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# The Effect of Exchange Rates on the Costs of Exporters when Inputs are Denominated in Foreign Currencies


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# The Effect of Exchange Rates on the Costs of Exporters when Inputs are Denominated in Foreign Currencies

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**Abstract**

Econometric estimates of exchange rate pass-through usually adopt an overly simple model of the exchange rate denomination of the exporter's costs: they usually assume that one hundred percent of the exporter's costs are denominated in the exporter's currency. However, the literature on trade in value added indicates that a country's exports often include imported intermediates with costs denominated in other currencies. Using an international input-output table, it is straightforward to calculate the currency shares of the costs of exporters of final manufactured goods based on the national shares of value added in these exports. We use these data to analyze whether unrealistic assumptions about the currency denomination of costs can explain some of the evidence of partial exchange rate pass-through in the econometrics literature. We find that models of exchange rate pass-through that rely on the usual cost assumption are likely to significantly understate pass-through rates and to significantly overstate the adjustment of the exporters' mark-ups to movements in exchange rates.

[1] This paper represents the opinions and professional research of the individual authors. It is not meant to represent in any way the views of the U.S. International Trade Commission or any of its individual Commissioners.

## 1. Introduction

The econometric literature on exchange rate pass-through concludes that there is only partial pass-through of exchange rate changes into local-currency import prices. The studies estimate regression models with import prices as a function of trade-weighted averages of exchange rate changes and a number of control variables. The economic models that underlie the econometric specifications usually assume that one hundred percent of the exporter's costs are denominated in the exporter's currency and that these costs increase in proportion to the change in the value of the exporter's currency. Under this assumption, a ten percent appreciation of the exporter's currency would translate into a ten percent increase in the exporter's costs (in terms the importer's currency). If there is complete exchange rate pass-through, then import prices in the currency of the importer will increase by ten percent as well. On the other hand, if there is incomplete pass-through then the ten percent increase in the exporter's costs will translate into a less than ten percent increase in import prices. The exporters will absorb some of the cost increase by reducing their margin of price over marginal cost.

However, there is a possible explanation for why nominal exchange rate movements appear to have only limited effects on import prices that does not rely on adjustments in margins: an exporter's costs may be only partially exposed to exchange rate changes if some of the exporter's costs are denominated in the currency of another country. For example, if only seventy percent of an exporter's costs were denominated in its own currency, then a ten percent appreciation of that currency would only increase the exporter's costs by seven percent, and import prices would rise by less than ten percent in response to the appreciation even if there were constant mark-ups and complete pass-through of costs into import prices.

Could the econometric literature be misinterpreting complete pass-through of partial cost effects as incomplete pass-through of unrealistically large cost effects? This paper investigates whether estimates of incomplete pass-through are biased by the usual assumption about the exporter's costs and whether more detailed modeling of the effects of exchange rates on these costs can improve estimates of pass-through rates.

The idea that imported inputs can affect the currency denomination of an exporter's costs has long been recognized in the exchange rate pass-through literature, but it is seldom addressed in econometric studies due to data limitations.[2] However, with advances in global value chain analysis it is now straightforward to estimate the share of costs in exports by tracing all value added back to its country of origin. We calculate trade in value added using international input-output tables. By assigning a share of the exporter's costs to the countries of origin of the value added in the exporter's final product, we generate a measure of the effect of fluctuations in the value of the exporter's currency on the exporter's costs of production. We use this measure to replace the usual assumption about the currency denomination of the exporter's costs. Then we present a set of regressions that indicate the magnitude of the potential bias in estimates of pass-through rates that rely on the usual assumption.

The rest of this paper is organized into seven sections. Section 2 provides a summary of estimates of pass-through rates in the literature. Section 3 introduces the concept of trade in value added and explains how we calculate value-added shares for each country's exports using data from international input-output tables for the period 1995 through 2009. Section 4 reports a set of measures of the exchange rate exposure of exporters' costs based on currency unions and the data on trade in value added. Section 5 reports the regression analysis of potential bias in econometric estimates of pass-through rates that rely on the usual cost assumption. Section 6 provides concluding remarks.

[2] For example, the issue is discussed in the literature review in Goldberg and Knetter (1997).

## 2. Estimates of Pass-Through Rates in the Literature

The pass-through rate is usually defined as the percent increase in import prices, denominated in the currency of the importing country, for every one-percent appreciation of the currency of the exporting country or countries.[3] When the percentage mark-up of price over marginal costs is fixed, as is the case in markets with perfect competition or Dixit-Stiglitz monopolistic competition, then exchange rate pass-through is complete, the pass-through rate is equal to one, and import prices rise by the same percentage that the exporter's currency appreciates. When the mark-ups fall as production costs rise, as is the case in most models of imperfect competition, then pass-through is incomplete, and the pass-through rate is less than one.

Estimates of pass-through rates usually do not use detailed information on the exchange rate denomination of an exporter's costs. Currency denomination can be difficult to measure when the exporter uses imported as well as domestic inputs. Given data limitations, the traditional assumption in the econometrics literature on exchange rate pass-through is that one hundred percent of the exporter's costs are denominated in the exporter's own currency. Under this simplifying but unrealistic assumption, incomplete exchange rate pass-through is attributed *entirely* to a reduction in the exporter's margin of price over cost.

There is an extensive econometric literature on exchange rate pass-through. We focus on estimates of the pass-through rate into the prices of U.S. imports of manufactured goods. Yang (1997) examines quarterly BLS import price indices for the period 1980 through 1991. He estimates a long-run pass-through rate is 0.42 in the dollar prices of these imports. Olivei (2002) uses the same quarterly BLS import price indices, but for a later period 1981 through 1999. He estimates a pass-through rate of 0.25 in dollar prices of these imports in the 1990s. Campa and Goldberg (2005) estimate pass-through rates

[3] Exchange rate pass-through has also been estimated for export prices and consumer price indices, but it is most often estimated for import prices.

for 23 OECD countries, using quarterly data for the period 1975 through 2003. They find evidence of partial pass-through that varies with the composition of imports, with lower pass-through rates in manufacturing industries. Using an OLS model in first-differences, the authors estimate a long-run pass-through rate in the dollar prices of U.S. manufacturing imports of 0.443. Marazzi et al. (2005) present evidence of a decline in the exchange rate pass-through into U.S. import prices. The authors estimate that the pass-through rate for U.S. imports of finished goods ranged from 0.10 to 0.25 in 2004. Yang (2007) finds similarly low pass-through rates, ranging from 0.14 to 0.18, using a first-differences specification. He tests whether there was a decline in pass-through rates after the 1980s, when the dollar began to depreciate. The estimates in these econometric studies do not take into account the possibility that imported inputs affect the currency denomination of the exporter's costs.

In a related literature, Campa and Goldberg (1999) present a model of investment activity that incorporates information about the industry's share of imported inputs. However, the authors do not differentiate by the source country of the imported inputs, as we do in our analysis. Goldberg and Campa (2010) examine how exchange rate movements affect CPIs when there are imported inputs in domestic production, but their model assumes that exporters' costs are denominated in their own currency.

## 3. Trade in Value Added

When a country's exports include imported inputs, then a share of the exporter's costs may be denominated in a foreign currency. Following the methodology in Johnson and Noguera (2012), Powers (2012), and Koopman, Wang, and Wei (forthcoming), we calculate a value-added decomposition of each country's exports of final manufactured goods.

The starting point for these calculations is a set of annual international input-output (IIO) tables. An IIO table reports how the output of each sector in each country is allocated across many alternative uses, including use as an intermediate input in each sector in the same country, as exports to other countries, and as final goods or services in private consumption, government consumption, and capital formation in each country. We use IIO tables from the World Input-Output Database (WIOD) for the analysis in this paper.[4]

Production in a general IIO table with $C$ countries and $N$ sectors is given by

$$X = AX + F, \tag{1}$$

where $X$ is the $NC$ by 1 vector of gross output in each sector and country for a given year. Input-output relations are provided in the $NC$ by $NC$ matrix $A$; coefficients of $A$ give direct intermediate input use of domestic and intermediate inputs for each country and sector per dollar of output. The value of output in each sector and country is the sum of its intermediate uses, $AX$, and its final uses, given in the $NC$ by 1 vector $F$. Elements of $F$ include world demand for final goods and services provided by each country and sector.[5]

Equation (2) is the solution for the matrix $X$. It represents the direct and indirect use of the output of each sector and country of origin in each destination country.

$$X = (I - A)^{-1}\,F = BF. \tag{2}$$

The matrix $I$ is an $NC$ by $NC$ identity matrix. $B$ is commonly called the Leontief inverse matrix; elements provide the amount of output used directly or indirectly to produce \$1 of final goods or services.

IIO analysis traces the flow of value added from the source sector to the final consumer. We

[4] Timmer et al. (2012) provides a detailed description of this database.
[5] The final demand vector combines private consumption, government consumption, and capital formation rather than including them in separate vectors.

incorporate value added (or GDP) of each country of origin by multiplying by a matrix $V$ that contains the shares of direct value added per dollar of output in each sector. Because we wish to distinguish value added by the countries of origin of inputs but not by individual sectors within those countries, we use a $C$ by $NC$ value-added matrix.

$$VX = V\,(I - A)^{-1}F = VBF. \tag{3}$$

Equation (3) produces a $C$ by $1$ vector of GDP for each country, which implicitly includes all flows of value from all source countries through all other countries (if any) to final consumers.

The empirical analysis below disaggregates $F_s$, the final goods supplied by source country $s$, by destination country $d$, so $F_s = \sum_d F_{sd}$. These flows can then be classified as domestic shipments $D_{ss}$ and exports $E_{sd}$, where $F_s = D_{ss} + \sum_d E_{sd}$. In matrix notation, these can be written as:

$$\begin{bmatrix} F_{11} & \cdots & \cdots & F_{11} \\ \vdots & \ddots & & \vdots \\ \vdots & & \ddots & \vdots \\ F_{C1} & \cdots & \cdots & F_{CC} \end{bmatrix} = \begin{bmatrix} D_{11} & 0 & \cdots & 0 \\ 0 & D_{22} & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & D_{CC} \end{bmatrix} + \begin{bmatrix} 0 & E_{12} & \cdots & E_{1C} \\ E_{21} & 0 & & \vdots \\ \vdots & & \ddots & E_{C-1C} \\ E_{C1} & \cdots & E_{CC-1} & 0 \end{bmatrix}. \tag{4}$$

Since our focus is on the value added in exports, $VBE$, we drop the domestic shipments from the calculation. $VBE_{nosdt}$ represents an element of the counterpart to $VBE$ that disaggregates bilateral flows of final goods and services. It is the amount of value added from country of origin $o$ in the exports of final goods in sector $n$ from country $s$ to country $d$ in year $t$. When exporting country $s$ is the same as country of origin $o$, then $VBE_{nosdt}$ is the amount of domestic value added in the exports from country $s$.

It requires a matrix with $NC^3$ elements in each year to report all of the different $VBE_{nosdt}$ values. Equation (5) provides a formula for generating the appropriate $C$ by $CNC$ matrix.

$$VBE = V\,(I - A)^{-1}[\hat{E}_{*1} \quad \cdots \quad \hat{E}_{*C}], \tag{5}$$

where $\hat{E}_{*d}$ represents a column of the $E$ matrix in (4), including flows of all final goods and services from all sources to country d.

The share of value added from each country of origin measures the share of the exporter's costs that are denominated in the currency of the country of origin. If the exchange rate of each country moves independently, then the domestic value-added share would be an accurate measure of the extent to which an exporter's costs are affected by changes in the value of the exporter's currency. However, if the exporter's currency is fixed to the currencies of other countries that also provide intermediate inputs to the exporter, then the domestic value added share will understate this effect.

## 4. Measures of the Exchange Rate Exposure of the Costs of Exporters

The exposure of an exporter's costs to exchange rate movements depends on the extent to which the exporter's currency is tied to the currencies of the other countries that supply value added to its exports. If the exporting country is in a currency union with these other countries, then the share of the exporter's costs that are denominated in the exporter's currency is not only its domestic share of value added but also the shares of the value added from its currency union partners. Similarly, if the currency of a country supplying some of the intermediate goods is de facto fixed to the currency of the exporting country, and the rates will likely continue to move together as they fluctuate, then the measure of exchange rate exposure also includes the share of value added from this input-supplying country in the exporter's costs.

The currency union of the European Community, the Eurozone, was formally implemented in 1999. Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain joined the Eurozone in 1999. Greece joined in 2000, Cyprus and Malta joined in 2007, Slovenia joined in 2006, and Slovakia joined in 2008. In addition, there are five other countries in WIOD that were not formally members of the Eurozone between 1995 and 2009 (the time period covered in WIOD) but whose currencies are de facto fixed to the currencies of the Eurozone countries during this period. The five countries are the Czech Republic, Denmark, Estonia, Latvia, and Sweden. Table 1 reports the average bilateral correlations of the annual exchange rates of these five countries' annual exchange rates with those of the Eurozone countries and with other non-Eurozone countries.

In this section, we consider a number of comparative static calculations that quantify the changes in the costs of the exporter in response to a change in the value of its currency, based on currency union designations and the data on trade in value added. If there are other countries that supply inputs to the exporter and they share the same currency or their currency is de facto fixed to the currency of the exporter, then we assume in the comparative static calculations that their currencies also appreciate by the same amount. To implement these calculations, we consider a narrow definition of currency union that only includes the countries in the Eurozone in the specific years when each country was a member. We also consider a broader definition that includes the entire WIOD period and includes the five countries whose exchange rates were de facto fixed to the Eurozone countries over the entire WIOD period.

The measure $U_{nst}$ in equation (6) represents the share of the cost of exports of country $s$ in sector $n$ in year $t$ that is denominated in the currency of exporting country $s$. In other words, it is the value contributed by factors from all sectors of country $s$ and its currency-union partners *as a share* of the value of the total exports by country $s$ in sector $n$.

$$U_{nst} = \frac{\sum_d \sum_{j \in J(s)} VBE_{njsdt}}{\sum_d \sum_o VBE_{nosdt}} \tag{6}$$

The variables $j$ and $o$ index the countries of origin, and $J(s)$ is the set of countries with the same currency as country $s$, including country $s$ itself. As noted above, $VBE_{nosdt}$ is the value added from country of origin $o$ in the exports of final goods in sector $n$ from country $s$ to country $d$ in year $t$.

We calculate weighted average values of $U_{nst}$ to summarize these exchange rate-exposed cost shares. Equation (7) is the average value of $U_{nst}$ across the exporting countries for sector $n$ in year $t$.

$$\overline{U}_{nt} = \frac{\sum_s \sum_d \sum_{j \in J(s)} VBE_{njsdt}}{\sum_s \sum_d \sum_o VBE_{nosdt}} \qquad (7)$$

In the special case in which one hundred percent of the value added in the exports is domestic value added—the usual assumption in the econometric literature on exchange rate pass-through—$\overline{U}_{nt}$ would be equal to one.

Table 2 reports $\overline{U}_{nt}$ for 1995, 2002 and 2009 and for the fourteen manufacturing sectors in WIOD, based on the formula in (7). The final row of the table reports a weighted average over all of the manufacturing sectors. This average increased slightly from 1995 to 2002, then declined by 2009. All of the estimates of $\overline{U}_{nt}$ are less than one, indicating that there was incomplete exposure of costs to movements in the exporter's currency. In 2009, $\overline{U}_{nt}$ was highest (indicating the most domestic or same-currency content) in food, wood, and non-metallic minerals products. The measure was lowest (indicating the least domestic or same-currency content) in refined petroleum, electrical and optical equipment, and chemical products.

Table 3 reports the weighted average values of $U_{nst}$ for each exporting country $s$ in each year $t$, averaged over the manufacturing sectors and destination countries in WIOD, based on the formula in (8).

$$\overline{U}_{st} = \frac{\sum_n \sum_d \sum_{j \in J(s)} VBE_{njsdt}}{\sum_n \sum_d \sum_o VBE_{nosdt}} \qquad (8)$$

$\overline{U}_{st}$ represents the share of value contributed from country $s$ and its currency-union partners in the total exports of country $s$. Again, in the special case in which one hundred percent of the value added in the exports is domestic value added, $\overline{U}_{st}$ would be equal to one. The exporting country averages varied from 0.490 to 0.906. In 2009, $\overline{U}_{st}$ was highest for Russia, Brazil, Japan, and Portugal. Of these countries, Portugal is tightly integrated into the global economy, and sources substantial inputs from the rest of the EU, while the other three are less globally integrated but domestic value added makes up a substantial share (close to 90 percent) of their total exports.[6] The measure is lowest for Hungary, the Czech Republic, Bulgaria, and Taiwan. There were big increases in $\overline{U}_{st}$ from 1995 to 2009 in several small Eurozone countries (Malta, Luxembourg, Belgium, Cyprus, Slovenia, and Portugal.)

Table 4 provides a sensitivity analysis of the weighted average calculations for $\overline{U}_{st}$. The first column of the table assumes that the currencies of each of the exporting countries are truly independent. In this case, $\overline{U}_{st}$ includes only the share of domestic value added in exports. The second column of estimates in Table 4 reproduces the 2009 estimates in the final column of Table 3, using Eurozone membership to define the set of countries with fixed currencies. The third column of estimates reports 2009 estimates using the broader definition of fixed currencies that includes the Eurozone members in all years and the five additional countries identified in Table 1. The (weakly) increasing values across the three columns illustrates the incremental effect of taking into account additional currency linkages.

For the Eurozone countries that import a significant share of their intermediate inputs from other Eurozone countries, there are large differences across the columns. For the non-Eurozone countries with currencies that move independently, such as Brazil, there are no differences in the measure across the columns. Comparing the first two columns, the exporting country average rises only

[6] See table 4 for the value of domestic value added in these country's exports in 2009.

in Eurozone countries.  The biggest differences are for Luxembourg, Belgium, Malta, and Slovenia, which source a very high share of intermediate inputs from within the EU.  Comparing the last two columns, there were large increases in the additional five countries (the Czech Republic, Denmark, Estonia, Latvia, and Sweden), smaller increases in the Eurozone countries, and no changes in any others.

## 5. Regression Analysis of Pass-Through Rates

Most estimates of pass-through rates in the literature are based on the correlation between import prices and nominal effective exchange rates, conditional on a set of control variables.  They may not be accurate measures of the pass-through of exchange rate-related changes in costs into import prices, since they usually do not take into account the currency denomination of the exporter's costs.

To assess the quantitative significance of this issue, we estimated a set of regressions using imputed import prices.  First, we used the data on trade in value added to construct $\Delta z_{dt}$, a weighted average of the first-differences of the logs of the costs of exporters to country $d$ in year $t$.  This is a measure of the effect of fluctuations in the value of the exporter's currency, and the currencies of intermediate input suppliers, on the exporter's costs of production.

$$\Delta z_{dt} = \frac{\sum_s \sum_n \sum_o VBE_{nosdt} \, (\Delta c_{ot} + \Delta e_{ot})}{\sum_s \sum_n \sum_o VBE_{nosdt}} \qquad (10)$$

The variable $\Delta c_{ot}$ represents the first-difference of the log of local-currency costs of production in country of origin $o$ in year $t$, and the variable $\Delta e_{ot}$ is the first-difference of the log of nominal exchange rate of country $o$, in terms of dollars.[7] Equation (10) uses value-added shares based on matrix $VBE$ in (5).[8]

Next we constructed a series of first-differences in the log of import prices by destination country and year, $\Delta p_{dt}$. This price imputation was necessary because WIOD does not report import prices (only the value of shipments). The import price changes are calculated according to equation (11) for an assumed pass-through rate $\beta$.

$$\Delta p_{dt} = \beta \, \Delta z_{dt} \tag{11}$$

We calculate import prices for different values of $\beta$, the assumed "true" rate of pass-through of cost fluctuations into import prices, ranging from 0.25 to 1.

Then we constructed a series of first-differences in the log of a nominal effective exchange rate index based on gross trade flows, $\Delta x_{dt}$.

$$\Delta x_{dt} = \frac{\sum_s \sum_n E_{nsdt} \, (\Delta c_{st} + \Delta e_{st})}{\sum_s \sum_n E_{nsdt}} \tag{12}$$

The variable $E_{nsdt}$ represents the value of gross exports of country $s$ in sector $n$ to country $d$ in year $t$. This index is comparable to the effective exchange rate measures in the pass-through literature, since it does not incorporate the pattern of trade in value added. It assumes implicitly that the exporters have one hundred percent domestic content.

Finally, we estimated the effect of $\Delta x_{dt}$ on $\Delta p_{dt}$ using the regression specification in equation (13).

[7] We use the *World Economic Outlook* GDP deflator of each country of origin, in local currency, as a proxy for local currency costs of production.

[8] Like the real effective exchange rate measure in Bems and Johnson (2012), we use value-added flows, nominal exchange rates, and proxies for local currency costs based on national GDP deflators. However, the cost measure in (10) is different than their real effective exchange rate because it does not incorporate information about the expenditure shares of consumers and other final users.

$$\Delta p_{dt} = a + b\,\Delta x_{dt} + \epsilon_{dt} \tag{13}$$

Table 5 reports OLS estimates of $b$ for different values of $\beta$. In each case, the OLS estimate of $b$ is significantly less than $\beta$, indicating a downward bias in the estimate of the pass-through rate when the exchanges rates are weighted by gross trade in the final good without incorporating information on trade in value added. The estimate of $b$ is approximately 13 percent less than $\beta$ for all of the assumed values of $\beta$, and the differences are statistically significant.

Tables 6, 7, and 8 report variations of the OLS models that relax the pooling restriction that $b$ is the same across the countries and the years. These are the two most common dimensions of variation in the econometric literature on pass-through rates. In each of these models, we generated an import price series that assumes that $\beta$ is equal to 0.50. The tables report the results of F tests of the hypothesis that all of the slope coefficients are equal. A high value of the F statistic indicates that the slope coefficients are significantly different.

Table 6 reports a separate $b$ coefficient for each year from 1996 through 2009, pooling over the manufacturing sectors and the source and destination countries. The F test indicates that the slope coefficients are significantly different over time. They rise to a peak in 2004, and then decline again. The value for 2009 is approximately the same as the value in 1996.

The discrepancy between $b$ and $\beta$ will depend in part on the countries included in the IIO tables. The discrepancy estimated with WIOD is probably different than the estimate that would be obtained using another IIO table. Of the 40 countries in WIOD, 27 are EU members with substantial intra-EU trade. Of the other 13 countries, most (Australia, Brazil, Indonesia, India, Japan, Russia, and the United States) contain substantially higher domestic content in exports that the world average. IIO databases employing a wider set of countries, such as the UNCTAD-Eora database, will have a lower share of countries in customs unions and will generally have lower average domestic value added in exports.[9]

Table 7 reports a separate $b$ coefficient for each destination country, pooling over the manufacturing sectors, the years, and the source countries. In this case, the F test does not reject the hypothesis that the slope coefficients are equal for the different destination countries. They are all close to the pooled estimate of 0.4362 in Table 6 (12.8 percent lower than $\beta$). The estimated value of $b$ ranges from 0.4275 for Turkey (14.5 percent lower than $\beta$) to 0.4420 for Russia (11.6 percent lower than $\beta$).

Table 8 reports a separate $b$ coefficient for each source country, pooling over the manufacturing sectors, the years, and the destination countries. The F test indicates that the slope coefficients are significantly different across the source countries. The estimated value of $b$ ranges from 0.3632 for Mexico (27.4 percent lower than $\beta$) to 0.5132 for the United States (2.6 percent higher than $\beta$).

## 6. Concluding Remarks

We are working to improve the modeling of the currency denomination of exporters' costs in econometric estimates of exchange rate pass-through. We use international input-output tables to estimate the share of each country of origin in these costs. Then we calculate weighted average exchange rate changes using these shares. We find that models of exchange rate pass-through that rely on the usual assumption about the currency denomination of the exporters' costs are likely to understate the pass-through rates and to overstate the adjustment of the exporters' mark-ups to movements in exchange rates.

[9] See UNCTAD (2013) for a comparison of foreign value added in WIOD and the UNCTAD-Eora database.

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**TABLE 1: Average Bilateral Correlations of Annual Nominal Exchange Rates, 1995-2009**

| Countries with Highly Correlated Exchange Rates | Five Additional Countries with Highly Correlated Exchange Rates | Eurozone Countries | Other Non-Eurozone Countries |
|---|---|---|---|
| Czech Republic | 0.868 | 0.903 | 0.270 |
| Denmark | 0.946 | 0.988 | 0.468 |
| Estonia | 0.942 | 0.986 | 0.491 |
| Latvia | 0.918 | 0.946 | 0.409 |
| Sweden | 0.861 | 0.913 | 0.514 |

**TABLE 2: Average of Exchange Rate Effects on Exporter Costs, by Manufacturing Industry and Year**

| Industry of Final Good | 1995 | 2002 | 2009 |
|---|---|---|---|
| Food, Beverages and Tobacco | 0.821 | 0.851 | 0.839 |
| Textiles and Textile Products | 0.753 | 0.761 | 0.778 |
| Leather, Leather Products and Footwear | 0.790 | 0.806 | 0.821 |
| Wood and Products of Wood and Cork | 0.805 | 0.828 | 0.830 |
| Pulp, Paper, Printing and Publishing | 0.790 | 0.822 | 0.822 |
| Coke, Refined Petroleum and Nuclear Fuel | 0.674 | 0.630 | 0.607 |
| Chemicals and Chemical Products | 0.772 | 0.799 | 0.757 |
| Rubber and Plastics | 0.771 | 0.802 | 0.769 |
| Other Non-Metallic Minerals | 0.844 | 0.837 | 0.825 |
| Basic Metals and Fabricated Metals | 0.768 | 0.797 | 0.758 |
| Machinery, nec | 0.813 | 0.823 | 0.777 |
| Electrical and Optical Equipment | 0.743 | 0.706 | 0.685 |
| Transportation Equipment | 0.743 | 0.785 | 0.761 |
| Manufacturing, nec; Recycling | 0.791 | 0.807 | 0.766 |
| Weighted Average of all Manufacturing Industries | 0.771 | 0.778 | 0.756 |

**TABLE 3: Average of Exchange Rate Effects by Exporting Country and Year**

| Country Exporting the Final Good | 1995 | 2002 | 2009 |
|---|---|---|---|
| Australia | 0.852 | 0.849 | 0.838 |
| Austria | 0.718 | 0.849 | 0.839 |
| Belgium | 0.547 | 0.789 | 0.774 |
| Brazil | 0.914 | 0.844 | 0.883 |
| Bulgaria | 0.664 | 0.618 | 0.591 |
| Canada | 0.640 | 0.655 | 0.698 |
| China | 0.828 | 0.799 | 0.748 |
| Cyprus | 0.626 | 0.657 | 0.823 |
| Czech Republic | 0.654 | 0.554 | 0.536 |
| Denmark | 0.747 | 0.722 | 0.711 |
| Estonia | 0.594 | 0.524 | 0.634 |
| Finland | 0.716 | 0.810 | 0.756 |
| France | 0.783 | 0.865 | 0.850 |
| Germany | 0.816 | 0.856 | 0.827 |
| Great Britain | 0.771 | 0.770 | 0.747 |
| Greece | 0.780 | 0.833 | 0.798 |
| Hungary | 0.674 | 0.471 | 0.490 |
| India | 0.892 | 0.829 | 0.727 |
| Indonesia | 0.802 | 0.774 | 0.780 |
| Ireland | 0.588 | 0.630 | 0.615 |
| Italy | 0.800 | 0.878 | 0.861 |
| Japan | 0.937 | 0.908 | 0.871 |
| Korea | 0.750 | 0.717 | 0.659 |
| Latvia | 0.716 | 0.639 | 0.683 |
| Lithuania | 0.618 | 0.581 | 0.612 |
| Luxembourg | 0.575 | 0.867 | 0.835 |
| Malta | 0.482 | 0.501 | 0.771 |
| Mexico | 0.613 | 0.601 | 0.625 |
| Netherlands | 0.642 | 0.764 | 0.715 |
| Poland | 0.815 | 0.707 | 0.689 |
| Portugal | 0.692 | 0.877 | 0.862 |
| Romania | 0.748 | 0.643 | 0.713 |
| Russia | 0.865 | 0.846 | 0.906 |
| Slovakia | 0.652 | 0.470 | 0.697 |
| Slovenia | 0.633 | 0.603 | 0.809 |
| Spain | 0.753 | 0.867 | 0.841 |
| Sweden | 0.704 | 0.665 | 0.632 |
| Taiwan | 0.657 | 0.640 | 0.591 |
| Turkey | 0.853 | 0.772 | 0.762 |
| United States | 0.869 | 0.871 | 0.844 |
| | | | |
| Weighted Average | 0.771 | 0.778 | 0.756 |

**TABLE 4: Average of Exchange Rate Effects in 2009 for Alternative Currency Unions**

| Country Exporting the Final Good | Domestic value added only 2009 | Domestic plus Eurozone 2009 | Domestic plus Eurozone plus Five 2009 |
|---|---|---|---|
| Australia | 0.838 | 0.838 | 0.838 |
| Austria | 0.663 | 0.839 | 0.856 |
| Belgium | 0.531 | 0.774 | 0.788 |
| Brazil | 0.883 | 0.883 | 0.883 |
| Bulgaria | 0.591 | 0.591 | 0.591 |
| Canada | 0.698 | 0.698 | 0.698 |
| China | 0.748 | 0.748 | 0.748 |
| Cyprus | 0.675 | 0.823 | 0.834 |
| Czech Republic | 0.536 | 0.536 | 0.767 |
| Denmark | 0.711 | 0.711 | 0.861 |
| Estonia | 0.634 | 0.634 | 0.802 |
| Finland | 0.653 | 0.756 | 0.792 |
| France | 0.736 | 0.850 | 0.857 |
| Germany | 0.740 | 0.827 | 0.843 |
| Great Britain | 0.747 | 0.747 | 0.747 |
| Greece | 0.719 | 0.798 | 0.802 |
| Hungary | 0.490 | 0.490 | 0.490 |
| India | 0.727 | 0.727 | 0.727 |
| Indonesia | 0.780 | 0.780 | 0.780 |
| Ireland | 0.507 | 0.615 | 0.624 |
| Italy | 0.778 | 0.861 | 0.867 |
| Japan | 0.871 | 0.871 | 0.871 |
| Korea | 0.659 | 0.659 | 0.659 |
| Latvia | 0.683 | 0.683 | 0.828 |
| Lithuania | 0.612 | 0.612 | 0.612 |
| Luxembourg | 0.505 | 0.835 | 0.850 |
| Malta | 0.553 | 0.771 | 0.779 |
| Mexico | 0.625 | 0.625 | 0.625 |
| Netherlands | 0.595 | 0.715 | 0.726 |
| Poland | 0.689 | 0.689 | 0.689 |
| Portugal | 0.689 | 0.862 | 0.868 |
| Romania | 0.713 | 0.713 | 0.713 |
| Russia | 0.906 | 0.906 | 0.906 |
| Slovakia | 0.512 | 0.697 | 0.739 |
| Slovenia | 0.594 | 0.809 | 0.824 |
| Spain | 0.722 | 0.841 | 0.849 |
| Sweden | 0.632 | 0.632 | 0.803 |
| Taiwan | 0.591 | 0.591 | 0.591 |
| Turkey | 0.762 | 0.762 | 0.762 |
| United States | 0.844 | 0.844 | 0.844 |
| | | | |
| Weighted Average | 0.720 | 0.756 | 0.766 |

**TABLE 5: Regression Estimates of Pass-Through Rates Using Simulated Import Prices**

Dependent variable is the log-difference in the import price.

| | $\beta$ = 0.25 | $\beta$ = 0.50 | $\beta$ = 0.75 | $\beta$ = 1.00 |
|---|---|---|---|---|
| Log-difference in the Cost Measure Based on Value-Added Weights | 0.2181<br>(0.0004) | 0.4362<br>(0.0008) | 0.6543<br>(0.0013) | 0.8725<br>(0.0015) |
| Constant | 0.0004<br>(0.0000) | 0.0007<br>(0.0001) | 0.0011<br>(0.0001) | 0.0015<br>(0.0001) |
| Number of Observations | 22,400 | 22,400 | 22,400 | 22,400 |
| R-Squared Statistic | 0.9749 | 0.9749 | 0.9749 | 0.9749 |

Note: The table reports the robust standard error in parentheses.

**TABLE 6: Year-Specific Slope Coefficients**

Dependent variable is the log-difference in the import price, $\beta$ = 0.50

| Year | Estimate |
|---|---|
| 1996 | 0.4262 (0.0027) |
| 1997 | 0.4187 (0.0020) |
| 1998 | 0.3897 (0.0021) |
| 1999 | 0.4326 (0.0015) |
| 2000 | 0.4188 (0.0014) |
| 2001 | 0.4047 (0.0024) |
| 2002 | 0.4290 (0.0027) |
| 2003 | 0.4625 (0.0010) |
| 2004 | 0.4818 (0.0012) |
| 2005 | 0.4439 (0.0022) |
| 2006 | 0.4455 (0.0016) |
| 2007 | 0.4556 (0.0015) |
| 2008 | 0.4539 (0.0020) |
| 2009 | 0.4286 (0.0022) |

Note: The regression includes a constant term and 22,400 observations. The R-Squared statistic is 0.9781, and the F statistic for equality of the slope coefficients is 195.88, with a p-value of 0.000. The table reports the robust standard error in parentheses.

**TABLE 7: Destination Country-Specific Slope Coefficients**

Dependent variable is the log-difference in the import price, $\beta$ = 0.50

| Destination | Estimate | Destination | Estimate |
|---|---|---|---|
| Australia | 0.4354 (0.0035) | Italy | 0.4379 (0.0027) |
| Austria | 0.4329 (0.0056) | Japan | 0.4408 (0.0035) |
| Belgium | 0.4381 (0.0045) | Korea | 0.4377 (0.0038) |
| Brazil | 0.4326 (0.0044) | Latvia | 0.4385 (0.0049) |
| Bulgaria | 0.4372 (0.0035) | Lithuania | 0.4406 (0.0060) |
| Canada | 0.4373 (0.0052) | Luxembourg | 0.4332 (0.0065) |
| China | 0.4285 (0.0053) | Malta | 0.4408 (0.0049) |
| Cyprus | 0.4375 (0.0048) | Mexico | 0.4297 (0.0059) |
| Czech Republic | 0.4391 (0.0047) | Netherlands | 0.4407 (0.0046) |
| Denmark | 0.4414 (0.0037) | Poland | 0.4362 (0.0045) |
| Estonia | 0.4409 (0.0046) | Portugal | 0.4371 (0.0036) |
| Finland | 0.4335 (0.0042) | Romania | 0.4365 (0.0044) |
| France | 0.4361 (0.0046) | Russia | 0.4420 (0.0026) |
| Germany | 0.4337 (0.0047) | Slovakia | 0.4372 (0.0046) |
| Great Britain | 0.4360 (0.0044) | Slovenia | 0.4319 (0.0067) |
| Greece | 0.4356 (0.0052) | Spain | 0.4358 (0.0045) |
| Hungary | 0.4327 (0.0054) | Sweden | 0.4361 (0.0041) |
| India | 0.4371 (0.0029) | Taiwan | 0.4333 (0.0046) |
| Indonesia | 0.4380 (0.0029) | Turkey | 0.4275 (0.0066) |
| Ireland | 0.4385 (0.0051) | United States | 0.4334 (0.0050) |

See note to Table 6. In this additional model, the R-Squared is 0.9750, and the F statistic is 0.55 with a p-value of 0.9896.

**TABLE 8: Source Country-Specific Slope Coefficients**

Dependent variable is the log-difference in the import price, $\beta$ = 0.50

| Destination | Estimate | Destination | Estimate |
|---|---|---|---|
| Australia | 0.4648 (0.0005) | Italy | 0.4732 (0.0011) |
| Austria | 0.4741 (0.0013) | Japan | 0.4689 (0.0008) |
| Belgium | 0.4472 (0.0015) | Korea | 0.3930 (0.0023) |
| Brazil | 0.4618 (0.0010) | Latvia | 0.4323 (0.0030) |
| Bulgaria | 0.4314 (0.0026) | Lithuania | 0.4560 (0.0040) |
| Canada | 0.4134 (0.0013) | Luxembourg | 0.4363 (0.0012) |
| China | 0.4314 (0.0018) | Malta | 0.4754 (0.0017) |
| Cyprus | 0.4600 (0.0023) | Mexico | 0.3632 (0.0029) |
| Czech Republic | 0.4139 (0.0030) | Netherlands | 0.4535 (0.0015) |
| Denmark | 0.4701 (0.0006) | Poland | 0.4319 (0.0025) |
| Estonia | 0.4088 (0.0028) | Portugal | 0.4780 (0.0009) |
| Finland | 0.4713 (0.0022) | Romania | 0.4127 (0.0023) |
| France | 0.4692 (0.0008) | Russia | 0.4466 (0.0015) |
| Germany | 0.4673 (0.0015) | Slovakia | 0.4076 (0.0016) |
| Great Britain | 0.4478 (0.0030) | Slovenia | 0.4678 (0.0015) |
| Greece | 0.4770 (0.0024) | Spain | 0.4663 (0.0007) |
| Hungary | 0.3856 (0.0032) | Sweden | 0.4485 (0.0018) |
| India | 0.4748 (0.0016) | Taiwan | 0.4322 (0.0028) |
| Indonesia | 0.4029 (0.0025) | Turkey | 0.4531 (0.0017) |
| Ireland | 0.3880 (0.0026) | United States | 0.5132 (0.0058) |

See note to Table 6. In this additional model, the R-Squared is 0.9797, and the F statistic is 267.96 with a p-value of 0.0000.