Job Creation in the Manufacturing Revival

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Summary

The health of the U.S. manufacturing sector is of ongoing interest to Congress. Numerous bills aimed at promoting manufacturing are introduced in each Congress, often with the stated goal of creating jobs. Implicit in many of these bills is the assumption that the manufacturing sector is uniquely able to provide well-paid employment for workers who have not pursued education beyond high school.

Lines between manufacturing and other economic sectors are increasingly blurred. Many workers in fields such as industrial design and information technology perform work closely related to manufacturing, but are usually counted as employees in other sectors unless their workplace is within a manufacturing facility. Temporary workers in factories typically are employed by third parties and not treated as manufacturing workers in government data. Further, technology, apparel, and footwear firms that design and market manufactured goods but contract out production to separately owned factories are not considered to be manufacturers, even though many of their activities may be identical to those performed within manufacturing firms. These definitional issues have made it more challenging to assess the state of the manufacturing sector.

This report addresses the outlook for employment in the manufacturing sector. Its main conclusions are the following:

- U.S. manufacturing output has risen approximately 22% since the most recent low point in 2009, but almost all of that expansion occurred prior to the end of 2014. Increased manufacturing activity has resulted in modest growth of employment in the manufacturing sector, a trend that seems likely to persist even if manufacturing output continues to expand.
- Wages for production and nonsupervisory workers in manufacturing, on average, have declined relative to wages of similar workers in other industries. Although workers in some manufacturing industries earn relatively high wages, the assertion that manufacturing as a whole provides better jobs than the rest of the economy is increasingly difficult to support.
- Manufacturers spend more per work-hour for worker benefits than private employers in other industries, but the difference has diminished in recent years.
- A declining proportion of manufacturing workers is involved in physical production processes, while larger shares perform managerial and professional tasks. Many routine manufacturing tasks are now performed by contract workers, whose wages are lower than those of manufacturing firms' employees in similar occupations. These changes are reflected in increasing skill requirements at manufacturing firms and diminished opportunities for workers without education beyond high school.
- The average number of new manufacturing establishments opened each year since the end of the last recession remains much lower than in the period between 1977 and 2009. Unlike in the service sector, few jobs in manufacturing are provided by new establishments. Conversely, plant closings are responsible for only a small share of jobs lost. Change in manufacturing employment overwhelmingly occurs through hiring or job reductions at existing facilities.

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Introduction

After rebounding from recession between 2009 and 2014, U.S. manufacturing output has grown little since the second half of 2014. Over the same period, employment in the U.S. manufacturing sector has increased slightly. These trends defy expectations that forces such as higher labor costs in the emerging economies of Asia, heightened concern about the risk of disruptions to long, complex supply chains, and the development of inexpensive domestic supplies of natural gas would bring a surge of factory production and manufacturing jobs in the United States.[1]

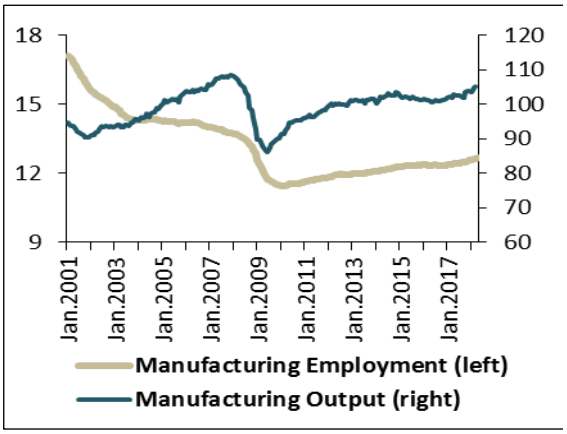
Changes in technology, business organization, and employment practices make it increasingly difficult to evaluate the state of the manufacturing sector. It appears that government statistics attribute a growing share of manufacturing-related jobs and output to other sectors of the economy, notably information, professional and business services, and wholesale trade. The extent to which output and employment in these sectors are related to manufacturing is difficult to quantify. However, evidence suggests that even strong growth in manufacturing is likely to have a modest impact on overall job creation, particularly for workers with lower levels of education.

Employment in the Manufacturing Sector

At the start of the 21st century, 17.1 million Americans worked in manufacturing. This number declined during the recession that began in March 2001, in line with the historic pattern. In a departure from past patterns, however, manufacturing employment failed to recover after that recession ended in November 2001 (see **Figure 1**). By the time the most recent recession began, in December 2007, the number of manufacturing jobs in the United States had fallen to 13.7 million. Currently, 12.6 million workers are employed in the manufacturing sector.

Figure 1. Employment and Output in Manufacturing

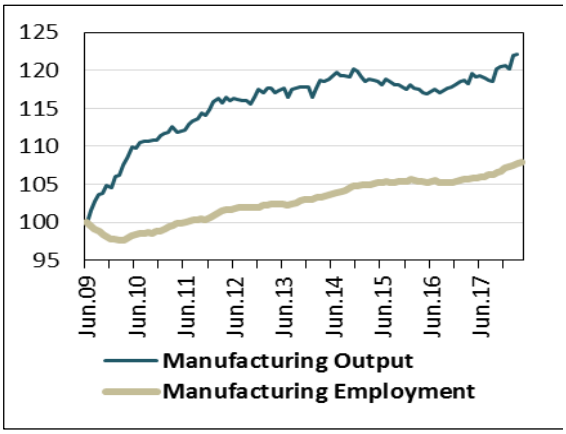
Employment in millions, output indexed 2012=100



Sources: Bureau of Labor Statistics, Current Employment Survey, and Federal Reserve Board, Industrial Production Index. Seasonally adjusted.

Figure 2. Growth in Employment and Output Since Cyclical Trough

Indexed, June 2009=100



Sources: Bureau of Labor Statistics, Current Employment Survey, and Federal Reserve Board, Industrial Production Index. Seasonally adjusted.

[1] See, for example, Harold L. Sirkin, Michael Zinser, and Douglas Hohner, "Made in America, Again: Why Manufacturing Will Return to the U.S.," Boston Consulting Group, August 2011.

The output of U.S. manufacturers hit a cyclical bottom in June 2009. Since that time, a 22% increase in manufacturing output has been accompanied by only an 8% increase in manufacturing employment (see **Figure 2**). The low point in manufacturing employment was reached in February 2010. Since that time the manufacturing job count has risen 10%.[2]

There is no single cause of the weakness in manufacturing employment. A sharp increase in the bilateral U.S. trade deficit with China following that country's accession to the World Trade Organization in 2001 contributed importantly to manufacturing job loss in the first half of the last decade, but changes in the bilateral balance in goods trade since 2006 are not associated with changes in employment of factory workers in the United States.[3] Cyclical forces aside, at least three distinct factors limit the prospects for job creation in the manufacturing sector, even if domestic production gains market share from imports.

- Some manufacturing industries, notably apparel and footwear, are tied to labor-intensive production methods that have proven difficult to automate. With labor costs accounting for a much higher share of value added in these industries than in manufacturing as a whole, declining import barriers allowed imports from low-wage countries, particularly in East Asia, to displace domestic production. From 1.3 million workers in 1980, U.S. employment in apparel manufacturing has fallen to 117,000. Leather manufacturing has seen a similar employment decline. Over the same period, U.S. output of apparel fell by 86%, and output of leather products fell by 81%.
- In other industries, technological improvements have enabled manufacturers to expand output without adding workers.[4] Steelmaking offers such an example: the 83,000 people working in the industry in 2017 produced 8% more steel than nearly 399,000 workers did in 1980.[5]
- Secular shifts in demand have dimmed employment prospects in some industries despite the general recovery in manufacturing output. Paper consumption, for example, was once closely associated with economic growth, but no longer; paper output has stabilized at a level about 20% lower than in the late 1990s, contributing to a 40% drop in industry employment over the same period. As

[2] Manufacturing output, as discussed in this section, is derived from the Federal Reserve Board Industrial Production Indexes, seasonally adjusted, http://www.federalreserve.gov/releases/g17/Current/default.htm. Employment figures in this section are from the Bureau of Labor Statistics (BLS) Current Employment Statistics database, http://www.bls.gov/ces/, and are seasonally adjusted.

[3] On the impact of China on manufacturing employment, see Justin R. Pierce and Peter K. Schott, "The Surprisingly Swift Decline of U.S. Manufacturing Employment," *American Economic Review*, vol. 106 (2016), pp. 1632-1662, and David H. Autor, David Dorn, and Gordon H. Hanson, "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, vol. 103 (2013), pp. 2121-2168. On U.S.-China trade more generally, see CRS Report RL33536, *China-U.S. Trade Issues*, by (name redacted) .

[4] Kerwin Kofi Charles, Erik Hurst, and Mariel Schwartz point out that since 2000, the capital intensity of the U.S. manufacturing sector has increased much more rapidly than the capital intensity of the nonfarm business sector; see "The Transformation of Manufacturing and the Decline in U.S. Employment," Working Paper 24468, National Bureau of Economic Research, March 2018, pp. 16, 18.

[5] In 1980, an average of 398,829 employees produced 83.9 million tons of steel; see American Iron and Steel Institute, *Annual Statistical Report 1980* (Washington, DC, 1981), pp. 8, 21. U.S. steel shipments in 2017 were 90.9 million tons, according to the Institute; see http://www.steel.org/Steel_org/document-types/news/2018/decembershipments.aspx?siteLocation=c481cc99-d816-4613-805c-b90af33cc162. BLS gives average industry employment in 2017 as 83,000.

cigarette consumption has waned, output in tobacco products manufacturing is down 57% since the most recent peak in 1996, and employment has fallen 55%.[6]

These changes have resulted in a significant shift in the composition of manufacturing employment even as most manufacturing industries have experienced declining employment. Food manufacturing, which two decades ago accounted for 1 in 11 manufacturing jobs, now accounts for 1 in 8; it is one of the few manufacturing sectors in which employment has grown. Transportation equipment, fabricated metal products, food manufacturing, and plastics and rubber manufacturing have added workers since the end of the last recession in 2009, and account for larger shares of manufacturing employment. Apparel, textiles, printing, and computers and electronic products now account for substantially smaller shares of manufacturing employment than was formerly the case (see **Table 1**).

Table 1. Shares of Manufacturing Employment by Industry, 2001-2018

Industry	2001 Share	2009 Share	2018 Share
Transportation Equipment	11.64%	11.22%	13.07%
Food	9.08%	11.68%	12.91%
Fabricated Metal Products	10.28%	11.36%	11.61%
Machinery	8.49%	9.02%	8.77%
Computers and Electronic Products	10.93%	9.58%	8.40%
Chemicals	5.71%	6.56%	6.59%
Plastics and Rubber	5.45%	5.30%	5.76%
Misc. Durables Manufacturing	4.25%	4.82%	4.71%
Printing	4.66%	4.45%	3.47%
Nonmetallic Mineral Products	3.25%	3.38%	3.32%
Electrical Equipment	3.41%	3.22%	3.15%
Furniture	3.96%	3.38%	3.12%
Primary Metals	3.55%	3.23%	3.01%
Paper	3.70%	3.38%	2.94%
Apparel	2.67%	1.41%	0.93%
Textiles	2.13%	1.07%	0.88%

Source: Bureau of Labor Statistics, Current Employment Statistics for January of respective year.

Note: Not all manufacturing industries are included.

[6] BLS no longer reports employment in tobacco products manufacturing. However, according to Census Bureau data, employment in the industry fell from 31,115 in March 1996 to 13,872 in March 2015. See U.S. Census Bureau, *County Business Patterns 1996: United States* (Washington, 1998), p. 12, and U.S. Census Bureau, CBP Tables 2015, data for tobacco manufacturing, industry code 3122, at https://www.census.gov/programs-surveys/cbp/data/tables.2015.html.

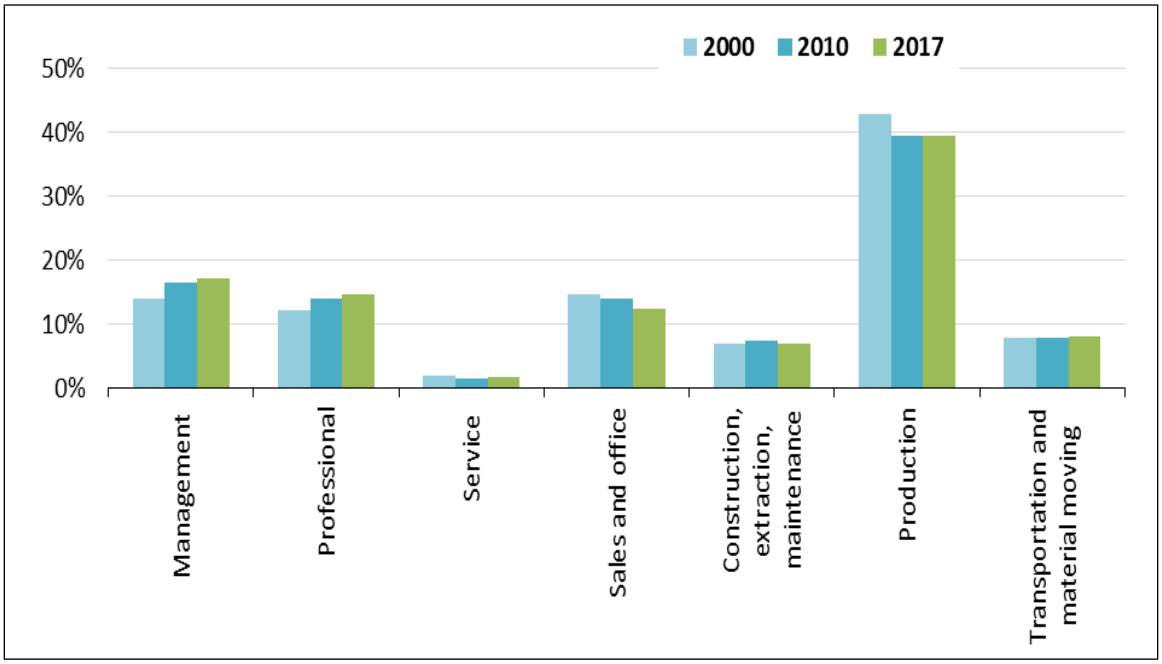
The Changing Character of Manufacturing Work

In the public mind, the word "factory" is associated with the concept of mass production, in which large numbers of workers perform repetitive tasks. While mass production is still an important aspect of manufacturing, routine production functions, from welding joints in truck bodies to removing plastic parts from a molding machine, have proven susceptible to automation. This has had important consequences for the nature of work in manufacturing establishments and for the skill requirements of manufacturing workers.

Goods production is no longer the principal occupation of workers in the manufacturing sector. Only two in five manufacturing employees are directly involved in making things. That proportion fell 3.4 percentage points between 2000 and 2017. Employment in other occupations within the manufacturing sector, notably office clerical work, has also declined (see **Figure 3**). As of 2017, 32% of all manufacturing workers held management and professional jobs.[7]

Figure 3. Manufacturing Employment by Occupation

Percentage of manufacturing workforce



Source: Bureau of Labor Statistics, Current Population Survey, Table 17, http://www.bls.gov/cps/cpsaat17.htm.

In many manufacturing industries, the shift to higher skill requirements is even more pronounced. Total employment in the U.S. computer and electronic product manufacturing industries has declined due to automation, sharp falls in demand for certain products once produced in the United States (notably television tubes and audio equipment), and changed production economies that cause manufacturers to concentrate worldwide production in a small number of locations. Of the 1.04 million people employed in this industry in 2017, 28% were engaged in production occupations, for which a high school education may be sufficient and for which workers received median annual pay of $35,010. Some 21% of the industry's workers were in architecture and

[7] Bureau of Labor Statistics, Current Population Survey for 2017 and previous years, Table 17. For the most recent data, see http://www.bls.gov/cps/cpsaat17.pdf.

engineering occupations paying a median annual wage of $87,010, and another 13% were in computer and mathematical occupations with a median annual wage of $104,120; the latter two occupational categories require much higher education levels than production work. Similarly, some 32% of the workers in the pharmaceutical manufacturing industry are involved with production. Many of the rest have scientific skills associated with higher education levels.[8]

The increasing demand for skills in manufacturing is most visible in the diminished use of "team assemblers"—essentially, line workers in factories and warehouses. In May 2016, employment in this occupation, which typically requires little training and no academic qualifications, was 1.3 million, down 15% since 2000. Some 862,300 team assemblers worked in manufacturing in 2016, representing less than 7% of manufacturing jobs. This type of job was once the core of manufacturing. Now, 19% of all team assemblers work for employment agencies, which furnish workers to other companies on an as-needed basis. Team assemblers working for employment agencies earned an average of $12.43 per hour, some 21% less than those employed directly by manufacturing companies.[9]

The changing occupational mix within the manufacturing sector is mirrored by changing educational requirements. In 2000, 53% of all workers in manufacturing had no education beyond high school. Between 2000 and 2017, that share dropped by 11 percentage points, even as the proportion of manufacturing workers with bachelor's degrees or graduate degrees rose by 9 percentage points, to 31%. Given that college-educated workers generally command significantly higher pay in the labor market than high-school dropouts and high-school graduates, it is unlikely that manufacturers would willingly hire more-educated workers unless there is a payoff in terms of greater productivity.

Despite the significant loss of manufacturing jobs between 2000 and 2017, the number of manufacturing workers with graduate degrees increased by approximately 343,000, or 34% (see **Figure 4**). Employment of workers with associate (community college or proprietary school) degrees in academic fields rose 23%, or approximately 150,000 jobs, over that period, while workers with associate degrees in occupational fields, which prepare students for immediate vocational entry and typically require less coursework in English, mathematics, and science, declined by 95,000.[10]

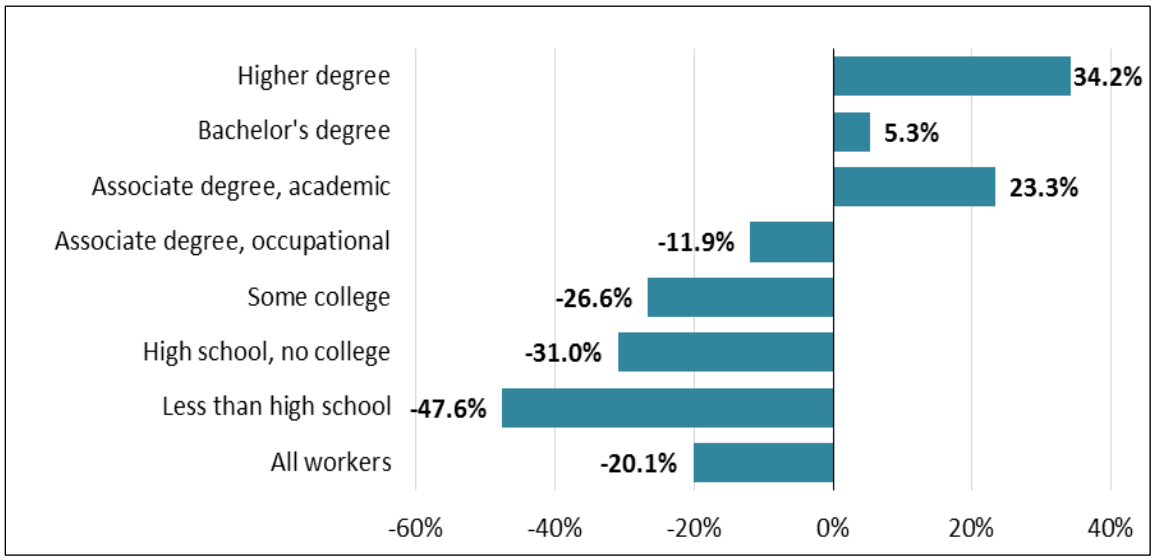
[8] Data from Bureau of Labor Statistics Occupational Employment Statistics database, http://data.bls.gov/oes/.

[9] Data are available at https://www.bls.gov/oes/tables.htm. Due to definitional changes, comparable data are not available for 2017.

[10] Bureau of Labor Statistics, Current Population Survey, "Employed Persons by Intermediate Industry, education, sex, race, and Hispanic or Latino ethnicity (25 years and over)," 2016 and prior years. It is unclear whether the higher demand for workers with academic associate degrees reflects higher skill levels among those workers or is a result of individuals with greater ability enrolling in the academic rather than occupational programs at community colleges.

Figure 4. Manufacturing Employment by Worker Education

Percentage change, 2000-2017



Source: Bureau of Labor Statistics, Current Population Survey.

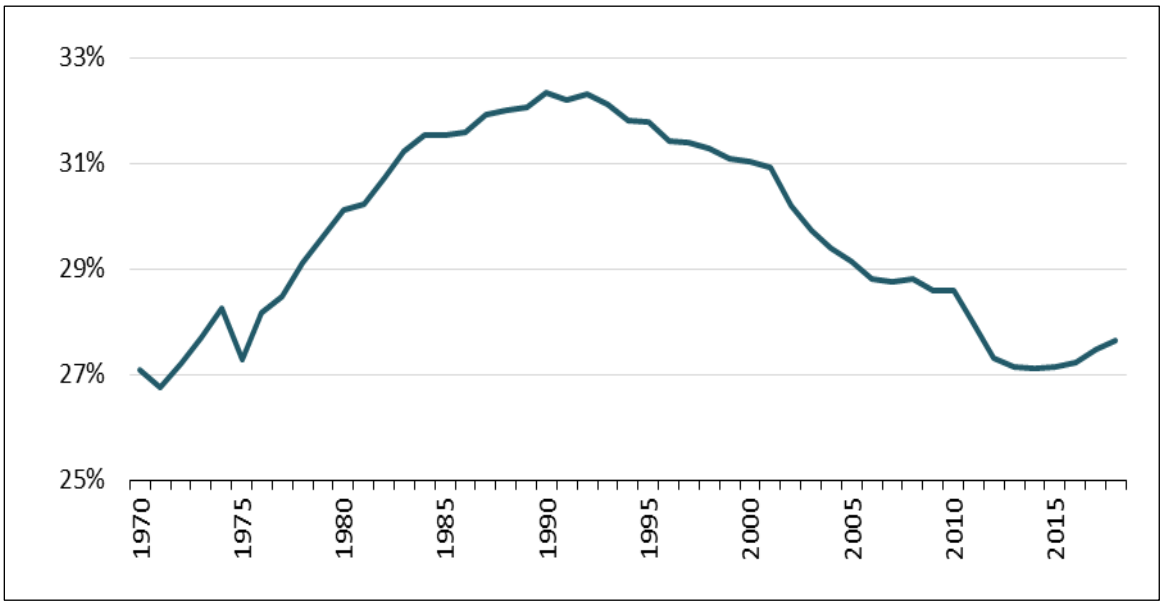
The proportion of manufacturing workers who are female has fallen from 32% as recently as 1993 to 28% currently (see **Figure 5**). Women have long accounted for a large share of employment in some of the industries that have experienced the steepest drops in employment, notably apparel, textiles, and electrical manufacturing. The female workforce was significantly less educated than the male workforce in manufacturing: in 2000, only 41% of female manufacturing workers had any education beyond high school, compared with 61% of their male counterparts.

This gender gap in education has closed since 2000, due largely to the departure of these less educated women from the manufacturing workforce. The number of female manufacturing workers with no education beyond high school fell 46% from 2000 to 2016. As a result, the number of years of schooling of female manufacturing workers is now very similar to that of males in manufacturing. Some 32% of women workers in manufacturing in 2017 held four-year college degrees or higher degrees, almost identical to the proportion for men. Some 11% of female manufacturing workers had not completed high school; the corresponding share of male manufacturing workers was around three percentage points less.

The female share of the manufacturing workforce has increased since reaching a low of 27.11% in 2014. Since then, manufacturers have added 200,000 workers along with 300,000 male workers.

Figure 5. Manufacturing Employment by Gender

Percentage of manufacturing workforce that is female



Source: Bureau of Labor Statistics, Current Employment Statistics.

Note: Data are for January of each year and are not seasonally adjusted.

The Shrinking Wage Premium

Policymakers traditionally have attached special importance to manufacturing because manufacturers appear to pay a wage premium, compared to employers in other industries. Based on pay, a 2012 U.S. Department of Commerce publication asserted, "manufacturing jobs are good jobs." According to that source, manufacturing jobs offered average hourly pay of $29.75 in 2010, compared to $27.47 for nonmanufacturing jobs. Including employer-provided benefits, the Commerce Department reported, manufacturing workers earned 17% more per hour than workers in other industries.[11] Those other industries, it should be noted, include the low-paying retailing and leisure and hospitality industries, which jointly account for 22% of nonfarm employment, as well as higher-paying industries such as construction and utilities.

Such comparisons, however, are not as straightforward as they may appear. At least some of the purported manufacturing wage premium exists because manufacturers employ far fewer young workers than industries with lower pay. In the lowest-paid sectors of the economy, a large share of the workforce—14% in leisure and hospitality, 7% in retailing—is under age 20, compared with only 1% of manufacturing workers.[12] Also, large numbers of workers in those two lower-paying industries are employed part time; the average work week is around 25 hours in leisure and hospitality and 30 hours in retailing, versus 42 hours in manufacturing.[13] Full-time workers in any industry are more likely to receive benefits than part-time workers.

[11] David Langdon and Rebecca Lehrman, "The Benefits of Manufacturing Jobs," U.S. Department of Commerce, Economics and Statistics Administration, Issue Brief #01-12, May 2012, p. 1.

[12] U.S. Bureau of Labor Statistics, Current Population Survey, Table 18b, http://www.bls.gov/cps/cpsaat18b.htm.

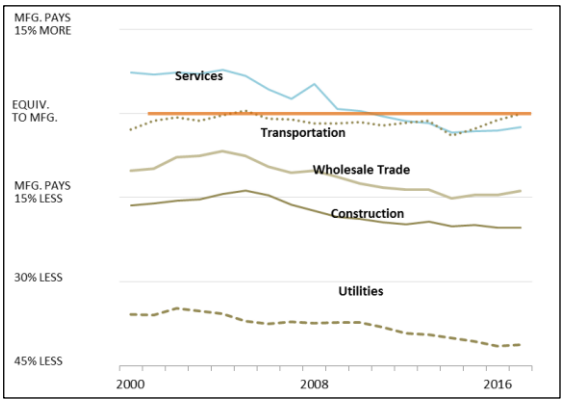
[13] U.S. Bureau of Labor Statistics, Current Employment Statistics, http://www.bls.gov/ces/.

Contrary to the popular perception, production and nonsupervisory workers in manufacturing, on average, earn significantly less per hour than nonsupervisory workers in industries that do not employ large numbers of teenagers, that have average workweeks of similar length, and that have similar levels of worker education. For example, nonsupervisory workers in manufacturing earned an average hourly wage of $21.29 in 2017, compared with $26.73 for nonsupervisory construction workers and $36.21 for nonsupervisory workers in the electric utility industry. Moreover, average wages for production and nonsupervisory workers in manufacturing have declined over time, compared to those in other industries, with the exceptions of retailing and transportation (see **Figure 6**). In 2000, for example, nonsupervisory workers in manufacturing earned 5.1% *more*, on an hourly basis, than nonsupervisory workers in the services sector; in 2017, they earned 2.4% *less* than services workers, on average.[14]

One criticism of this analysis is that the Bureau of Labor Statistics (BLS) considers a smaller proportion of employees to be production and nonsupervisory workers in manufacturing than in other sectors of the economy, so that comparing the wages of this subset of workers may lead to misleading conclusions about relative pay in manufacturing.[15] One alternative is to look at relative earnings of all workers rather than just nonsupervisory workers. These data, which are available only since 2007, show more modest relative declines in manufacturing wages than appear in the figures for production and nonsupervisory workers (see **Figure 7**). However, the wages of highly paid workers, including managers and executives, are included in these data, so the averages may not be reflective of the relative pay of factory-floor workers.

Figure 6. Wages for Nonsupervisory Workers in Selected Industries

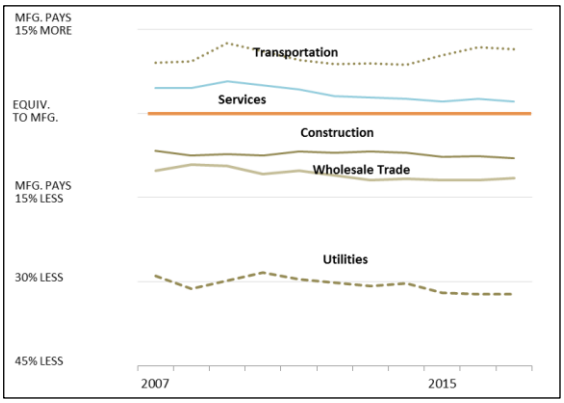
Relative hourly pay of workers in manufacturing



Source: Bureau of Labor Statistics, Current Employment Statistics.

Figure 7. Wages for All Workers in Selected Industries

Relative hourly pay of workers in manufacturing



Source: Bureau of Labor Statistics, Current Employment Statistics.

A recent econometric analysis[16] draws on data from a different BLS survey to estimate that workers without college educations earn average hourly wages 7.8% higher in manufacturing

[14] Ibid.

[15] Jessica R. Nicholson and Regina Powers, "The Pay Premium for Manufacturing Workers as Measured by Federal Statistics," U.S. Department of Commerce, Economics and Statistics Administration, Issue Brief #05-15, October 2, 2015, p. 12. There are differences among federal statistical agencies in identification of production and nonsupervisory workers. For example, BLS estimates that 79.5% of workers in motor vehicle manufacturing in 2016 were production and nonsupervisory workers, whereas Census Bureau surveys put the figure at 86.4%.

[16] The analysis was produced by the Economic Policy Institute, a nonpartisan think tank concerned with the needs of

than elsewhere in the private sector. It concludes that "there remains a manufacturing wage premium, but that it has substantially fallen since the 1980s."[17] The study adjusts the data for gender, experience, education, race, ethnicity, and region of the country, so it provides an answer to the question, "Is an individual who works in manufacturing likely to earn a higher hourly wage than an individual with similar characteristics who works in another private-sector industry?" However, adjusting for individual characteristics may obscure broader trends in relative wages of manufacturing workers. For example, the share of manufacturing workers identifying themselves as "Black or African American" and "Hispanic or Latino" has been increasing. On average across all industries, black and Hispanic workers earn less than non-Hispanic white workers. Hence, it is arithmetically possible that a growing proportion of manufacturing workers earns a wage premium relative to what those individuals could earn in other industries, even as the wage premium for manufacturing workers overall has disappeared.[18]

Whether manufacturing pays higher wages than other types of work attracting a similar workforce depends in part on the location and type of industry. In 2010, according to BLS, the average hourly wage for all workers in manufacturing was higher than the average for all private-sector workers in 29 of the 46 states for which data were available. By 2017, the average manufacturing wage exceeded the private-sector average in 25 of 46 states.[19] The national average hourly wage for production workers in durable-goods manufacturing, including such industries as transportation equipment and computers and electronic products, $22.25, is well above the $19.80 average in non-durables manufacturing, which includes such low-paying industries as food, textiles, and apparel.

Traditionally, manufacturing employers have tended to offer more generous employee benefits than those in other industries. This was due mainly to the comparatively large union presence in the manufacturing sector; in 2000, for example, employers of blue-collar union workers in manufacturing spent nearly twice as much per hour worked on benefits as employers of blue-collar non-union workers in manufacturing.[20] While manufacturing employers, on average, still spend more on benefits than private-sector employers in general, the differential has diminished in recent years, according to BLS data (see **Table 2**).[21]

low- and middle-income workers and closely associated with organized labor.

[17] Lawrence Mishel, "Yes, manufacturing still provides a pay advantage, but staffing firm outsourcing is eroding it," Economic Policy Institute, March 12, 2018, p. 11, https://www.epi.org/publication/manufacturing-still-provides-a-pay-advantage-but-outsourcing-is-eroding-it/.

[18] For another example of why a regression analysis using worker-specific variables does not fully answer the question about whether manufacturing pays higher wages than other industries, consider a hypothetical factory in Massachusetts that pays its workers the state manufacturing average of $31.66 per hour. This is 1.4% less than the average private-sector wage in Massachusetts. Now, assume that the factory relocates to Mississippi, where it pays $22.93 per hour, that state's average wage in manufacturing. This is 12.3% above the average private-sector wage in Mississippi. Regression analysis using a geographic variable would show that the Mississippi workers receive a manufacturing wage premium, while the former workers in Massachusetts, who received no wage premium despite earning a much higher wage, have disappeared from the data.

[19] Bureau of Labor Statistics, State and Metro Area Employment, Hours, & Earnings, https://www.bls.gov/sae/.

[20] Bureau of Labor Statistics, "Employer Costs for Employee Compensation—March 2000," https://www.bls.gov/news.release/history/ecec_06292000.txt, Tables 10, 13.

[21] Using a definition of benefits that excludes paid leave and supplemental pay, Lawrence Mishel finds that the manufacturing premium in benefits has not declined; see "Yes, manufacturing still provides a pay advantage, but staffing firm outsourcing is eroding it," p. 13.

Table 2. Employer Costs for Worker Benefits

Per hour worked, full-time workers

Year	Manufacturing	All Private Sector	Manufacturing Premium
2000	$7.53	$6.37	18.2%
2005	$10.69	$8.54	25.2%
2010	$11.15	$9.75	14.4%
2017	$13.73	$12.41	10.6%

Source: Bureau of Labor Statistics, Employer Costs for Employee Compensation, various years.

Note: Benefits include paid leave, supplemental pay, insurance, retirement and savings benefits, and legally required benefits.

On balance, modest job creation in manufacturing has not been accompanied by an improvement in the average position of manufacturing workers, relative to those in other sectors. Some manufacturing workers appear to have done well: the average hourly wage of workers in petroleum refining rose 46% between 2008 and 2017. On the other hand, average hourly wages in motor vehicle, auto parts, and rubber products manufacturing were lower in 2017 than in 2008.[22] Although workers in some manufacturing industries earn relatively high wages, the assertion that the manufacturing sector as a whole provides better wages and benefits than the rest of the economy is increasingly difficult to defend. However, a considerable share of manufacturing-related work is performed in other sectors of the economy, some of which have much higher average wages than the manufacturing sector itself.

Manufacturing-Related Work in Other Sectors

Under current statistical practices, whether an activity is classified as manufacturing depends largely on where it is conducted. Government statistical agencies track most types of economic activity at the level of the establishment—that is, a single facility or business location—rather than at the level of a firm that may own multiple establishments or an enterprise that may own many firms. As a general rule, if an establishment is "primarily engaged" in transforming or assembling goods, then all output from that establishment is considered output of the manufacturing sector, and all workers (except those employed by outside contractors) are considered manufacturing workers.

Thus, if a firm locates its product design employees at a U.S. facility that is primarily engaged in producing goods, those designers will likely be counted as working in a manufacturing establishment, and their work will add to the total value added created in U.S. manufacturing. If, however, the product designers work at a separately located design center, they will probably be considered to work in an industrial design establishment, not a manufacturing establishment. In that case, they will be counted as industrial design workers, and their value added will be attributed to the professional, scientific, and technical services sector, not to the manufacturing sector.[23] The same will be true if the product designers at a manufacturing establishment are employed by a separate firm rather than by the manufacturer.

[22] U.S. Bureau of Labor Statistics, Current Employment Statistics, http://www.bls.gov/ces/.

[23] Manufacturing activities fall within North American Industrial Classification System (NAICS) sectors 31-33, whereas professional, scientific, and technical services of all sorts fall within NAICS sector 54.

One might identify four separate groups of U.S. workers whose jobs are related to manufacturing:

- Production employees of manufacturing establishments: approximately 8.6 million workers at the end of 2016.
- Nonproduction employees of manufacturing establishments: approximately 3.7 million workers.
- Workers producing manufactured goods but employed by nonmanufacturing establishments: number unknown.
- Workers producing services and software used in manufacturing but employed by nonmanufacturing establishments: number unknown.

Data related to the first two groups are generally captured by government statistics depicting the manufacturing sector. Data related to the roles of workers in the last two groups are far more tenuous.

Information Technology

Establishments in the computer systems design and related services industry employed a total of 1.9 million Americans in 2015. Rough calculations suggest that perhaps 23% of the work hours in this industry, equivalent to 447,000 jobs, might have been considered manufacturing work if the workers were employed by manufacturing establishments (**Table 3**).[24]

Table 3. Manufacturing Employment Potentially Attributable to the Computer Systems Design and Related Services (CSD) Industry, 2015

Line	Statistic	Output ($bn)	Employment
A	CSD direct employment in 2015		1,911,400
B	CSD total output in 2015	$462.7	
C	CSD sales to manufacturers	$16.6	
D	CSD sales to manufacturers as share of CSD output (C/B)	3.6%	
E	CSD employment attributable manufacturing inputs (D*A)		68,424
F	CSD sales for private nonresidential investment in IP	$236.5	
G	Total private nonresidential investment in IP	$717.9	
H	Investment by manufacturers in IP	$278.0	
I	Manufacturers' investment in IP as share of total (H/G)	38.7%	
J	CSD output possibly attributable to manufacturers' investment in IP (F*I)	$91.6	
K	CSD sales of IP to manufacturers as share of output (J/B)	19.8%	
L	CSD employment possibly attributable to manufacturers' investment in CSD IP (K*A)		378,260
M	Manufacturing-like employment in CSD (E+L)		446,684

Source: CRS. See note 23.

Note: IP=intellectual property. Figures subject to rounding.

[24] Estimate derived by CRS from U.S. Bureau of Economic Analysis (BEA), Input-Output tables, Use of Commodities by Industries Before Redefinitions; BEA, Fixed Assets Accounts Table 3.71; and U.S. Bureau of Labor Statistics (BLS), Employment, Hours, and Earnings from Current Employment Survey, NAICS code 5415.

Another 378,000 U.S. workers are employed in software publishing, an industry in which employment has been rising approximately 6% annually. An unknown number of these workers are involved in writing and testing computer software that is eventually embedded in manufactured goods. However, in government statistics these workers are allocated to the information sector, and they are not counted as part of the manufacturing workforce.

Bundled Services

Anecdotal evidence suggests that a growing proportion of manufactured goods are sold in conjunction with after-sale services. For example, Boeing Corp., an aircraft manufacturer, recently set a goal of $50 billion of annual revenue from services such as supplying spare parts, modifying and repairing aircraft, training pilots, and monitoring aircraft systems during flights.[25] Many other manufacturers are reshaping themselves to be service providers as well, attracted by the prospect of continuing revenue streams from customers rather than one-time payments.[26]

It is possible that a manufacturer might demand a different price for a good sold as a stand-alone product than for the same good when bundled with a service contract. In such a case, the amount of the product's value to attribute to the manufacturing sector rather than the "other services" sector, which includes machinery and equipment repair and maintenance, may be arbitrary.[27] Government data collectors may not be able to capture the value of the good separately from the value of the bundled services, and may not be able to distinguish the workers involved in the original production process from those providing related services.

Factoryless Goods Production/Contract Manufacturing

Factoryless goods producers are firms that design products to be manufactured and own the finished goods but do not engage directly in physical transformation. The transformation or assembly of the goods they sell is done by external suppliers, known as contract manufacturers, in the United States or abroad, although the factoryless goods producer may be closely involved in its contract manufacturers' operations. Examples might include a U.S.-based footwear company that engages other firms to produce the shoes it designs and markets,[28] and a "fabless" semiconductor company that contracts with an unrelated "foundry" to manufacture its chips.[29]

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[25] Dominic Gates, "Boeing goes outside for new Commercial Airplanes CEO," Seattletimes.com, November 21, 2016.

[26] As an example, United Technologies Corp., which manufactures elevators, aircraft engines, and many other products, reported that "product sales" accounted for 69% of its $59.8 billion of sales in its FY2016, and "service sales" accounted for 31%. Its competitor, General Electric Co., reported that nearly half the sales of its industrial segment and a majority of the sales in its power segment were services rather than equipment. See United Technologies, "Management's Discussion and Analysis of Financial Condition and Results of Operations," *Form 10-K for the fiscal year ended December 31, 2017*, p. 34, and General Electric Co., *Form 10-K for the fiscal year ended December 31, 2017*, pp. 27, 31. It is unclear how either of these companies classifies employees and establishments in its responses to government statistical surveys.

[27] "Other Services (except Public Administration)" fall within NAICS sector 81.

[28] Nike Inc., based in Oregon, reports that "Virtually all of our products are manufactured by independent contractors. Nearly all footwear and apparel products are produced outside the United States, while equipment products are produced both in the United States and abroad." The company was supplied by 127 footwear factories in 15 countries and 363 apparel factories in 37 countries. Nike does not disclose U.S. employment, but reported that its Oregon headquarters was occupied by approximately 10,800 employees. Nike Inc., *Form 10-K for the fiscal year ended May 31, 2017*, pp. 55, 57, 68. According to a press report. Nike had 31,977 U.S. employees in its FY2015. See John Kell, "Majority of Nike's U.S. Employees Are Minorities for the First Time," http://fortune.com/2016/05/12/nike-staff-diversity/, May 12, 2016.

[29] See CRS Report R44544, *U.S. Semiconductor Manufacturing: Industry Trends, Global Competition, Federal Policy*,

It is impossible to identify factoryless goods producers with certainty; responses to related questions on government surveys are confidential, and companies' annual reports filed with the Securities and Exchange Commission may not provide sufficient detail to determine whether they own manufacturing establishments. Alphabet Inc., parent of Google Inc., appears to meet the definition. Alphabet generated 86% of its revenue in 2017 from delivering online advertising. The company also sells computers, telephones, and security systems to consumers; designs and oversees production of computer servers used in its data centers; and designs semiconductors used in computers and smartphones.[30] In 2012 a company official referred to Google as "probably ... one of the largest hardware manufacturers in the world." However, according to Alphabet's 2017 annual financial report, "We rely on third parties to manufacture many of our assemblies and finished products," leaving the question of whether Alphabet owns and operates its own manufacturing facilities unanswered.[31] It is unclear whether any Alphabet employees are categorized as manufacturing workers and whether any of the company's sales are registered as manufacturing output.

According to Census Bureau estimates, at least 54,000 nonmanufacturing firms employing 3.4 million workers purchased contract manufacturing services in 2012.[32] Many of the tasks performed by the employees of the purchaser firms may be identical to those performed by employees of manufacturing establishments in management, professional, sales, office, and transportation occupations. However, as the facilities owned by factoryless goods producers are usually classified as wholesale, retail, or professional, scientific, and technical service establishments rather than manufacturing establishments, it is likely that few if any of their workers are counted as manufacturing workers.

Most contract manufacturing services are provided by establishments in the manufacturing sector, either in the United States or abroad. At the same time, however, more than 20,000 U.S. enterprises whose primary business is not manufacturing reported providing contract manufacturing services in 2012. These enterprises—an "enterprise" may own one or many establishments or firms—collectively employed 1.5 million workers (**Table 4**). The number of those 1.5 million workers who were engaged in manufacturing-related work cannot be determined from published data. Nor is it known how many of those workers were captured as manufacturing-sector workers in government data.[33]

Table 4. Characteristics of U.S. Enterprises Providing Contract Manufacturing

Ranked by number of contract manufacturers

Sector	Number of Contract Manufacturers in Sector	Total Employment of Contract Manufacturers in Sector
Manufacturing	14,683	2,372,674

by (name redacted) and (name redacted)

[30] Cade Metz, "Google Makes Its Special A.I. Chips Available to Others," *New York Times*, February 12, 2018.

[31] Cade Metz, "Where in the World Is Google Building Servers?," *Wired*, July 6, 2012; Alphabet Inc., Form 10-K for the fiscal year ended December 31, 2017, pp. 13, 28.

[32] U.S. Census Bureau, "Enterprise Statistics: 2012 Enterprise Tables," https://www.census.gov/econ/esp/, Table 8. In this survey, which collected data from "enterprises" rather than establishments, each enterprise was assigned to the economic sector with the largest share of the enterprise's payroll (measured in dollars). Most large enterprises would thus be expected to control establishments in more than one economic sector. Some 1.9 million enterprises with a collective $7.7 trillion of sales did not respond to the survey, so the actual number of nonmanufacturing firms purchasing contract manufacturing services may be considerably larger than indicated by the survey.

[33] U.S. Census Bureau, "Enterprise Statistics: 2012 Enterprise Tables," Table 7.

Sector	Number of Contract Manufacturers in Sector	Total Employment of Contract Manufacturers in Sector
Professional, scientific, and technical services	5,042	230,648
Wholesale trade	4,699	156,276
Construction	2,244	67,355
Retail trade	2,130	659,501
Accommodation and food services	1,686	73,965
Other	4,332	347,253

Source: U.S. Census Bureau, Enterprise Statistics: 2012 Enterprise Tables, Table 7.

Note: An enterprise may have establishments in multiple sectors and may control more than one firm.

The definitional questions associated with factoryless goods producers have proven controversial. In 2010, U.S. statistical agencies proposed to categorize factoryless goods producers as manufacturers starting in 2017.[34] This change would have increased both the number of individuals counted as manufacturing workers and the reported value added of the manufacturing sector.[35] The proposal met with strong objections. In 2014, the Office of Management and Budget ordered the change postponed, citing the poor quality of statistical data about factoryless producers.[36] As a result, a significant amount of manufacturing-like work and value added is not attributed to manufacturing in government statistics.

Employment Services Firms

Manufacturers make significant use of workers employed by temporary help agencies and other employment services firms in addition to their own employees. According to estimates based on Bureau of Labor Statistics data, 983,904 people in typical manufacturing production occupations

[34] U.S. Census Bureau, "Economic Classification Policy Committee (ECPC) Recommendation for Classification of Outsourcing in North American Industry Classification System (NAICS) Revisions for 2012," http://www.census.gov/eos/www/naics/fr2010/ECPC_Recommendation_for_Classification_of_Outsourcing.pdf.

[35] The data are difficult to interpret. The Census Bureau assigned enterprises to economic sectors based in establishment-level data about employment. So, for example, an enterprise would likely have been assigned to the retail trade sector if the largest group of its employees worked in retail establishments, even if it owned establishments in other sectors as well. In March 2012, 643 enterprises classified as being in the retail trade sector, with a total of 75,470 employees, reported that 100% of their operating revenue and net sales came from providing contract manufacturing services. It is not apparent why such enterprises would have been classified as retail enterprises. For data, see U.S. Census Bureau, "Enterprise Statistics: 2012 Enterprise Tables," Table 7. For definitions, see U.S. Census Bureau, "Definitions for the Enterprise Statistics Program," https://www.census.gov/econ/esp/definitions.html. The Enterprise Statistics Program operated from 1954 to 1992 and again from 2007 to October 2016, when it was again discontinued.

[36] For background on factoryless manufacturing, see Andrew B. Bernard and Teresa C. Fort, "Factoryless Goods Producing Firms," *American Economic Review: Papers & Proceedings 2015*, vol. 105, no. 5, pp. 518-523. The statistical issues are discussed in Maureen Doherty, "Reflecting Factoryless Goods Production in the U.S. Statistical System," Fariha Kamal, Brent R. Moulton, and Jennifer Ribarsky, "Measuring 'Factoryless' Manufacturing: Evidence from U.S. Surveys," and Kimberly Bayard, David Byrne, and Dominic Smith, "The Scope of U.S. 'Factoryless Manufacturing,'" all in Susan Houseman and Michael Mandel, eds., *Measuring Globalization: Better Trade Statistics for Better Policy*, vol. 2 (Kalamazoo, MI: Upjohn Institute, 2015). Some of the objections to the change are laid out in Robert E. Scott, "What Is Manufacturing and Where Does It Happen?," Economic Policy Institute, July 21, 2014, http://www.epi.org/publication/what-is-manufacturing-and-where-does-it-happen/. The postponement order appeared as Office of Management and Budget, "2017 North American Industry Classification System (NAICS) Revision," *Federal Register*, vol. 79, no. 153, August 8, 2014, p. 46558.

worked for employment services firms in May 2017. They typically earn $2-$3 less per hour than workers in the same occupation who are employed directly by manufacturers (**Table 5**).[37] The overwhelming majority of employment service firms' employees who work in manufacturing are engaged on a temporary basis.[38]

Table 5. Employees of Employment Services Firms Engaged in Factory Production

May 2017

Occupation	Number of Workers	Hourly Mean Wage	Corresponding Mean Wage of Manufacturing Workers
First-line supervisors of production and operating workers	4,565	$28.29	NA
Assemblers and fabricators	202.793	$13.56	$17.26
Food processing workers	17,816	$11.89	$13.96
Metal and plastic workers	79,348	$16.08	$19.35
Printing workers	4,964	$14.82	$17.92
Textile, apparel, and furnishing workers	8,670	$11.68	$13.87
Woodworkers	4,352	$13.17	$15.67
Plant and system operators	1,335	$25.35	$30.37
Other production occupations	305,499	$13.43	$17.84
Hand laborers and material movers	354,444	$12.28	$14.48
Total	**983,904**		

Source: CRS calculations based on Bureau of Labor Statistics, Occupational Employment Statistics Query System, http://data.bls.gov/oes. See also note 37.

It is likely that many nonproduction workers in manufacturing establishments are employed by employment services as well. This includes workers in office, maintenance, and food service occupations. The lack of comparable data makes it difficult to ascertain how the number of workers employed within manufacturing establishments as employees of employment services has changed over time. One recent study finds that the number of temporary-help workers in

[37] According to the BLS Occupational Employment Statistics, 740,410 workers in production occupations and 709,110 hand laborers and material movers worked for employment services firms in May 2017. Following Matthew Dey, Susan Houseman, and Anne Polivka, "Manufacturers' Outsourcing to Temporary Help Services: A Research Update," BLS working paper 493, January 2017, the figures given here and in **Table 5** assume that 85% of employment service workers in production occupations and 50% of those in hand labor and material moving are engaged in manufacturing. The analysis by Dey et al. assigns some temporary workers in office and administrative support occupations to manufacturing, whereas the analysis here does not. For details, see Matthew Dey, Susan N. Houseman, and Anne E. Polivka, "Manufacturers' Outsourcing to Staffing Services," *Industrial & Labor Relations Review*, vol. 65 (2012), p. 549.

[38] Some 92% of the employment service employees working in manufacturing as defined in note 37 are employed by establishments designated "temporary help services."

manufacturing came to 9.7% of the number of workers employed directly by manufacturers in 2015, up from 6.9% in 2005.[39]

The Decline of the Large Factory

The stereotypic U.S. manufacturing plant has thousands of employees filling a cavernous factory hall. This stereotype is outdated. Of more than 291,000 manufacturing establishments[40] counted by the Census Bureau in March 2016, only 886 employed more than 1,000 workers (see **Table 6**). This is up from the modern low of 795 in 2010, but remains far below the level of the 1990s. Those very large factories, the ones most prominent in public discussion of manufacturing, collectively employ 1.8 million workers, 16% of the manufacturing workforce and slightly more than 1% of the U.S. labor force.[41]

As the number of factories in all size classes declined, mean employment in U.S. manufacturing establishments fell from 46.3 workers in 1998 to 36.2 in 2010. Since then, the number of factories in all size classes above 100 employees has edged higher, and mean employment size has risen to 39.6 workers.

Table 6. Size Distribution of Factories

Number of establishments by number of employees

	99 or fewer	100-249	250-499	500-999	1,000 or more
1998	330,956	22,499	7,968	3,322	1,504
2004	309,909	19,227	6,349	2,486	1,112
2010	277,148	15,428	4,764	1,847	795
2016	266,745	16,421	5,397	2,094	886
Change, 1998-2016	-19%	-27%	-32%	-37%	-41%

Source: Census Bureau, *County Business Patterns by Employment Size Class*, various years.

The decline in the number of large factories was widespread across the manufacturing sector, with the exception of the food processing industry. Four industries—chemicals, computers and electronic products, machinery, and transportation equipment—accounted for more than half the decline in the number of factories with more than 1,000 workers between 1998 and 2010. More recently, however, the number of such large factories has increased in several industries, notably food, chemicals, and transportation equipment manufacturing (see **Table 7**),[42] suggesting that existing plants have added workers as business conditions have improved.

[39] Dey et al., "Manufacturers' Outsourcing to Temporary Help Services," p. 6.

[40] An establishment is defined as "a single physical location where business is conducted or where services or industrial operations are performed." In the manufacturing sector, an establishment is analogous to a factory, and the terms are used interchangeably in this section.

[41] U.S. Census Bureau, Geography Area Series: County Business Patterns by Employment Size Class, Table CB1400A13. The number of manufacturing establishments with more than 1,000 employees was 1,504 in 1998, and declined until 2013. Due to definitional changes, data for 1998 and subsequent years are not compatible with those for earlier years.

[42] Census Bureau, *County Business Patterns*, https://www.census.gov/programs-surveys/cbp.html.

Table 7. Factories with over 1,000 Workers by Selected Industries

Number of establishments

Industry	1998	2004	2010	2016
Food	169	182	167	178
Chemicals	107	75	60	63
Primary Metals	71	47	31	33
Computers and Electronic Products	269	155	122	99
Electrical Equipment	66	41	24	31
Machinery	122	77	63	77
Transportation Equipment	298	266	163	225

Source: CRS, computed from Census Bureau, *County Business Patterns by Employment Size Class*, various years.

Among the factories with more than 1,000 workers, average employment size has held steady around 2,050 workers since 2004 after several years of decline. Approximately 16% of manufacturing workers were employed in plants with more than 1,000 workers in 2016, down from 19% in 1998 but up from the low of 14.9% in 2012 (**Table 8**).

Table 8. Manufacturing Employment by Establishment Size

Percentage of manufacturing employment in employment size category in given year

	99 or Fewer	100-249	250-499	500-999	1,000 and Over
1998	30.9%	20.5%	16.2%	13.3%	19.2%
2002	32.3%	21.3%	16.0%	12.5%	17.9%
2008	34.7%	21.9%	15.7%	12.1%	15.6%
2012	35.9%	21.9%	15.7%	11.6%	14.9%
2016	34.4%	21.7%	16.0%	12.1%	15.7%

Source: CRS, computed from Census Bureau, *County Business Patterns by Employment Size Class*, various years.

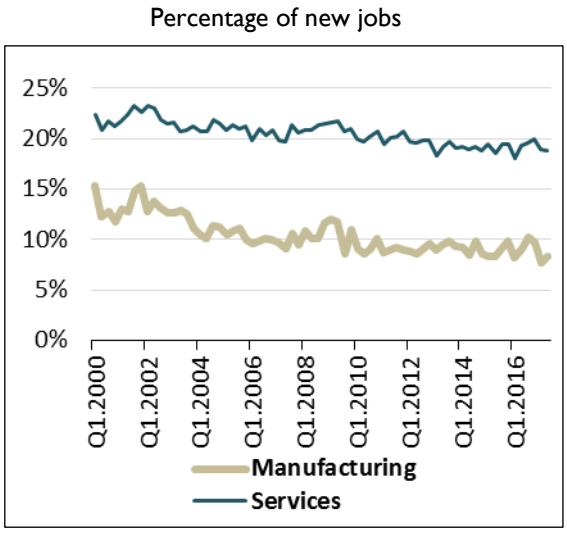
Start-Ups and Shutdowns

The employment dynamics of the factory sector differ importantly from those in the rest of the economy. In other economic sectors, notably services, business start-ups and shutdowns account for a large proportion of job creation and job destruction. In manufacturing, by contrast, employment change appears to be driven largely by the expansion and contraction of existing firms, with entrepreneurship and failure playing lesser roles. This may be due to obvious financial factors: the large amounts of capital needed for manufacturing equipment may serve as a deterrent to opening a factory, and the highly specialized nature of manufacturing capital may make it difficult for owners to recover their investment if an establishment shuts down entirely rather than reducing the scope of its production activities.

The dynamics of employment change in manufacturing can be seen in two different government databases. The Bureau of Labor Statistics' Business Employment Dynamics database, which is based on firms' unemployment insurance filings, offers a quarterly estimate of gross employment gains attributable to the opening of new establishments and to the expansion of existing ones, and

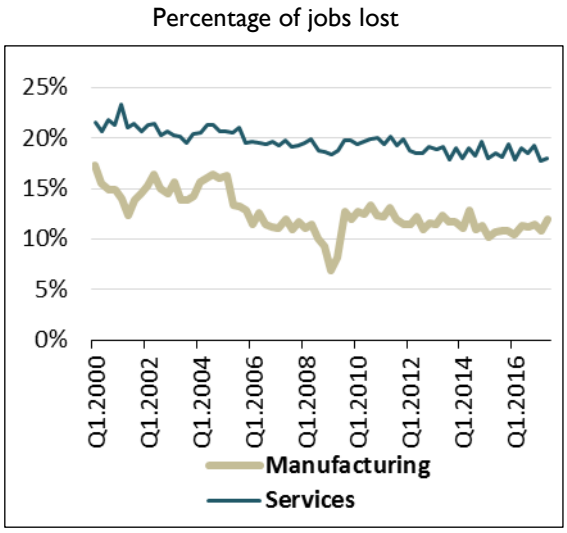
of the gross job losses attributable to the contraction or closure of establishments.[43] In manufacturing, BLS finds, less than 10% of gross job creation in recent years is attributable to new establishments, and more than 90% to the expansion of existing establishments. This is quite a different picture from that offered by the service sector, in which openings routinely account for around 20% of all new jobs (see **Figure 8**).

Figure 8. Jobs Created by Establishment Openings



Source: Bureau of Labor Statistics.

Figure 9. Jobs Lost Due to Establishment Closings



Source: Bureau of Labor Statistics.

Similarly, while plant closings are frequently in the headlines, closings are responsible for less than 12% of the manufacturing jobs lost over the past decade. This represents a change from the early years of the 21st century, when plant closings routinely accounted for 15% or 16% of lost manufacturing jobs. Closure is far less likely to be the cause of job loss in the manufacturing sector than in the service sector, where 19% of job losses are due to establishments closing (see **Figure 9**).[44]

The other source of data on the connection between new factories and manufacturing job creation is the longitudinal business database maintained by the Census Bureau's Center for Economic Studies. This database covers some establishments (notably certain public sector employers) not included in the BLS database and links individual firms' records from year to year in an attempt to filter out spurious firm openings and closings.[45] The Census database has different figures than the BLS database, but identifies similar trends, in particular that establishments open and close at far lower rates in the manufacturing sector than in other sectors of the economy.

The Census Bureau data make clear that the rate at which new business establishments of all sorts were created fell significantly during the 2007-2009 recession.[46] As of 2015, the business creation

[43] "Gross" job gains and losses refer to the number of positions created and eliminated, respectively; the net change in employment can be calculated by subtracting gross job losses from gross job gains. For technical details on this database, see http://www.bls.gov/news.release/cewbd.tn.htm.

[44] See http://www.bls.gov/web/cewbd/table1_5.txt and http://www.bls.gov/web/cewbd/table1_6.txt.

[45] For information about this database, see https://www.census.gov/ces/dataproducts/bds/data.html.

[46] John Haltiwanger, Ron Jarmin, and Javier Miranda, *Historically Large Decline in Job Creation from Startup and*

rate had not recovered to prerecession levels. The data also show that 16,365 manufacturing establishments employing 241,643 workers opened their doors in the year to May 2015. This represents an increase in the number of new plants over 2013 and 2014, but fewer than in any other year since 1977, the year for which the data were first collected. The average number of new manufacturing establishments opened each year from 2010 through 2014 was less than half the average during the 1980s and 1990s.[47]

These two data sources on business dynamics thus support similar conclusions about the role of plant openings and closings in manufacturing employment. Only a small share of the jobs that are created in the manufacturing sector comes from new establishments, largely because factories typically expand slowly in their early years.[48] The average manufacturing establishment that opened in 2015 provided 16 jobs during its first year. Conversely, a minority of the jobs lost come from the closure of existing factories, perhaps because factories shrink over a period of years before closing. These facts indicate that marginal employment change in manufacturing depends more heavily on staffing decisions at existing factories than on the creation of new factories.

Selected Policy Issues for Congress

In recent years, Congress has considered a large amount of legislation intended to strengthen the manufacturing sector. Bills introduced in the 115th Congress take diverse approaches, ranging from providing financial and technical assistance to designated manufacturing communities (H.R. 2264, Make It In America Manufacturing Communities Act, and the substantially similar S. 701) to requiring that construction and repairs funded by the drinking water treatment revolving loan program use only iron and steel products made in the United States (H.R. 939; Buy America for Drinking Water Extension Act of 2017) to directing the President to appoint a Chief Manufacturing Officer (S. 399 and H.R. 1092, Chief Manufacturing Officer Act) to providing a tax credit for 25% of the cost of new manufacturing facility built by a U.S.-based start-up company (H.R. 340; Next Generation American Manufacturing Act of 2017).

These proposals, and many others, are typically advanced with the stated goal of job creation, and often with the subsidiary goals of improving employment opportunities for less educated workers or reversing employment decline in communities particularly affected by the loss of manufacturing jobs. The available data suggest, however, that these goals may be difficult to achieve. In particular

- Even large increases in manufacturing activity are likely to translate into relatively modest gains in manufacturing employment due to firms' preference to use U.S. facilities for highly capital-intensive production. After adjusting for inflation, U.S. manufacturers' fixed assets per full-time-equivalent employee rose 55% from 2006 to 2016.[49] With the average manufacturing worker making use of more than $300,000 of fixed assets, even large investments are likely to lead to

Existing Firms in the 2008-09 Recession, March 2011, http://www.ces.census.gov/docs/bds/plugin-BDS%20March%202011%20single_0322_FINAL.pdf.

[47] U.S. Census Bureau, Business Dynamics Statistics, Establishment Characteristics Data Tables, September 2017, https://www.census.gov/ces/dataproducts/bds/data_estab.html.

[48] Lucia Foster, John Haltiwanger, and Chad Syverson, *The Slow Growth of New Plants: Learning About Demand?*, Working Paper 12-06, Census Bureau Center for Economic Studies, March, 2012, ftp://ftp2.census.gov/ces/wp/2012/CES-WP-12-06.pdf.

[49] The increase in fixed assets per employee is calculated from Bureau of Economic Analysis (BEA) fixed assets accounts table 3.1ES and National Income and Product Accounts table 6.5D, http://www.bea.gov.

relatively little manufacturing employment, although they may create demand for workers in other sectors, such as construction or information services.

- The decline in energy costs due to the development of shale gas, strongly encouraged by federal policy, is having only relatively modest effects on manufacturing employment in the United States. The three sectors that jointly account for about 65% of natural gas consumption in manufacturing—chemicals, petroleum refining, and primary metals—are the most capital-intensive sectors of U.S. manufacturing. Collectively, they have added fewer than 20,000 employees over the past five years. To the extent that expansion in these industries creates jobs, these are more likely to be in supplier industries than in their own facilities.
- Changes in methods, products, and materials may transform some manufacturing industries over the next few years. Some of these changes have been supported by the federal government. Such improvements may lead to greater manufacturing output, but technological advances in manufacturing are likely to further reduce the need for factory production workers.
- Increases in manufacturing employment are unlikely to result in significant employment opportunities for workers who have not continued their educations beyond high school, as the sorts of tasks performed by manufacturing workers increasingly require higher levels of education and training.
- Policies that promote construction of new facilities for manufacturing may be less effective ways of preserving or creating jobs than policies aimed at existing facilities, as new establishments appear to be relatively limited drivers of employment in manufacturing.

It is important to note that increased manufacturing activity may lead to job creation in economic sectors other than manufacturing. For example, the professional services, information, and finance industries provide about 8% of all inputs into manufacturing, and the transportation and warehousing industry furnishes about 5%, so expansion of manufacturing is likely to stimulate employment in those sectors.[50]

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[50] Estimates taken from Bureau of Economic Analysis, "Use of Commodities by Industries before Redefinitions," 2013, http://www.bea.gov/iTable/index_industry.cfm.