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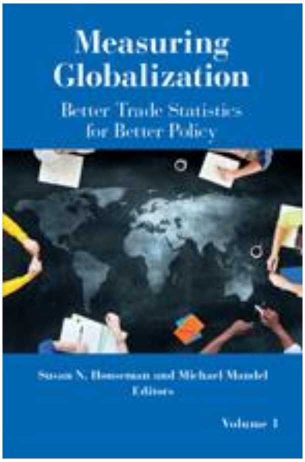

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Measuring Globalization

Better Trade Statistics for Better Policy

Volume 1

Biases to Price, Output, and Productivity Statistics from Trade

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and
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Editors

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Import Allocation across Industries, Import Prices across Countries, and Estimates of Industry Growth and Productivity

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The increased role of international trade in U.S. economic activity is evident in the headline gross domestic product (GDP) statistics. Between 1948 and 1965, the value of imports of goods and services relative to gross domestic product held steady at about 4 percent. By the end of the 1970s this ratio had grown to close to 10 percent, and it remained at about 10 percent through the end of the 1980s. Between 1990 and 2000, imports relative to GDP increased to nearly 15 percent, and they peaked at 17.9 percent of GDP in 2008. During the events surrounding the financial crisis in 2009 and 2010, imports fell relative to GDP, but the value of imported goods and services relative to GDP bounced back to 17.6 percent of GDP in 2011.

While the trend of increased reliance on imports within the U.S. economy is clear, the uses of these imports within the economy are subsumed in the aggregate data. Given the published level of detail in the National Income and Product Accounts (NIPAs), which measure GDP from the expenditure side, it is difficult to analyze major questions about the economic impact of increased imports on the economy. More importantly, it is not possible to quantify how imports are used by industries in their production processes, and how these substitutions affect the economy as a whole. The most-often-studied economic impacts are the effects of increased globalization on U.S. labor markets and industry competitiveness.

The economic impact of imports depends on how the imports are used. For example, a particular import could be made for any of three purposes: 1) for direct consumption by households, 2) for a select group of industries as an intermediate input, or 3) for a broad set of industries as a substitute for goods that are already produced domestically. While each of these scenarios has ramifications for the production and labor-market decisions of U.S. producers, as well as for U.S. industry competitiveness, the implications across the economy may be significantly different. In one case, an import may be a close substitute for a good that is *used* by only one industry. In this case, not only are the U.S.-based suppliers of the competitive good affected, but the suppliers to the original domestic producers are affected as well, through reduced demand for their production of intermediate goods. In another case, an import may be a substitute for a good that is *produced* by only one industry. In this case, the production of the industry itself is affected, as are all of the suppliers that sell to the producing industry, and all of the industries that produce similar products and face new competition. Thus, analyzing the overall impact of imports on the U.S. economy requires a set of transaction data that accounts for interindustry linkages.

Empirical research on the effects of increasing imports on the U.S. economy has focused both on the broad economic impact of increased trade and on the industry-specific effects. A large body of research has examined the impact of increased trade on wages in the United States. For example, Feenstra and Hanson (1999) argue that, depending on the specification, outsourcing accounted for between 15 and 40 percent of the increase in the nonproduction-to-production relative wage rate between 1979 and 1990. Lawrence and Slaughter (1993) argue that international trade did not play a major role in the slow growth of real hourly compensation in the United States between 1973 and 1991, but Haskel et al. (2012) conclude that the effects of globalization on the labor market became more important in the early 1990s. Eldridge and Harper (2012) econometrically estimate the impact of imports on production processes in the manufacturing sector, while Kurz and Lengermann (2008) and Yuskavage, Strassner, and Medeiros (2008) analyze the contribution of offshoring to economic growth in the United States.

Analyzing the effects of imports across industries on the economy requires data on the use of imports by industry and by type of import. Houseman et al. (2011) argue that measurement issues related to imports result in an overstatement of growth in the official statistics on value-added and productivity growth in the manufacturing sector, a conclusion that may also have implications for economic research that relies on this type of data.

Two major issues related to assembling the data necessary to analyze the effects of increasing imports on the U.S. economy are that 1) imports used by industry and categorized by detailed type of import are not available at the necessary level of detail in the source data, and 2) shifts to lower-cost suppliers of imports are not captured in the price data, according to Houseman et al. (2011).

These two data issues are directly related to a primary objective of the Industry Directorate at the Bureau of Economic Analysis (BEA). Two major functions of the directorate are the production of estimates of 1) value-added growth by industry and 2) industry value-added contributions to aggregate growth; the directorate also estimates price and quantity inputs used by industry. When an import, at the level of detail in which the accounts are constructed, cannot be treated as a perfect substitute for the domestically produced good, either because of a lower price for the same good or because of quality or compositional differences, the estimation of real value-added at the industry level requires estimates of the value of imports used by industry by type of import, as well as estimates of each import's respective price.

As the body of research on the economic impact of globalization grows, these measurement issues have come to the forefront. Feenstra and Romalis (2012) construct a trade model that incorporates product quality and produces a quality-adjusted set of import and export prices to be used in the new generation of the Penn World Table. In Chapter 4 of this volume, Bridgman analyzes how to adjust import prices for quality differences in the presence of fixed market entry costs. Motivated by Houseman et al. (2011), Inklaar, in Chapter 6 of this volume, estimates the impact of import sourcing bias on 38 major economies over the 1995–2008 period.

In this chapter, we provide an overview of the role of imports in current measurement practices at the BEA in constructing estimates of value-added growth by industry. We compare these baseline accounts to alternative estimates that differ in their approach to estimating imported goods purchased as intermediate inputs. In particular, using broad economic categories (BEC), we employ a two-step approach to produce an alternative industry import-use matrix that underlies the estimates of the quantity index of intermediate inputs used across industries in the U.S. economy between 1998 and 2011. We also examine the import price data and, based on Inklaar (see Chapter 6), analyze an alternative price covering 2002–2011 that treats switches in sourcing between exporting countries as switches to goods with different prices, as opposed to switches to a heterogeneous good. In contrast to Inklaar, we present results at the industry level.

Overall, we frame the analysis in the context of an industry-level production account that provides the sources of U.S. economic growth across industries, factors of production, and multifactor productivity. Our approach focuses on the measurement of imported goods, but it also analyzes the impact on all industries within the economy that purchase these goods. We use the industry production account and growth accounting techniques to compare the baseline case of current practice to three alternatives: 1) an alternative import-use matrix for 1998–2011, 2) an alternative set of import prices for 2002–2011, and 3) both the alternative import-use matrix and the alternative set of import prices for 2002–2011.

Our major findings are as follows:

- Compared to the standard import proportionality assumption, the use of broad economic categories to allocate imports to intermediate inputs produces noticeably different distributions for many commodities, but this does not translate to significantly different import shares of intermediate inputs across most industries.
- The alternative assumptions we consider on import use and import prices have only a small impact on measures of aggregate real value-added and multifactor productivity growth. Over the 1998–2011 period, value-added grew by 1.87 percent a year in the baseline and by 1.87 percent a year based on the alternative import allocation. For the 2002–2011 period, aggregate value-added increased by 1.38 percent a year in the base-

line compared with a range of between 1.34 and 1.37 percent under the alternatives. Over the same period, multifactor productivity (MFP) increased by 0.42 percent a year in the baseline compared with a range of between 0.38 and 0.41 percent a year under the alternatives.

- The impact on real value-added and MFP for the manufacturing sector is also small: over the 2002–2011 period, manufacturing contributed 0.22 percentage points a year to aggregate value-added growth in the baseline, compared with a range of between 0.20 and 0.21 percentage points a year under the alternatives.
- For manufacturing excluding "Computer and electronic products," value-added growth was −0.13 percent a year between 2002 and 2011 in the baseline and ranged from −0.21 to −0.16 percent a year under the alternatives.

The chapter proceeds along the following outline: In Section Two, "The BEA Industry Accounts and the Role of Imports," we provide an overview of the current measurement practices in the BEA industry accounts, including the approach to accounting for imports across industries and their prices. In Section Three, "Alternative Import Allocation Using Broad Economic Catagories," we discuss our alternative import-use matrix, while in Section Four, "Import Prices and Country-Pooled Import Prices," we discuss the alternative set of import prices. Section Five, "Value-Added and Productivity under Alternative Import Assumptions," gives our results for the sources of U.S. economic growth under the baseline and alternative assumptions, and Section Six presents the conclusion.

THE BEA INDUSTRY ACCOUNTS AND THE ROLE OF IMPORTS

A major objective of the Industry Directorate at the Bureau of Economic Analysis is the production both of estimates of gross domestic product by industry and of estimates of contributions of industry GDP to aggregate GDP growth.[1] These measures of value-added by industry, which are published at the 65-sector level, require nominal values, prices, and quantities of industry output and intermediate input over time that are consistent with GDP measured from the expenditure side as part of the NIPAs. Real value-added is calculated using the double deflation method, so that real value-added growth is the difference between the growth rate of industry output, deflated by the appropriate output deflator, and the growth rate of industry input, deflated by an industry input deflator that reflects the heterogeneity of the input use of the industry. Mayerhauser and Strassner (2010) provide a complete description of the methodology used to construct the time series of industry accounts.

The starting point for the published time series of industry accounts is the benchmark input-output account produced approximately every five years. The most recent published version covers the year 2002 and is described by Stewart, Stone, and Streitwieser (2007). This account, while published at about the 550-industry level, is constructed at about the 900-industry level and the 5,000 "item," or product, level, and relies heavily on data tabulated by the Census Bureau from the quinquennial Economic Census.

As imports to the U.S. economy continue to grow, the treatment of import measurement in the GDP by industry accounts has garnered attention. For example, Houseman et al. (2011) argue that the current treatment of import prices may lead to an offshoring bias in estimates of industry value-added, especially for industries concentrated in the manufacturing sector.

Conceptually, imports are treated as heterogeneous items and distinct from domestically produced items in order to allow for price differences between foreign and domestically produced goods that are purchased as intermediate inputs. That is, at the item level, the import and the domestic commodity are treated as differentiated goods, whether because of the cost of the item, the quality of the item, or the composition of goods within the item category; thus, imports are allowed to have prices that differ from the domestically produced item. An important measurement difficulty is that the value of imports by item by industry is not measured directly.

The BEA uses the import proportionality, or comparability, assumption to allocate the value of imports by item by industry. This approach is discussed in Mayerhauser and Strassner (2010); Moyer, Reinsdorf, and Yuskavage (2006); Strassner, Yuskavage, and Lee (2010); and Yuskavage, Strassner, and Medeiros (2008, 2009). The proportionality method assumes that each industry that purchases an item for intermediate use purchases an amount from a foreign supplier that is in the same proportion as the ratio of imports to domestic supply for that item. In other words, the imported portion of intermediate inputs by industry is homogenous at the item level for each industry that purchases that particular item. This homogeneity is imposed only at the 900-industry-by-5,000-item level, not at higher levels of aggregation.

It is worth noting a couple of aspects of the treatment of imports in calculating GDP by industry. First, the import proportionality assumption does not affect the estimates of nominal value-added by industry. This is because the import proportionality assumption does not determine the level of use of an item by an industry; it only determines the share of an item used by an industry that belongs to imported intermediate use, for the purpose of deflating intermediate use by the appropriate price index in constructing real value-added. Second, if at the item level domestically produced and imported goods are assumed to be homogeneous, or perfect substitutes, import and domestic prices change at the same rate, and there is no need for a separate treatment of imports in calculating real value-added growth.

The allocation of intermediate inputs to domestic versus foreign sources allows the BEA to incorporate the full suite of price statistics available within the U.S. economic statistical system. The Bureau of Labor Statistics' (BLS) producer price indexes are the primary source used to deflate the domestic portion of intermediate inputs. These prices are the same as those used to deflate the commodity composition of gross output by industry. In other words, each industry that purchases a domestic item pays the same price for that item. Table F in Washington et al. (2012) provides the principal sources of data used to deflate gross output by industry and the domestic portion of intermediate inputs by item. BLS import price indexes (MPI) are used to deflate the imported portion of intermediate inputs by item, also with the assumption that each industry that purchases imported inputs pays the same price for the imported intermediate input. Both the Producer Price Indexes (PPIs) and the MPIs are used at their most detailed levels available: PPIs range mostly from four- to seven-digit detail; NAICS MPIs are more aggregated—typically these indexes are available only for two- to four-digit detail. To deflate a small subset of items, the BEA uses prices from the National Income and Wealth Division at the BEA.

ALTERNATIVE IMPORT ALLOCATION USING BROAD ECONOMIC CATEGORIES

Our alternative approach to allocating commodity imports across industries is motivated by the World Input-Output Database (WIOD) method of Timmer (2012). The WIOD approach deviates from the import proportionality assumption by first assigning imports to one of three BECs: 1) intermediates, 2) final consumption, or 3) investment. The second step is to proportionally allocate imported intermediate inputs across industries after this initial split has been applied. It is worth noting that this approach is purely an alternative allocation, and no new data are used to give additional detail on actual use of different types of imports by industry.[2]

For the first step in this exercise, our objective is to construct a share for each imported item in the BEA industry accounts that reflects its broad economic classification. Specifically, for each imported item in the BEA industry accounts and each year, we estimate the share of the item that is sold to intermediates, consumption, and investment based on a concordance between harmonization codes and BEC categories. Our objective is not to construct new estimates of trade flows but to reallocate current estimates of trade flows. This preserves consistency with the NIPA trade data. Once we have item-level BEC shares, we apply these shares to estimate the value of each item sold to intermediate input. The second step is to allocate this total value of imported intermediate input across industries.

We use the concordance between the harmonized trade data and broad economic categories that is published by the United Nations to do the initial allocation of imports to the three broad groups.[3] The harmonized trade data are at the 10-digit level, while the harmonization code for BEC concordance is at the six-digit level. Because of the different levels of detail, we first assume that for each of the six-digit commodities in the harmonization code to BEC mapping, the 10-digit components have the same broad economic category.[4] This gives us the value of imported goods by broad economic classification at the 10-digit level for all of the components of the harmonized trade data.[5] To go from the 10-digit harmonized data by broad economic classification to the BEA's item-level detail, we apply the Industry Directorate's mapping between harmonization codes and items to get the value of items by broad economic classification, based on the harmonized trade data.[6] We use these import values by item and broad economic category to construct the share, by BEA item, that was sold to intermediate input. We apply this value share to the current estimates of imports by item in the BEA industry accounts to derive an alternative value of imports that were sold to intermediate use. Finally, we allocate this total imported intermediate proportionally by item across industries to yield the import-use matrix. Because the harmonized trade data cover mostly goods, we exclude any adjustments to nongoods items. We apply the above methodology for years 1998–2011 so that the results are consistent with the GDP-by-industry estimates published in November 2012. For the sake of clarity, the following nine steps enumerate how we construct our alternative import-use table:

1) Compile concordances between the six-digit harmonization code trade data and the United Nations–based broad economic categories covering 1998–2011.
2) Construct a map from 10-digit harmonization data to six-digit harmonization codes.
3) Aggregate the 10-digit harmonization trade data on imports to the six-digit level.
4) Apply the six-digit harmonization code to the BEC concordance to get estimates at the six-digit level of the values sold in the intermediate, final consumption, investment, or undetermined categories.[7]
5) Assume that the allocation for the 10-digit components of the harmonization code data is the same as for the 6-digit allocation to obtain values sold in the intermediate, final consumption, investment, or undetermined categories at the 10-digit harmonization level.
6) Allocate the 10-digit values to BEA item codes using the existing internal BEA mapping. Note that a 10-digit code may apply

to multiple items, and a single item may be made up of multiple 10-digit coded values.

7) Based on the results from Step 6, construct the share of each BEA item that was sold to intermediate input.
8) Use the baseline item-level import data as a control and distribute the value that was sold to intermediate input using the shares of values calculated in Step 7.
9) Allocate imports across industries.
   - For items that have a portion that goes to intermediate input according to UN Comtrade, allocate items across industries using the proportionality assumption. This is the two-step approach of Timmer (2012).
   - For items that have an undetermined allocation, revert to the standard proportionality assumption.
   - For items that have a BEC coding of "capital good," revert to the standard proportionality assumption.[8]

The impact of the BEC allocation of imports on estimates of GDP by industry depends on three basic elements. The first is that the value of trade by item that belongs to intermediate input based on the BEC allocation must be different from that based on the baseline import proportionality assumption. A different allocation of imports translates to a different nominal value of imported goods used by industries that buy a particular item. Second, the price of imported items must differ from prices paid for domestic goods. And third, the value share of imports used in production within an industry must be significantly different under the BEC allocation. The third condition is important, because while the BEC allocation may produce a different allocation of inputs for a particular item, if the value share of total imports in a particular industry's production is relatively unchanged as a result of the new allocation across all commodities used by the industry, the BEC-based allocation will have very little impact on estimates of value-added growth by industry.

Table 8.1 compares the share of imports allocated to intermediate input by commodity based on the alternative import allocation to the baseline approach of applying the import proportionality assumption. The level of aggregation corresponds to that published in the annual input-output accounts, although, as described above, the import allocations are estimated at the item level. Differences in estimated allocations have the potential to affect estimates of value-added growth for any industry that purchases that particular commodity. The difference in allocations between the baseline and BEC-based allocation reflects the binary assignment of an import to either an intermediate or final demand in the BEC mapping; it also reflects the item-level component allocations from the import proportionality assumption. For example,

Table 8.1 Share of Imports Allocated to Intermediate Inputs by Commodity, 2007

	Baseline	BEC-based allocation	Difference (absolute value)
Forestry, fishing, and related activities	0.85	0.24	0.61
Utilities	0.45	1.00	0.55
Food and beverage and tobacco products	0.48	0.13	0.35
Textile mills and textile product mills	0.53	0.37	0.16
Publishing industries (includes software)	0.15	0.02	0.14
Chemical products	0.51	0.64	0.14
Miscellaneous manufacturing	0.16	0.28	0.12
Plastics and rubber products	0.72	0.83	0.11
Printing and related support activities	0.82	0.72	0.11
Farms	0.56	0.48	0.08
Apparel and leather and allied products	0.10	0.02	0.08
Electrical equipment, appliances, and components	0.55	0.61	0.06
Machinery	0.42	0.48	0.06
Furniture and related products	0.15	0.10	0.04
Computer and electronic products	0.36	0.39	0.03
Fabricated metal products	0.82	0.84	0.03
Motor vehicles, bodies and trailers, and parts	0.31	0.33	0.02
Other transportation equipment	0.51	0.52	0.01
Paper products	0.93	0.92	0.01
Mining, except oil and gas	0.99	1.00	0.01
Wood products	0.92	0.93	0.01

SOURCE: Bureau of Economic Analysis (BEA) and authors' calculations.

within the "Forestry, fishing, and related activities" commodity, the BEC-based approach allocated 98 percent of commercial fishing to final demand, while the baseline allocated 20 percent.

The largest differences in import allocation are for the "Forestry, fishing, and related activities" commodity and the "Utilities" commodity, for each of which the share of imports allocated to intermediate inputs differs by more than 50 percentage points. The next largest difference is for "Food and beverage products," where the item-level import proportionality assumption allocated 48 percent to intermediate purchases, while the BEC approach allocated only 13 percent, a difference of 35 percentage points. Next, there are differences in allocations of between 10 and 16 percentage points for the following categories: "Textile mills and textile product mills," "Publishing industries (includes software)," "Chemical products," "Petroleum and coal products," "Miscellaneous manufacturing," "Plastics and rubber products," and "Printing and related support activities." Allocation differences of between 5 and 10 percentage points exist for "Farms," "Apparel and leather and allied products," "Electrical equipment appliances and components," and "Machinery." The remainder of the commodities show minor differences or none at all in import allocation. Recall that we restrict our alternative import data to only goods.

While there are some large differences in import allocations across intermediate and final use, the impact of the alternative allocations depends on the particular imports by an industry and on the value of imported goods relative to the use of goods produced domestically. For example, if an industry relies heavily on chemical products relative to all other inputs, a change in the estimated share of imported goods used in production has the potential to have a significant impact on estimates of the growth of that industry's intermediate input, and thus on that industry's value-added growth. Table 8.2 gives the share of imported intermediate inputs relative to total intermediate inputs based on the baseline and the BEC allocations. Based on the baseline allocation, 15 percent of the inputs in "Miscellaneous manufacturing" are imported, while according to the BEC mapping, 26 percent are imported. The "Food services and drinking places" category differs by 5 percentage points across allocations, and "Ambulatory health care services," "Food and beverage and tobacco products," and "Nonmetallic mineral products" all differ by 4 percentage points. The alternative allocation

Table 8.2 Share of Imports in Total Industry Intermediate Use, 2007

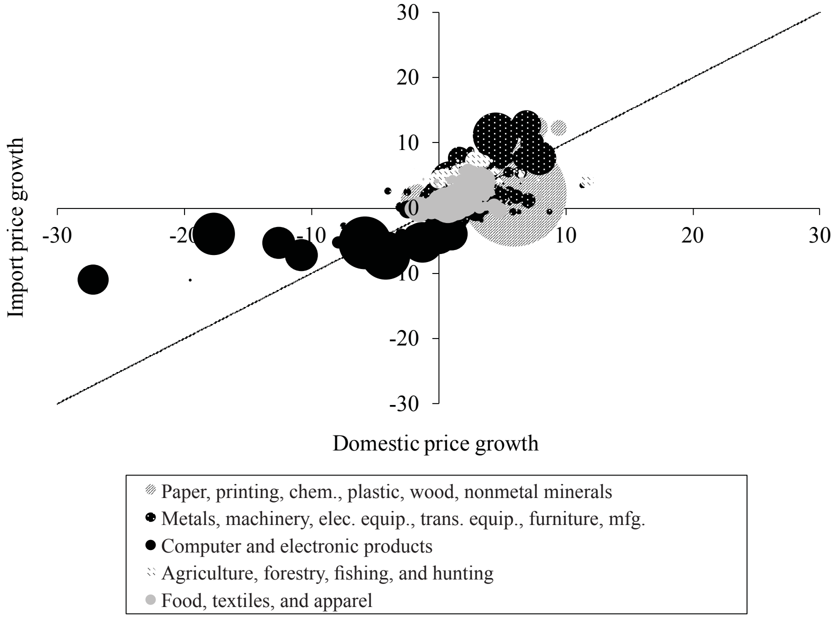
	Baseline	BEC-based allocation	Difference (absolute value)
Miscellaneous manufacturing	0.15	0.26	0.11
Food services and drinking places	0.09	0.04	0.05
Ambulatory health care services	0.08	0.12	0.04
Food and beverage and tobacco products	0.10	0.06	0.04
Nonmetallic mineral products	0.10	0.14	0.04
Computer and electronic products	0.23	0.26	0.03
Furniture and related products	0.19	0.17	0.03
Social assistance	0.06	0.04	0.02
Printing and related support activities	0.12	0.10	0.02
Other transportation equipment	0.19	0.21	0.02
Motor vehicles, bodies and trailers, and parts	0.23	0.25	0.02
Mining, except oil and gas	0.09	0.11	0.02
Federal general government	0.14	0.15	0.01
Amusements, gambling, and recreation industries	0.06	0.05	0.01
Wholesale trade	0.08	0.09	0.01
Accommodation	0.06	0.05	0.01
Textile mills and textile product mills	0.17	0.16	0.01
Machinery	0.19	0.19	0.01
State and local general government	0.08	0.08	0.01
Educational services	0.05	0.04	0.01
Electrical equipment, appliances, and components	0.20	0.21	0.01
Forestry, fishing, and related activities	0.12	0.13	0.01
State and local government enterprises	0.07	0.08	0.01
Chemical products	0.15	0.16	0.01
Hospitals and nursing and residential care facilities	0.06	0.07	0.01

SOURCE: Bureau of Economic Analysis (BEA) and authors' calculations.

made very little or no difference for the remainder of the industries at the published level.

As mentioned above, for the allocation of imports based on BECs to produce different estimates of value-added growth by industry, the price of imported goods must be different from the price used to deflate purchases from U.S suppliers. Figure 8.1 plots the item-level price growth of imported versus domestically produced goods, excluding "Mining except oil and gas" and "Petroleum and coal products,"

Figure 8.1 Item-Level Price Growth (%), 1998–2011



NOTE: This figure plots import price growth by item between 1998 and 2011 versus domestic price growth for prices used in the industry accounts. Area of marker determined by value of imports in 2007.
SOURCE: BEA GDP by Industry accounts.

weighted by the import values of the individual items relative to other items in the same aggregated commodity. The figure indicates that, in general, there are item-level price differences between imported and domestic goods. Thus, the allocation of intermediate input between domestic and foreign is a potentially important element in estimating value-added growth by industry.

Comparing import and domestic prices at the detailed level limits compositional effects at higher levels of aggregation. For example, the price indexes for total imported intermediate materials and total domestic intermediate materials reflect the compositional differences in types of materials that are imported versus purchased from domestic sources. At the item level, skewness above the 45-degree line would indicate a disproportionate number of cases where import prices increased relative to domestic prices. The data indicate that, at the item level, about 62 percent of the items are assigned import prices that fell relative to their domestic counterparts over the 1998–2011 period.

Tables 8.1 and 8.2 indicate that the allocation of imports between final demand and intermediate input is noticeably different based on the BEC coding, but that the import share of inputs is not significantly different for most industries under the BEC coding. To estimate the effect of the BEC allocation on measured value-added growth at the industry level requires taking into account these effects, in addition to the price differences between domestic and foreign goods. We do this analysis below in the context of an industry-level production account covering 1998–2011.

IMPORT PRICES AND COUNTRY-POOLED IMPORT PRICES

Recent literature has argued that the prices used in estimating GDP by industry may be biased. Specifically, Houseman et al. (2011) contend that switches to low-cost providers are excluded from the index number estimate of the intermediate input price at the time of the switch, leading to an overstatement of the growth in value-added quantity indexes in manufacturing industries. Inklaar, in Chapter 6 of this volume, argues that a portion of the bias can be analyzed by assuming that imports across countries are perfect substitutes. It is worth noting that in our exercise below, we do not consider the index number problems that occur when product sourcing is switched between domestic and foreign sources, which is a major focus of Houseman et al. We focus on switches between foreign suppliers.

We follow the basic approach used in Inklaar (see Chapter 6) to construct alternative import prices that we refer to as country-pooled import prices. The rationale for this adjustment is that import source switches between high-priced and low-priced exporting countries may not be captured in the official import price data because the same good from different countries has the potential to be treated as a different good. Thus, the import price index for an item needs to “link in” the switch to the new provider, instead of treating the new lower price paid in the initial year of the switch as a lower price paid for the same good.

For example, if a low-cost Chinese semiconductor producer enters the market and an importer switches from Japan to China, treating the semiconductors as homogenous would result in a price index that declines to reflect the price discount. On the other hand, if the semiconductor from China was treated as heterogeneous, there would be no period $t - 1$ price to use to calculate the price decline in the semiconductor from China, so this observation would, effectively, be dropped from the estimation of the import price.

We use data from UN Comtrade that include the value (V_{ic}) and quantity (Q_{ic}) of imports of type by six-digit harmonization codes from 2002 to 2011 into the United States from Country c.[9] Unfortunately, while data exist for earlier years, the relationship between the Comtrade-based and official prices deteriorates in years prior to 2002.[10] We map imports by country by year to the level of detail for which the BEA has import price information from the BLS and construct two alternative price indexes for item i.[11] The first is

$$\Delta \ln pf_i = \sum_c \overline{w_{ic}} \Delta \ln pf_{ic} ,$$

where pf_i is the item-specific import price, c indexes country, and $\overline{w_{ic}}$ is the average value share of imports of type i from Country c in periods t and $t - 1$, so that pf_i is a Törnqvist price index. Assuming that items are perfect substitutes across countries yields an alternative price for item i :

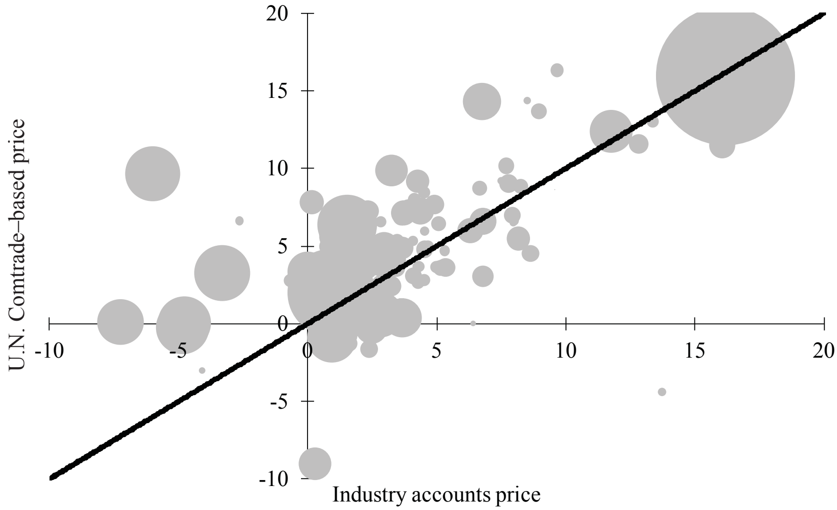
$$\Delta \ln pf_{alt,i} = \Delta \ln \left(\frac{\sum_c V_{ic}}{\sum_c Q_{ic}} \right) .$$

The annual adjustment, which we refer to as country-pool adjustment, is defined as $\Delta \ln B_i = \Delta \ln pf_i - \Delta \ln pf_{alt,i}$ for each imported item and captures the difference in item-level prices under the two alternative assumptions. We apply this bias adjustment to the baseline import prices used in the construction of GDP by industry at the item level. The approach of adding the bias to the baseline prices used in the construction of GDP by industry allows the import prices to maintain the existing adjustments to hold quality fixed. This is particularly important for information technology goods, which exhibit rapidly changing product characteristics. The relationship between the UN Comtrade–based prices and the import prices used in the industry accounts is given in Figure 8.2.

VALUE-ADDED AND PRODUCTIVITY UNDER ALTERNATIVE IMPORT ASSUMPTIONS

In this section, we analyze how the alternative approaches to imports affect measured value-added and productivity growth at the industry and aggregate level. We use an industry-level production account that includes nominal values, along with prices and quantities for industry output and inputs. The account used here covers 1998–2011 and is an updated version of Fleck et al. (2012), which covers the 63 industries

Figure 8.2 Item-Level Price Comparison: Price Growth (%), 2002–2011



NOTE: This figure plots growth of the Törnqvist index of UN Comtrade–based prices by item versus import prices used in the industry accounts. Area of marker determined by value of imports between 2002 and 2011.

SOURCE: Author calculations, based on BLS import prices and Comtrade data, as described in text.

that are published in the BEA's GDP-by-industry data.[12] This section discusses the pertinent accounting details, but we refer the reader to Fleck et al. (2012) for detail on the data sources and methods.

Industry-Level Production Account

The fundamental equation for analyzing the industry sources of growth is the equation defining multifactor productivity (MFP) as the residual after subtracting from industry output growth ($\Delta \ln Q_j$) the weighted growth rates of industry capital ($\Delta \ln Q_{Kj}$), labor ($\Delta \ln Q_{Lj}$), and intermediate inputs ($\Delta \ln Q_{Xj}$):

$$(8.1) \quad \Delta \ln MFP_j \equiv \Delta \ln Q_j - \overline{w_{Kj}} \Delta \ln Q_{Kj} - \overline{w_{Lj}} \Delta \ln Q_{Lj} - \overline{w_{Xj}} \Delta \ln Q_{Xj}$$

where the weights are the average of period t and $t - 1$ value shares of each of the inputs in the value of output, which is the typically used Törnqvist index of MFP.

To analyze the industry contributions to aggregate value-added growth, we appeal to the translog production possibility frontier analyzed in Jorgenson et al. (2007):

$$(8.2) \quad \Delta \ln V = \sum_j \overline{w_j} \Delta \ln V_j \ ,$$

so that aggregate value-added growth $\Delta \ln V$ is a translog index over industry value-added growth rates $\Delta \ln V_j$. Because the quantity index of industry value-added $\Delta \ln V_j$ is not directly observable, we appeal to the nominal accounting identity that says the value of gross output equals nominal value-added plus nominal intermediate input. Differentiating this accounting identity with respect to time and taking a discrete time approximation yields a Törnqvist index for the growth rate of industry gross output:

$$(8.3) \quad \Delta \ln Q_j = \overline{w_{Vj}} \Delta \ln V_j + \overline{w_{Xj}} \Delta \ln Q_{Xj} \ ,$$

which, solving for $\Delta \ln V_j$, yields an estimate of industry value-added growth. This approach to estimating value-added growth is typically referred to as the double deflation method because it allows for separate price deflators for output and intermediate input.

To analyze the industry sources of growth at the aggregate level, we combine Equations (8.1), (8.2), and (8.3) to yield a decomposition of aggregate value-added growth:

(8.4)

$$\Delta \ln V = \sum_j \overline{w_j} \frac{\overline{w}_{K,j}}{\overline{w}_{V,j}} \Delta \ln Q_{Kj} + \overline{w_j} \frac{\overline{w}_{L,j}}{\overline{w}_{V,j}} \Delta \ln Q_{Lj} + \overline{w_j} \frac{1}{\overline{w}_{V,j}} \Delta \ln MFP_j$$

which gives aggregate economy value-added growth as the weighted industry contributions of capital, labor, and MFP to industry output growth. We define

(8.5) $$\Delta \ln MFP_{Agg} \equiv \sum_j \overline{w_j} \frac{1}{\overline{w}_{V,j}} \Delta \ln MFP_j$$

and refer to this as aggregate MFP growth.[13] We call $\overline{w_j} \frac{1}{\overline{w}_{V,j}} \Delta \ln MFP_j$ the industry contribution to aggregate MFP, or Domar-weighted MFP growth.[14] The industry production account framework allows us to analyze contributions of industries and sectors to aggregate growth and productivity. The aggregate sector classification scheme that we use is based on the classification scheme in Jorgenson and Schreyer (2013).

Import Measurement and Growth Accounting

Our analysis of the treatment of imports in the industry accounts reduces to alternative estimates of Q_{Xj}, which is the quantity index of intermediate inputs used by industry. Intuitively, the three reasons why Q_{Xj} differs under the alternatives are as follows:

1) With an alternative allocation of imports by broad economic category, the share of intermediate use by industry by item that is imported now reflects the information available in the BEC mapping; this division of use by industry by item across domestically produced and imported items then is deflated by either the domestic or the import price. In other words, under the alternative, the share of imports is different, and this new share is deflated by the import price index.

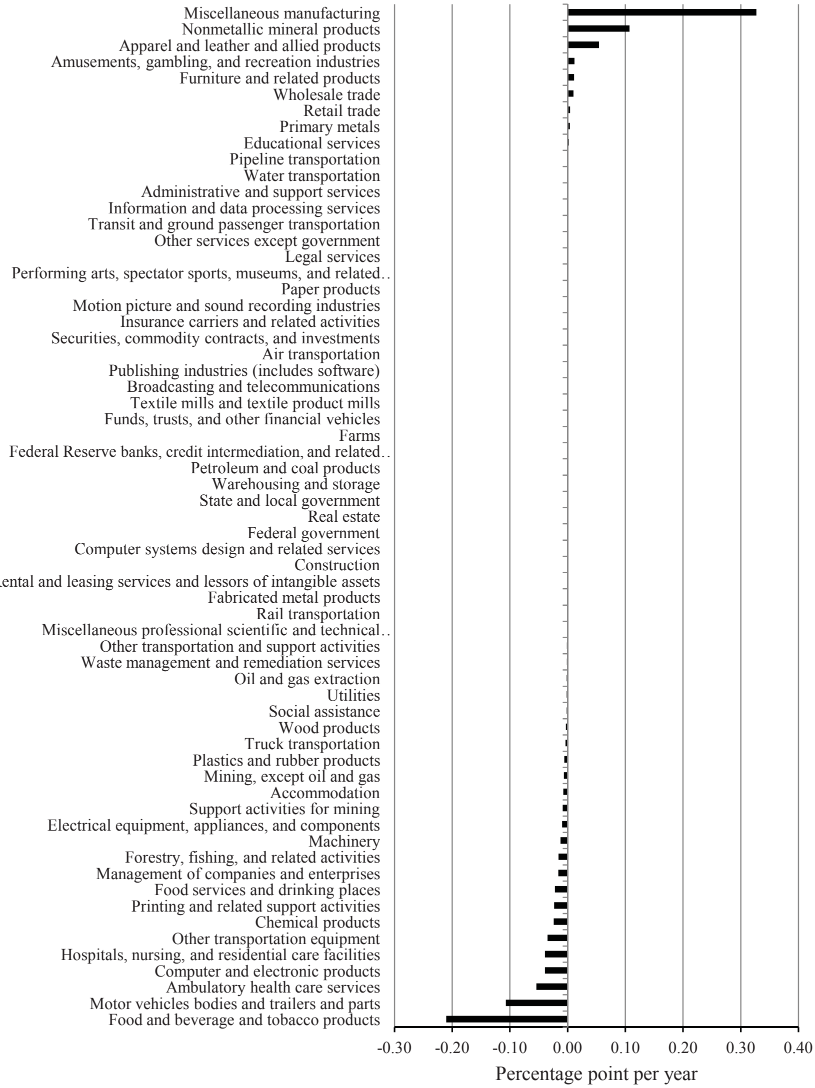
2) The value of imports is deflated by an alternative price index, thus yielding a different quantity.
3) Both an alternative estimate of the value of imports by item by industry (Reason 1) and an alternative price index (Reason 2) contribute to yielding a different quantity.

The three treatments of imports lead us to define alternative estimates of Q_{Xj} that feed through our exercise by means of Equation (8.1); the first uses the BEC-based allocation, the second uses the country-pooled import prices, and the third uses both the BEC allocation and the country-pooled price. Based on Equations (8.1) through (8.5), we define the alternative estimates of value-added growth and its sources. Equation (8.3) yields three alternative estimates of value-added growth by industry: $\Delta \ln V_{j,Alt1} \ldots \Delta \ln V_{j,Alt3}$. Equation (8.1) gives alternative estimates of MFP growth by industry: $\Delta \ln MFP_{j,Alt1} \ldots \Delta \ln MFP_{j,Alt3}$. Based on Equation (8.2), there are three alternative estimates of aggregate value-added growth: $\Delta \ln V_{Alt1} \ldots \Delta \ln V_{Alt3}$, while based on Equation (8.5) each alternative estimate of aggregate MFP is due to alternative estimates at the industry level.

Import Treatment and Value-Added Growth Estimates

In this section, we compare the baseline estimates of industry value-added growth in the United States to estimates based on the alternative treatments of imports.[15] Figure 8.3 shows that the BEC allocation of imports produces minor differences in the estimates of value-added growth by industry over the 1998–2011 period. The effects are detailed across industries in Table 8.3. As discussed above, the differences between the baseline estimate of value-added growth and the alternatives are due to alternative estimates of the growth of intermediate inputs by industry. This difference takes into account the alternative value of imported commodities within an industry and the price difference between domestic and foreign purchases. Between 1998 and 2011, value-added in “Miscellaneous manufacturing” would have grown 0.3 percentage points a year faster (3.22 percent a year versus 2.89 percent a year) if estimated with the BEC allocation, while “Food and beverages” would have grown about 0.2 percentage points a year slower (0.85 percent a year versus 1.06 percent). “Nonmetallic minerals” would be esti-

Figure 8.3 Measured Value-Added Growth, 1998–2011: Alt1 Less Baseline



NOTE: Difference in value-added growth under Alt1. See text.
SOURCE: Authors' calculations, based on BEA and BLS data.

Table 8.3 Growth in Industry Value-Added and MFP under Alternatives (%)

	Value-added growth						MFP Growth					
	1998–2011		2002–2011				1998–2011		2002–2011			
	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3
Farms	2.12	2.12	1.34	1.34	1.34	1.34	0.95	0.95	0.57	0.57	0.57	0.57
Forestry, fishing, and related activities	3.34	3.33	2.84	2.81	2.83	2.83	2.05	2.03	1.43	1.40	1.42	1.42
Oil and gas extraction	−3.74	−3.75	−2.45	−2.45	−2.46	−2.46	−2.84	−2.84	−3.02	−3.02	−3.03	−3.03
Mining, except oil and gas	−2.92	−2.93	−4.29	−4.30	−4.36	−4.38	−1.38	−1.38	−2.85	−2.85	−2.88	−2.89
Support activities for mining	6.31	6.30	4.75	4.74	4.67	4.65	1.81	1.81	−0.15	−0.16	−0.19	−0.19
Utilities	1.36	1.36	1.57	1.57	1.57	1.56	0.28	0.28	0.15	0.15	0.14	0.14
Construction	−2.24	−2.24	−3.54	−3.54	−3.58	−3.58	−1.15	−1.15	−1.28	−1.28	−1.30	−1.30
Wood products	0.22	0.22	0.28	0.28	0.27	0.26	1.21	1.20	1.36	1.36	1.36	1.36
Nonmetallic mineral products	−3.15	−3.04	−4.11	−3.97	−4.09	−4.01	−0.73	−0.69	−0.76	−0.71	−0.74	−0.72
Primary metals	−3.13	−3.13	−4.53	−4.52	−4.65	−4.64	−0.12	−0.12	−0.80	−0.79	−0.82	−0.82
Fabricated metal products	−1.18	−1.18	−0.49	−0.49	−0.50	−0.51	−0.06	−0.06	0.11	0.11	0.10	0.10
Machinery	0.22	0.21	2.84	2.82	2.53	2.51	0.64	0.64	1.30	1.30	1.19	1.18
Computer and electronic products	17.51	17.47	15.41	15.36	15.08	15.02	8.15	8.13	8.07	8.04	7.92	7.88
Electrical equipment appliances and components	0.80	0.79	−0.13	−0.14	−0.20	−0.23	0.96	0.95	0.43	0.42	0.40	0.39
Motor vehicles, bodies and trailers, and parts	0.28	0.17	−1.02	−1.15	−1.55	−1.70	0.70	0.68	0.64	0.62	0.55	0.52
Other transportation equipment	0.95	0.92	1.55	1.53	0.93	0.95	0.57	0.56	0.35	0.34	0.12	0.13
Furniture and related products	−2.76	−2.74	−3.37	−3.37	−3.38	−3.38	0.08	0.09	0.37	0.37	0.36	0.36
Miscellaneous manufacturing	2.89	3.22	2.48	3.00	2.48	2.91	1.46	1.63	1.22	1.47	1.21	1.43

Food and beverage and tobacco products	1.06	0.85	1.26	0.90	1.33	0.98	0.19	0.14	0.29	0.20	0.33	0.23
Textile mills and textile product mills	−4.26	−4.26	−4.40	−4.41	−4.62	−4.63	1.33	1.33	1.78	1.78	1.70	1.70
Apparel and leather and allied products	−4.83	−4.77	−4.30	−4.29	−4.39	−4.37	3.37	3.39	4.35	4.35	4.30	4.31
Paper products	−2.87	−2.87	−2.58	−2.58	−2.58	−2.58	−0.09	−0.09	0.05	0.05	0.05	0.05
Printing and related support activities	−0.96	-0.98	−1.35	−1.39	−1.39	−1.45	1.11	1.11	0.98	0.97	0.97	0.95
Petroleum and coal products	1.44	1.44	2.24	2.24	2.35	2.34	0.20	0.20	0.37	0.37	0.38	0.38
Chemical products	1.03	1.00	0.36	0.33	0.51	0.43	0.42	0.41	0.28	0.27	0.33	0.31
Plastics and rubber products	−0.68	−0.69	−1.00	−1.01	−0.84	−0.84	0.24	0.23	0.26	0.26	0.32	0.32
Wholesale trade	2.19	2.20	1.21	1.23	1.20	1.21	0.67	0.68	0.13	0.14	0.13	0.13
Retail trade	1.41	1.42	0.60	0.61	0.59	0.60	0.15	0.15	0.03	0.03	0.02	0.02
Air transportation	3.03	3.03	3.42	3.42	3.42	3.42	2.18	2.18	2.57	2.57	2.57	2.58
Rail transportation	0.10	0.10	0.27	0.27	0.23	0.23	0.54	0.54	0.07	0.07	0.05	0.05
Water transportation	9.00	9.00	17.17	17.17	17.17	17.17	2.73	2.73	5.21	5.21	5.21	5.21
Truck transportation	1.74	1.74	2.20	2.20	2.18	2.18	0.68	0.68	1.03	1.02	1.02	1.01
Transit and ground passenger transportation	1.25	1.25	0.62	0.63	0.62	0.62	−0.71	−0.71	−0.89	−0.89	−0.90	−0.90
Pipeline transportation	6.62	6.63	5.03	5.03	5.05	5.05	2.20	2.20	1.68	1.68	1.69	1.69
Other transportation and support activities	1.77	1.77	1.92	1.91	1.91	1.91	1.39	1.39	1.67	1.67	1.67	1.67
Warehousing and storage	3.69	3.69	4.95	4.95	4.94	4.94	0.76	0.76	1.64	1.64	1.64	1.64
Publishing industries (includes software)	2.62	2.62	2.30	2.30	2.29	2.29	0.28	0.28	0.91	0.91	0.90	0.90

(continued)

Table 8.3 (continued)

	Value-added growth						MFP Growth					
	1998–2011		2002–2011				1998–2011		2002–2011			
	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3
Motion picture and sound recording industries	1.18	1.18	0.14	0.14	0.15	0.14	0.59	0.59	0.37	0.37	0.37	0.37
Broadcasting and telecommunications	5.79	5.79	5.04	5.04	5.01	5.00	1.85	1.85	2.73	2.72	2.70	2.70
Information and data processing services	7.16	7.16	4.69	4.69	4.67	4.67	−0.17	−0.17	−0.40	−0.40	−0.41	−0.41
Federal Reserve banks, credit intermediation, and related activities	2.99	2.99	0.68	0.68	0.67	0.67	0.45	0.45	−0.23	−0.23	−0.24	−0.24
Securities, commodity contracts, and investments	5.59	5.59	−0.83	−0.83	−0.83	−0.83	1.02	1.02	−1.47	−1.47	−1.47	−1.47
Insurance carriers and related activities	1.41	1.41	2.57	2.57	2.57	2.57	−0.51	−0.51	0.50	0.51	0.51	0.51
Funds, trusts, and other financial vehicles	4.48	4.48	3.24	3.24	3.24	3.24	0.04	0.04	−0.29	−0.29	−0.29	−0.29
Real estate	2.28	2.28	2.05	2.05	2.05	2.05	0.25	0.25	0.28	0.28	0.28	0.28
Rental and leasing services and lessors of intangible assets	1.89	1.89	0.89	0.89	0.89	0.89	−1.08	−1.08	0.41	0.41	0.41	0.41
Legal services	−0.35	−0.35	−1.51	−1.51	−1.51	−1.51	−2.28	−2.28	−2.69	−2.69	−2.70	−2.70
Computer systems design and related services	6.91	6.91	8.08	8.08	8.05	8.05	2.02	2.02	3.09	3.09	3.07	3.07
Miscellaneous professional scientific and technical services	3.11	3.11	2.96	2.96	2.95	2.95	0.13	0.13	0.22	0.22	0.22	0.21

Management of companies and enterprises	0.27	0.26	−0.75	−0.77	−0.78	−0.79	−2.28	−2.29	−3.58	−3.59	−3.60	−3.61
Administrative and support services	3.06	3.06	3.23	3.23	3.23	3.23	1.23	1.23	1.83	1.83	1.83	1.83
Waste management and remediation services	2.56	2.56	2.34	2.33	2.32	2.32	0.90	0.90	0.80	0.80	0.79	0.79
Educational services	1.15	1.15	0.82	0.81	0.80	0.80	−1.26	−1.25	−1.11	−1.11	−1.12	−1.12
Ambulatory health care services	3.52	3.47	3.35	3.28	3.30	3.14	0.36	0.32	0.03	-0.02	-0.01	-0.11
Hospitals, nursing and residential care facilities	1.89	1.85	2.00	1.94	1.96	1.85	−0.17	−0.19	0.00	−0.04	−0.02	−0.09
Social assistance	2.99	2.99	2.58	2.57	2.58	2.57	0.62	0.61	0.90	0.89	0.90	0.89
Performing arts, spectator sports, museums, and related activities	2.28	2.28	1.53	1.52	1.53	1.53	0.27	0.27	−0.24	−0.24	−0.24	−0.24
Amusements, gambling, and recreation industries	1.25	1.26	2.16	2.17	2.14	2.17	0.10	0.11	1.39	1.40	1.38	1.40
Accommodations	1.77	1.76	1.53	1.52	1.53	1.52	0.19	0.19	0.06	0.05	0.06	0.05
Food services and drinking places	2.04	2.02	1.57	1.52	1.56	1.51	0.64	0.63	0.53	0.50	0.53	0.50
Other services, except government	−1.00	−0.99	−0.82	−0.82	−0.82	−0.82	−1.15	−1.14	−0.73	−0.73	−0.73	−0.73
Federal government	1.03	1.03	1.34	1.34	1.34	1.34	0.20	0.20	0.22	0.22	0.22	0.22
State and local government	0.85	0.85	0.35	0.35	0.35	0.35	−0.38	−0.38	−0.35	−0.35	−0.35	−0.35

NOTE: Alt.1 uses the alternative import allocation based on the BEC. Alt. 2 uses the alternative set of import prices. Alt. 3 uses both the alternative allocation and the alternative import prices.

SOURCE: Authors' calculations, based on BEA and BLS data.

mated to decline by 3.04 percent a year instead of 3.15 percent a year, while "Motor vehicles" would have grown at 0.17 percent a year versus 0.28 percent. The other of the 63 industries all exhibited percentage-point differences of less than 0.1 percentage points a year.

To understand the impact of the BEC allocations (summarized in Table 8.1) on the value-added growth estimates, we trace the effect of the BEC-based distribution of "Forestry, fishing, and related activities." Table 8.1 indicates that a significantly smaller share of imported "Forestry, fishing, and related activities" was purchased as an intermediate input under the BEC mapping. The implication of this alternative allocation for value-added growth depends on which industries purchase "Forestry, fishing, and related activities" items, and the value of the imported items relative to the value of other intermediate inputs used by the industries. Furthermore, the impact depends on the item-level allocations within each commodity. For example, as discussed above, the major difference between the BEC-based and the baseline treatment of "Forestry, fishing, and related activities" is the treatment of commercial fishing. Because the commercial fishing item is sold mainly to a subset of the industries that purchases forestry and fishing items, the BEC-based allocation affects only this set of industries. In particular, the largest purchaser of "Forestry, fishing, and related activities" is the "Wood products" industry, yet the BEC-based and baseline estimates of imports of "Forestry, fishing, and related activities" purchased by the "Wood products" industry are equivalent because the wood industry does not purchase commercial fishing.[16]

On the other hand, the treatment of commercial fishing has a large impact on the estimates of imports purchased by the "Food services and drinking places" industry. In this "Food services and drinking places" industry, however, purchases of forestry and fishing items were about 2 percent of total intermediate purchases, while the difference in price growth between domestic and imported items was about 8 percentage points. This implies a value-added growth rate for the "Food services and drinking places" industry that differs by about 0.1 percentage points in 2007, and no difference in value-added growth in the "Wood products" industry. Over the 1998–2011 period, value-added estimates for the "Food services and drinking places" industry differed by 0.02 percentage points when the baseline was compared to the BEC-based import allocation. This difference reflects the treatment of commercial fishing, other items in the “Forestry, fishing, and related activities” commodity, and the effects on value-added growth for the other years in the sample.

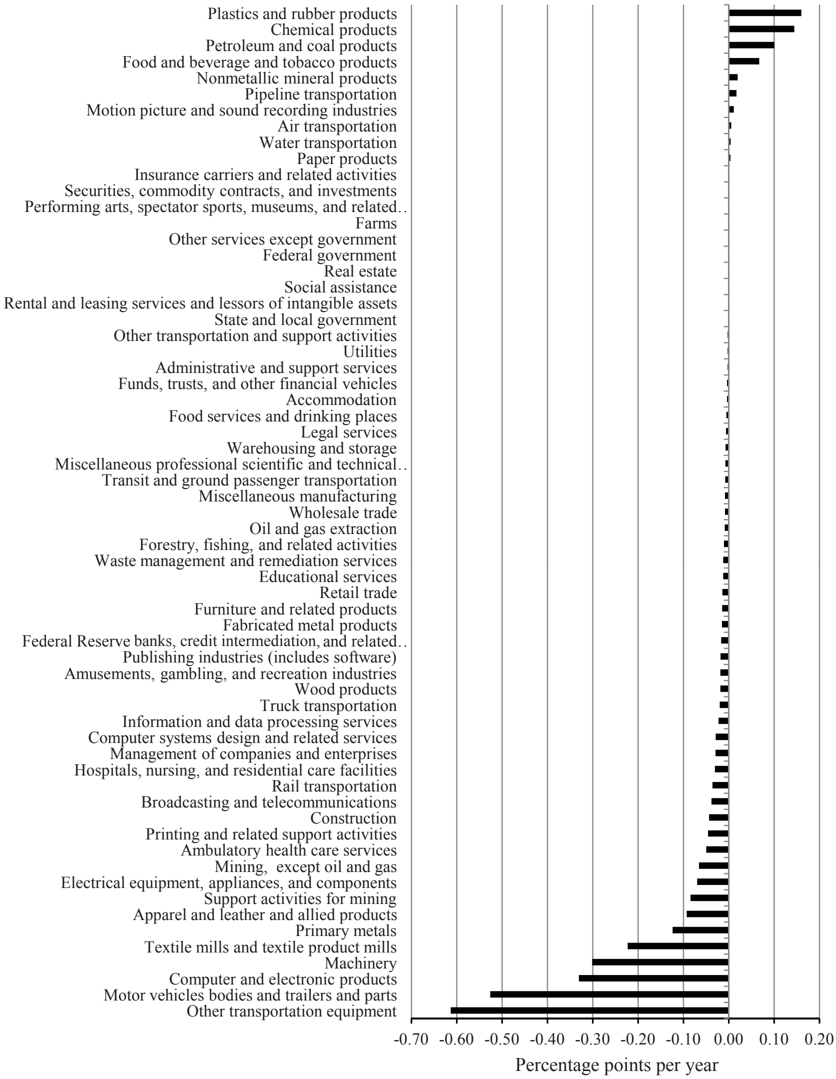
The differences in value-added by industry estimates that incorporate the country-pooled adjusted import prices are given in Figure 8.4. In 49 out of the 63 industries, estimated value-added growth was slower during the 2002–2011 period (the details are given in Table 8.3). The largest difference (in absolute value) was for “Other transportation equipment”; it is estimated that that category would have grown about 0.6 percentage points a year more slowly using the country-pool-adjusted import price. “Motor vehicle bodies and trailers and parts,” “Computer and electronic products,” “Machinery,” “Textile mills and textile product mills,” “Primary metals,” “Plastics and rubber products,” and “Chemical products” were the industries where estimated value-added growth differed by more than 0.1 percentage points a year, with the differences for plastics and chemicals being of opposite sign.

Table 8.3 and Figure 8.5 show the combined effects for the 2002–2011 period of the BEC-based allocation and alternative import prices. “Motor vehicle bodies and trailers and parts” would have been estimated to grow more slowly, by about 0.7 percentage points a year; “Other transportation equipment” also more slowly, by 0.6 percentage points a year; “Computer and electronic products” more slowly by 0.4 percentage points a year; and “Machinery” and “Food and beverage and tobacco products” more slowly by about 0.3 percentage points a year. “Miscellaneous manufacturing” would have been estimated to grow about 0.4 percentage points a year faster. Table 8.3 indicates that, in general, differences in growth estimates due to the alternative treatments were small in comparison to the baseline estimates of value-added growth.

Import Treatment and MFP Growth Estimates by Industry

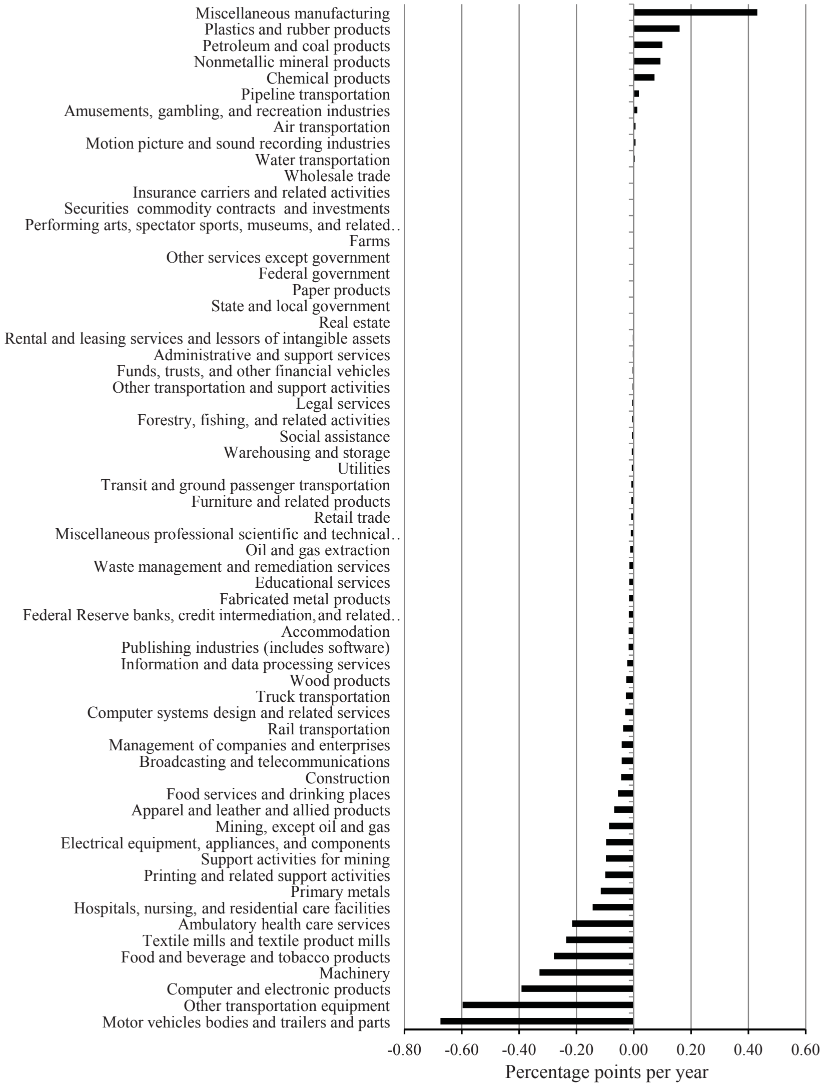
Because MFP growth accounts for about 30 percent of growth in aggregate value-added between 1998 and 2010, according to Fleck et al. (2012), small changes in estimates of MFP growth at the industry level may have important ramifications for the sources of aggregate MFP growth.

Figure 8.4 Measured Value-Added Growth, 2002–2011: Alt2 Less Baseline



NOTE: Difference in value-added growth under Alt2. See text.
SOURCE: Authors' calculations, based on BEA and BLS data.

Figure 8.5 Measured Value-Added Growth, 2002–2011: Alt3 Less Baseline



NOTE: Difference in value-added growth under Alt3. See text.
SOURCE: Authors' calculations, based on BEA and BLS data.

Table 8.3 compares MFP growth rates across the baseline and alternative treatments for imports. The table shows that the BEC-based import allocation produces both marginally faster and slower MFP growth rates across industries. The largest difference was for “Miscellaneous manufacturing,” where MFP would have grown about 0.17 percentage points a year faster under the BEC mapping (1.63 percent versus 1.46 percent). “Food and beverages and tobacco products” MFP grew 0.05 percentage points a year slower based on the BEC, while all of the other industries’ MFP growth differed by less than 0.05 percentage points a year.

Table 8.3 shows the effect of the alternative import prices (Alt2) and the combination of the alternative import prices and BEC allocation (Alt3) on MFP estimates. With the alternative import prices, measured MFP growth in “Other transportation equipment” would have been 0.22 percentage points a year slower compared to the baseline, while that for “Computer and electronic products” would have been about 0.1 percentage points a year slower. Both “Machinery” and “Motor vehicle bodies and trailers and parts” would have exhibited slower MFP growth by about 0.1 percentage points a year. “Plastics and rubber products” would have been estimated to have higher MFP growth for the period by about 0.05 percentage points a year. Table 8.3 shows that the differences in MFP under the alternatives are, in general, small compared to the baseline estimates. Finally, Table 8.3 indicates that combining the alternative import allocation and alternative import prices leads to relatively minor differences in MFP estimates across industries. The industries with the largest differences are “Other transportation equipment,” “Computer and electronic products,” “Ambulatory health care services,” and “Miscellaneous manufacturing.”

Houseman et al. (2011) argue that the measurement bias from offshoring as a percentage of growth in real value-added and MFP is particularly high for manufacturing excluding computers. Table 8.4 presents the effects of the alternative import assumptions on estimated value-added and MFP in this sector of the economy. For the 1998–2011 period, under the BEC allocation of imports, value-added would have decreased by 0.15 percent a year compared to 0.13 percent a year, while MFP growth would have been unchanged under the alternative. In comparison, under the alternative import prices between 2002 and 2011, valued-added fell by 0.16 percent a year compared to a decrease of

Table 8.4 Value-Added and MFP: Manufacturing Excluding Computers and Electronic Products (%)

	1998–2011		2002–2011			
	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3
Value-added growth	−0.13	−0.15	−0.13	−0.16	−0.16	−0.21
Contribution to aggregate VA growth	0.00	−0.01	0.00	0.00	0.00	−0.01
MFP growth	0.37	0.36	0.33	0.32	0.32	0.31
Contribution to aggregate MFP growth	0.11	0.11	0.10	0.09	0.09	0.09

NOTE: All figures are average annual percentages. Sector aggregation is discussed in the text. Alt. 1 uses the alternative import allocation based on the BEC. Alt. 2 uses the alternative set of import prices. Alt. 3 uses both the alternative allocation and the alternative import prices.

SOURCE: Authors' calculations, based on BEA and BLS data.

0.13 percent a year in the baseline. Again, MFP growth was basically unchanged. Combining the alternative import allocation and prices yields a value-added decline of 0.21 percent a year compared to a 0.13 percent decline in the baseline, and MFP growth of 0.09 percent a year compared to 0.10 percent a year without the adjustments.

The Sources of Growth under the Alternatives

In this section, we compare the sources of aggregate value-added and MFP growth by industry across the alternative treatments. Table 8.5, which presents the sector contributions to aggregate value-added growth, indicates that there are very few significant differences based on the alternative import measurement approaches. For the BEC-based allocation over the 1998–2011 period, the contributions by major sector were observationally equivalent at 1.87 percent a year. Over the 2002–2011 period, for which we consider both the BEC-based import allocation and the alternative import prices, there were some minor differences in sector contributions to growth. Specifically, in the baseline aggregate, value-added grew by 1.38 percent a year, while it grew by 1.34 percent a year under the alternative using the BEC allocation and alternative import price. This difference was due to minor differences in "Construction," "Manufacturing," "Information," and "Other services."

Across each of the cases that we consider, MFP growth accounts for between 25 and 30 percent of aggregate value-added growth. Table 8.6 shows that for the broad economic sectors, the sources of aggregate MFP growth exhibit a similar pattern across the treatments of imports that we analyze. For the 1998–2011 period, the BEC-based allocation produces a sectoral decomposition of aggregate MFP that is almost identical to the baseline. For the 2002–2011 period, there are minor differences in "Transportation, warehousing, and utilities," "Durable goods," and "Other services." Overall, the fundamental sources of aggregate MFP are very similar across the different treatments of imports for this sector classification.

Table 8.5 Sector Contributions to Aggregate Value-Added Growth (%)

	1998–2011		2002–2011			
	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3
Value-added	1.87	1.87	1.38	1.37	1.36	1.34
Agriculture, forestry, fishing, hunting, and mining	0.02	0.02	0.01	0.01	0.01	0.01
Transportation, warehousing, utilities	0.10	0.10	0.11	0.11	0.11	0.11
Construction	−0.10	−0.10	−0.15	−0.15	−0.16	−0.16
Manufacturing	0.25	0.25	0.22	0.21	0.21	0.20
Durable goods	0.25	0.25	0.22	0.22	0.21	0.21
Nondurable goods	0.00	0.00	0.00	−0.01	0.00	0.00
Trade	0.23	0.23	0.11	0.11	0.11	0.11
Information	0.21	0.21	0.18	0.18	0.17	0.17
Finance, insurance, real estate, rental and leasing	0.51	0.51	0.33	0.33	0.33	0.33
Other services	0.54	0.54	0.52	0.51	0.51	0.50
Government	0.11	0.11	0.06	0.06	0.06	0.06

NOTE: All figures are average annual percentages. Sector aggregation is discussed in the text. Alt. 1 uses the alternative import allocation based on the BEC. Alt. 2 uses the alternative set of import prices. Alt. 3 uses both the alternative allocation and the alternative import prices.

SOURCE: Authors' calculations, based on BEA and BLS data.

Table 8.6 Sector Contributions to Aggregate MFP Growth (%)

	1998–2011		2002–2011			
	Baseline	Alt1	Baseline	Alt1	Alt2	Alt3
Aggregate MFP	0.49	0.48	0.42	0.41	0.40	0.38
Agriculture, forestry, fishing, hunting, and mining	−0.01	−0.01	−0.04	−0.04	−0.04	−0.04
Transportation, warehousing, utilities	0.07	0.07	0.09	0.09	0.08	0.08
Construction	−0.11	−0.11	−0.13	−0.13	−0.13	−0.13
Manufacturing	0.39	0.39	0.33	0.33	0.32	0.31
Durable goods	0.35	0.35	0.30	0.30	0.28	0.28
Nondurable goods	0.04	0.04	0.03	0.03	0.04	0.03
Trade	0.07	0.07	0.01	0.01	0.01	0.01
Information	0.09	0.09	0.14	0.14	0.14	0.14
Finance, insurance, real estate, rental and leasing	0.06	0.06	0.01	0.01	0.01	0.01
Other services	−0.03	−0.04	−0.01	−0.02	−0.02	−0.03
Government	−0.04	−0.04	0.02	0.02	0.02	0.02

NOTE: All figures are average annual percentages. Sector aggregation is discussed in the text. Alt. 1 uses the alternative import allocation based on the BEC. Alt. 2 uses the alternative set of import prices. Alt. 3 uses both the alternative allocation and the alternative import prices.

SOURCE: Authors' calculations based on BEA and BLS data.

CONCLUSION

Estimated GDP from the expenditure side demonstrates the increasing role of imports in U.S. economic activity. In this chapter, we have examined a narrow set of issues related to import measurement and the effects on estimates of the sources of GDP growth from an industry perspective. Between 1998 and 2011, the value of imports relative to GDP increased from 12.7 percent to 17.7 percent. Over the same period, based on the value-added approach to measuring GDP, the share of imported intermediates used in domestic production increased from about 9 percent in 1998 to 13 percent in 2011 for the economy as a whole, and from 16 percent in 1998 to 25 percent in 2011 in manufacturing. Because of interest in how these imports are treated in the measurement of GDP by industry, we have documented the current approach to capturing the role of imports on measures of growth and productivity at the industry level and have shown how import measurement at the industry level is related to aggregate measures of growth and productivity. The industry production account that we analyze in this chapter is an important element of quantifying the impact of imports on the U.S. economy.

Because a basic requirement in assembling industry estimates of real value-added and MFP growth is knowing the values of imports by type that are used by all industries in the economy, we have discussed the application of the import proportionality assumption in the BEA industry accounts and compared this to an approach that relies on the broad economic classifications published by the United Nations. We find that estimates of GDP and MFP growth by industry show no major differences based on the BEC allocation. We attribute this to the level of detail at which the BEA applies the import comparability assumption, which is much finer than the 63-sector level at which the annual accounts are published.

Another component of the accounts that affects measures of GDP and MFP by industry is made up of the prices that serve to deflate imports used across industries. We compare the current practice, which relies heavily on published BLS import price indexes, to an import price that pools goods across countries. This approach allows us to capture import switches from a new, lower-priced entrant into the export market, which Houseman et al. (2011) have argued may be missing from the official import prices. Again, we do not find significant impacts on the industry growth rates, or on the sectoral growth decomposition at the aggregate level.

The industry production account approach that we make use of in our analysis reinforces the notion that the economy-wide impact of increasing imports depends on industry measures of import use. While there is some evidence that the alternative methodologies that we consider have some minor industry-specific measurement effects, across industries these effects often cancel each other out. Thus, at higher levels of aggregation there are very few observable differences across the methodologies that we analyze. It is worth recalling that our analysis focuses solely on different treatments of imported goods in the accounts.

Surely, measurement issues related to the growth in globalization will not dissipate. This study was based on the 2002 benchmark input-output table, which forms the basis of the annual industry accounts. The 2007 benchmark input-output table, which became available in December 2013, incorporates updated information on the structure of inter-industry purchases, and the annual industry accounts will be revised to reflect this new information. Looking further ahead, the treatment of factoryless goods production is a measurement area that is gaining attention. Methodologists for the GDP-by-industry account are actively involved in discussing methods to treat factoryless goods and how to incorporate these concepts into their estimates.

Notes

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1. The vintage of data used in this project is consistent with the GDP by industry and annual Input-Output accounts, released in December 2012. The latest data are updated here: http://www.bea.gov/industry/index.htm.

2. Strassner, Yuskavage, and Lee (2010) use data from multinational companies (MNC) and compare reported use of imports by broad type to the import proportionality assumption. They find broadly consistent results between current practice and the MNC data and attribute some of the differences to the difference between establishment and company concepts.
3. Because our analysis covers 1998–2011, we use the 1996 concordance for 1998–2001, the 2002 concordance for 2002–2006, and the 2007 concordance for 2007–2011. Concordances are available here: http://unstats.un.org/unsd/trade/conversions/HS%20Correlation%20and%20Conversion%20tables.htm.
4. There are limited cases where the BEC code for a given six-digit commodity is ambiguous in the published concordance. For example, the six-digit harmonization code can be listed multiple times and assigned to BEC codes that do not give a unique map to intermediate input, consumption, or investment. In these cases, we default to the import proportionality assumption for the proportion of this item included in this six-digit harmonization code.
5. In constructing the "GDP by Industry" accounts, typically reexports are netted out from the value of imports, but in constructing the value to be used to allocate imports across broad economic categories, we do not net out reexports.
6. The foundation for this mapping is made up of the census guidelines on appropriate NAICS codes for each harmonization code (when this information is available).
7. An import is assigned to "undetermined" if the six-digit harmonization code to the BEC map is ambiguous.
8. An alternative is to assume that capital goods get sold only to final demand, but this leads to all of the capital goods that typically get embedded in other goods being allocated to final demand.
9. UN Comtrade provides quantity data in units recommended by the World Customs Organization. We construct prices for each of the 13 quantity types and construct value-share-weighted growth rates for each item (across quantity type). We use the value and quantity to define the implicit price. A previous version of this research used only data that was reported in kilograms.
10. In a regression with observations weighted by import values of UN Comtrade Törnqvist prices on BEA prices, the coefficient on the BEA prices is about 0.7 for the 2002–2011 period but declines to −0.1 over the 1997–2002 period.
11. The BEA has details on about 150 import prices from the BLS.
12. Industry output and intermediate input for the baseline case is taken from the 1998–2011 annual revision of the GDP-by-industry data (http://www.bea.gov/industry/gdpbyind_data.htm). Capital and labor services are extrapolated through 2011 using internal estimates and include a labor and capital composition adjustment based on the approach of Jorgenson, Ho, and Samuels (2011).
13. This decomposition is the direct-aggregation-across-industries approach of Jorgenson et al. (2007).
14. Note that this differs from the concept of aggregate TFP used in Jorgenson et al. (2007) by their reallocation terms.
15. Because of differences in index number methodology, there are small differences between published estimates and estimates given here.

16. This excludes the purchases by the "Forestry, fishing, and related activities" industry itself. It is based on the 2007 annual input-output table.

References

Eldridge, Lucy P., and Michael J. Harper. 2012. "Substitution of Imports for Domestic Labor, Capital, and Materials in U.S. Manufacturing." Paper presented at the 32nd General Conference of the International Association for Research in Income and Wealth, held in Boston, August 5–11.

Feenstra, Robert C., and Gordon H. Hanson. 1999. "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979–1990." *Quarterly Journal of Economics* 114(3): 907–940.

Feenstra, Robert C., and John Romalis. 2012. "International Prices and Endogenous Quality." NBER Working Paper No. 18314. Cambridge, MA: National Bureau of Economic Research.

Fleck, Susan, Steven Rosenthal, Matthew Russell, Erich H. Strassner, and Lisa Usher. 2012. "A Prototype BEA/BLS Industry-Level Production Account for the United States." Paper presented at the Second World KLEMS Conference, held in Cambridge, MA, August 9–10.

Haskel, Jonathan, Robert Z. Lawrence, Edward E. Leamer, and Matthew J. Slaughter. 2012. "Globalization and U.S. Wages: Modifying Classic Theory to Explain Recent Facts." *Journal of Economic Perspectives* 26(2): 119–140.

Houseman, Susan, Christopher Kurz, Paul Lengermann, and Benjamin R. Mandel. 2011. "Offshoring Bias in U.S. Manufacturing." *Journal of Economic Perspectives* 25(2): 111–132.

Jorgenson, Dale W., Mun Sing Ho, and Jon D. Samuels. 2011. "Information Technology and U.S. Productivity Growth: Evidence from a Prototype Industry Production Account." *Journal of Productivity Analysis* 36(2): 159–175.

Jorgenson, Dale W., Mun Sing Ho, Jon D. Samuels, and Kevin J. Stiroh. 2007. "Industry Origins of the American Productivity Resurgence." *Economic Systems Research* 19(3): 229–252.

Jorgenson, Dale W., and Paul Schreyer. 2013. "Industry-Level Productivity Measurement and the 2008 System of National Accounts." *Review of Income and Wealth* 59(2): 185–211.

Kurz, Christopher, and Paul Lengermann. 2008. "Outsourcing and U.S. Economic Growth: The Role of Imported Intermediate Inputs." Federal Reserve Board paper presented at the 2008 World Congress on National Accounts and Economic Performance Measures for Nations, held in Arlington, VA, May 12–17.

Lawrence, Robert Z., and Matthew J. Slaughter. 1993. "International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup?" *Brookings Papers on Economic Activity: Microeconomics* 2(1993): 161–226.

Mayerhauser, Nicole M., and Erich H. Strassner. 2010. "Preview of the Comprehensive Revision of the Annual Industry Accounts: Changes in Definitions, Classification, and Statistical Methods." *Survey of Current Business* 90(3): 21–34.

Moyer, Brian C., Marshall B. Reinsdorf, and Robert E. Yuskavage. 2006. "Aggregation Issues in Integrating and Accelerating the BEA's Accounts: Improved Methods for Calculating GDP by Industry." In *A New Architecture for the U.S. National Accounts*, Dale W. Jorgenson, J. Steven Landefeld, and William D. Nordhaus, eds. Chicago: University of Chicago Press, pp. 263–308.

Stewart, Ricky L., Jessica Brede Stone, and Mary L. Streitwieser. 2007. "U.S. Benchmark Input-Output Accounts, 2002." *Survey of Current Business* 87(10): 19–48.

Strassner, Erich H., Robert E. Yuskavage, and Jennifer Lee. 2010. "Imported Inputs and Industry Contributions to Economic Growth: An Assessment of Alternative Approaches." In *Measurement Issues Arising from the Growth of Globalization*, Susan N. Houseman and Kenneth F. Ryder Jr., eds. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research; Washington, DC: National Academy of Public Administration, pp. 341–358.

Timmer, Marcel, ed. 2012. "The World Input-Output Database (WIOD): Contents, Sources, and Methods." WIOD Working Paper No. 10. Brussels: European Commission.

Washington, Patricia A., Jeff M. Bellone, Anna M. Jacobson, and Jennifer Lee. 2012. "Annual Industry Accounts: Revised Statistics for 2009–2011." *Survey of Current Business* 92(12): 14–23.

Yuskavage, Robert E., Erich H. Strassner, and Gabriel W. Medeiros. 2008. "Domestic Outsourcing and Imported Inputs in the U.S. Economy: Insights from Integrated Economic Accounts." Paper presented at the 2008 World Congress on National Accounts and Economic Performance Measures for Nations, held in Arlington, VA, May 12–17.

———. 2009. "Outsourcing and Imported Services in BEA's Industry Accounts." In *International Trade in Services and Intangibles in the Era of Globalization*, Marshall B. Reinsdorf and Matthew J. Slaughter, eds. Chicago: University of Chicago Press, pp. 247–288.