. <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

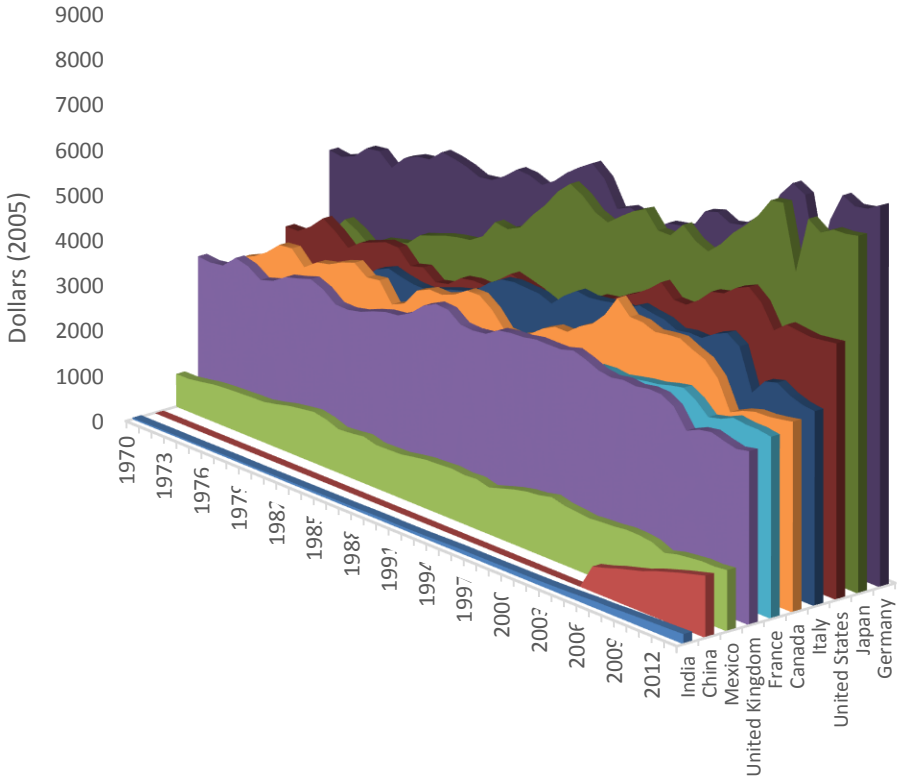


Figure 2.4: Manufacturing Value Added Per Capita, Top 10 Manufacturing Countries (1970 to 2013)

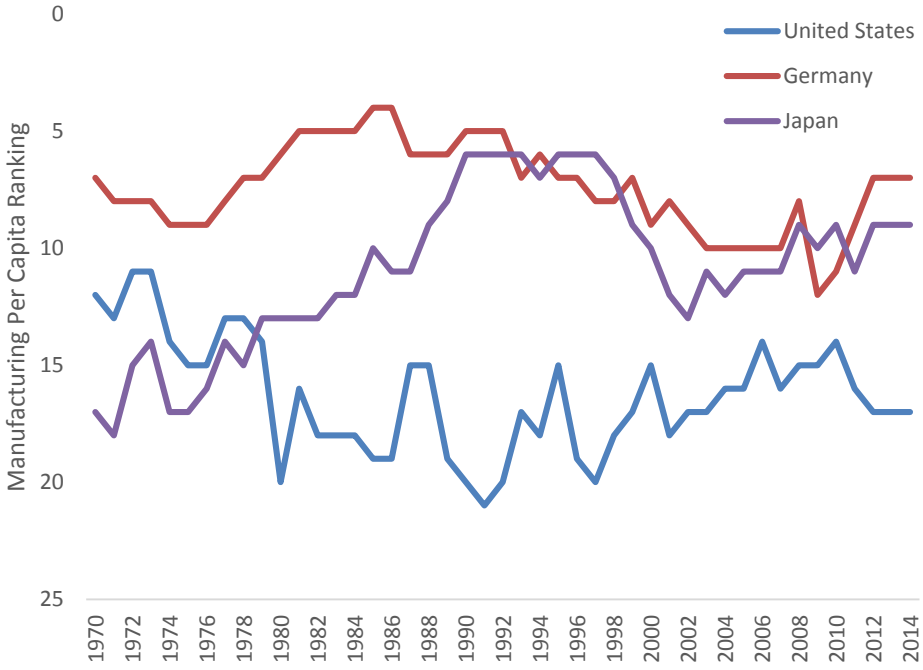


Figure 2.5: Manufacturing Per Capita Ranking

grew 5.1 %, -0.7 %, 2.8 %, and 7.8 % respectively. Shipments increased 1.2 % over the same period to a total of $5881 billion. The ASM calculation of value added is equal to the value of shipments less the cost of materials, supplies, containers, fuel, purchased electricity, and contract work. It is adjusted by the addition of value added by merchandising operations plus the net change in finished goods and work-in-process goods:

$$ASM\ Value\ Added = shipments - net\ inventories\ shipped - suppliers\ of\ materials + merchandising\ operations$$

Value added avoids the duplication caused from the use of products of some establishments as materials. It is important to note that the Bureau of Economic Analysis (BEA) and the ASM calculate value added differently. The BEA, which follows the more traditional method, calculates value added as "gross output (sales or receipts and other operating income, plus inventory change) less intermediate inputs (consumption of goods and services purchased from other industries or imported)." Moreover, the difference is that ASM's calculation of value added includes purchases from other industries such as mining and construction while BEA's does not include it. Table 2-1 has both the ASM's calculation and a calculation that follows the more traditional approach.

Net income, which could also be referred to as profit, was $798 billion in 2014, which equates to 16.3 % of expenditures. Net income as a percent of expenditures for machinery manufacturing (NAICS 333), computer and electronic product manufacturing (NAICS 334), electrical equipment (NAICS 335), and transportation equipment (NAICS 336) was 17.5 %, 11.8 %, 19.2 %, and 11.4 %.

Table 2-1: Manufacturing Activity by Economic Measure by Subsector

	2013 ($Billions 2013)	2014 ($Billions 2014)	Percent Change
I. Manufacturing Shipments and Value Added			
a. TOTAL MANUFACTURING			
i. Net Inventories Shipped	-9.41	-5.71	39.3%
ii. Depreciation of Capital	185.51	187.78	1.2%
iii. Net Income	791.24	798.22	0.9%
iv. Expenditures	4 842.41	4 900.60	1.2%
a. Suppliers of Materials	3 463.51	3 486.76	0.7%
v. Shipments (i + ii + iii + iv)	**5 809.74**	**5 880.89**	**1.2%**
vi. ASM Value Added = v - i - iv.a + adjustment[1]	**2 356.03**	**2 400.06**	**1.9%**
vii. Value Added = v - i - iv + Compensation [2]	**1 766.85**	**1 789.23**	**1.3%**
viii. BEA Value Added	**1 829.50**	**1 922.90**	**5.1%**
b. NAICS 324: Petroleum & coal products mfg			
i. Net Inventories Shipped	0.39	8.48	2078.0%
ii. Depreciation of Capital	10.94	10.09	-7.8%
iii. Net Income	62.02	35.94	-42.0%
iv. Expenditures	779.45	732.00	-6.1%
a. Suppliers of Materials	722.51	681.48	-5.7%
v. Shipments (i + ii + iii + iv)	**852.80**	**786.51**	**-7.8%**
vi. ASM Value Added = v - i - iv.a + adjustment	**129.96**	**96.58**	**-25.7%**
vii. Value Added = v - i - iv + Compensation	**85.99**	**59.29**	**-31.1%**
c. NAICS 325: Chemical mfg			
i. Net Inventories Shipped	-1.28	0.06	104.8%
ii. Depreciation of Capital	30.22	30.34	0.4%
iii. Net Income	195.73	197.96	1.1%
iv. Expenditures	560.94	560.33	-0.1%
a. Suppliers of Materials	416.10	406.86	-2.2%
v. Shipments (i + ii + iii + iv)	**785.62**	**788.69**	**0.4%**
vi. ASM Value Added = v - i - iv.a + adjustment	**371.17**	**382.01**	**2.9%**
vii. Value Added = v - i - iv + Compensation	**294.92**	**298.34**	**1.2%**
d. NAICS 326: Plastics & rubber products mfg			
i. Net Inventories Shipped	-0.71	-0.63	10.5%
ii. Depreciation of Capital	9.78	10.19	4.2%
iii. Net Income	24.95	23.89	-4.2%
iv. Expenditures	191.75	201.75	5.2%
a. Suppliers of Materials	122.13	127.67	4.5%
v. Shipments (i + ii + iii + iv)	**225.76**	**235.20**	**4.2%**
vi. ASM Value Added = v - i - iv.a + adjustment	**104.34**	**108.24**	**3.7%**
vii. Value Added = v - i - iv + Compensation	**76.17**	**77.18**	**1.3%**

	2013 ($Billions 2013)	2014 ($Billions 2014)	Percent Change
e. NAICS 327: Nonmetallic mineral product mfg			
i. Net Inventories Shipped	-0.38	-0.30	22.5%
ii. Depreciation of Capital	8.15	8.73	7.0%
iii. Net Income	11.94	11.99	0.5%
iv. Expenditures	86.47	93.24	7.8%
a. Suppliers of Materials	47.26	50.11	6.0%
v. Shipments (i + ii + iii + iv)	**106.18**	**113.67**	**7.0%**
vi. ASM Value Added = v - i - iv.a + adjustment	**59.30**	**63.90**	**7.8%**
vii. Value Added = v - i - iv + Compensation	**42.40**	**43.99**	**3.8%**
f. NAICS 331: Primary metal mfg			
i. Net Inventories Shipped	-0.21	-1.22	-469.5%
ii. Depreciation of Capital	8.79	8.80	0.1%
iii. Net Income	22.01	24.16	9.8%
iv. Expenditures	232.63	231.83	-0.3%
a. Suppliers of Materials	175.24	174.45	-0.4%
v. Shipments (i + ii + iii + iv)	**263.21**	**263.56**	**0.1%**
vi. ASM Value Added = v - i - iv.a + adjustment	**88.10**	**90.39**	**2.6%**
vii. Value Added = v - i - iv + Compensation	**62.59**	**64.92**	**3.7%**
g. NAICS 332: Fabricated metal product mfg			
i. Net Inventories Shipped	-1.24	-2.27	-83.0%
ii. Depreciation of Capital	13.78	14.25	3.4%
iii. Net Income	37.28	39.93	7.1%
iv. Expenditures	297.28	307.05	3.3%
a. Suppliers of Materials	162.85	168.70	3.6%
v. Shipments (i + ii + iii + iv)	**347.10**	**358.96**	**3.4%**
vi. ASM Value Added = v - i - iv.a + adjustment	**185.66**	**192.56**	**3.7%**
vii. Value Added = v - i - iv + Compensation	**138.87**	**144.93**	**4.4%**
h. NAICS 333: Machinery mfg			
i. Net Inventories Shipped	-0.54	-2.62	-387.8%
ii. Depreciation of Capital	10.72	10.91	1.8%
iii. Net Income	51.16	58.55	14.4%
iv. Expenditures	332.18	333.61	0.4%
a. Suppliers of Materials	207.87	207.20	-0.3%
v. Shipments (i + ii + iii + iv)	**393.53**	**400.44**	**1.8%**
vi. ASM Value Added = v - i - iv.a + adjustment	**186.46**	**195.94**	**5.1%**
vii. Value Added = v - i - iv + Compensation	**140.41**	**148.32**	**5.6%**
i. NAICS 334: Computer & electronic product mfg			
i. Net Inventories Shipped	-0.27	0.53	296.0%
ii. Depreciation of Capital	14.69	14.51	-1.2%
iii. Net Income	28.39	30.66	8.0%
iv. Expenditures	265.72	259.00	-2.5%
a. Suppliers of Materials	130.36	127.11	-2.5%
v. Shipments (i + ii + iii + iv)	**308.53**	**304.70**	**-1.2%**
vi. ASM Value Added = v - i - iv.a + adjustment	**178.39**	**177.11**	**-0.7%**
vii. Value Added = v - i - iv + Compensation	**124.88**	**125.11**	**0.2%**

	2013 ($Billions 2013)	2014 ($Billions 2014)	Percent Change
j. NAICS 335: Electrical equipment, appliance, & component mfg			
i. Net Inventories Shipped	-0.33	-0.21	37.2%
ii. Depreciation of Capital	3.47	3.52	1.6%
iii. Net Income	19.14	19.65	2.6%
iv. Expenditures	101.23	102.53	1.3%
a. Suppliers of Materials	64.17	64.40	0.4%
v. Shipments (i + ii + iii + iv)	**123.51**	**125.50**	**1.6%**
vi. ASM Value Added = v - i - iv.a + adjustment	**59.63**	**61.32**	**2.8%**
vii. Value Added = v - i - iv + Compensation	**46.23**	**47.15**	**2.0%**
k. NAICS 336: Transportation equipment mfg			
i. Net Inventories Shipped	-3.28	-4.47	-36.2%
ii. Depreciation of Capital	23.61	25.36	7.4%
iii. Net Income	77.47	90.57	16.9%
iv. Expenditures	743.22	791.88	6.5%
a. Suppliers of Materials	541.11	580.70	7.3%
v. Shipments (i + ii + iii + iv)	**841.01**	**903.33**	**7.4%**
vi. ASM Value Added = v - i - iv.a + adjustment	**303.16**	**326.85**	**7.8%**
vii. Value Added = v - i - iv + Compensation	**222.24**	**241.21**	**8.5%**
l. NAICS 339: Miscellaneous mfg			
i. Net Inventories Shipped	-0.08	-0.70	-824.7%
ii. Depreciation of Capital	5.12	5.15	0.5%
iii. Net Income	33.27	33.47	0.6%
iv. Expenditures	117.57	118.71	1.0%
a. Suppliers of Materials	56.98	57.53	1.0%
v. Shipments (i + ii + iii + iv)	**155.89**	**156.63**	**0.5%**
vi. ASM Value Added = v - i - iv.a + adjustment	**98.89**	**99.84**	**1.0%**
vii. Value Added = v - i - iv + Compensation	**74.79**	**75.15**	**0.5%**
m. Food mfg			
i. Net Inventories Shipped	-0.40	-0.56	-38.5%
ii. Depreciation of Capital	16.91	17.52	3.6%
iii. Net Income	118.39	121.73	2.8%
iv. Expenditures	627.95	651.82	3.8%
a. Suppliers of Materials	497.59	516.09	3.7%
v. Shipments (i + ii + iii + iv)	**762.85**	**790.51**	**3.6%**
vi. ASM Value Added = v - i - iv.a + adjustment	**265.55**	**274.96**	**3.5%**
vii. Value Added = v - i - iv + Compensation	**208.10**	**213.81**	**2.7%**
n. Other: Apparel, wood product, and printing mfg			
i. Net Inventories Shipped	-1.08	-1.81	-67.6%
ii. Depreciation of Capital	29.58	30.02	1.5%
iii. Net Income	109.24	108.13	-1.0%
iv. Expenditures	506.01	516.86	2.1%
a. Suppliers of Materials	319.34	324.46	1.6%
v. Shipments (i + ii + iii + iv)	**643.75**	**653.20**	**1.5%**
vi. ASM Value Added = v - i - iv.a + adjustment	**325.42**	**330.37**	**1.5%**
vii. Value Added = v - i - iv + Compensation	**249.27**	**249.81**	**0.2%**

[1] It is adjusted by the addition of value added by merchandising operations plus the net change in finished goods and work-in-process goods.
[2] Compensation includes payroll and fringe benefits (not shown)

Bureau of Economic Analysis – Chained Dollars: There are two primary methods for adjusting value added for inflation. The first is using chained dollars, which uses a changing basket of goods to adjust for inflation. The second uses an unchanging basket of goods to adjust for inflation. [20] The BEA estimate for manufacturing value added in 2015 was $2168 billion. Using chained dollars from the BEA shows that manufacturing increased by 0.3 % in the first quarter of 2016[21] and contributed 11.7 % of GDP growth since the first quarter of 2014.[22]

As illustrated in Figure 2.6, manufacturing declined significantly in 2008 and has nearly returned to its peak level occurring in 2007. Manufacturing value added declined more than total US GDP, creating a persistent gap. The result is that first quarter GDP in 2016 is 10.2 % above its pre-recession peak level while manufacturing is at 1.1 % below its peak level. This is largely driven by nondurable goods manufacturing, which is 7.1 % below its peak occurring in 2007.[23]

Figure 2.7 and Figure 2.8 provide data on durable and nondurable goods. As seen in Figure 2.7, value added for a number of durable goods is higher in 2014 than it was in 2006, including computer and electronic products and motor vehicles. The growth in durable goods is largely driven by computer and electronic products. As seen in Figure 2.8, in 2014 every category of nondurable goods except petroleum and coal products was below its 2006 value, including chemical manufacturing and plastics and rubber. The largest manufacturing subsector in the US is chemical manufacturing followed by computer and electronic products and food, beverage, and tobacco products, as seen in Figure 2.9.

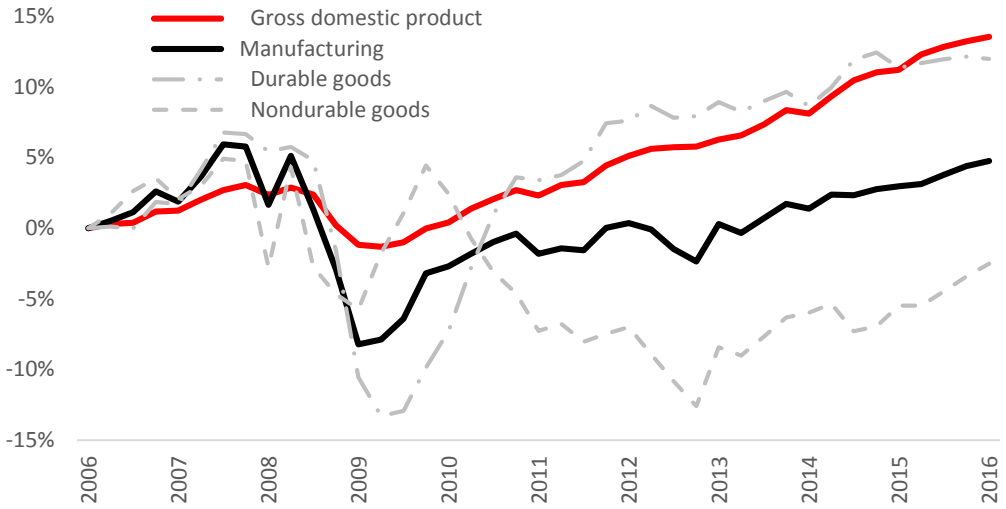
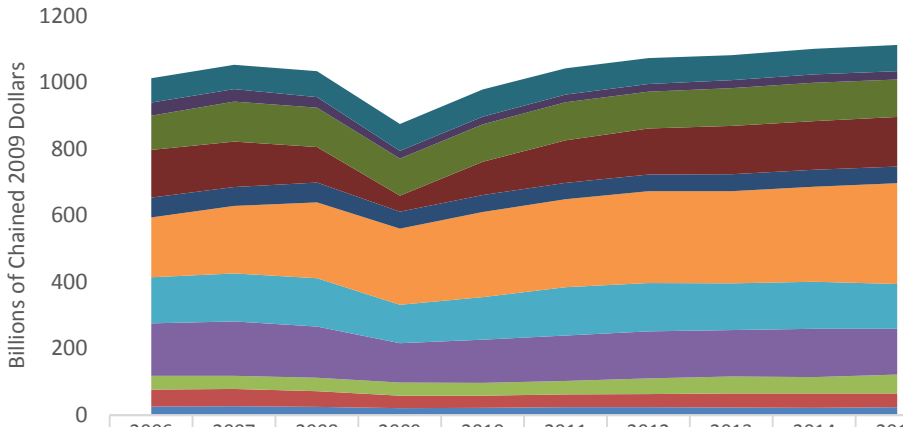


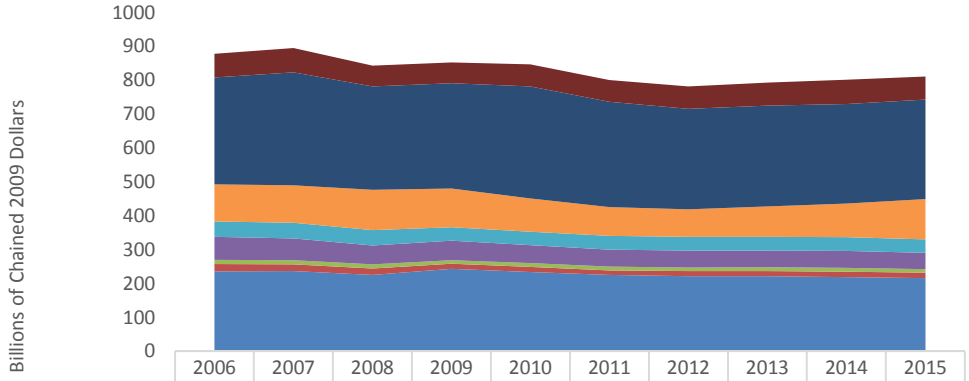
Figure 2.6: Cumulative Percent Change in Value Added (2009 Chained Dollars)

[20] Dornbusch, Rudiger, Stanley Fischer, and Richard Startz. Macroeconomics. Eighth Edition. (Boston, McGraw Hill, 2001): 32.
[21] Billions of chained dollars seasonally adjusted at annual rates
[22] Growth estimates were made using billions of chained 2009 dollars seasonally adjusted at annual rates.
[23] Bureau of Economic Analysis. "Industry Economic Accounts Data."
<http://www.bea.gov/iTable/index_industry_gdpIndy.cfm>



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Miscellaneous manufacturing	73	74	78	80	82	79	78	75	77	79
Furniture and related products	40	37	32	23	23	24	23	25	25	25
Other transportation equipment	103	121	118	112	112	114	111	113	115	113
Motor vehicles and parts	143	136	107	48	100	127	138	146	146	148
Electrical equipment/appliances	60	57	60	50	51	49	50	51	51	50
Computer and electronic products	180	203	228	229	256	265	276	277	286	303
Machinery	139	145	145	116	128	145	144	141	141	135
Fabricated metal products	158	164	154	118	129	137	142	139	145	138
Primary metals	41	39	41	40	38	40	47	51	49	57
Nonmetallic mineral products	51	51	47	37	37	39	40	42	43	42
Wood products	26	27	25	21	21	23	23	23	22	23

Figure 2.7: Value Added for Durable Goods by Type (chained dollars), 2006-2015



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Plastics and rubber products	70	71	62	62	65	64	67	68	71	68
Chemical products	315	334	305	310	330	311	296	297	294	294
Petroleum and coal products	109	111	119	115	99	85	81	90	99	118
Printing and related activities	45	47	46	39	40	41	41	41	41	40
Paper products	69	64	56	59	53	51	50	50	50	49
Apparel, leather, and allied products	13	12	12	10	11	11	10	11	11	10
Textile mills and products	21	20	19	15	16	13	15	16	16	16
Food, beverage, and tobacco	236	236	225	243	233	225	222	221	219	216

Figure 2.8: Value Added for Nondurable Goods by Type (chained dollars), 2006-2015

NOTE: CAG5 = 5 year compound annual growth rate

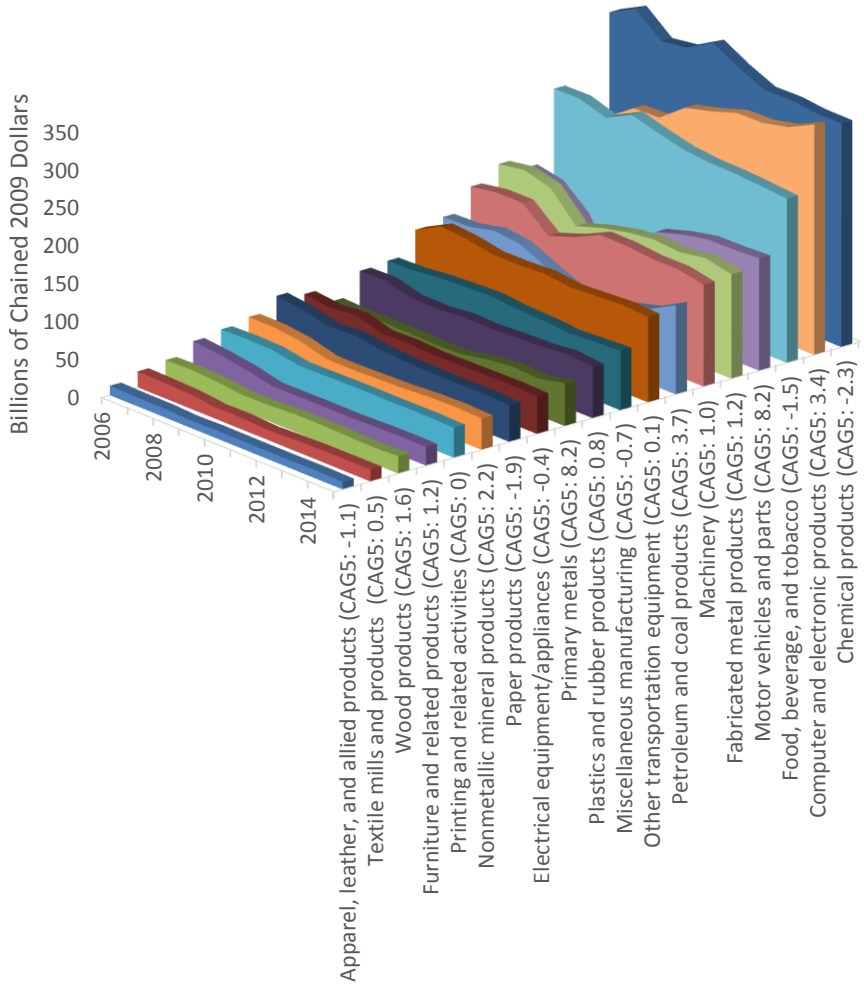
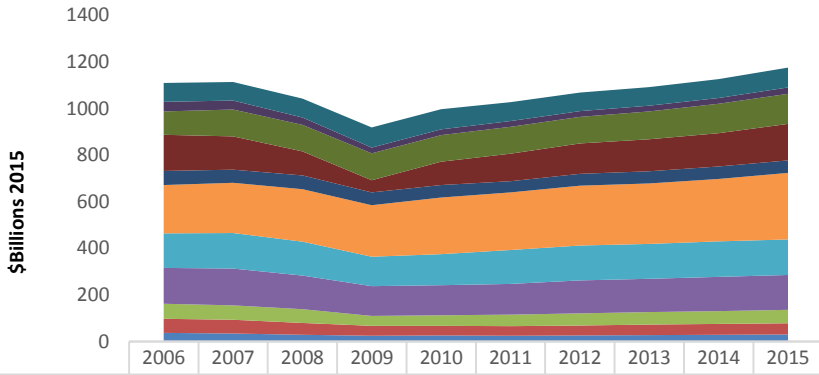


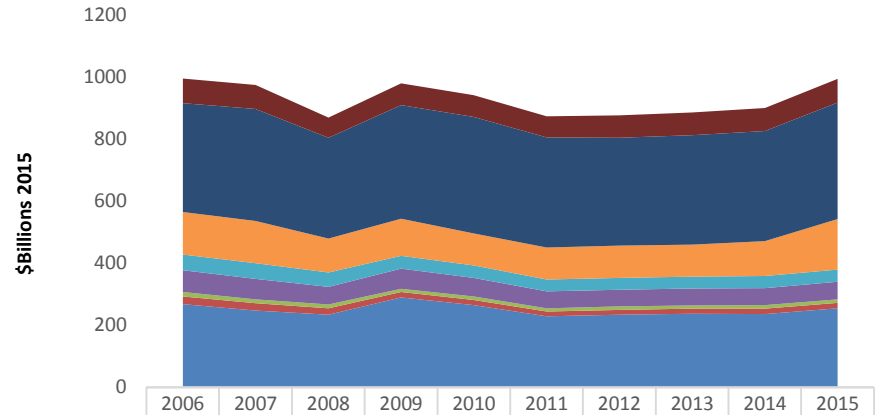
Figure 2.9: Manufacturing Value Added by Subsector (chained dollars)

Bureau of Economic Analysis – Constant Dollars: Some concerns have been raised regarding the use of chained dollars to adjust for inflation; therefore, it is prudent to examine manufacturing value added using the producer price index. Figure 2.10 and Figure 2.11 presents value added for durable and nondurable goods adjusted using the producer price index from the Bureau of Labor Statistics. The general trends are similar to those calculated using chained dollars; however, the 2015 total for manufacturing using chained dollars is 2.5 % higher than the 2006 value while the constant dollar value is only 1.6 % higher. As seen in Figure 2.12, the growth in computer and electronic manufacturing is more modest using the producer price index, 3.6 % growth over the period compared to 6.0 %. This difference illustrates the concern in regards to chained dollars compared to constant dollars.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Miscellaneous manufacturing	81	81	82	86	86	81	80	79	81	85
Furniture and related products	41	38	32	25	24	24	24	25	26	27
Other transportation equipment	100	116	114	115	114	116	114	119	126	129
Motor vehicles, bodies and trailers, and parts	156	143	102	53	100	118	131	138	142	157
Electrical equipment, appliances, and components	61	57	60	54	52	48	51	53	53	55
Computer and electronic products	207	215	226	222	244	247	257	259	268	285
Machinery	148	152	146	126	133	146	149	150	153	153
Fabricated metal products	154	157	144	127	129	132	141	142	147	149
Primary metals	65	62	58	43	45	49	53	53	55	58
Nonmetallic mineral products	61	59	50	42	41	41	42	46	48	49
Wood products	36	34	29	25	26	25	26	27	28	30

Figure 2.10: Value Added for Durable Goods by Type (constant dollars), 2006-2015



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Plastics and rubber products	79	78	64	70	70	68	72	72	74	76
Chemical products	351	360	325	366	375	354	348	353	354	375
Petroleum and coal products	136	136	109	119	104	103	104	103	113	163
Printing and related support activities	50	51	47	41	40	38	38	38	38	40
Paper products	71	66	57	65	59	54	54	55	55	56
Apparel and leather and allied products	14	13	13	11	11	11	11	11	11	11
Textile mills and textile product mills	24	23	20	17	17	15	16	17	17	18
Food and beverage and tobacco products	268	247	233	289	264	228	233	236	236	254

Figure 2.11: Value Added for Nondurable Goods by Type (constant dollars), 2006-2015

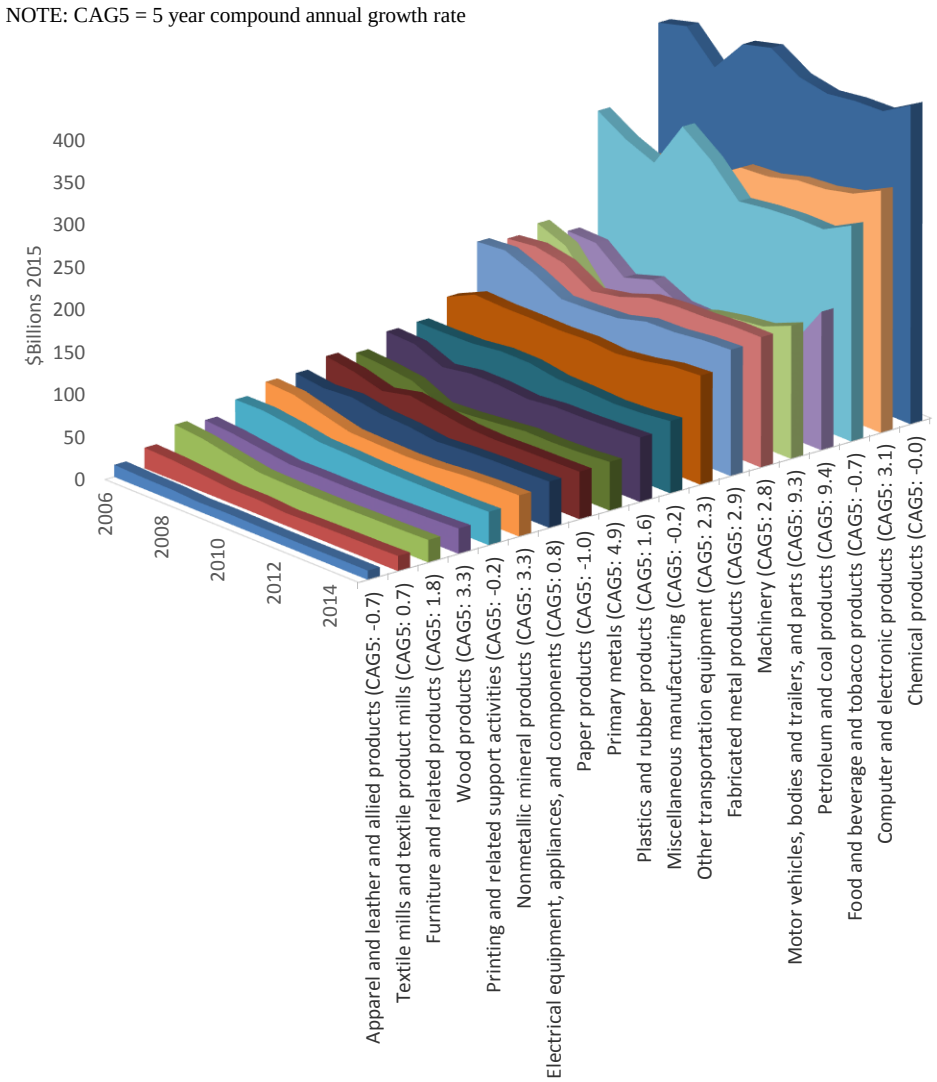


Figure 2.12: Manufacturing Value Added by Subsector (constant dollars)

Construction Put in Place: Construction of new manufacturing facilities can be indicative of future manufacturing activities. In July of 2016, chemical manufacturing accounted for 51 % of construction for manufacturing, as seen in Figure 2.13. The "other" category is the next largest (16 %) with transportation equipment being the third (14 %). Additionally, an increase in manufacturing construction can be seen in the Construction Put in Place estimates from the Census Bureau. Between March of 2014 and March of 2015, manufacturing construction increased 53 %; however, this trend may have reached a

plateau, as July 2016 is down 6 % from July of the previous year.[24] This growth is largely due to construction of chemical manufacturing facilities. The Annual Survey of Manufactures seems to confirm that there is significant growth in capital expenditures on buildings for chemical manufacturing, as 10 of 29 subsectors having growth of more than 50 % with some as much as 100 % to 200 %.

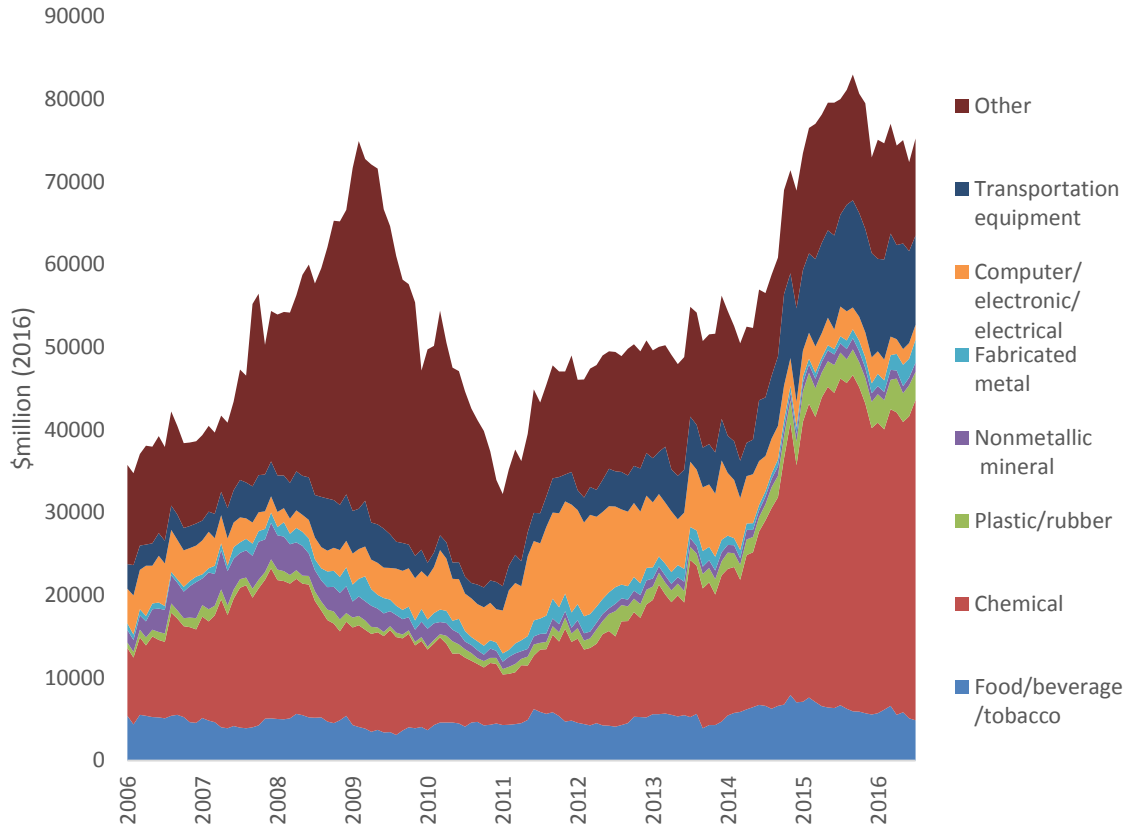


Figure 2.13: Construction Put in Place, 2006-2016

[24] Census Bureau. Construction Spending. Construction put in place. <https://www.census.gov/construction/c30/c30index.html>

3 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 with values from the ASM.[25] Table 3-1 presents and Figure 3.1 maps, the purchases that the manufacturing industry made for production, which is disaggregated into five categories: suppliers of services, computer hardware, software, and other costs (blue), refuse removal, intermediate goods, and recycling (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 are 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.

Table 3-1: Supply Chain Entities and Contributions

	2013 ($Billions 2013)	2014 ($Billions 2014)	Percent Change
I. Services, Computer Hardware, Software, and Other Expenditures			
a. Communication Services	4.73	4.81	1.7%
b. Computer Hardware, Software, and Other Equipment	7.10	12.70	79.0%
c. Professional, Technical, and Data Services	37.75	40.36	6.9%
d. Other Expenditures	267.39	286.16	7.0%
e. TOTAL	**316.97**	**344.03**	**8.5%**
II. Refuse Removal Expenditures	**13.78**	**14.28**	**3.6%**
III. Machinery, Structures, and Compensation Expenditures			
a. Payroll, Benefits, and Employment	790.10	803.22	1.7%
b. Capital Expenditures: Structures (including rental)	59.52	58.04	-2.5%
c. Capital Expenditures: Machinery/Equipment (including rental)	13.72	146.29	965.9%
d. TOTAL	**863.35**	**1007.55**	**16.7%**
IV. Suppliers of Materials Expenditures			
a. Materials, Parts, Containers, Packaging, etc… Used	3 143.32	3 158.62	0.5%
b. Contract Work and Resales	230.60	232.53	0.8%
c. Purchased Fuels and Electricity	89.59	95.61	6.7%
d. TOTAL	**3 463.51**	**3 486.76**	**0.7%**
V. Maintenance and Repair Expenditures	**46.53**	**47.97**	**3.1%**
VI. Shipments			
a. Expenditures	4 704.13	4 900.60	4.2%
b. Net Inventories Shipped	-9.41	-5.71	39.3%
c. Depreciation	185.51	187.78	1.2%
d. Net Income	791.24	798.22	0.9%
E. TOTAL	**5 671.46**	**5 880.89**	**3.7%**

[25] Census Bureau. "Annual Survey of Manufactures." February 2015. Accessed from the American FactFinder. <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

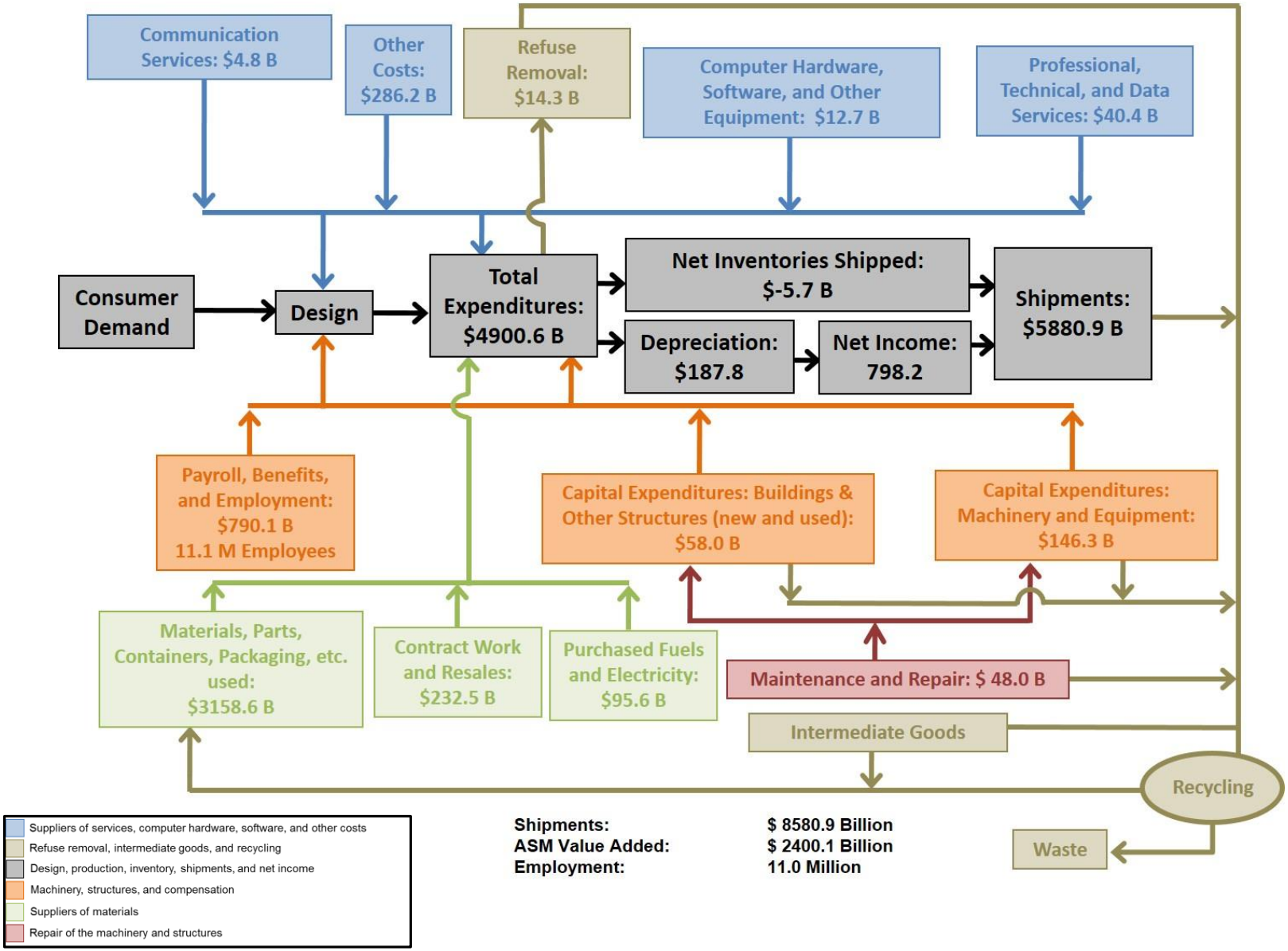


Figure 3.1: Manufacturing Supply Chain

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." [26] As seen in Table 3-2, there is an estimated $2081 billion in manufacturing value added with an additional $905 billion in indirect value added from other industries for manufacturing, as calculated using input-output analysis.[27]

In 2014, the US imported approximately 23.1 % of its intermediate imports, as seen in Table 3-3. As a proportion of output and imports (i.e., a proportion of the total inputs), intermediate imports represented 13.0 %. As can be seen in Table 3-3, these proportions have not changed dramatically in recent years.

A frequently invoked axiom posits that roughly 80 % of a problem is due to 20 % of the cause, a phenomenon referred to as the Pareto principle. [28] Moreover, a small portion of the cause accounts for a large portion of the problem. Identifying that small portion can facilitate making large efficiency improvements in manufacturing. Table 3-4 presents the top 20 supply chain entities by cost for manufacturing and a selection of manufacturing subsectors. Table 3-5 presents the top 20 occupation costs for manufacturing as a whole and a selection of manufacturing subsectors. For example, the data in the column labeled

Table 3-2: Direct and Indirect Manufacturing Value Added ($millions 2014)

	Value Added	Indirect Value Added	Total
a. TOTAL MANUFACTURING	2 080 659	904 990	2 985 649
b. NAICS 333: Machinery mfg	153 534	131 272	284 805
c. NAICS 334: Computer & electronic product mfg	204 853	67 840	272 693
d. NAICS 335: Electrical equipment, appliance, & component mfg	50 228	17 722	67 949
e. NAICS 336: Transportation equipment mfg	296 465	275 118	571 583
f. NAICS 337: Furniture	28 011	33 146	61 157
g. NAICS 339: Miscellaneous mfg	81 112	49 643	130 755
h. NAICS 311-312: Food, beverage, and Tobacco mfg	255 940	362 431	618 371
i. NAICS 313-323: Textiles, apparel, leather, wood, and paper mfg	134 951	28 444	163 395
j. NAICS 324-332: Chemicals, materials and energy mfg	875 565	212 522	1 088 087

[26] Tassey Gregory. (2010) "Rationales and Mechanisms for Revitalizing US Manufacturing R&D Strategies." *Journal of Technology Transfer*. 35. 283-333.
[27] This analysis uses an Input-Output model discussed in Thomas, Douglas and Anand Kandaswamy. "Identifying High Resource Consumption Areas of Assembly-Centric Manufacturing in the United States." NIST Publication 921139. Unpublished.
[28] Hopp, Wallace J. and Mark L. Spearman. Factory Physics. Third Edition. (Waveland Press, Long Grove, IL, 2008. 674.

Table 3-3: Imported Intermediate Manufacturing

Year	Intermediate Manufacturing	Intermediate Manufacturing Imports	Total Manufacturing Output	Intermediate Imports as a Percent of Intermediates	Intermediate imports as a Percent of Total Output plus Imports
2006	3 247 782	714 103	4 888 467	22.0%	12.7%
2007	3 463 140	743 599	5 160 737	21.5%	12.6%
2008	3 573 053	767 370	5 276 399	21.5%	12.7%
2009	2 713 744	527 981	4 295 179	19.5%	10.9%
2010	3 088 872	664 888	4 833 972	21.5%	12.1%
2011	3 528 087	787 065	5 432 507	22.3%	12.7%
2012	3 665 614	832 938	5 680 253	22.7%	12.8%
2013	3 718 764	843 459	5 786 929	22.7%	12.7%
2014	3 887 341	897 777	6 005 642	23.1%	13.0%

"NAICS 334: Computer & Electronic Product mfg" shows the supply chain entities by NAICS code that contribute to producing computer and electronic products. These costs can be used to identify and select new projects that have the potential for having a high impact on manufacturing efficiency. As seen in Table 3-4, wholesale trade, the management of companies and enterprises, and oil and gas extraction appears in every list. As seen in Table 3-5, management occupations, business and financial operations, top executives, operations specialties managers, and business operations specialists, occupations are listed in every table.

Table 3-4: Top 20 Supply Chain Entities for Selected Manufacturing Subsectors

NAICS 31-33: Total manufacturing			NAICS 311-312 (except tobacco): Food and Beverage mfg		
NAICS	Description	Value Added ($millions)	NAICS	Description	Value Added ($millions)
211000	Oil and gas extraction	185 507	420000	Wholesale trade	45 965
420000	Wholesale trade	143 674	1121A0	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	21 895
550000	Management of companies and enterprises	92 690	211000	Oil and gas extraction	21 022
324110	Petroleum refineries	68 771	550000	Management of companies and enterprises	20 590
325412	Pharmaceutical preparation manufacturing	54 408	31161A	Animal (except poultry) slaughtering, rendering, and processing	18 754
336411	Aircraft manufacturing	49 270	312120	Breweries	13 156
312200	Tobacco product manufacturing	46 357	112A00	Animal production, except cattle and poultry and eggs	13 065
336112	Light truck and utility vehicle manufacturing	33 443	112120	Dairy cattle and milk production	11 526
336111	Automobile manufacturing	24 375	311910	Snack food manufacturing	11 283
334413	Semiconductor and related device manufacturing	23 223	311810	Bread and bakery product manufacturing	11 039
1121A0	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	22 407	484000	Truck transportation	9 833
484000	Truck transportation	21 162	311615	Poultry processing	9 478
31161A	Animal (except poultry) slaughtering, rendering, and processing	19 144	312110	Soft drink and ice manufacturing	9 242
334511	Search, detection, and navigation instruments manufacturing	18 876	1111A0	Oilseed farming	8 985
52A000	Monetary authorities and depository credit intermediation	16 661	311300	Sugar and confectionery product manufacturing	8 953
541100	Legal services	16 419	3118A0	Cookie, cracker, pasta, and tortilla manufacturing	8 304
334510	Electromedical and electrotherapeutic apparatus manufacturing	16 370	111300	Fruit and tree nut farming	7 965
336412	Aircraft engine and engine parts manufacturing	16 335	112300	Poultry and egg production	7 920
325610	Soap and cleaning compound manufacturing	16 207	311111	Dog and cat food manufacturing	6 544
325620	Toilet preparation manufacturing	16 017	324110	Petroleum refineries	6 529

NAICS 333: Machinery mfg

NAICS	Description	Value Added ($millions)
420000	Wholesale trade	17 444
333111	Farm machinery and equipment manufacturing	9 562
333130	Mining and oil and gas field machinery manufacturing	8 744
333120	Construction machinery manufacturing	8 641
550000	Management of companies and enterprises	8 411
333920	Material handling equipment manufacturing	7 288
33391A	Pump and pumping equipment manufacturing	6 383
33399A	Other general purpose machinery manufacturing	6 331
33329A	Other industrial machinery manufacturing	5 843
211000	Oil and gas extraction	5 473
331110	Iron and steel mills and ferroalloy manufacturing	4 902
333912	Air and gas compressor manufacturing	4 155
33331A	Vending, commercial laundry, and other commercial and service industry machinery manufacturing	3 942
333611	Turbine and turbine generator set units manufacturing	3 585
333514	Special tool, die, jig, and fixture manufacturing	3 341
333295	Semiconductor machinery manufacturing	3 184
333511	Industrial mold manufacturing	2 920
33351A	Metal cutting and forming machine tool manufacturing	2 676
33291A	Valve and fittings other than plumbing	2 537
333415	Air conditioning, refrigeration, and warm air heating equipment manufacturing	2 427

NAICS 334: Computer &electronic product mfg

NAICS	Description	Value Added ($millions)
334511	Search, detection, and navigation instruments manufacturing	17 015
334510	Electromedical and electrotherapeutic apparatus manufacturing	16 073
334413	Semiconductor and related device manufacturing	15 354
420000	Wholesale trade	9 885
334220	Broadcast and wireless communications equipment	8 527
550000	Management of companies and enterprises	6 347
334516	Analytical laboratory instrument manufacturing	6 103
334515	Electricity and signal testing instruments manufacturing	5 560
334111	Electronic computer manufacturing	5 069
33451A	Watch, clock, and other measuring and controlling device manufacturing	4 402
334513	Industrial process variable instruments manufacturing	4 253
334517	Irradiation apparatus manufacturing	3 175
334418	Printed circuit assembly (electronic assembly) manufacturing	2 803
211000	Oil and gas extraction	2 386
541100	Legal services	2 177
334112	Computer storage device manufacturing	2 074
533000	Lessors of nonfinancial intangible assets	1 810
541610	Management consulting services	1 559
561300	Employment services	1 534
334210	Telephone apparatus manufacturing	1 386

NAICS 335: Electrical equipment, appliance, & component mfg

NAICS	Description	Value Added ($millions)
335999	All other miscellaneous electrical equipment and component manufacturing	2 967
420000	Wholesale trade	2 309
335313	Switchgear and switchboard apparatus manufacturing	1 647
335221	Household cooking appliance manufacturing	1 442
335311	Power, distribution, and specialty transformer manufacturing	1 432
335912	Primary battery manufacturing	1 414
335222	Household refrigerator and home freezer manufacturing	1 338
335224	Household laundry equipment manufacturing	1 068
550000	Management of companies and enterprises	1 049
211000	Oil and gas extraction	924
331110	Iron and steel mills and ferroalloy manufacturing	759
335228	Other major household appliance manufacturing	724
335210	Small electrical appliance manufacturing	631
33441A	Other electronic component manufacturing	465
33211B	Crown and closure manufacturing and metal stamping	387
331490	Nonferrous metal (except copper and aluminum) rolling, drawing, extruding and alloying	375
335911	Storage battery manufacturing	328
332720	Turned product and screw, nut, and bolt manufacturing	301
334413	Semiconductor and related device manufacturing	300
484000	Truck transportation	287

NAICS 336: Transportation equipment mfg

NAICS	Description	Value Added ($millions)
336411	Aircraft manufacturing	48 828
420000	Wholesale trade	43 810
336112	Light truck and utility vehicle manufacturing	33 415
550000	Management of companies and enterprises	25 436
336111	Automobile manufacturing	24 278
336412	Aircraft engine and engine parts manufacturing	14 764
336413	Other aircraft parts and auxiliary equipment manufacturing	13 995
211000	Oil and gas extraction	10 926
336370	Motor vehicle metal stamping	9 382
336611	Ship building and repairing	9 135
336390	Other motor vehicle parts manufacturing	7 649
331110	Iron and steel mills and ferroalloy manufacturing	7 513
336350	Motor vehicle transmission and power train parts manufacturing	6 911
336414	Guided missile and space vehicle manufacturing	5 900
336360	Motor vehicle seating and interior trim manufacturing	5 636
336120	Heavy duty truck manufacturing	5 627
484000	Truck transportation	5 138
336310	Motor vehicle gasoline engine and engine parts manufacturing	4 833
334413	Semiconductor and related device manufacturing	4 180
541100	Legal services	4 112

Table 3-5: Top 20 Occupation Categories for Selected Manufacturing Subsectors

NAICS 31-33: Total manufacturing			NAICS 311-312 (except tobacco): Food and Beverage mfg (excluding agricultural occupations)		
SOC	Description	Value Added ($millions)	SOC	Description	Value Added ($millions)
510000	Production Occupations	228 030	510000	Production Occupations	51 154
110000	Management Occupations	149 100	110000	Management Occupations	30 677
430000	Office and Administrative Support Occupations	84 363	530000	Transportation and Material Moving Occupations	28 061
130000	Business and Financial Operations Occupations	84 045	430000	Office and Administrative Support Occupations	21 525
170000	Architecture and Engineering Occupations	75 810	519000	Other Production Occupations	19 629
530000	Transportation and Material Moving Occupations	65 100	410000	Sales and Related Occupations	19 055
410000	Sales and Related Occupations	63 076	130000	Business and Financial Operations Occupations	16 602
172000	Engineers	60 998	513000	Food Processing Workers	16 406
519000	Other Production Occupations	58 113	537000	Material Moving Workers	13 920
514000	Metal Workers and Plastic Workers	57 675	490000	Installation, Maintenance, and Repair Occupations	13 731
111000	Top Executives	55 762	111000	Top Executives	12 941
131000	Business Operations Specialists	53 641	111021	General and Operations Managers	10 661
512000	Assemblers and Fabricators	52 625	113000	Operations Specialties Managers	10 381
113000	Operations Specialties Managers	50 331	537060	Laborers and Material Movers, Hand	10 075
150000	Computer and Mathematical Occupations	49 611	533000	Motor Vehicle Operators	9 994
490000	Installation, Maintenance, and Repair Occupations	47 736	131000	Business Operations Specialists	9 786
151100	Computer Occupations	46 243	414010	Sales Representatives, Wholesale and Manufacturing	9 435
111021	General and Operations Managers	45 658	533030	Driver/Sales Workers and Truck Drivers	9 373
512090	Miscellaneous Assemblers and Fabricators	36 389	499000	Other Installation, Maintenance, and Repair Occupations	9 242
414010	Sales Representatives, Wholesale and Manufacturing	34 932	414012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	7 790

NAICS 333: Machinery mfg			NAICS 334: Computer &electronic product mfg		
SOC	Description	Value Added ($millions)	SOC	Description	Value Added ($millions)
510000	Production Occupations	37 736	110000	Management Occupations	17 369
110000	Management Occupations	20 652	170000	Architecture and Engineering Occupations	14 774
514000	Metal Workers and Plastic Workers	18 760	510000	Production Occupations	12 351
170000	Architecture and Engineering Occupations	11 980	172000	Engineers	11 737
430000	Office and Administrative Support Occupations	11 709	150000	Computer and Mathematical Occupations	9 776
130000	Business and Financial Operations Occupations	10 506	130000	Business and Financial Operations Occupations	9 089
172000	Engineers	9 333	151100	Computer Occupations	8 796
410000	Sales and Related Occupations	8 977	430000	Office and Administrative Support Occupations	7 180
512000	Assemblers and Fabricators	8 562	151130	Software Developers and Programmers	6 509
111000	Top Executives	8 419	131000	Business Operations Specialists	6 058
530000	Transportation and Material Moving Occupations	6 731	113000	Operations Specialties Managers	5 860
113000	Operations Specialties Managers	6 701	410000	Sales and Related Occupations	5 545
131000	Business Operations Specialists	6 626	111000	Top Executives	5 340
490000	Installation, Maintenance, and Repair Occupations	6 619	512000	Assemblers and Fabricators	4 712
512090	Miscellaneous Assemblers and Fabricators	5 715	172070	Electrical and Electronics Engineers	4 336
150000	Computer and Mathematical Occupations	5 675	119000	Other Management Occupations	3 748
519000	Other Production Occupations	5 637	414010	Sales Representatives, Wholesale and Manufacturing	3 262
414010	Sales Representatives, Wholesale and Manufacturing	5 455	514000	Metal Workers and Plastic Workers	3 167
151100	Computer Occupations	4 841	132000	Financial Specialists	3 040
499000	Other Installation, Maintenance, and Repair Occupations	4 266	173000	Drafters, Engineering Technicians, and Mapping Technicians	2 949

NAICS 335: Electrical equipment, appliance, & component mfg			NAICS 336: Transportation equipment mfg		
SOC	Description	Value Added ($millions)	SOC	Description	Value Added ($millions)
110000	Management Occupations	2 579	110000	Management Occupations	38 418
111000	Top Executives	926	111000	Top Executives	13 584
112000	Advertising, Marketing, Promotions, Public Relations, and Sales Managers	373	112000	Advertising, Marketing, Promotions, Public Relations, and Sales Managers	4 734
112020	Marketing and Sales Managers	355	112020	Marketing and Sales Managers	4 389
113000	Operations Specialties Managers	901	113000	Operations Specialties Managers	13 624
119000	Other Management Occupations	376	119000	Other Management Occupations	6 457
119030	Education Administrators	1	119030	Education Administrators	23
130000	Business and Financial Operations Occupations	1 375	130000	Business and Financial Operations Occupations	24 452
131000	Business Operations Specialists	894	131000	Business Operations Specialists	16 294
131020	Buyers and Purchasing Agents	190	131020	Buyers and Purchasing Agents	3 338
131030	Claims Adjusters, Appraisers, Examiners, and Investigators	22	131030	Claims Adjusters, Appraisers, Examiners, and Investigators	291
131070	Human Resources Workers	59	131070	Human Resources Workers	1 559
132000	Financial Specialists	484	132000	Financial Specialists	8 198
132050	Financial Analysts and Advisors	123	132050	Financial Analysts and Advisors	2 035
132070	Credit Counselors and Loan Officers	34	132070	Credit Counselors and Loan Officers	543
132080	Tax Examiners, Collectors and Preparers, and Revenue Agents	6	132080	Tax Examiners, Collectors and Preparers, and Revenue Agents	100
150000	Computer and Mathematical Occupations	726	150000	Computer and Mathematical Occupations	15 032
151100	Computer Occupations	702	151100	Computer Occupations	14 264
151120	Computer and Information Analysts	101	151120	Computer and Information Analysts	2 772
151130	Software Developers and Programmers	336	151130	Software Developers and Programmers	7 500

4 Employment and Compensation

The Annual Survey of Manufactures estimates that there were 11.0 million employees in manufacturing in 2014, which is the most recent data available (see Table 4-1). The Current Population Survey and Current Employment Statistics have more recent data that estimate that there were 15.3 million and 12.3 million employees in 2015, respectively (see Table 4-2 and Table 4-3). Each of these estimates has its 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; thus, the estimates from the Current Employment Statistics are lower than the 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 2014 and 2015, manufacturing employment increased 1.6 % according to the Current Population Survey (see Table 4-2) and 1.1 % according to the Current Employment Statistics (see Table 4-3). Meanwhile, total employment increased 1.7 % according to the Current Population Survey (see Table 4-3).

Table 4-1: Employment, Annual Survey of Manufactures

	2013 (employees)	2014 (employees)	Percent Change
VI. Employees			
a. NAICS 324: Petroleum & coal products mfg	100 216	102 408	2.2%
b. NAICS 325: Chemical mfg	718 003	714 567	-0.5%
c. NAICS 326: Plastics & rubber products mfg	702 944	716 591	1.9%
d. NAICS 327: Nonmetallic mineral product mfg	349 396	355 275	1.7%
e. NAICS 331: Primary metal mfg	388 619	382 788	-1.5%
f. NAICS 332: Fabricated metal product mfg	1 382 810	1 375 346	-0.5%
g. NAICS 333: Machinery mfg	1 050 825	1 027 684	-2.2%
h. NAICS 334: Computer & electronic product mfg	823 159	789 735	-4.1%
i. NAICS 335: Electrical equipment & component mfg	334 076	329 081	-1.5%
j. NAICS 336: Transportation equipment mfg	1 384 293	1 416 901	2.4%
k. NAICS 339: Miscellaneous mfg	534 399	524 341	-1.9%
l. NAICS 311: Food mfg	1 373 864	1 374 345	0.0%
M. Other: apparel, wood product, and printing mfg	1 949 117	1 912 415	-1.9%
N. TOTAL MANUFACTURING	**11 091 721**	**11 021 476**	**-0.6%**

Table 4-2: Employment by Industry for 2013 and 2014 (Thousands): Current Population Survey

Industry	Total Employed 2014	Total Employed 2015	Employment Change	Percent Change
Mining	1 088	917	-171	-15.7%
Construction	9 813	9 935	122	1.2%
Manufacturing	15 100	15 338	238	1.6%
Wholesale and Retail Trade	20 251	20 320	69	0.3%
Transportation and Utilities	7 581	7 726	145	1.9%
Information	3 115	2 988	-127	-4.1%
Financial Activities	9 871	10 087	216	2.2%
Professional and Business Services	17 004	17 409	405	2.4%
Education and Health Services	32 830	33 678	848	2.6%
Leisure and Hospitality	13 489	13 821	332	2.5%
Other Services	7 169	7 264	95	1.3%
Public Administration	6 757	6 928	171	2.5%
Agriculture	2 237	2 422	185	8.3%
TOTAL*	146 305	148 833	2 528	1.7%

* The sum may not match the total due to rounding of annual averages

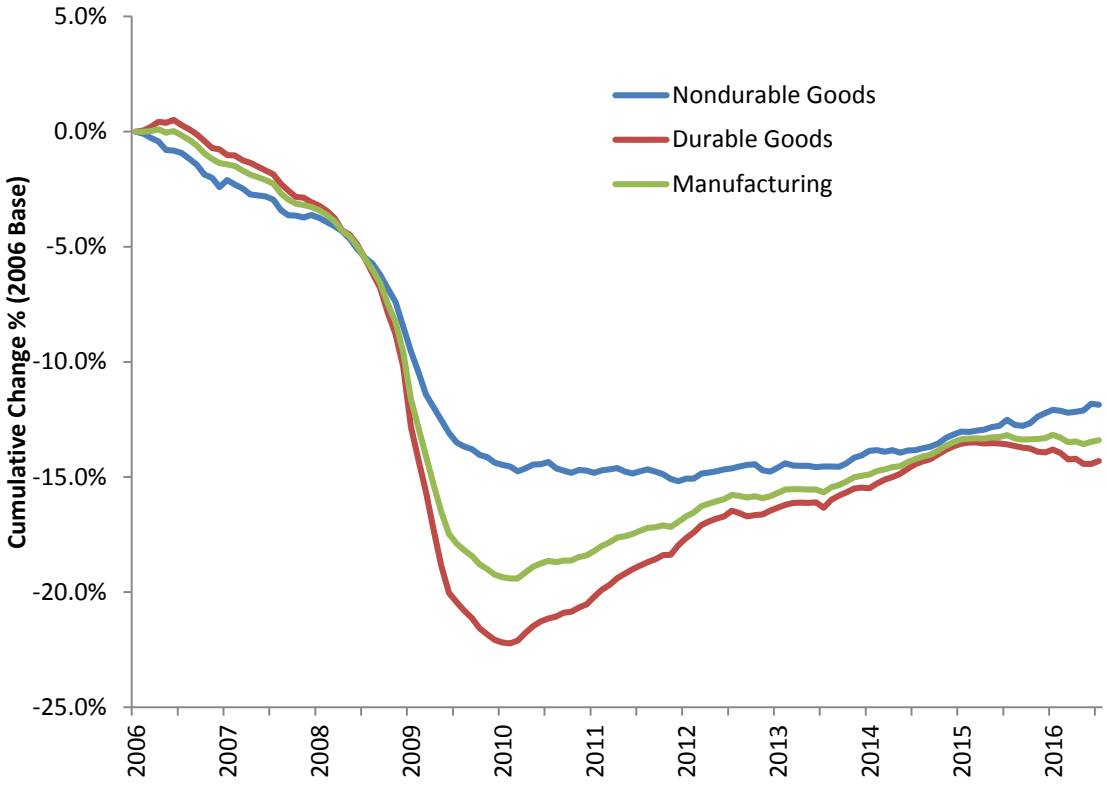
Source: Current Population Survey, Bureau of Labor Statistics. "Table 17: Employed Persons by Industry, Sex, Race, and Occupation." <http://www.bls.gov/cps>

Table 4-3: Manufacturing Employment (Thousands): Current Employment Statistics

	2014	2015	Percent Change
Manufacturing	12 185	12 318	1.1%
Durable Goods	7 674	7 756	1.1%
Nondurable Goods	4 512	4 562	1.1%

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

Between January of 2006 and January of 2010, manufacturing employment declined by 19.4 %, as seen in Figure 4.1. As of July 2016, employment is still 13.4 % below its 2006 level. In times of financial difficulty, large purchases are often delayed or determined to be unnecessary. Thus, it would be expected that during the recent recession durable goods would decline more than nondurable goods. As can be seen in Figure 4.1, durable goods declined more than manufacturing as a whole while nondurable goods did not decline as much. By January of 2010, durable goods had declined 22.2 % while nondurables declined 14.5 %. As of July of 2016, employment in durables was 14.3 % below its 2006 levels while that for nondurables was at 11.9 % below 2006 levels.



Source: Bureau of Labor Statistics. Current Employment Statistics. <http://www.bls.gov/ces/>

Figure 4.1: Cumulative Change in Percent in Manufacturing Employment (Seasonally Adjusted), 2006-2016

The employees that work in manufacturing offer their time and, in some cases, risk their safety in return for compensation. In terms of safety, the number of fatal injuries increased between 2013 and 2014 (see Table 4-4). Nonfatal injuries increased while the injury rate remained the same (see Table 4-5). However, the incident rate for nonfatal injuries in manufacturing remains higher than that for all private industry. As seen in Figure 4.2, fatalities, injuries, and the injury rate have had an overall downward trend since 2000.

During the recession, the 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 recession and decreased during the following recovery, 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, they also have more job security. The compound annual growth rate in real wages was 0.5 % between 2011 and 2016. From 2015 to 2016, they grew 2 %. As seen in Figure 4.5, employee compensation, which includes benefits, has had a 5 year compound annual growth of 1 %.

Table 4-4: Fatal Occupational Injuries by Event or Exposure

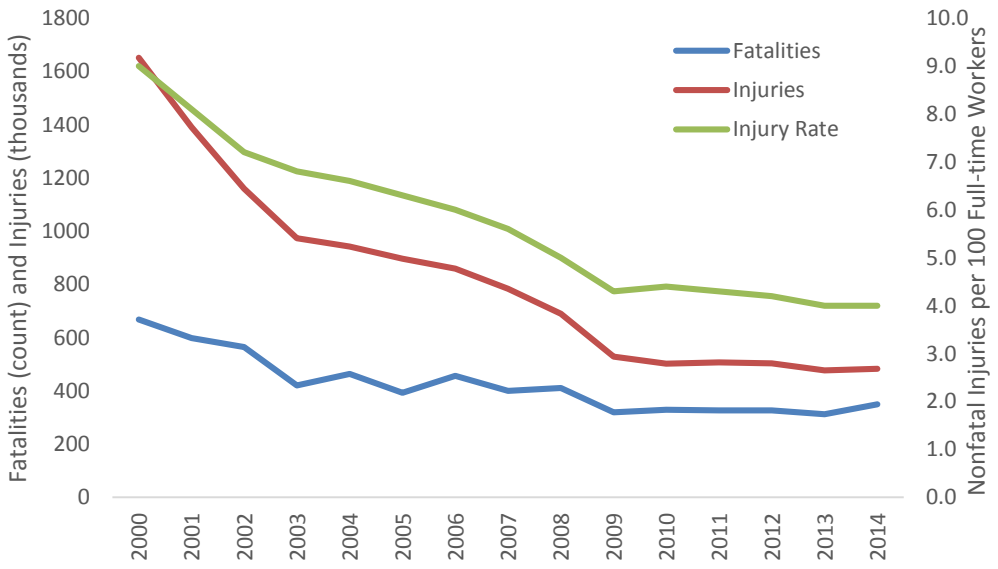
		Total	Violence and other injuries by persons or animals	Transportation Incidents	fires and explosions	Falls, slips, trips	exposure to harmful sub-stances or environments	Contact with objects and equipment
2013	Total	4585	773	1865	149	724	335	721
	Manufacturing	312	36	91	12	42	18	110
2014	Total	4821	765	1984	137	818	390	715
	Manufacturing	349	41	87	23	49	46	101
Percent Change	Total Private Industry	5.1%	-1.0%	6.4%	-8.1%	13.0 %	16.4%	-0.8%
	Manufacturing	11.9%	13.9%	-4.4%	91.7%	16.7 %	155.6%	-8.2%

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, Private Industry

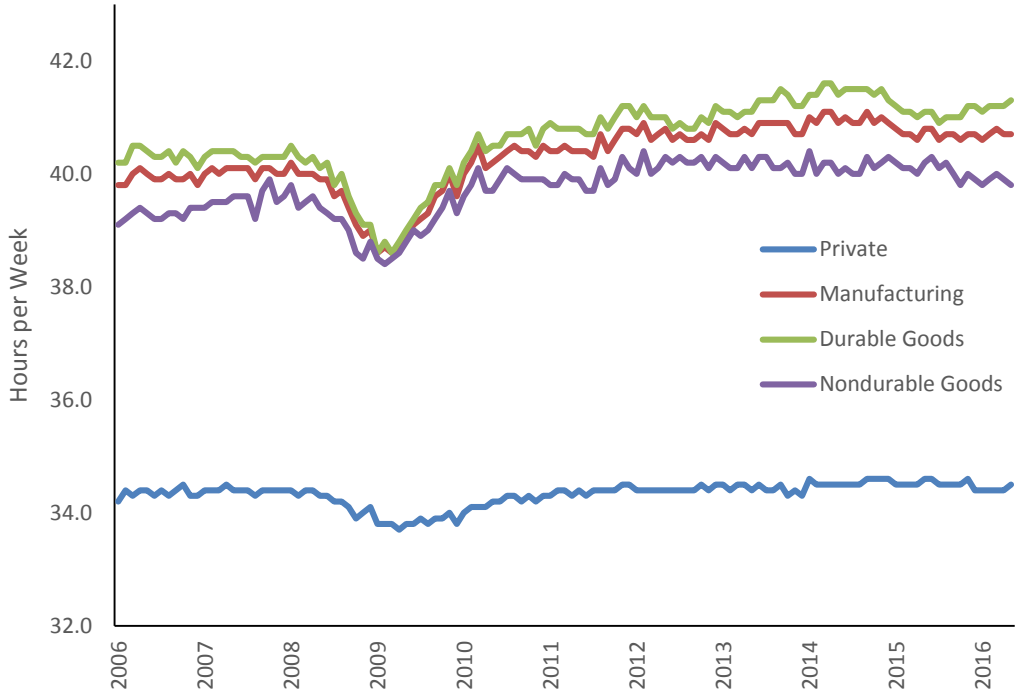
		2013	2014	Percent Change
Manu-facturing	Incident Rate per 100 full time workers	4.0	4.0	0.0%
	Total Recordable Cases (thousands)	476.7	483.3	1.4%
Private Industry	Incident Rate per 100 full time workers	3.3	3.2	-3.0%
	Total Recordable Cases (thousands)	3007.3	2953.5	-1.8%

Source: Bureau of Labor Statistics. Injuries, Illness, and Fatalities Program. 2013-2014. http://www.bls.gov/iif/



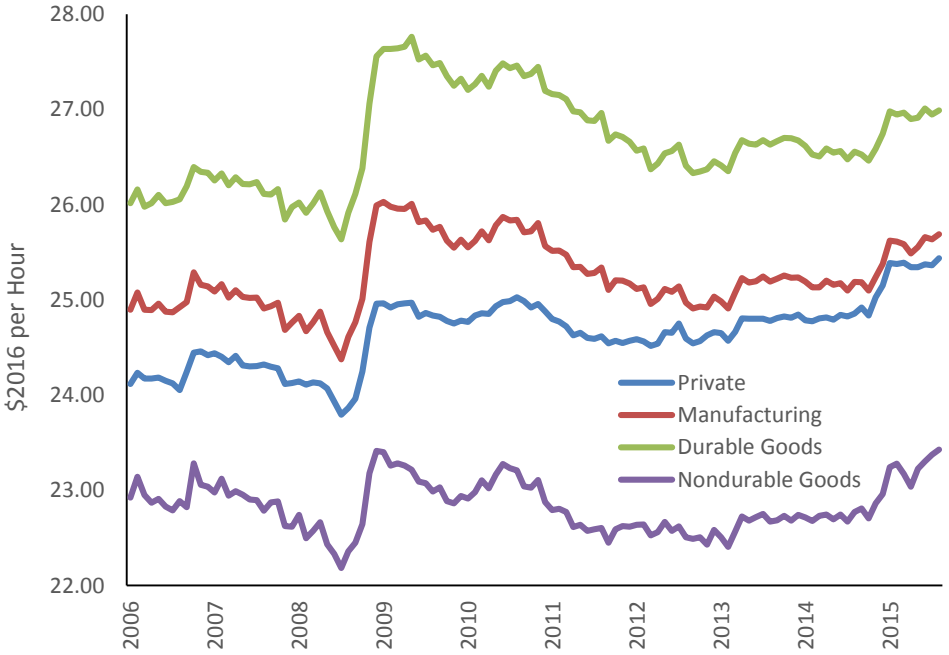
Source: Bureau of Labor Statistics. Injuries, Illness, and Fatalities Program. 2013-2014. http://www.bls.gov/iif/

Figure 4.2: Manufacturing Fatalities and Injuries



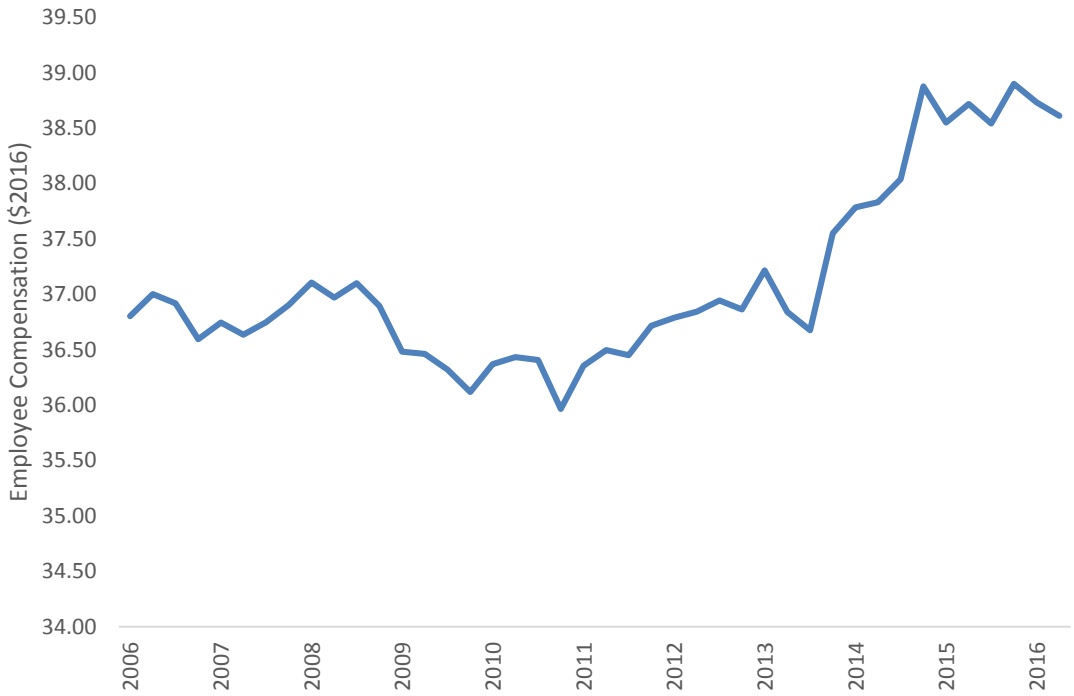
Source: Bureau of Labor Statistics. Current Employment Statistics. <http://www.bls.gov/ces/home.htm>

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



Source: Bureau of Labor Statistics. Current Employment Statistics. <http://www.bls.gov/ces/home.htm>

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



Source: Bureau of Labor Statistics. National Compensation Survey. <http://www.bls.gov/ncs/>

Figure 4.5: Manufacturing Employee Compensation (Hourly)

5 Innovation and Competitiveness

Manufacturing goods involves not only physical production, but also design and innovation. Measuring and comparing innovation between countries is problematic, however, as there is not a standard metric for measuring this activity. Four measures are often discussed in regards to innovation: number of patent applications, research and development expenditures, number of researchers, and number of published journal articles. As seen in Table 5-1, the US ranked 3rd in 2014 in patent applications per million people, which puts it above the 90th percentile. Using patent application as a metric can be problematic though, as not all innovations are patented. The US ranked 10th in research and development expenditures as a percent of GDP in 2012, which puts it at the 90th percentile. In terms of researchers per million people, the US ranked 20th, putting it at the 75th percentile. In journal articles per million people it ranked 21st, putting it at the 91st percentile.[29]

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 additional insight into the US innovation landscape. Figure 5.1 provides the US ranking for 20 measures of competitiveness. This provides some indicators to identify opportunities for improvement in US economic activity. The US ranks low in public finance, prices, and fiscal policy. Overall, the US is ranked 3rd in competitiveness for conducting business.[30] The Competitive Industrial Performance Index, published by the United Nations Industrial Development Organization, ranks the US 3rd out of 147 countries in its economic performance in 2014. This index assesses an economy's ability to competitively produce and export manufactured goods.[31]

Table 5-1: Patent Applications per Million People

Country Name	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Korea, Rep.	2538	2594	2648	2597	2589	2668	2773	2962	3186	3254
Japan	2880	2715	2605	2578	2306	2265	2250	2250	2134	2092
United States	703	743	801	762	733	782	795	856	910	894
Germany	586	583	582	600	584	575	574	580	577	595
China	72	93	116	147	172	219	309	396	519	587
New Zealand	458	515	448	295	361	364	342	323	363	363
Finland	349	345	341	339	338	323	306	314	293	260
Austria	276	275	288	276	271	290	257	268	255	245
Denmark	306	276	304	297	275	293	283	251	239	244
Singapore	133	142	152	164	150	176	204	203	212	238
United States Rank	5	4	3	4	3	3	3	3	3	3
United States Percentile	96	97	98	97	97	98	98	98	98	98

[29] World Bank. World Development Indicators. <http://data.worldbank.org/data-catalog/world-development-indicators>

[30] IMD. IMD World Competiveness Country Profile: US. <https://worldcompetitiveness.imd.org/countryprofile/US>

[31] United Nations Industrial Development Organization. Competitive Industrial Performance Report 2014. Working Paper 12/2014. <http://www.unido.org/fileadmin/user_media/Services/PSD/WP2014_12_CIPReport2014.pdf>

Table 5-2: Research and Development Expenditures as a Percent of GDP

Country Name	2005	2006	2007	2008	2009	2010	2011	2012
Israel	4.09	4.19	4.48	4.39	4.15	3.96	4.10	4.25
Korea, Rep.	2.63	2.83	3.00	3.12	3.29	3.47	3.74	4.03
Finland	3.33	3.34	3.35	3.55	3.75	3.73	3.64	3.42
Japan	3.31	3.41	3.46	3.47	3.36	3.25	3.38	3.34
Sweden	3.39	3.50	3.26	3.50	3.42	3.22	3.22	3.28
Denmark	2.39	2.40	2.51	2.78	3.07	2.94	2.97	3.02
Switzerland	-	-	-	2.73	-	-	-	2.96
Germany	2.43	2.46	2.45	2.60	2.73	2.72	2.80	2.88
Austria	2.38	2.37	2.43	2.59	2.61	2.74	2.68	2.81
United States	2.51	2.55	2.63	2.77	2.82	2.74	2.77	2.81
United States Rank	7	7	6	7	7	8	8	10
United States Percentile	94	93	95	94	94	93	93	90

The 2016 Deloitte Global Manufacturing Competitiveness Index uses a survey of CEOs to rank countries based on managerial perception. The US was ranked 2nd out 40 nations with China being ranked 1st. High-cost labor, high corporate tax rates, and increasing investments outside of the US were identified as challenges to the US industry. Manufacturers indicated that companies were building high-tech factories in the US due to rising labor costs in China, shipping costs, and low cost shale gas.[32] Additionally, an increase in manufacturing construction can be seen in the Construction Put in Place estimates from the Census Bureau. Between March of 2014 and March of 2015, manufacturing construction increased 53 %; however, this trend may have reached a

Table 5-3: Researchers per Million People

Country Name	2005	2006	2007	2008	2009	2010	2011	2012
Israel	-	-	-	-	-	-	7 296	8 282
Finland	7 545	7 673	7 373	7 692	7 649	7 717	7 414	7 460
Denmark	5 201	5 302	5 519	6 497	6 660	6 744	7 026	7 311
Singapore	5 292	5 425	5 769	5 741	6 149	6 307	6 496	6 442
Korea, Rep.	3 777	4 175	4 604	4 868	5 001	5 380	5 853	6 362
Norway	4 584	4 838	5 163	5 360	5 439	5 408	5 496	5 548
Sweden	6 101	6 133	5 005	5 443	5 069	5 256	5 135	5 164
Japan	5 360	5 387	5 378	5 158	5 148	5 153	5 160	5 084
Luxembourg	4 864	4 412	4 636	4 716	4 829	5 190	5 829	4 677
Austria	3 457	3 531	3 816	4 142	4 146	4 359	4 406	4 655
Canada	4 238	4 313	4 588	4 712	4 451	4 649	4 727	4 490
Switzerland	-	-	-	3 288	-	-	-	4 481
Germany	3 350	3 452	3 597	3 752	3 941	4 078	4 211	4 379
Slovenia	2 631	2 920	3 098	3 463	3 645	3 753	4 261	4 307
Netherlands	2 930	3 241	3 101	3 071	2 833	3 229	3 502	4 247
France	3 307	3 418	3 580	3 654	3 741	3 868	3 940	4 076
North America	3 769	3 834	3 840	3 991	4 109	3 944	4 082	4 066
Portugal	2 016	2 344	2 671	3 820	3 761	3 923	4 173	4 042
United Kingdom	4 129	4 188	4 132	4 084	4 116	4 091	3 979	4 029
United States	3 718	3 782	3 758	3 912	4 072	3 867	4 011	4 019
United States Rank	13	14	14	15	14	17	17	20
United States Percentile	86	83	85	84	85	84	82	75

[32] Deloitte. 2016 Global Manufacturing Competitiveness Index. <http://www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/us-gmci.pdf>

Table 5-4: Journal Articles per Million People

Country Name	2005	2006	2007	2008	2009	2010	2011	2012	2013
Switzerland	2037	2167	2212	2239	2303	2370	2462	2578	2603
Denmark	1497	1539	1616	1646	1748	1833	2018	2188	2223
Australia	1461	1543	1662	1687	1749	1819	1922	1957	2068
Sweden	1788	1809	1804	1767	1810	1845	1900	1982	2017
Singapore	1818	1814	1747	1750	1764	1894	1909	1996	1974
Norway	1411	1489	1591	1613	1784	1805	1906	2001	1940
Finland	1648	1689	1712	1733	1772	1766	1824	1844	1867
Netherlands	1439	1472	1533	1579	1692	1702	1751	1806	1810
Iceland	1163	1144	1155	1337	1535	1731	1692	1957	1779
Slovenia	1155	1192	1317	1472	1561	1571	1766	1726	1706
Canada	1420	1472	1552	1573	1615	1630	1642	1681	1644
New Zealand	1237	1301	1379	1442	1483	1517	1634	1678	1631
United Kingdom	1344	1397	1440	1438	1473	1462	1492	1519	1518
Ireland	1103	1100	1210	1251	1382	1499	1571	1510	1495
Belgium	1198	1216	1271	1320	1373	1371	1408	1477	1476
Austria	1074	1096	1184	1227	1300	1320	1384	1424	1419
Israel	1475	1540	1541	1531	1479	1408	1419	1456	1402
Luxembourg	310	398	446	633	773	890	1104	1085	1348
North America	1250	1266	1281	1288	1299	1321	1346	1356	1338
Czech Republic	756	841	937	999	1056	1179	1253	1293	1334
United States	1231	1244	1251	1257	1265	1287	1313	1320	1304
United States rank	14	14	16	17	20	19	19	19	21
United States Percentile	94	94	93	93	92	92	92	92	91

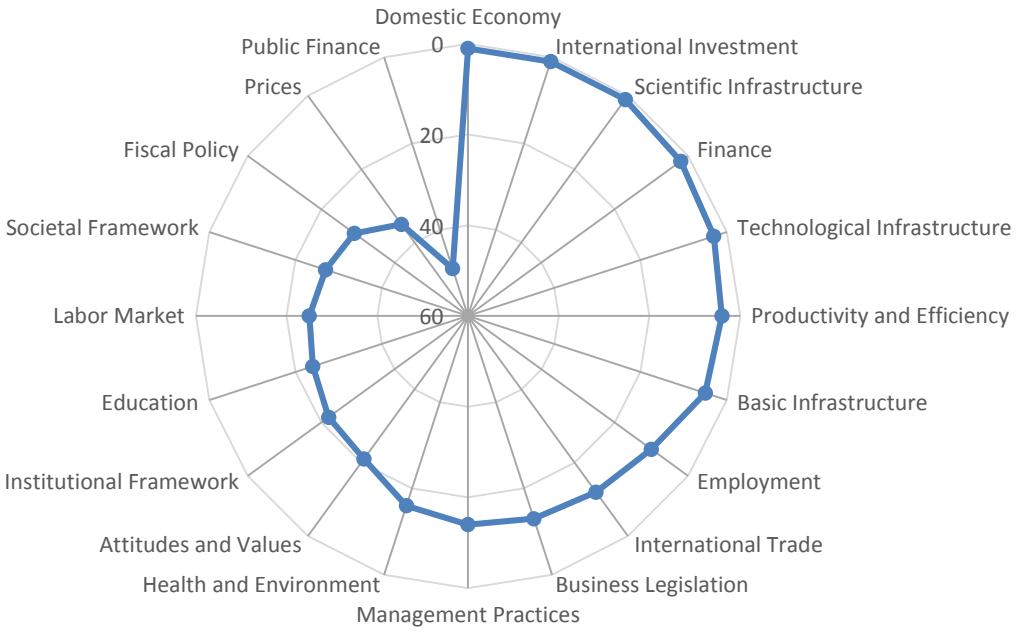


Figure 5.1: IMD World Competitiveness Rankings for the US

plateau, as July 2016 is down 6 % from July of the previous year.[33] According to the Deloitte Global Manufacturing Competitiveness Index, advantages to US 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.

The World Economic Forum's 2015-2016 Global Competitiveness Report uses 12 items to assess the competitiveness of 140 economies, which includes the set of "institutions, policies and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the country can achieve." As seen in Figure 5.2, the US was ranked 3rd with low rankings in macroeconomic environment, health and primary education, and institutions.[34] The index uses a set of 115 factors to produce the 12 items in Figure 5.2 (see Table 5-5). Among the lowest ranking factors are the costs of terrorism, education enrollment, and crime. Business executives were asked to identify and rank the top 5 most problematic factors for doing business from a list of 16 factors. US education is among the top 5.

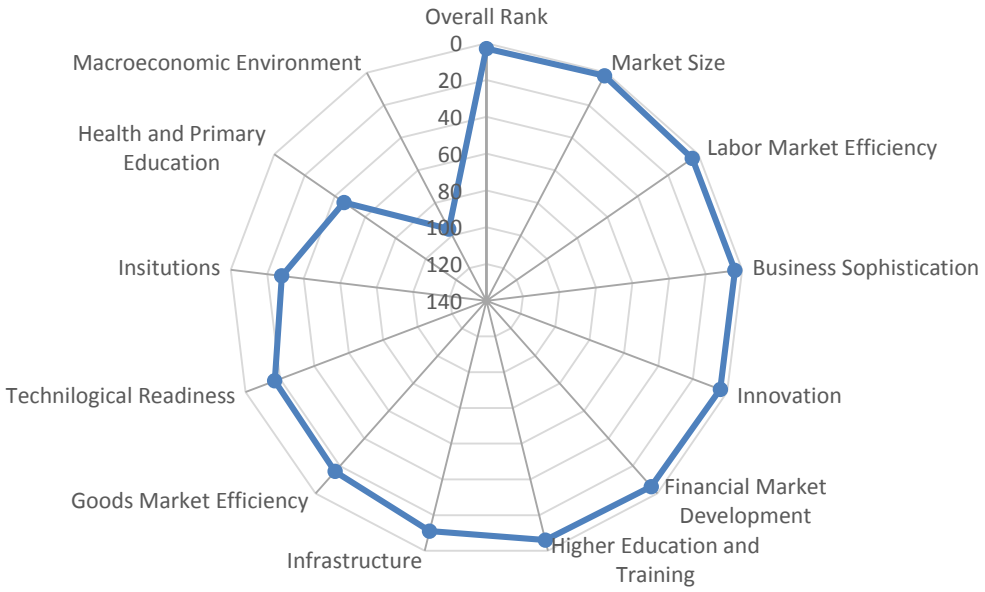


Figure 5.2: World Economic Forum 2015-2016 Global Competitiveness Index: US Rankings

[33] Census Bureau. Construction Spending. Construction put in place. <https://www.census.gov/construction/c30/c30index.html>
[34] World Economic Forum. The Global Competitiveness Report 2015-2016. <http://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf>

Table 5-5: US Rank for Indicators used in the World Economic Forum Competitiveness Index

Indicator	Rank	Indicator	Rank
Imports as a percentage of GDP	136	Mobile-broadband subscriptions/100 pop.	17
Exports as a percentage of GDP	136	Quality of electricity supply	16
General government debt, % GDP	129	Nature of competitive advantage	16
Business costs of terrorism	114	Intellectual property protection	15
Government budget balance, % GDP	114	Efficacy of corporate boards	15
Mobile telephone subscriptions/100 pop.	99	Quality of railroad infrastructure	15
Total tax rate, % profits	95	Degree of customer orientation	15
HIV prevalence, % adult pop.	92	Quality of roads	14
Primary education enrollment, net %	91	Extent of staff training	14
Gross national savings, % GDP	87	Buyer sophistication	14
Business costs of crime and violence	77	Ease of access to loans	14
Wastefulness of government spending	75	Quality of overall infrastructure	13
Business impact of HIV/AIDS	75	Individuals using Internet, %	13
Organized crime	62	Availability of specialized training services	11
Secondary education enrollment, gross %	61	Extent of market dominance	11
No. procedures to start a business	57	Gov't procurement of advanced tech products	11
Business impact of rules on FDI	53	PCT patents, applications/million pop.	11
Prevalence of non-tariff barriers	52	Quality of port infrastructure	10
Women in labor force, ratio to men	52	Effectiveness of anti-monopoly policy	10
Burden of government regulation	51	Hiring and firing practices	10
Business impact of tuberculosis	51	Affordability of financial services	10
Public trust in politicians	44	Local supplier quality	10
Favoritism in decisions of government officials	44	Quality of management schools	9
Quality of math and science education	44	Reliance on professional management	9
Infant mortality, deaths/1,000 live births	42	Willingness to delegate authority	9
Int'l Internet bandwidth, kb/s per user	41	Pay and productivity	8
Prevalence of foreign ownership	40	Local supplier quantity	7
Soundness of banks	39	Value chain breadth	7
Effect of taxation on incentives to invest	35	Production process sophistication	7
Effect of taxation on incentives to work	35	Country capacity to attract talent	6
Life expectancy, years	34	Control of international distribution	6
FDI and technology transfer	34	Quality of air transport infrastructure	5
Trade tariffs, % duty	33	Country credit rating, 0–100 (best)	5
Irregular payments and bribes	32	Financing through local equity market	5
Cooperation in labor-employer relations	31	Venture capital availability	5
Burden of customs procedures	30	Intensity of local competition	4
Quality of primary education	29	Availability of financial services	4
Diversion of public funds	28	Legal rights index, 0–12 (best)	4
Judicial independence	28	Quality of scientific research institutions	4
Ethical behavior of firms	27	Availability of scientists and engineers	4
No. days to start a business	27	Tertiary education enrollment, gross %	3
Efficiency of legal framework in settling disputes	25	Firm-level technology absorption	3
Strength of investor protection, 0–10 (best)	25	Company spending on R&D	3
Agricultural policy costs	25	Tuberculosis cases/100,000 pop.	2
Regulation of securities exchanges	24	Country capacity to retain talent	2
Strength of auditing and reporting standards	23	Availability of latest technologies	2
Property rights	22	Foreign market size index, 1–7 (best)	2
Transparency of government policymaking	22	GDP (PPP$ billions)	2
Reliability of police services	22	State of cluster development	2
Fixed-telephone lines/100 pop.	20	Capacity for innovation	2
Efficiency of legal framework in challenging regs.	19	University-industry collaboration in R&D	2
Flexibility of wage determination	19	Available airline seat km/week, millions	1
Quality of the education system	18	Inflation, annual % change	1
Protection of minority shareholders' interests	17	Redundancy costs, weeks of salary	1
Internet access in schools	17	Domestic market size index, 1–7 (best)	1
		Extent of marketing	1

Table 5-6: Problematic Factors for Doing Business (16 total possible factors ranked)

Factor	Score
Tax rates	14.0
Inefficient government bureaucracy	13.7
Complexity of tax regulations	12.5
Restrictive labor regulations	9.7
Inadequately educated workforce	8.6
Poor work ethic in labor force	7.0
Access to financing	6.7
Insufficient capacity to innovate	5.5
Inadequate supply of infrastructure	5.3
Policy instability	5.2
Inflation	3.5
Foreign currency regulations	3.3
Poor public health	1.6
Government instability/coups	1.2
Crime and theft	1.1
Corruption	1.0

6 Discussion

This report provides an overview of the US manufacturing industry. There are three aspects of U.S. manufacturing that are considered: (1) how the US industry compares to other countries, (2) the trends in the domestic industry, and (3) the industry trends compared to those in other countries. According to the 2014 Annual Survey of Manufactures (ASM), the US manufacturing sector produced $2.4 trillion in value added in 2014, up 1.9 %. Value added in machinery manufacturing (NAICS 333), computer and electronic product manufacturing (NAICS 334), electrical equipment (NAICS 335), and transportation equipment (NAICS 336) grew 5.1 %, -0.7 %, 2.8 %, and 7.8 % respectively. US compound real (controlling for inflation) annual growth between 1989 and 2014 was 2.2 %, which places the US in the 47th percentile of all countries. This growth exceeded that of Germany, France, Canada, Japan, and Australia; however, it is slower than the global average (3 %) and that of many emerging economies. US manufacturing value added, as measured in constant 2005 dollars, is the second largest just behind that of China. In current dollars, the US produced $1.8 trillion in manufacturing valued added while China produced $1.9 trillion. Among the ten largest manufacturing countries, the US is the 3rd largest manufacturing value added per capita.

The US remains a major manufacturing nation; however, other countries are rising rapidly. US manufacturing was significantly impacted by the previous recession and, as of 2016, has not returned to pre-recession levels of production or employment. The US has advantages in technological prowess, innovation, productivity, and research and development; however, education was ranked low in two indices (i.e., IMD and World Economic Forum), which could negatively impact US advantages in the future. Institutions and institutional framework, which include crime, regulatory frameworks, country credit rating, and government spending among other things, ranked low in two indices. A number of costs were identified as challenges to US manufacturing, including high labor costs, which is likely related to high productivity. Systematic cost analysis of US manufacturing reveals that management is a significant cost along with a number of other non-production costs such as wholesale trade. The number of injuries and the injury rate in US manufacturing has a general downward trend.

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