The Myth and the Reality of Manufacturing in America

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The production and shipment of goods in the United States is a large, important, and growing part of the economy. Despite the continued growth and long-term health of manufacturing, significant misconceptions remain about the sector's demand for labor and how it has changed in recent decades.

In this brief, we identify and explain a major source of misunderstanding in manufacturing. In the first section, we focus on what effects productivity change, domestic demand, and foreign trade have on U.S. manufacturing employment. We then discuss policy dimensions of these findings. We begin with a brief overview of manufacturing in the United States.

The Manufacturing Base

The Great Recession of 2007-2009 was very damaging to the production of goods in the United States. This should not be surprising because consumer durable goods and business plant and equipment are among the most sensitive sectors of the economy to a cyclical downturn (Eaton, et. al. 2011). The recession offered a remarkably large decline in national manufacturing production with an accompanying disruption in employment and earnings across manufacturing regions of the United States.

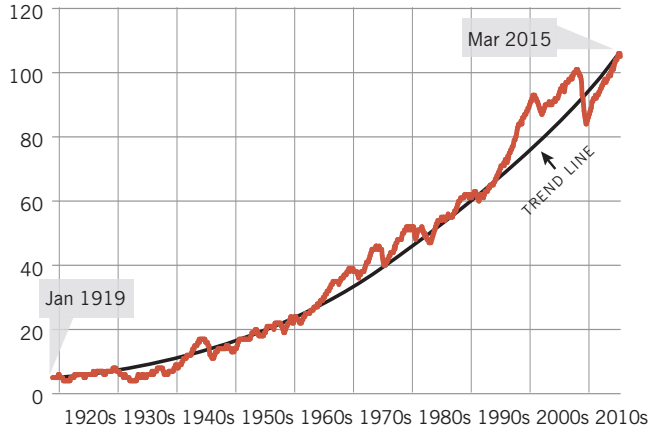
Still, national manufacturing production, in inflation-adjusted dollars, remains on a steady and long-term growth path. By 2014, the manufacturing economy had completely recovered with record levels of production. The country's growth of manufacturing production has been a constant feature of the economy throughout the past century. See *Figure 1*.

Leading the growth in manufacturing production has been the growth of durable goods purchased by households and business at home and abroad. As with manufacturing as a whole, 2013 was a record year for the production of consumer durables. The production of consumer non-durables; goods used for less than a year such as clothing and food products have remained static for a decade or longer. See *Figure 2*.

The persistent growth of manufacturing production, when adjusted for inflation, has been an important and consistent contributor to output in the United States. The notion that manufacturing in the United States is in decline is factually incorrect. Indeed, it is almost certain that 2015 will again offer a year of record manufacturing production, displacing 2014 as the previous record year. However, manufacturing production growth has been mixed across sectors, as recent history clearly suggests.

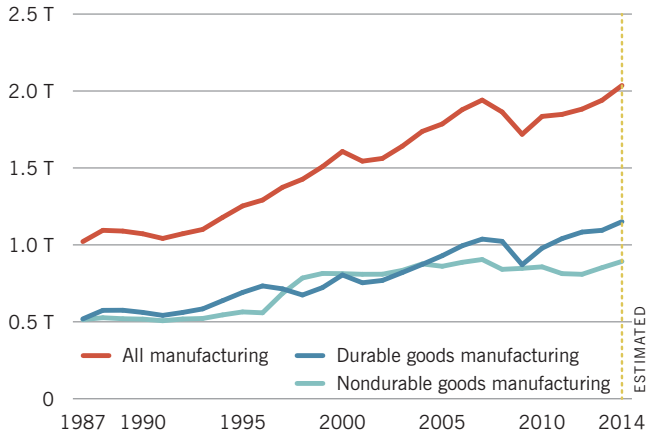
From the last peak of the pre-recession year (2006) to the end of the recession (June 2009) all manufacturing sectors except transportation equipment experienced output declines. The demand for military equipment during this period sustained that sector. The deepest declines were in wood products, textiles, and apparels. These are both durable and non-durable goods, the latter of which are least sensitive to the business cycle, but highly impacted by international trade.

Figure 1. U.S. Manufacturing Production Index, 1919-2014



Source: Board of Governors of the Federal Reserve System (U.S.)

Figure 2. U.S. Durable and Non-Durable Goods, 1987-2013



Source: Author calculations.

During the recovery through our most recent data of 2013, all sectors except printing and printed goods recovered. The largest gains were in metals, machinery, automobiles, apparel, and petroleum. Over the entire period 2006-2013, manufacturing grew by 17.6 percent, or at roughly 2.2 percent per year. This is modestly slower than the economy as a whole, which grew by 19.4 percent over the same period, or 2.4 percent per year on average. Growth during the 2006-2013 period varied dramatically by sector, as reported in *Table 1*.

Growth in manufacturing remains positive and the sector as a whole has appeared strong and resilient over the past several decades. The story is not uniform. Houseman (2010, 2013) reports that much of the recent growth concentrated in computers and electronics might be overstated by failure to appropriately measure productivity growth in these sectors. Still, the strong recovery in more traditional sectors suggests a broader recovery than might have been expected. That is not the belief among many observers who feel manufacturing in the United States is in sectoral decline. We believe a contribution to the myth of manufacturing decline is the state of labor usage in manufacturing. It is to that issue we now turn our attention.

What Happened to Manufacturing Jobs?

The size of American manufacturing as represented by the total value of goods produced (GDP) has enjoyed a healthy growth trend almost since the founding of the republic. This trend continued throughout the last several decades, across recessions and trade agreement regimes. However, employment over the same period was largely stagnated.

To understand what has occurred within manufacturing, it is helpful to review the accounting of employment. To do so we outline the relationship: $E = f(C,M,X,P)$, where employment in domestic manufacturing is a function of the domestic consumption of manufactured goods C, imports M, exports X, and the productivity of workers P. The change in manufacturing employment over time is expressed as...

$$dE/dt = w_c (dC/dt) - w_M (dM/dt) + w_x (dX/dt) - dP/dt \qquad (1)$$

...which is a familiar relationship between demand for goods, the net export of goods, and how many workers are required to produce the goods that are sold and consumed. A more complete understanding of the role of each of these changes can be derived by isolating each of the potential effects on overall manufacturing employment.

Changes in Productivity

We begin by examining productivity. The most common measure of productivity is the average product of labor, which is simply the value of all goods manufactured in the U.S. divided by the number of workers. In 2012, the average product of labor for all manufacturing was $149,299, but ranged from a low of $45,930 for manufacturers of apparel and leather goods to $733,861 for petroleum and coal products manufacturing.

"While manufacturing sectors are experiencing healthy growth in their production, their employment numbers remain largely stagnated."

Table 1. Manufacturing Sector Performance, 2006-2013

Sectors	Recession 2006-2009	Recovery 2009-2013	Overall 2006-2013
All manufacturing	*-11.5%*	*32.9%*	*17.6%*
Durable goods manufacturing	*-18.9%*	*36.8%*	*10.9%*
Wood products	-43.0%	35.9%	-22.5%
Nonmetallic mineral products	-28.8%	13.6%	-19.1%
Primary metals	-28.6%	80.4%	28.8%
Fabricated metal products	-11.1%	23.6%	9.8%
Machinery	-12.5%	45.7%	27.5%
Computer and electronic products	-14.4%	3.3%	-11.6%
Electrical equipment, appliances, and components	-13.1%	17.5%	2.0%
Motor vehicles, bodies and trailers, and parts	-39.0%	87.8%	14.6%
Other transportation equipment	17.5%	29.9%	52.7%
Furniture and related products	-30.0%	11.1%	-22.3%
Miscellaneous manufacturing	-0.7%	15.1%	14.4%
Nondurable goods manufacturing	*-3.6%*	*29.4%*	*24.7%*
Food and beverage and tobacco products	16.6%	17.5%	37.0%
Textile and textile product mills	-35.1%	21.3%	-21.3%
Apparel, leather, and allied products	-48.7%	67.8%	-13.9%
Paper products	-4.4%	6.3%	1.6%
Printing and related activities	-17.0%	-5.5%	-21.6%
Petroleum and coal products	-10.1%	66.0%	49.1%
Chemical products	-5.5%	26.0%	19.1%
Plastics and rubber products	-20.3%	30.7%	4.2%

Source: U.S. Bureau of Economic Analysis

Table 2. Average Product of Labor, Productivity Growth, and GDP Growth, 1998-2012

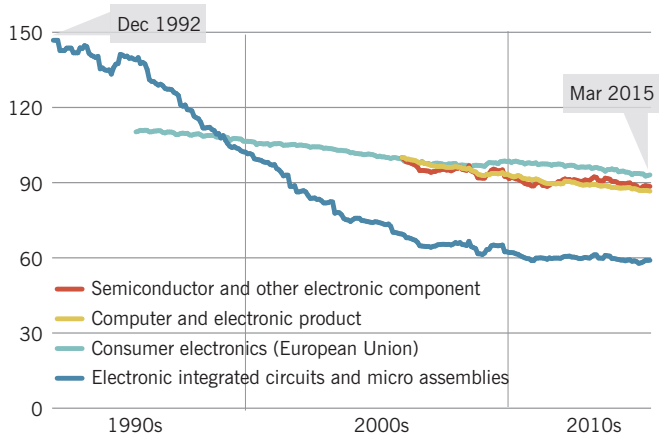
Sector	Avg Product of Labor 2013	Change in APL 1998-2012	GDP Growth 1998-2012
All manufacturing	*$149,299*	*90%*	*32%*
Durable goods manufacturing	*$137,515*	*130%*	*61%*
Wood products	$60,304	64%	-4%
Nonmetallic mineral products	$97,525	6%	-24%
Primary metals	$122,629	80%	15%
Fabricated metal products	$94,038	13%	-9%
Machinery	$128,824	48%	10%
Computer and electronic products	$244,473	829%	462%
Electrical equipment, appliances, and components	$131,452	71%	10%
Motor vehicles, bodies and trailers, and parts	$170,427	121%	37%
Other transportation equipment	$172,147	46%	23%
Furniture and related products	$62,438	17%	-35%
Miscellaneous manufacturing	$122,776	73%	44%
Nondurable goods manufacturing	*$170,999*	*49%*	*3%*
Food and beverage and tobacco products	$129,311	15%	11%
Textile and textile product mills	$59,555	31%	-50%
Apparel, leather, and allied products	$45,930	63%	-50%
Paper products	$135,377	16%	-30%
Printing and related activities	$76,263	76%	4%
Petroleum and coal products	$733,861	11%	3%
Chemical products	$395,718	60%	30%
Plastics and rubber products	$99,297	31%	-10%

Source: U.S. Bureau of Economic Analysis

From 1998 through 2012, productivity grew in all sectors when adjusted for inflation. That growth was highest in the production of computer and electronic products, a remarkable 829 percent growth, and ranged as little as 6.0 percent for nonmetallic mineral product manufacturing. Overall production of goods and services in these sectors rose by 32 percent, but there was great sectoral variation. See *Table 2*.

Growth in manufacturing production was led by computer and electronics, but double-digit growth occurred in automobiles, transportation equipment, miscellaneous products, primary metals machinery, electrical equipment, and food. Much of this productivity increase was spawned by growth in the industrial use of information technology (see Hicks 2013; Fernald 2009). Major declines in

Figure 3. Price Indices for Consumer Electronics for Export and in the European Union, 1992-2015



Source: U.S. Bureau of Labor Statistics and Statistical Office of the European Communities

inflation adjusted production occurred in the manufacturing of minerals, fabricated metals, furniture, textiles, apparel, paper, and plastics.

Changes to production are determined domestically by several factors. Overall demand for products, along with productivity changes that increase the quantity demanded of product will influence the dollar value that is sold. International demand for U.S. products will add to overall GDP growth, while consumption by American households of imported goods that compete with U.S. firms will reduce GDP. International competition is dependent on production costs and productivity and transport costs of goods.

A closer examination of productivity yields some interesting insights as well. In 1998, the inflation-adjusted output per worker was much lower than it is today. This is due to a variety of factors, chief among them being the automation and information technology advances absorbed by these sectors over this time period. The higher output per worker has meant firms could lower their price for goods. Very clear examples of this are the price indices for different types of consumer electronics. See *Figure 3*.

The increase in productivity and decrease in price facilitates an increased quantity demand by consumers. But to evaluate the effects of productivity growth on employment, we focus on a period from 2000 to 2010, which was the largest decline in manufacturing employment in U.S. history. Here we calculated the total employees needed to produce the 2010 levels of production, but using 2000-level worker productivity. Of course this isn't actually the lost jobs to productivity; because without higher productivity, the quantity demanded of the products purchased by consumers would not have risen; so this should

"Had we kept 2000-levels of productivity and applied them to 2010-levels of production, we would have required 20.9 million manufacturing workers. Instead, we employed only 12.1 million."

Table 3. Potential Manufacturing Productivity Employment Effects, 2010

Sector	Potential 2010 Employment at 2000 Productivity Levels	Actual 2010 Employment	Jobs Not Filled Due to Productivity	Actual Job Losses 2000-2010
All manufacturing	20,269,410	12,102,900	8,166,510	-5,647,700
Durable goods manufacturing	13,580,191	7,424,800	6,155,391	-3,737,200
Wood products	572,628	389,500	183,128	-274,900
Nonmetallic mineral products	416,758	391,500	25,258	-177,000
Primary metals	517,519	372,100	145,419	-248,500
Fabricated metal products	1,448,268	1,330,100	118,168	-478,200
Machinery	1,452,225	1,037,700	414,525	-447,400
Computer and electronic products	5,037,889	1,118,900	3,918,989	-693,700
Electrical equipment, appliances, and components	581,560	369,600	211,960	-233,700
Motor vehicles, bodies and trailers, and parts	1,270,690	684,700	585,990	-627,100
Other transportation equipment	900,717	666,200	234,517	-89,400
Furniture and related products	413,311	391,500	21,811	-327,700
Miscellaneous manufacturing	1,091,628	673,000	418,628	-139,600
Nondurable goods manufacturing	6,946,974	4,678,100	2,268,874	-1,910,500
Food and beverage and tobacco products	2,076,249	1,687,100	389,149	-119,200
Textile and textile product mills	312,183	255,100	57,083	-345,200
Apparel, leather, and allied products	338,835	232,300	106,535	-370,500
Paper products	447,955	396,500	51,455	-210,300
Printing and related activities	852,049	553,000	299,049	-318,600
Petroleum and coal products	159,194	112,900	46,294	-9,100
Chemical products	1,233,424	807,100	426,324	-186,500
Plastics and rubber products	826,979	634,100	192,879	-351,100

Source: U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics

be viewed as an illustration of the impacts of productivity growth. Had we kept 2000-levels of productivity and applied them to 2010-levels of production, we would have required 20.9 million manufacturing workers. Instead, we employed only 12.1 million.

As *Table 3* makes clear, the growth in production per worker played a significant role in the change in national manufacturing employment in the past decade for which we have complete data.

To more fully explore the impact of trade, changes to domestic demand for goods, and productivity growth, we return to the jobs equation mentioned earlier. From *Equation 1* we can calculate the job losses attributable to trade (exports minus imports), changes in domestic demand for goods, and changes to productivity. However, we make one modification to the productivity and export analysis.

Firms mix labor, capital, and raw materials to produce goods. That mix changes as a result of technology or process improvements, which are generally viewed as productivity based. They may also change the inputs if relative prices change. Typically, there are changes to both the relative price of inputs and the relative productivity of capital and labor, so the net effect may be a change in productive inputs. However, one factor that is not immediately susceptible to productivity changes are raw materials. So, changes in the cost share of raw materials typically reflect a price change. Often that price change is due to a relatively less expensive substitute acquired through trade.

> "The growth in production per worker played a significant role in the last decade's change in manufacturing employment."

This is not well captured in the import and export data, and imposes some statistical bias into the productivity estimates (Houseman, Kurz, Lengermann, and Mandel 2011). In an effort to adjust for some of this bias, we subtract from the productivity the change in materials purchased for each sector. In this way we capture the potential shift of input purchases from domestic to foreign firms.

The data for this calculation come from the GDP components for 2006-2013 (U.S. Census Bureau). We focus only on the most likely foreign purchases in manufacturing (materials inputs), though the other two elements (energy and services) may also have a foreign source. This is an imperfect adjustment, but in most cases it reduces the productivity measure by very small shares. Only three of these estimates reduced the productivity impact by more than 5.0

Table 4. Impact of Productivity, Trade, and Domestic Demand for Manufactured Goods, 2000-2010

Sector	Production Change Per Worker	Actual Job Losses	Job Loss Share		Job Gain Share
			Trade	Productivity	Domestic Demand
All manufacturing	67.5%	*5,647,700*	*13.4%*	*87.8%*	*1.2%*
Durable goods manufacturing	*82.9%*	*3,737,200*	*12.3%*	*88.2%*	*0.5%*
Wood products	47.0%	274,900	14.4%	81.9%	-3.6%
Nonmetallic mineral products	6.5%	177,000	12.8%	90.4%	3.2%
Primary metals	39.1%	248,500	-3.3%	76.7%	-26.7%
Fabricated metal products	8.9%	478,200	6.9%	97.7%	4.5%
Machinery	39.9%	447,400	0.8%	99.6%	0.4%
Computer and electronic products	350.3%	693,700	18.8%	117.7%	36.5%
Electrical equipment, appliances, and components	57.3%	233,700	19.0%	88.1%	7.1%
Transportation and motor vehicles	64.1%	716,500	5.5%	85.5%	-9.0%
Furniture and related products	5.6%	327,700	40.2%	81.1%	21.3%
Miscellaneous manufacturing	62.2%	139,600	21.7%	76.7%	-1.6%
Nondurable goods manufacturing	*48.5%*	*1,910,500*	*12.3%*	*90.0%*	*2.3%*
Food and beverage and tobacco products	23.1%	119,200	4.3%	96.8%	1.1%
Textile and textile product mills	22.4%	345,200	9.5%	97.6%	7.0%
Apparel, leather, and allied products	45.9%	370,500	44.6%	58.5%	3.1%
Paper products	13.0%	210,300	1.7%	93.2%	-5.0%
Printing and related activities	54.1%	318,600	-2.1%	101.8%	-0.3%
Petroleum and coal products	41.0%	9,100	13.3%	77.1%	-9.6%
Chemical products	52.8%	186,500	1.4%	101.1%	2.5%
Plastics and rubber products	30.4%	351,100	7.4%	100.5%	7.9%

Source: Author calculations using data from the U.S. Census Bureau

Note: In this table, the motor vehicles and transportation sectors are aggregated and are represented as one sector due to incomplete data.

percent. These were in textiles and apparels and in computer and electronics. This latter industry is the one most clearly identified by Houseman, et. al. for suffering the offshoring bias of this type.

Our results appear in *Table 4*. Losses in productivity and trade varied dramatically by sector, with those sectors most heavily exposed to international competition suffering the greatest declines. Other estimates of trade-related job losses have been performed within recent years. Some of these studies have provided historically large estimates of trade displacement relative to productivity growth (Scott 2011; Atkinson 2012). The most scholarly work in this area (Acemoglu, et. al. 2014) estimates employment losses in the United States due to imports from 1999-2013 in the 2.0 million to 2.4 million range. This estimate includes impacts beyond direct manufacturing. Our estimates reported here are consistent with the estimate offered by Acemoglu. For example, our job loss estimates only cover 2000-2010, while the Acemoglu, et. al. estimates include 1999 and 2011-2013 impacts of imports. During this time, we estimate roughly 750,000 jobs (13.4 percent of lost jobs) were due to direct imports and import substitution.

Acemoglu, et. al. approach included general equilibrium effects, they also estimated the impact of lower employment in manufacturing on other sectors. One way to approximate this is to apply a general multiplier from an economic input-output model (or short-run general equilibrium effects). That would yield manufacturing-related job losses due to imports of roughly 1.6 million workers economy wide. If we adjust Acemoglu, et. al. estimates to the shorter time period we examine, we get between 1.4 million and 1.7 million jobs lost during that time period due to import growth. This is an unusually close estimate using two very different methods of assessment.

Summary

Manufacturing has continued to grow, and the sector itself remains a large, important, and growing sector of the U.S. economy. Employment in manufacturing has stagnated for some time, primarily due to growth in productivity of manufacturing production processes.

Three factors have contributed to changes in manufacturing employment in recent years: Productivity, trade, and domestic demand. Overwhelmingly, the largest impact is productivity. Almost 88 percent of job losses in manufacturing in recent years can be attributable to productivity growth, and the long-term changes to manufacturing employment are mostly linked to the productivity of American factories. Growing demand for manufacturing goods in the U.S. has offset some of those job losses, but the effect is modest, accounting for a 1.2 percent increase in jobs beyond what we would expect if consumer demand for domestically manufactured goods was flat.

Exports lead to higher levels of domestic production and employment, while imports reduce domestic production and employment. The difference between these, or net exports, has been negative since 1980, and has contributed to roughly 13.4 percent of job losses in the U.S. in the last decade. Our estimate is almost exactly that reported by the more respected research centers in the nation.

Manufacturing production remains robust. Productivity growth is the largest contributor to job displacement over the past several decades. This leads to a domestic policy consideration.

What Does This Mean for Policy?

Several analysts have made recommendations regarding manufacturing promotion. We lean heavily upon Houseman 2014 for a balanced set of concerns.

Exchange rates clearly play a part of the role of manufacturing import substitution and employment displacement. Any non-market factor which influences dollar valuation should be diligently opposed by international trade agencies and agreements.

U.S. national corporate income tax rates are the highest of the OECD nations, and clearly impose a disincentive for transnational corporate location in the U.S. The government should consider lowering barriers to headquarter and manufacturing facility location through a reduction of federal corporate tax rates.

Sustainable manufacturing employment growth requires high levels of human capital. The nation and individual states should actively support education reforms at the secondary and tertiary level that prepare students for employment opportunities in manufacturing, which will be large due to job turnover among the baby boom share of the manufacturing labor force (see Hicks and Devaraj 2014). Human capital interventions should also begin at the pre-K level, focusing on skills that enable acquisition of the mathematical and cognitive skills required of the modern manufacturing workforce. ■

Note: The April 2017 edition of this report includes minor typographic corrections that do not affect the data or findings of this work.

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