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Outsourcing and Offshoring:
Problems for Price and Productivity Measurement and Implications for Labor Research

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August 2008
Revised February 2009

The Sloan Foundation and the Bureau of Economic Analysis provided funding for this research. I have benefited from the input from many individuals, including Katharine Abraham, Bill Alterman, Erwin Diewert, Robert Feenstra, Michael Mandel, Alice Nakamura, Emi Nakamura, Marshall Reinsdorf, and participants of the World Congress on National Accounts and Economic Performance Measures for Nations, Washington, DC, May 13-17, 2008. Lillian Vesic-Petrovic provided excellent research assistance. Any errors are solely mine.

The lowering of communications costs, transportation costs, and trade barriers coupled with economic reform and rapid development in many countries such as China have stimulated tremendous growth in world trade. Imports and exports expressed as a percent of U.S. GDP grew from 20 percent in 1989 to 29 percent in 2007. Most of the increase in the relative importance of trade in the U.S. economy is accounted for by the expansion of imports, and most of the import growth, in turn, is accounted for by imports from developing countries. Imports from China alone made up 39 percent of the growth in non-oil imports since 2000.

Most imports, whether purchased for further processing or for distribution to final consumers, may be broadly classified as intermediate inputs, and it is in this broad sense that I use the term intermediate input in this paper. As communications costs, transportation costs, and trade barriers have fallen and as developing countries have instituted reforms and improved economic capabilities, the optimal sourcing of intermediate inputs has rapidly changed. The shift of the sourcing of intermediate inputs from domestic to foreign producers—often referred to as offshore outsourcing or offshoring in the literature—is driven by factor price arbitrage. The substitution of lower-cost auto parts from Mexico and China for domestically produced parts is an example of offshore outsourcing or offshoring of intermediate inputs in manufacturing (auto assembly) as well as services (auto repair). The move from suppliers with domestic production to suppliers with production in lower-cost countries such as China illustrates offshore outsourcing of "inputs" in the retail or wholesale trade sectors in which imported goods do not undergo further processing.

The growth of offshore outsourcing and offshoring and associated growth in imports from low-wage countries has spurred numerous academics and policy analysts to study its implications for U.S. economy, most notably for productivity, employment, wage levels, and inequality. The purpose of this paper is not to weigh in on the costs, benefits, or distributional impacts of the trade. Rather, it is to argue that the data are not suitable for making such assessments.

Input price declines, which are the salient feature of offshore outsourcing and offshoring, are not generally captured in import price statistics. As a consequence, the value of real imports is understated and GDP, industry value-added output measures, and productivity will be overstated. This mismeasurement will tend to bias studies against finding employment and wage effects from import growth.

I begin the paper by reviewing previous studies that also have argued that the growth of imports from developing countries may significantly bias prices, output, and productivity measures. In an early study, Mishel (1988) noted that, as a result of outsourcing, imported inputs were becoming increasingly important in manufacturing, yet import prices were not used in the construction of real Gross Product Originating (GPO) statistics. At the time, Mishel was particularly concerned that price deflators were not capturing the appreciation of the dollar against other currencies and hence that manufacturing value-added was overstated. A more recent literature models the growth in trade as resulting in an increase in product variety for consumers. Because the increase in consumer surplus from any increase in product variety is not measured in price statistics, it is argued that import prices are overstated (Broda and Weinstein 2006; Feenstra, Reinsdorf, and Slaughter 2008).

Building upon observations made in an earlier paper (Houseman 2007), I draw a sharp distinction between the previous literature on import price measurement and the principal measurement issues arising from the growth of offshore outsourcing and offshoring, which are primarily motivated by the reduction of input costs for any given product—not by the introduction of new products. I discuss two types of problems in measuring input price drops with outsourcing. In the first instance an organization outsources a task previously performed in-house. This unbundling of the production process results in a "new" input, whose price was not previously observed. In the second type, an organization obtains an input through an arms-length transaction, but switches sources. Because the construction of input price deflators assumes stable sourcing, this price drop is not captured either (Alterman 2008). Although the focus of this paper is on foreign outsourcing, I note that the measurement issues are similar in cases of domestic outsourcing.

The bias in input price indexes that results from switching sources for intermediate inputs is analogous to the outlet substitution noted in the literature pertaining to biases in Consumer Price Index. Just as the outlet substitution bias can be addressed by sampling consumers on their purchase prices, the bias resulting from changes in sourcing may be addressed through the construction of an input price index, as proposed by Alterman (2008). In other words, in both instances, biases resulting from changes in the sourcing of purchases may be addressed by sampling the purchasers rather than the sellers.

Addressing biases that result when organizations outsource tasks previously performed in-house is more challenging, because the input price for that task may not be observed in the preceding period and may not be easily constructed. Similarly, if a shift in sourcing coincides with a model or other change such that inputs in the two periods are not identical, it may be difficult to disentangle price changes owing to a change in source versus a change in product quality.

The biases to import prices affect aggregate and industry level output and productivity statistics as well as the validity of studies based on these statistics. Recent evidence of substantial growth in the use of imported intermediate inputs among manufacturers suggests that biases to estimates of output and productivity may be particularly large in this sector. In addition, although numerous studies have sought to determine the effects of foreign outsourcing on the U.S. economy and its workers, I argue that the data are not suitable for examining these issues. I illustrate the problems the data pose for the methodologies utilized in several prominent studies and point out that failure to measure input price drops that result from foreign outsourcing tend to bias studies against finding effects of such outsourcing.

1. Prior Literature on Measurement Issues related to the Growth of Imports

The idea that output and productivity, particularly in the manufacturing sector, are overstated due to the growth of imports is not new. Two decades ago Mishel (1988) asserted that manufacturing output and productivity growth in the 1980s were lower than government estimates, in part, because of the growth in imported intermediate inputs. Mishel argued that because, at the time of his writing, import price indexes were not used to deflate purchased inputs and import prices had risen less rapidly than domestic inputs, estimates of manufacturing value-added and productivity were overstated. Although international price series were subsequently used in conjunction with the PPI to deflate intermediate inputs, input price declines resulting from offshore outsourcing and offshoring were still not measured for the most part, as is explained below.

A more recent literature focuses on price measurement problems associated with import growth in the context of trade models that assume product differentiation and monopolistic competition. The essential argument in this literature is that the growth in imports results in an increase in product variety and that consumer surplus from the increase in product variety is not measured. As a consequence, import price growth is overstated and the growth in real imports is understated. This, in turn, implies that domestic output and productivity are overstated (Feenstra 1994, Broda and Weinstein 2006, Feenstra, Reinsdorf and Slaughter 2008). Broda and Weinstein develop a methodology for measuring the welfare gains from increases in product variety associated with the growth of imports. Extending the work of Broda and Weinstein, Feenstra, Reinsdorf and Slaughter estimate the overstatement of domestic output and productivity growth from the growth in product variety due to increased imports.

Both the Broda and Weinstein and the Feenstra, Reinsdorf and Slaughter papers define a variety as a particular product from a specific country. For mathematical tractability, their models assume that imported goods are separable from domestic goods in consumers' utility functions and hence the substitution of foreign for domestic goods is not explicitly considered.

This approach has been criticized on the grounds that growth in trade does not necessarily increase total product variety when domestic variety is taken into account (Arkolakis et al. 2008, Baldwin and Forslid 2004). In addition, Arkoloks et al. show that welfare does not depend on variety under different model assumptions.

More important for the purposes of this paper, any mismeasurement of prices owing to the growth of import variety generally is not applicable to the circumstances of offshore outsourcing or offshoring. If new varieties are close substitutes for existing or disappearing varieties, there is little gain to consumers from the introduction of the new variety and hence little distortion to price indexes. In the limit, if the new product is the same as the domestically produced product, there is no increase in product variety and no distortion to prices. This may be seen from the term that captures the bias to the exact price of a good with the introduction of product variety in Broda and Weinstein (2006, equation 11):

$$\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{1/(\sigma_g-1)}$$

The term λ_{gt} is the ratio of expenditures on varieties that are available in both periods relative to the full set of varieties available in the current period *t*. If there is no change in varieties over time, the expression inside the bracket is 1, and there is no bias to the price index. Similarly, σ_g is the elasticity of substitution between varieties of the good. As varieties become closer substitutes, $\sigma_g \to \infty$ and $1/(\sigma_g - 1) \to 0$, and there is little or no bias in price measurement.

True new varieties are difficult to observe in the data. The literature on import growth and product variety typically defines variety as a detailed product imported from a specific country. In addition to the Arkoloks et al. (2008) critique that these imports may displace domestic varieties, Krugman (2008) points out that there may be a problem of product aggregation in the data. With the growth of offshore outsourcing, imports of a particular product category from various countries may simply represent the same product at different stages of processing. Krugman cites examples of this phenomenon from the IT sector, which is the focus of the import product variety study by Feenstra, Reinsdorf, and Slaughter (2008). Furthermore, the literature implicitly assumes that the market is in equilibrium at any point in time. Yet, the introduction of a new, lower-cost imported input or consumer product does not displace its imported or domestic counterpart instantaneously. The coexistence of imports and domestic products at a detailed classification level at any point in time may represent the equilibrium coexistence of different varieties, or it may represent a point along an adjustment path in which the import is displacing an import from another country or a domestically produced good.

In sum, it is difficult to observe the degree to which the increase in imports represents new product variety and the degree to which it represents the substitution of relatively homogeneous, lower-cost foreign inputs for domestic inputs, with little or no change in product variety offered to consumers. However, I present some evidence suggesting that the latter characterizes much of the growth of trade. Import price growth is overstated when such offshore outsourcing and offshoring occurs, but, as detailed below, the measurement issues are distinctly different from those discussed in the import variety literature.

2. Changes in Sourcing of Intermediate Inputs: Some Definitions and Evidence of Growth

The measurement problems associated with offshore outsourcing and offshoring are part of broader set of price measurement problems that result when organizations change sources for intermediate inputs. Although the focus of the paper is on foreign outsourcing and the associated growth of imports, I discuss the analogous problems that arise from domestic outsourcing.

An organization may outsource the production of a particular task or input previously performed in-house to a domestic supplier (domestic outsourcing), to a foreign supplier (offshore outsourcing), or to a foreign affiliate (offshoring). A manufacturer that uses a staffing agency in lieu of directly hiring workers is an example of domestic outsourcing; a bank that outsources back office functions to an Indian company is an example of offshore outsourcing; and a manufacturer that sets up a factory in China to produce the first stage of a good and finishes it in the United States is an example of offshoring.

In addition, I consider the case in which the organization already purchases the good or service in an arms length transaction, but switches from a domestic to a foreign supplier. A retailer that shifts from a domestic to foreign supplier to stock a particular good exemplifies this type change in sourcing, which sometimes is also labeled offshore outsourcing.

The driving force behind outsourcing, offshoring, and other changes in input sourcing is factor-price arbitrage: the substitution of a lower-priced input for an input produced internally or purchased from a domestic supplier. The salient feature of outsourcing and offshoring thus is the reduction of production costs for any given good or service. Although a change in the sourcing of inputs may result in some change in product quality, for ease of exposition and to distinguish from the product variety literature, below I assume that the inputs acquired through outsourcing or offshoring are identical to those they replace.

In the international trade literature, models of changing comparative advantage are appropriate for understanding the dynamic process of offshore outsourcing and offshoring, which to a large degree involves outsourcing to developing countries. Vernon (1966) described a process by which the optimal location of production might change from advanced to developing countries as a product matured and became standardized. The process of offshore outsourcing and offshoring is different in important respects than that originally conceptualized in Vernon's product cycle theory of international trade, however. About 46 percent of trade occurs among financially related parties, and often offshoring involves not the shift in location of an entire product or service, but rather a particular task or stage of production. This dividing up of the production process across countries—or what variously has been termed the "slicing up of the value chain (Krugman, Cooper, and Srinivasan 1995) and "disintegration" of the production process (Feenstra 1998)—poses special measurement problems, as discussed below.

In addition, changes in comparative advantage and the optimal location of production were previously seen as occurring relatively slowly. However, over the last couple of decades a combination of factors has lowered the costs of trade and hence appears to have driven the growth in offshore outsourcing and offshoring. A series trade agreements, including the Tokyo Round of the General Agreement on Tariffs and Trade (GATT) in 1979, the Uruguay Round of GATT in 1993, and the North American Free Trade Agreement (NAFTA) of 1994, have reduced trade barriers. The reduction in transportation costs, in large part due to the development of container shipping, greatly improved the competitiveness of developing countries as a location for manufactured goods (Levinson 2005). Similarly, the development of the Internet and the lowering of other communications costs have enabled the offshoring of many services tasks previously considered "un-tradeable". Economic and political reforms in China, Russia, and Eastern European countries over the last two decades have opened up large areas of the world to trade. At the same time, rapid economic development in China and other Asian and Latin American countries have made them more competitive as locations of production. Economic reforms and development coupled with declining transportation and communication costs, not reduction of trade barriers, likely explains the explosive growth in trade with China (Hummels, Ishii, Yi 2001, Krugman 2008).

Figure 1 illustrates the growing importance of trade in the U.S. economy. Total trade—imports and exports of goods and services—as a percent of GDP increased from about 20 percent in 1989 to 29 percent in 2007. The growth in the relative importance of trade is primarily attributable to the growth of imports, which as a percent of GDP increased from under 11 percent in 1989 to 17 percent in 2007. Moreover, imports from least developed countries (LDCs) accounted for the majority and an increasing share of that growth. Figure 2 displays non-oil imports by broad class of country: advanced (e.g. Canada, Japan, Australia, Western European countries), intermediate (e.g. Russia, Eastern European countries, South Korea), and least developed (e.g. China, India, Mexico, African countries, other Asian countries). The least developed countries accounted for about half of the growth in non-oil imports from 1989 to 2000 and two-thirds of the growth from 2000 to 2008. The growth in imports from China has been particularly dramatic. Imports from China, which made up just 13 percent of the growth of non-oil imports from 1989 to 2000, accounted for 38 percent of the growth from 2000 to 2007. Because imports are expressed in nominal dollars and imports from developing countries tend to be priced significantly lower than comparable goods and services produced domestically, these figures understate the importance of the growth of imports in terms of real goods and services, as is discussed further below.

The growth of imports from China and other developing countries is only suggestive that these imports may be substituting for domestically produced inputs and that problems in measuring the real value of these imports is potentially important. Recent studies by Yuskavage, Strassner, and Mediros (2008) and Kurz and Lengermann (2008) provide more direct evidence of substantial substitution of imported for domestic inputs over the period from 1997 to 2005. Both studies find that the growth in imported intermediates was especially strong in manufacturing and accelerated over the 1997 to 2005 period. Kurz and Lengermann estimate that over two-thirds of imported intermediate commodities are used in manufacturing. Moreover, both studies find dramatic growth in the share of intermediate inputs sourced from overseas by manufacturers, particularly since 2002. Yuskavage, Strassner, and Mediros estimate that the import share of intermediate inputs in manufacturing grew by 48 percent between 1997 and 2006, increasing from 13.5 percent to 20.0 percent.

In addition, Yuskavage, Strassner, and Mediros find substantial growth in domestic providers of outsourcing services—which they define as a subset of purchased services for functions that an establishment could itself perform. Yuskavage, Strassner, and Mediros estimate that from 1982 to 2006 domestic providers of outsourcing services increased from 7 percent to 12 percent of GDP. They estimate that domestic outsourcing was especially strong in durable goods manufacturing.

The findings of both studies are subject to caveats concerning the data underlying the estimates. Estimates for the entire 1997 to 2005 time period are based on the structure of input use in the BEA 1997 benchmark input-output tables and hence assume that input structure has not changed.   In addition, use of imported versus domestic inputs are not distinguished in the data. Consequently, these studies, like all previous studies of imported intermediate inputs, assume that the fraction of any particular imported good or service used as an input in an industry is the same as the overall fraction of that good or service used in the industry—the so-called import comparability assumption. Particularly when sourcing patterns are rapidly changing, as appears to the case over the estimation period, both assumptions are likely to be violated in non-trivial ways. Nevertheless, these studies generally provide strong evidence of the importance of the growth of domestic outsourcing and imported intermediate inputs in the domestic economy, even if the estimates for specific industries may be imprecise.

3. Price Measurement Problems Associated with Changes in Sourcing

Factor price arbitrage to a large degree drives changes in input sourcing. Yet, the price drops intrinsic in outsourcing, offshoring, and other changes in the sourcing of inputs, for the most part, are not captured in national statistics. As a result, the real value of these new inputs is understated, the growth of real sector value-added or of sector value-added and domestic output is overstated, and associated productivity growth overstated.

3.1 Outsourcing and Offshoring

Consider first measurement problems associated with domestic and foreign outsourcing and offshoring, which I addressed in Houseman (2007). In these cases, there is a shift from domestic, internal production of an input to the production of that input by a domestic contractor or an offshore producer. This unbundling of the production of a good or service often entails the reclassification of inputs, and any input price drop is not measured across input categories.

In Houseman (2007) I discussed a simple example of domestic or offshore outsourcing of labor by a manufacturer. If a manufacturer cuts its employees' wages there will be no first order effect on productivity. In particular, although there may be reallocation among inputs in response to the price change, if the quantity of each input does not change, nothing real has changed and measured productivity is the same. If instead the manufacturer implements, in effect, a wage cut by purchasing labor services from a domestic or foreign contractor, the labor input is now labeled purchased services input, the input price drop is not measured, and labor cost savings from the outsourcing are factored into productivity growth.

Formally, the KLEMS multifactor productivity model for manufacturing may be written as:

(1) $$a = q - [w_k k + w_l l + w_n n]$$

Where *a*, *q, k, l*, and *n* measure the change in the logarithm of multifactor productivity, output, capital, labor, and intermediate purchases, respectively, in time *t* and *t-1*; the weights, *w*, are computed as the average share of production costs in adjoining periods *t* and *t-1*. Thus, the rate of change in multifactor productivity is the rate of change in real output less a weighted average of the rate of change of inputs. If the manufacturer cuts the wages of its employees, there should be no first order effect on measured productivity. If all real input use remains the same, labor (measured in hours worked) will remain the same, and $a = q = k = l = n = 0$. Similarly, if the manufacturer contracts out certain labor tasks and the cost of the contract labor, relative to its productivity, is the same as employees, then measured productivity will remain the same if all other input use remains the same, $w_l l = w_n n$. If, however, the manufacturer contracts out labor services to take advantage of lower-priced labor (relative to its productivity), then the effective input price drop is not measured because it occurs across input categories—labor and purchased services—and there will be a first order effect of the input price drop on measured productivity. Even if all real inputs remain the same, labor is now measured as purchased services and $|w_l l| > |w_n n|$. Consequently, the outsourcing of labor will result in an increase in measured productivity even if no change in real input use occurs.

As I previously noted, in effect, when an organization outsources certain inputs, the construction of the productivity statistics implicitly assumes that any lower payment for that factor of production reflects lower productivity (Houseman 2007). Yet, the growth of outsourcing and offshoring presents *prima facie* evidence that this is not the case. In essence, the price and productivity statistics are not designed in a way that permits capturing the dynamic adjustment process that occurs in outsourcing and offshoring.

The outsourcing of labor is an example of a broader phenomenon in which factor price arbitrage and associated input price drops, a driving force of the outsourcing and offshoring phenomenon, are not captured in price statistics. Mann (2004) points out that when an organization offshore outsources or offshores a particular task, the price of that service input was not previously observed but rather was bundled into the production of the product. While the old domestic price of the service is not measured, neither is the new international services price; initiatives to develop international service prices in the area of business and professional services were discontinued owing to budget constraints. Mann points to the growth of services offshoring to argue for development of such international services price statistics. To actually fully capture the drop in the price of the service when services offshoring occurs, however, one would have to develop an implicit domestic price prior to offshoring and link the two.

The problem is not limited to services outsourcing. Take, for example, a company that offshores the first stage of production of a product but keeps the final processing in the United States. The import of the semi-finished product enters as a new input; its implicit domestic price was never previously observed because it was bundled into the production of the final product, and the price change that occurs with the offshoring of that component is not measured. Note that although the imported product was never previously observed, it does not constitute a new good or an increase in variety for the consumer, as assumed in the international trade and product variety literature.

3.2 Change in Suppliers

Domestic and foreign outsourcing, which involves the unbundling of inputs in the production process, represents one way in which the sourcing of inputs in production is changing. In addition, organizations that already acquire inputs through arms length transactions may change suppliers. Here I focus on shifts from domestic to foreign suppliers, which also is sometimes referred to as offshore outsourcing. As with outsourcing, a change from domestic to foreign suppliers (or a change from one domestic supplier to another) is typically driven by lower prices, but the input price drop is not measured.

The failure of price indexes to capture these price changes arises from the way price indexes are constructed. In addition to the Consumer Price Index, the BLS maintains an index of imported and exported goods as part of its International Prices Program (IPP), and an index of domestically produced inputs in its producer price index (PPI). The basic unit of observation in the construction of all price indexes is the change in price of a specific product from one period to the next period at a specific retailer (for the CPI), producer (for the PPI), or importer or exporter (for the IPP). In other words, prices for specific products are not averaged in a particular period across retailers, producers or importers. Although constructing price indexes in this way better ensures that measured price changes are between identical goods, it does mean that the price indexes fail to capture price drops associated with shifts in "sourcing" by consumers or producers. Such a construction implicitly assumes that price differences across suppliers for identical (or quality adjusted products) do not exist.

Consider, for example, an organization that switches from a U.S. to a Chinese supplier of an input. The PPI would cover the period-to-period change in the price of the domestically produced input, while the IPP would cover the period-to-period price changes of the Chinese produced input. There is no link between the two series, and no way for any input price change associated with the shift in sourcing to be measured. The same problem would exist even in cases in which a domestic supplier introduced a lower cost input and over time gained market share from higher cost suppliers; conceptually the PPI would measure the period-to-period price change charged by the higher cost and by lower cost domestic suppliers, but not the input price drop associated with the shift from high to low cost producer.

Organizations also may shift among foreign suppliers, and, in some of these cases, price changes associated with changes in sourcing will be captured. The IPP program measures import prices through a survey of importers. Because the importer is the purchaser, a drop in the imported input price will be captured if the importer itself shifts sources. However, it will not be captured if an organization acquires new inputs from a different importer.

4. Parallels to Outlet Substitution Bias in CPI Literature and Possible Solutions

The fact that price indexes generally do not record drops that occur when organizations change sources for their intermediate inputs is similar in many respects to the bias in the CPI that occurs when consumers shift from one retail outlet to another to take advantage of lower prices—the so-called outlet substitution bias (Reinsdorf 1993, Diewert 1993, Hausman 2003). Discount stores, such as Wal-Mart, Best Buy and Circuit City, have captured a growing share of the retail sales market in the United States, driving out higher-priced, often smaller retailers.

Giving a greater weight to discount chains in the CPI as they expand market share does not solve the problem of outlet substitution bias. The lower price growth consumers experience from shifting to a lower-priced retailer is not captured in the CPI because, by and large, consumers are responding to a disequilibrium situation of persistent differences in price levels among stores—not to period to period differences in price changes (e.g. temporary sales).[1] In the same way, giving greater weight to international prices in constructing estimates of intermediate inputs does not solve the problem of overstated output and productivity measures that result from foreign outsourcing;[2] in general, such outsourcing is in response to a pre-existing difference in price levels, not in response to a contemporaneous price change. For example, political and economic reforms greatly opened the Chinese economy and low-priced Chinese goods to world markets. As foreign demand for Chinese imports grows, the prices of imported Chinese products

[1] A type of substitution bias in price indexes, distinct from outlet substitution bias, also arises from period-to-period differences in price movements among substitutable goods. A large literature characterizes the problem and discusses index formulas to address the bias, but it is less applicable to outsourcing and offshoring, which are the focus of this paper.

[2] Partly as a response to criticisms by Mishel (1988) and others that sectoral output and productivity measures were overstated due to the growth in outsourcing, the BEA began estimating foreign and domestic input use and separately deflating them. See Yuskavage, Strassner, and Medeiros (2008) for a discussion of these changes.

would be expected to rise over time as markets equilibrate.[3] Thus, in the short and medium term, the IPP potentially could record price increases for many imported products (which would be incorporated into price indexes used to deflate inputs in sector output and productivity measures), whereas the U.S. businesses engaging in foreign outsourcing would actually experience input price reductions.

Under the current construction of price indexes, lower-priced goods at discount stores like Wal-Mart implicitly are treated as inferior (Hausman 2003), and lower-priced foreign inputs implicitly are treated as less productive (Houseman 2007). Yet, just as the rapid growth in the share of sales accounted for by discount retail outlets suggests that quality differences do not fully account for price differences, the rapid growth of foreign intermediate inputs from developing countries indicates that lower prices of foreign inputs are not fully offset by lower productivity.

In order to capture price declines that result from changes in sourcing, the purchaser rather than the seller must be the source for price information on specific products. Indeed, emerging research that collects data directly from consumers who use home scanners is designed to address the problem of outlet substitution bias, among other measurement problems, in the CPI (Hausman and Leiptag 2007). Similarly, Alterman (2008) has proposed constructing an input price index to address the failure of the PPI and IPP to capture shifts in the sourcing of intermediate inputs.

Note, however, that the construction of an input price index will not, by itself, resolve problems in measuring price changes that result from outsourcing and offshoring in which the production process is unbundled. As discussed above, in these cases, prices for the tasks being outsourced may not have been previously observed as input prices. Although the observed outsourced inputs may be new, the final product produced for consumers may essentially be the same, and hence the analogy to the "new goods" problem in the CPI literature is not appropriate.

[3] Adjustment does not occur instantaneously to price differentials, and formal modeling of the time path of adjustment would involve some assumption about information or other non-linear or lumpy adjustment costs.

Using the terminology from that literature, the "virtual price" of the new imported input in the period prior to its introduction equals the price of the domestically produced input for which it is substituted in cases where the two inputs are exact substitutes. To capture any implicit price drops resulting from outsourcing presumably would require that information be collected directly from the organizations engaging in the outsourcing on the magnitude of the cost savings.

Similarly, an input price index will not fully solve the problem if offshore outsourcing coincides with a model or other change such that the imported good is not identical to the one it replaces. Nakamura and Stinsson (2009) demonstrate that this problem is prevalent in import data. Although adjusting for product attributes is possible with hedonic pricing models, it is expensive.

5. Implications of Measurement Problems for Labor Market Research

Price declines resulting from the substitution of imported for domestically produced inputs results in an understatement of real imports. The understatement of real imports, in turn, leads directly to an overstatement of GDP, sectoral value-added, and productivity measures. The overwhelming majority of imports are manufactured goods and an estimated 65 percent are used as intermediate inputs by domestic manufacturers.[4] Recent studies point to evidence of particularly strong growth of imported intermediate inputs in the manufacturing sector. Hence, the overstatement of output and productivity measures caused by mismeasurement of imports is likely to be particularly important in manufacturing industries.

Arguably, as important as the direct effect of import price measurement problems on aggregate and industry output and productivity statistics are the implications for the research that utilizes these statistics to draw causal inferences about the effects of offshore outsourcing, offshoring, and associated growth of imports from developing countries on the U.S. economy and its workers. Although numerous studies have endeavored to examine the effects of trade on employment and wages, particularly in the manufacturing sector, the data on which they are

[4] Robert Yuskavage provided this unpublished BEA estimate.

based are not suitable for studying these effects in a period when the structure of sourcing of intermediate inputs is rapidly changing.

5.1 Assessments of the Effects of Trade on Manufacturing Employment

To illustrate the problem, I utilize a methodology developed by Baily and Lawrence (2004) to examine the relationship between employment losses in U.S. manufacturing industries and trade. Baily and Lawrence note that the imports and exports of goods classified in a particular industry embody inputs of goods and services from other industries. For instance, the value of an imported car embodies value added from the motor vehicle manufacturing industry, value added motor vehicle parts manufacturing industry, value added from fabricated metals manufacturing industries, value added from the primary metals manufacturing industries, and so forth. A manufactured good includes value added from manufacturing as well as service industries. For each commodity, the sum of the value-added contribution from each industry yields the gross value of imports, exports, or domestic production of that commodity. Using the concept of the value added of imports and exports in a particular industry, value added of output in industry *i*, Q_i, may be expressed as the following identity:

$$(2) \qquad Q_{it} \equiv D_{it} + X_{it} - M_{1it} - M_{2it} - M_{3it}$$

For any industry *i*, value added of output equals domestic demand for value added of the product produced in the industry (D_i) plus the value added of exports (X_i) less the value added of imports (M_i). Baily and Lawrence do not distinguish country of origin for imports. Because the import price measurement problems discussed above primarily pertain to low-cost developing countries, however, I classify imports into three broad categories, by country of origin: M_1, imports from advanced countries (e.g. Western Europe, Canada, Australia, Japan), M_2, imports from intermediate countries (e.g. Russia, Eastern European countries, South Korea), and M_3, imports from least developed countries (e.g. China, Mexico, India, African countries).

Labor productivity may be defined as the ratio of value-added output (Q) and employment (E),

$$\text{(3)} \qquad \mathrm{P}_{it} \equiv \frac{Q_{it}}{E_{it}}$$

With some algebraic manipulation and taking logarithmic approximations, equations (2) and (3) may be combined to yield the following identity:

$$\text{(4)} \qquad e_{it} = w_{dit}d_{it} + w_{xit}x_{it} - w_{m1i}m_{1it} - w_{m2it}m_{2it} - w_{3it}m_{3it} - \lambda$$

where, $e_{it} = \ln(E_{it}) - \ln(E_{it-1}); x_{it} = \ln(X_{it}) - \ln(X_{it-1}); m_{it} = \ln(M_{it}) - \ln(M_{it-1}); \lambda = \ln(P_{it}) - \ln(P_{it-1})$

and w_{it} are weights defined as the average in periods *t* and *t-1* of the ratio of value-added domestic demand, value-added exports, or value-added imports to the value added of domestic output in industry *i*. By construction, $w_{dit} + w_{xit} - w_{m1it} - w_{m2it} - w_{m3it} = 1$.

Equation (4) shows that the growth rate of employment in industry *i* may be decomposed into a weighted average of the log growth rate in the domestic demand, the growth rate in exports, and the growth rate in imports less the growth rate in productivity. Each term in equation (4) therefore represents the contribution of domestic demand, exports, imports, and productivity to the growth in employment. Baily and Lawrence use this identity to assess the contribution of imports to the decline in U.S. manufacturing employment from 2000 to 2002, although they caveat their results by noting that equation (4) represents an *ex post* identity and thus technically can not be used to draw causal inferences.

From the above discussion, the growth of real imports, particularly from developing countries is understated, in equation (4). Moreover, to the degree that imports are used as intermediate inputs, domestic value added and labor productivity will be overstated. Thus, all else equal, this decomposition will tend to understate the true contribution of imports and overstate the true contribution of domestic demand and productivity growth to recent employment declines in U.S. manufacturing. Although the magnitude of the bias is unknown, one can nonetheless assess whether a significant bias is plausible by examining the size of the term for imports from least developed countries ($w_{3it}m_{3it}$) in the decomposition of equation (4). If the term is small relative to the rate of growth of employment, even large percentage errors in the measurement of the term will have modest implications for the measurement of other terms in the decomposition. In contrast, if the term is large, error in its measurement could have significant implications for the measurement of other terms and for inferences drawn from the decomposition.

U.S. manufacturing employment rose following the recession of the early 1990's, peaking in 1998. Since then it has declined steadily; the drop has been precipitous since 2000. Although the decline from 2000 to 2002 has been largely attributed to the recession of those years (Baily and Lawrence 2004), manufacturing employment continued to fall during the economic recovery. I use data on imports by country of origin, exports, and domestic value added, which are available on a consistent industry basis (NAICS), from 1998 to 2007. Following Baily and Lawrence, I assume that the structure of production is the same for imported goods, exported goods, and goods produced to meet domestic demand that are classified the same detailed industry. With this assumption, the input-output structure of the U.S. economy may be used to estimate the value added of imported goods by country type and of exported goods for detailed industries. Specifically, I use input-output relations of 2002 benchmark tables, available for 130 industry breakouts, to estimate the fraction of the gross value of imports or exports by detailed industry coming from the value-added of each of the 130 industries (including own industry). This, in turn, is used to compute value added of imports by industry, country type, and year and the value added of exports by industry and year.[5] Typically, slightly over half of the gross value of an imported or exported manufacturing good comes from value-added of manufacturing industries, which comprise 50 of the 130 detailed industries. I aggregate the value added of

[5] The use of the 2002 benchmark tables assumes that the structure of production does not significantly change over the period studied. Because I am examining the impact of imported manufactured goods on employment in manufacturing industries, I do not consider trade in services and only compute the value added of imported and exported goods by manufacturing industry. An appendix, available from the author, provides a detailed description of the calculation.

imports and exports to 19 manufacturing industries, which corresponds to annual published industry data on the value added of domestic production (Q_{it}).

Ideally, value-added of imports and exports would be computed in real terms, but because published price indices for imports and exports on a NAICS basis are only available since 2006, most figures reported in this paper are in nominal (not deflated) dollars. Even if price deflators were available, however, the real value of imports, in particular from developing countries, would be understated.

Figure 3 plots the ratio of nominal value-added of manufacturing imports from advanced, intermediate, and least developed countries to nominal domestic manufacturing value added from 1998 to 2007. Also plotted is the ratio of nominal value-added of manufacturing exports to nominal manufacturing value added. These ratios correspond to the weights in equation (4). Consistent with Figure 2, which plots total imports and exports, the value-added of manufacturing LDC imports grew rapidly relative to domestic manufacturing value added, and in recent years exceeded the value added of manufacturing imports from advanced countries, even in nominal terms. It is important to emphasize that real growth of the value added of manufacturing imports is likely considerably greater than that plotted in Figure 3.

If the growth of imports from developing countries contributed significantly to the decline in manufacturing employment, one would expect that the growth in the ratio of value added imports to domestic value added would be greatest in manufacturing industries with the steepest employment declines. Table 1 shows employment declines over the 1998 to 2007 period for each of the 19 manufacturing industries. Employment in manufacturing as a whole dropped by 22.5 log points, and losses were widespread: ten of the nineteen industries experienced percentage drops at least as large as the average and no manufacturing industry expanded employment over the period. Appendix Figure 1 plots the ratio of value added imports and exports to domestic value added for each of the 19 manufacturing industries, ordered by the percentage change in employment. Because the ratios varied considerably among industries, it is not practical to use the same scale for each industry. It is notable that the industries with the largest percentage employment declines had high level and large increases in the ratio of value-added LDC imports to domestic value-added. In almost all industries, the value added of LCD imports grew rapidly relative to domestic value added, and grew relative to value-added imports from advanced countries.[6]

The simple correlation between the change in the ratio of value added LDC imports to domestic value added (change in w_{m3}) and the change in the logarithm of employment over the 1998 to 2007 period for the 19 manufacturing industries is -0.93 and highly significant. In contrast, the simple correlation between the change in the ratio of value added imports from advanced countries to domestic value added (change in w_{m1}) and the change in log of employment for the same period is -0.34 and insignificant at conventional levels.

In addition, I have used equation (4) to decompose the employment growth by industry over varying time periods into the contributions from growth of domestic demand; growth in imports from advanced, intermediate, and least developed countries; growth in exports; and productivity growth. In Table 2, I report the results of this decomposition for the 2005 to 2007 time period, which is the only period for which price indices for imports and exports on a NAICS basis are available, and thus the only period for which I am able to do the decomposition using deflated import, exports, and domestic value added figures.[7] From 2005 to 2007, manufacturing employment declined by 358,000 or about 2.5 log points. Columns 1-3 show for each of the 19 manufacturing industries the absolute employment change, the percent of total decline in manufacturing employment accounted for by the industry, and the employment growth rate over

[6] One notable exception is the motor vehicle industry. Although value-added LDC imports grew relative to domestic value added, the increase in the ratio was greater for advanced country imports. The growth of the value-added of motor vehicle manufacturing imports relative to domestic motor vehicle value added reflects the growth in the market share of foreign, primarily Japanese, brands and their use of foreign parts suppliers.

[7] Using nominal figures, as Baily and Lawrence (2004) did, implicitly assumes that the growth rates in prices for imports, exports, and domestic value added are the same. Except for the period 2000-2002, which was dominated by recession, the findings from other periods using nominal figures are qualitatively similar to those reported for the 2005 to 2007 period using deflated values.

the period. Columns 4-9 show the contribution of the growth of productivity, exports, imports and domestic demand to employment growth; the sum of the terms in columns 4 to 9 approximately equals employment growth in column 3. For instance, the largest employment declines occurred in the textile industry, which lost 56,000 workers, representing 15.6 percent of total manufacturing losses and (coincidentally) a 15.6 percent decline in employment in the industry. By itself, measured real growth of LDC imports would result in an 11.5 percent employment decline. The growth of imports from developing countries along with a weak domestic demand appears to account for the steep drop in employment in textiles.

In most other industries, the terms in column 8—the contribution of imports from least developed countries appear to employment growth—are large relative to employment growth (column 3) though not necessarily relative to productivity and other factors. The most important implication of the magnitude of the terms in column 8 is that, because the growth of real LDC imports is likely to be significantly understated, correcting for this bias will significantly affect other terms in the equation and the assessment of the contribution of imports to job losses in manufacturing. For instance, in a different part of their paper, Baily and Lawrence run simulations of the employment effects from likely future services offshoring to low-wage countries. Based on McKinsey consulting reports, they assume that the cost savings from offshoring to developing countries would be at least 50 percent. Yet, such large price drops—which underlie the least developed countries' import growth and market share in many product lines—would not be captured in import price indexes.

Equation (4) is an identity, and hence a change in the contribution of imports to employment changes must be offset by other terms. If imports were not used as inputs in manufacturing industries, then the nature of the offset would be simple to characterize. In this case, any bias in imports would not affect the measurement of domestic value added or productivity, and a correction of an understatement of imports would be matched by an equal and offsetting increase in domestic demand ($D \equiv Q + M_1 + M_2 + M_3 - X$).

However, an estimated two-thirds of imported goods are used as intermediate inputs by U.S. manufacturers. In these cases, a bias in measured real import growth would bias measures of the growth of real domestic value added and productivity in any industry using that import as an intermediate input. Thus, the nature of the offset from any correction to biases in measured import growth is not easily characterized. It would require fuller modeling to first simulate the effects biases in measured real import growth have on real domestic output growth and productivity measures. These simulated values, in turn, could be used in the accounting framework of equation (4) to assess the contribution of import growth to manufacturing employment decline under varying assumptions about the bias in measured real import growth.

5.2 Assessments of the Effects of Trade on Wages

Several studies have addressed the effects of import growth on wage inequality, in particular the extent to which the growth in imports from low-wage countries can explain the growing inequality among low and high skilled workers. The basic premise is that imports from low-wage developing countries should be concentrated in less skill-intensive industries. As U.S. labor is reallocated from less skill-intensive to more skill-intensive industries in response to import competition, the demand for low-skilled labor relative to high-skilled labor should fall, resulting in larger wage differentials among skill levels. The leading competing hypothesis is that technological change has been biased in favor of high-skilled workers.

Lawrence and Slaughter (1993) and Sachs and Shatz (1994) draw on Heckscher-Ohlin-Samuelson trade theory, which posits a relationship between factor prices and product prices, to study this issue. Both studies examine whether there is correlation between import price changes and skill intensity of the domestic industry. If the growth of imports is in part responsible for the increase in inequality between high and low skilled workers, then the price index of imports of less skill-intensive products, produced in relatively low-wage countries, should rise more slowly than import prices of products that compete with products produced in skill-intensive industries. While Sachs and Shatz (1994, Table 16) find no significant relationship, Lawrence and Slaughter (1993, Figure 8) actually find that import prices rose faster in products that compete with skill-intensive industries.

Given measurement problems in the import price index, the lack of significant results in Sachs and Shatz and even counterintuitive results in Lawrence and Slaughter are perhaps not surprising. The price declines associated with outsourcing to low-wage countries—i.e. precisely the cases these studies are trying to capture—generally are not measured in the import price index.[8]

Lawrence and Slaughter (1993) and Sachs and Shatz (1994) also examine the relationship between an industry's skill intensity and the domestic price index for that industry's product. Import competition could contribute to the growth of inequality by lowering the relative domestic price of goods in less skill intensive industries. To control for productivity growth in an industry, which would increase the payments to factors in the industry all else the same, both studies construct an effective price, equal to the actual price index of products in the industry multiplied by the total factor productivity in the industry:

$$P_i^e = P_i TFP_i$$

Lawrence and Slaughter (1993, Table 4) suggest that the effective price of less-skill intensive goods actually rose relative to that of more skill-intensive goods, while Sachs and Shatz (1994, Table 16) find weak evidence that it declined.[9] Note, however, that examination of the effects of imports on factor prices as they operate through domestic product prices does not skirt the import

[8] Sachs and Shatz suggest that the reason for the lack of significance is that the import price index is poorly measured, but do not elaborate on this point.

[9] Sachs and Shatz (1994) obtain different results than do Lawrence and Slaughter (1993) primarily for two reasons: 1) they include a dummy variable in their regression models for the computer industry, whose price index was an outlier due to product quality adjustments, and 2) they examine a somewhat different time period and include only industries for which a complete time series exists.

price measurement problem. When import price indexes fail to pick up declines in import prices, as typically occurs with outsourcing, growth of total factor productivity in the industry that uses these imports as intermediate inputs is biased upward. If less skill-intensive industries also disproportionately use inputs from less skill-intensive industries, this bias on industry productivity will also bias findings against showing any link between imports and wage inequality as it operates through effective prices.

Feenstra and Hanson (2001) critique Lawrence and Slaughter (1993) for their focus on differences in domestic or effective domestic price changes across industries. Instead, they argue that because virtually all imports are used as intermediate inputs somewhere in the value chain, the appropriate comparison is between trends in domestic prices and the imported good prices within industries. Yet, biases in import price indexes limit the value of such comparisons.

More generally, the growth of offshore outsourcing and offshoring motivated by lower-cost foreign intermediate inputs has spurred numerous studies to examine the role that import growth, particularly from low-wage countries, may have had on employment and wage inequality in the United States. Yet the key variable—the drop in input price resulting from the outsourcing—is not adequately captured in the price statistics. Quite simply, the data are not constructed in a way that permits such analysis, and studies generally will be biased against finding any effect of imports on employment and wages. Without adequate data, it is impossible to know what influence the growth of foreign outsourcing and imports from low-wage countries have had on U.S. labor markets. The rapid growth of imports from China and other developing countries since 2000, however, suggests that it is becoming more important to address this and other measurement problems related to the growth of globalization.

6. Conclusion

Available evidence indicates that much of the rapid growth in imports from developing countries, particularly since 2000, has been driven by what I broadly term offshore outsourcing and offshoring. The substitution of lower-cost imported intermediate inputs for domestically produced products has been prevalent in all sectors of the economy, but has been especially great in manufacturing (Yuskavage, Strassner, and Meideros 2008; Kurz and Lengermann 2008). Because the lower input prices driving this substitution are not captured in price statistics, the real value of imports is understated and, all else the same, the real value of GDP, industry value-added, and productivity measures are overstated. This measurement problem is analogous to the outlet substitution bias discussed in the literature on the Consumer Price Index.

The measurement problem has broad implications not only for various aggregate and industry statistics, but also for the research that relies on them. Although the growth of imports from developing countries has spurred great interest in academic and policy circles about their effects on the U.S. economy and its workers, credible research into these issues cannot be conducted without accurate data on real import values.

In closing, I note that although I have focused on problems associated with measuring input prices and the real value of imports, this is not the only challenge to the accurate construction of statistics posed by the growth of globalization. The treatment of intangible assets and transfer prices has potentially important implications for national statistics given the growth of multinational corporations and their incentives to record profits in countries with low corporate tax rates. Measurement of prices and even nominal values for services trade, which is growing rapidly, albeit from a small base, is especially difficult. Long lags in the development of benchmark input-output tables for the economy are problematic for the accuracy of statistics in an economy in which rapid growth of outsourcing and offshoring are changing the structure of input use. Frequent updates of industry classification for organizations are important when, for example, many manufacturing establishments are offshore outsourcing or offshoring all or most transformation functions and becoming wholesale importers. Together, these measurement issues render it more difficult to produce accurate economic statistics and to assess the effects of globalization on the U.S. economy.

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Table 1 Employment in U.S. Manufacturing Industries, 1998-2007

Industry	Employment 2007	Change 1998-2007	% of total decline 1998-2007	ΔLN(Emp) 1998-2007
Food, beverage and tobacco products	1,691,000	-65,000	1.8	-0.038
Textile mills and textile product mills	331,000	-307,000	8.7	-0.656
Apparel and leather and allied products	261,000	-461,000	13.1	-1.018
Wood products	535,000	-86,000	2.4	-0.149
Paper products	456,000	-165,000	4.7	-0.309
Printing and related support activities	639,000	-196,000	5.6	-0.268
Petroleum and coal products	115,000	-16,000	0.5	-0.130
Chemical products	862,000	-124,000	3.5	-0.134
Plastics and rubber products	755,000	-188,000	5.3	-0.222
Nonmetallic mineral products	502,000	-30,000	0.9	-0.058
Primary metals	457,000	-173,000	4.9	-0.321
Fabricated metal products	1,562,000	-167,000	4.7	-0.102
Machinery	1,192,000	-323,000	9.2	-0.240
Computer and electronic products	1,273,000	-536,000	15.2	-0.351
Electrical equipment, appliances, components	430,000	-156,000	4.4	-0.310
Motor vehicles, bodies and trailers, and parts	994,000	-265,000	7.5	-0.236
Other transportation equipment	717,000	-82,000	2.3	-0.108
Furniture and related products	533,000	-104,000	3.0	-0.178
Miscellaneous manufacturing	661,000	-79,000	2.2	-0.113
Total Manufacturing	13,966,000	-3,523,000	100	-0.225

Table 2 Decomposition of Employment Growth, U.S. Manufacturing Industries, 2005-2007

	Employment Growth			Contribution to Employment Growth					
	1	2	3	4	5	6	7	8	9
	Employment change	% of total employment change	Employment growth rate	Productivity	Exports	Imports, Advanced Countries	Imports, Intermd Countries	Imports, Least Developed Countries	Domestic Demand
Food and beverage and tobacco products	3,000	-0.8	0.002	-0.141	0.005	-0.015	-0.001	-0.015	0.168
Textile mills and textile product mills	-56,000	15.6	-0.156	0.018	0.014	-0.014	0.003	-0.115	-0.065
Apparel and leather and allied products	-50,000	14.0	-0.175	-0.124	-0.019	-0.004	0.021	-0.273	0.224
Wood products	-46,000	12.8	-0.082	-0.076	0.009	0.052	0.001	-0.013	-0.056
Paper products	-28,000	7.8	-0.060	-0.008	0.028	-0.025	-0.004	-0.055	0.005
Printing and related support activities	-22,000	6.1	-0.034	-0.051	0.015	-0.013	-0.001	-0.025	0.042
Petroleum and coal products	3,000	-0.8	0.026	0.397	0.012	-0.051	-0.022	-0.055	-0.267
Chemical products	-13,000	3.6	-0.015	-0.153	0.037	-0.074	-0.005	-0.044	0.224
Plastics and rubber products	-43,000	12.0	-0.055	0.063	0.042	-0.028	-0.005	-0.068	-0.061
Nonmetallic mineral products	-4,000	1.1	-0.008	0.080	0.023	-0.021	-0.003	-0.040	-0.046
Primary metals	-10,000	2.8	-0.022	0.005	0.096	-0.282	-0.042	-0.265	0.458
Fabricated metal products	38,000	-10.6	0.025	-0.066	0.048	-0.055	-0.008	-0.078	0.184
Machinery	26,000	-7.3	0.022	-0.081	0.066	-0.053	-0.006	-0.049	0.145
Computer and electronic products	-38,000	10.6	-0.029	-0.424	0.071	-0.010	0.003	-0.088	0.422
Electrical equipment, appliances, components	-6,000	1.7	-0.014	-0.128	0.067	-0.056	-0.011	-0.135	0.249
Motor vehicles and parts	-108,000	30.2	-0.103	-0.290	0.073	-0.033	-0.006	-0.053	0.206
Other transportation equipment	41,000	-11.5	0.059	-0.084	0.123	-0.060	-0.002	-0.009	0.090
Furniture and related products	-35,000	9.8	-0.064	-0.034	0.009	0.003	0.000	-0.050	0.009
Miscellaneous manufacturing	-10,000	2.8	-0.015	-0.081	0.054	-0.045	-0.002	-0.130	0.189
Total Manufacturing	-358,000	100.0	-0.025						

Figure 1: Imports and Exports as a Percent of GDP

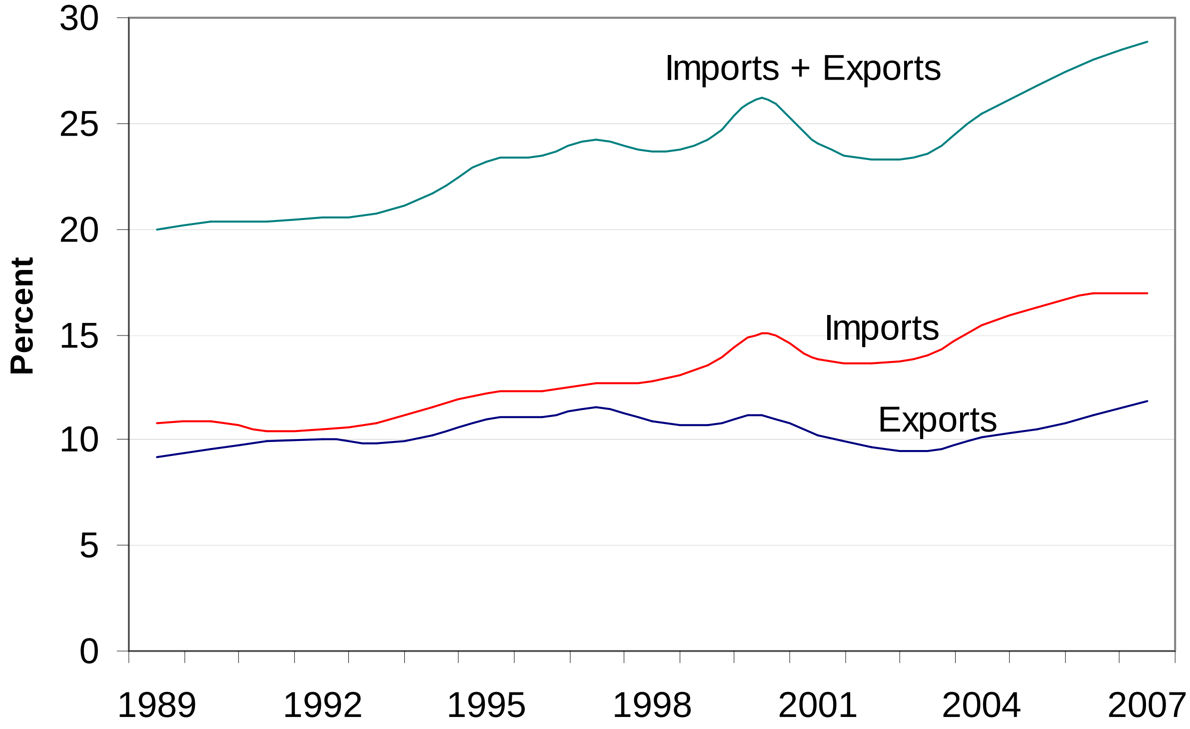


Figure 2: U.S. Non-oil Imports, by Country Type, 1989-2007
(Nominal dollars, in Billions)

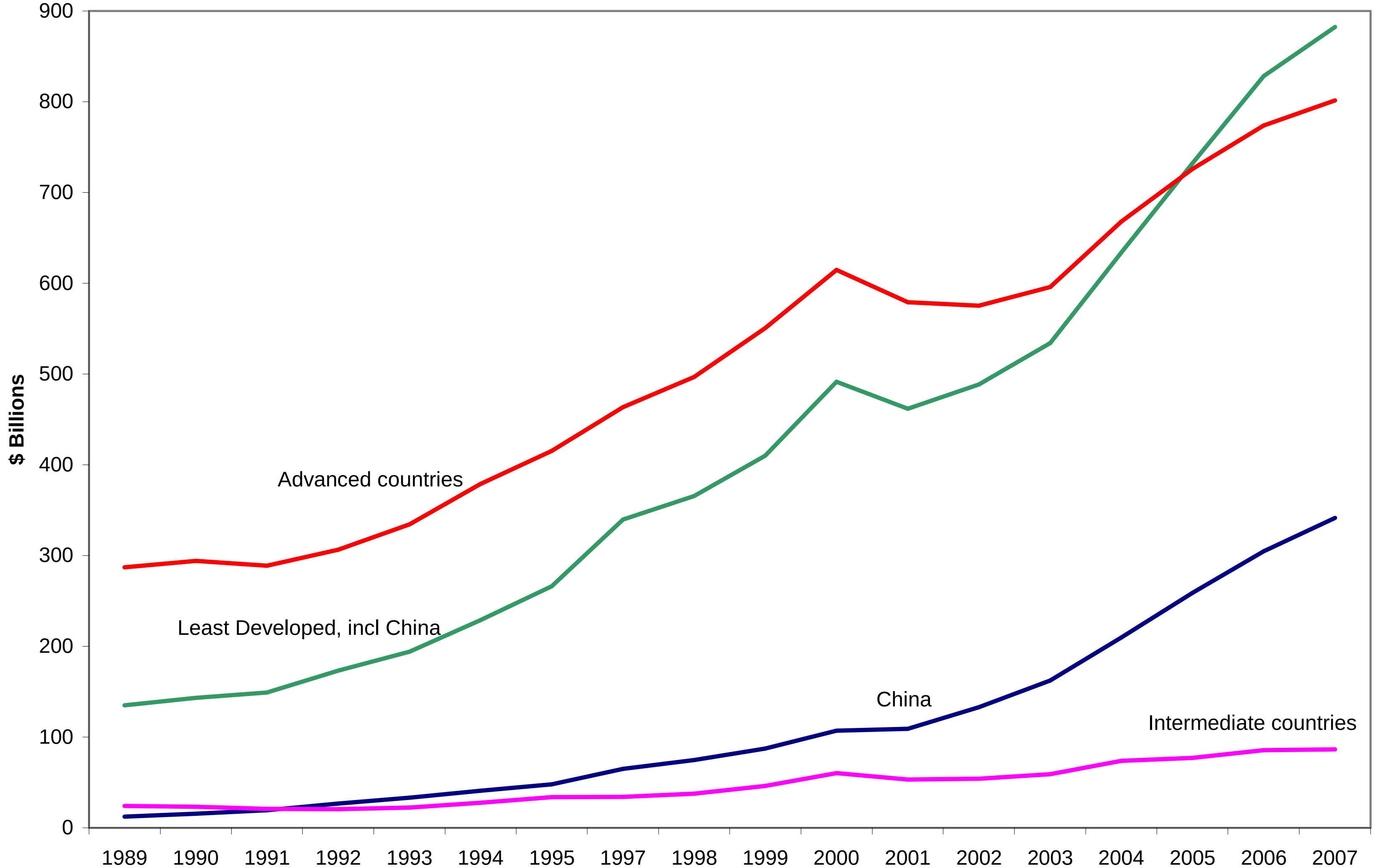
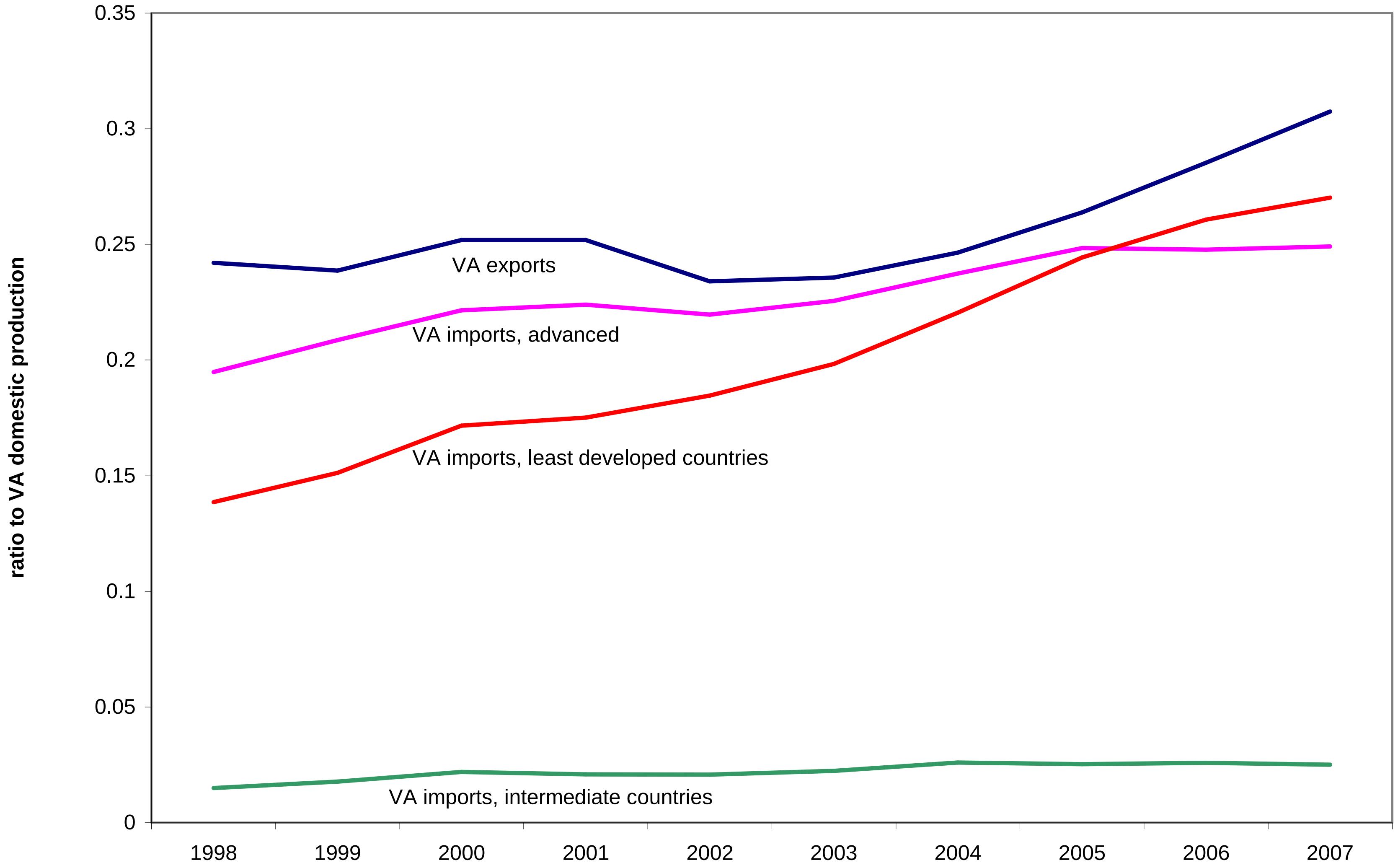
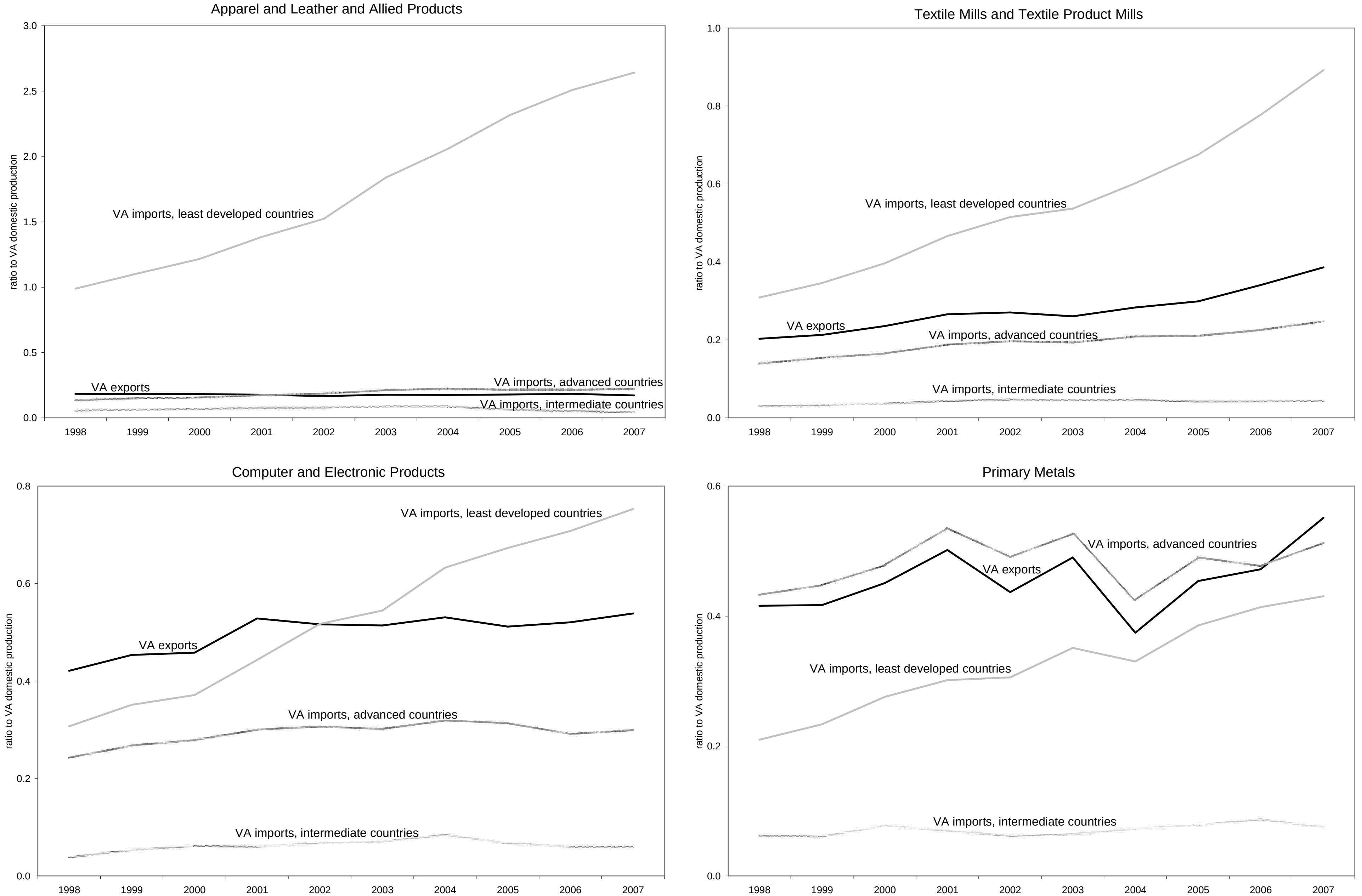


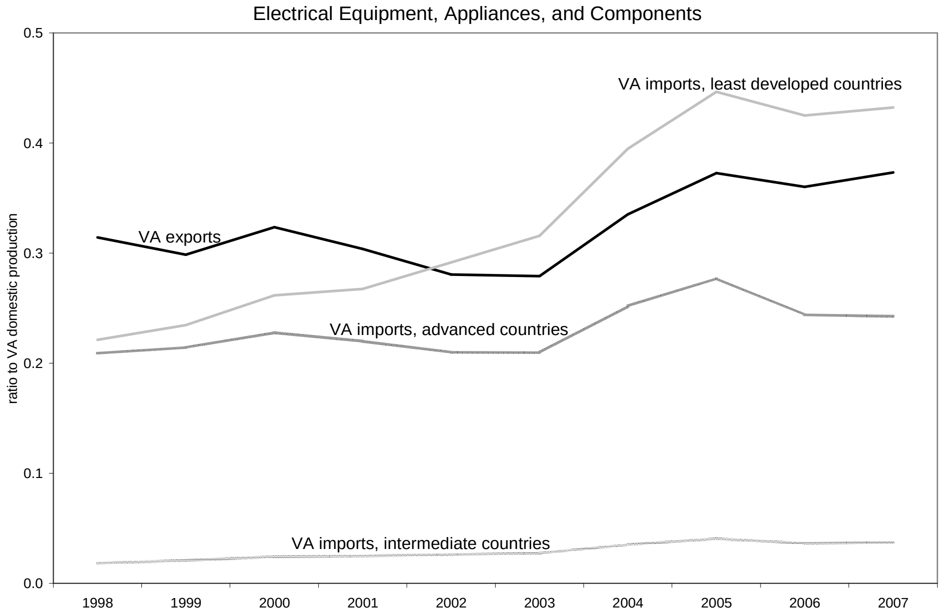
Figure 3: Ratio of Value Added of Manufacturing Imports and Exports to Domestic Manufacturing Value Added: 1998 to 2007 (Nominal Dollars)

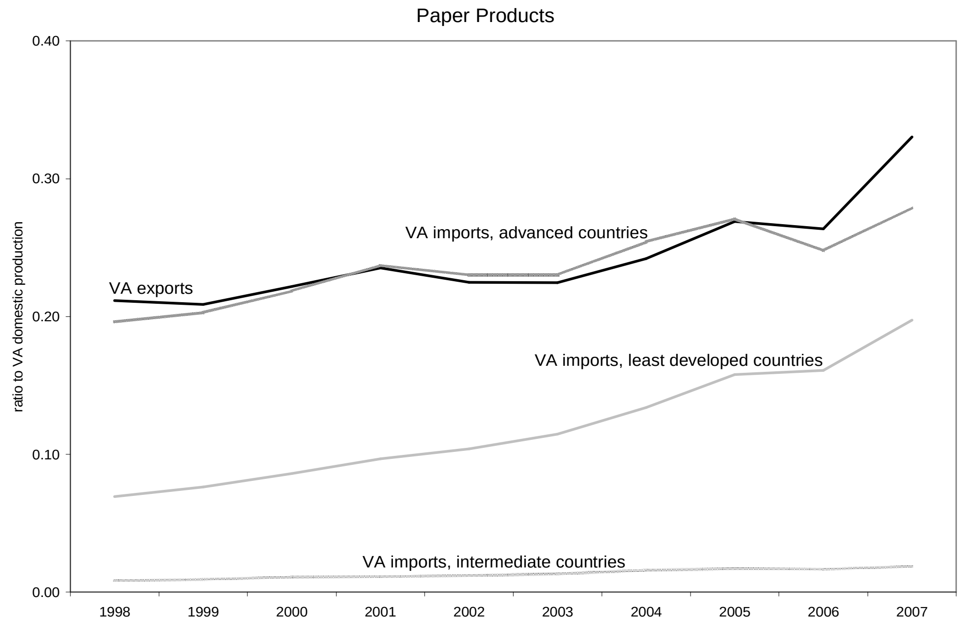


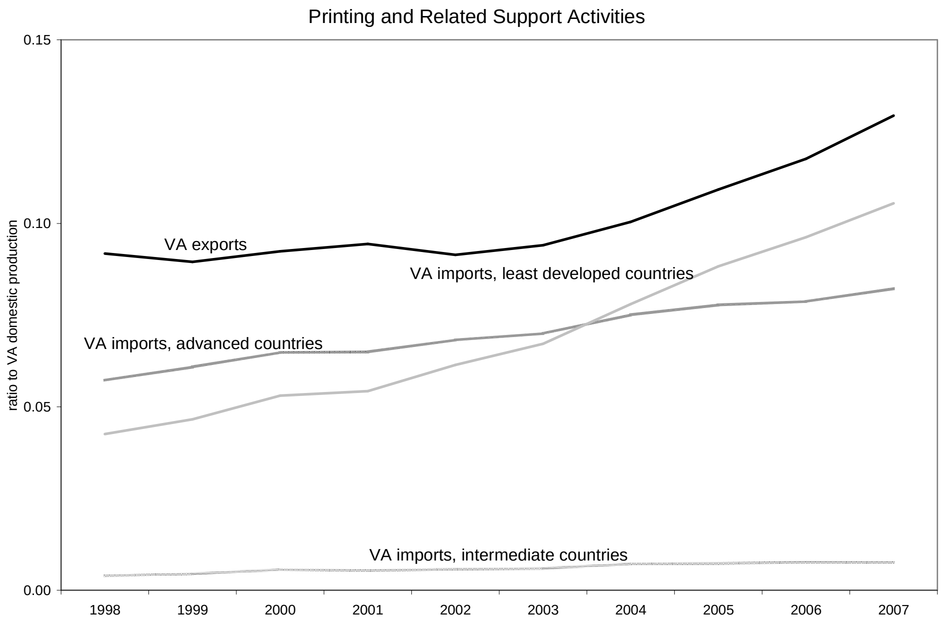
Appendix Figure 1: Ratios of Value Added Imports and Exports to Domestic Value Added: 1998 to 2007 (Nominal Dollars)

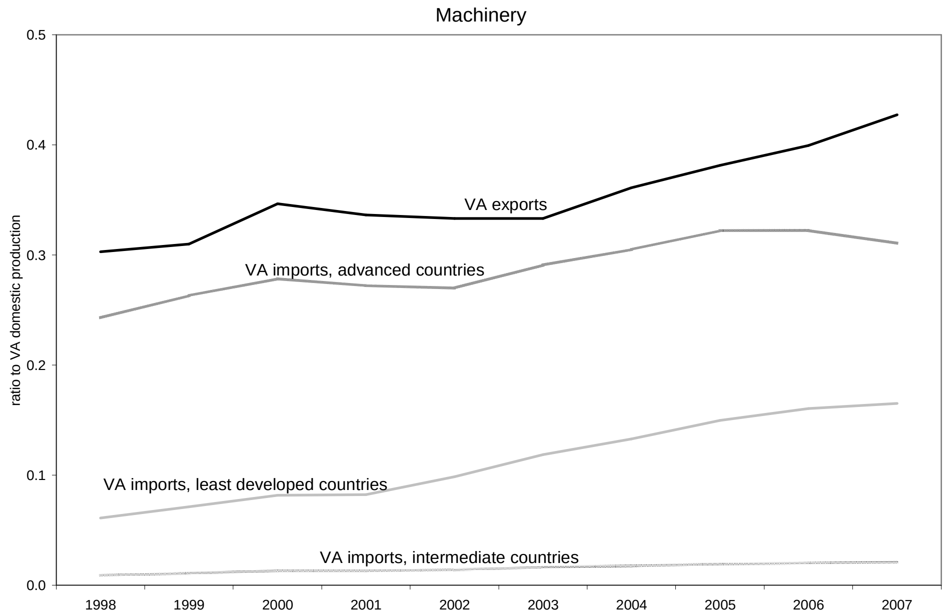


Ratios of Value Added Imports and Exports to Domestic Value Added: 1998 to 2007 (Nominal Dollars)

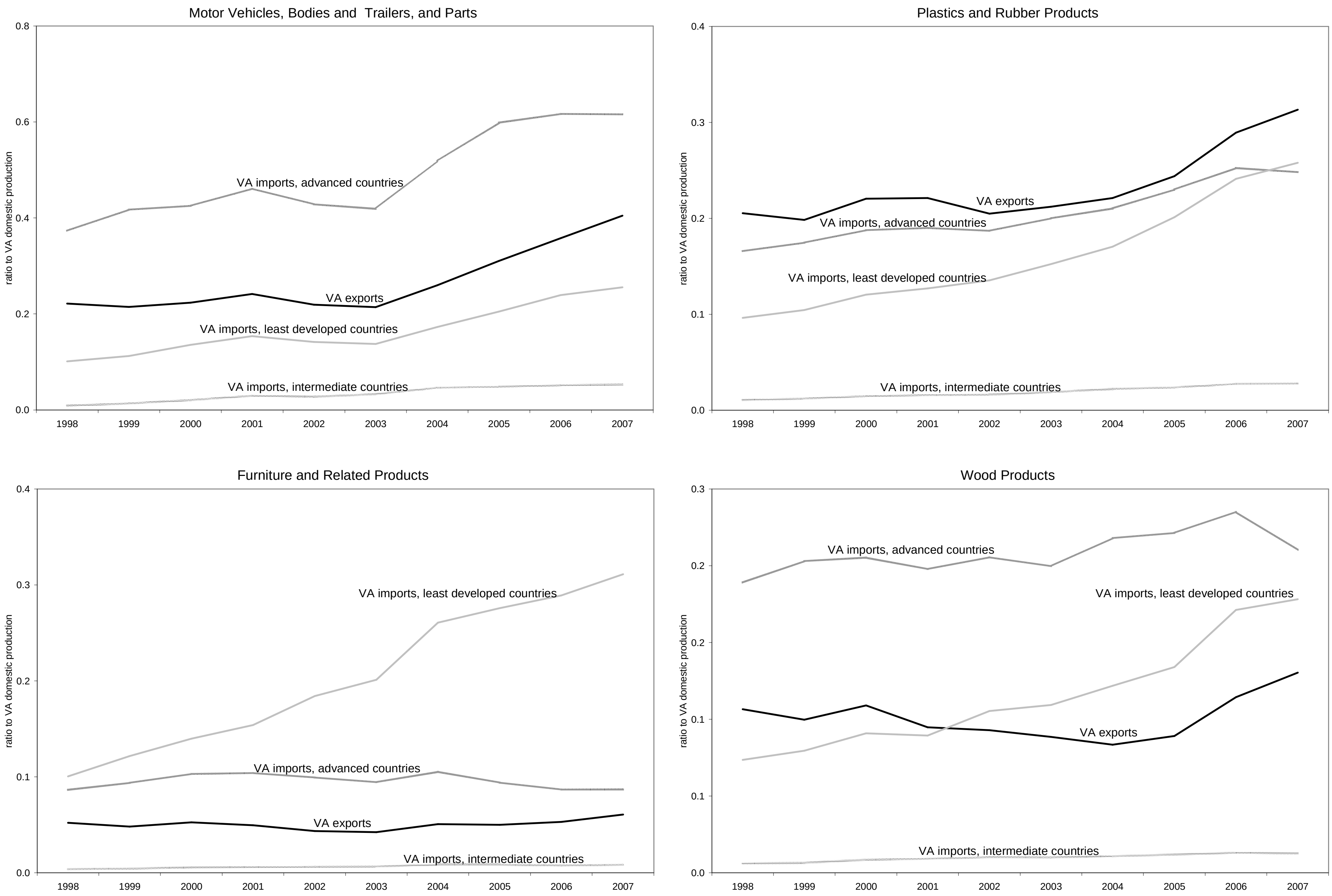




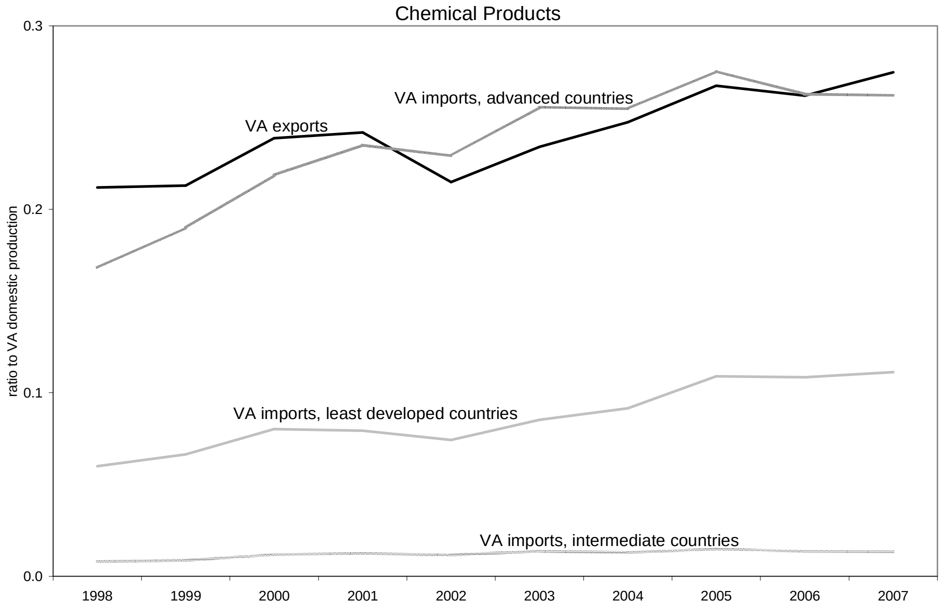


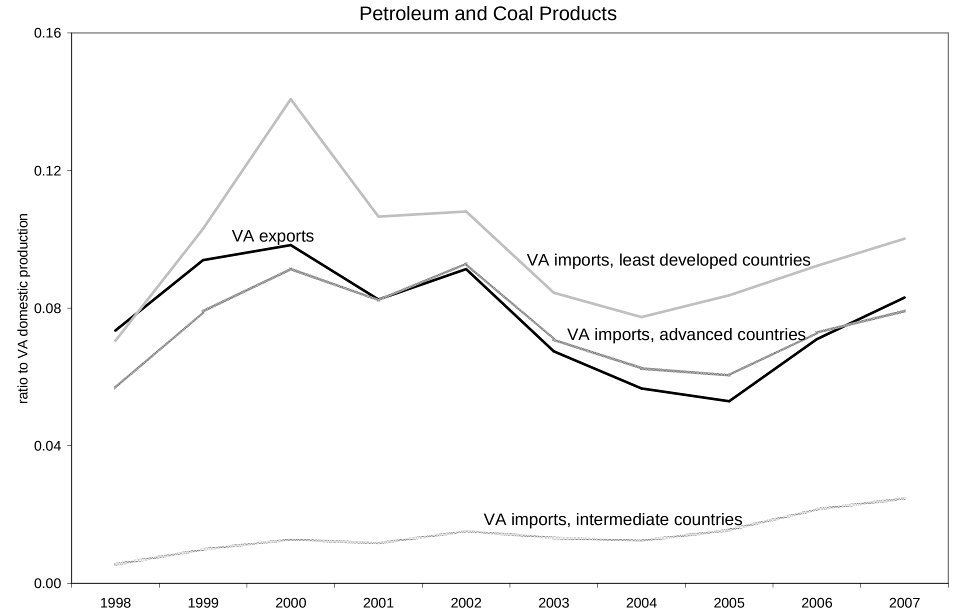


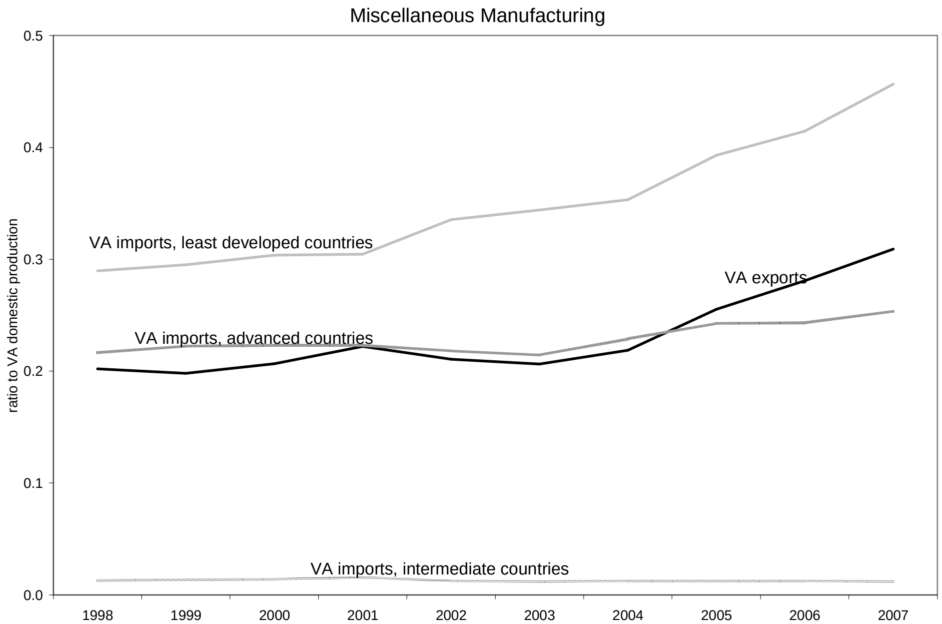
Ratios of Value Added Imports and Exports to Domestic Value Added: 1998 to 2007 (Nominal Dollars)

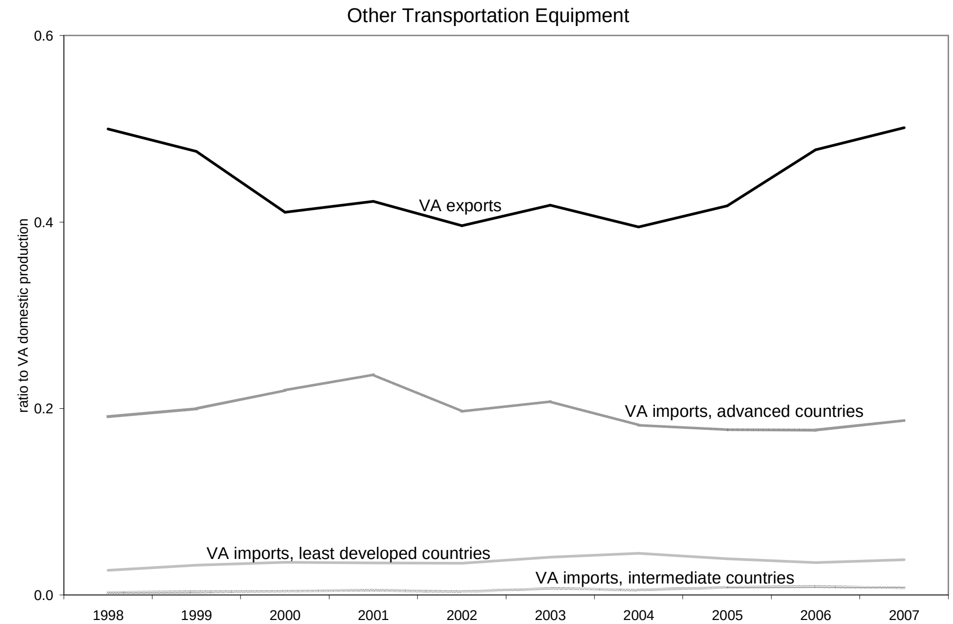


Ratios of Value Added Imports and Exports to Domestic Value Added: 1998 to 2007 (Nominal Dollars)









Ratios of Value Added Imports and Exports to Domestic Value Added: 1998 to 2007 (Nominal Dollars)