6-1-2010

Offshoring and the State of American Manufacturing

Susan N. Houseman
W.E. Upjohn Institute for Employment Research, houseman@upjohn.org

Christopher Kurz
Federal Reserve Board

Paul A. Lengermann
Federal Reserve Board

Benjamin J. Mandel
Federal Reserve Board

Upjohn Author(s) ORCID Identifier:
https://orcid.org/0000-0003-2657-8479

Upjohn Institute Working Paper No. 10-166

Published Version

In Journal of Economic Perspectives 25(2): 111-132

Citation
Houseman, Susan N., Christopher Kurz, Paul A. Lengermann, and Benjamin J. Mandel. 2010. "Offshoring and the State of American Manufacturing." Upjohn Institute Working Paper No. 10-166. Kalamazoo, MI: W.E. Upjohn Institute. https://doi.org/10.17848/wp10-166

W.E. UPJOHN INSTITUTE FOR EMPLOYMENT RESEARCH

Researching the causes and consequences of unemployment

Offshoring and the State of American Manufacturing

Upjohn Institute Working Paper No. 10-166

Susan Houseman+
Christopher Kurz*
Paul Lengermann*
Benjamin Mandel*

June 2010

ABSTRACT

The rapid growth of offshoring has sparked a contentious debate over its impact on the U.S. manufacturing sector, which has recorded steep employment declines yet strong output growth—a fact reconciled by the notable gains in manufacturing productivity. We maintain, however, that the dramatic acceleration of imports from developing countries has imparted a significant bias to the official statistics. In particular, the price declines associated with the shift to low-cost foreign suppliers generally are not captured in input cost and import price indexes. To assess the implications of offshoring bias for manufacturing productivity and value added, we implement the bias correction developed by Diewert and Nakamura (2009) to the input price index in a growth accounting framework, using a variety of assumptions about the magnitude of the discounts from offshoring. We find that from 1997 to 2007 average annual multifactor productivity growth in manufacturing was overstated by 0.1 to 0.2 percentage point and real value added growth by 0.2 to 0.5 percentage point. Furthermore, although the bias from offshoring represents a relatively small share of real value added growth in the computer and electronic products industry, it may have accounted for a fifth to a half of the growth in real value added in the rest of manufacturing.

JEL Classification Codes: O41, O47, F14, L60
Key Words: offshoring, manufacturing, price measurement, productivity, output growth

Acknowledgments: This research was supported with funding from the Bureau of Economic Analysis and the Alfred P. Sloan Foundation, and was conducted with restricted access to Bureau of Labor Statistics (BLS) import price data as well as unpublished detail on imported materials provided to us by the Bureau of Economic Analysis (BEA). The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the research staff of the Board of Governors, the BLS, or the BEA. We thank Jonathan Collins and Lillian Vesic-Petrovic for research assistance and participants of the conference "Measurement Issues Arising from the Growth of Globalization," held in Washington, DC, November 2009, for comments and suggestions. We are especially grateful to Bill Alterman, Erwin Diewert, Nicole Mayerhauser, Emi Nakamura, Alice Nakamura, Marshall Reinsdorf, Erich Strassner, and Rozi Ulics for their invaluable feedback and assistance on this project.

+Houseman (houseman@upjohn.org) *Upjohn Institute for Employment Research*
*Kurz (christopher.j.kurz@frb.gov); Lengermann (paul.a.lengermann@frb.gov),
Mandel (benjamin.r.mandel@frb.gov) *Federal Reserve Board*

Offshoring and the State of American Manufacturing

Developing economies have become the new, low-cost suppliers of a wide range of products purchased by consumers and used as intermediate inputs by producers, with China—now the largest exporter to the United States—accounting for about a third of the growth in commodity imports over the last decade. The rapid growth of offshoring—defined as the substitution of imported for domestically produced goods and services—contributed to a ballooning trade deficit and sparked a contentious debate over its impact on the U.S. manufacturing sector, which shed 20 percent of its employment, or roughly 3.5 million jobs, from 1997 to 2007. Concerns over employment losses and the trade deficit have prompted a recent spate of government and private sector proposals to revitalize manufacturing.[1]

Our paper highlights the dramatic growth of offshoring and the structural changes occurring in manufacturing in the decade prior to the current recession. During this time, more than 40 percent of imported manufactured goods were used as intermediate inputs, primarily by domestic manufacturers. Using a growth accounting framework, we examine the contributions to the growth in real (constant price) domestic shipments in manufacturing from the inputs to production and from multifactor productivity (MFP). A novel feature of our analysis is that we distinguish between imported and domestic materials inputs, which enables us to more closely examine offshoring by manufacturers. We find substantial evidence of offshoring. The contribution from imported materials to the growth in real manufacturing shipments was larger than that of any other factor input and was more than twice the contribution from capital. At the same time, contributions from domestic materials and, reflecting declining employment, labor were negative.

In spite of the steep employment declines in manufacturing, official statistics indicate that real value-added growth in U.S. manufacturing was robust, increasing almost as quickly as that for all nonfarm business. What happened in manufacturing? As put by former Labor Secretary Robert Reich (2009), "In two words, productivity growth." Indeed, the disparate trends in manufacturing—steep

---

[1] See, for example, Executive Office of the President (2009), Helper (2008), New America Foundation (2010), Pisano and Shih (2009), Pollin and Baker (2010), and Surdna Foundation (2010).

employment declines and strong output growth—are reconciled in the data by high productivity growth. While Reich and others have cited the strong output and productivity figures as evidence of the strength of the American manufacturing, we discuss reasons to qualify this conclusion.

First, the robust output and productivity growth in manufacturing is largely attributable to one industry: computer and electronic products manufacturing. The average annual growth rate of value added in manufacturing excluding computers—which accounted for about 90 percent of manufacturing value added throughout the period—was less than a third of the published growth rate for all manufacturing. As a result, the aggregate numbers do not accurately characterize trends in most of manufacturing.

Second, the price declines associated with the shift to low-cost foreign suppliers generally are not captured in price indexes. The problem is analogous to the widely discussed problem of outlet substitution bias in the literature on the Consumer Price Index (CPI). Just as the CPI fails to capture lower prices for consumers due to the entry and expansion of big-box retailers like Wal-Mart, import price indexes and the intermediate input price indexes based on them do not capture the price drops associated with a shift to new low-cost suppliers in China and other developing countries. A bias to the input price index from offshoring implies that the real growth of imported inputs has been understated. And if input growth is understated, it follows that the growth in MFP and real value added have been overstated.

Building upon Diewert's (1998) characterization of the bias from outlet substitution to the CPI, Diewert and Nakamura (2010) demonstrate that the bias to the input price index is proportional to the growth in share captured by the low-cost supplier and the percentage discount offered by the low-cost supplier. Although the actual input price changes from offshoring are not systematically observed, evidence from import price microdata from the Bureau of Labor Statistics (BLS), industry case studies, and the business press indicate that there are sizable discounts from offshoring to low-wage countries.

If this evidence is representative of the actual discounts manufacturers realized from offshoring, then the biases to MFP and value-added growth may well be significant. We estimate that average annual MFP growth in manufacturing was overstated by 0.1–0.2 percentage points and real value-added growth by 0.2–0.5 percentage points from 1997 to 2007. And, although the bias from offshoring represents a relatively small share of real value-added growth in the computer industry, it may have accounted for one-fifth to one-half of the growth in real value added in the rest of manufacturing. Moreover, our work only examines biases to manufacturing statistics from the offshoring of material inputs. Additional biases may have arisen from the substitution of imported for domestically produced capital equipment and from the offshoring of services.

These biases have implications not only for the industry statistics, but also for the analyses based on them. Because the growth of these imports will be understated in real terms, offshoring will, at least to some degree, manifest itself as mismeasured productivity gains. As a result, studies that endeavor to assess the impact of low-cost imports on the American economy and its workers may well understate the true effects.

INTERNATIONAL TRADE AND THE STATE OF AMERICAN MANUFACTURING

One of the most important developments in the U.S. economy in recent years has been the rapid growth of trade. After being little changed in the early 1990s, the total value of imports and exports of goods and services jumped from roughly 20 percent of U.S. GDP to 28 percent prior to the recent downturn. About 80 percent of the increase was attributable to a run up in the value of imports. The growth of nonoil imports was the most important contributor to the increase in imports during this period, and nonoil goods imports—largely manufactured goods—accounted for almost half of total import growth, while oil accounted for about a third and services for the remainder.[2]

The surge in the imports of manufactured goods—more than 100 percent from 1997 to 2007—reflects both an increase in the import share of goods for final consumption as well as the import share of intermediate inputs. According to the BEA, the import share of intermediate material inputs used by

[2] BEA data on the trade in services in 2008 indicate that 59 percent was travel, transport, royalties, and education related, while the remaining 41 percent was business services.

manufacturers increased from under 17 percent in 1997 to 25 percent in 2007.[3] Figure 1 plots this substantial shift in the sourcing of intermediates from domestic to foreign suppliers.

Also in Figure 1 the imported intermediate materials are classified by type of source country—developing, intermediate, and advanced. We classify countries with less than 20 percent of U.S. per capita GDP in 2008 as developing, and with a few exceptions, countries with per capita GDP equal to or exceeding two-thirds that of that in the United States as advanced. The remaining countries are classified as intermediate.[4] Developing countries accounted for half of the growth in foreign materials inputs, with much of that growth coming from China. Intermediate countries, such as Mexico, accounted for about a third of the growth.

How has the manufacturing sector performed given the growth of imports from low-wage countries? In particular, has the substantial shift in sourcing "hollowed out" manufacturing or instead contributed to the emergence of a leaner, more efficient industrial sector? On the one hand, dramatic drops in employment are often taken to portray a sector in decline. The precipitous decline in manufacturing employment since the late 1990s is evident in Figure 2 and is coincident with the rise in foreign sourcing. Employment never rebounded after the 2001–2002 recession as it had following previous downturns. Indeed, in the decade leading up to the current recession, manufacturing employment declined by 20 percent, while manufacturing's share of employment in the economy fell from 14 percent in 1997 to 10 percent in 2007 (Figure 3). Reflecting plant closures that accompanied the employment declines, the net number of manufacturing establishments fell by 10 percent from 1998 to 2007. At the same time, the nominal share of manufacturing value added in GDP fell from 15.4 percent in 1997 to 11.7 percent in 2007.

Statistics on manufacturing production, however, paint a much more favorable picture of the sector. From 1960 to 2009, the average annual rate of change in real nonfarm business output was 3.5

[3] Government surveys do not explicitly track the destination of imports to final and intermediate uses. In the data we employ within this paper, the BEA assumes that an industry's use of a specific import is in proportion to its overall use of that commodity in the economy, i.e., the import comparability or proportionality assumption.

[4] The main exceptions are Middle Eastern oil producers, which we classify as intermediate countries.

percent, only slightly higher than the 3.2 percent average annual change for manufacturing.[5] More recently, from 1997 to 2007, the average annual growth rate of real manufacturing production was 3 percent, almost the same as the 3.1 percent growth for all private industry.[6] Moreover, cross-country comparisons show larger production gains in U.S. manufacturing relative to other advanced industrial countries, according to OECD data.

The divergent trends of employment declines and plant closures, on the one hand, and rapid growth in real value added, on the other, are primarily reconciled through the lens of productivity. The steadily increasing series displayed in Figure 3 shows the ratio of output per hour in manufacturing to output per hour in all nonfarm business since 1960; the series indicates that labor productivity grew considerably faster in manufacturing throughout the period. Indeed, the average annual growth rate of labor productivity in manufacturing during 1997 to 2007 was 4.1 percent compared to 2.7 percent for all nonfarm business. Manufacturing labor productivity also grew substantially faster in the United States than in most other major industrialized countries during that decade (see BLS 2009). The rapid growth in labor productivity has more than offset the declines in labor input and has permitted firms to sustain robust growth in real value added.

Analysts have pointed to the robust output and productivity growth to argue that the manufacturing sector is relatively healthy.[7] Our work, however, suggests the story is more complex. The aggregate numbers are unrepresentative of the trends in most of manufacturing. Moreover, we find that

[5] Although the average growth of manufacturing has been fairly close to that of the economy as a whole, the sector has typically exhibited greater cyclical swings. As a result, the sector tends to make outsized contributions to changes in GDP growth during economic turning points (Corrado and Mattey 1997). In addition, the relatively faster gains in manufacturing productivity have resulted in lower relative goods prices, which, in combination with inelastic demand for goods (on average), has led to a decline in manufacturing's share of nominal output.

[6] With the BEA's May 2010 comprehensive revision to the annual industry accounts, manufacturing output now expands at a slightly faster rate during this period. The analysis throughout this paper is based upon the previous vintage of these data published in 2009.

[7] This perspective is illustrated by Executive Office of the President (2009), which emphasizes the strength of output and productivity and growth of U.S. manufacturers vis-à-vis the aggregate economy and manufacturers in other industrialized countries and which largely attributes employment declines to productivity growth. Recent articles in the popular press also have advanced this view (e.g., *Economist* 2005; Murray 2009).

the performance of U.S. manufacturing has been overstated to some extent in the official statistics because of offshoring.

EVIDENCE OF OFFSHORING BY MANUFACTURERS

We begin our analysis by examining the sources of the growth in manufacturing. Toward this end, we utilize a standard growth accounting framework in which output is defined as manufacturing shipments adjusted for price changes—termed real gross output. We decompose growth into the parts resulting from the growth of inputs to production—capital, labor, services, energy, and materials inputs—and MFP growth, which is computed as a residual. In other words, MFP growth is the part of output growth that cannot be accounted for by the growth of factor inputs, and therefore represents the returns to all factors of production.[8]

As mentioned, a novel feature of our analysis is that we distinguish between domestically sourced and foreign materials inputs. Specifically, we use unpublished BEA data on the value of imports and imported input prices at a detailed commodity level to distinguish between the growth of domestic and imported materials inputs.

Using these data, we compute MFP growth for manufacturing as the growth in real gross output ($\hat{Q}$) less a weighted average of the growth rate of labor ($\hat{L}$), capital ($\hat{K}$), energy ($\hat{E}$), services ($\hat{S}$), domestic materials ($\hat{M}^D$), and foreign materials ($\hat{M}^F$) inputs:

(1) $$\hat{MFP} = \hat{Q} - \left[w^L \hat{L} + w^K \hat{K} + w^E \hat{E} + w^S \hat{S} + w^{m^D} \hat{M}^D + w^{m^F} \hat{M}^F \right]$$

[8] See Jorgenson, Gollop, and Fraumeni (1987) and Hulten (2009) for more on the growth accounting methodology, its early development, and current applications. The industry-level data for output, materials, energy, and services come from the BEA's GDP-by-industry accounts. Capital services inputs for are derived from the BEA's fixed asset accounts. The labor input is based on industry-level hours worked from the national income and product accounts, adjusted for changes in the worker composition effects using wage data from the Census Bureau's county business patterns.

The weights (w) on each input represent the input's share of total input costs. Any error in the measurement of input growth—including errors that result from biased price indexes used to deflate the inputs—will directly result in an error in the measurement of productivity growth.

Equation (1) can be rearranged to obtain an identity in which output growth is decomposed into MFP growth and contributions from the growth of factor inputs. Table 1 provides the results of this decomposition for manufacturing and selected industry breakouts from 1997 to 2007. Note that the figures in column (1), which represent the average annual real output growth rate over the period, equal the sum of the figures in columns (2) through (8), which represent the contributions to output growth from MFP and from the growth of the indicated inputs.

Several striking findings emerge from this table. One is the strong MFP growth. The contribution to real output growth from MFP actually exceeds real gross output growth, indicating that MFP can account for *all* of the growth in real gross output over the decade. Capital, purchased services, and materials all play important, albeit more modest, roles, while the contribution of labor is negative and large, reflecting the steep employment declines during the period.[9]

Columns (7) and (8) in Table 1 provide a clear picture of the rapid pace of structural change currently under way in U.S. manufacturing. During the period, the contribution of domestically supplied materials inputs fell, while that of imported materials inputs greatly expanded, reflecting the substitution of foreign for domestic intermediate inputs. The growth of imported intermediate inputs, to some degree, will also reflect the direct substitution of imported goods for domestic labor and capital. To see this, consider the case in which a firm previously produced an intermediate input and final product internally, but now sources that input from a foreign supplier. In this instance, gross output will not change, but imported materials inputs will rise and the labor and capital previously used to produce the input will fall.

For all manufacturing, the contribution of imported materials inputs to output growth was greater than that of any other factor of production and was more than double the contribution from capital. For

[9] The growth accounting results in Table 1 reflect the authors' calculations and rely on a different methodology than what is used by the BLS. However, these two salient features of the data are also observed in the BLS estimates. A full reconciliation of the two approaches appears in Houseman et al. (2010).

manufacturing excluding the computer industry, imported materials account for 60 percent of the growth during this period.

Another striking result in Table 1 is that computer and electronic products manufacturing—which includes computers, semiconductors, and telecommunications equipment—accounts for most of the output and productivity growth in manufacturing over the period.[10] Output and productivity growth in the computer industry averaged 7.4 and 6.8 percent per year, respectively, compared to growth of only about 0.5 percent for output and 0.7 percent for MFP in the rest of manufacturing. The extraordinary productivity and output growth in computers reflects, to a large degree, technological improvements of the products produced and output price deflators that, when properly adjusted for product improvements, are often falling rapidly.[11]

Throughout the decade, the computer industry's share of manufacturing value added remained relatively constant at around 10 percent. Because manufacturing output and productivity statistics are strongly affected by the computer industry, which represents such a small share of the sector, researchers should be cautious in drawing general inferences about manufacturing from the aggregate numbers. It also bears note that statistics on industry output and productivity growth should be interpreted in relation to growth in demand for the industry's products. Indeed, in spite of rapid value added and productivity growth of computers and electronic products manufacturing during the decade, the trade deficit within this product group greatly widened and substantial offshoring of components of the industry occurred (Brown and Linden 2005; Linden, Dedrick, and Kraemer 2009).

Because statistics on labor productivity, defined as output per hour worked, are widely used in research and policy analyses, it is also of interest to consider the relationship between labor productivity growth and offshoring. In the official BLS labor productivity release, manufacturing output includes imported intermediates but excludes intermediates sourced from within the domestic manufacturing

---

[10] Similar findings have been reported in other studies. See, for example, Jorgenson, Ho, and Stiroh (2008) and Oliner and Sichel (2000). See also Oliner, Sichel, and Stiroh (2007) and Syverson (2010) for more in-depth reviews of recent research on U.S. productivity.

[11] The BLS uses hedonic methods to adjust prices in the computer industry. For a review of these, see Wasshausen and Moulton (2006).

sector. As a result, shifts in sourcing from a domestic to a foreign supplier do not offset each other, mechanically increasing labor productivity.[12] To this point, Eldridge and Harper (2009) find that imported intermediate materials explain 20 percent of the growth in manufacturing labor productivity from 1997 to 2006. We find that the contribution to manufacturing labor productivity from imported materials inputs significantly accelerated over the period.

Although Table 1 documents the substantial growth in offshoring during the period, it nevertheless likely *understates* the true magnitude of the phenomenon. Our focus below concerns the systematic upward bias in the price indexes used to deflate intermediate materials. We could not account for the measurement of two additional factors, which likely also impart an upward bias: 1) imported capital inputs, such as computers and machinery, have exhibited substantial gains in import penetration; and 2) imported services inputs (i.e., services offshoring) have accelerated in recent years, albeit from a very low level.[13]

BIAS TO PRICE INDEXES FROM OFFSHORING

Understanding why offshoring likely results in biases to the price indexes used to deflate inputs requires some background on the relevant price programs. In addition to the Consumer Price Index (CPI), the BLS constructs separate price indexes for imports, exports, and domestically produced goods. Just as the BLS constructs the CPI to measure the rate of price change of goods and services purchased by consumers, the BEA constructs input price indexes to measure the rate of price change of inputs to production purchased by businesses. The BEA constructs industry-specific input price indexes using import and domestic price indexes in conjunction with information on each industry's input structure from the input-output tables. The import price data come from the BLS's International Price Program

[12] This could also occur if a firm imports an intermediate input it previously produced internally. In this case, output will not change, but the labor input used to produce that intermediate input will fall.

[13] See Cavallo and Landry (2010) for a discussion of imported capital goods, and Eldridge and Harper (2009) and Yuskavage, Strassner, and Maderios (2008) and for estimates of services offshoring.

(IPP), which surveys importing establishments on the prices paid for imports of a detailed product. For domestic materials prices, the BEA primarily uses the Producer Prices Index (PPI) in which BLS surveys domestic producers on the prices they receive for a sample of products.[14]

The BLS takes great care to ensure that it is pricing the same item over time, and thus that price indexes are based on "apples-to-apples" comparisons. Each observation used in the construction of a particular price index represents the period-to-period price change of an item as defined by very specific attributes and reported by a specific establishment. These methods mean, however, that price indexes neither capture the price changes associated with the entry of a low-cost supplier nor the level differences in prices which drive its subsequent market share expansion. As mentioned, this problem has been studied extensively in the CPI literature, where it has been dubbed "outlet substitution bias" (Diewert 1998, Hausman 2003, and Reinsdorf 1993).

Figure 4 presents a stylized depiction of the problem in the context of offshoring. The BLS measures the price change from period t to $t+1$ of a specific imported product at a specific importer in the IPP, and it measures the price change from period t to $t+1$ of a specific product produced by a specific domestic producer in the PPI. Neither the IPP nor the PPI captures the price drop (d) that occurs when businesses shift from a high-cost domestic to a low-cost foreign supplier. The input price index is, in essence, a weighted average of period-to-period changes measured in the IPP and the PPI, and thus the price drop from offshoring is missed.[15]

To further illustrate how offshoring can impart a bias into the input price index, Table 2 provides a hypothetical numerical example. Suppose that pharmaceutical companies purchase a common chemical compound, "obtanium," from a domestic supplier at $10 per ounce. A Chinese supplier enters the market and sells obtanium for $6 per ounce. As the new, lower-cost source becomes known, its reliability is established, and contracts with the domestic supplier expire, U.S. pharmaceutical companies begin shifting their purchases to the Chinese supplier. For simplicity, we assume that the domestic and foreign

[14] For more information on the BLS price index computations, see Chapters 14 and 15 in BLS (2009).

[15] Although our empirical focus is on the substitution of imported for domestic inputs, a bias would also occur with the entry and market share expansion of a new low-cost domestic supplier.

dollar prices of obtanium remain the same throughout the period.[16] Even if the BLS picks up the Chinese import of obtanium in its import prices sample without a lag, it will not capture the input price drop enjoyed by drug manufacturers at the time of the switch.

The input price index, as computed by the statistical agencies, is a weighted average of the domestic and import index, and, in our example, does not change. The correct index, however, would capture the period-to-period change of the average price that U.S. companies pay for obtanium and falls by 12 percent. More rapid introduction of new suppliers into the BLS sampling frame or more frequent sampling of prices—common suggestions for improving price statistics—will not address this particular problem.

The bias to the price index arises because neither the U.S. producer nor the U.S. importer can report the price drop that buyers experience when they shift their purchases from domestic to foreign suppliers. To address this problem, the BLS has proposed that an input index be constructed based on a survey of purchasers (Alterman 2009).[17] In theory, the buyers could accurately report the period-to-period changes in the price they pay for specific inputs, irrespective of source.

Diewert and Nakamura (2010) characterize the bias to the input price index resulting from a shift in input suppliers. The upward bias (B) to the rate of inflation in the input price index ($1+i$) is proportional to the share captured by the low-cost supplier over the period (s) and the percentage difference in the prices of the low- versus the high-cost supplier—or discount—(d):

$$B = (1+i)sd \qquad (2)$$

Returning to our obtanium example, over the period there is no measured inflation (i.e., i equals zero), the low-cost supplier captures a 30 percent market share, and the discount from the low-cost supplier is 40 percent. Whereas the measured rate of price change is zero, the true rate of price change for that input is -0.12, or negative 12 percent. The characterization of the bias to the input price index in Equation (2) is

[16] Because prices are often contractually set for periods of time, this simplifying assumption of price stickiness is not unrealistic. Nakamura and Steinsson (2009) document that 40 percent of prices on imported items never change for the entire duration they are in the BLS sample.

[17] The proposed input cost index is still at the concept and design stage at the BLS.

identical to the characterization of the bias to the CPI (Diewert 1998). It is the same problem manifested in a different index.[18]

As shown in Figure 5, the problem is evident in the input price indexes used by the BEA to deflate intermediate materials inputs. If price indexes were accurately capturing the cost savings to businesses that presumably underlie the recent share growth of imported intermediates, then the growth of the import price index should be *slower* than the domestic price index, indicating a fall in the price of imported relative to domestic inputs. Instead, the foreign price deflator for intermediate materials rose *faster* than the domestic deflator. The differential between foreign and domestic materials price deflators is especially apparent beginning in 2002, coincident with the rapid rise of imports from China.

EVIDENCE OF COST SAVINGS FROM OFFSHORING

No comprehensive evidence exists on the magnitude of the cost savings from shifts in sourcing—i.e., the discount, *d*, in Equation (2). A few case studies, however, provide some evidence for selected products and industries. Byrne, Kovak, and Michaels (2010) find sizable cross-country differences in the prices of semiconductor wafers with identical specifications. On average, they find that, compared to prices of semiconductor wafers produced in U.S. foundries, prices were on average about 40 percent lower in China and about 25 percent lower in Singapore. Klier and Rubenstein (2009) find that offshoring aluminum wheel production to Mexico lowered overall costs by 19 percent and processing costs by 36 percent.

The different samples in the IPP and PPI do not permit a direct comparison of prices for domestic and imported items. However, such a comparison is possible among imported products originating in different countries. Products from intermediate and, especially, developing countries were gaining market share not only vis-à-vis the United States but also other advanced countries. On the grounds that

[18] Although the goods in this model are treated as homogeneous, Diewert (1998) provides a simple extension to where the goods are different qualities. In this case, the discount represents the price differential adjusted for quality.

production cost structures are likely to be more similar between the United States and other advanced countries, systematic import price differentials between products from advanced versus developing and intermediate countries may be informative about the size of the discount relative to U.S. goods.

Figure 6 shows the average percentage differences between imported products from advanced and developing countries and between advanced and intermediate countries as recorded in the BLS microdata underlying the IPP. The position of each bubble represents the size of the discount for a single North American Industry Classification System (NAICS) 4-digit category in manufacturing. The size of each bubble is proportional to the gain in U.S. market share for developing and intermediate countries within each category. In almost all cases, the discounts are negative, indicating lower prices in developing and intermediate countries compared to advanced countries. In many cases, these discounts appear to be quite sizable. Further, the size of a discount is negatively correlated with a gain in market share, indicating that the larger the developing or intermediate country's price differential, the greater the U.S. market share captured. Products on the left side of the figure (i.e., food, beverages, textiles, and apparel) are characterized by smaller discounts and share gains, whereas products to the right (i.e., machinery, electronics, semiconductors, and transportation) are characterized by larger discounts and share gains.

An important caveat to this figure is that even within very detailed product codes there may be considerable heterogeneity that may explain at least some of the price differentials. Returning again to our example in the previous section, if obtanium is a differentiated product and the Chinese version is of a lower quality than that from Japan, then Chinese obtanium should trade at a discount relative to a variety that is not strictly comparable. We adopt various methods to control for possible heterogeneity. In particular, one method restricts the import price sample to cases in which there is a newly observed price for an incumbent importing firm within the same detailed product code. In this way, we are able to narrow the sample to instances in which an importer appears to be switching sources of a specific product from a supplier in an advanced country to one in a developing or intermediate country. The observed price differentials are somewhat smaller but still sizable when we limit our sample in this way.[19]

The evidence from case studies and from comparisons of import prices is consistent with reports of large discounts in the business literature. For example, in 2004 *Business Week* reported that prices of imported goods from China typically were 30 to 50 percent lower than the prices for comparable products produced in the United States, and that the discounts were sometimes higher (Engardio and Roberts 2004). Similarly, a McKinsey & Company (2006) study cited cost savings from production of electronic equipment in China of between 20 and 60 percent. Estimates of the savings from offshoring auto parts production to Mexico are generally in the range of 20 to 30 percent (see discussion in Kinsman 2004). In sum, although no systematic data exist, a variety of evidence points to large cost savings from offshoring.

The above-mentioned price differentials could be the result of numerous factors, such as labor costs, industrial policy, or disequilibrium in exchange rate markets. For instance, the Manufacturers Alliance of the National Association of Manufactures provides estimates of manufacturing labor costs, adjusted for productivity, for major U.S. trading partners as compared to the United States. Their estimates of large labor cost savings—58–72 percent lower in China and 22–62 percent in Mexico from 2002 to 2009—are consistent with the large product discounts reported in research and in the business press (Leonard 2008). Also consistent with the evidence of cost savings from offshoring are estimates that the Chinese *renminbi* may be significantly undervalued relative to the dollar, perhaps by as much as 40 percent (Bergsten 2010, Cline and Williamson 2010).

[19] Houseman et al. (2010) describe this approach in greater detail. We also attempt to account for unobserved differences in product characteristics using an econometric model informed by estimates of product-level quality from Mandel (2010). We find that the price dispersion across source countries decreases but remains substantial. In short, it is unlikely that product differentiation accounts for the large, persistent price differences across countries.

BIAS TO PRODUCTIVITY AND VALUE ADDED FROM OFFSHORING

We implement the bias correction to input prices in Equation (2) and simulate the effects of the bias on MFP and value-added growth. Figure 7 illustrates what the bias to industry-level materials deflators would be if the true import discounts match those derived from the full sample of import price microdata. The vertical distance between each point and the 45 degree line represents the size of the bias. For all manufacturing, if the true import discount can be approximated by the IPP microdata, then the cumulative price growth of 20 percent between 1997 and 2007 would overstate the bias-corrected inflation rate by a full 9 percentage points. Thus, once we account for offshoring bias, the materials costs faced by U.S. manufacturers would only have risen at *half* the rate reported in official estimates. This, in turn, would imply that the real use of materials by U.S. manufacturers was twice as large as reported. With more production being generated by purchased materials, both productivity and value added would be diminished. Also shown in Figure 7 are the implied industry-level cumulative price changes under this set of assumptions about import price discounts.

By how much might the productivity statistics be overstated from failing to account for offshoring? The top panel of Table 3 presents alternative estimates of MFP growth based upon different assumptions about the import discount. Column (1) restates our baseline MFP results from Table 1, while column (2) presents estimates in which all commodities—both domestic and imported—have been deflated with domestic deflators provided to us by the BEA. Since our alternative materials deflators are derived by adjusting domestic commodity prices (primarily PPIs), the estimates in column (2) should be viewed as the appropriate reference or “jumping-off” point for gauging the extent of offshoring bias. In other words, they show what MFP would be if the rate of price inflation for imported commodities was the same as for their domestic counterparts. This assumption in Equation (2) is maintained in order to hone in on the impact of the level difference in prices between imported and domestic commodities.

For the entire manufacturing sector, deflating imported materials with domestic prices reduces MFP growth by a bit less than 0.1 percentage point, from 1.30 percent in our baseline scenario to 1.23

percent. Almost all of this change owes to differences in the price deflators used for imported and domestic semiconductors. In other words, prices for imported semiconductors—a product used heavily by the computer and electronic products industry—fell less rapidly than their domestic counterparts. The discrepancies are especially evident in the early years of our data and appear to be the result of inconsistent adjustment of imported and domestic semiconductor prices for quality improvements. Although not the focus of our paper, the drop in MFP between columns (1) and (2) likely represents an additional modest bias.[20]

Columns (3) and (4) present MFP estimates that have been adjusted for offshoring using our micro evidence on the import discount. We report estimates using product-level discounts based on the entire microdata sample ("full sample") and on a sample limited to instances where importers appear to shift from suppliers in advanced counties to ones in developing or intermediate countries ("switchers"). In columns (5) and (6), we estimate MFP using import discounts informed by the business press and available case study evidence, applying these discounts uniformly across commodities. The column labeled "50/30" assumes discounts of 50 percent for developing countries and 30 percent for intermediate countries, whereas the column labeled "30/15" assumes discounts of 30 percent for developing countries and 15 percent for intermediate countries. These represent discounts on the high and low end, respectively, of those found in the case study and business literature.

On balance, for the entire manufacturing sector, we find that adjusting for offshoring lowers MFP growth by an additional 0.1–0.2 percentage point, which implies average annual productivity growth is reduced between 6 and 14 percent. These numbers are fairly significant, as a 0.1 percent average annual growth rate for MFP roughly equals the average annual contribution of the capital stock to manufacturing growth during this period.

[20] Because of the high import penetration in semiconductors and other high-tech products, consistently adjusting domestic and import prices for product improvements is important for the accuracy of industry and national income statistics, though difficult owing to lack of product detail, particularly for imports. Addressing this problem has resulted in substantial revisions to the national accounts statistics in the past (Grimm 1998).

If we exclude the contribution of the computer and electronic products industry, correcting for offshoring results in larger percentage adjustments to MFP, which falls from 0.67 percent in column (2) to between 0.52 percent (column 3) and 0.58 percent (column 4); in other words, the reduction in MFP widens to as much as 22 percent. The results for the case study scenarios shown in columns (5) and (6) are quite consistent with our results based on IPP microdata.

What about the likely range of bias to value added? Recall that value added nets out intermediate inputs from an industry's shipments, and therefore represents the additional product produced in an industry.[21] If, as suggested by Figure 7, the actual amount of intermediate materials used by U.S. manufacturers has been larger than what is contained in the official statistics, then value added has been overstated as well. This implies that a larger share of the sector's production has simply been final assembly, and relatively less of domestic manufacturing shipments are contributing value to the overall economy.

The BEA derives indexes for industry-level value added using the double-deflation method in which real value added is computed as the difference between real gross output and real intermediate inputs. We replicate this double-deflation procedure using our adjusted measures of real purchased materials. We therefore derive the implied value of real value added –associated with published measures of gross output, energy, and services and our adjusted measures of purchased materials inputs.

The bottom panel of Table 3 presents alternative estimates for value added based on our different assumptions on the import discount. Of note, the unadjusted average growth rate in value added for all manufacturing is about 3 percent, while the annual growth rate for manufacturing, excluding the computer sector, is less than one-third of this size—about 0.9 percent. The annual growth rate for the computer industry exceeds 20 percent. As shown in columns (3) through (6), our simulations indicate that value-added growth for all manufacturing was overstated by 0.2–0.5 percentage point, or about 7–18 percent of the growth. Excluding computers, real value-added growth for manufacturing is biased by 0.2–0.4

[21] Gross domestic product can therefore be derived as the sum of value added across all sectors of the economy.

percentage point, which accounts for 21–49 percent of the growth. 22 The annual growth rate of real value added for manufacturing excluding computers falls under a half percent per year in some of our adjusted estimates, while that for nondurable goods turns negative for all of our adjusted estimates.

IMPLICATIONS FOR DATA AND RESEARCH

The above analysis focuses on biases to manufacturing productivity and value added from the substitution of lower-cost imported for domestic materials inputs. Such biases, however, may also arise from the offshoring of other inputs and affect statistics for other sectors and for the aggregate economy.[23] In the 2000s, sizable import penetration by developing countries occurred in computers and machinery products, which largely are treated as capital inputs in the industry accounts. Price drops accompanying the substitution of imported for domestic capital equipment would not be captured in capital price deflators, possibly leading to an understatement of the growth of capital services and an overstatement of growth in MFP and real value added.

The same problem arises from services offshoring. Collecting accurate price information on services trade is complicated by the fact that the level of detail in services sector data is quite limited (Jensen 2009, Norwood et al. 2006,Sturgeon et al. 2006,), and that the BLS international prices program does not cover business services imports and exports. If services offshoring were to expand rapidly in the near future, as some predict, the absence of accurate price deflators could impart significant biases in official statistics.

More generally, the Shumpetarian dynamic by which low-cost producers enter and capture market share from incumbents is an important mechanism by which prices change, but is a dynamic

[22] In addition to the "switchers" estimates, we attempted to adjust for unobserved differences within detailed product codes using econometric techniques. These estimates do not alter the qualitative results of our analysis, and imply bias adjustments to MFP and value added roughly in line with the "30/15" estimates in Table 3.

[23] Reinsdorf and Yuskavage (2009) examine pricing in selected consumer goods and provide preliminary evidence of biases to GDP from import growth. Biases to price indexes from offshoring and their implied biases to GDP growth also have been covered in the business press (see Mandel 2007, 2009).

largely missed in price indexes. Although we have focused on the substitution of low-cost foreign for domestic inputs because of the recent empirical importance of offshoring, the entrance and market share expansion of low-cost domestic suppliers is an important aspect of firm dynamics in the United States and also would impart biases to price indexes.[24] As mentioned above, a proposal to construct an input price index based on a survey of purchasers, if implemented by BLS, would address the biases to the industry statistics from all shifts in sourcing (Alterman 2009).[25]

The growth of low-cost imports has spurred numerous studies to assess their effects on the U.S. economy and its workers. Biases to price indexes that arise from offshoring affect the accuracy not only of the industry statistics, but also of analyses based on them. Because such import growth will be understated in real terms and, to some degree, will be manifested as false productivity gains, studies may underestimate the true effects of import growth.

The pace of globalization is unlikely to abate in the near future, underscoring the need for reliable economic statistics to understand its effects and formulate policy responses. The biases to price indexes discussed in this paper are emblematic of a broader set of measurement problems that arise from the growth of globalization (Feenstra and Lipsey 2010, Houseman and Ryder 2010). Understanding the effects of globalization requires better data, including, quite critically, better price deflators.

---

[24] See Foster, Haltiwager, and Syverson (2008) for evidence that entrants, on average, have higher physical productivity and offer lower prices than incumbent firms.

[25] The proposed index, which would not distinguish source country, would capture price changes from shifts in sourcing among domestic suppliers, among domestic and international suppliers, and among international suppliers. Although the input price index would address biases in the industry statistics, it would not address biases in published statistics on GDP growth, which are based on expenditure, not industry value-added, data.

References

Alterman, William. 2009. "Producing an Input Price Index." Paper prepared for the conference "Measurement Issues Arising from the Growth of Globalization," held in Washington, DC, November, 6–7

Bergsten, C. Fred. 2010. "Beijing Is Key to Creating More U.S. Jobs." Foreignpolicy.com. http://www.foreignpolicy.com/articles/2010/04/14/china_the_job_killer?print=yes&hidecomments=yes&page=full (accessed June 10, 2010).

Brown, Clair, and Greg Linden. 2005. "Offshoring in the Semiconductor Industry: A Historical Perspective." In *Brookings Trade Forum: 2005: Offshoring White-Collar Work*, Lael Brainard and Susan M. Collins, eds. Washington, DC: Brookings Institution Press, pp. 279–333.

Bureau of Labor Statistics. 1997. "International Price Indexes." *BLS Handbook of Methods*, 154–159. Washington, DC.: U.S. Government Printing Office.

Bureau of Labor Statistics. 2008. "Producer Prices." BLS Handbook of Methods, 1–12. Washington, DC.: U.S. Government Printing Office.

Bureau of Labor Statistics. 2009. "International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends, 2008." News Release. http://www.bls.gov/news.release/pdf/prod4.pdf

Byrne, David, Brian Kovak, and Ryan Michaels. 2010. "Offshoring and Price Measurement in the Semiconductor Industry." Paper prepared for the conference "Measurement Issues Arising from the Growth of Globalization," held in Washington, DC, November, 6–7, 2009.

Cavallo, Michele, and Anthony Landry. 2010. "The Quantitative Role of Capital Goods Imports in U.S. Growth." *American Economic Review* 100(2): 78–82.

Cline, William R., and John Williamson. 2010. "Notes on Equilibrium Exchange Rates: January 2010." Peterson Institute for International Economics Number PB10-2. Washington, DC: Peterson Institute for International Economics.

Corrado, Carol, and Joe Mattey. 1997. "Capacity Utilization." *Journal of Economic Perspectives* 11(1): 151–167.

Diewert, W. Erwin. 1998. "Index Number Issues in the Consumer Price Index." *Journal of Economic Perspectives* 12(1): 47–58.

Diewert, W. Erwin, and Alice Nakamura. 2010. "Bias in the Import Price Index Due to Outsourcing: Can It be Measured?" Paper prepared for the conference "Measurement Issues Arising from the Growth of Globalization," held in Washington, DC, November, 6–7, 2009.

Economist. 2005. "Finance and Economics—Manufacturing Employment—Industrial Metamorphosis." 377(8446): 69.

Eldridge, Lucy P., and Michael J. Harper. 2009. "Effects of Imported Intermediate Inputs on Productivity." Paper prepared for the conference "Measurement Issues Arising from the Growth of Globalization," held in Washington, DC, November, 6–7.

Engardio, Pete, and Dexter Roberts. 2004. "The China Price." *Business Week*, December 6. http://www.businessweek.com/magazine/content/04_49/b3911401.htm (accessed June 9, 2010).

Executive Office of the President of the United States. 2009. "A Framework for Revitalizing American Manufacturing." Washington, DC: U.S. Government Printing Office.

Feenstra, Robert, and Robert Lipsey. 2010. *Report on the State of Available Data for the Study of International Trade and Investment*. Report prepared for the **C**ommittee on Economics Statistics of the American Economic Association.

Foster, Lucia, John Haltiwanger, and Chad Syverson. 2008. "Reallocation, Firm Turnover and Efficiency: Selection on Productivity or Profitability?" *American Economic Review* 98(1): 394–425.

Grimm, Bruce T. 1998. "Price Indexes for Selected Semiconductors." *Survey of Current Business* 78(2): 8–24.

Hausman, Jerry. 2003. "Sources of Bias and Solutions to Bias in the Consumer Price Index." *Journal of Economic Perspectives* 17(1): 23–44.

Helper, Susan. 2008. "Renewing U.S. Manufacturing: Promoting a High-Road Strategy." EPI Briefing Paper 212. Washington, DC: Economic Policy Institute.

Houseman, Susan, Christopher Kurz, Paul Lengermann, and Benjamin Mandel. 2010. “Offshoring Bias: The Effect of Import Price Mismeasurement on Manufacturing Productivity and Value Added Growth.” Mimeo.

Houseman, Susan, and Kenneth Ryder. 2010. *Measurement Issues Arising from the Growth of Globalization.* Report prepared for the U.S. Bureau of Economic Affairs, Washington, DC

Hulten, Charles R. 2009. “Growth Accounting.” NBER Working Paper No. 15341. Cambridge, MA: National Bureau of Economic Research.

Jensen, J. Bradford. 2009. “Measuring the Impact of Trade in Services: Prospects and Challenges.” Paper prepared for the conference “Measurement Issues Arising from the Growth of Globalization,” held in Washington, DC, November, 6–7.

Jorgenson, Dale W., Frank M. Gollop, and Barbara M. Fraumeni. 1987. *Productivity and U.S. Economic Growth*. Cambridge, MA: Harvard University Press.

Jorgenson, Dale W., Mun S. Ho, and Kevin J. Stiroh. 2008. “A Retrospective Look at the U.S. Productivity Growth Resurgence.” *Journal of Economic Perspectives* 22(1): 3–24.

Kinsman, Michael. 2004. “Exporting Work: Outsourcing That Once Sent Low-Skill Jobs to Mexico Is Now Sending Some of San Diego’s High-Skilled, High-Wage Jobs to India, China and Elsewhere.” *San Diego Tribune*, April 4. http://64.9.213.241/files/old/news/articles/san_diego_tribune_4_4_04.pdf (accessed June 9, 2010).

Klier, Thomas H., and James M. Rubenstein. 2009. “Imports of Intermediate Parts in the Auto Industry—A Case Study.” Paper prepared for the conference “Measurement Issues Arising from the Growth of Globalization,” held in Washington, DC, November 6–7.

Leonard, Jeremy A. 2008. “The Tide is Turning: An Update on Structural Cost Pressures Facing U.S. Manufacturers.” Published jointly by the Manufacturers Alliance/MAPI and The Manufacturing Institute. http://institute.nam.org/view/2001005065073451188/info (accessed June 10, 2010).

Linden, Greg, Jason Dedrick, and Kenneth L. Kraemer. 2009. "What the iPod Tells Us." http://delong.typepad.com/egregious_moderation/2009/12/greg-linden-jason-dedrick-and-kenneth-l-kraemer-what-the-ipod-tells-us.html (accessed June 10, 2010).

Mandel, Michael. 2007. "The Real Costs of Offshoring." *Business Week*, June 18. http://www.businessweek.com/magazine/content/07_25/b4039001.htm (accessed June 9, 2010).

———. 2009. "Growth: Why the Stats Are Misleading." *Business Week,* June 3. http://www.businessweek.com/magazine/content/09_24/b4135000594984.htm (accessed June 9, 2010).

Mandel, Benjamin R. 2010. "Heterogeneous Firms and Import Quality: Evidence from Transaction-Level Prices." Board of Governors of the Federal Reserve System, International Finance Discussion Paper No. 991. Washington, DC: Board of Governors of the Federal Reserve System.

McKinsey & Company. 2006. "China and India as Global Supply Points: A Business Opportunity!" Consensor Results. Presentation Pudong Shangri-La Hotel, Shanghai, May 22–24.

Murray, Sara. 2009 "U.S. Manufacturing Productivity Jumps." *Wall Street Journal*, October 23, A:2.

Nakamura, Emi, and Jón Steinsson. 2009. "Lost in Transit: Product Replacement Bias and Pricing to Market." New York: Columbia University http://www.columbia.edu/~en2198/papers/ippsubs.pdf (accessed June 10, 2010).

New America Foundation. 2010. "America Needs a Manufacturing Strategy." (February 3). http://www.newamerica.net/publications/policy/america_needs_a_manufacturing_ strategy.

Norwood, Janet L., Carol Carson, Manuel Deese, Norman J. Johnson, Franklin S. Reeder, and John E. Rolph. 2006. *Offshoring: How Big Is It?* Report of the Panel of the National Academy of Public Administration for the U.S. Congress and the Bureau of Economic Analysis, National Academy of Public Administration, Washington, DC.

Oliner, Stephen D., and Daniel E. Sichel. 2000. "The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?" *Journal of Economic Perspectives* 14(4): 3–22.

Oliner, Stephen D., Daniel E. Sichel, and Kevin J. Stiroh. 2007. “Explaining a Productive Decade.” *Brookings Papers on Economic Activity* 1: 81–137.

Pisano, Gary P., and Willy C. Shih. 2009. “Restoring American Competitiveness.” *Harvard Business Review* July-August: 114–125.

Pollin, Robert, and Dean Baker. 2010. “Reindustrializing America: A Proposal for Reviving U.S. Manufacturing and Creating Millions of Good Jobs.” *New Labor Forum* 19(2): 17–34.

Reich, Robert B. 2009. “Made in America: Manufacturing Jobs are Never Coming Back.” Forbes.com: http://www.forbes.com/2009/05/28/robert-reich-manufacturing-business-economy.html (accessed June 10, 2010)

Reinsdorf, Marshall. 1993. “The Effect of Outlet Price Differentials in the U.S. Consumer Price Index.” In *Price Measurements and Their Use,* Murray F. Foss, Marylin E. Manser, and Allan H. Young, eds. Chicago: University of Chicago Press, pp. 227–254.

Reinsdorf, Marshall, and Robert Yuskavage. 2009. “Are There Unmeasured Declines in Prices of Imported Final Consumption Goods?” “Measurement Issues Arising from the Growth of Globalization,” held in Washington, DC, November, 6–7.

Sturgeon, Timothy J., Frank Levy, Clair Brown, J. Bradford Jensen, and David Weil. 2006. “Why We Can’t Measure the Economic Effects of Services Offshoring: The Data Gaps and How to Fill Them.” *Services Offshoring Working Group Final Report*. Cambridge, MA: Massachusetts Institute of Technology, Industrial Performance Center. http://web.mit.edu/ipc/publications/pdf/IPC_Offshoring_Report.pdf (accessed June 10, 2010).

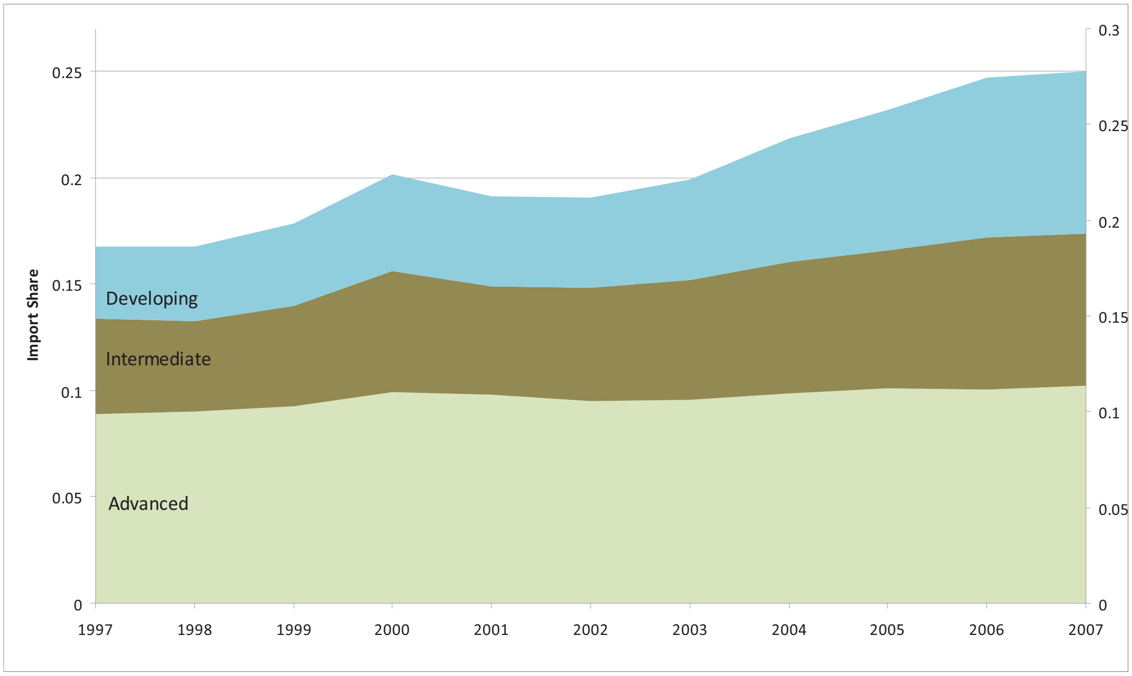
Surdna Foundation. 2010. “Revitalizing America’s Manufacturing Sector.” Surdna.org. http://www.surdna.org/what-we-fund/sustainable-environments/sustainable-environments-whats-new/203-revitalizing-americas-manufacturing-sector-summary-of-surdna-roundtable.html.

Syverson, Chad. 2010. “What Determines Productivity?” NBER Working Paper No. 15712. Cambridge, MA: National Bureau of Economic Research.

Wasshausen, David B., and Brent R. Moulton. 2006. “The Role of Hedonic Methods in Measuring Real GDP in the United States. Prepared for the 31st Committee on Statistical Information in the Economic and Social Sphere (CEIES) seminar “Are We Measuring Productivity Correctly?” held in Rome, October 12–13.

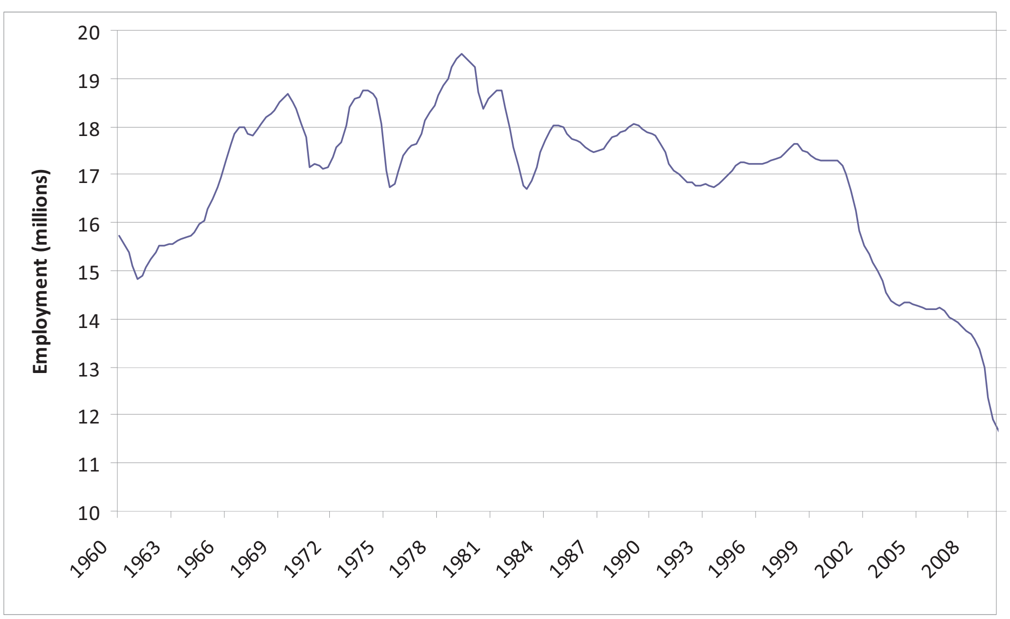
Yuskavage, Robert E., Erich H. Strassner, and Gabriel W. Medeiros. 2008. “Outsourcing and Imported Services in BEA’s Industry Accounts.” In *International Flows of Invisibles: Trade in Services and Intangibles in the Era of Globalization*, Marshall Reinsdorf, and Matthew Slaughter, eds. Chicago: University of Chicago Press, pp. 247–288.

Figure 1: The Import Share of Material Inputs Used by U.S. Manufactures



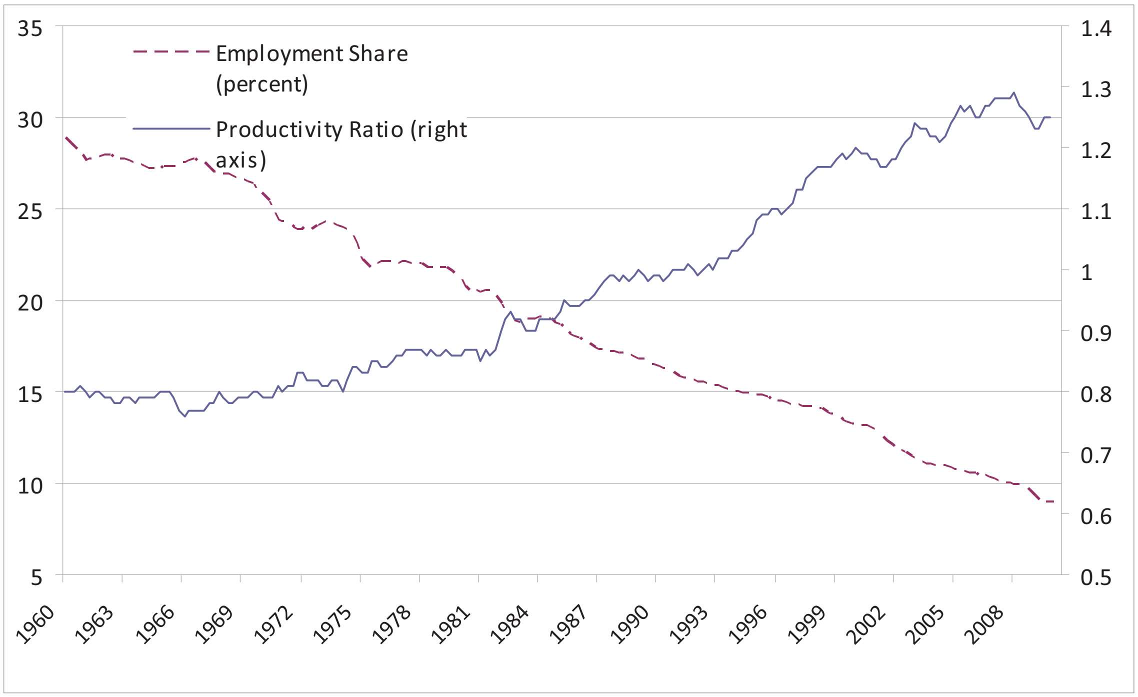
NOTE: Imported intermediates are decomposed into their source country of origin and plotted as their portion of the share of imported intermediate in total materials use by the manufacturing sector.
SOURCE: BEA Annual Industry Accounts and Import Microdata

Figure 2: Manufacturing Employment, 1960-2009



SOURCE: BLS

Figure 3: Manufacturing: Labor Productivity and Employment Relative to Total



NOTE: Productivity series is calculated as ratio of manufacturing output per worker as a fraction of total nonfarm business labor productivity. Employment share is ratio of manufacturing employment to total employment.
SOURCE: BLS

Figure 4

How Offshoring Biases an Input Price Index

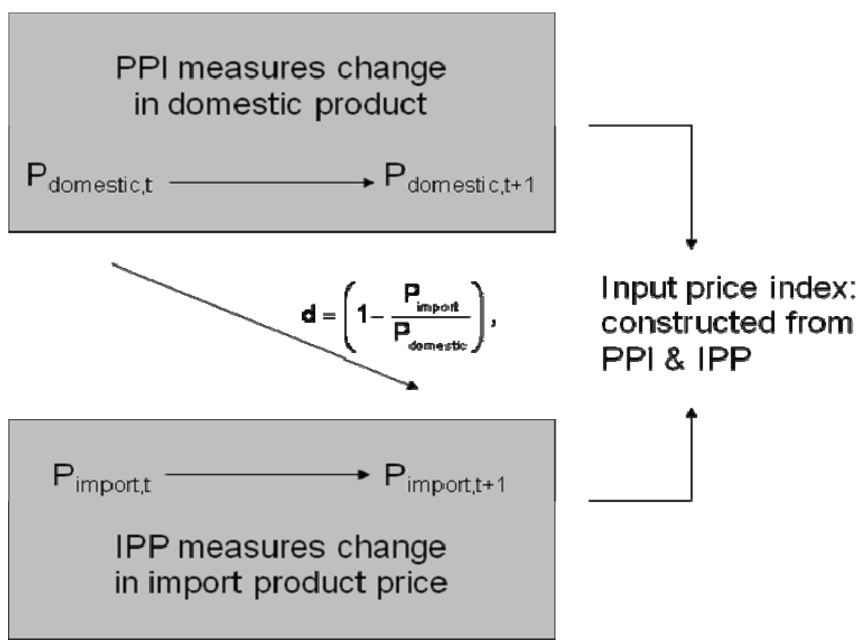
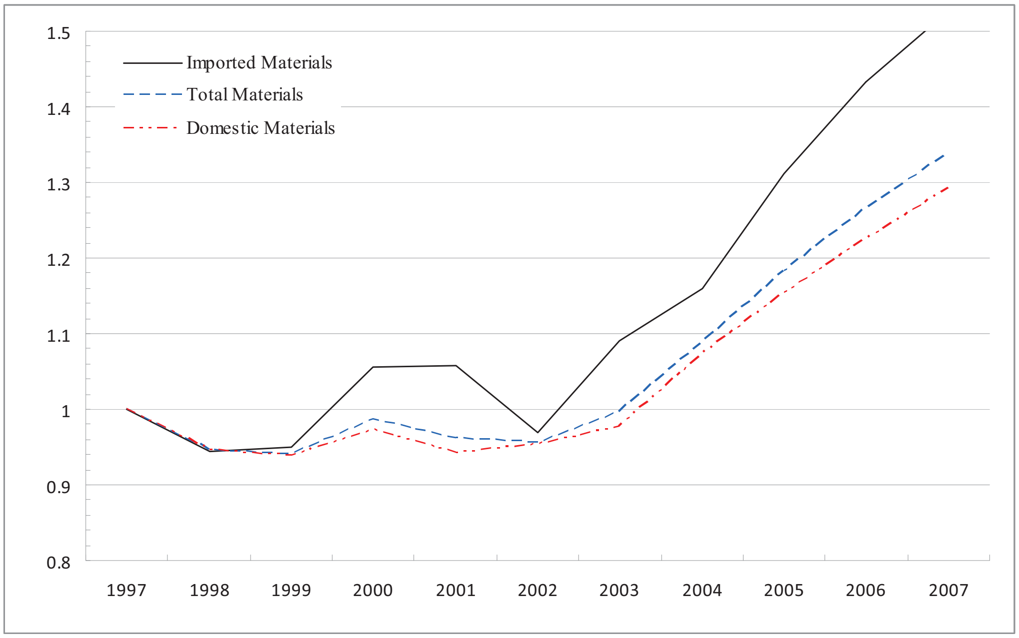
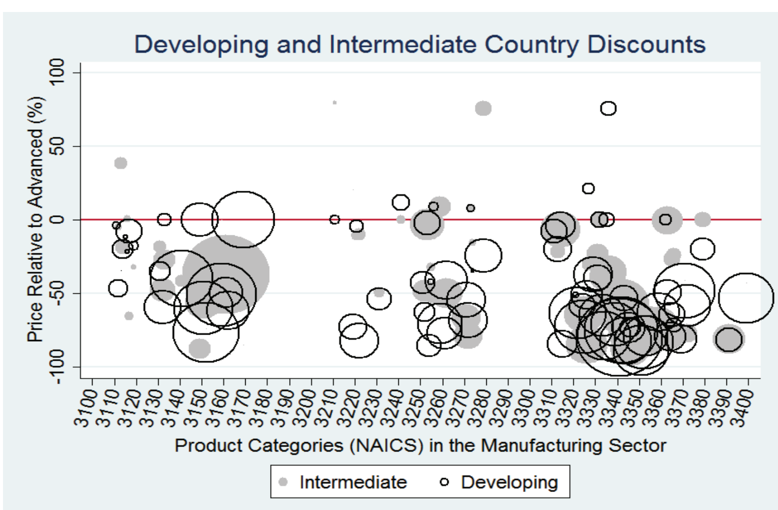


Figure 5: Baseline Input Price Indexes for the Manufacturing Sector



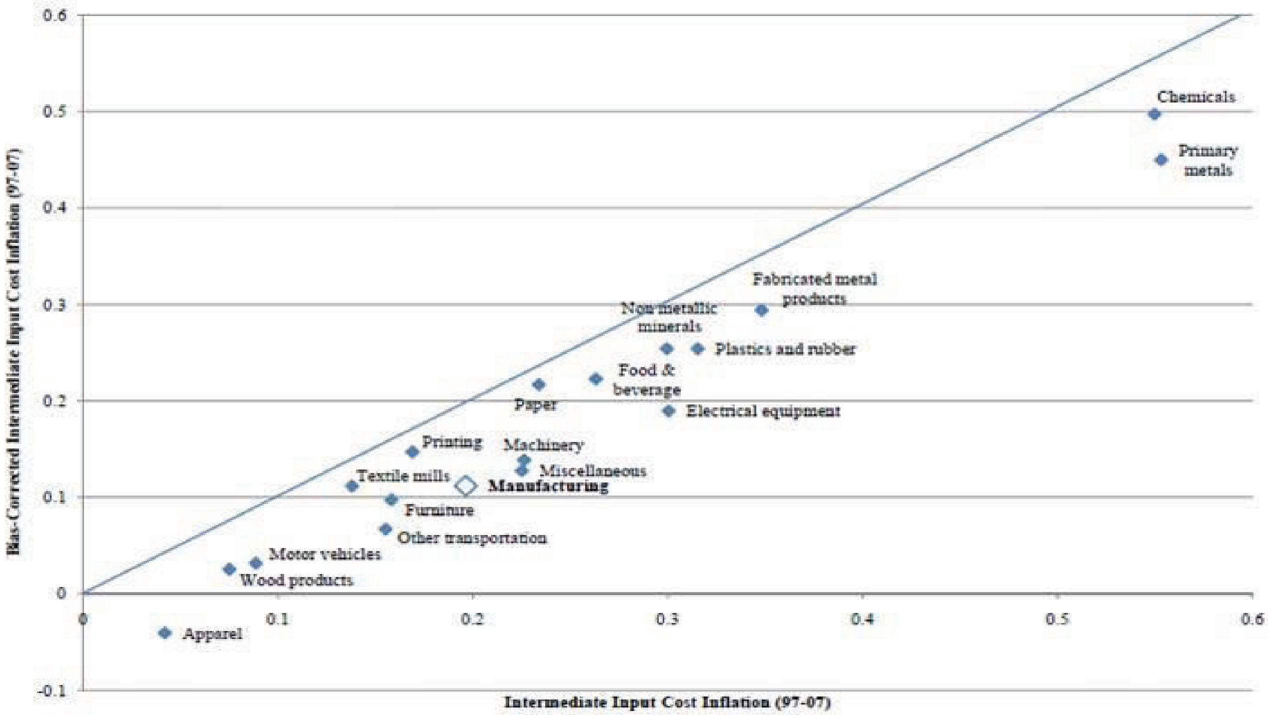
NOTE: The total materials deflator is from the BEA's Annual Industry Accounts, while the imported materials deflator is an aggregate of confidential BEA commodity price data. The implied domestic materials price deflator is computed from the total and imported materials price deflators.

Figure 6



NOTE: The import price discount for each NAICS category averages across many underlying detailed product groups classified according to the U.S. Harmonized System (HS 10-digit) for the months September 1993–May 2007. Within an HS group, the developing (or advanced) country discount is the average of individual item prices exported from developing (or advanced) countries relative to a geometric mean of advanced country transaction prices.
SOURCE: BLS

Figure 7: Materials Cost Inflation for U.S. Manufacturing Industries



NOTE: The figure contrasts the materials cost inflation as published by the BEA with an adjusted measure derived from IPP micro data and Census foreign trade shares. For each manufacturing industry, and manufacturing as a whole, cost measures are computed as the cumulative percent change between the published and hypothetical index values in 2007 and 1997. A cost inflation of 0.2, for example, represents a 20 percent increase in prices over the decade. Two industries, petroleum products, and computer and electronic components, were included in the overall manufacturing number but excluded from the charts. Petroleum products had cumulative input cost inflation of 137 percent and bias-corrected inflation of 134 percent. Computer and peripherals had input costs decline by 35 percent, 51 percent adjusted.
SOURCE: BEA, BLS, and Census.

Table 1: Sources of Growth for U.S. Manufacturing Industries, 1997–2007[1]

	Gross Output (1)	MFP2 (2)	Capital3 (3)	Labor (4)	Energy (5)	Services (6)	Purchased Materials Domestic (7)	Foreign (8)
1. Manufacturing	1.18	1.30	0.13	-0.53	-0.05	0.22	-0.19	0.28
2. Manufacturing excl. Computers and electronic products	0.46	0.69	0.11	-0.47	-0.05	0.13	-0.23	0.28
3. Durable goods:	2.00	2.02	0.17	-0.66	-0.05	0.30	-0.15	0.37
4. Computer and electronic products	7.35	6.82	0.25	-1.11	-0.05	1.05	0.04	0.35
5. Durable goods excl. Comp. & electr. products	0.77	0.95	0.15	-0.57	-0.05	0.12	-0.22	0.38
6. Nondurable goods:	0.16	0.45	0.07	-0.37	-0.04	0.14	-0.25	0.17

1. Average annual rate for period shown. Column (1) is percent change. For each row, columns (2) through (8) are percentage points that sum across columns to (1).
2. MFP is multifactor productivity. 3. Includes Non-IT equipment, IT Capital, (computers and peripheral equipment, software, and communication equipment), structures, and inventories

Table 2: Hypothetical Offshoring of "Obtanium"

	t	t+1	t+2	t+3
Domestic supplier price	$10.00	$10.00	$10.00	$10.00
Domestic quantity sold	100	90	80	70
Chinese supplier price	$6.00	$6.00	$6.00	$6.00
Chinese quantity sold	0	10	20	30
Average price paid for obtanium	$10.00	$9.60	$9.20	$8.80
Domestic input price index	100	100	100	100
Import input price index	—	100	100	100
Input index, as computed	100	100	100	100
True input price index	100	96	92	88

Table 3: Foreign Offshoring and the Bias to U.S. Multifactor Productivity and Value Added, 1997-2007

Simulation:	Baseline (1)	IPP=PPI (2)	Micro Evidence: Full Sample (3)	Micro Evidence: Switching (4)	Micro Evidence: Dev50, Int30 (5)	Micro Evidence: Dev30, Int15 (6)
Multifactor Productivity:						
1 Manufacturing	1.30	1.23	1.05	1.12	1.08	1.16
2 Manuf.excl. Comp. & electronic products	0.69	0.67	0.52	0.58	0.54	0.61
3 Durable goods:	2.02	1.87	1.64	1.73	1.67	1.77
4 Computer and electronic products	6.82	6.33	5.91	6.13	6.05	6.18
5 Durable goods excl. Comp. & electr. products	0.95	0.89	0.70	0.76	0.71	0.81
6 Nondurable goods:	0.45	0.45	0.36	0.40	0.38	0.42
Value Added:						
7 Manufacturing	3.04	2.82	2.31	2.50	2.39	2.61
8 Manuf.excl. Comp. & electronic products	0.94	0.86	0.44	0.59	0.48	0.68
9 Durable goods:	5.25	4.86	4.19	4.44	4.27	4.57
10 Computer and electronic products	22.68	21.12	19.73	20.44	20.17	20.61
11 Durable goods excl. Comp. & electr. products	1.74	1.58	1.05	1.22	1.07	1.34
12 Nondurable goods:	0.07	0.08	-0.23	-0.10	-0.15	-0.03

NOTE: Figures represent average annual percent growth in real value-added. For "IPP=PPI," imported materials are deflated with domestic deflators. For "full sample," estimates are adjusted with product-level discounts from the entire IPP micro data sample. For "switchers," the import discount is based on a sample where importers appeared to shift from suppliers in advanced counties to ones in developing or intermediate countries. "50/30" assumes discounts of 50 percent for developing countries and 30 percent for intermediate countries, while "30/15" assumes discounts of 30 percent and 15 percent respectively.