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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 have been introduced in 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 advanced education.

U.S. manufacturing output has risen approximately 9% since the most recent low point in 2009, but almost all of that expansion occurred prior to the end of 2014. The upswing in manufacturing activity has resulted in negligible employment growth. Although a variety of forces seem likely to support further growth in domestic manufacturing output over the next few years, including higher labor costs in the emerging economies of Asia and increased concern about disruptions to transoceanic supply chains, evidence suggests that such a resurgence would lead to relatively small job gains within the manufacturing sector. Manufacturing wages are below those in many other industries and continue to decline in relative terms. Data taking insurance, pensions, and other employee benefits into account indicate that production workers have experienced a decline in average total compensation relative to workers in other occupations over the past decade.

The past few years have seen important changes in the nature of manufacturing work. A steadily smaller proportion of manufacturing workers is involved in physical production processes, while larger shares are engaged in managerial and professional work. These changes are reflected in increasing skill requirements for manufacturing workers and severely diminished opportunities for workers without education beyond high school. Even if increased manufacturing output leads to additional employment in the manufacturing sector, it is likely to generate little of the routine production work historically performed by workers with lower education levels.

As manufacturing processes have changed, factories with large numbers of workers have become much less common than they once were. This suggests that promotion of manufacturing as a tool to stimulate local economies is likely to meet with limited success; even if newly established factories prosper, few are likely to require large amounts of labor.

The development of large supplies of oil and natural gas from shale formations in several states has led to considerable speculation about prospects for expanded chemical manufacturing. While substantial new investment has occurred in the chemical industry, many announced plants and plant expansions have been postponed or canceled. In any event, chemical plants are extremely capital-intensive, and even large amounts of new investment are likely to result in the creation of relatively few jobs.

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Introduction

After rebounding from the 2007-09 recession, 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 been flat. 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 increase the relative attractiveness of the United States as a location for factory production.

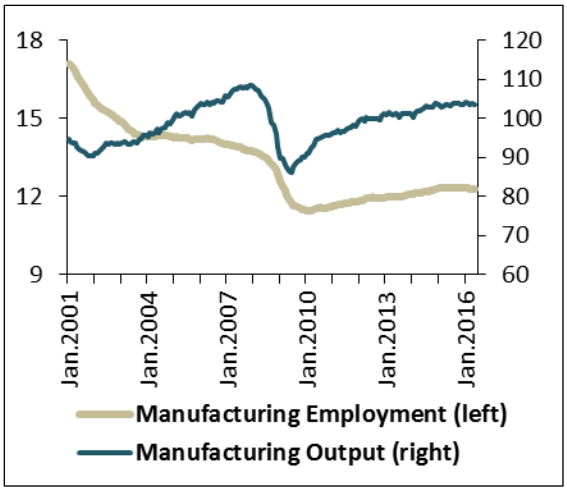
The health of U.S. manufacturing is a subject of ongoing interest in Congress. Numerous bills are introduced in each session to encourage capital investment, support training of workers for manufacturing jobs, increase research and development related to manufacturing, and strengthen mandates for the use of domestic goods in federally funded projects and programs. Proponents of such efforts often associate increased factory activity with the creation of jobs for workers without higher education. Evidence suggests, however, that even strong growth in manufacturing output could well have only modest impact on job creation, and is unlikely to increase demand 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, 12.3 million workers are employed in the manufacturing sector.

Figure 1. Employment and Output in Manufacturing

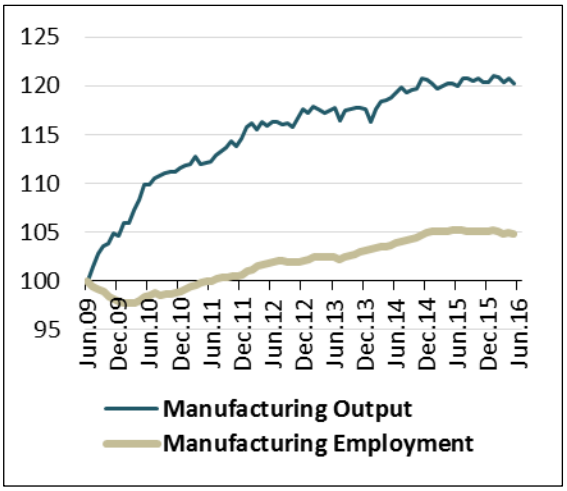
Employment in millions, output indexed 2012=100



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.

The output of U.S. manufacturers hit a cyclical bottom in June 2009. Since that time, a 21% increase in manufacturing output has been accompanied by only a 5% 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 7.2%.[1] The employment recovery in manufacturing lags far behind the cyclical norm following past recessions.

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.[2] 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 to displace domestic production. From 1.3 million workers as recently as 1980, U.S. employment in apparel manufacturing has fallen to 133,000. Leather manufacturing has seen a similar employment decline. Over the same period, U.S. output of apparel fell by 84%, and output of leather products fell by 78%.
- In other industries, technological improvements have led to large increases in labor productivity that have reduced the need for workers. Steelmaking offers such an example: the 87,000 people working in the industry in 2015 produced 3% more steel than nearly 400,000 workers did in 1980.[3]
- 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; as electronic communication supplants print in many uses, paper output is down 20% from its peak in 1999, contributing to a 61% drop in industry employment over the same period. As cigarette consumption has waned, output in tobacco products manufacturing is down by 54% since the most recent peak in 1996, while employment has fallen by nearly two-thirds.

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

[2] 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*, forthcoming, 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) .

[3] 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 2015 were 86.5 million tons, according to the Institute; see http://www.steel.org/Steel_org/document-types/news/2016/decembershipments.aspx. BLS gives average industry employment in 2015 as 87,000.

These changes have resulted in a significant shift in the composition of manufacturing employment even as all 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. Transportation equipment, fabricated metal products, machinery, and chemicals manufacturing have become more important parts of manufacturing—although these sectors have not been immune from the decline in 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. Manufacturing Employment by Industry, 2001-2016

Shares of total manufacturing employment and thousands of workers

Industry	2001 Share	2001 Employment	2016 Share	2016 Employment
Transportation Equipment	11.64%	1,992	13.05%	1,610
Food	9.08%	1,554	12.33%	1,521
Fabricated Metal Products	10.28%	1,759	11.73%	1,447
Machinery	8.49%	1,453	8.91%	1,099
Computers and Electronic Products	10.93%	1,871	8.48%	1,046
Chemicals	5.71%	977	6.61%	815
Plastics and Rubber	5.45%	932	5.59%	690
Misc. Durables Manufacturing	4.25%	728	4.85%	599
Printing	4.66%	798	3.63%	448
Primary Metals	3.55%	608	3.10%	382
Nonmetallic Mineral Products	3.25%	556	3.25%	401
Furniture	3.96%	677	3.16%	390
Electrical Equipment	3.41%	583	3.13%	386
Paper	3.70%	599	3.03%	374
Apparel	2.67%	457	1.09%	134
Textiles	2.13%	364	0.94%	116

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

Note: Not all manufacturing industries are included.

The Changing Character of Manufacturing Work

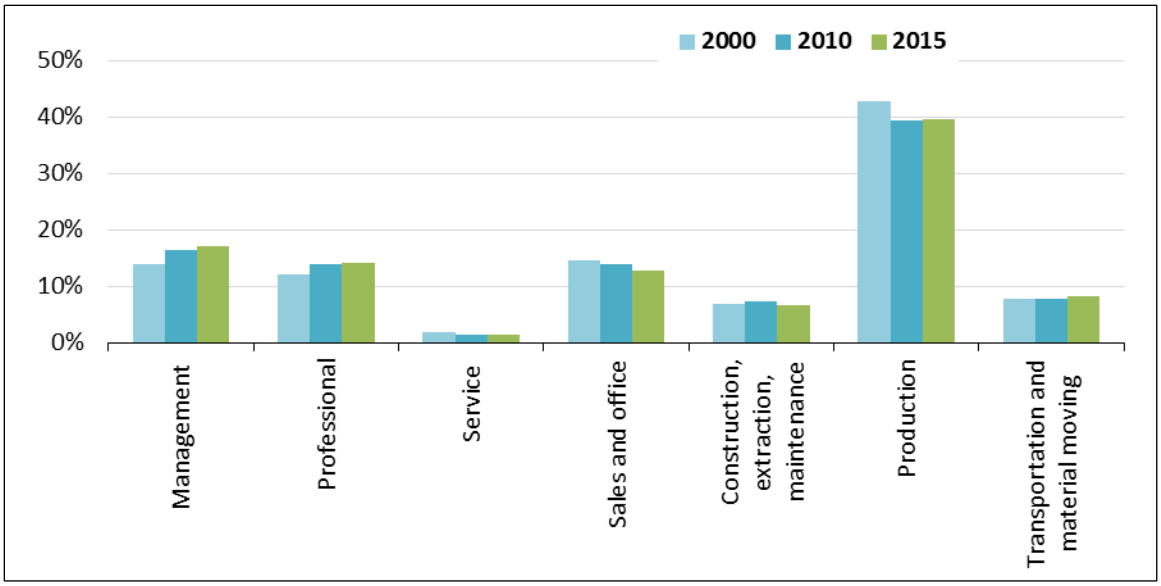
In the public mind, the word "factory" is associated with the concept of mass production, in which large numbers of workers perform repetitive tasks. While mass production is still an important aspect of manufacturing, routine production functions, from welding joints in truck bodies to removing plastic 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.[4]

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 3.3 percentage points between 2000 and 2015. Employment in other occupations within the manufacturing sector, notably office clerical work, has also declined (see **Figure 3**). As of 2015, 31% of all manufacturing workers held management and professional jobs.[5]

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 sectors, the shift to higher skill requirements is even more pronounced. Total employment in the U.S. computer and electronic product manufacturing subsector 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 1.05 million people employed in this subsector in 2015, 28% were engaged in production work, for which a high school education may be sufficient and for which workers received median annual pay of $37,220. Some 22% of the subsector's workers were in architecture and engineering occupations paying a median annual wage of $90,210, and another 13% were in computer and mathematical occupations with a median annual wage of $104,870; the latter two occupational categories require much higher education levels than production work. Similarly, some 33% of the workers in the pharmaceutical manufacturing subsector are involved with production. Many of the rest have scientific skills associated with higher education levels.[6]

[4] On the changing sources of value in U.S. manufacturing, CRS Report R41712, *"Hollowing Out" in U.S. Manufacturing: Analysis and Issues for Congress*, by (name redacted)

[5] Bureau of Labor Statistics, Current Population Survey for 2014 and previous years, Table 17. For the most recent data, see http://www.bls.gov/cps/cpsaat17.pdf.

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

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 2015, employment in this occupation, which typically requires little training and no academic qualifications, was 1.1 million. Of those, 850,780 worked in manufacturing, representing less than 7% of manufacturing jobs. This type of job, once the core of manufacturing, has decreased in importance to many manufacturers and warehouse operators to the extent that 15% 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 earn an average of $11.96 per hour, some 25% less than those employed directly by manufacturing companies.[7]

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 2015, that share dropped by seven percentage points, even as the proportion of manufacturing workers with bachelor's degrees or graduate degrees rose by eight percentage points. 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.

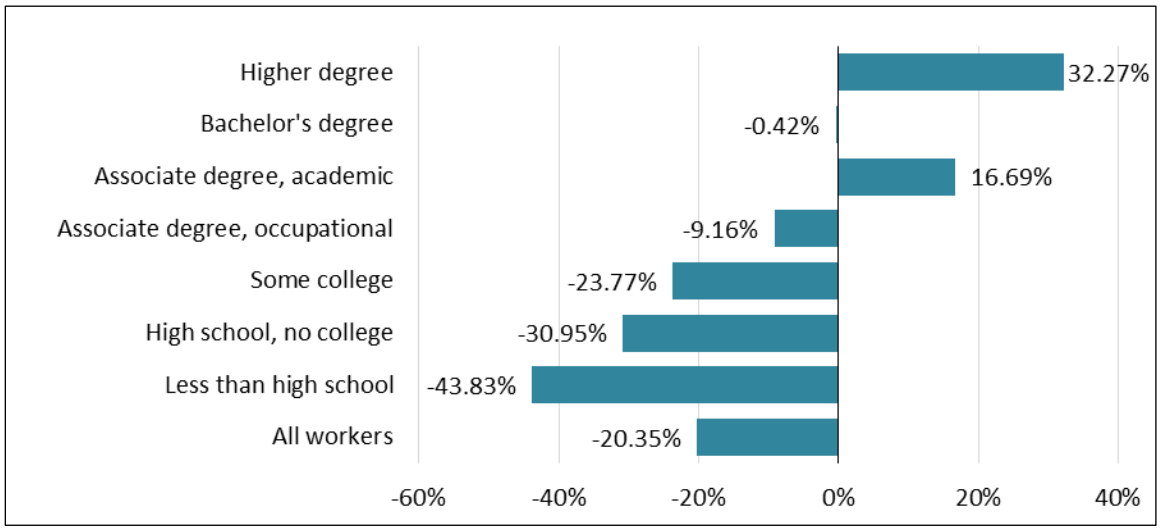
It is noteworthy that, despite the loss of nearly 4 million manufacturing jobs between 2000 and 2015, the number of manufacturing workers with graduate degrees increased by 32% (see **Figure 4**). Demand for workers with associate (community college or proprietary school) degrees in academic fields, which qualify the recipient to pursue education to the bachelor's degree level, rose 17%, even as the total number of manufacturing workers without degrees beyond high school fell by one-third. Workers with academic-track associate degrees fared much better than those with associate degrees in occupational fields, which prepare students for immediate vocational entry and typically require less coursework in English, mathematics, and science. As manufacturing employment has recovered from its cyclical low in January 2010, manufacturers have shown a preference for workers with academic-track associate degrees; from 2010 to 2015, the manufacturing sector added 151,000 workers with academic-track associate degrees, while the number of manufacturing jobs held by workers with occupational degrees rose by 80,000.[8]

[7] Ibid.

[8] Bureau of Labor Statistics, Current Population Survey, "Employed Persons by Intermediate Industry, education, sex, race, and Hispanic or Latino ethnicity (25 years and over)," 2015 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, 2000-2015



Source: Bureau of Labor Statistics, Current Population Survey.

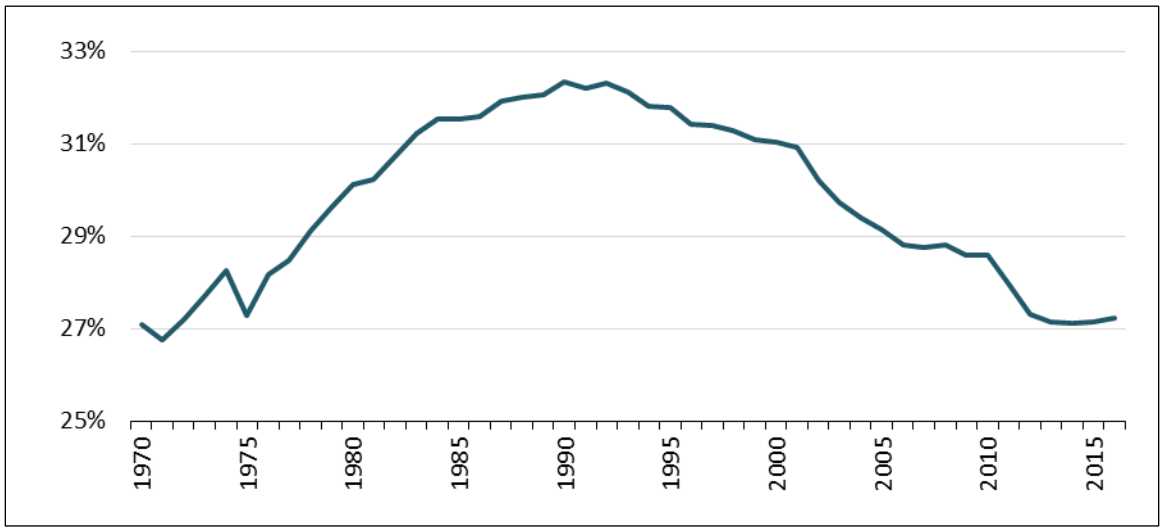
The proportion of manufacturing workers who are female has fallen from 32% as recently as 1993 to 27% currently (see **Figure 5**). Women have long accounted for a large share of employment in some of the industries that have experienced the steepest drops in employment, notably apparel, textiles, and 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 45% from 2000 to 2015. As a result, the number of years of schooling of female manufacturing workers is now very similar to that of males in manufacturing. Some 30% of women workers in manufacturing in 2015 held four-year college degrees or higher degrees, whereas 11% had failed to complete high school.

Female employment in manufacturing has risen little since 2010, even as male employment has increased by nearly 800,000 jobs. The main reason for this is that within the overall manufacturing workforce, women are less likely than men to work in some of the highly cyclical durable goods industries that have experienced the largest increases in employment, such as fabricated metal products and transportation equipment manufacturing.

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 Declining 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.[9] 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.

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.[10] Also, large numbers of workers in those two relatively low-paid 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.[11] Full-time workers in any industry are more likely to receive benefits than part-time workers.

Contrary to the popular perception, manufacturing workers, on average, earn significantly less per hour than workers in industries that do not employ large number of teenagers and that have average work weeks of similar length. Moreover, average manufacturing wages have declined

[9] 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.

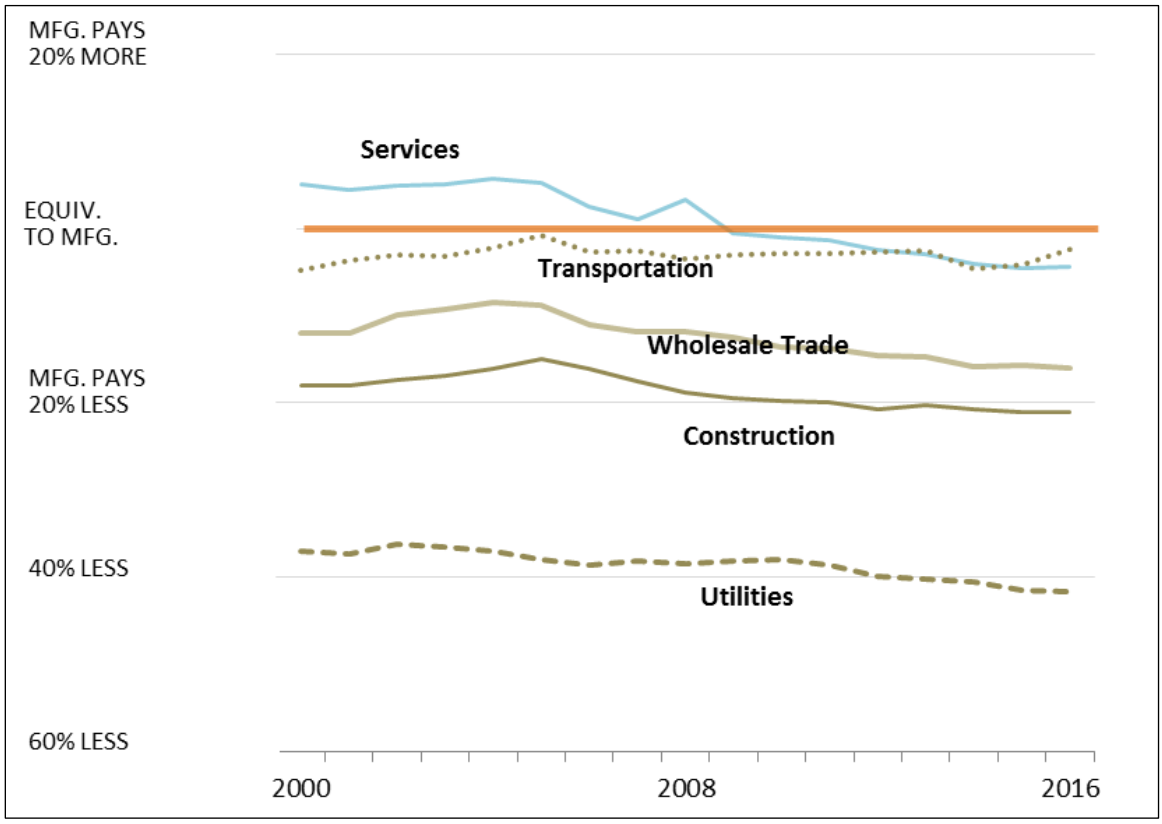
[10] U.S. Bureau of Labor Statistics, Current Population Survey, Table 18b, http://www.bls.gov/cps/cpsaat18b.htm.

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

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 workers in the services sector; in 2016, they earn 4.3% *less* than services workers. These trends reflect both competitive pressures on employers and the diminished bargaining power of workers in a sector with comparatively few employment opportunities.[12]

Figure 6. Wage Trends in Selected Industries

Relative Hourly Pay of Nonsupervisory Workers in Manufacturing



Source: Bureau of Labor Statistics, Current Employment Statistics.

According to Bureau of Labor Statistics data, 3.3% of jobs in manufacturing were unfilled in April 2016, up from 2.7% one year earlier. However, all of the increase in unfilled jobs occurred in non-durables industries, where the average wage, $18.72 per hour, was well below the $21.45 average in durable-goods manufacturing. Manufacturers responded to the rising number of openings by increasing production workers' wages in non-durables much faster over the year to April 2016 (3.5%) than in durables (2.4%).

Traditionally, manufacturing employers have tended to offer more generous employee benefits than those in other industries. This may no longer be the case. Data from the Bureau of Labor Statistics compensation survey, which takes the cost of insurance, pensions, and other employee benefits into account, show that production workers have experienced a decline in average

[12] Ibid.

compensation relative to workers in other occupations over the past decade.[13] The vast majority of production workers are employed in manufacturing (see **Table 2**).[14]

On balance, then, modest job creation in manufacturing has not been accompanied by an improvement in the position of manufacturing workers, relative to those in other sectors. Although workers in some manufacturing industries earn high wages, the assertion that manufacturing as a whole provides better jobs than the rest of the economy is increasingly difficult to defend.

Table 2. Employer Costs for Employee Compensation in Selected Occupations

Occupation	Dollars per Hour		Relative to Manufacturing	
	2006Q1	2016Q1	2006Q1	2016Q1
Production Occupations	$23.06	$27.45	100.0%	100.0%
Construction and Extraction	$28.98	$36.02	125.7%	131.2%
Sales	$25.22	$34.20	109.4%	124.6%
Installation, Maintenance, Repair	$28.29	$34.14	122.7%	124.4%
Transportation and Material Moving	$22.47	$30.98	97.4%	112.9%
Office and Administrative Support	$21.91	$26.38	95.0%	96.1%
Service Occupations	$14.72	$18.35	63.8%	66.8%

Source: Bureau of Labor Statistics, National Compensation Survey.

The Disappearance of the Large Factory

The stereotypic U.S. manufacturing plant has thousands of employees filling a cavernous factory hall. This stereotype is seriously outdated. The United States now has very few factories with large employment: of more than 292,000 manufacturing establishments[15] counted by the Census Bureau in March 2014, only 846 employed more than 1,000 workers (see **Table 3**). The number of large factories has risen slightly since reaching a modern low of 795 in 2010, but remains far below the level of the 1990s. Those large factories, the ones most prominent in public discussion of manufacturing, collectively employ 1.7 million workers, 15% of the manufacturing workforce and slightly more than 1% of the U.S. labor force.[16]

As the number of large factories has plummeted since the late 20th century, the number of small factories, those with fewer than 100 workers, has declined far more slowly. Most of the plants in the latter category are extremely small, with 60% of them having fewer than 10 workers. The

[13] For data, see http://www.bls.gov/ncs.

[14] According to BLS data, 78% of those in production occupations worked either in manufacturing or for employment services in 2015; for data, see http://www.bls.gov/oes. Most of those working for employment services were likely employed in manufacturing establishments as temporary workers.

[15] 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.

[16] 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.

growing prominence of small factories contributed to a decline in mean employment in U.S. manufacturing establishments, from 46.3 workers in 1998 to 36.2 in 2010. Since then, mean employment size has risen to 39 workers, due mainly to employment increases at large establishments in aircraft and automobile manufacturing.

Table 3. Size Distribution of Factories

Number of establishments by number of employees

	99 or less	100-249	250-499	500-999	1,000 or more
1998	330,956	22,499	7,968	3,322	1,504
2003	312,056	19,548	6,574	2,531	1,140
2008	298,223	18,694	5,957	2,340	1,002
2010	277,148	15,428	4,764	1,847	795
2012	273,339	16,058	5,096	1,919	809
2014	268,096	16,295	5,293	2,013	846
Change, 1998-2014	-19.00%	-27.57%	-33.57%	-39.40%	-43.75%

Source: Census Bureau, *County Business Patterns*, various years.

The decline in the number of large factories has been 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. Since then, the number of large factories has increased in primary metals, machinery, and transportation equipment (see **Table 4**).[17] These are among the most cyclical manufacturing industries, and the renewed growth in the number of large factories suggests that existing plants have added workers as business conditions have improved.

Table 4. Factories with over 1,000 Workers by Selected Industries

Number of establishments

Industry	1998	2003	2008	2010	2014
Food	169	179	171	167	166
Chemicals	107	81	71	60	55
Primary Metals	71	44	42	31	34
Computers and Electronic Products	269	168	140	122	104
Electrical Equipment	66	39	28	24	29
Machinery	122	82	86	63	84
Transportation Equipment	298	260	243	163	210

Source: Census Bureau, *County Business Patterns*, various years.

[17] Census Bureau, *County Business Patterns*, http://www.census.gov/econ/cbp/.

The recent economic literature on the causes of changes in factory size is scant, but evidence suggests two principal causes. One is automation: as firms substitute capital for labor, fewer workers are required to produce a given quantity of output. The other is the increase in what economists refer to as "vertical specialization," with individual plants making a narrow range of the components required for a finished product, and those partially finished goods, known as "intermediate products," being shipped from one location to another through sometimes complex production network before the final good is manufactured.[18] Much of the growth in international trade in recent years has involved intermediate products in international production networks, and one logical—although undocumented—corollary of that growth would be that large factories reduce the scope of their activities and shed workers who formerly made inputs that are now obtained elsewhere.

Among the remaining factories with more than 1,000 workers, average employment size has held steady since 2004. In aggregate, however, large factories account for a diminishing share of manufacturing employment (see **Table 5**). Approximately 15% of manufacturing workers are employed in plants with more than 1,000 workers, down from 19% in 1998.

Table 5. Manufacturing Employment by Establishment Size

Percentage of manufacturing employment in employment size category in given year

	99 or less	100-249	250-499	500-999	1,000 and over
1998	30.9%	20.5%	16.2%	13.3%	19.2%
2003	33.7%	21.2%	16.0%	12.1%	17.0%
2008	34.7%	21.9%	15.7%	12.1%	15.6%
2010	36.6%	21.7%	15.1%	11.4%	15.2%
2014	34.9%	21.8%	16.0%	11.9%	15.2%

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.

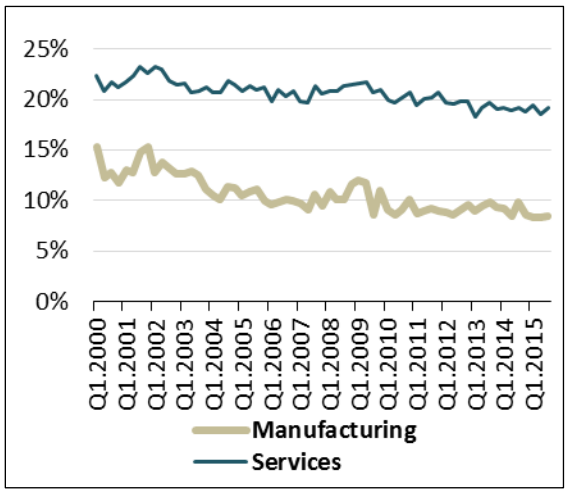
[18] For a survey of the evidence on vertical specialization, see Gary Herrigel, *Manufacturing Possibilities: Creative Action and Industrial Recomposition in the United States, Germany, and Japan* (New York: Oxford University Press, 2010), ch. 4-6. The literature on the implications of vertical specialization for international trade flows, which stems from the observation that trade in manufactured goods has grown far more rapidly than global output of manufactured goods, is now quite large, but economists have paid much less attention to the implications of vertical specialization for the structure of the manufacturing sector.

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.[19] In manufacturing, BLS finds, less than 10% of gross job creation since 2005 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 more than 20% of all new jobs (see **Figure 7**).

Similarly, while plant closings are frequently in the headlines, closings are responsible for less than 12% of the manufacturing jobs lost since 2005, according to BLS data. The vast bulk of manufacturing job losses occur at establishments that remain in operation. 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 8**).[20]

Figure 7. Jobs Created by Establishment Openings

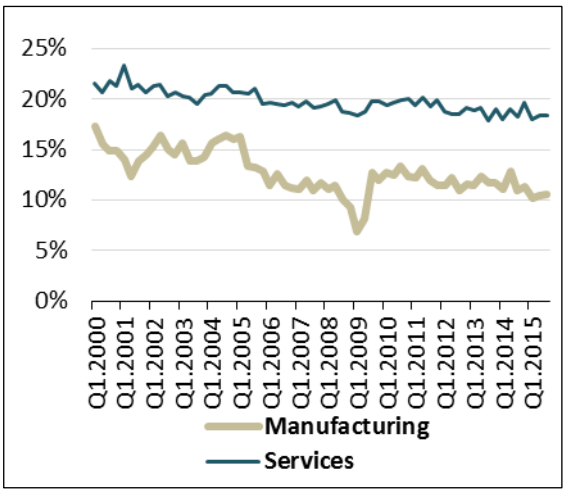
Percentage of New Jobs



Source: Bureau of Labor Statistics.

Figure 8. Jobs Lost Due to Establishment Closings

Percentage of Jobs Lost



Source: Bureau of Labor Statistics.

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, which contains data since 1976, 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.[21] The Census database has different figures than the BLS database, but identifies similar trends, in

[19] "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.

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

[21] For information about this database, see http://www.ces.census.gov/index.php/ces/researchdata?detail_key=10.

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.[22] As of 2013, the business creation rate had not recovered to pre-recession levels. The data also show that, within the manufacturing sector, the rate at which new factories have opened increased in 2011 and 2012 after declining for more than three decades, but fell back again in 2013. The number of manufacturing establishments opened in 2013 (16,412) was less than half the number that opened in 1977.

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 factories, largely because factories typically expand slowly in their early years.[23] The average new manufacturing establishment provides 10 jobs during its first year in operation.[24] 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.

Is There a Chemical Comeback?

The chemical industry figures prominently in discussions of a possible revival in U.S. manufacturing. The production of large amounts of natural gas from shale formations in several states has lowered the domestic price and provided some assurance of long-term availability, making the United States a more attractive location for producing nitrogen fertilizers and other chemical products that make intensive use of natural gas. Additionally, large-scale production of oil from shale formations in North Dakota and Texas has raised the prospect of increased petrochemical manufacturing.[25]

The chemical industry's investment in U.S. fixed assets, such as machinery and structures, averaged $97 billion annually from 2007 through 2012, but then moved sharply higher. In 2014, according to government data, the industry's fixed investment reached $125 billion.[26] Many corporate announcements and news reports have pointed to substantial new investment in the sector. In April 2016, the American Chemistry Council, an industry group, said it had counted 264 new facilities, expansions, or plant restarts completed, under way, or planned.[27] However, not all announced projects will be undertaken. In June 2016, BASF postponed a planned $1.4 billion propylene plant in Texas, and a month earlier Ascent Performance Materials announced it would

[22] John Haltiwanger, Ron Jarmin, and Javier Miranda, *Historically Large Decline in Job Creation from Startup and Existing Firms in the 2008-09 Recession*, March 2011, http://www.ces.census.gov/docs/bds/plugin-BDS%20March%202011%20single_0322_FINAL.pdf.

[23] 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.

[24] Census Bureau, Longitudinal Business Database, http://www.census.gov/ces/dataproducts/bds/data_firm.html.

[25] For background, see CRS Report R43148, *An Overview of Unconventional Oil and Natural Gas: Resources and Federal Actions*, by (name redacted) and (name redacted)

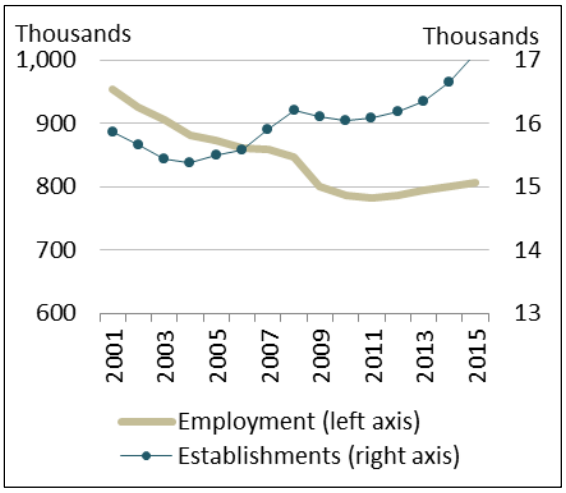
[26] Bureau of Economic Analysis, fixed assets accounts tables, Table 3.7ESI.

[27] "ACC Highlights Economic Benefits, Key Policies at Hudson Institute Forum," April 6, 2016, https://www.americanchemistry.com/Content.aspx?id=9243.

delay construction of a $1.2 billion plastics plant. G2X Energy, which broke ground on a $1.6 billion methanol plant in Louisiana in January 2016, subsequently delayed construction.[28]

However investment plans develop, there is little reason to expect significant job creation within the chemical industry itself. While the number of establishments in the industry is at the highest level in many years, employment is well below its level prior to 2009 (see **Figure 9**), as average employment per establishment continues to decline to 47 workers. As of the first quarter of 2016, industry-wide production capacity was at the lowest level since 2002, and industry output was at roughly the same level as in 2012 (see **Figure 10**). The industry had $1.1 million of plant and equipment for each employee in 2014,[29] implying that even very large capital investments will lead to comparatively little direct employment.

Figure 9. Chemical Industry Employment and Establishments

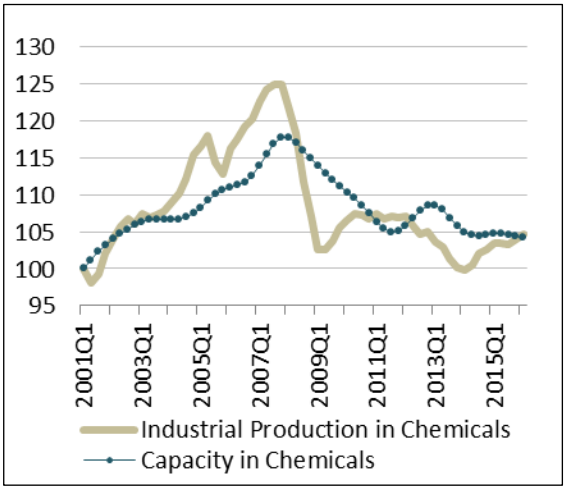


Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

Note: Annual data.

Figure 10. Capacity and Output

Index, 2001Q1=100



Source: Federal Reserve Board, Industrial Production Index.

Note: Quarterly data, seasonally adjusted.

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 114th Congress take extremely diverse approaches, ranging from establishing tax-exempt manufacturing reinvestment accounts (H.R. 2608, Manufacturing Reinvestment Account Act of 2015) to providing federal grants for installation of energy-efficient manufacturing equipment (H.R. 2296, Job Creation through Energy Efficient Manufacturing Act) to accelerating tariff reductions on inputs used by U.S. manufacturers (S. 998, American Manufacturing Competitiveness Act of 2015) to providing grants to universities that emphasize manufacturing-related curricula (S. 771, H.R. 1441, Manufacturing Universities

[28] Jordan Blum, "BAST to delay $1.4 billion plant expansion," *Houston Chronicle*, June 7, 2016; http://fuelfix.com/blog/2016/04/13/houston-chemical-companies-buys-half-of-new-methanol-plant/.

[29] Computed from Bureau of Economic Analysis, fixed assets accounts tables, Table 3.1ESI, and National Income and Product Account data, full-time equivalent employees by industry, Table 6.5D.

Act of 2015) to changing the tax code to discourage "offshoring" of manufacturing (S. 162, H.R. 305, Offshoring Prevention Act).

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 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 52% from 2006 to 2014.[30] With the average manufacturing worker making use of more than $300,000 worth of fixed assets, even large investments are likely to lead to 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 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 three most capital-intensive sectors of U.S. manufacturing; refineries and chemical plants produce far more value added per employee than other manufacturing establishments. To the extent that expansion in these industries creates jobs, those 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. For example, the Revitalize American Manufacturing and Innovation Act of 2014, part of the Consolidated and Further Appropriations Act, 2015 (P.L. 113-235, Division B, Title VII), enacted an Obama Administration proposal to establish a Network for Manufacturing Innovation "to improve the competitiveness of United States manufacturing and to increase the production of goods manufactured predominantly within the United States." The act authorizes up to seven years of federal support for centers of manufacturing innovation seeking to improve manufacturing technology.[31] Such improvements may lead to greater manufacturing output, but technological advances in manufacturing are likely to further reduce the need for 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. This suggests that government-supported training efforts, while potentially helpful in preparing individuals for specific manufacturing jobs, should not be expected to lead to an increase in total manufacturing employment.

[30] 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.

[31] 128 Stat. 2222.

- To the extent that federal policies lead to the establishment of new manufacturing facilities in the United States, those facilities are likely to provide only limited employment opportunities in the locations where they are built. Plants with more than 1,000 workers are much less common than they once were, and nearly three in five manufacturing workers are employed in establishments with fewer than 250 workers. This suggests that there will be relatively few instances in which the siting of a new plant, by itself, will suffice to revitalize a community with a struggling economy.
- 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 are relatively unimportant as 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.[32] To the extent that increased domestic production of manufactured goods supplants imports, however, any increases in ancillary employment related to domestic manufacturing may be counterbalanced by reduced employment related to the transportation and processing of imported goods, leaving the net employment effect uncertain.

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