

# Import sourcing bias in manufacturing productivity growth - evidence across advanced and emerging economies

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## **Abstract**

Manufacturers are increasingly buying their material inputs from lower-cost producers. Statistical practice likely misses out on much of these cost-savings and as a result, growth of imports is understated and growth of manufacturing productivity growth is overestimated. I use detailed import unit values to estimate this import sourcing bias for 38 major economies between 1995 and 2008. I find a systematic upward bias in measured productivity growth in advanced economies of 0.18-0.34 percentage points, or 10-20% of measured productivity growth. In emerging economies, there is no systematic upward bias.

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## Introduction

One of the main features of the current wave of globalization is the rise in outsourcing to emerging economies. Especially manufacturing industries are at the forefront of this development, sourcing ever more of their materials from emerging economies.<sup>1</sup> The motive for this development is straightforward enough: from the perspective of advanced economies, materials sourced from emerging economies are often considerably cheaper than those from domestic producers or other advanced economies. The consequences for US productivity of the shift from high-cost domestic producers to cheaper imports is the topic of the work by Houseman, Kurz, Lengermann and Mandel (2010, 2011; HKLM henceforth).<sup>2</sup> As HKLM show, many of the cost-savings associated with this offshoring of production are not captured in official statistics, leading to what they label ‘offshoring bias.’ This is because lower prices for imports from an emerging economy are often fully attributed to quality differences, precluding the possibility of real cost savings.<sup>3</sup> Correcting for this, HKLM conclude that US manufacturing value added and multifactor productivity growth are considerably biased upwards because input growth is biased downwards.

This paper provides an international comparative perspective to this topic. In order to do this, I limit the scope of the analysis to the effect on productivity growth of changing the source of imports, so not taking into account shifts from domestic to foreign sources. I will refer to this effect as ‘import sourcing bias’ rather than HKLM’s ‘offshoring bias’. While this is a narrower concept than that of HKLM, it can be more widely applied since it relies on unit values of imported products from UN Comtrade. This is in contrast to HKLM’s combination of confidential transaction-level prices used by the Bureau of Labor Statistics to compile the US import price

indexes and US case study evidence. My analysis of import sourcing bias thus allows for a comparison of the import sourcing bias in manufacturing productivity growth across countries.

The import sourcing bias measure is based on comparing two polar alternatives for treating the same product imported from different countries. A product imported from country A could be treated as different from the same product imported from country B or it could be considered a perfect substitute. In the first case, any observed price differences would be considered quality differences, while in the second case, observed price differences would be considered actual price differences. These two alternatives were also outlined in Diewert (1995, 1998) in the context of dealing with consumer prices from different outlets. I will assume that official statistics treat imports from A and B as different products so that cost savings from switching to cheaper source countries will be missed and the import price index will be biased.

Whether this bias estimate is correct depends, first, on whether it accurately reflects price (rather than quality) differences across source countries and, second, on whether the ‘different products’ price index is an accurate reflection of the approach in the official import price statistics. Caution is in order on both grounds. First, the trade unit values are available at the 4-digit SITC level, so there is still ample scope for quality differences within these product categories, as shown in Feenstra and Romalis (2012). When some of the price differences are actually quality differences, the true import sourcing bias is likely closer to zero than the bias estimated here. Second, it almost goes without saying that if statistical agencies already accurately distinguish and account for price and quality differences in estimating their import price index, there is no import sourcing bias.<sup>4</sup> However, there is reason to believe that statistical agencies would sooner err on the side of ascribing too much of price differences to

quality differences, although reliable information on statistics methodologies is hard to come by.<sup>5</sup> These considerations suggests that import sourcing bias is certainly possible in official statistics, but also that the current analysis is likely to overstate any true bias. From that point of view, this analysis should be seen more exploratory regarding the potential scope of this problem, rather than a definitive estimate of its precise magnitude.

The impact of import sourcing bias on productivity growth in manufacturing is computed based on input-output tables. I calculate the bias in manufacturing multifactor productivity (MFP) growth for the period 1995 to 2008 for 38 economies included in the World Input-Output Database (WIOD).<sup>6</sup> Results show that MFP growth in manufacturing is overstated by on average between 0.18 and 0.34 percentage points in advanced economies. Bias estimates for emerging economies are more mixed and include many negative bias estimates as well, which imply shifts towards higher-price imports. As it would be highly unlikely that manufacturers would willingly switch to higher-cost sources of materials, this suggests that these are actually shifts towards higher-quality products. In case of the United States, the import sourcing bias found here is between 14 to 33 percent of the offshoring bias of HKLM. The fact that it is lower is no surprise, as import sourcing bias ignores the shifts of sourcing from domestic to foreign suppliers, but it still represents a notable fraction. Howells et al. (2013) have taken a similar approach as discussed here for the US based on more detailed unit value data and find import sourcing bias estimates that are similar to those presented here.

My estimates indicate that import sourcing bias is larger in Western Europe than in the US. This may be due to the integration of many Central and Eastern European countries into European supply chains, following their accession to the European

Union (EU). Sinn (2006) recently questioned the apparent solidity of Germany's growth in light of increased offshoring. My findings of lower bias-corrected productivity growth in Germany would seem in line with his argument. But while productivity growth is quite noticeably affected by import sourcing bias, the impact is also not so large that it materially affects cross-country growth patterns. So productivity growth in Germany after correcting for import sourcing bias is still quite healthy.

From the perspective of the quality of statistics, my results indicate that import sourcing bias should also be of concern in advanced economies outside the United States. This is certainly not to argue that my unit-value approach would be a superior alternative to import price surveys. Instead, surveying prices of inputs directly from firms, as suggested by Alterman (2009, 2013), would be an approach that would solve import sourcing bias as well as the broader offshoring bias.

## **Methodology**

### **Import sourcing bias**

The bias this paper aims to quantify can best be illustrated using a stylized example, adapted from HKLM to the case of switching between importers. Table 1 compares the price of a television in two periods from two foreign suppliers. Both suppliers – Sri Lanka and Switzerland – export televisions and we assume the product is identical. Given the lower price and identical nature of the product, the number of televisions that is imported from Switzerland drops from 75 to 50 units, while Sri Lanka supplies 25 in the first period and 50 units in the second period. For simplicity, we assume that the price of the both suppliers remains unchanged between the two periods, so the price change, shown in the final column, is equal to 0.

We distinguish two cases: case 1, where the two suppliers are treated as supplying a different product and case 2, where they are treated as supplying the same product. Case 1 is assumed to correspond to current statistical practice (more on which below), while case 2 is the true input price, given that we are dealing with identical products. Using a Törnqvist price index, the import price change in case 1 is calculated as:

$$\begin{aligned}
 \log(P_t^M / P_{t-1}^M) &= \frac{1}{2}(sl_t + sl_{t-1})\log(P_t^{SL} / P_{t-1}^{SL}) + \frac{1}{2}(sw_t + sw_{t-1})\log(P_t^{SW} / P_{t-1}^{SW}) \\
 (1) \qquad \qquad &= \frac{1}{2}(sl_t + sl_{t-1})\log(5/5) + \frac{1}{2}(sw_t + sw_{t-1})\log(10/10) \\
 &= 0
 \end{aligned}$$

Where superscript *SL* refers to the price of televisions from Sri Lanka, *sl* is the share of Sri Lanka in the total value of imports and *SW* and *sw* refer to the price and import value share for Switzerland. Since the price of both suppliers is constant over time, the weighted average price change is zero.

In case 2, the input price in period *t* is a weighted average of the price of the two suppliers, so  $(25*5+75*10)/100=8.75$ . Here the (correct) assumption is made that these products are substitutes and the true import price change is thus a 14 percent drop. This drop will be missed by standard statistical methods, even if all the relevant information is available, simply because the products from the two suppliers are assumed to be different even though they are the same. So if the statistical agency decides (mistakenly here) that the price difference reflects a difference in quality, there will be an import sourcing bias.

In this example, the two suppliers sell an identical product by assumption. If this is not the case, because, for instance, the quality of the domestic supplier's product is higher, then the quality-adjusted price difference is smaller. Adjusting trade unit values for quality differences is not straightforward, but it is feasible as shown by

Hallak and Schott (2011) and Feenstra and Romalis (2012). However, such adjustments rely on a specific underlying theoretical model. Furthermore, even when adjusting for quality differences, Mandel (2010), Byrne et al. (2012) and Feenstra and Romalis (2012) still find substantial deviations from the law of one price. This implies that there is certainly scope for import sourcing bias.

The main analysis compares import prices for individual products according to the two cases outlined in Table 1. The main difference is that many different foreign suppliers are compared, rather than the simple two-supplier case. For case 1, the price change for product  $i$  from  $t-1$  to  $t$  can be written as:

$$(2) \quad dP_i^1 \equiv \log(P_i/P_{i-1})^1 = \sum_j \bar{v}_{ijt} \log(P_{ijt}/P_{ijt-1}),$$

where  $\bar{v}_{ijt} = \frac{1}{2} \left( V_{ijt} / \sum_j V_{ijt} + V_{ijt-1} / \sum_j V_{ijt-1} \right)$  is the two-period average share of imports from country  $j$  in the total value of imports of product  $i$ . The subscript for the importing country is omitted to avoid notational clutter. The price of each product is computed using import quantities and values as  $P_{ijt} = V_{ijt} / Q_{ijt}$ , see also the next section for more details about the data and implementation. The price change for case 2 is defined as:

$$(3) \quad dP_i^2 \equiv \log(P_i/P_{i-1})^2 = \log \left( \frac{\sum_j V_{ijt} / \sum_j Q_{ijt}}{\sum_j V_{ijt-1} / \sum_j Q_{ijt-1}} \right),$$

so the weighted average unit value of imports calculated by summing import values and quantities across all source countries.

If the example from Table 1 would be the typical case, we would expect to see that  $P_{ijt}$  used in case 1 would be lower for emerging economies compared with advanced economies and that the share of imports from those countries,  $\bar{v}_{ijt}$ , would increase over time. As a result, the import price  $dP_{it}^2$  (equation (3)) would typically increase by less than  $dP_{it}^1$  (equation (2)). The difference between the two price changes,  $\Lambda_{it} = dP_{it}^1 - dP_{it}^2$ , is used to determine the import sourcing bias in manufacturing value added growth.

What is specifically included in this difference,  $\Lambda_{it}$ , is not immediately obvious when comparing equations (2) and (3). However, Diewert and Nakamura (2010) have shown that it is possible to write the true index,  $dP_{it}^2$  here, as a function of the typically observed index  $dP_{it}^1$  and a bias term. In their simplest case, with a new lower-priced product entering in the second of a two-period example, the bias is equal to the price discount of the lower-price entrant times the quantity share that this entrant captures in the second period. In the more general case, with many products and arbitrary quantity shares, the expression for the bias becomes more complicated, but is still only depends on the shifts in imports and the price difference between different source countries.<sup>7</sup> This implies that the difference  $\Lambda_{it}$  captures only import sourcing bias and would not be affected by other measurement problems.

There will be a bias if  $\Lambda_{it}$  is different from zero, since in that case the import price measure used by the statistical office, which I assume is well-proxied by  $dP_{it}^1$ , is not the same as the true import price measure, which I assume is well-proxied by  $dP_{it}^2$ . In general, I would expect  $\Lambda_{it}$  to be positive, which implies that the price index used to

deflate imports is increasing too fast and thus the quantity of imports increases too slowly.

The ‘true’ import sourcing bias is likely to be smaller (closer to zero) than the bias I estimate here. This is because all true quality differences are considered to be price differences and it seems likely that sellers of a high-quality product would not charge a lower (true) price than sellers of a low-quality product. To see this, consider a modification of the example in Table 1. The assumption in that example was that the Swiss and Sri Lankan television are identical, but say that the Sri Lankan product is of lower quality. For instance, assume that 20 percent of the Sri Lankan product is defective compared with no defects for the Swiss product. The quality-adjusted price of the Sri Lankan product is then 6 rather than 5 because you have to buy 20 percent more of the product to get the same amount of non-defective units. The true price change would then be -11 rather than -14 percent.<sup>8</sup> The same logic holds for a shift of imports towards higher-quality imports. Bias estimate  $\Lambda_{it}$  would then be negative because quality differences are assumed away. Accounting for quality differences would reduce the observed price differences and thus bring  $\Lambda_{it}$  closer to zero. The estimated  $\Lambda_{it}$  could also be *understated* if the high-quality product has a lower price than the low-quality product. While this cannot be ruled out, it seems less likely a priori. For instance, the results of Feenstra and Romalis (2012) indicate that estimates of quality and prices based on their model are positively correlated.

### **The impact on value added and productivity growth**

Value added growth is calculated as a residual: the growth in output that is not accounted for by growth in intermediate inputs, a process called double deflation. Imports make up part of intermediate inputs so if growth in the quantity of imports is

too low, then growth in value added is too high. To be more precise, the price of imported materials used in manufacturing will be biased to the following degree:

$$(4) \quad \Delta_t^{MM} = \sum_i \bar{w}_{it}^m \Delta_{it}$$

where  $\bar{w}_{it}^{MM}$  is the two-period average share of product  $i$  in the total value of imported materials use in manufacturing. Imported materials are, in turn, part of total materials use, which together with energy and services make up total intermediate inputs. Nominal gross output,  $P^Y Y$ , can thus be written as the following accounting identity:

$$(5) \quad P_t^Y Y_t = P_t^{VA} VA_t + P_t^I I_t = P_t^{VA} VA_t + (P_t^{MM} MM_t + P_t^{DM} DM_t + P_t^{OI} OI_t)$$

where  $VA$  is value added,  $I$  are total intermediate inputs,  $MM$  are imported materials,  $DM$  are domestically-sourced materials and  $OI$  are other intermediate inputs; and  $P^X$  is the price of  $X$ . In National Accounts, prices are available for gross output and the different intermediate inputs and the price of value added is solved for implicitly. The Törnqvist index for the change in the value added price is defined as:

$$(6) \quad \log\left(\frac{P_t^{VA}}{P_{t-1}^{VA}}\right) = \frac{1}{va_t} \left( \log\left(\frac{P_t^Y}{P_{t-1}^Y}\right) - \overline{mm}_t \left(\frac{P_t^{MM}}{P_{t-1}^{MM}}\right) - \overline{dm}_t \left(\frac{P_t^{DM}}{P_{t-1}^{DM}}\right) - \overline{oi}_t \left(\frac{P_t^{OI}}{P_{t-1}^{OI}}\right) \right),$$

where an upper-bar denotes a two-period average and a lower case variable is the share of that variable in gross output, so, for example,  $\overline{va}_t = \frac{1}{2} \left( P_t^{VA} VA_t / P_t^Y Y_t + P_{t-1}^{VA} VA_{t-1} / P_{t-1}^Y Y_{t-1} \right)$ . Based on the argument above, the price of imported materials,  $P^{MM}$ , is biased by  $\Delta_t^{MM}$  so using equation (6), the bias in the price of value added is:

$$(7) \quad \Delta_t^{PVA} = -\frac{\overline{mm}_t}{va_t} \Delta_t^{MM} = -\frac{1}{2} \left( \frac{P_t^M MM_t}{P_t^{VA} VA_t} + \frac{P_{t-1}^M MM_{t-1}}{P_{t-1}^{VA} VA_{t-1}} \right) \Delta_t^{MM}.$$

Since the bias in prices has no bearing on the growth of nominal value added, the bias in the growth of the quantity of value added is equal to minus the bias in the growth of the price of value added,  $\Delta_t^{VA} = -\Delta_t^{PVA}$ . As the bias in the growth of imported materials has no effect on the growth of labor or capital, the growth bias of value added translates one-for-one into a bias in multifactor productivity (MFP) growth,  $\Delta_t^{MFP} = \Delta_t^{VA}$ .

## Data sources and implementation

To implement the bias calculation in equation (7), two data sources are used, namely on import prices and the input-output structure. The import prices are based on the UN Comtrade database, which provides information on the quantity and value of imports by product, importing country and source countries for each year in the period 1995-2008. There is data for up to 804 products, classified according to the 4-digit level of the SITC revision 2 system. The valuation concept for the import value is cif (cost, insurance and freight), so it reflects the full price the importer has to pay to get the product into the country.

I undertake two processing steps before implementing equations (2) and (3). First, I only keep observations for which the quantity unit is kilograms. This is done to ensure that the unit values are comparable across source countries.<sup>9</sup> Second, I compute the median unit value of a product across all 38 importers and 139 source countries and drop observations for which the unit value is smaller than 1 percent or larger than 100 times the median unit value as these are more likely to reflect data errors – the sensitivity of the results to these trimming criteria is discussed below. Also included

in the data error category are observations for which the quantity is equal to zero while the value is positive. Around one percent of observations is dropped as a result. Based on the resulting price and value data, equations (2) and (3) are implemented and the price change difference,  $\Lambda_{it}$ , is computed.

The price change difference for each imported product then needs to be weighted by the share of that product in imported materials used in manufacturing, as discussed in equation (4). From the World Input-Output Database (WIOD), I have annual data on the composition of imported intermediates for the 38 countries that are analyzed. However, this composition is only available at a higher level of aggregation, namely for 14 manufacturing industries that deliver materials to manufacturing.<sup>10</sup> So I first use a concordance from SITC revision 2 to the ISIC revision 3 industrial classification to aggregate product-level price change differences to the level of these 14 manufacturing industries using the share of each product in total imports by each country. Then equation (4) is applied as described and the outcome is used in equation (7) to arrive at the estimate of the bias in manufacturing productivity growth.

I use the Socio-Economic Accounts (SEA) that are part of WIOD to compute the growth of manufacturing MFP growth:<sup>11</sup>

$$(8) \quad \log\left(\frac{MFP_t}{MFP_{t-1}}\right) = \log\left(\frac{VA_t}{VA_{t-1}}\right) - \sum_i \bar{\alpha}_i \log\left(\frac{H_{it}}{H_{i,t-1}}\right) - \left(1 - \sum_i \bar{\alpha}_i\right) \log\left(\frac{K_t}{K_{t-1}}\right)$$

Based on SEA, there is information for manufacturing on value added at constant prices (VA), employment by skill type ( $H_{it}$ ), the total capital stock ( $K_t$ ) and the share of labor compensation to each skill type in value added ( $\alpha_i$ ). Ideally, there should be data on capital stocks by asset type, but this is not available for all countries. As a

result, the contribution to growth from changes in the composition of the capital stock is included in this measure of MFP growth.

For my analysis, I assume that statistical agencies treat imports of the same product from different countries as different products. Establishing whether this is actually the case is a much harder challenge. As a general principle, the main concern in official statistics is to avoid ignoring quality differences and they would thus be likely to treat products from different countries as having a different quality, rather than a different price, see e.g. Eurostat (2001) and IMF (2009). How US statisticians deal with this issue is discussed in detail in HKLM.<sup>12</sup> Put briefly: unless it is clear that a “new” product imported from a different country is identical to the “old” product, price differences are assumed to be due to quality differences. European countries would have to follow a similar approach as the US to be in line with Eurostat (2001) requirements. Since separate import price indices are published for imports from euro area countries and for imports from non-euro area countries, this suggests that products from different countries are not treated as close substitutes. For other countries, information on import prices and the estimation methodology is even harder to establish. For instance, RBI (2012) shows import prices for India based on unit values, but it is unclear from what level of detail these are constructed. If they distinguish import unit values by source country, there would be scope for import sourcing bias, but otherwise their measure may be similar to my  $dP_{it}^2$ . This paucity of methodological documentation is a challenge for most countries outside the US.<sup>13</sup>

This might not be a major problem if  $dP_{it}^1$  from equation (2) would be close to official import prices. Using data provided by Eurostat, a comparison could be made for nine European countries and the results actually show substantial differences. Indeed,  $dP_{it}^1$

is much more similar to  $dP_{it}^2$  (a correlation of 0.93) than to the official import prices (0.18). The standard deviation of  $dP_{it}^1$  and  $dP_{it}^2$  is also about three times larger than that of that the official indices. To some extent, this is unsurprising as  $dP_{it}^1$  will capture many changes that official import prices are designed to ignore. While both capture price changes of individual products by a specific producer in a particular country,  $dP_{it}^1$  will also capture shifts between producers of the same product in the same country, shifts between products within the 4-digit category and changes in the importance of the individual product in the broader category.

However, as discussed above, Diewert and Nakamura (2010) show that it is possible to express the true price index,  $dP_{it}^2$ , as a function of the typically observed price index  $dP_{it}^1$  and a bias term. This bias term  $\Lambda_{it}$ , the difference between  $dP_{it}^1$  and  $dP_{it}^2$ , depends only on the price difference and shifts in imports across source countries. In other words, even when  $dP_{it}^1$  is a poor approximation of official import prices, the import sourcing bias estimate  $\Lambda_{it}$  is not ‘contaminated’ by factors unrelated to import prices and patterns.

This discussion implies that caution is in order in interpreting the results on two counts. First, if statistical agencies adequately account for price and quality differences across source countries, the method employed here would incorrectly ascribe a bias to the import price index of that country. A bias would only occur if the statistical agencies ascribe too much of the price differences across source countries to quality differences. Second, our trade unit values are available at a level of detail at which quality differences will still be a notable factor. As long as the correlation between (true) prices and quality is not negative, the bias estimates are likely to be too

large. Given these caveats, the results should be regarded more as indicative of the likely scope of this problem rather than the final word on the precise magnitude.

## Results

The increased sourcing of materials from lower-cost countries is shown in Figure 1 for the three largest European countries and the United States. Between 1995 and 2008, each of these countries considerably increased the share of imported materials from emerging economies. I define two groups of emerging economies. The first group consists of the (mostly) Central and Eastern European countries that joined the European Union since 2004, the EU12.<sup>14</sup> The second group, ‘other emerging’, includes Brazil, China, India, Indonesia, Mexico, Russia and Turkey. The advanced economies are the EU15<sup>15</sup> and ‘other advanced’, which include Australia, Canada, Japan, Korea, Taiwan and United States.<sup>16</sup> This grouping is informative as the share of imports from advanced economies went down considerably over this period, while both groups of emerging economies gained considerably in import market share.<sup>17</sup>

This shift in import market share towards emerging economies is an indication that imports from these economies are cheaper. To illustrate this further, we can compare the import price for the same product across countries. To make this more straightforward to visualize, I first compute the median unit value by source country group (advanced/emerging, EU/other), importer, product and year. These median unit values are then compared with the median value of imports from the EU15. Figure 2 plots the median price difference relative to the EU15 for each country group over time. The median price for imports from other advanced economies<sup>18</sup> was about 20 percent higher than the price for imports from the EU15 throughout the period. To give an indication of the distribution around the median price difference, the

percentage of products that had a lower price than imports from EU15 countries is also indicated. For imports from other advanced economies, only about 40 percent of products are cheaper than imports from EU15 countries. The generally higher prices of imports from other advanced economies could be a ‘Washington Apples’ effect (Alchian and Allen, 1964). Since most countries in the analysis are EU countries (27 out of 38 countries), imports from other advanced economies tend to come from farther away and would thus need to be of higher quality to overcome higher trade costs.

Importing from emerging economies was much cheaper than importing from EU15 countries throughout the period for most products. The median difference in 1995 was around 30-35 percent for imports from the EU12 and other emerging economies. The price advantage shrank over this period, to about 20 percent for other emerging economies and about 10 percent for EU12 countries. Most products from both groups of countries had lower prices than when imported from EU15 countries. This figure, though, treats all products identically even if they represent a small part of imports.

We therefore turn to the results from estimating import sourcing bias, where products are weighted by their share in the value of imports. In the results we focus on how the difference in price levels translates to a different rate of import price change, rather than price level differences in themselves. Table 2 illustrates for which products and country groups the import sourcing bias is most relevant. For each traded product, I calculate the difference between a price index assuming products are different when imported from a different country (equation (2)) and a price index assuming products imported from different countries are perfect substitutes (equation (3)). This difference is then weighted by the share of each product in the total imports of each country and summed across three groups of products.

This product grouping, introduced by Rauch (1999), distinguishes between homogenous and differentiated products. Some products, typically commodities such as oil or lead, are traded on exchanges and are thus considered homogenous. For a second category of products, it is possible to find so-called reference prices in trade journals, such as for chemicals. The remainder of products, i.e. for which no ‘standard’ prices are available are considered differentiated. This determination is made at the 5-digit level and depending on the choices made in translating this 5-digit classification into a 4-digit classification, Rauch (1999) defines a conservative classification (favoring the label ‘differentiated’) and a liberal classification (leaning towards ‘reference-priced’ and ‘exchange traded’). The final step is to compute an (unweighted) average of the price change differences across countries.

The top row of Table 2 shows that, across all countries, there is only evidence of a (positive) import sourcing bias for differentiated products.<sup>19</sup> For reference-priced and exchange-traded products, i.e. the more homogenous products, there is little indication that a shift towards low-cost sources is biasing import price indexes, especially in Rauch’s (1999) conservative product grouping (which uses a stricter rule for classifying products as homogenous). Indeed, the negative import sourcing bias numbers for some product and country groups imply shifts towards higher-cost sources. Across country groups, only advanced economies show notable positive import sourcing bias numbers and then only for differentiated products. This group of products is where one would expect products of different price, but also of different quality levels to be able to co-exist. The positive import sourcing bias numbers in Table 2 could then imply that advanced economies are shifting towards lower-quality imports or towards lower-cost imports (at a given quality). In that regard, the import

sourcing bias estimates in Table 2 and those that follow are likely to be an overestimate of the true bias.

Figure 3 moves to the country level and shows the import sourcing bias in combination with average annual growth in manufacturing MFP for the 20 advanced economies between 1995 and 2008 (ordered by measured MFP growth). The total bar equals manufacturing MFP growth as computed from the SEA (equation (8)), which is divided into the bias calculated from equation (7) and the corrected MFP growth. This illustrates how the bias is substantial in most countries and positive in all but Luxembourg and Greece. For this set of countries, the average bias is 0.34 percentage points, which is 25 percent of the (corrected) average annual MFP growth of 1.38 percent. In other words, measured MFP growth in advanced economies could well substantially overstate actual growth. At the same time, the cross-country pattern of MFP growth is not much distorted: though the growth rates are lower, the measured MFP growth and corrected MFP growth rates are very highly correlated across countries (0.98).

The import sourcing bias found for the United States of 0.07 percentage points is smaller than the offshoring bias found by HKLM, whose estimates range from 0.21 to 0.51 percentage points over mostly the same period.<sup>20</sup> Since any bias from shifting from domestic to foreign suppliers is not included in my import sourcing bias, this is as expected. It does suggest that import sourcing bias captures a notable share (14-33%) of the overall offshoring bias. In smaller, more open economies than the US, my import sourcing bias is likely to be an even larger part of the overall offshoring bias.

To gauge the robustness of these bias estimates, I repeated the analysis with more restrictive criteria for removing outliers in the unit value data. Rather than removing

unit value that were 100 times larger or 0.01 times as large, I used 20-0.2 and 10-0.1. The resulting bias estimates are noticeably smaller, indicating that mostly small unit values are dropped from the dataset. For advanced economies, the average bias drops from 0.34 in the 100-0.01 case to 0.28 in the 20-0.2 case and 0.18 in the 10-0.1 case.<sup>21</sup> The cross-country pattern is very similar, though, confirming the finding that the cross-country pattern of MFP growth is not affected by import sourcing bias.

Figure 4 shows the bias estimates for the 18 emerging economies. As already shown in Table 2, there is no clear positive import sourcing bias, with an average bias of -0.06 and varying between -1.9 (Estonia) and +1.37 (Hungary). Taken at face value, the negative bias estimates suggest that measured productivity growth is understated because manufacturers are shifting towards imports of higher-cost materials. This is hard to stomach, unless these materials are also of higher quality. These negative biases could reflect an increasing integration of emerging into advanced economies' supply chains, with, for instance, (high-quality) car parts arriving from western European manufacturers for assembly in countries such as Slovakia. From the perspective of productivity measurement, import sourcing bias seems to be less of a problem in these emerging economies.

## **Concluding remarks**

While manufacturers increasingly buy their materials from lower-cost countries, official statistics lag behind. Methods to measure the price change of imported materials miss out on cost-savings that manufacturers achieve by sourcing from lower-cost countries. By overestimating price changes of imports, the growth in the quantity of imports is underestimated, leading to an upward bias in growth of productivity. In this paper, I quantify this import sourcing bias for 38 advanced and

emerging economies and estimate bias-adjusted growth of manufacturing value added for the period 1995-2008. This relies on data for import unit values across importing countries, so that price changes of import products can be calculated under the assumption that imports from different countries are either different products or perfect substitutes. Treating imports from different countries as substitutes allows for cost-savings to be registered in the statistics.

The analysis for advanced economies shows that there is a shift towards imports with lower unit values for the group of differentiated products. As a result, manufacturing MFP growth in advanced economies is biased upwards by on average 0.18 to 0.34 percentage points, or 10 to 20 percent of measured growth. In emerging economies, there is no clear bias in either direction. The true import sourcing bias is likely to be closer to zero than these estimates as the method used here ascribes none of the price differences to differences in quality. Furthermore, if statistical agencies already deal well with price and quality differences across source countries, then there is no bias to begin with. From that perspective, it is comforting that even with the larger estimate of import sourcing bias, the cross-country pattern of productivity growth is not affected. On the other hand, this analysis is limited to analyzing import sourcing bias and any bias stemming from shifts between domestic and foreign suppliers is not accounted for.

Yet even the current estimates have implications for the reliability of output and productivity statistics. These questions cannot easily be resolved in the standard statistical framework where price changes are measured separately for inputs from domestic and different foreign sources. Instead, surveying an input price index, as discussed by Alterman (2009, 2013), may hold greater promise since for such an index firms would provide the overall input price, regardless of source. The earlier

experiences of the US Bureau of Labor Statistics in surveying margin prices (i.e. the sales price minus the purchase price of the product) in wholesale and retail trade suggest that this would be feasible. Those new prices led to much lower productivity growth, in particular in retail trade (Harchaoui, 2012), which points to the importance of accurately measuring not only output but also input prices. From a policy perspective, these findings suggest that some of the offshoring of activities, in particular from Western Europe to Central and Eastern European countries, have led to an overestimation of productivity growth. However, import sourcing bias by itself is not a large enough factor that the cross-country productivity growth patterns are materially affected.

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## Tables & Figures

**Table 1, Hypothetical import switching example – Sri Lankan and Swiss televisions**

	<b>t</b>	<b>t+1</b>	<b>Change (t+1/t-1)</b>
<b>Swiss price</b>	10	10	0%
<b>Sri Lankan price</b>	5	5	0%
<b>Swiss quantity</b>	75	50	-33%
<b>Sri Lankan quantity</b>	25	50	+50%
<b>Import price</b>			
Case 1: measured			0%
Case 2: true	8.75	7.5	-14%

**Table 2, Offshoring bias across product groups and country groups, 1995-2008**

<i>Type of product</i>	<i>Differentiated</i>		<i>Reference-priced</i>		<i>Exchange-traded</i>	
	Conservative	Liberal	Conservative	Liberal	Conservative	Liberal
Overall	0.33	0.29	-0.01	0.03	-0.06	-0.06
EU15	0.51	0.44	0.02	0.08	-0.04	-0.04
Other advanced	0.53	0.51	0.07	0.09	0.02	0.03
EU12	0.26	0.15	-0.06	0.05	-0.06	-0.06
Other emerging	-0.08	0.04	-0.04	-0.15	-0.18	-0.18

Note: The table shows the weighted average difference between the price change for a ‘different products’ and ‘perfect substitutes’ price index over the period 1995 to 2008. The ‘different products’ price index is defined in equation (2) and the ‘perfect substitutes’ index is defined in equation (3). The price changes for each product are multiplied by the two-period average share of that product in country imports and summed across product groups. The product groups are defined by Rauch (1999) and used to indicate the extent to which products or homogenous (exchange-trade) or differentiated; both his conservative and liberal grouping of products is shown. The differences in price changes for each group are then averaged across countries.

**Figure 1, Share of source country groups in imported materials used in manufacturing, selected countries for 1995 and 2008**

**Figure 2, Median price difference relative to EU15 imports and percentage of products that have lower prices than EU15 imports, by country grouping, 1995-2008**

Note: the solid lines show the median price difference of imports from a specific country grouping relative to imports from EU15 countries, the percentages indicate the percentage of products with lower prices.

**Figure 3, Average annual manufacturing MFP growth in advanced economies, bias and bias-corrected measure, 1995-2008**

**Figure 4, Average annual manufacturing MFP growth in emerging economies, bias and bias-corrected measure, 1995-2008**

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<sup>1</sup> See e.g. OECD (2010).

<sup>2</sup> There has also been earlier work on this, see e.g. Schott (2004) and Reinsdorf and Yuskavage (2009).

<sup>3</sup> In the literature on bias in consumer prices, this is known as outlet substitution bias, see e.g. Reinsdorf (1993), Diewert (1998), or Hausman (2003).

<sup>4</sup> There would still be offshoring bias until prices of domestic and foreign sources of inputs would be compared and any price differences would be accounted for.

<sup>5</sup> See IMF (2009) for international measurement guidelines but also Inklaar, Timmer and van Ark (2008) on the topic of the measurement of industry output prices across Europe in relation to measurement guidelines.

<sup>6</sup> See [www.wiod.org](http://www.wiod.org). Taiwan is excluded due to missing trade data and Malta due to highly erratic unit values.

<sup>7</sup> Diewert and Nakamura (2010) show this for a Fisher index, while here a Törnqvist index is used. Given the similarity in the structure of these two indexes, there is likely a similar decomposition for the Törnqvist as for the Fisher. Furthermore, import sourcing bias estimates based on the Fisher index are similar in size to the Törnqvist estimates shown in the paper.

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<sup>8</sup> The first-period price is now  $25\% * 6 + (1 - 25\%) * 10 = 9$  and the second-period price is 8.

<sup>9</sup> More than 90 percent of the unit values are based on quantities in kilograms. Furthermore, the same product could be reported in kilograms by some countries and in another unit (e.g. number of items) by other countries. To avoid mixing prices per kilogram and prices per unit for the same product, only prices per kilogram are used.

<sup>10</sup> WIOD distinguishes inputs from 35 industries, but these also include non-manufacturing inputs.

<sup>11</sup> See e.g. Timmer et al. (2010) for more detail on (industry-level) growth accounts and MFP growth estimates.

<sup>12</sup> See also Nakamura and Steinsson (2012) and Bureau of Labor Statistics (1997).

<sup>13</sup> See, for instance, Inklaar, Timmer and van Ark (2008) on price measurement of industry output across Europe.

<sup>14</sup> These are Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovakia and Slovenia.

<sup>15</sup> Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and UK.

<sup>16</sup> We could not include Taiwan in our full analysis because of missing trade price data.

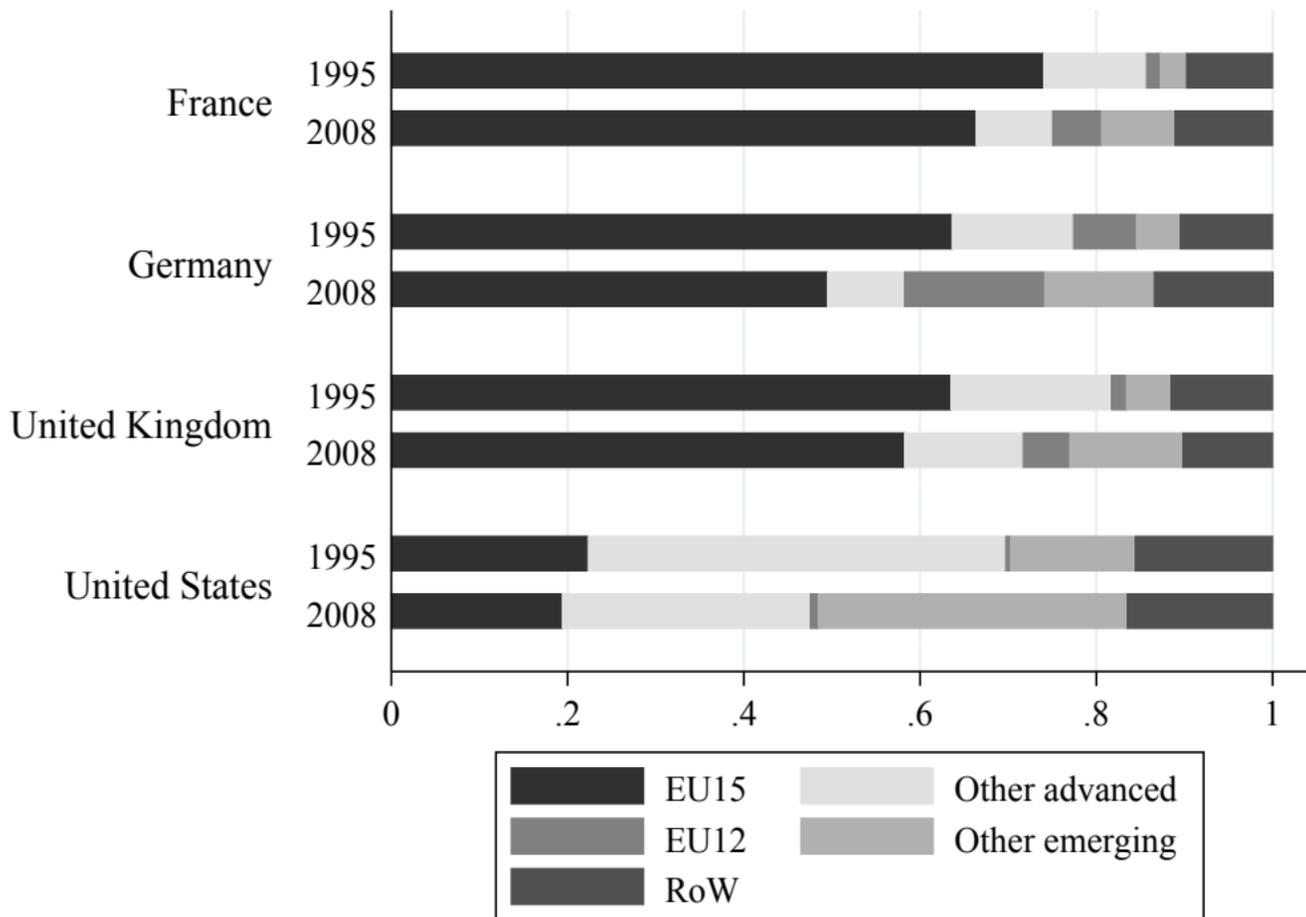
<sup>17</sup> Note that the share of imported materials in total material use also increased, so imports from advanced economies did not decline in absolute sense.

<sup>18</sup> The import price data covers more countries than the input-output data, so there are more advanced economies. All non-EU countries with a 2008 GDP per capita level exceeding 55% of the US level are labeled 'advanced'. This threshold was chosen as it is the dividing line between the EU15 and EU12.

<sup>19</sup> Results based on unweighted average price changes are very similar.

<sup>20</sup> The bias in value-added-based MFP growth is identical to the bias in value added growth, as was noted in the discussion of equation (7), so I use HKLM's estimate of the bias in value added growth here.

<sup>21</sup> In the 10-0.1 case, the import sourcing bias for the US drops almost to zero, which would imply that all of the offshoring bias is due to switching from domestic to foreign suppliers.



Source: computations based on WIOD, see [www.wiod.org](http://www.wiod.org)

