Offshoring Bias: The Effect of Import Price Mismeasurement on Manufacturing Productivity

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I. Background and Motivation

Over the past decade, emerging 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.[1] It is important to note that although the dollar value of imports into the United States shrank in 2009, the shift in the import composition towards developing economies, especially China, has accelerated during the current downturn as consumers and businesses have become increasingly price-sensitive.[2]

This expansion in imports has resulted from a confluence of factors, such as rapid economic development, lower communication and transportation costs, and declining trade barriers. The surge in imports from developing countries occurred not singularly as a result of an increase in the volume of trade in existing products, but also has resulted from a striking expansion in the types of products being imported. The dramatic acceleration of imports from developing countries, we maintain, is imparting a bias to the official statistics reported by governmental agencies.[3]

Indeed, much of the price decline associated with the entry of a new, foreign supplier and its expansion of market share is likely not captured in the import price

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[1] Expressed as a percent of GDP, imports rose by roughly 5 percentage points from 12½ percent of GDP in 1997 to 17½ percent in 2008, while exports as a share of GDP increased only marginally. In 2007 China became the largest exporter of commodities to the United States, surpassing Canada.

[2] See "In Recession, China Solidifies its Lead in Global Trade," *The New York Times*, October 14, 2009.

[3] Michael Mandel makes note of this phenomenon in his June 3rd, 2009 Business Week article, "Growth: Why the Stats are Misleading."

statistics. The problem is analogous to the widely discussed problem of outlet substitution bias in the literature on the Consumer Price Index (CPI).[4] Just as the CPI fails to capture lower prices for consumers brought by the entry and expansion of big-box retailers like Wal-Mart, import price indexes and the intermediate input price indexes based on them generally do not fully capture the price drops associated with a shift to new suppliers in China and other developing countries. Because the bias arises from a shift in sourcing to a new, low-cost supplier and much of that shift has been to developing countries, we term it "offshoring bias."

A glance at materials price indexes in manufacturing illuminates the possibility of a systematic bias in import price statistics. Figure 1A contains the materials deflators for total imported materials and domestic materials.[5] Interestingly, from 2002 to 2007, the time frame during which the share of imported intermediates in the manufacturing sector increased by more than a 30 percent, the price index for imported materials increased at a significantly faster rate than both the index for total intermediates and the index for domestic intermediates. This anomaly provides strong evidence of mismeasurement in import and input prices and, by implication, an overstatement in manufacturing productivity.

We believe that the overall magnitude of offshoring bias has been extensive in recent years. As discussed below, price measurement is especially problematic in the context of frequent product churning and an environment of persistent price differentials between suppliers of largely identical goods. Recent work shows that both of these

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[4] See Diewert (1998), Hausman (2003), and Reinsdorf (1993) on biases to the CPI arising from outlet substitution bias and Houseman (2008) and Diewert and Nakamura (2009) for discussions about the relationship between outlet substitution bias and biases to input price indexes arising from shifts in the sourcing of inputs.

[5] The derivation of these estimates is discussed further below.

conditions are pervasive in the case of imported goods (Nakamura and Steinsson 2009, Gopinath and Rigobon 2008). The recent, rapid shifts in sourcing between suppliers also adds to the likelihood that offshoring bias may be significant.

For example, Figure 2A documents the rapid rise in both the levels and share of materials used by U.S. manufactures that are sourced from abroad. Over the ten year period from 1997 to 2007, the import share of total materials jumped roughly 50 percent, as the fraction of materials used climbed from 17 to 25 percent. Moreover, and as shown in Figure 2B, not only has the volume of imported materials increased substantially but the composition of imports has also shifted towards goods from developing and intermediate countries; the developing share of imported materials increased from a 20 to a 30 percent share.[6]

Since price declines are being omitted from the aggregate price index, mismeasurement has a first-order effect on computed real output and productivity growth. GDP, computed from the expenditure side, is the sum of consumption, investment, government spending and net exports. An understatement of real import growth, all else equal, will directly result in an overstatement of the growth of real GDP.

In addition, BEA uses import and producer price indexes from BLS to construct industry-level intermediate input price indexes. BEA and BLS, in turn, use intermediate price indexes to compute industry and sector-level value added and productivity measures.[7] If import price growth is overstated, it follows that the real growth of

[6] Importantly, in terms of total manufacturing imports, the developing country share increased from 20 percent in 1983 to 45 percent in 2008. This increase has occurred as advanced country imports of manufactured products fell from roughly 65 percent to 45 percent of total manufacturing imports. The country classification scheme can be found in the appendix and is discussed in section 3.

[7] The annual industry accounts are published at the NAICS three-digit industry level using a comprehensive methodology that integrates detailed source data within an input-output framework that balances and reconciles industry production with commodity usage (BEA, 2009).

imported inputs is understated and industry value-added and productivity measures are overstated. Real GDP, computed as the sum of real value added across all sectors of the economy, also will be upward-biased.

Our paper focuses on the latter mechanism by which biases in price indexes affect statistics. In particular, we examine how biases to the import price indexes affect productivity measures in manufacturing, a sector in which, as just noted, substantial growth in the sourcing of intermediate inputs from overseas has occurred.[8]

The ideal empirical approach to measure the switching of input sources from domestic to foreign would be to match individual varieties across countries and to explicitly incorporate the price drop due to a switch into the input price deflator, but such a comprehensive dataset of matched international prices does not exist. Similarly, statistical agencies could develop an input pricing measure along the lines of what has recently been proposed by Alterman (2009). Such a measure would help to ameliorate the distortions that occur at present when the price drops associated with sourcing shifts are missed.

An alternative approach, and the one we use here, is a formula-based procedure that adjusts the fixed-weight Laspeyres formulas used by statistical agencies. Specifically, in what follows, we apply the outlet substitution bias formula developed in Diewert (1998) and applied in Diewert and Nakamura (2009) to the problem of outsourcing. We adjust import price indexes using detailed measures of shifting input supply as well as the relative prices (or discount) that U.S. producers obtain by sourcing abroad or by shifting sourcing from high to low-wage countries. As a novel proxy for the

[8] See Kurz and Lengermann (2008) and Yuskavage, Strassner, and Medeiros (2008) for evidence on the increased sourcing of intermediate inputs.

price drop obtained by offshoring U.S. firms, we measure the relative price of U.S. imports from low-wage countries compared to the prices from other “advanced” nations, where the advanced country prices serve as a gauge of the domestically sourced U.S. input price.

Our paper is closest in spirit to recent work by Feenstra, Reinsdorf and Slaughter (2008). That paper documents the effect of various biases in published statistics for aggregagate real output and productivity. Like our paper, Feenstra, Reinsdorf and Slaughter find that measurement problems, which are tantamount to under-reported terms of trade gains, create a significant upward bias to measured output and multi-factor productivity growth in the United States.[9] In this paper, which focuses on productivity growth in manufacturing at a detailed level, we capture an additional source of bias via the level changes in input costs when U.S. producers offshore intermediate inputs or shift sourcing among foreign countries.

Using BLS micro-data on import prices, we first document evidence of substantial price differentials for products sourced from developing and advanced countries relative to their counterparts from more advanced economies. These differentials remain sizable even after controlling for product quality using an approach recently developed by Mandel (2009). We then investigate the consequences of import price mismeasurment on manufacturing productivity, using a conventional neo-classical growth accounting framework. As in Kurz and Lengermann (2008), our analysis makes use of unpublished

[9] FRS recompute the IPP indexes using the Tornqvist formula and updated aggregation weights, and then further adjust the indexes to account for tariffs and for new country sources of varieties. They estimate that mismeasured terms of trade gains account for approximately 20 percent of the annual productivity growth in the United States.

data on imported commodities and their prices to decompose the contribution of purchased materials into domestic and foreign components.

Although preliminary, our analysis presents evidence that offshoring bias has been substantial in recent years. We find that the growth rate of imported intermediate input prices may have been biased upwards by between 16 to 35 percentage points, which in turn has led the average annual growth rate in manufacturing productivity to be overstated by 0.1 to 0.3 percentage point or by between 9 and 20 percent over the entire period from 1997 - 2007. These numbers are significant, as 0.1 percent average annual growth rate for multifactor productivity is roughly equal to the average annual contribution of capital to manufacturing growth from 1997 to 2007. Moreover, the overall bias to manufacturing MFP may be even larger if we could fully account for the effect of sourcing shifts between domestic and foreign suppliers along the lines proposed by Diewert & Nakamura (2009).

The paper proceeds as follows. The next section presents an overview of import price measurement, quantifies the recent shift in sourcing, and discusses price biases that arise from offshoring. Section three provides evidence from IPP microdata that quantifies the import discount. Section four presents our growth accounting framework, which is followed by section five, which presents the alternative price measures and the multifactor productivity results. Section six concludes.

II. Import Prices and Biases Related to Shifts in Sourcing

Background on prices programs

Understanding why offshoring bias arises requires some background on the relevant price programs. The Bureau of Labor Statistics (BLS) constructs separate price indexes for imports and domestically produced goods. In the International Price Program (IPP), BLS surveys a sample of importing establishments on the prices they pay for imports of a detailed product. To construct the Producer Prices Index (PPI), the BLS surveys domestic producers on the prices they receive for a sample of products. The Bureau of Economic Analysis (BEA) subsequently uses an input-output (I-O) structure to combine both domestic output prices and import prices into an industry's intermediate input price index. We will now visit each of these three pricing programs in more detail.

The BLS's IPP program aims to calculate broad and consistent Laspeyres import and export price indexes. In order to compute import price indexes, the IPP program selects a sample of importing establishments and products to be followed in overlapping 5-year periods. All told, the IPP collects 'at-the-dock' unit prices of imports on a monthly basis for approximately 20,000 individual items. Importers report characteristics of the imported items of interest and their transaction prices. The elemental unit of observation used to construct the import price index is the period-to-period *change* in the purchase price of a specific item imported by a specific establishment. Therefore, the first time a product is sampled at a reporting establishment, its price change is missing and cannot be used in the construction of the index. If a change is made to the description of a sampled item or to its trade factors, which include country of origin, BLS attempts to adjust for the value of new characteristic. If changes are too large and adjustments are not feasible, the item is added to the group and the new series is "linked in" to the index.[10] This means that the price change between the old product and the new item that replaces it is dropped when computing the price index, and it assumed that the price movements of newly sampled product are the same as the average price changes of on-going products at the time of its introduction. The BLS uses weighted averages to aggregate across establishment/detailed product categories.[11]

The producer price indexes measure average changes in prices received by domestic producers for their products. The PPI is a transaction based pricing metric, with price-determining variables, such as color, dictating different products. The BLS performs quality adjustment over time, as characteristics change. If there is a physical change in the product that can be assigned a value, then the BLS uses quality adjustment methods, or hedonic methods. The PPI is a modified Laspeyres formula, with aggregation weights constructed from the latest census of manufactures. If no price is reported by the survey respondent, the change is imputed as the average change for other items in the same cell.

The BEA integrates information from the annual and benchmark I-O accounts, from the GDP-by-industry accounts, and from various price indexes constructed by BLS to create the National Income and Product Accounts (NIPAs). An important part of that exercise involves deflating intermediate purchases in order to properly measure value

[10] Nakamura and Steinsson (2009) provide a thorough description of the International Prices Program. They note that because performing hedonic adjustments is extremely expensive, the procedure is rarely done and the overwhelming majority of product replacements in the import prices sample are linked in.

[11] The weights for the upper-level indexes change at an annual rate since 2001. Prior to the annual updating, the weights changed infrequently. For instance the 1997 index used 1995 weights, and the 1993-1996 indexes used 1990 weights.

added at the industry and sector level. Using the I-O accounts, BEA estimates the amount of each commodity used in the creation of each industry's gross output. The I-O accounts do not distinguish whether intermediate inputs are of foreign or domestic origin. Therefore, when constructing a price index to deflate intermediate inputs, BEA assumes that the fraction of a particular intermediate input that is foreign is the same across all user industries and that it equals the import share of all domestic consumption of that commodity—the so-called import comparability or constant industry assumption. The PPI is used to deflate the value of domestically produced intermediate inputs while the import price index from the IPP is used to deflate imported intermediate inputs. The resulting commodity quantity indexes are aggregated up to the industry level via a Fisher index-number formula and used to calculate a price index at that same level (Strassner and Moyer 2002).[12]

Price biases arising from offshoring and other shifts in sourcing of inputs

Consider first the problem of measuring the drop in an input price when an organization shifts its sourcing from a domestic supplier to a new, low-cost foreign supplier. There may be considerable lag before a new item is included in the import price sample, and, as noted above, because indexes are constructed from observations of price changes of specific items sampled in a reporting establishment, the price change will be missing when the item is first sampled. Moreover, to correctly measure the input price

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[12] By definition, an industry's value added equals its gross output minus its consumption of intermediates. The chain-type quantity index for an industry's value added is prepared by deflating the current-dollar commodity measures of gross output and intermediate inputs with the corresponding commodity price indexes and combining the resulting commodity quantity indexes of gross output and intermediate inputs by industry in a Fisher index-number formula

change at the elemental level, BLS should measure the price difference between the imported item and the domestic item it replaces.

Because of the rapid entry and market share expansion of low-cost suppliers from developing countries in recent years, the empirical focus of this paper is on price biases arising from offshoring. However, it should be noted that the producer price index and the input price index also would be biased with the entry of a new, low-cost domestic suppliers of intermediate inputs. The relevant price change is the discount the new supplier offers, which will not be measured even when the new entrant is introduced into PPI sample because the index is constructed from observations on period-to-period changes in the sales price received by individual suppliers.

Bias in price indexes arising from a shift in sourcing to a new, low-cost domestic or foreign supplier is analogous to outlet substitution bias in the CPI literature (Houseman 2008, Diewert and Nakamura 2009). Building upon Diewert (1998), which characterizes outlet substitution bias to the CPI, Diewert and Nakamura (2009) note that the bias to the input price index from a shift in sourcing to low-cost domestic or foreign suppliers is proportional to the percentage difference in the prices of the new and old supplier and to the growth in market share of the low-cost provider. Diewert and Nakamura derive the magnitude of the bias by taking the difference between the growth rate[13] in the true index (P_T) that captures substitution and the measured growth rate in the Laspeyres index (P_L). The bias (B_O) to the rate of expansion in the Laspeyres price index may be characterized as:

(1) $$Bo = P_L - P_T = (1 + i)sd,$$

[13] All the rates of growth expanded upon within this section are gross rates, i.e, one plus the net rate.

where (1+*i*) is the rate of price change for the high cost input supplier, *s* is the share of the inputs supplied by low-cost importers, and *d* is the percentage discount between the low cost importer over the substituted inputs.[14]

Evidence suggests widespread shifts in sourcing not only from domestic to low-cost foreign suppliers but also from relatively high-cost foreign suppliers toward new, low-cost foreign entrants.[15] Figure 3 presents import shares for the purchased materials used by the 19 U.S. manufacturing industries included in the GDP-by-industry accounts. These shares are broken out by the development status of the country from which the materials are sourced.[16] These shares have increased markedly both for durable and nondurable manufacturing industries between 1997 and 2007. Moreover, in most industries, the import share of materials from developing countries—which we confirm below have a particularly large price discount—has increased the fastest.[17]

Unlike the PPI, the import prices program surveys the purchaser, rather than the seller, of the items sampled. Thus, it is possible that a price change associated with such shifts in sourcing among foreign suppliers will be captured in the import price index. The key to capturing the price change is that when the shift to the new source occurs the imported item from the new source is not treated as a new series but rather as a continuation of the old item. Suppose, for example, that a manufacturer purchases a specific part from a wholesale importer that, in turn, shifts its sourcing of the part to a lower-cost provider in a different country. A shift in sourcing the item from one country

[14] As in Diewert (1998) the discount term *d* is assumed to be constant in the two periods and the period to period rate of growth in the imported input prices is the same as the supplanted intermediate inputs.
[15] See, for example, Byrne, Kovak and Michaels (2009) for evidence of such shifts in the semi-conductor industry.
[16] Our country-level breakout is described in greater detail below.

to another will be flagged as a change in a trade factor, which may trigger the discontinuation of one series, the introduction of a new series, and hence a break in the price series. If, however, the importer confirms that the item from the new source country is identical to the one it replaces or if it can adjust for any quality differences, the series will be continued and the price change from the shift in sourcing will be recorded. If, instead, it is a different wholesale importer that purchases the item from the new, low-cost foreign supplier and, in shifting source countries for its imported parts, the manufacturer simultaneously changes import wholesalers, the price change will be missed.

Descriptive evidence of problems with import and input price indexes

It is commonly believed that biases to price indexes from the introduction of new goods or—what is observationally equivalent in the data—the entry of a new supplier of existing goods, is not large because a) at any point in time the number of new goods or new suppliers is small, and b) the market share of new products or new entrants is small (Aizcorbe, Corrado, and Doms 2003). With respect to the first point, however, recent research points to high product turnover in the import data. Broda and Weinstein (2006) report that fully 33 percent of imports in 2001 were in detailed product codes (10-digit Harmonized System) that did not exist in 1990 or from countries that did not export those commodities in 1990. Extending Broda and Weinstein's tabulations, we find that 31 percent of US imports in 2007 were in detailed product-country pairs that did not exist in 2001. These large changes in the product classification and in the composition of countries exporting products to the United States are broadly indicative of rapid changes in the structure of US imports. In complementary findings, Besedes and Prusa (2006) analyze publicly available import data at the product level and show that the median spell of imports lasts only about 1 year, while 70 percent of import trade spells last roughly 2 years. Consistent with this large amount of product churn, Nakamura and Steinsson (2009) find that roughly 4½ percent of products are replaced each month in the sample compiled by the import prices program.

The second point—that biases to price indexes are small because market shares of new products or new entrants are small—assumes that subsequent growth in market share of new goods or new suppliers will be the result of subsequent relative price changes, which can be measured. In the context of firm demand for intermediate inputs, the theory implicitly assumes that firms adjust instantaneously to changes in relative input prices and thus are always on their long-run demand curve. In other words, the theory on which the premise is based is comparative static in nature and lacks any modeling of the dynamic process by which firms adjust to relative price changes. However, because adjustment costs are likely to be sizable in the short run, it is plausible that persistent and even large differences in price levels would exist, particularly during dynamic periods characterized by large structural shifts in global production.[18]

Recent studies based on the micro data from the import prices program suggest that much of the dynamic in import prices is being missed in the BLS indexes. In addition to evidence of high levels of product replacement—in which case there is a new

[18] In practice, firms often face substantial short-run costs to changing suppliers, but those costs likely decline over time. Firms, for example, may learn of a new, lower-priced source for inputs with some lag, or it may take time to verify the quality of the new source. Firms may also have supply contracts that can be broken in the short-term only at high cost. In addition, firms may respond to new opportunities to produce at lower average cost overseas with a long lag because they have large sunk costs in existing facilities (Byrne, Kovak, and Michaels 2009). Finally, once the decision is made to offshore operations, it may takes considerable time to set up facilities overseas.

product or a new supplier and the price change is missing—Gopinath and Rigobon (2008) and Nakamura and Steinsson (2009) find considerable rigidity in the prices reported by the IPP. In particular, Nakamura and Steinsson (2009) report that 45 percent of prices in the IPP have no price changes and more than 70 percent have two price changes or less.[19]

Whatever the reason for the rigidity in import prices, the stylized fact is important because if the import price for a particular product registers most of its relative price change *after* entering the US market, such a dynamic, in theory, might be picked up by the IPP. The growth in market share of low-cost imports from developing economies no doubt reflects continual productivity gains in those countries, quality improvements, and declines in quality-adjusted product prices. Yet, the combination of high rates of product replacement and price rigidity in ongoing products suggests that the import price index is not picking up this dynamic. We now present some direct evidence on this problem for the case of imported intermediate materials used by U.S. manufacturers.

Quantifying and interpreting our measure of bias due to shifts in sourcing

Although we provide preliminary estimates of biases that arise from offshoring in manufacturing—i.e. shifts in sourcing from a domestic to a foreign supplier—our empirical focus in this paper is on assessing biases due to shifts in the sourcing of intermediate goods among foreign countries. To measure the shift in sourcing from high

[19] Nakamura and Steinsson offer two possible reasons for the observed price rigidity: 1) exporters face menu costs of changing prices of ongoing products and implement price changes when they introduce model changes, and 2) the survey instrument, which allows reporting establishments to check a box of "same price" for ongoing items, biases respondents towards reporting no price change. In addition, new suppliers are likely to experience their largest productivity improvements and quality adjusted price changes in the early stages of production. If there is a lag in the introduction of a product to the IPP sample, the initial period of potentially large price changes will be missed.

to low-wage countries, we categorize countries into one of three groups—developing, intermediate, and advanced—based on the country's per capita GDP in 2008. We classify countries with less than 20 percent of U.S. per capita GDP 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. A comprehensive list of countries by category is provided in Appendix Table 1.[20]

As described in more detail below, we construct an empirical measure of the price discount, *d*, in equation (1) for imports from both developing and intermediate countries at the transactions level within narrowly defined product groups. The discount is expressed relative to the corresponding price for imports from advanced countries. Similarly, the market share term, *s*, is defined at the detailed commodity level for both developing and intermediate countries. We then compute the bias for each detailed commodity and use this measure to adjust the detailed import price measures provided to us by BEA. The adjusted import prices are then used to adjust the input cost measures in our growth accounting analysis of the U.S. manufacturing sector.

By calculating equation (1) in this manner, our intention is to gauge the significance of failing to account for levels differences in prices when U.S. firms shift their sourcing of intermediate goods from suppliers in advanced countries to ones in developing or intermediate countries. The bias is a function of the growth in the import

[20] We classify the Middle East oil-producing countries as intermediate, although per capita GDP exceeds two-thirds of U.S. per capita GDP on account of their oil revenues. In addition, we classify Singapore, Hong Kong and Brunei as intermediate although in recent years their per capita GDP has been at or somewhat higher than our cut-off level. Below we report evidence of large differences in observed price levels of imports from these countries and those from advanced countries within detailed product categories, which provide a justification for classifying these borderline countries as intermediate.

share captured by the supplier located in a developing or intermediate country and its price relative to suppliers in advanced countries. In addition, as it is implemented here, to the extent that shifts in sourcing from domestic to foreign suppliers manifest themselves as newly imported goods, our bias term should also capture some of the bias to input prices due to offshoring.[21]

III. Evidence on the Import Discount from IPP Microdata

As mentioned, we use microdata collected by the IPP to construct an empirical proxy for *d,* which we define as the relative output price of low-wage exporters to the U.S. These relatives are constructed at the level of transactions within narrowly defined product groups over the period September 1993 to May 2007. When an item enters the IPP sample, a detailed description is collected and the reporting importer is asked to update the price for that specifically defined item (i) over time (t). Items are identified by an array of transaction and product characteristics, including: country of origin (c), Harmonized System 10-digit product code[22] (j) and the unit of measure (e.g., pound, kg, container, etc.) in which the sale took place (u).[23]

[21] However, our measure will not capture any shifts in sourcing from high-cost domestic suppliers to low-cost domestic suppliers.

[22] The IPP has its own internal classification scheme which is slightly more aggregate than the HS10 codes, called classification groups. The purpose of those groups is to combine related categories to an appropriate mass of imports where sampling is relatively sparse. In the majority of cases classification groups map uniquely to HS10 codes, and in the majority of the remainder to only 2, and so we use HS10 to describe both types of category.

[23] Other item fields include shipping information, price collection details as well as flags for transfer prices and missing value imputations. In certain instances where comparability is feasible, instead of starting a new series for a new item IPP staff will replace an item and make an adjustment to the price. These types of adjustment account for about 1 percent of the price observations and are treated as real prices.

As described above, we separate countries into three groups: advanced, developing, and intermediate, based on the country's per capita GDP in 2008 relative to the U.S.: $c \in A$ denotes the set of advanced countries; $c \in I$ denotes the set of intermediate-income countries; and $c \in D$ denotes the set of developing countries. The import price discount for an individual item in the developing set, and analogously for items from intermediates, is measured as:

(2) $$d_{iujt}^{c\in D} = \ln p_{iujt}^{c\in D} - \sum_{c\epsilon A} \sum_{u} \sum_{i} w_{\mathrm{ij}} * \ln p_{iujt}^{c\in A}$$

where w_{ij} is the item-level probability weight used by the IPP in aggregating to the HS10 product-level. d_{iucjt} can then be aggregated further using IPP item- and establishment-level weights; for instance, $d_{jt}^{c\in D}$ is the average discount for developing country c in product *j* at time *t*. Aggregation of $d_{iujt}^{c\in D}$ across time periods and products uses fixed weights; for example, China's growing market share and compositional shifts into new and larger product groups do not feed back into a greater weight to China's differentials.

Figure 4A illustrates the magnitude of d for developing and intermediate-income exporters by NAICS 4-digit product code in the manufacturing sector. The vast majority of relative prices are negative with an average log price difference of -1 for the developing group and -0.88 for the intermediate group. There is a substantial amount of heterogeneity in the import discount across product: both the left (i.e., food, beverage, textiles, apparel) and middle (i.e., wood, fuel, chemicals, plastics, minerals) portions of the product spectrum are characterized by significant dispersion in both discount magnitude as well as the difference between developing and intermediate, whereas the right (i.e., machinery, electronics, semiconductors, transportation) is characterized by large cross-product variation but smaller differences between developing and intermediate prices. Weighting the products by their overall size in U.S. imports (Figure 4B) shows that where the bulk of mass resides, to the right of the figure, developing country discounts tend to range between -0.5 and -1.5 and lie systematically below the intermediate export prices for the same products.

The left-most column of Tables 1A and 1B break out the import discount at the country level. For the developing countries, with the exception of Argentina and some smaller exporters, all price differences are negative, with Bangladesh, Bolivia, China, India, Nicaragua and Pakistan notably low. For the intermediate countries, all price differences, save Croatia and Venezuela, are negative, with Hong Kong, Hungary, Poland and Taiwan notably low.

As exporter productivity and the macroeconomic conditions of each country evolve, export relative prices can be expected to adjust accordingly. The third column of Tables 1A and 1B shows the estimates a time trend for *d* by country.[24] There does not seem to be an overall trend for the narrowing or widening of the discount relative to the advanced set of exporters, though there are many instances of significant trends in either direction. Brazil, India and the Ukraine are among the larger exporters 'catching up', whereas Colombia, Honduras, Pakistan, Russia and Thailand are among the countries with widening price gaps.

[24] The estimates are the α_1 coefficients from the following regression and can be interpreted as the annual percent change in the relative import price within an HS10-country pair:

$$d_{iujt}^{c} = \alpha_0 + \alpha_1 * year + \sum_{j} \sum_{c} \alpha_{2cj} * dummy_{cj} + \varepsilon_{iujt}$$

Adjusting the Import Discount for Quality Differences

Of course, the raw relative prices described above ignore a large source of cross-country variation, namely the compositional differences in quality specifications of exports. Indeed, even a cursory look at the detailed item descriptions collected by the IPP reveals an enormous array of differentiation at the item-level. Unfortunately, these descriptions are not collected in a systematic enough manner so as to make hedonic pricing feasible for the majority of import categories, meaning quality characteristics at the item level remain effectively unobservable.

Several recent empirical studies have sought to quantify the scope of quality differentiation (i.e., the length of quality ladders) at the level of disaggregate products, by making inference from various moments of the price data. We use estimates of product quality scope from Mandel (2009)[25] to approximate the degree to which low-wage exporter relative prices are driven by quality differences. Under this approach, which is described in greater detail in the Appendix, the quality-adjusted price is the observed price normalized by quality to obtain a comparable measure of price across items. The key assumption for identifying quality differences is that the dispersion in observed item prices is proportional to the underlying dispersion in quality composition. This relationship is identified in the data by regressing the relative price of developing and intermediate-income exporters on a measure of product-level quality variance estimated

[25] In Mandel (2009), quality ladder length is structurally estimated using the higher order moments of the U.S. import price distribution and proxies for exporters' productivity distribution. The identification strategy is predicated on the relationship between the output price and relative size of exporters. A negative relationship between price and size denotes a narrow scope for quality differentiation: high-price producers obtain a smaller market share, as predicted by standard models of monopolistic competition (i.e., with horizontal differentiation only). Conversely, a positive correlation between exporter price and size denotes a broad scope for quality differentiation, where quality is reflected in the ability of high-price producers to maintain their market share. For other variations on this identification strategy, see: Hallak and Schott (2008), Khandelwal (2009) and Baldwin and Ito (2009). The resulting product classification scheme covers approximately 1,100 HS6 codes for U.S. imports.

by Mandel (2009). After experimenting with several specifications, we ultimately chose the most conservative estimates for our subsequent analysis, i.e. the specification which ascribed the most observed price variance to quality.

The resulting product-level relative prices are illustrated in Figures 5A and 5B. As expected given the positive relationship between price and quality variance, there is a pronounced compression of the variance of quality-adjusted prices relative to the unadjusted set in Figures 4A and 4B, with developing and intermediate country relative prices increasing to about 30 and 15 percent below their advanced country counterparts, respectively. This large adjustment is driven by low-priced varieties in long quality ladder industries being given a correspondingly large boost upwards. In most cases, the ordering of developing versus intermediate country groups is preserved, with some exceptions.

The quality-adjustment also provides a basis for comparison between our estimates of the import discount and detailed industry studies where quality is observed. For example, Klier and Rubenstein (2009) find Mexican aluminum wheels to cost approximately 0.8 of the comparable U.S. product, with relative processing costs of about 0.64. These are similar to our log quality-adjusted relative price estimates for NAICS 3363 (Motor Vehicle Parts Manufacturing) of -0.27 or a price ratio of 0.76. Byrne, Kovak and Michaels (2009) find the price of identical semiconductors for China relative to the U.S. to be roughly -.85 and -.45, expressed as logs, for ‘leading edge’ and ‘mature’ technologies, respectively. Our unadjusted and quality-adjusted prices for developing countries in NAICS 3332 (Industrial Machinery Manufacturing) are -2.72 and 0.20, respectively, suggesting that in some cases the quality-adjustment may indeed be over-correcting for price differences due to import specification.

The second column in Table 1A shows the quality-adjusted relative price measures by source country. Notably large increases in relative price due to quality differences occurred in Bangladesh, Bolivia, Costa Rica, China, India, Kenya, Nicaragua, Pakistan and Sri Lanka. For the intermediate set of countries, there are instances in which the relative price flipped signs due to the quality-adjustment. The underlying reason for this is that low-priced producers in a long quality ladder industry would be expected to be the least competitive in a setting bereft of quality differences to the extent that their relative prices would be positive.

The penultimate column in Tables 1A and 1B shows the estimated relative price trends.[26] Since the estimation controls for the item characteristics of the developing/intermediate-sourced item in the numerator but not for the composition of imports from advanced countries in the denominator, we may expect the quality-adjusted trends to be negative as new and better varieties enter the denominator without corresponding price rises in the numerator. Indeed, we see that the relative price of individual items declines over time. The difference between the unadjusted and quality-adjusted relative price trends is a rough measure of the changes in quality composition by source country.

Overall, quality increases from developing countries were tantamount to 4 percent annual price increases, compared to 3 percent for the intermediate-income exporters.

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[26] The estimates are the α_1 coefficients from the following regression and can be interpreted as the annual percent change in the relative import price by individual item:

$$d^c_{iujt} = \alpha_0 + \alpha_1 * year + \sum_j \sum_c \sum_i \alpha_{2i} * dummy_i + \varepsilon_{iujt}$$

Over the sample period, notable quality increases took place in Brazil, China, Costa Rica, Ecuador, Egypt, India, Malaysia, Philippines, Poland and Venezuela. Notable downgrades took place in Colombia, Croatia, Dominican Republic, Pakistan, Russia and Zimbabwe. Nevertheless, even after implementing our quality adjustment, sizable price discounts remain for products from both developing and intermediate countries.

IV. Growth accounting

The traditional neoclassical growth accounting framework provides a useful tool to measure the effects of import price mismeasurement on multifactor productivity. Growth accounting decomposes the sources of growth among the factors that drive economic activity, i.e., capital, labor, intermediate inputs, and productivity—which is estimated residually. Our adjusted import price series allows us to calculate alternative estimates of the contribution to output growth from real imported intermediate inputs, and hence to re-estimate the residual, which is multifactor productivity. In what follows, we employ a gross output approach to measure the contribution of imported intermediates to economic growth which, as opposed to a sectoral output approach, fully accounts for the substitution between intermediate inputs at the detailed industry level.[27]

Growth rates will be denoted with hat-notation, where $\hat{y}$ denotes the real growth rate of y. The following assumes a general aggregate *k*, either an industry or aggregation over industries. The data required to estimate industry-level multifactor productivity

[27] Although the sectoral output approach is useful for measuring the contribution of foreign intermediates to overall growth, the two intermediate input categories are not comparable. This argument is similar to that by Jorgenson, et al, (2005a) where the authors favor a gross-output sources of growth decomposition over the value-added approach in order to identify the role of intermediate inputs.

include industry-level growth rates for gross output $\hat{Q}_k$, and industry-level growth rates for the production inputs, i.e. labor $\hat{L}_k$, capital $\hat{K}_k$, and intermediate inputs $\hat{M}_k$.[28]

Total intermediate inputs at the industry level, M_k, can be decomposed into several components,

$$M_k = M_k^D + M_k^F + E_k + S_k,$$

where k denotes the industry aggregate, D and F denote domestic and foreign, and E_k and S_k are energy and services, respectively.[29] For this decomposition of total intermediate use, the sum $(M_k^D + M_k^F)$ is the total value of materials Mat_k for industry *k*. The above decomposition of intermediates inputs into materials, energy, and services is achieved through use of BEA's KLEMS decomposition, whereas the split of non-energy and non-services materials into a domestic and foreign component is performed using the BEA import commodity matrix. We also define the cost shares for each input for industry *k* $(s_k^L, s_k^K, s_k^{m^D}, s_k^{m^F}, s_k^S, s_k^E)$, where the weights are two-period averages of the factor cost to the total cost for all input factors for aggregate *k*.

Price indexes for the various components are available from the BEA's industry annual accounts at the GDP-by-industry level. To calculate the real growth of domestic materials purchases, we derive a domestic materials price index using total materials prices from the industry accounts and commodity-level data on imports and import prices provided to us by the BEA. Given prices and nominal values for total materials

[28] The definitions and notation presented here are similar to those presented in Corrado, et. al. (2007).
[29] We do not decompose services into a domestic or foreign split in order to quantify a separate contribution to output growth. Services trade expanded little over our time frame and is about 15 percent of total imports to the U.S. Additionally, roughly 60 percent of all trade in services is related to travel, 8 percent is royalty and license fees, and 6 percent education related. The remaining 25 percent of services imports include business, professional, and technical services, and financial insurance and telecommunication services.

purchases (Mat_k) and prices and nominal values for imported materials, the price index and nominal values for domestic materials purchases (M_k^D) are calculated by chain stripping the real values of imported intermediates from the real value of total materials.

Given the aforementioned definitions, we define productivity growth as:

$$M\hat{F}P_k = \widehat{Q_k} - \left(s_k^L \hat{L}_k + s_k^K \hat{K}_k + s_k^{m^D} \widehat{M_k^D}, + s_k^{m^F} \widehat{M_k^F} + s_k^S \widehat{E_k} + s_k^E \widehat{S_k}\right)$$

Once the estimates of productivity are calculated for each of the 19 GDP-by-industry manufacturing industries *k*, we then obtain estimates of productivity for the entire manufacturing sector, and for the durable and nondurable manufacturing subsectors, by aggregating industry-level productivity measures with gross output weights.

Data for the growth accounting framework

Multiple data sources are required in order to estimate industry-level multifactor productivity and the contribution of foreign intermediates to growth. Gross output, intermediate inputs, and their respective prices come from BEA's GDP-by-industry accounts. Industry-level capital stock was derived from BEA's detailed asset-by-industry net stocks. Asset-by-industry capital stocks are aggregated using ex-post rental prices following the Jorgenson-Griliches (1967) approach used by BLS. The detailed capital asset types are aggregated into two components, information technology (IT) and other capital (equipment, structures, and inventories).[30]. The labor input is measured by changes in the hours worked of all persons (employees and self employed) with no explicit differentiation by characteristics of workers. Instead, following Corrado, et al. (2007), the hours worked series from the BEA are implicitly adjusted using the Census

[30] Information technology is defined as computers, communications equipment, and software. The tabulated results do not include the decomposition of capital between IT and other capital as the focus of this paper is on the contribution from foreign intermediates.

Bureau's County Business Patterns file, which provides additional information on employment and payrolls at the detailed industry level.

Imported intermediate inputs and their respective prices are derived from a combination of published and unpublished BEA data. The value of imported inputs is available at the detailed commodity and industry level for the years 1997 through 2007. As noted, BEA calculates the value of imported commodities used by each industry by assuming that each industry uses imports of a commodity in the same proportion as the overall ratio of imports-to-domestic supply of the same commodity. This approach has been used in multiple studies pertaining to offshoring and the use of imported intermediate inputs, starting with Feenstra and Hanson's outsourcing work (1996 and 1998) and is also described in Yuskavage, et al, (2008). The BEA also provided us with detailed imported commodity price indexes. These indexes are constructed through the use of a concordance between the Bureau of Labor Statistics' SITC import price indexes and BEA's commodity (item) codes. When there is not a concordance between the BLS price measures and the BEA commodity codes, the BEA constructs its own end-use import price index. Taken altogether, we have data on 272 imported commodities, representing more than half of the approximately 500 detailed BEA commodity codes.

V. Results

Alternative import price measures

As discussed above, if import prices are biased from a failure to account for shifts in sourcing, then the contribution of real imported intermediate materials to economic growth will also be understated, and productivity growth will be overstated. In this section, we derive three alternative import price series which we use in the growth accounting analysis that follows.

Alternative 1: IPP=PPI: The first, and a natural starting point for the comparison, would be to estimate an import price index, based on an assumption of similar quality and no specialization and that there should be a cost benefit to importing intermediates from abroad.[31] Part of the rational for starting with this scenario is that, as reported earlier, we have seen dramatic shifting in the shares of imported intermediates for domestic intermediates, which should result from a sustained relative cost advantage for imported intermediates. Specifically, we set the 5-digit commodity level import prices indexes equal to their domestic counterparts in the PPI whenever domestic prices were found to grow at a slower rate over the entire 1997 – 2007 period. When the expansion of the PPI falls below that of the import price series, we replace that series and aggregate up the new composite set of import prices. All told, out of 524 commodity codes, 317 are populated with prices, and 107 are replaced with the analogous producer price index. The adjusted imported materials price index from this experiment, as depicted by the solid (blue) line in Figure 1b, increases only 17 percent over the time period of interest, a substantially lower rate of growth than the 53 percent pace implied by the official values.

For the next two alternatives, we apply equation (1) to the import price index in order to estimate the bias due to shifts in sourcing. This equation is decomposed for two

[31] It is important to note that this scenario is primarily made to provide a basis for comparison, as it does not address the levels differences between domestic and foreign prices. It could be the case that import prices are advancing rapidly from a very low level relative to domestic input prices.

of our country classifications and the bias correction applied at the 6-digit commodity level is as follows:

$$P_T = P_L - [(1+i)s_d d_d + (1+i)s_i d_i], \qquad (1')$$

Once again, P_T is the bias-corrected commodity price index, P_L is Laspeyres commodity price index, $(1+i)$ is the rate of price change for the commodity-level Laspeyres import price index, s_i is the low-cost import market share for *d* the developing country classification and *i* the intermediate country classification. The d_i's in equation (1') are the aforementioned discount for a specific country classification *i* as estimated from the IPP microdata.

Alternative 2: unadjusted d's: For our second alternative price index, we apply equation (1') using the non-quality adjusted *d*'s (unadjusted *d*'s) estimated from IPP microdata. From Tables 1A and 1B, the unadjusted *d*'s for both our developing country classification and intermediate country, when averaged over countries within the classification, imply a discount relative to advanced country imports of roughly 63 percent for the developing country classification and 59 percent for the intermediate classification.[32] The discount for each country classification is estimated at the 4-digit NAICS level of aggregation and is used, in conjunction with the corresponding market share values, to adjust the import prices provided to us by BEA. The resulting imported materials price index is plotted as the dashed (red) line in Figure 1b. While this index lies above that of the first alternative (IPP=PPI) for most of the period of interest, both series exhibit very similar growth patterns, with the unadjusted *d*'s series increasing 17¾ percent from 1997-2007.

[32] The numbers in table 1 are log differences, so taking one less the exponent of the values in the table will allow us to estimate the percent discount, which is used to apply equation (1').

Alternative 3: quality-adjusted d's: As discussed, some of the large import discount used in alternative 2 may in fact reflect differences in import quality. To address this concern we apply the alternative set of *d*'s, described in Section 3, to derive our third alternative price series. The country classification discounts in the case of the quality-adjusted *d*'s are 25 and 14 percent for developing and intermediate classifications, respectively. Using the quality adjustment to correct the bias reduces the differential between the "published" import price index and our third alternative, as shown by the green line in Figure 1b. However, even with these conservative estimates of price differentials there continues to be a significant difference between two indexes, with the quality-adjusted price index increasing just 37 percent from 1997 to 2007 as compared to the 53 percent gain in the "published" index.

Table 2 summarizes the growth rates of the various materials price indexes used throughout the paper. Total MPI is the total materials price index that includes both domestic and foreign intermediates. The domestic series is the chain-stripped domestic price index backed out by using nominal values for domestic, foreign, and total materials inputs, and both the import and total materials price indexes. The final three columns present the three alternatives just discussed and which we now use in our growth accounting analysis.

Growth accounting: baseline results

We begin with a baseline set of estimates derived from the unadjusted data. Our empirical decomposition of output growth for U.S. manufacturing, including aggregates for total, durable, and nondurable manufacturing, and the 19 individual GDP-by-industry sectors can be found in Table 3, which presents the average annual rate of growth from 1997 to 2007 for real gross output and each of the sources of growth. The sources of growth are contained in columns 1 though 8, including MFP, capital, labor, energy, services, and domestic and foreign materials. The contributions from MFP and each factor input (columns 2-8) sum across the row to equal the growth in gross output. The first row in Table 3 reports the decomposition for manufacturing as a whole, while the subsequent rows show decompositions for the various subsectors and industries.

We estimate that real output growth for manufacturing averaged 1.2 percent between 1997 and 2007, with most of the output gains driven by the durable goods producing sector. Contributions from MFP, capital, services, and foreign materials all played important roles over the time period of interest; however, the sources-of-growth vary notably across industries. In particular, while MFP growth is a contributor to output gains across all sectors, industries such as primary metals recorded negative contributions from both capital and services inputs. On the other hand, the contribution to growth from labor, energy, and domestic materials were, on balance, negative. Taken together, our baseline growth accounting results present a picture in which MFP is the predominant contributor to the output in the manufacturing sector, with the gains averaging 1.3 percent for total manufacturing, nearly 2 percent for durables, and about 0.5 percent for nondurables producing industries.[33]

[33] According to BLS, manufacturing MFP growth averaged 1.8 percent for the period 1997 to 2006 (the last year available for the published estimates). In addition to different vintages of source data used in our analysis, there are several methodological differences which could explain the 0.5 percentage point discrepancy with our calculation. In particular, BLS uses a sectoral output concept for their manufacturing productivity program, while the analysis here is based on the concept of gross output. Indeed, the year-to-year growth rates of the underlying factor inputs—which unlike the contributions to growth do not depend on output weights—display very similar patterns.

As described further in Kurz and Lengermann (2008), imported materials were the second largest contributor to growth, making consistently positive and significant contributions in most industries. This stands in stark contrast to the contribution of domestic materials, which was consistently negative, and provides further evidence as to the extent to which U.S. manufacturers shifted their sourcing of intermediate materials from domestic to foreign suppliers during this period.

Growth accounting: alternative estimates

Table 4 contrasts the MFP and the foreign materials contributions from our baseline growth accounting results with estimates derived from the three alternative price scenarios described above. The year-to-year differences in MFP growth are also displayed in Figure 6. As we hold the domestic materials prices fixed at the values estimated in the baseline scenario, MFP will increase or decrease directly as a result of a change in the contribution of imported materials.

Alternative 1: IPP=PPI: The fourth and fifth columns of Table 4 show the MFP growth and imported materials contribution associated with the alternative price series that sets a commodity's import price index equal to the producer price index when the 1997 to 2007 growth rate is higher for import prices. For the manufacturing sector as a whole, MFP growth is reduced by an average rate of 0.25 percentage point per year, or by 20 percent over the entire period. Put another way, under this scenario, the bias to MFP is equivalent to the entire contribution of purchased services as shown in Table 3, and twice the size of the contribution of capital. Looking at the industry-level data, we find that the majority of the reallocation from MFP to foreign materials contribution takes place in durables manufacturing, with much of that difference fitting into the category of computer and electronic products manufacturing.[34] This evidence is consistent with Byrne, Kovak, and Michaels (2009), who find large discrepancies between published import price growth for semiconductors and their estimates of price growth based on a comprehensive data on prices, quantities, and characteristics of imported semiconductors.

During a period when imported input shares are growing, without frictions theory would predict that relative prices of imported inputs to domestic inputs would be falling. By setting import price growth equal to domestic price growth where this condition is violated, we *arguably* provide a lower bound estimate of the bias from mismeasured import prices on manufacturing productivity over the period. This bias could derive from offshoring or related shifts in sourcing from high to low-cost foreign producers. It also could derive from other problems associated with measuring import prices, such as those discussed in Feenstra, Reinsdorf and Slaughter (2008). The next two estimates focus specifically on the bias arising from shifts in sourcing.

Alternative 2: Unadjusted d's: The sixth and seventh columns of Table 4 present our estimates for MFP and the contribution of imported materials after correcting for the bias in import prices from calculating equation (1') with d's that are not adjusted for quality. First, it is interesting to note that the "bias-corrected" MFP growth rate from 1997 to 2007 is almost identical to the above IPP=PPI scenario. This should not be entirely surprising given the similarity in the growth rates of the imported materials deflators derived under these two scenarios (Table 2). The results from the unadjusted d's lends additional support to our view that import price mismeasurement associated

[34] In the four-digit NAICS code 3341, the import share from our developing country category increased from 1¼ percent in 1983 to 75 percent in 2008. In contrast, the intermediate country import share fell from 31 percent to 16 percent and the advanced category dropped from 70 percent to 9¼ percent.

with sourcing shifts has led to an overstatement of manufacturing MFP; once again, we see average productivity growth is reduced by about 0.25 percentage point from 1997 to 2007 and by 20 percent over the entire period.

Alternative 3: Quality-adjusted d's: The final two columns in Table 4 contain the results from using the quality-adjusted d's to correct for sourcing bias. By moving from about a 60 percent discount for developing countries to roughly a 25 percent discount, the quality adjustment tempers the effect on MFP that we observed in the previous two alternative scenarios. The revised measure of average MFP is reduced by 0.1 percentage point from 1997 to 2007. At face value, this may seem inconsequential, however, it is equivalent to the contribution of capital over our time period. Moreover, even using these conservative estimates of d we find that manufacturing productivity is roughly 9 percent lower over the entire period.

Accounting for mismeasurement due to domestic to foreign sourcing[35]

It is important to note that due to the nature of the outlet substitution bias correction being applicable to Laspeyres price indexes, we have been correcting for the substitution *within* the import price index and passing alternative price series through our growth accounting framework. A different, and no less important phenomenon, is the switching of sourcing from domestic to foreign sources. It is no doubt just as likely to result in a form of sourcing bias, just not one that, at this point in time, has a closed form solution, and that is applicable given a set of discounts, shares, and prices. In order to attempt to address the substitution between domestic and foreign sources we apply

[35] This section presents a back-of-the envelope attempt at quantifying the bias imparted from domestic-to-foreign shifts in sourcing on intermediate input prices. We are in the process of updating the results for a true reduced form domestic to foreign outlet substitution bias formula.

equation (1') to total intermediates (i.e. not just to imported materials) by using the developing and intermediate import shares of total materials usage and adjusting with the non-quality and quality adjusted d's.[36] The results to this exercise can be found in Table 5.

As in Tables 3 and 4, the first column in Table 5 presents the industry definitions, while the second presents the baseline MFP estimates from the "published" data. The two columns labeled foreign outsourcing bias present the non-quality adjusted and quality adjusted MFP growth rates. As with the previous results, the total materials price adjustment lowers average annual MFP growth by roughly two tenths in the unadjusted case and one tenth in the quality adjusted case.

While it is not the case that domestic-to-foreign and within-import substitution bias are mutually exclusive, the bias in import prices introduced by switching outlets within the Laspeyres import price index is not the same as the bias introduced into the composite Fisher index used to deflate intermediate materials. For instance, an increase in shares due to switching to a new imported product from a domestically-sourced product might be picked up by the application of equation (1'). Alternatively, if producers switch sources from a domestic provider to an extant foreign supplier already priced within the IPP, that discount and the share change reflects a component of offshoring bias not captured by equation (1').

[36] Thus, we are assuming here that the price discounts for products from developing and intermediate countries relative to their U.S. counterparts are the same as for advanced foreign economies.

VI. Conclusion

Imported inputs have risen dramatically as a share of inputs used in manufacturing over the last decade. Moreover, the composition of those imported inputs has shifted heavily toward low-wage economies. Despite these trends, measured price growth for imported materials inputs used in the manufacturing sector has greatly exceeded measured price growth for domestic inputs—a fact that is at odds with the surge in foreign inputs' market share. This anomaly provides strong prima facie evidence of mismeasurement in import and input prices and, by implication, an overstatement in manufacturing productivity.

Because imported input prices would be expected to grow less rapidly than domestic input prices, we argue that setting imported input price growth equal to domestic input price growth in detailed products where the former exceeds the latter provides a lower bound estimate of the mismeasurement in import and input prices arising from various sources. Our simulations suggest that over the decade from 1997 to 2007 the contribution of imported inputs to the growth in gross manufacturing output is roughly double that of the measured contribution and that multi-factor productivity is 0.2 percentage points, or about 20 percent, lower than measured.

We also examine biases that arise specifically from shifts in sourcing: from suppliers in advanced countries to suppliers in low-wage countries and from domestic suppliers to suppliers in low-wage countries. Using information on differences in unit value prices among imports from advanced, intermediate, and developing at the detailed (HS10) product level, we estimate that shifts in sourcing among foreign producers leads to a 0.1 to 0.2 percentage point decline (10 to 20 percent) in measured multi-factor productivity in manufacturing from 1997 to 2007. In addition, preliminary estimates that take into account shifts in sourcing of intermediate inputs from domestic suppliers to suppliers in low-wage countries show that multi-factor productivity in manufacturing could be reduced by another 0.1 or 0.2 percentage points over the period. All of our estimates adopt the assumption, also employed by BEA, that manufacturing industries use imported products in proportion to their overall use of the product in the economy. If manufacturers have engaged in relatively more (less) offshoring than other sectors, the biases would be higher (lower) than our estimates.

On net, our results indicate that bias to manufacturing productivity, and by implication value added, arising from shifts in the sourcing of inputs to low-cost foreign producers is substantial. The input price index proposed by Alterman (2009), if implemented, would help eliminate these biases. By sampling the purchaser of the inputs, the respondent, in theory, could accurately report the price change of a given item, irrespective of source. Conceptually, such an index would address price measurement problems when purchasers shift sources among foreign providers, between domestic and foreign providers, as well as among domestic providers.[37] Sampling purchasers also would eliminate errors in input price measurement that arise owing to violations of the import comparability assumption; input price changes would be measured directly and would not depend on assumptions about the fraction purchased from domestic and foreign sources.

[37] Capturing price changes in cases of outsourcing—i.e. when a firm shifts from producing the input internally to purchasing it—would be likely be missed, however, both because a transactions price would likely not exist when produced internally and because the item for the outsourcing purchaser would not be sampled at the time of the outsourcing.

In closing, we note that although we have limited our empirical examination to the measurement of imported intermediate goods used in manufacturing, the problem of offshoring bias is not limited to intermediate inputs, goods, or manufacturing. Almost all imported goods destined for final consumption—which represent slightly over half of all imported goods—enter into the U.S. supply chain in the wholesale or retail trade sectors. When, for example, Wal-Mart shifts from domestic to lower-cost foreign suppliers for various items it sells in its stores, the import price index likely will not capture the price drop enjoyed by Wal-Mart, although any cost savings the retailer passes on to consumers should be picked up in the CPI. The problem in measuring import prices in the case of services offshoring is more fundamental: no price series exists for imported business services, such as engineering, telemarketing, and computer programming services.[38] Thus, it is very likely that government statistics are not accurately capturing the real growth of imported services when American companies offshore. This gap in data could compound the mismeasurement in U.S. statistics if, as many predict, services offshoring rapidly expands in the near future.

[38] A recent initiative to begin collecting import price data on business services was the casualty of budget cuts.

Appendix: Adjusting the Import Discount for Quality Differences

The assumption used to identify quality differences in export relative prices is that the dispersion in observed item prices is proportional to the underlying dispersion in quality composition. To be concrete, let us define a quality-adjusted item price, q_i, and some measure of that item's quality, z_i. The quality-adjusted price is the observed price normalized by quality to obtain a comparable measure of price across items: $p_i = q_i * z_i$. The variance of (the log of) observed prices within an HS10 group can then be rewritten as a function of the variance of ln(z) and ln(q), as follows:

$$
\begin{aligned}
var_j(\ln p_i) &= \textstyle\sum_i \left(\ln p_i - \overline{\ln p_\iota}\right)^2 \\
&= \textstyle\sum_i \left(\left(\ln q_i - \overline{\ln q_\iota}\right) + \left(\ln z_i - \overline{\ln z_\iota}\right)\right)^2 \qquad (2) \\
&= var_j(\ln q_i) + var_j(\ln z_i) + 2cov_j(\ln q_i\,, \ln z_i)
\end{aligned}
$$

where $\overline{\ln x_\iota}$ is a geometric mean of variable x across items within an HS10 group. It is immediate that if the covariance of quality and quality-adjusted price were to be zero, then the variance of observed prices would vary one-for-one with the variance of quality. Recent empirical studies suggest that this covariance may be negative due to the positive links between exporter income and export prices (see, for instance, Schott (2004) or Hummels and Klenow (2005)); the implication is that richer, more productive countries export higher quality items, but with lower marginal costs per unit of quality. On the other hand, theoretical frameworks in which markups vary across producers suggest that this covariance may be positive. Under general specifications of industry demand such as the translog expenditure function, higher productivity exporters obtain a higher market share, and hence charge a higher markup over marginal cost. The partial effect of markups would be to increase quality-adjusted prices of the higher productivity, higher quality exporters, offsetting at least in part the marginal cost effect. Since no reliable measures exist for this covariance, and since there are offsetting theoretical rationale for its sign, we proceed by employing the simplifying assumption that it is zero. The variance of quality-adjusted prices from (2) is then approximated by the difference in the variance of observed prices and unobserved quality:

$$(3) \qquad var_j(\ln q_i) \cong var_j(\ln p_i) - var_j(\ln z_i)$$

This relationship is implemented in the data by regressing the relative price of developing and intermediate-income exporters on a measure of product-level quality variance estimated by Mandel (2009) and a quadratic term for quality variance:

$$(4) \qquad |d_{kjt}| = \alpha_0 + \alpha_1 * var_j(\ln z_i) + \alpha_2 * var_j(\ln z_i)^2 + \varepsilon_{kjt}$$

where the size of the country relative price, $|d_{kjt}|$, is an apt measure of intra-product price dispersion. Since quality variance measures are only available at the HS 6-digit level of aggregation, we estimate robust standard errors clustering HS10-country groups within HS6 categories. Table A1 displays regression results for (4) for two sets of U.S. import product groups. In the left panel, for all exporters the relationship is significant and positive, and particularly strong for the quadratic term; the variance of prices increases at an increasing rate with the variance of quality. Given that the relative prices are in reference to the advanced set by construction, product variance is better described by the relative prices of only the developing and advanced countries. The right panel shows results for that specification and, indeed, the estimates are larger for both the linear and quadratic terms.

Variable:	All countries (i)	All countries (ii)	Developing & Intermediate Countries (iii)	Developing & Intermediate Countries (iv)
var(z)	0.05	0.06 *	0.10	0.10 *
	(0.04)	(0.03)	(0.07)	(0.06)
var(z)^2		0.14 ***		0.28 ***
		(0.02)		(0.04)
n	505,800	505,800	132,407	132,407

Table A1: The correlation of price and quality variance

For our purposes, the most conservative estimates to use are those which ascribe the most observed price variance to quality. With this in mind, we apply estimates from specification (iv) to the construction of quality-adjusted relative prices as follows:

(5) $$\hat{d}_{kjt} = \begin{cases} d_{kjt} - \hat{\alpha}_1 * var_j(\ln z_i), & d_{kjt} > 0 \\ d_{kjt} + \hat{\alpha}_1 * var_j(\ln z_i), & d_{kjt} < 0 \end{cases}$$

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Country	Relative Price	Quality-Adjusted Relative Price	Relative Price Trend	Quality-Adjusted Relative Price Trend	Difference
ALGERIA	-0.17	-0.07	0.00	0.04 *	-0.04
ARGENTINA	0.37	0.41	0.04 **	0.03 **	0.01
BANGLADESH	-1.34	-0.53	0.07 *	0.09 **	-0.02
BOLIVIA	-1.33	-0.53	-0.15	-0.15	0.00
BRAZIL	-0.60	-0.19	0.06 **	-0.06 **	0.12
BULGARIA	-0.97	0.43	-0.01	-0.01 **	0.00
CHINA	-1.38	-0.43	0.00	-0.05 **	0.05
COLOMBIA	-0.72	-0.21	-0.22 **	-0.04 **	-0.18
COSTA RICA	-1.53	-0.60	-0.04	-0.29 **	0.25
DOMINICAN REP.	-0.98	-0.33	-0.17 **	-0.06 **	-0.12
ECUADOR	-0.51	-0.49	0.13 **	-0.09 **	0.23
EGYPT	-1.60	-0.34	0.09 **	-0.08 **	0.16
EL SALVADOR	-0.81	-0.19	-0.01	-0.10 **	0.10
GUATEMALA	-0.99	-0.25	-0.03	-0.03 *	0.00
HONDURAS	-0.23	0.09	-0.12 **	-0.01	-0.12
INDIA	-1.44	-0.66	0.03 **	-0.07 **	0.10
INDONESIA	-1.00	-0.09	-0.09	-0.10 **	0.01
JAMAICA	-0.41	0.25	0.03 **	0.00	0.03
JORDAN	-2.29	-0.91	0.12 **	0.07 **	0.05
KENYA	-1.76	-0.37	0.38 **	0.20 **	0.18
MACAO	-1.05	-0.15	0.02	0.41 **	-0.39
MALAYSIA	-0.80	-0.15	-0.01	-0.07 **	0.06
MONGOLIA	-2.20	-1.03	0.01	0.04 *	-0.03
NETHERLANDS ANT.	0.04	-0.44	0.00	0.00 **	0.00
NICARAGUA	-1.60	-0.47	0.02 **	-0.01	0.02
PAKISTAN	-1.64	-0.59	-0.13 **	-0.05 **	-0.08
PANAMA	0.51	-0.34	-0.05	-0.08 **	0.03
PERU	-0.52	-0.41	-0.05 *	-0.09 **	0.04
PHILIPPINES	-0.62	-0.11	0.02	-0.03 **	0.06
RUSSIA	-0.21	0.03	-0.14 **	0.06 **	-0.20
ROMANIA	-0.79	-0.18	0.03	-0.02	0.05
SRI LANKA	-1.49	-0.40	0.06 **	0.01	0.05
THAILAND	-1.14	-0.42	-0.08 **	-0.05 **	-0.03
TUNISIA	-0.88	0.49	-0.03	-0.03 *	0.00
UKRAINE	-0.80	-0.15	0.09 **	0.16 **	-0.08
VIETNAM	-0.64	-0.16	0.02	0.03 *	-0.01
ZIMBABWE	-0.90	0.23	0.05 *	0.14 **	-0.09
Total	-1.00	-0.29	0.00	-0.05 **	0.04

Table 1a: Import prices from developing countries (log difference relative to advanced)

Country	Relative Price	Quality-Adjusted Relative Price	Relative Price Trend		Quality-Adjusted Relative Price Trend		Difference
BAHAMAS	-1.88	-1.12	0.01		0.14	**	-0.13
BAHRAIN	-0.64	0.27	-0.04	**	-0.02	**	-0.02
BARBADOS	-0.04	0.66	0.06	**	0.06	**	0.00
CHILE	-0.51	0.29	-0.02	**	-0.05	**	0.02
CROATIA	0.44	-0.59	-0.22	**	-0.10	**	-0.13
CZECH REPUBLIC	-0.48	-0.01	0.21	**	0.26	**	-0.05
HONG KONG	-1.20	-0.40	-0.04	**	-0.06	**	0.02
HUNGARY	-1.35	-0.83	-0.03	**	-0.05	**	0.02
MEXICO	-0.79	-0.13	0.00		0.01	**	-0.01
POLAND	-1.13	-0.53	0.11	**	-0.02		0.13
PORTUGAL	-0.54	0.03	-0.06	**	-0.06	**	0.00
SAUDI ARABIA	-0.48	-0.16	-0.07	*	-0.11	**	0.05
SINGAPORE	-1.01	-0.30	-0.06	**	0.00		-0.06
SLOVAKIA	-0.36	0.24	0.09	**	0.19	**	-0.10
SLOVENIA	-0.91	0.06	-0.04		-0.12	**	0.08
SOUTH KOREA	-0.73	0.12	0.03	**	-0.03	**	0.05
TAIWAN	-1.17	-0.41	0.00		-0.07	**	0.07
TRINIDAD & TOB.	-0.12	0.99	-0.06	**	-0.07	**	0.01
TURKEY	-0.89	0.07	0.02	**	0.01		0.01
URUGUAY	-0.59	0.56	-0.03	*	0.00		-0.03
VENEZUELA	0.36	0.28	0.10	**	-0.05	**	0.14
	-0.88	-0.15	0.00	*	-0.03	**	0.03

Table 1b: Import prices from intermediate-income countries (log difference relative to advanced)

Table 2: Growth Rates for Price Indexes

Total MPI	Domestic	Import IPP	IPP=PPI	Adjusted d's	Quality Adj. d's
33.8	29.1	52.6	17.3	17.7	37.1

Table 3

Sources of growth for U.S. manufacturing industries, 1997-2007[1]

	Gross Output (1)	MFP (2)	Capital[2] (3)	Labor (4)	Energy (5)	Services (6)	Purchased Materials Domestic (7)	Purchased Materials Foreign (8)
1. **Manufacturing**	1.18	1.27	0.13	-0.51	-0.05	0.24	-0.18	0.27
2. *Durable goods:*	2.00	1.95	0.17	-0.63	-0.05	0.34	-0.14	0.36
3. Wood products	0.36	0.42	0.01	-0.33	-0.07	0.19	0.07	0.07
4. Nonmetallic mineral products	0.45	0.03	0.26	-0.25	-0.12	0.16	0.29	0.08
5. Primary metals	-0.76	0.75	-0.13	-0.78	-0.13	-0.24	-0.36	0.13
6. Fabricated metal products	0.48	0.74	0.11	-0.43	-0.06	-0.05	-0.01	0.19
7. Machinery	0.40	0.88	0.44	-0.76	-0.04	0.05	-0.58	0.40
8. Computer and electronic products	7.35	6.66	0.24	-1.10	-0.05	1.21	0.02	0.35
9. Electrical equipment, appliances, and components	-0.75	1.56	-0.09	-0.90	-0.05	-0.25	-1.13	0.10
10. Motor vehicles, bodies and trailers, and parts	1.36	1.05	0.09	-0.47	-0.02	0.28	-0.17	0.60
11. Other transportation equipment	1.35	0.84	0.31	-0.26	-0.02	0.27	-0.47	0.69
12. Furniture and related products	0.54	0.64	0.23	-0.60	-0.04	0.27	-0.21	0.25
13. Miscellaneous manufacturing	2.91	2.14	0.17	-0.73	-0.01	0.56	0.51	0.27
14. *Nondurable goods:*	0.16	0.45	0.07	-0.37	-0.04	0.14	-0.24	0.17
15. Food and beverage and tobacco products	0.76	0.12	0.00	-0.06	-0.03	0.56	0.05	0.12
16. Textile mills and textile product mills	-3.71	0.73	-0.19	-1.69	-0.21	-0.29	-2.03	-0.03
17. Apparel and leather and allied products	-9.45	0.92	-0.12	-3.05	-0.15	-1.59	-4.91	-0.55
18. Paper products	-1.32	0.04	-0.15	-0.71	-0.20	-0.06	-0.29	0.05
19. Printing and related support activities	-0.72	0.44	0.24	-0.83	-0.04	0.17	-0.74	0.04
20. Petroleum and coal products	1.01	0.20	0.10	-0.07	0.06	-0.17	0.36	0.53
21. Chemical products	0.97	1.32	0.16	-0.19	-0.07	-0.01	-0.35	0.11
22. Plastics and rubber products	0.72	0.37	0.16	-0.49	-0.04	0.18	0.23	0.30

1. Average annual rate for period shown. Column (1) is percent change. Columns (2) through (8) are percentage points.
2. Includes Non-IT equipment, IT Capital, (computers and peripheral equipment, software, and communication equipment), structures, and inventories

Note—For each row, column (1) equals the sum of columns (2) through (8).

Table 4

Import price mis-measurement and U.S. manufacturing productivity, 1997-2007

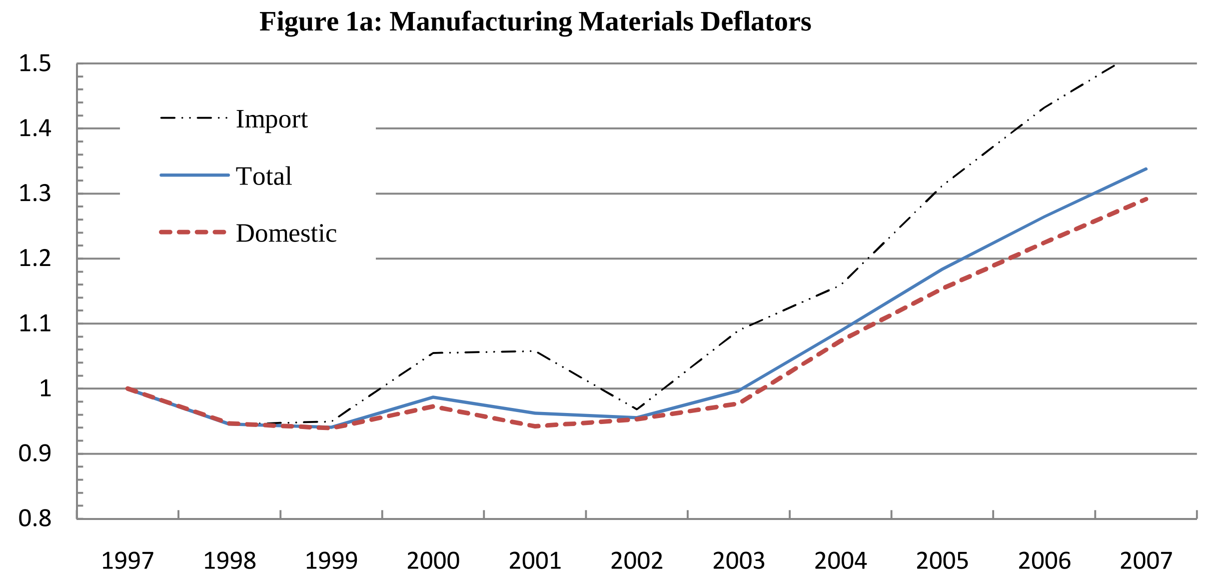
	Baseline:		*IMPPI=PPI*		*Subst bias correction*		*Quality Adj. Prices*	
	MFP	Foreign Materials	MFP	Foreign Materials	MFP	Foreign Materials	MFP	Foreign Materials
1. **Manufacturing**	1.27	0.27	1.03	0.51	1.02	0.52	1.16	0.38
2. *Durable goods:*	1.95	0.36	1.58	0.73	1.58	0.73	1.85	0.46
3. Wood products	0.42	0.07	0.37	0.13	0.36	0.13	0.40	0.09
4. Nonmetallic mineral products	0.03	0.08	-0.03	0.13	-0.02	0.13	0.02	0.08
5. Primary metals	0.75	0.13	0.51	0.38	0.73	0.16	0.75	0.14
6. Fabricated metal products	0.74	0.19	0.62	0.31	0.68	0.25	0.72	0.21
7. Machinery	0.88	0.40	0.73	0.55	0.68	0.60	0.83	0.45
8. Computer and electronic products	6.66	0.35	5.36	1.65	5.28	1.73	6.27	0.74
9. Electrical equipment, appliances, and com	1.56	0.10	1.28	0.39	1.26	0.41	1.48	0.18
10. Motor vehicles, bodies and trailers, and pa	1.05	0.60	0.91	0.74	0.80	0.84	0.98	0.66
11. Other transportation equipment	0.84	0.69	0.64	0.88	0.48	1.04	0.75	0.78
12. Furniture and related products	0.64	0.25	0.55	0.34	0.55	0.34	0.62	0.28
13. Miscellaneous manufacturing	2.14	0.27	1.96	0.45	2.03	0.38	2.12	0.29
14. *Nondurable goods:*	0.45	0.17	0.39	0.22	0.34	0.28	0.33	0.28
15. Food and beverage and tobacco products	0.12	0.12	0.09	0.15	0.11	0.13	0.12	0.12
16. Textile mills and textile product mills	0.73	-0.03	0.68	0.02	0.63	0.06	0.73	-0.03
17. Apparel and leather and allied products	0.92	-0.55	0.79	-0.43	0.82	-0.45	0.90	-0.53
18. Paper products	0.04	0.05	-0.03	0.13	-0.02	0.11	0.04	0.06
19. Printing and related support activities	0.44	0.04	0.40	0.08	0.40	0.08	0.44	0.04
20. Petroleum and coal products	0.20	0.53	0.19	0.54	-0.14	0.87	-0.41	1.14
21. Chemical products	1.32	0.11	1.25	0.18	1.25	0.18	1.30	0.13
22. Plastics and rubber products	0.37	0.30	0.30	0.38	0.22	0.46	0.35	0.32

Table 5

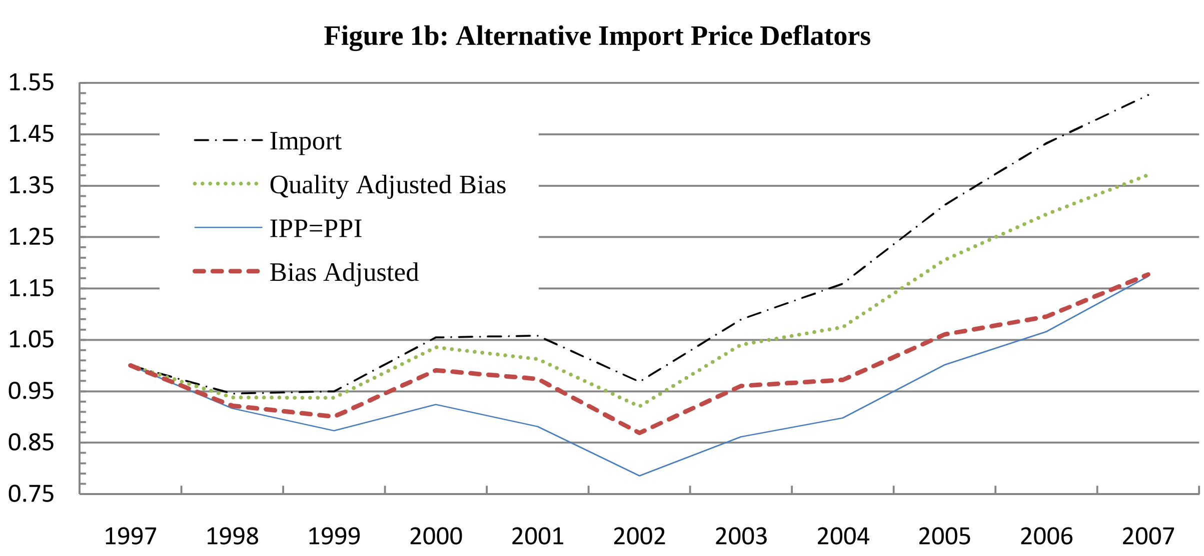
Foreign Outsourcing and the Bias to U.S. manufacturing productivity, 1997-2007

	Baseline MFP	*Foreign Outsourcing Bias* raw	*Foreign Outsourcing Bias* quality adjusted
1. **Manufacturing**	1.3	1.1	1.2
2. *Durable goods:*	2.0	1.7	1.9
3. Wood products	0.4	0.3	0.4
4. Nonmetallic mineral products	0.0	0.0	0.0
5. Primary metals	0.8	0.7	0.7
6. Fabricated metal products	0.7	0.7	0.7
7. Machinery	0.9	0.7	0.8
8. Computer and electronic products	6.7	5.8	6.5
9. Electrical equipment, appliances, and components	1.6	1.5	1.5
10. Motor vehicles, bodies and trailers, and parts	1.0	0.8	1.0
11. Other transportation equipment	0.8	0.6	0.8
12. Furniture and related products	0.6	0.5	0.6
13. Miscellaneous manufacturing	2.1	2.0	2.1
14. *Nondurable goods:*	0.4	0.4	0.4
15. Food and beverage and tobacco products	0.1	0.1	0.1
16. Textile mills and textile product mills	0.7	0.6	0.7
17. Apparel and leather and allied products	0.9	0.7	0.9
18. Paper products	0.0	0.0	0.0
19. Printing and related support activities	0.4	0.4	0.4
20. Petroleum and coal products	0.2	0.2	0.2
21. Chemical products	1.3	1.3	1.3
22. Plastics and rubber products	0.4	0.4	0.4

Figure 1: Price Indexes in Manufacturing



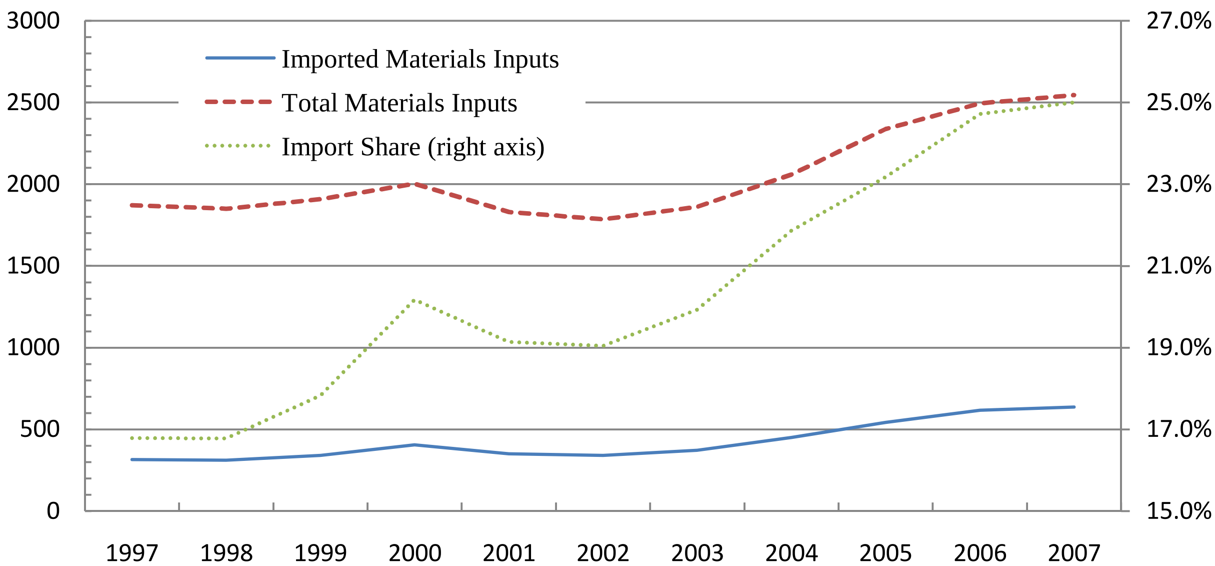
Source: BEA and BLS



Source: BEA and BLS

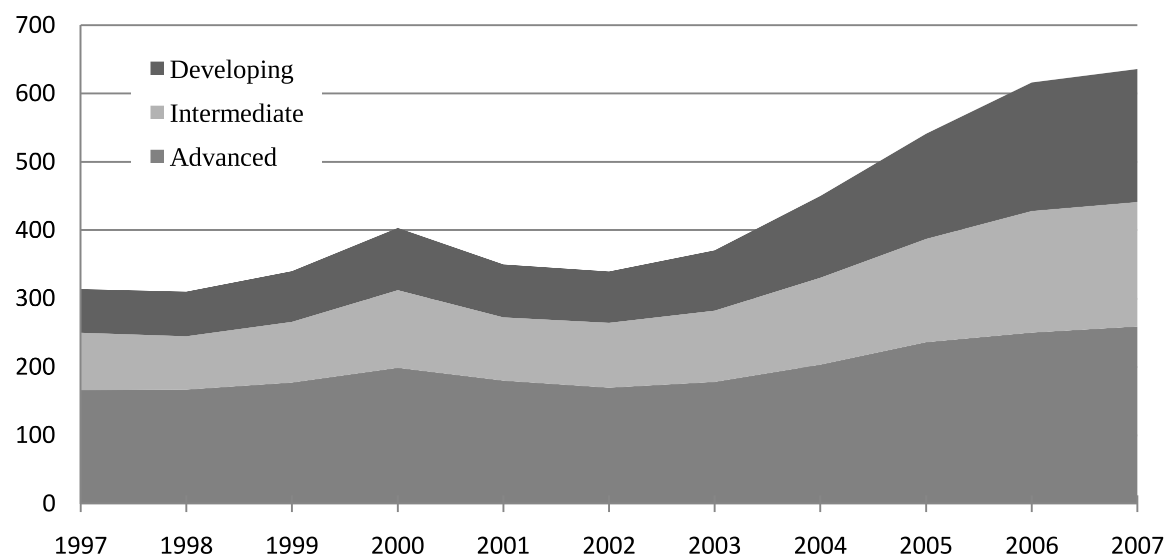
Figure 2: Materials Usage in Manufacturing

Figure 2a: Materials Inputs in Manufacturing



Notee: Values in billions of dollars; Source: BEA Annual Industry Accounts and Import Microdata

Figure 2b: Imported Materials Usage by Country Type



Note: Values in Billions of dollars; Source BEA Annual Industry Accounts and Import Microdata

Figure 3a: Import Shares of Purchased Materials

by Development Status

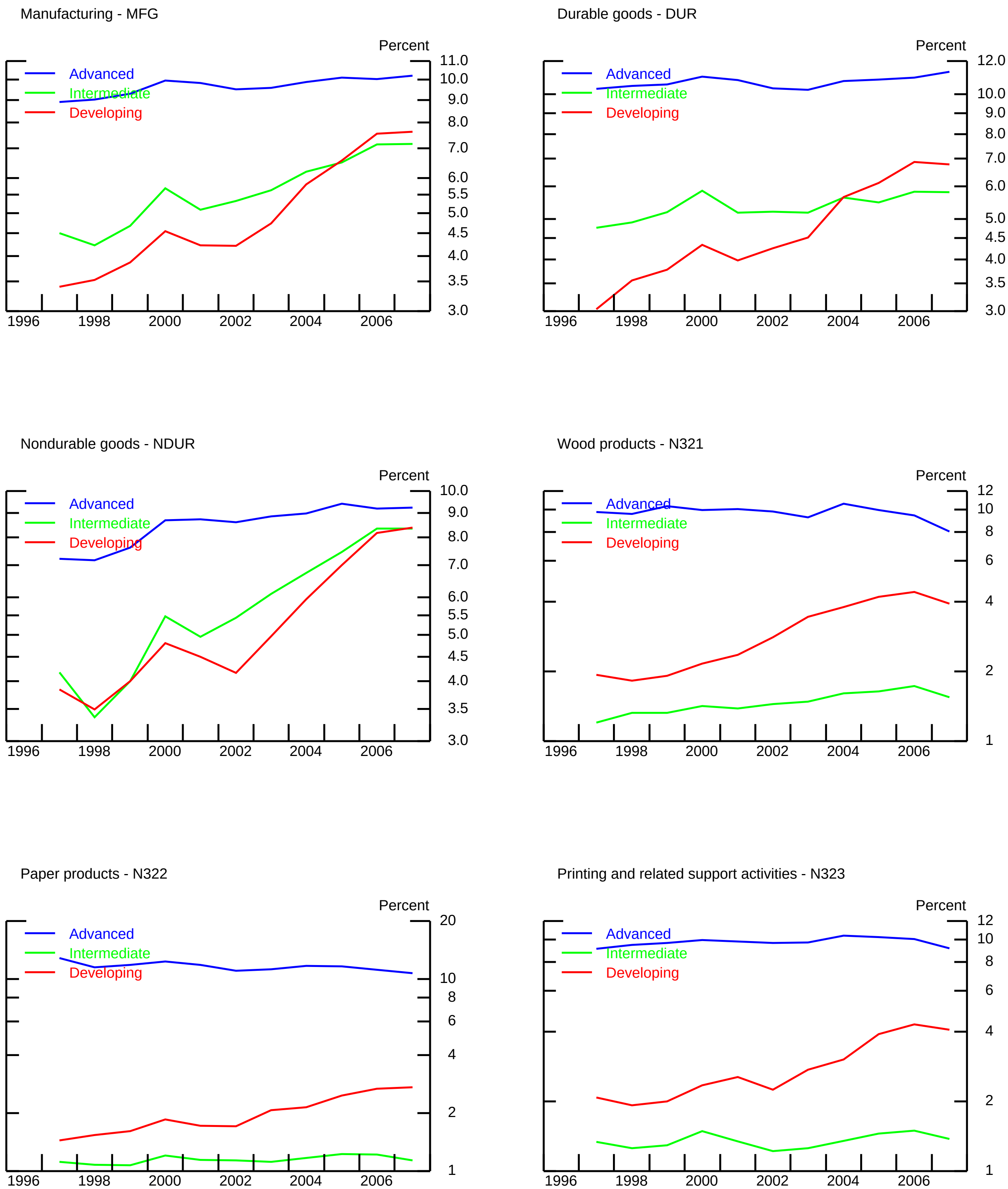
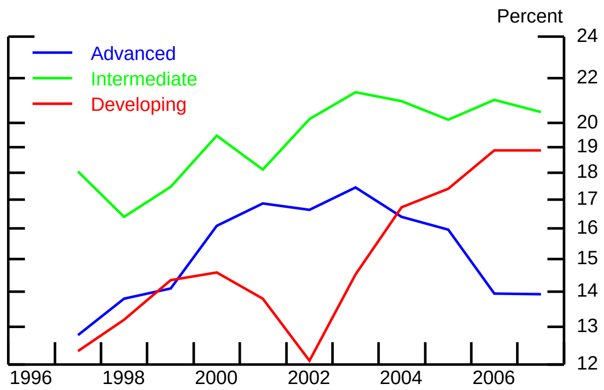


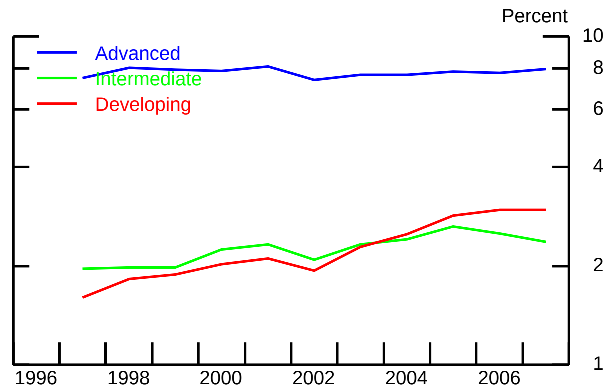
Figure 3b: Import Shares of Purchased Materials

by Development Status

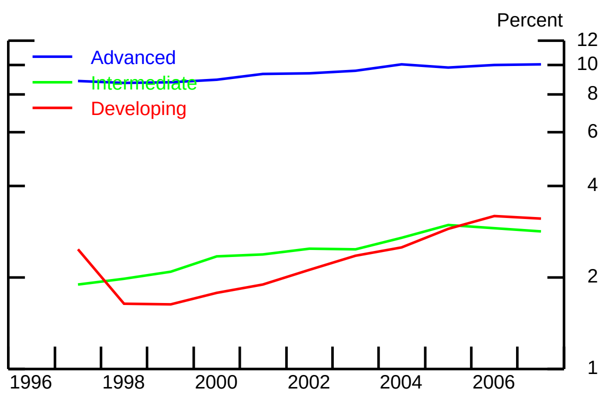
Petroleum and coal products - N324



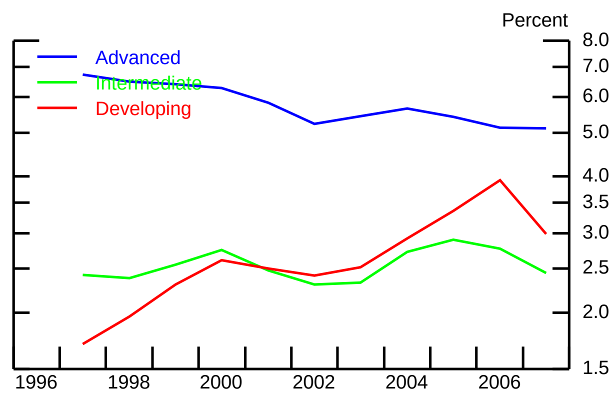
Chemical products - N325



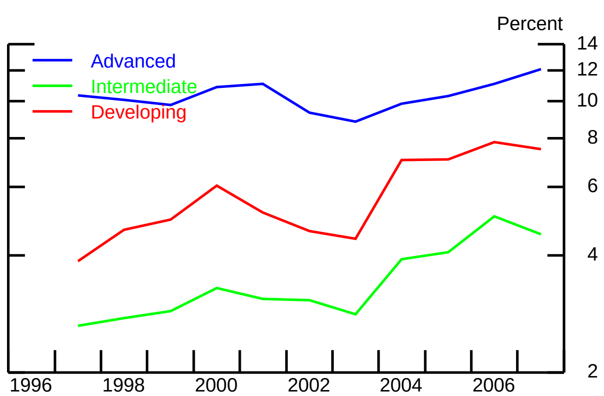
Plastics and rubber products - N326



Nonmetallic mineral products - N327



Primary metals - N331



Fabricated metal products - N332

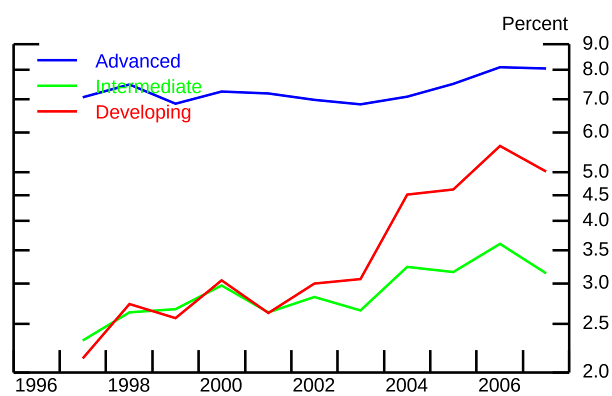
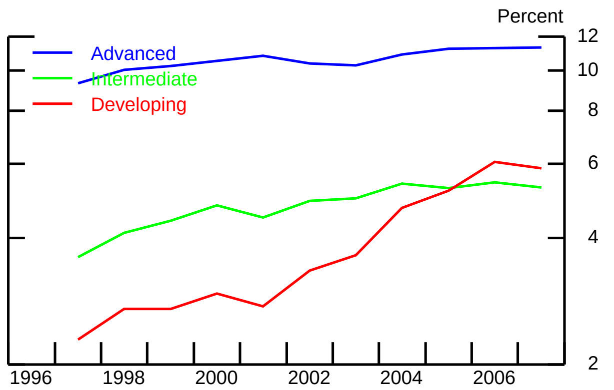


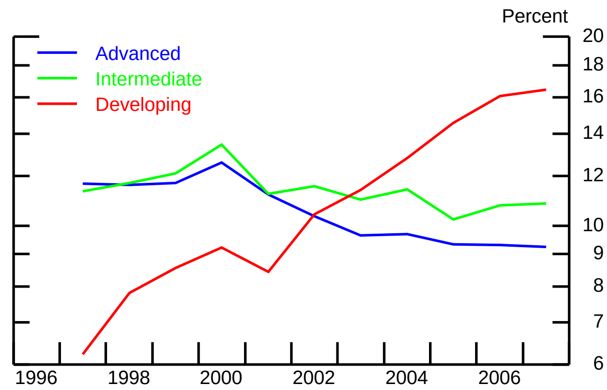
Figure 3c: Import Shares of Purchased Materials

by Development Status

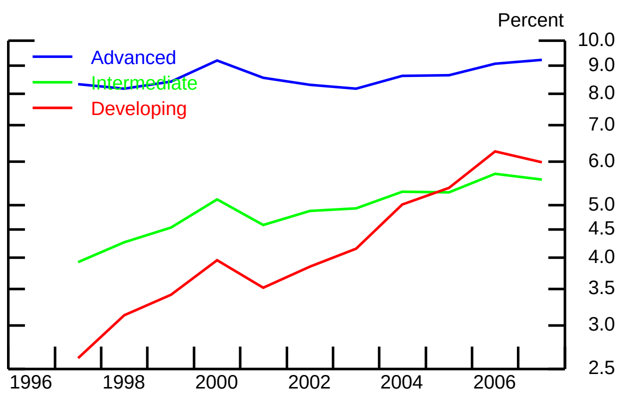
Machinery - N333



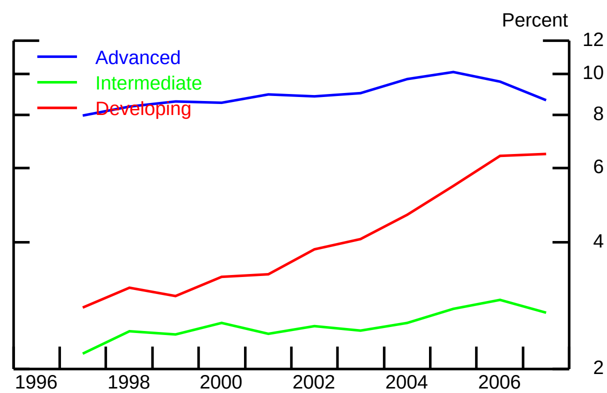
Computer and electronic products - N334



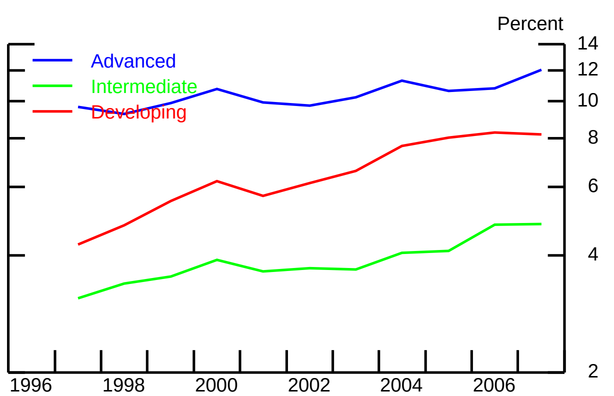
Electrical equipment, appliances, and components - N335



Furniture and related products - N337



Miscellaneous manufacturing - N339



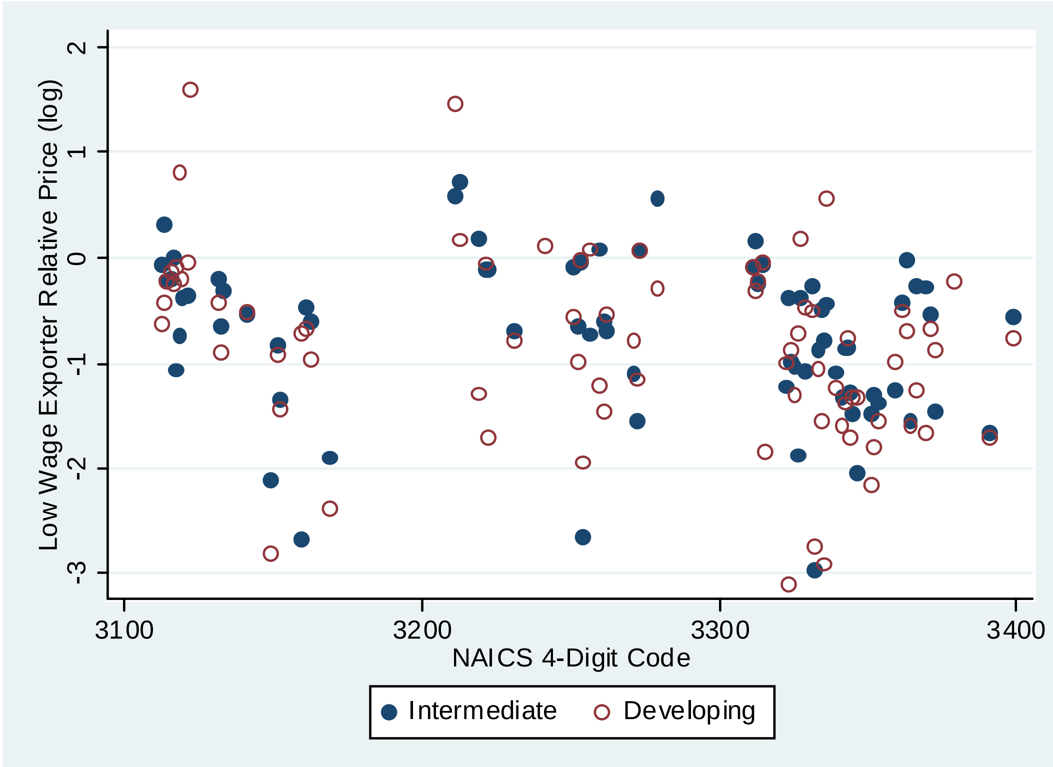


Figure 4a: The relative import price from low-wage countries

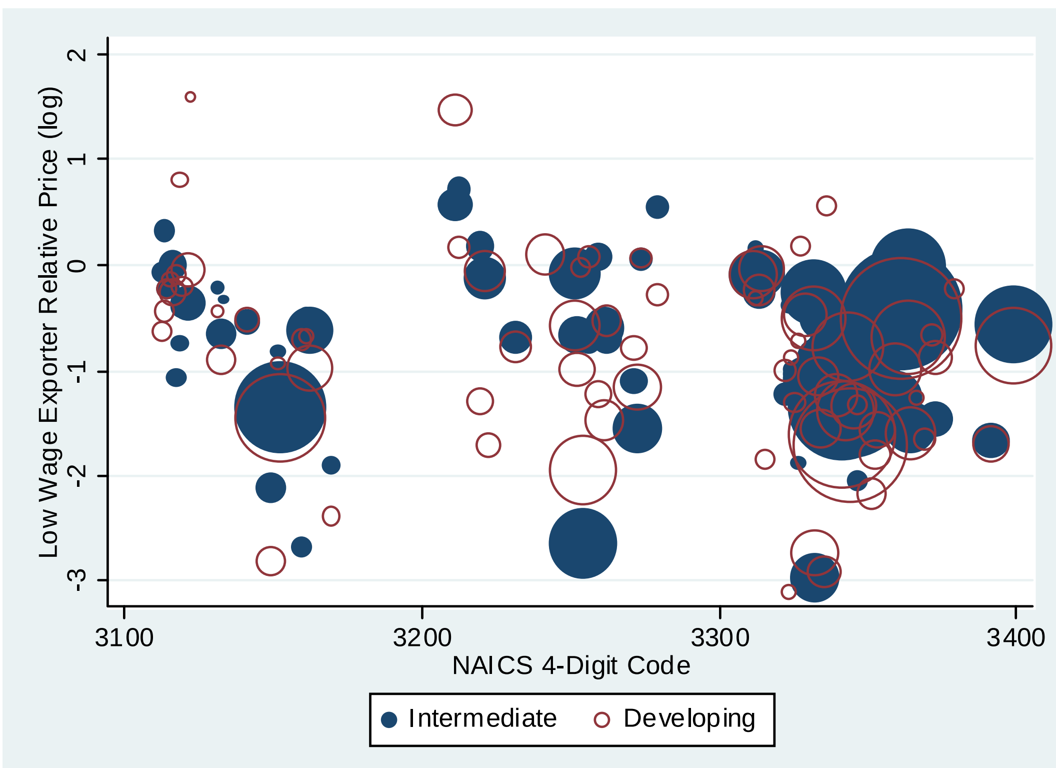


Figure 4b: The relative import price from low-wage countries, weighted by size

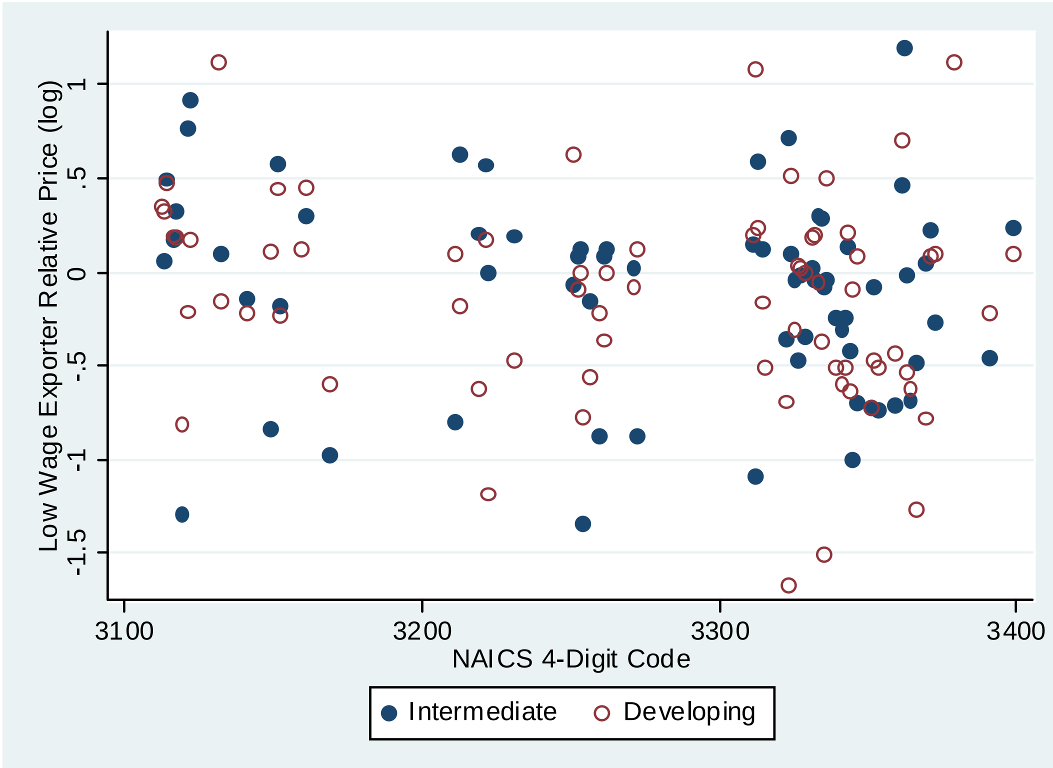


Figure 5a: The quality-adjusted relative import price from low-wage countries

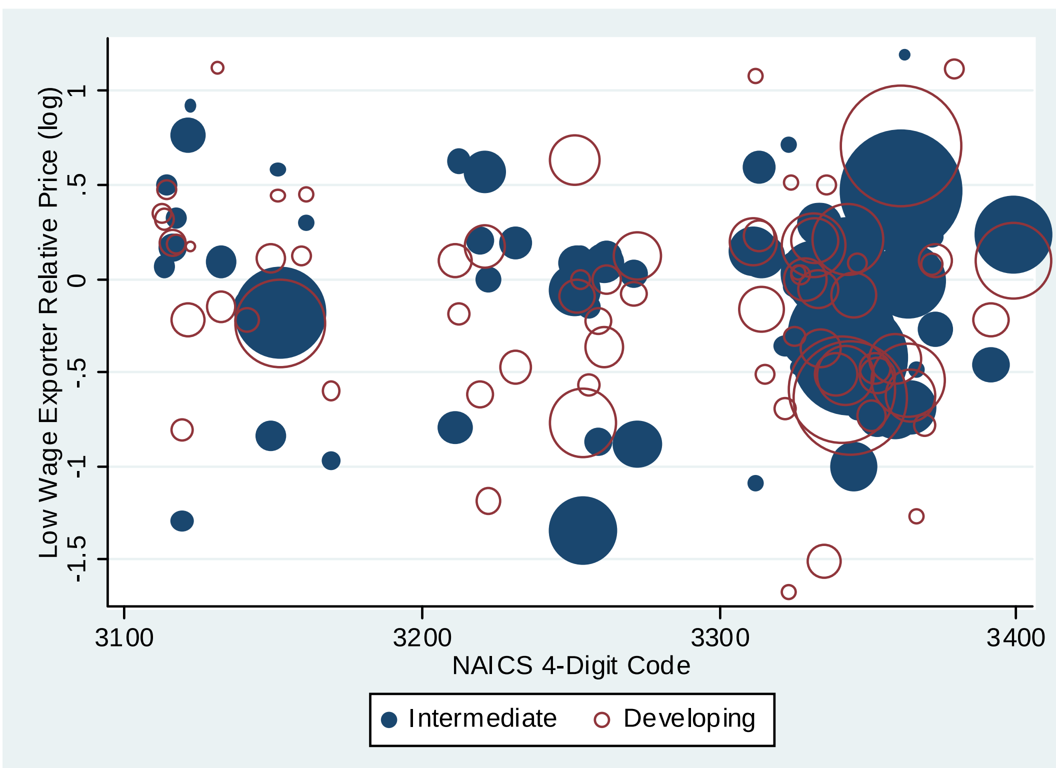


Figure 5b: The quality-adjusted relative import price from low-wage countries, weighted

Figure 6: Manufacturing Multifactor Productivity, 1997-2007

Appendix Table 1 Classification of Countries according to Level of Economic Development

Developing Countries

Afghanistan
Albania
Algeria
Angola
Anguilla
Argentina
Armenia
Aruba
Azerbaijan
Bangladesh
Belarus
Belize
Benin
Bermuda
Bhutan
Bolivia
Bosnia-Hercegov
Botswana
Br Indian O Ter
Br Virgin Is
Brazil
Bulgaria
Burkina Faso
Burma (Myanmar)
Burundi
Cambodia
Cameroon
Cape Verde
Cayman Is
Cen African Rep
Chad
China
Christmas Is
Cocos Is
Colombia
Comoros
Congo (DROC)
Congo (ROC)
Cook Is
Costa Rica
Cote d`Ivoire
Cuba
Djibouti
Dominica Is
Dominican Rep
East Timor
Ecuador
Egypt
El Salvador
Eritrea
Ethiopia
F St Micronesia
Falkland Is
Faroe Islands
Fiji
Fr Polynesia
Fr S & Ant land
French Guiana
Gambia
Gaza Strip
Georgia
Ghana
Greenland
Grenada Is
Guadeloupe
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Heard & McDn Is
Honduras
India
Indonesia
Iran
Iraq
Jamaica
Jordan
Kazakhstan
Kenya
Kiribati
Kyrgystan
Laos
Lebanon
Lesotho
Liberia
Macao
Macedonia
Madagascar
Malawi
Malaysia
Maldive Is
Mali
Marshall Is
Martinique
Mauritania
Mauritius
Mayotte
Moldova
Mongolia
Montenegro
Montserrat Is
Morocco
Mozambique
Namibia
Nauru
Nepal
Netherlands Ant
New Caledonia
Nicaragua
Niger
Nigeria
Niue
Norfolk Is
North Korea
Pakistan
Palau
Panama
Papua New Guin
Paraguay
Peru
Philippines
Pitcairn Is
Reunion
Rwanda
Samoa
Sao Tome & Prin
Senegal
Serbia Pre-2009
Serbia/Monteneg
Sierra Leone
Solomon Is
Somalia
South Africa
Sri Lanka
St Helena
St Lucia Is
St Pierre & Miq
St Vinc & Gren
Sudan
Suriname
Svalbard,May Is
Swaziland
Syria
Tajikistan
Tanzania
Thailand
Togo
Tokelau Is
Tonga
Tunisia
Turkmenistan
Turks & Caic Is
Tuvalu
Uganda
Ukraine
Uzbekistan
Vanuatu
Vietnam
Wallis & Futuna
West Bank
Western Sahara
Yemen
Zambia
Zimbabwe

Appendix Table 1 (continued)

Intermediate Countries			
Antigua Barbuda	Estonia	Oman	Slovenia
Bahamas	Gabon	Poland	St Kitts-Nevis
Bahrain	Hong Kong	Portugal	Taiwan
Barbados	Hungary	Qatar	Trin & Tobago
Brunei	Korea	Romania	Turkey
Chile	Kuwait	Russia	United Arab Em
Croatia	Latvia	Saudi Arabia	Uruguay
Czech Republic	Libya	Seychelles	Venezuela
Eq Guinea	Lithuania	Singapore	
	Mexico	Slovak Republic	

Advanced Countries			
Andorra	France	Japan	San Marino
Australia	Germany	Liechtenstein	Spain
Austria	Gibraltar	Luxembourg	Sweden
Belgium	Greece	Malta	Switzerland
Canada	Iceland	Monaco	United Kingdom
Cyprus	Ireland	Netherlands	Vatican City
Denmark	Israel	New Zealand	
Finland	Italy	Norway	