Is American Manufacturing in Decline?
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U.S. manufacturing has been in the spotlight in this presidential campaign. The candidates, most notably Donald Trump and Bernie Sanders, have argued that globalization has severely weakened domestic manufacturing, citing large trade deficits and job losses to back their claim. This argument resonates in many American communities.

Countering the prevailing view, some analysts and pundits cite strong manufacturing output and productivity statistics to assert that American manufacturing has never been healthier. They contend that automation, not globalization, accounts for the nearly 30 percent reduction in manufacturing jobs since 2000. Typical of this viewpoint, Binyamin Appelbaum, in a recent *New York Times* article, writes, "From an economic perspective . . . there can be no revival of American manufacturing, because there has been no collapse. Because of automation, there are far fewer jobs in factories. But the value of stuff made in America reached a record high in the first quarter of 2016, even after adjusting for inflation."

Do a vast number of Americans have the story completely wrong, as Appelbaum and others imply? No. Rather, these analysts have misread the numbers, as I explain in "Measuring Manufacturing: How the Computer and Semiconductor Industries Affect the Numbers and Perceptions" (coauthored with Timothy Bartik and Timothy Sturgeon) and a policy brief based on that research, published in 2014.

This piece updates the analysis in those articles and makes several points:

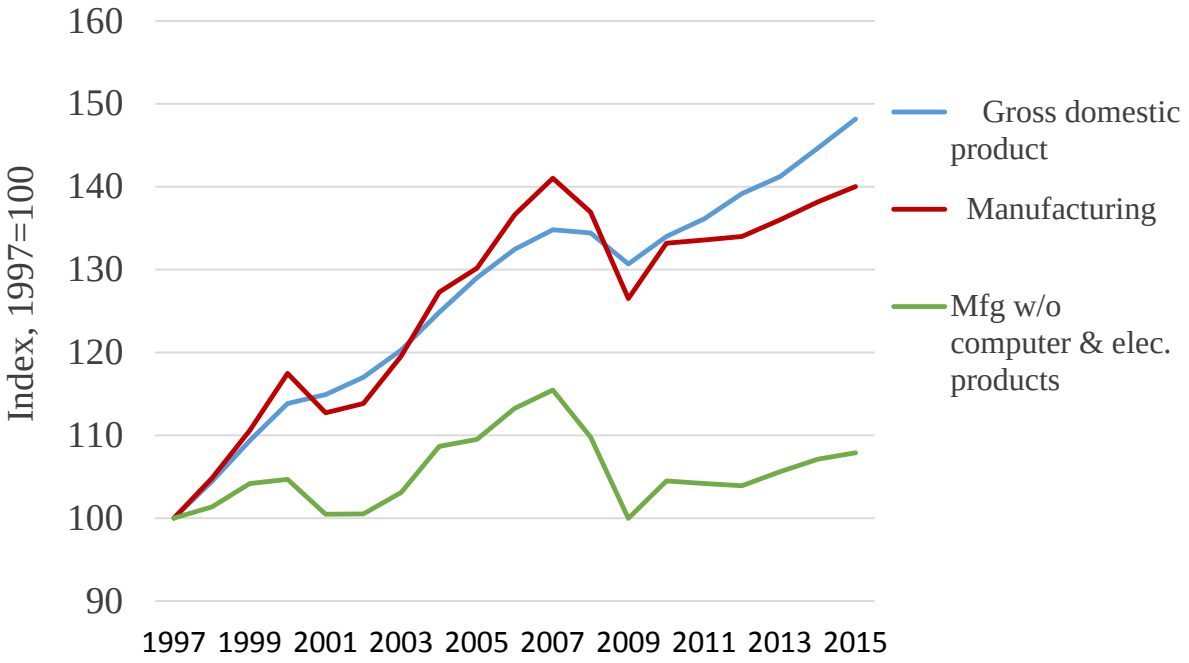
- A small industry—computers, semiconductors and related products, which account for only 13 percent of value-added in manufacturing—drives the apparent robust output and productivity growth in the sector.
- Performance in most manufacturing industries has been very weak. Excluding output from the computer and semiconductor industry, the amount produced in American factories is barely higher than in the late 1990s and is about 5 percent lower than before the Great Recession.
- The extraordinary output and productivity growth in computers and semiconductors reflects the way statistical agencies account for improvements in the products produced in this industry. Rapid productivity growth in this industry—and by extension the above-average productivity growth in the manufacturing sector—has little to do with automation.
- Manufacturing's anemic output growth is largely the result of globalization, and that fact (coupled with automation) is responsible for the large reductions in manufacturing employment since the 1990s.

Manufacturing Output Statistics Mask Weak Performance in Most of the Sector

Output growth in the manufacturing sector has generally kept pace with overall growth in GDP, as shown in Figure 1. Specifically, the top two lines in Figure 1 depict an index of output for the overall economy (GDP) and for the manufacturing sector, adjusted for inflation, between 1997

and 2015.[1] Although manufacturing is more sensitive to business cycles, the average growth in the quantity produced in manufacturing has been similar to that of the overall economy, except in recent years. By 2015, GDP was 48 percent higher and output in manufacturing was 40 percent higher than in 1997.

Figure 1: Trends in output in the U.S. economy and manufacturing, 1997–2015



NOTE: Output refers to aggregate GDP or manufacturing value-added (GDP), adjusted for inflation.
SOURCE: Author calculations based on data from Bureau of Economic Analysis.

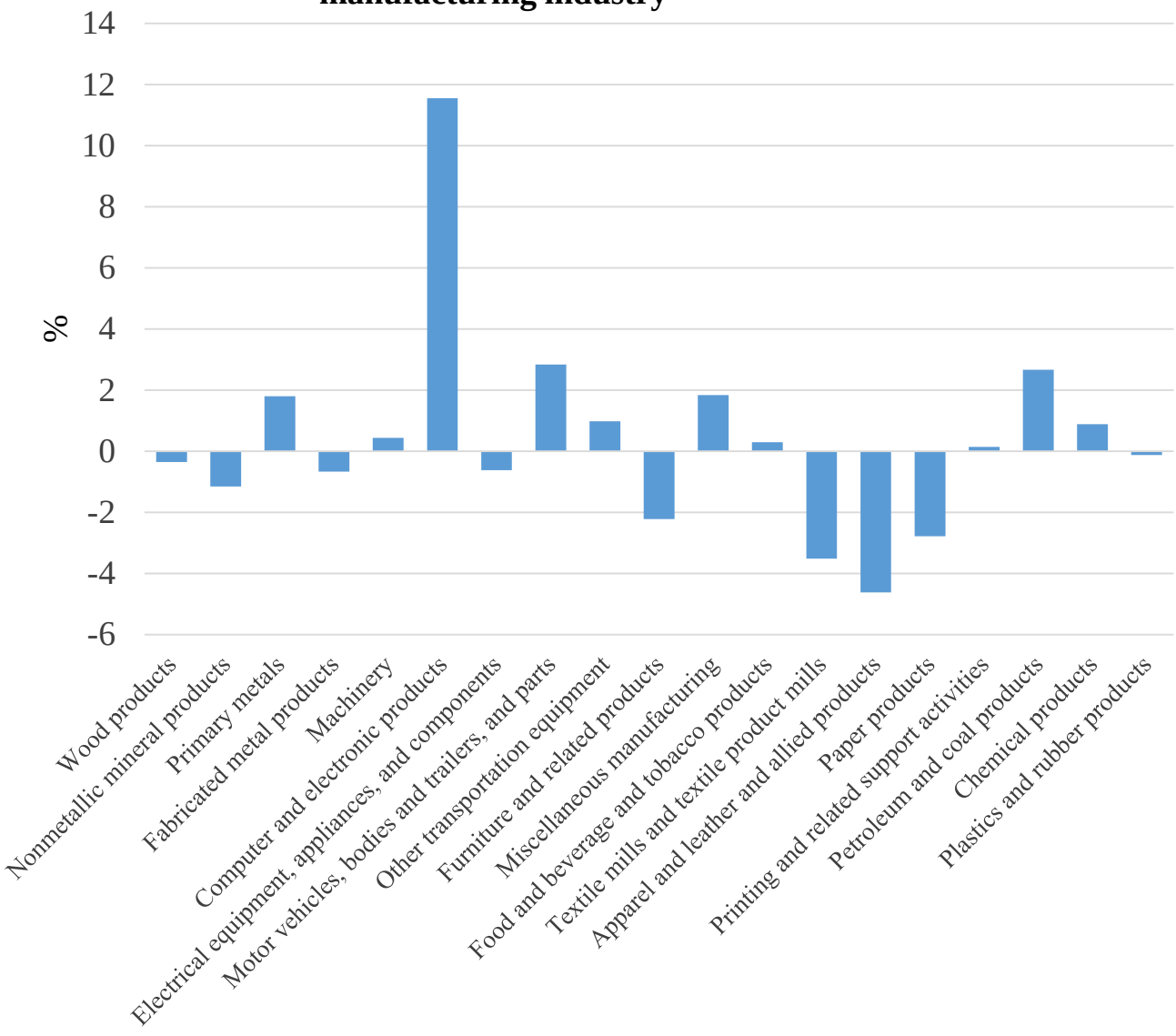
The output statistics for the manufacturing sector, however, mask considerable weakness in most of the industries that make up the sector. Figure 2 shows average annual growth in output, adjusted for inflation, between 1997 and 2015 for the industries that comprise manufacturing. The computer and related electronic products industry, which includes semiconductors, is an outlier, experiencing an astonishing average annual growth rate of 11.5 percent over the period. Average annual output growth is much lower in all other industries, and in nine manufacturing industries it is negative.

Although the computer and semiconductor industry represents only about 13 percent of the dollar amount of value-added in the manufacturing sector, the industry accounts for the robust output and productivity growth in manufacturing, a phenomenon long established in the

[1] For the sake of simplicity, I use the terms *output* or *output growth* throughout this piece to refer to value-added, adjusted for inflation, which is designed to capture the quantity produced by an economy or industry. The terms *real value-added* or *real GDP* are generally used in the technical literature.

economics research literature.[2] Excluding this one industry, as shown in the bottom line of Figure 1, reveals a very different picture of manufacturing: the amount produced is only about 8 percent higher in 2015 than in 1997 and is about 5 percent lower than before the Great Recession.

Figure 2: Average annual output growth rate, 1997–2015, by manufacturing industry



NOTE: Output refers to industry value-added (GDP), adjusted for inflation.
SOURCE: Author calculations based on data from the Bureau of Economic Analysis.

[2] See, for example, Houseman et al. (2011); Houseman, Bartik, and Sturgeon (2014); and Baily and Bosworth (2014). The last shows that without the computer and electronic products industry, labor productivity growth was no higher in U.S. manufacturing than in the economy overall, and total factor productivity growth was lower from 1987 to 2011 (Table 3).

What Explains the Extraordinary Output Growth in the Computer and Semiconductor Industry?

The answer to the question of what explains the large and sustained growth in computers and semiconductors lies in the way that the statistical agencies, through the construction of price indexes, account for the rapid technological advances in the products produced in this industry. The semiconductors embedded in our electronics are much more powerful today than they were a decade or even a year ago. Likewise, the computers and related devices that consumers and businesses buy today have much greater functionality than in the past. If, for example, buyers are willing to pay 15 percent more for a new computer model that boasts greater speed and more memory than last year's model, then 100 of the new computers would be the equivalent of 115 of the previous year's model. The rapid output growth in this industry does not necessarily imply that American factories are producing many more computers, semiconductors, and related products—they may be producing less. Instead, it reflects the fact that the quality of the products produced is better than in the past.

It follows that the rapid productivity growth accompanying output growth in this industry has little, if anything, to do with automation. Production of computers and semiconductors has been automated for many years. Rather, rapid productivity growth in the industry—and by extension the above-average productivity growth in manufacturing—largely reflects improvements in high-tech products.

Nor is the rapid growth in measured computer and semiconductor output a good indicator of the international competitiveness of domestic manufacturing of these products. As detailed in "Measuring Manufacturing," the locus of production of these products has been shifting to Asia, and the large employment losses in this industry are the result of offshoring and foreign competition. The shift in production to Asia is likely responsible, in part, for the slowdown in aggregate manufacturing output since the Great Recession, which is apparent in Figure 1.[3]

It should be emphasized that the statistical agencies are correct to adjust prices for improvements in product quality. The adjustments, however, can be highly sensitive to methodology, and there is debate over whether the size of the quality adjustments for the computer and semiconductor industry has been too great or too little. Although that question lies beyond the scope of this piece, it is an important area for future research.[4]

Such quality adjustment, however, can make the numbers difficult to interpret. Because the computer and semiconductor industry, though small in dollar terms, skews the aggregate manufacturing statistics and has led to much confusion, figures that exclude this industry, as in Figure 1, arguably provide a clearer picture of trends in manufacturing output.

[3] A change in Intel's pricing strategy for older-generation semiconductors is also partly responsible for the slowdown, as explained in Byrne, Oliner, and Sichel (2015). This fact illustrates the sensitivity of measures of real output growth to methodology—and, in this case, to a single company's pricing policies.

[4] The statistical agencies adjust other products for changes in quality, most notably automobiles. The effects of quality adjustment in other industries on aggregate statistics is relatively small, however.

What Has Caused the Job Loss in Manufacturing?

Before 2000, the number of jobs in manufacturing had been relatively stable, although manufacturing's *share* of total employment in the economy has been gradually falling since the 1950s. Automation no doubt played a large role in that relative decline. Between economic peaks in 2000 and 2006, however, the number of manufacturing jobs fell precipitously—by 20 percent—and further declines since the Great Recession have left it 29 percent lower than in 2000. That decline is historically unprecedented and is the focus of today's policy debate.

As in other sectors, many processes in manufacturing have been automated. The critical difference is that, in contrast to other sectors, the amount produced in most manufacturing industries has barely risen or declined since the late 1990s. Even in the computer and semiconductor industry, the rapid growth in measured output reflects improvement in product quality, not an increase in the number of products produced. Behind the anemic output growth in manufacturing is the fact that U.S. consumers and businesses increasingly purchase imported products, and American exports have not risen commensurately with imports.[5] Instead of manufacturing their products in the United States and exporting them to foreign markets, U.S. multinational companies now often locate production overseas to take advantage of lower labor costs and lower taxes, among other factors.

Anemic output growth—in large part the result of globalization—when combined with continued automation of manufacturing processes has led to the sharp decline in manufacturing jobs in recent years. Competition from low-wage countries may have accelerated the adoption of automated processes in some industries. In sum, the forces of globalization and their interaction with technological change account for the recent job losses in manufacturing; automation alone cannot explain them.

[5] Studies have established a sizable effect of imports, primarily from China, on employment (e.g., Autor et al. 2013), while research has found no association between an industry's productivity growth and employment growth (e.g., Helper, Krueger, and Wial 2015). No study has definitively shown the relative importance of globalization and automation in the decline of manufacturing jobs, and indeed the two forces are interrelated.