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Pass-Through of Exchange Rates to Consumption Prices
What Has Changed and Why?

José Manuel Campa and Linda S. Goldberg

5.1 Introduction

Both traded and nontraded goods prices can be sensitive to exchange rate movements. There are a number of forces that contribute to less than complete pass-through of exchange rates into the final consumption prices of imported goods. First, pass-through into prices at the border is incomplete, and varies considerably across goods and across countries. Second, distribution services, like local storage, transportation, and retail costs, provide some insulation of consumption prices of traded goods, both by diluting the import content of the final consumption good and because distributors may actively adjust profit margins to absorb currency fluctuations. For home produced tradable goods, production costs are expected to become more sensitive to exchange rates and import prices as production increasingly relies on imported components. Indeed, a producer of tradable goods achieves such production cost sensitivity both through his own reliance on imported components, and through the reliance of his domestic suppliers and distributors on imported inputs. Imported goods play a role, directly introducing sensitivity to exchange rates in the domestic economy through costs, as in Campa and Goldberg (2006), or alternatively, by keeping pass-through into import prices low in a model of foreign exporting firms selling intermediate goods to domestic producers who

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compete with nontraded goods producers, as argued by Bacchetta and van Wincoop (2003).[1]

In this paper, we consider the evolution over the past decade in the predicted sensitivity of consumption prices of imported and domestically-produced goods with respect to exchange rates. For this work, we focus on changes in distribution margins and imported inputs use, as well as on pass-through into import prices at the border for five broad categories of goods: manufactured, nonmanufactured, food, energy, and raw materials. Thus, we build on Campa and Goldberg (2006), where we explored the role of the distribution sector and imported inputs in levels of consumer price index (CPI) sensitivity to exchange rates across twenty-one Organization for Economic Cooperation and Development countries. That study documented that distribution expenditures associated with goods consumed by households are between 30 and 50 percent of the purchasers' prices. These distribution expenditures are dominated by wholesale and retail sector costs, with transportation and storage costs relatively low except in the case of various raw materials and mining industries. In tradable goods production, imported inputs are shown to account for between 10 and 48 percent of the final price. Nontradable goods are produced with lower shares of imported inputs, ranging from 3 percent in the United States to 22 percent in Hungary. Using this evidence across countries within a calibrated model, we found that predicted and actual CPI sensitivity to exchange rate movements are low, often below 10 percent of any exchange rate change.

Yet that study did not address changes over time in the effects of exchange rates on the consumption prices of different types of goods. With distribution expenditures partially insulating final consumption prices from import price changes at the border, consumption price sensitivity to exchange rates can rise if the structure of the retail and distribution sector leads to lower distribution costs. In particular, we ask whether there has been something like a "Wal-Mart effect" influencing exchange rate pass-through, whereby expenditure on such services declines as large-box retailers and distributors are increasingly present in local markets.

One issue is the potential for changing pass-through into the prices of imports at the border. Some studies present evidence that pass-through into the import prices of industrialized countries has declined in the past decade, particularly on finished goods (Marazzi, Sheets, and Vigfusson 2005; Otani, Shiratsuka, and Shirota 2005; Frankel, Parsley, and Wei 2005), while other studies dispute the magnitude and significance of such changes (Campa and Goldberg 2005; Campa, Goldberg, and González-Minguez 2007; Ihrig, Marazzi, and Rothenberg 2006; Daly, Hellerstein, and Marsh 2006; Thomas and Marquez 2006).

1. Corsetti and Dedola (2005) make related arguments in a different production chain and pricing setup.

Another relevant issue is the growth of globalization of production over the recent decade. If more imported components are used in production, and these components are priced as other imports at the border, then there is more opportunity for local costs to be sensitive to exchange rates. This growth in imported inputs could raise the sensitivity of final consumption prices to exchange rates.

In this paper, we pull together evidence on these three sources of changing pass-through into consumption prices of types of goods using data drawn from eighteen countries. We compare the roles of expenditures on distribution services, use of imported inputs and components in production, and of changes in the rate of exchange rate pass-through into border prices of goods across countries, across sectors, and for pre- and post-1995 time periods. The analysis yields the following observations. Pass-through into the prices of imports, at the border, is defined more by industry than by country. The notable exception is the United States, where pass-through into import prices is unusually low. Pass-through into import prices is noisiest and least precisely measured for energy imports. Pass-through into import prices of manufactured goods and, less so, food prices, are the only categories measured with precision across countries. Evidence of declining pass-through into the border prices of imports is concentrated within some manufactured goods categories (Marazzi and Sheets 2006; Campa, Goldberg, and González-Minguez 2007), but only for some countries.

Across countries and industries, distribution expenditures have a large industry-specific component but are not trending in a consistent direction across these industries. Imported input use likewise has industry characteristics, but—unlike distribution expenditures—trend changes have been significant and widespread. Imported input use has tended to grow over time, both across countries and across industries. These findings together will suggest that changes in distribution margins have not been the key contributor to changing pass-through into consumption prices of goods over the past decade. By contrast, the significant expansion of imported input use, including its use in distribution services, has increased the predicted sensitivity of retail prices of imported goods and other tradable goods to exchange rates.

It is important to point out that our exercise is one of generating changes in prices imputed to be associated with exchange rate movements. This exercise is one of "all else equal." The exercise shows pressures on prices that are generated by exchange rates. However, these price pressures may not be observable in realized consumption price data. As Gagnon and Ihrig (2005) compellingly argue, and Gust and Sheets (2006) build into general equilibrium models, the inflationary impetus from a home currency depreciation may be met with monetary tightening. In this case, some of the inflationary pressures from depreciation are offset by policy.

Section 5.2 begins our exposition by presenting evidence on industry-specific exchange rate pass-through into import prices and the (more sparse) evidence available on pass-through into consumption prices at the level of particular industries. In section 5.3 we delve into the industry-specific features of distribution margins and imported input use, and focus specifically on decomposing patterns into ones associated with specific countries, industries, and points in time. Section 5.4 pulls together this information and evidence on exchange rate pass-through into import prices to generate predicted values for the consumption price sensitivity to exchange rates of different types of goods across countries. Section 5.5 concludes by summarizing key findings and discussing implications for trade balance adjustment to exchange rates.

5.2 Import Price Elasticities with Respect to Exchange Rates

There is a large literature that has looked at the extent to which exchange rate changes affect import prices of goods. Most of these studies generally have found that pass-through is incomplete, implying that import prices are less volatile than exchange rates. Goldberg and Knetter (1997) present a review of the literature in this area and concluded that pass-through into U.S. import prices was on the order of 50 percent. Large variations around this estimate occur by industry. Antzoulatos and Yang (1996), Yang (1997), and Olivei (2002) all perform estimation of pass-through rates into import prices at the industry level and conclude that pass-through varies across industries. The existing evidence has been obtained by either focusing on a subset of narrowly defined industries, using data at the firm or product level (microstudies) or, more broadly, by looking at a cross-section of relatively aggregated industry statistics (industry studies).

Micro-oriented studies generally focus on pass-through from one country's firms into another's and concentrate on a particular product or industry. For example, Feenstra (1989) and Gron and Swenson (1996) examined the pass-through of movements of the yen into U.S. import prices for Japanese shipments of cars, trucks, and motorcycles. Gil-Pareja (2003) and Goldberg and Verboven (2001) also focus on the degree of pass-through in the automobile industry by looking at detailed product imports from different countries. In other industries, Bernhofen and Xu (2000) examined the exchange rate pass-through into U.S. petrochemical imports from Germany and Japan, and Blonigen and Haynes (2002) looks at Canadian exports of iron and steel into the United States.

The cross-industry studies focus on import prices for more than one industry at a time, often with more aggregated data than found in the micro-oriented studies. Feinberg (1989), Yang (1997), and Pollard and Coughlin (2005) provide estimates of pass-through at broader industry classifications for imports in the manufacturing sector in the United States. Similar evidence for five industry categories is presented for OECD countries in Campa and Goldberg (2005, 2006), Marazzi, Sheets, and Vigfusson (2005), Gagnon and Ihrig (2006) and, for European Union countries, in Campa, Goldberg, and González-Mínguez (2007). Across the OECD countries, industry considerations, and particularly the sectoral composition of a country's imports, have been more important than macroeconomic volatility in explaining changes in exchange rate pass-through into aggregated import prices.

Table 5.1 reports estimated pass-through rates into import prices for all imports and for five broad industry categories across 16 countries. The reported coefficients are the estimated pass-through rates from a regression of changes in import prices on changes in nominal exchange rates and foreign prices using quarterly data for the period 1976:1 to 2004:1.[2] The reported estimates of pass through of exchange rate changes are the contemporaneous effect and the cumulative one-year impact from an exchange rate shock. These estimates come from a partial-adjustment model of the form:

$$\Delta p_t^j = \alpha + \sum_{i=0}^{4} a_i^j \Delta e_{t-i}^j + \sum_{i=0}^{4} b_i^j \Delta w_{t-i}^j + c^j \Delta gdp_t^j + \vartheta_t^j,$$

where p_t^j are local currency import prices or the local consumer price index, e_t^j is the exchange rate, w_t^j is the foreign production costs, gdp_t^j is real GDP, and the final term is the regression residual. The short-run relationship between exchange rates and the respective price series of country j is given by the estimated coefficient a_0^j. The long run elasticity is given by the sum of the coefficients on the contemporaneous exchange rate and four lags of exchange rate terms $\Sigma_{i=0}^{4} a_i^j$. While the theoretical antecedents of this equation suggest a log-levels relationship among variables, for estimation the variables in these equations are first differences in logarithms to control for the possibility of unit roots (Campa and Goldberg 2006; Osbat 2006).

Across the eighteen countries for which pass-through rates are presented in table 5.1, the (unweighted) average pass-through elasticity of import prices is 0.59. Consistent with the findings of prior studies, most industries exhibit a striking degree of partial pass-through. In the "all imports" category the hypothesis of zero exchange rate pass-through is rejected for more than half of the countries. Across industries, pass-through rates equal to 1, or complete pass-through, are strongly rejected for manufacturing and for food.

Pass-through is smaller in manufacturing than in commodities such as energy and raw materials. The precision of the estimates also is tightest for

2. The sample period begins later for the Netherlands (1977:2), Norway (1978:2), Portugal, and Sweden (1980:2), Australia and Belgium (1981:2), Italy (1982:2), Denmark and New Zealand (1987:3), and Hungary (1995:2) and ends earlier for Netherlands (1997:4), Portugal (1998:4), Austria (1999:4), Denmark and New Zealand (2002:4). France is missing data from 1987:1 to 1996:1.

Table 5.1 **Pass-through-rates into industry import price indices**

	All Imports	Food	Energy	Raw Materials	Manufacturing	Nonmanufacturing
Australia	0.67*+	0.35*+	–0.69+	0.43*+	0.93*	0.66+
Austria	0.10	0.06	2.24	1.74	–0.32+	1.50
Belgium	0.68	0.55	–0.70	1.72*	0.43	0.51
Denmark	0.82*	0.99*	3.50	1.14*	0.57*+	1.61*
Finland	0.77	0.83	1.46	0.28	0.74	1.08
France	0.90*	1.41*	1.89	—	0.99*	1.27
Germany	0.80*	0.48*+	2.72*	1.12*	0.42*+	1.54*
Hungary	0.78*	0.63*	0.89	–0.00	0.79*+	0.67
Ireland	–0.06	1.23*	1.78*	2.06*	1.19*	1.70*
Italy	0.35+	0.81*	–.80	0.76	0.56*+	0.07
Netherlands	0.84*	0.54*+	2.19	1.72*	0.32*+	1.44*
New Zealand	0.22+	0.23+	0.27	–0.04+	0.24+	0.18
Norway	0.63*	0.15+	–0.69	0.69	0.61*	0.07
Portugal	1.08*	1.07*	0.79	1.41*	1.02*	0.85
Spain	0.70*	1.01	–0.01	1.23*	1.06+	0.61
Sweden	0.38*+	0.85*	–1.64+	0.11+	0.66*+	–0.66+
United Kingdom	0.46*+	0.52*+	0.39	0.47*+	0.46*+	0.39+
United States	0.42*+	0.21+	0.20	0.44*+	0.44*+	0.33
Average	0.59	0.66	0.77	0.90	0.62	0.77
Standard Deviation	0.30	0.39	1.42	0.67	0.36	0.68

Sources: Nominal exchange rate and consumer prices come from the IFS; import price comes from the OECD. Specific start and end dates by country are detailed in the data appendix. Long-run elasticities (four quarters) shown.

Note: *Significantly different from zero (5%), + Significantly different from one (5%). Most data are quarterly, spanning 1975 through the end of 2004.

manufacturing and for food, with dispersion of estimated rates of pass-through across countries lowest for these categories. Our 2005 study reached similar conclusions for both short-run and long-run pass-through rates in the OECD countries. These differences across industries also occur at more disaggregated levels within manufacturing, as Yang (1997) and Pollard and Coughlin (2005) show for manufacturing industries in the United States, and Campa, Goldberg, and González-Minguez (2007) show for the euro-area countries. Pass-through into the import prices of non-manufactured goods, energy, and raw materials appears to be poorly measured by the basic estimating equation.[3]

Recent studies have debated whether pass-through of exchange rates

3. There are many reasons why the pass-through estimation equation can generate poor results. One of these reasons is that the proxies for production costs may be poor. Another reason could be codetermination of exchange rates and the prices of some goods. In recent years, the dollar and petroleum prices have exhibited stronger comovement than in the preceding decade.

into import prices may have declined since 1997, particularly for the United States (Marazzi, Sheets, and Vigfusson 2005; Ihrig, Marazzi, and Rothenberg 2006). Campa, Goldberg, and González-Minguez (2007) argue that the evidence is mixed across European countries. We replicate these tests for fifteen of the eighteen countries[4] in table 5.1 and find that it is difficult to make a case that pass-through into import prices has systematically declined. Typically, the relationship between exchange rates and the local currency import prices of energy, raw materials, and nonmanufactured goods are found to be noisy and unstable. It is difficult to make definitive statements about whether pass-through rates have altered meaningfully for these sectors. By contrast, for manufactured goods estimates of exchange rate pass-through are more informative. We observe some instances of increasing pass-through of exchange rate movements into import prices and other instances of declining pass-through as we look across the sample of countries. Importantly, we stress here that the presumption that pass-through rates have systematically declined across countries, and across a wide spectrum of goods, is not supported. It is not yet appropriate to conclude that persistent change has occurred in the distribution of pass-through into import prices of manufactured goods.

5.3 Mapping Imported Inputs and Distribution Margins into Consumption Prices of Goods

One goal of the analysis is to understand the feedback between exchange rate changes and stimuli to consumption prices or goods across countries.[5] In order to move from exchange rate sensitivity in the border prices of goods to sensitivity in retail prices, analyses need to account for the role of the distribution sector and imported inputs used in production. For this purpose, we use a basic approach of a two country model with wage stickiness and monopolistically competitive producers. Our specific formulation closely follows our 2006 study, and the prior studies discussed therein.

5.3.1 The Mapping

This approach follows a utility-based framework that explicitly tracks the degree of substitutability of imported and domestic products, and presents the explicit cost functions faced by producers. C.E.S. utility functions

4. We are able to compare a pre-1995 period with the period from 1995 to the present for all countries except France and the Netherlands, for which the import price data ends in 1997, and Hungary, for which the available data begins in 1993.

5. Another goal of the analysis of pass-through and consumption prices of categories of goods is to understand the signal sent to consumers to induce expenditure switching between imported and home produced goods. This signal is a critical link in trade balance sensitivity to exchange rate fluctuations. See Goldberg and Tille (2006).

are assumed over nontraded (n) and traded goods (t) consumption, with both sectors producing a continuum of varieties with similar elasticities of substitution, θ. Prices for any good i are a markup over costs $c_t(i)$, with the markup rate as $\theta/(1 - \theta)$. Consumption of tradable and nontradable products are also governed by a constant elasticity of substitution ϕ. Home (h) and foreign (f) tradable goods are imperfect substitutes in consumption, with an elasticity of substitution of $\phi_T > 1$. Bringing one unit of good i where $i \in (h, f, n)$ to consumers requires units of a basket of differentiated nontraded goods for distribution services.[6] We denote these distribution costs per unit of output by $m_t(i : e_t)$, where this basket of differentiated nontraded goods includes expenditures on wholesale and retail sector services, as well as expenditures on transportation and storage. These distribution expenditures are permitted to be sensitive to the exchange rate e_t, which is defined as the domestic cost per unit of foreign exchange. Per unit production requires domestic labor and imported inputs. Labor inputs required per unit of output are inversely related to sectoral productivity parameters Z_i. W_t refers to the wage per unit of labor at home, and W_t^* refers to foreign wages. Productivity parameters as well as domestic and foreign wages are assumed sticky over the relevant pricing horizon. Imported input shares per unit of output are denoted by $\mu_t(i : e_t)$ for home tradable goods and home nontradable goods. These imported cost shares also are sensitive to exchange rates. Foreign currency variables are indicated by superscript "*." The pricing equations $P_t(i)$ for home nontradable goods n, home tradable goods h, and imported consumption goods f are given by:

$$(1) \quad P_t(n) = \frac{\theta}{\theta - 1} c_t(n) = \frac{\theta}{\theta - 1}\left[\frac{W_t}{Z_N} + \mu_t(n : e_t)\frac{e_t W_t^*}{Z_F}\right]$$

$$(2) \quad P_t(h) = \frac{\theta}{\theta - 1} c_t(h) = \frac{\theta}{\theta - 1}\left[\frac{W_t}{Z_H} + m_t(h : e_t) \cdot P_t(n) + \mu_t(h : e_t)\frac{e_t W_t^*}{Z_F}\right]$$

$$(3) \quad P_t(f) = \frac{\theta}{\theta - 1} e_t c_t^*(f) = \frac{\theta}{\theta - 1}\left[\frac{e_t W_t^*}{Z_F} + m_t(f : e_t) \cdot P_t(n)\right]$$

Differentiating equations (1) through (3), we derive expressions for exchange-rate pass-through elasticities into home tradable, home nontradable, and imported goods prices. The respective pass-through rates into the consumption prices of these goods are shown in equations (4) through (6). Notationally, $\eta^{a,b}$ terms denote elasticities of a with respect to changes in b.

6. Burstein, Neves, and Rebelo (2003) highlight the role that distribution margins can play in lowering exchange-rate pass-through into consumption prices.

$$(4) \qquad \eta^{P(n),e} = \frac{\dfrac{\partial P(n)}{\partial e}}{\dfrac{P(n)}{e}} = (1 + \eta^{u_t(n:e),e})\left[\frac{\mu_t(n:e)\dfrac{ew^*}{Z_F}}{c_t(n)}\right] = \frac{\theta}{\theta - 1}(1 + \eta^{u_t(n:e),e})\left[\frac{\mu_t(n:e)\dfrac{eW^*}{Z_F}}{P_t(n)}\right]$$

$$(5) \qquad \eta^{P(h),e} = \frac{\dfrac{\partial P(h)}{\partial e}}{\dfrac{P(h)}{e}} = \frac{\theta}{\theta - 1}\left[(\eta^{P(n),e} + \eta^{m(h),e})\frac{m(H:e)P(n)}{P_t(h)} + (1 + \eta^{u_t(h:e),e_t})\frac{u(h:e)\dfrac{eW^*}{Z_F}}{P_t(h)}\right]$$

$$(6) \qquad \eta^{P(f),e} = \frac{\partial P(f)/\partial e}{P(f)/e} = 1 - \frac{\theta}{\theta - 1}\frac{[m(f:e)P_t(n)]}{P(f)}\left[1 - (\eta^{m(f),e} + \eta^{P(n),e})\right]$$

Equation (4) shows that pass-through into the consumption price of nontradables occurs only when this sector has cost sensitivity to exchange rates through its use of imported inputs. Some of the exchange rate pass-through in nontradables can be mitigated to the extent that nontradable producers can substitute away from these imported inputs as they become more expensive, $\eta^{\mu_t(n:e),e} < 0$.

Equation (5) shows exchange rate pass-through into the consumption prices of tradables produced in the home market. This pass-through occurs both because home tradables use imported inputs and also because sectoral expenditures on nontraded distribution services can be sensitive to exchange rates. Such sensitivity can be passive, because nontradables prices can respond to exchange rates through imported inputs (as in 4). More active sensitivity arises if distributors strategically adjust the markups they take on home tradables that compete with imported brands. This phenomenon, called double marginalization, is explored in our 2006 study, and Hellerstein (2004).

Pass-through into the consumption prices of imports, equation (6), differs from border price sensitivity of imports. For the derivations of equations (4) through (6), exchange-rate pass-through at the border is assumed to be complete, that is, equal to one. If pass-through at the border is different than one, the actual border pass-through rate simply multiplies equations (4) through (6). Whatever the border price sensitivity, local expenditures on distribution dilute the import content of this consumption good (the first term), even more so if distributors also actively reduce the margins changed during home currency depreciations to limit changes in market shares of the products being distributed. One force magnifying the pass through of exchange rates, and therefore working in the opposite direction, is that from equation (4), whereby distribution costs rise if these services rely on imported inputs into production and have costs that are sensitive to exchange rates.

Equations (4) to (6) also show the impact that increases in the distribution margins have on the expected pass-through rates of a given change in imported prices of final goods, or intermediate inputs in final consumer prices. In general, increases in the share of the distribution sector in the final price of a good decrease the impact on the final consumption price of the good. For nontraded goods, this effect occurs mainly through imported inputs used in production. For domestically-produced traded goods, the impact in equation (5) occurs through a decrease in the foreign value added part of the product. Moreover, as the share of imported inputs in the production of the good increases, changes in border prices of imported products have a higher percentage impact in the production cost of domestically produced goods. This results in higher pass-through into consumer prices.

The existing evidence on pass-through into import prices at the aggregate level suggests that the pass-through may have declined in the last decade, at least in developed countries (see Pollard and Coughlin 2005; Marazzi et al. 2006; and Olivei 2002). We have argued that such evidence is not definitive and requires further monitoring. Yet, despite this possible change in pass-through at the border, the outcome of the debate does not impinge on the key roles that imported inputs and distribution costs have in the final impact of import prices on consumer prices. Increases in imported inputs and in vertical trade that have occurred in the last decade would suggest a rise in import price pass-through. Increases in vertical trade also raise the likelihood that imported products have value added that originates in the home market. For example, U.S. imports of cars from Canada could contain engines that were first produced in the United States, exported to Canada, and ultimately re-exported to the United States. The result is a smaller share of Canadian value-added in U.S. imports, and less Canadian content to be acted upon by exchange rate movements. In this context, we could expect declining sensitivity to exchange rate changes of auto import prices from Canada as Canadian content falls. At the same time, increases in the imported input component of domestically produced goods imply a higher exposure of domestically produced products to exchange rate changes, and a higher pass-through from import prices into final consumer prices.[7] To quantify the relative size of each of

7. Feenstra (1998) and Rauch (1999) show the increasing role that the vertical integration of production across borders has on international prices and trade. This discussion has not

these effects and the insulating role of the distribution sector, in the next section we examine the evolution of imported input shares and distribution margins over the last decade.

5.3.2 Patterns in Imported Input Use and Distribution Expenditures

We measure the share of imported inputs and distribution expenditures for industries by using country-specific input-output tables.[8] Our full sample of imported input data spans 16 countries, 59 homogeneous manufacturing, primary-industry, and service industry groupings, and 1 to 2 years per country-industry observation.[9] The data on distribution margins span all but one of the same countries, but with narrower availability in terms of industries. The reduced availability occurs because, in some cases, service industry inputs into industry production are unavailable. Details on data construction and availability are provided in appendix table 2.

Our analysis extends information reported in our 2006 study, which looked at the disaggregated data across countries. That study observed that industries with the highest imported input share are Coke, refined petroleum products, and nuclear fuel manufacturing. Within the manufacturing sector, the next highest imported input shares are in computers and communication equipment, at around 50 percent. More generally, industries involved in services, agriculture, and commodity production have much lower shares of imported inputs than industries in manufacturing. For instance, real estate services, and forestry, logging and related services have average imported input shares between 6 percent and 14 percent of total costs, respectively. By contrast, almost all manufacturing industries have imported input shares above 20 percent. The industry within manufacturing with the lowest imported input share is food and beverage manufacturing.

The dispersion of imported input shares in production differs significantly by country. In general, larger countries have lower shares of imported inputs while smaller countries have higher shares. The United States has by far the lowest ratio of imported inputs into production of all countries in our sample. Ireland, with 51 percent, has by far the largest reliance on imported inputs with other smaller countries like Belgium, Hungary and the Netherlands also heavily reliant on imported parts and components.

More formally, we consider the extent to which industries versus countries versus time explain the prevalence of import input use. We run re-

dealt with the issue of transfer pricing, which pertains to intra-firm pricing policies. For instance, a multinational may differentially price sales of goods to subsidiaries versus to unrelated parties.

8. Details on construction methods are in Campa and Goldberg (2006).

9. Compared with table 5.1, we drop Australia and Greece from the analysis due to lack of input-output information to allow us to compute the data on imported inputs.

Table 5.2 **Imported input variance decomposition**

	Adjusted R^2 for regression excluding each set of dummies	Adjusted R^2 for regression with only each set of dummies	Percent of full regression specification adjusted R^2 explained by each set of dummies
Industry dummies	0.19	0.48	68.3
Country dummies	0.60	0.19	26.7
Year dummies	0.69	0.10	14.2

Note: We define the percent of the full regression adj. R^2 explained by the industry dummies as (adjusted R^2 from the regression including only the industry dummies)/(adj. R^2 of the full specification). The alternative, (adj. R^2 from the regression including everything but the industry dummies)/(adj. R^2 of the full specification), would yield slightly higher percents. Adjusted R^2 for the full regression specification with all dummy variables = 0. 70.

gressions using 1,394 imported share observations, covering 59 industries and 16 countries. Variance decompositions are used to identify the portions of the observational variance within this data base that are attributable to industry fixed effects, country fixed effects, or time dummies. With the exception of France, Ireland, Norway, Portugal, Spain, and the United Kingdom, each country included in the sample has two years (typically five years apart) of imported input data.

The full regression specification accounts for 70 percent of the variation in imported input use (table 5.2). In order of importance, imported input use is determined first by industry identity, then country, then by time. Having already discussed industry and country highlights, it is interesting to focus attention on time trends in imported input use across countries. Of the 57 industries with enough observations to run a regression, 16 industries had time trends that were statistically significant at a 10 percent level. All of these trends were positive.[10] On average, the industries with significant trends had imported input use increase by 0.9 percentage points per year. The manufacturing industries Coke, refined petroleum products, and nuclear fuel had the largest (statistically significant) increase in imported input share, rising 3.4 percentage points per year, on average. Real estate activities had the smallest significant increase, averaging 0.2 percentage points per year.

While this regression analysis has used disaggregated industry data, it also is useful to consider broader aggregates. The results of this aggregation are provided in table 5.3. Across the broadly aggregated sections it is clear that energy and manufactured goods have by far the highest imported input shares at, on average, 43 percent and 38 percent of total inputs respectively. Nonmanufactured goods, food, raw materials, and the

10. The industries with significant time trends include food, energy extraction and refining, manufacture and servicing of computers and other machinery, and some service industries.

Table 5.3 **Imported input share**

	Year	All Industries	Manufactured Goods	Nonmanufacturing	Energy	Food	Raw Materials	Distribution Sector
Austria	2000	0.29	0.48	0.18	0.46	0.18	0.15	0.17
Belgium	2000	0.35	0.53	0.23	0.61	0.34	0.32	0.28
Denmark	2000	0.23	0.39	0.16	0.30	0.20	0.19	0.17
Finland	2000	0.25	0.35	0.16	0.58	0.15	0.11	0.17
France	2000	0.14	0.22	0.09	0.47	0.11	0.17	0.07
Germany	2001	0.19	0.31	0.12	0.44	0.16	0.19	0.17
Hungary	2000	0.44	0.63	0.21	0.71	0.20	0.16	0.21
Ireland	1998	0.52	0.68	0.42	0.48	0.30	0.48	0.46
Italy	2000	0.20	0.30	0.13	0.54	0.16	0.18	0.17
Netherlands	2000	0.30	0.46	0.22	0.45	0.35	0.44	0.28
Norway	2001	0.21	0.30	0.17	0.13	0.14	0.17	0.22
Portugal	1999	0.24	0.40	0.13	0.36	0.25	0.06	0.15
Spain	1995	0.18	0.27	0.11	0.40	0.12	0.08	0.08
Sweden	2000	0.25	0.37	0.18	0.57	0.20	0.20	0.20
United Kingdom	1995	0.18	0.29	0.12	0.12	0.16	0.15	0.13
United States	2002	0.06	0.09	0.03	0.28	0.04	0.07	0.03
Average		0.25	0.38	0.17	0.43	0.19	0.20	0.19
Standard Deviation		0.11	0.15	0.08	0.16	0.08	0.12	0.10

distribution sector all have average imported input shares at or just under 20 percent. Across countries we confirm the observation that Ireland, at 52 percent, and the United States, at 6 percent, span the spectrum of intensities for the group of sixteen countries.

Comparable data analysis of expenditures on distribution services also generates interesting observations. First, we conduct a variance decomposition exercise across the most disaggregated industry level data (59 industries, 16 countries). As shown in table 5.4, this decomposition explains substantially less of the sample variation than was the case when we examined patterns of imported input use. Industry fixed effects had the strongest explanatory power. There are common patterns across countries in the incidence of high and low distribution margin expenditures for industries. Distribution expenses are consistently high in apparel (18 percent), leather (19), furniture manufacturing (36), and fishing and related services (5). Distribution expenses appear to be lowest on some commodity-type products and industries, such as petroleum and natural gas extraction (11 percent); uranium, thorium, and metal ore mining (12 and 13), and nonautomobile transportation equipment manufactures (35).

Time fixed effects explain little of the variation observed in distribution expenditures. Each country in the sample typically had two years of distribution margins data included in the analysis. Of 30 industries with enough observations to examine trends, only 7 had statistically significant time trends. Among these industries, 4 had positive time trends (agriculture, mining, manufacturing of food products, and pulp, paper, and paper products) and 3 had negative time trends (manufacturing of radio and television, motor vehicles, and medical and precision equipment). Thus, the number of industries with strong distribution expenditure trends was low, and the pattern of changes in distribution expenditures was not persistent for all industries in either a positive or negative direction. Hungary and Finland have the lowest overall level for distribution expenditures. On the other extreme, the United States had the largest distribution expenditures in the sample (0.29 in 2002). This observation contrasts sharply with what was observed for imported input use, where increasing globalization of production was readily apparent across many industries. Over the past decade, imported input use and globalization of production has grown substantially, while changes in distribution expenditures have been more diffuse and bidirectional.

One short-coming of this distribution margin data, as explained in our 2006 study, is that there is a trade-off in getting information expenditure margins at the industry-level and getting information relevant for the consumption of households. The total distribution margins with industry-level detail encompass margins on total final consumption. This total includes distribution margins for household consumption, investment, public sector, and export markets. In our modelling of CPI sensitivity to exchange

Table 5.4 **Distribution expense variance decomposition**

	Adjusted R^2 for regression excluding each set of dummies	Adjusted R^2 for regression with only each set of dummies	Percent of full regression specification adjusted R^2 explained by each set of dummies
Industry dummies	0. 13	0. 34	69. 1
Country dummies	0. 44	0. 13	26. 9
Year dummies	0. 49	0. 09	18. 3

Note: Adjusted R^2 for the full regression specification with all dummy variables = 0. 49.

rates and import prices we use the distribution expenditure specifically for the household sector, eschewing the more extensive industry-specific information used in the variance decomposition. In part, the country-fixed effects in the variance decomposition just discussed reflect the components of final demand in each country. Distribution margins in fixed capital formation and exports are substantially lower than those on household consumption.

5.4 Calibrating Pass Through of Exchange Rates into Consumption Prices

Pass-through of exchange rates into consumer price indices has two main components. First, we require information on how exchange rates pass through into import prices. This information was presented in section 5.2 and in table 5.1. Second, we require a model of import price transmission into consumer prices. This model was provided in section 5.3.1 and is based on Campa and Goldberg (2006). In this section of the paper, we focus on calibrating the model using our information on changes in key parameters, including sectoral distribution expenditure and imported input use. Our goal is to track, quantitatively and qualitatively, the sources of change in predicted pass-through of exchange rates into consumption prices. We begin by assuming relevant parameters for calibrating equations (4) to (6).

Assumptions are made for the values of demand elasticity (θ), the elasticities of substitution among groups of products, and elasticities of response to exchange rates of distribution margins and imported inputs.[11] Our assumed estimate of the demand elasticity, θ, is consistent with evidence on the steady state price over cost markups, defined by markup = $\theta/(\theta - 1)$. Basu and Fernald (1997) find markups for U.S. industries in the range of 11 percent. Oliveira Martins, Scarpetta, and Pilat (1996) find

11. The calibrations basically shut down the role of initial conditions and substitution between tradables and nontradables goods by setting the relative price terms to equal one in the calculations. Accordingly, values of ϕ do not matter for these calibrations.

markups ranging between 10 and 35 percent, in data spanning 14 OECD countries and 36 manufacturing industries. These markup values imply a range for θ between 10 and 4. For our calibration we assume $\theta = 7$. Using higher demand elasticities would yield lower values of pass-through into home tradables and now tradeable goods prices.

The simple model of equations (4) through (6) is able to explore many alternative specifications on substitution elasticities, changes to industry competitive structures, and state-contingent markups. Likewise, a range of assumptions could be made about the ability of producers to substitute between home-produced inputs and imported inputs when exchange rates alter the relative prices of inputs from different sources, or about proactive adjustment of profit margins of distributors of goods. These important themes, explored at length in our 2006 paper, are not emphasized here.

Our specific goal is to explore the changes in pass-through into consumer prices that are specifically attributable to changes in pass-through at the border, changes in imported input use, and changes in distribution sector expenditures. With this objective in mind, we shut down some of the other forces that would influence the exchange-rate transmission into the final consumption prices of goods. Specifically, the initial relative prices of imported and home tradables, and of home tradables and nontradables, are assumed to be the same. Imported input shares are assumed inelastic with respect to exchange rates and are assumed to be identical across the production of nontradables and home tradables. Finally, distribution expenditures are assumed inelastic with respect to exchange rates, so that $\eta^{m(f:e),e}$ and $\eta^{m(h:e),e} = 0$.

We focus on data for all industries, manufacturing, nonmanufacturing, energy, food, and raw materials, which are the industry groupings for which we also have information on import prices and exchange rate pass-through at the border. While there are eighteen countries for which we have been able to estimate exchange rate pass-through into import prices at this level of index disaggregation, changes in both imported input use and distribution expenditures are available only for ten of these countries.

5.4.1 Calibrated Pass-through

Table 5.5 reports the calibrated pass-through elasticities into final prices of imports and domestically produced traded goods according to equations (5) and (6). These pass-through coefficients imply the transmission into final prices of a given percentage change in the import price at the border. The estimates use the imported input shares and distribution ratios calculated as described in the previous section for the years indicated in the second column of the table.

The pass-through transmission to final prices of imported products is relatively high and fluctuates for the aggregate of all industries between

Table 5.5 **Pass-through of a change in import prices at the border into the consumption prices of imported and domestically-produced traded products**

	Year	All Industries	Manufactured	Nonmanufactured	Energy	Food	Raw Materials
			For imported products				
Austria	1995	0.851	0.858	0.809	0.842	0.831	0.875
Belgium	1995	0.886	0.887	0.874	0.877	0.853	0.911
Denmark	1995	0.825	0.819	0.851	0.884	0.821	0.760
Finland	1995	0.887	0.881	0.918	0.900	0.762	0.976
Germany	1995	0.844	0.852	0.784	0.863	0.757	0.764
Hungary	1998	0.902	0.905	0.892	0.857	0.848	1.000
Ireland	1998	0.939	0.930	0.987	1.000	0.939	0.974
Italy	1995	0.847	0.857	0.754	0.864	0.744	0.932
Netherlands	1995	0.878	0.873	0.899	0.928	0.849	0.876
Portugal	1999	0.859	0.859	0.858	0.828	0.814	0.904
Spain	1995	0.866	0.875	0.822	0.922	0.807	0.732
Sweden	1995	0.903	0.891	0.948	0.901	0.858	0.966
United Kingdom	1955	0.846	0.833	0.925	0.967	0.750	0.914
United States	1997	0.684	0.696	0.518	0.497	0.620	0.876
			For domestically produced products				
Austria	1995	0.354	0.496	0.276	0.372	0.211	0.291
Belgium	1995	0.389	0.607	0.245	0.528	0.429	0.431
Denmark	1995	0.259	0.463	0.144	0.401	0.201	0.194
Finland	1995	0.259	0.376	0.149	0.517	0.192	0.151
Germany	1995	0.195	0.295	0.137	0.307	0.218	0.142
Hungary*	1998	0.443	0.661	0.273	0.668	0.273	0.169
Ireland	1998	0.648	0.837	0.502	0.560	0.391	0.581
Italy	1995	0.243	0.228	0.181	0.612	0.223	0.147
Netherlands	1995	0.376	0.563	0.257	0.392	0.442	0.423
Portugal	1999	0.306	0.489	0.184	0.454	0.329	0.087
Spain	1995	0.227	0.329	0.151	0.475	0.163	0.128
Sweden	1995	0.326	0.365	0.295	0.372	0.054	0.331
United Kingdom	1995	0.230	0.361	0.150	0.146	0.231	0.184
United States	1997	0.068	0.101	0.042	0.262	0.058	0.069

Note: The numbers reported here are the estimated values of equations (5) and (6). The computation further assumes an elasticity of demand of 7, and zero elasticities of exchange rate changes to distribution margins in home products, and to the share of imported inputs used in production.

0.68 for the United States and 0.9 for Hungary and Sweden. This means that, given a change in imported goods prices at a country's border, nearly 70 percent of this price signal will be transmitted to the final consumption prices of the imported goods in the United States, and nearly 90 percent in Hungary and Sweden. The two key determinants of variations in this rate of pass-through are the share of imported inputs in the production of nontraded services that enter the distribution sector, and the share of the distribution sector into final prices of the product. For a given share of imported inputs into the production of nontraded goods in the country, the higher the share of distribution costs the lower the rate of transmission into final prices. However, as the share of imported inputs into nontraded goods increases, so does the sensitivity of distribution costs to changes in import prices.

Differences in calibrated pass-through across industries for a given country are relatively small. Such differences arise due to differences in the share of distribution costs in different sectors, and these tend to be relatively small. Larger differences arise across countries. For instance, the United States has the highest share of distribution costs in the sample (see table 5.5) and a low share of imported inputs in production in distribution services (see table 5.3) leading to the result that the predicted transmission into final prices of imported goods is the lowest. On the other extreme, Hungary has the lowest share of distribution margins (0.07 in table 5.5) and the second highest, after Ireland, ratio of imported inputs into production (0.44 in table 5.3). Its rate of pass-through into final prices of imported products is 0.90, the highest in the sample.

Pass-through into final prices of domestically produced traded goods is reported in the lower panel of table 5.5. Transmission rates are significantly lower than the transmission rates for imported products. The transmission rates for all industries (column 3) fluctuate between 0.65 for Ireland and 0.07 for the United States. Looking at equation (5), two key differences explain the lower transmission rates. First, and most important, is the ratio of imported inputs into the production of domestic goods (the last term in the square brackets of equation [5]). The lower this ratio, the less sensitive are input costs to changes in prices of imported products and the weaker are cost pressures arising from exchange rates into the prices of domestically produced goods. The second factor is the importance of the distribution sector and the sensitivity of this sector to changes in import prices (the first term in the square brackets of equation [5]). The lower the sensitivity of the distribution sector to import prices, the lower the pass-through into final prices of domestically produced goods.

The United States shows the lowest sensitivity of domestically produced goods prices. This is due mainly to two factors: its low sensitivity of final prices of imports reported above and its lower share of imported inputs into production of domestic goods. In contrast, Hungary again shows the highest predicted sensitivity of the prices of domestically-produced goods to changes in the border prices of imported goods.

Differences across industries are much larger for the case of domestically produced goods. Transmission rates are substantially larger for energy and manufacturing than for the other three industries in almost all countries in the sample. This is mainly due to the higher ratio of imported inputs into the production of manufacturing and energy products relative to the other industries (see table 5.3).

5.4.2 Changes Over Time in Calibrated Pass-through

To evaluate the evolution of changes in these transmission rates over time we compute the same transmission rates as those reported in table 5.5 using the latest available information on distribution margins and imported input shares for each country.[12] Table 5.6 reports the difference between the estimated values for equations (5) and (6) using data from these later years and the estimated transmission rates using 1995 data and reported in table 5.5.

Increases in the pass-through for imported products can be due, following equation (6), to decreases in the share of distribution costs in the final price of imported products. Increases in the prices of nontraded goods due to increases in the imported inputs used in the production of nontraded goods can result in an increase in pass-through of exchange rates into final prices of imported products.

The results in the top-panel of table 5.6 indicate that there has been an increase in the calibrated pass-through of movements in border prices of imports into the final prices of imported and domestically-produced goods for most countries. For aggregated imported goods, this increased transmission of border prices to final consumption prices has happened in all countries shown, with the exception of the United States, Italy, and, to a very small degree, Belgium and Sweden. The countries with an increase in the rate of transmission have this result mainly because imported inputs are more extensively used in the production of nontraded goods that factor into the costs of distribution services.

For the United States and Italy, the decline in border price transmission into the final prices of imported goods is a feature of manufacturing, food, and raw materials. For the United States, pass through into nonmanufactured imports and energy imports rose, while it declined for these sectors in Italy. The share of imported inputs into production on nontradables in these countries has also increased, although relatively less than for other countries, in the last decade. Therefore, this lower calibrated sensitivity of the final consumption prices of imported goods has been mainly due to in-

12. The year used for each country to calculate the measure of imported inputs is reported in table 5.3, and the corresponding date for the share of distribution costs is reported in table 5.5.

Table 5.6 **Changes in implied pass-through into the consumption prices of imported and domestically produced traded products**

	All Industries	Manufactured	Nonmanufactured	Energy	Food	Raw Materials
			For imported products			
Austria	0.016	0.009	0.063	–0.013	–0.029	0.121
Belgium	–0.003	–0.002	–0.011	0.033	0.007	0.044
Denmark	0.025	0.027	0.019	0.037	0.014	0.022
Finland	0.000	0.009	–0.053	–0.016	–0.021	–0.066
Germany	0.017	0.017	0.008	0.011	–0.005	0.012
Hungary	0.036	0.023	0.106	0.057	–0.001	0.090
Italy	–0.012	–0.007	–0.063	–0.004	–0.025	–0.240
Netherlands	0.007	0.002	0.021	0.017	0.001	0.097
Sweden	–0.001	0.012	–0.066	0.002	–0.042	–0.026
United States	–0.014	–0.017	0.116	0.122	–0.056	–0.235
			For domestically produced products			
Austria	0.023	0.102	–0.036	0.207	0.054	–0.115
Belgium	0.058	0.052	0.072	0.222	0.022	–0.040
Denmark	0.043	0.020	0.066	–0.038	0.063	0.077
Finland	0.059	0.055	0.074	0.189	0.047	–0.004
Germany	0.055	0.083	0.041	0.232	0.013	0.114
Hungary	0.088	0.098	–0.025	0.189	0.010	–0.019
Italy	0.013	0.040	0.017	0.040	0.013	0.115
Netherlands	0.014	0.015	0.019	0.148	0.006	0.097
Sweden	–0.005	0.089	–0.047	0.319	0.234	–0.085
United States	0.008	0.020	0.001	0.077	0.003	0.022

Note: The numbers reported here are the estimated values of equations (5) and (6) for each country using data around 1995 (reported in table 5. 5) and using data for the year 2000. The computation further assumes an elasticity of demand of 4, and zero elasticities of exchange rate changes to distribution margins in home products, and to the share of imported inputs used in production.

creases in expenditure on distribution services in these industries. In contrast, for the United States the substantial decrease in the distribution expenditures in energy and nonmanufacturing (of almost 25 percent) have resulted in a substantial increase in pass-through for those industries.

The bottom panel of table 5.6 shows the imputed changes in the pass-through of import price changes into the prices of domestic tradable products. Following equation (5), the two forces that would increase this pass through are increases in the share of imported inputs in production, whether for these goods specifically or for the distribution costs of domestically produced goods. This pass-through would also rise if distribution services fall as a share of the total production costs of the respective types of home produced goods. The results in table 5.6 show that the imputed pass-through into home-produced tradable goods has increased in almost all industries and countries. The effect is positive in all cases in manufacturing, food and energy industries. These changes have been larger in absolute value in energy than in the other industries.

This rise in transmission of import price moves into the final prices of domestically-produced goods has been mainly due to changes in the ratio of imported inputs in the production in these industries. The increase in imported inputs in the production of these industries in conjunction with the increase in the use of imported inputs in the production of nontraded goods discussed above have both contributed to a higher sensitivity of final goods prices of domestically produced goods to changes in import prices. The United States has had the smallest overall increase in its pass-through, mainly due to its much lower pass-through rates among the countries in the sample, as reported in table 5.5. However, in percentage terms its pass-through for all industries has increased by 12 percent, among the higher percentage increases of all countries in the sample.

The share of imported inputs in the production of domestic tradables has increased in all countries in the sample over the past decade. This increase has been proportionally larger in energy and manufacturing than in the other three industries. The share of imported inputs in the production of nontradables has also increased in the majority of countries. Only Sweden and Austria show a small decline in this ratio. In contrast, the change in the share of distribution costs has not been so homogeneous across countries. This share increased for Belgium, Finland, Italy, and the United States. The increase in distribution services has been primarily in food (it increased for all countries) and in manufacturing. This pattern results in a higher growth of pass-through into the consumption prices of domestically-produced goods, in most cases, than for imported goods (see table 5.6). This is especially the case for manufactured goods. Given a change in goods prices at the border, the implication is that an induced relative price effect is smaller. This observation may be relevant for discussions of expenditure switching induced by exchange rate changes.

Goldberg and Tille (2006) argue that an adjustment process to current account imbalances is likely to be asymmetric across the United States and its partners in trade, in particular because consumption price sensitivity to exchange rates is expected to be substantially less in the United States. This would lead relative prices of imports for the United States to move to a lesser degree with exchange rate fluctuations than the relative prices of United States' trading partners. The results of table 5.6 provide perspective on how this asymmetry has changed recently. In particularly, focusing only on manufacturing and the all industries columns of table 5.6, we observe that the increased transmission into prices was smaller for the United States than for other countries. This suggests that the asymmetry in adjustment to exchange rate movements may, all else equal, have gotten larger between the United States and some trading partners in the most recent decade.

5.5 Conclusions

This paper has explored the channels for transmission of exchange rates into various types of consumption goods prices and into the aggregate level of prices across eighteen economies. First, we highlight transmission of exchange rates into the border prices of imported goods as the initial step in pass-through into final consumption prices of goods. We find that rates of exchange-rate pass-through into import prices are measured with considerable precision for manufactured goods, but are less precisely measured with respect to nonmanufactured goods, raw materials, and energy. The period since 1995 may have been one of marked changes in pass-through into import prices of manufactured goods, as we observe some countries with higher and others with lower rates of pass-through over the past decade.

Yet, these changes in transmission of exchange rates into the border prices of imports are not analogous to levels or directions of change in the transmission into the consumption prices of the same categories of goods. Thus, the second part of this paper is on the transmission of these border prices into final consumption prices. We take a model-based approach to transmission that highlights the role of sectoral expenditures on imported inputs and on distribution services. Examination of detailed cross-country data leads to the conclusion that changes in transmission into final consumption prices are associated more with the evolution of imported input use in production than to evolution in distribution expenditures at the industry level. In general, use of imported inputs in production grew sharply since the mid-1990s, increasing the sensitivity to exchange rates of the production costs of a broad spectrum of goods. By way of contrast, we observe that expenditures on distribution services have not trended consistently across countries or across industries.

This increase in the sensitivity of consumption prices to the role of imported inputs is particularly important for the East Asian region. The East Asian economies are in general very open to international trade. Not surprisingly, international trade in the region grows at a faster rate than in other parts of the world. This growth is in part driven by the vertical disintegration of production. Hummels, Ishii, and Yi (2001) estimate that vertical specialization accounts for 30 percent of world exports. To the extent that trade in intermediate products continues to increase, the imported input channel for the transmission of changes into consumer prices is likely to play a larger role.

The findings of generalized increases in the calibrated sensitivity of consumption prices of domestically-produced traded goods are important for understanding the potential for expenditure switching and trade adjustment to occur in the aftermath of changes in exchange rates. Goldberg and Tille (2006) argue that an adjustment process to current account imbalances is likely to be asymmetric across the United States and its partners in trade, in particular because price sensitivity to exchange rates is expected to be substantially less in the United States. This would lead to relative prices of imports for the United States to move to a lesser degree with exchange rate fluctuations than the relative prices of United States trading partners. It is useful to explore if this asymmetry is likely growing over time, or declining over time.

Our results imply that the calibrated sensitivity of consumption prices of domestically-produced tradables is rising at a faster rate than the price sensitivity of imported goods. If this is the case, the expenditure switching effects of exchange rate movements are weakened over time, primarily as a result of more integrated production internationally and greater use of imported inputs in production. All else equal, a greater movement in nominal exchange rates would be needed to generate the same elasticity of response of real trade flows. This is an issue that warrants further study.

Another implication of these findings is that increases in the transmission into United States final prices have been smaller than into final prices in other countries. With exchange rate pass-through into border prices already larger outside the United States, the changes over time have magnified the differences in transmission into final consumption prices. With the exchange rate as one instrument of trade balance adjustment, it may be the case that the task of expenditure-switching induced by exchange rates now falls even more heavily on the U.S. trade partners than on the United States. This too warrants further study.

Appendix

Data Sources

OECD Import Price Series

Source: OECD Statistical Compendium. Quarterly time series of aggregate import price indices in local currency for 1975:Q1 to approximately 2004:Q4. We work with the maximum amount of data available by country in our analysis.

Effective Exchange Rate Indices

The nominal exchange rate index is the trade weighted exchange rate index provided by the IMF. Code in IFS database: *neu.* The real effective exchange rate used is code *reu.* Regression analysis uses the inverse of the reported series, so that an increase in the exchange rate is a currency depreciation.

Foreign Price Index

We construct a consolidated export partners cost proxy by taking advantage of the IFS reporting of both real (*reu*) and nominal (*neu*) exchange rate series and computing $W_t^{x,j} = neu_t^j \cdot P_t^j / reu_t^j$ by each country in our sample. This gives us a measure of trading partner costs (over all partners x of importing country j), with each partner weighted by its importance in the importing country's trade. The real effective exchange rate is calculated from Unit Labour Costs for developed countries by the IMF. Code in IFS database: *reu.* The consumer price indices from the *International Financial Statistics.* Code in IFS database. *64.*

Input-Output (I/O) Databases

The Input-Output data for the different countries come from different sources:

- Data for Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Spain, Sweden, and the United Kingdom come from the Eurostat National Accounts database. This database computes the input-output tables for these countries and reports a supply and a use table disaggregated to a total of fifty-nine industries. These fifty-nine industries include twenty-two manufacturing industries, five mining and extraction industries, three agriculture industries, five construction and energy industries, eight trade and transport industries, and seventeen service industries. We report distribution margin data for twenty-nine manufacturing, mining, and agriculture industries (we merge two mining industries into one, given their small production values in most countries).
- Data for Australia on input-output tables comes from the Australian Bureau of Statistics. The data reports supply and final use tables for a total of 237 industries. We convert these industries into the CPA classification of twenty-nine manufacturing, mining, and agriculture industries.
- Data for the United States on input-output tables come from the "Benchmark Input Output Accounts for the U.S. economy" (years 1992 and 1997). The U.S. input-output accounts use a specific IO industry classification, which can then be transformed into the NIPA classification (Nacional Income and Product Account Tables) and then aggregated into the CPA classification of twenty-nine manufacturing, mining, and agriculture industries used in the paper.
- Data for New Zealand on input-output tables come from Statistics New Zealand. The data reports supply, use, and import tables for a total of 210 industries. We aggregate these industries into the CPA classification of twenty-nine manufacturing, mining, and agriculture industries.

Calculation of Distribution Margins

We compute the distribution margins for total supply in the industry as the ratio of the value of trade and transport margins to the value of total supply in the industry at purchasers' prices. Purchaser prices include the cost of supply at basic prices plus the distribution (retail, wholesale, and transportation) costs plus net taxes on products. To the extent that taxation differs significantly across countries for the same industry and across industries within a country, distribution margins may not be perfectly comparable in all cases. See Campa and Goldberg (2006).

Calculation of Imported Input Ratios

The Input-Output tables report the value of the use matrix broken down to the use of inputs by origin: domestic and imported. We calculate imported inputs into the production of each industry as the ratio between the total value of imported intermediate inputs by an industry to the value of total intermediate inputs.

Techniques to construct the imported intermediate flows matrix in the input-output tables vary by country. Most countries used, to some extent, the import proportionality assumption. This technique assumes that an industry uses an import of a particular product in proportion to its total use of that product. This assumption is limiting since some industries may be using inputs from domestic and import sources in different proportions than the average of the economy. Countries made use of this assumption at very different levels of aggregation. For instance, the OECD reports that Germany and Denmark made used of over 2,000 different commodities, while the U.S. and Japan used slightly over 500 and the United Kingdom less than 200.

Table 5A.1 Long-run import price pass-through

	All Imports	Manufactured Goods	Non-manufactured Goods	Energy	Food	Materials Raw
			Pre-1995			
Australia	0.62*+	0.89*	0.16+	–0.51	0.38*+	0.32+
Austria	1.01	0.55	2.27*	2.85	0.49	2.86*
Belgium	1.03	0.6	0.56	–3.13	1.36*	3.18*+
Denmark	0.95*	0.77*	1.10	1.37	0.74	1.95*
Finland	0.72	0.6	1.43	2.01	1.06	0.27
France	0.87*	0.86*	1.12	1.57	1.43*	
Germany	1.00*	0.54*+	1.69*	2.64*	0.55*+	1.45*
Hungary						
Italy	0.32+	0.48+	–0.09	–1.53	0.80*	1.07
Netherlands	0.93*	0.25+	1.77*	2.36	0.73*	2.42*+
New Zealand	0.36+	0.29+	0.99	1.91	0.04+	–0.43+
Norway	0.97*	0.77*	0.31	–0.21	–0.41+	0.83
Portugal	1.18*	1.06*	1.03*	1.06	1.14*	1.48*+
Spain	0.66*	1.00*	0.58	0.06	0.95	1.16*
Sweden	0.32+	0.56*+	–0.30+	–0.88+	0.79*	0.28
United Kingdom	0.45*+	0.46*+	0.36+	0.18	0.50*+	0.55*+
United States	0.44*+	0.47*+	0.15+	–0.22+	0.24+	0.36*+
Average	0.74	0.63	0.82	0.60	0.67	1.18
Standard Deviation	0.29	0.24	0.73	1.66	0.48	1.05

			Post-1995			
Australia	0.82*	0.93*	0.44	0.45	0.10+	0.43
Austria	–1.40	–1.30	–2.55	–7.60	–1.11	3.02
Belgium	0.25+	0.14+	0.47	2.08	–0.30+	0.73
Denmark	0.83*	0.45*+	1.80*	3.67	1.30*	0.82
Finland	–0.16	–0.24	–1.58	–3.37	2.50	–1.70
France	0.28	0.28+	1.00	0.12	1.31	
Germany	0.68	0.68*	0.63	0.54	0.44	0.93
Hungary	0.78*+	0.79*+	0.67	0.89	0.63*	0.00
Italy	0.85*	0.81*	1.82	4.11*	0.57	0.23
Netherlands						
New Zealand	0.12+	0.19+	–0.26+	–0.62	0.27+	0.18+
Norway	0.09+	0.06+	–0.23	1.90	1.02	–1.27
Portugal	1.96	1.66	–0.64	–16.58	6.47	7.55
Spain	1.18*	1.70	0.84	–3.18	2.23	3.18*+
Sweden	0.21+	0.61*	–1.74*+	–3.22*+	0.67*	–0.19+
United Kingdom	0.32*+	0.26+	0.43	1.30	0.62*	0.08+
United States	0.30*+	0.27*+	0.54	0.97	0.03+	0.34
Average	0.44	0.46	0.10	–1.16	1.05	0.96
Standard Deviation	0.71	0.71	1.22	5.07	1.70	2.23

Notes: * indicates different from 0 with 10% significance; + indicates different from 1 with 10% significance.

Table 5A.2 **Overview of data on imported inputs and distribution margins, by country and industry**

Country	Imported Input Data Availability: Years	Imported Input Data Availability: Number of Industries	Distribution Margin Data Availability: Years	Distribution Margin Data Availability: Number of Industries
Austria	1995, 2000	1995: 54, 2000: 56	1995, 2001	1995: 27, 2001: 29, in both: 27
Belgium	1995, 2000	1995: 54, 2000: 55	1995, 2001	1995: 29, 2001: 29, in both: 29
Denmark	1995, 2000	1995: 55, 2000: 55	1995, 2000	1995: 27, 2000: 28, in both: 27
Finland	1995, 2000	1995: 56, 2000: 56	1995, 2002	1995: 29, 2002: 30, in both 29
France	2000	2000: 57	1995, 2001	1995: 30, 2001: 29, in both: 29
Germany	1995, 2001	1995: 57, 2001: 56	1995, 2001	1995: 30, 2001: 30, in both: 30
Greece			1995, 1999	1995: 30, 1999: 30, in both: 30
Hungary	1998, 2000	1998: 57, 2000: 57	1998, 2000	1998: 30, 2000: 30, in both: 30
Ireland	1998	1998: 55	1998	1998: 26
Italy	1995, 2000	1995: 57, 2000: 57	1995, 2001	1995: 29, 2001: 29, in both: 29
Netherlands	1995, 2000	1995: 55, 2000: 55	1995, 2001	1995: 30, 2001: 30, in both: 30
Norway	2001	2001: 57	2002	2002: 29
Portugal	1999	1999: 56	1995, 1999	1995: 28, 1999: 28, in both: 28
Spain	1995	1995: 57	1995, 2000	1995: 29, 2000: 29, in both: 29
Sweden	1995, 2000	1995: 48, 2000: 55	1995, 2001	1995: 29, 2001: 29, in both: 29
United Kingdom	1995	1995: 57	1995, 2001	1995: 29, 2001: 29, in both: 29
United States	1997, 2002	1997: 30, 2002: 30	1992, 1997	1992: 29, 1997: 29, in both: 27

Table 5A.3 **Industry names for disaggregated imported input and distribution margin data**

Number	Industry Name	Mapping
a01	Agriculture, hunting and related service activities	nonmanufacturing
a02	Forestry, logging and related service activities	nonmanufacturing, raw materials
b05	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing	nonmanufacturing
ca10	Mining of coal and lignite; extraction of peat	nonmanufacturing, raw materials
ca11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying	nonmanufacturing, raw materials
ca12+	Mining of uranium and thorium ores	nonmanufacturing, raw materials
cb13	Mining of metal ores	nonmanufacturing, raw materials
cb14	Other mining and quarrying	nonmanufacturing, raw materials
da15	Manufacture of food products and beverages	manufacturing, food
da16	Manufacture of tobacco products	manufacturing, food
db17	Manufacture of textiles	manufacturing
db18	Manufacture of wearing apparel; dressing; dyeing of fur	manufacturing
dc19	Tanning, dressing of leather; manufacture of luggage	manufacturing
de21	Manufacture of pulp, paper and paper products	manufacturing
de22	Publishing, printing, reproduction of recorded media	manufacturing
df23	Manufacturing of Coke, refined petroleum products and nuclear fuel	manufacturing, energy
dg24	Manufacture of chemicals and chemical products	manufacturing

Table 5A.3 (continued)

Number	Industry Name	Mapping
dh25	Manufacture of rubber and plastic products	manufacturing
di26	Manufacture of other nonmetallic mineral products	manufacturing
dj27	Manufacture of basic metals	manufacturing
dj28	Manufacture of fabricated metal products, except machinery and equipment	manufacturing
dk29	Manufacture of machinery and equipment n.e.c.	manufacturing
dl30	Manufacture of office machinery and computers	manufacturing
dl31	Manufacture of electrical machinery and apparatus n.e.c.	manufacturing
dl33	Manufacture of medical, precision and optical instruments, watches and clocks	manufacturing
dm34	Manufacture of motor vehicles, trailers and semi-trailers	manufacturing
dm35	Manufacture of other transport equipment	manufacturing
dn36	Manufacture of furniture; manufacturing n.e.c.	manufacturing
dn37	Recycling	nonmanufacturing
e40*	Electricity, gas, steam and hot water supply	nonmanufacturing, energy
e41*	Collection, purification and distribution of water	nonmanufacturing
f45*	Construction	nonmanufacturing
g50*	Sale, maintenance and repair of motor vehicles	nonmanufacturing
g51*	Wholesale trade and commission trade, except of motor and motorcycles	nonmanufacturing
g52*	Retail trade, except of motor vehicles, motorcycles; repair of personal and household goods	nonmanufacturing
h55*	Hotels and restaurants	nonmanufacturing
i60*	Land transport; transport via pipelines	nonmanufacturing
i61*	Water transport	nonmanufacturing
i62*	Air transport	nonmanufacturing
i63*	Supporting and auxiliary transport activities; activities of travel agencies	nonmanufacturing
i64*	Post and telecommunications	nonmanufacturing
j65*	Financial intermediation, except insurance and pension funding	nonmanufacturing
j66*	Insurance and pension funding, except compulsory social security	nonmanufacturing
j67*	Activities auxiliary to financial intermediation	nonmanufacturing
k70*	Real estate activities	nonmanufacturing
k71*	Renting of machinery and equipment without operator and of personal and household goods	nonmanufacturing
k72*	Computer and related activities	nonmanufacturing
k73*	Research and development	nonmanufacturing
l75*	Public administration and defense; compulsory social security	nonmanufacturing
m80*	Education	nonmanufacturing
n85*	Health and social work	nonmanufacturing
o90*	Sewage and refuse disposal, sanitation and similar activities	nonmanufacturing
o91*	Activities of membership organization n.e.c.	nonmanufacturing
o92*	Recreational, cultural and sporting activities	nonmanufacturing
o93*	Other service activities	nonmanufacturing
p95+*	Private households with employed persons	nonmanufacturing

Notes: + Excluded from imported input time trend regressions because of insufficient observations.

Table 5A.4 **Distribution margin share**

	Year	All Industries	Manufactured Goods	Nonmanufactured Goods	Energy	Food	Raw Materials
Austria	2001	0.14	0.14	0.14	0.19	0.21	0.10
Belgium	2001	0.14	0.13	0.16	0.11	0.16	0.14
Denmark	2000	0.16	0.16	0.14	0.08	0.17	0.22
Finland	2002	0.12	0.12	0.15	0.12	0.28	0.13
France	2001	0.12	0.12	0.12	0.10	0.17	0.04
Germany	2001	0.14	0.13	0.21	0.12	0.25	0.22
Greece	1999	0.20	0.20	0.15	0.18	0.20	0.07
Hungary	2000	0.07	0.08	0.00	0.10	0.18	–0.11
Ireland	1998	0.09	0.10	0.02		0.09	0.04
Italy	2001	0.16	0.15	0.31	0.14	0.28	0.31
Netherlands	2001	0.13	0.14	0.09	0.06	0.17	0.03
Norway	2002	0.17	0.19	0.12	0.17	0.20	0.06
Portugal	1999	0.14	0.14	0.15	0.18	0.19	0.10
Spain	2000	0.13	0.13	0.18	0.07	0.20	0.10
Sweden	2001	0.11	0.11	0.13	0.11	0.20	0.07
United Kingdom	2001	0.21	0.22	0.10	0.05	0.28	0.07
United States	1997	0.29	0.29	0.33	0.34	0.39	0.32
Average		0.15	0.15	0.15	0.13	0.21	0.11
Standard Deviation		0.05	0.05	0.08	0.07	0.07	0.11

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Comment M. Chatib Basri

Linda Goldberg and Jose Manual Campa have produced a chapter that is both solid and stimulating. This chapter has a strong theoretical base and its empirical findings are important. Using a very rich database that covers sixteen countries in Europe and the United States in the pre- and post-1995 time periods and fifty-nine homogenous manufacturing, primary-industry, and service industry groupings, this chapter explores the role of distribution margins and imported inputs in exchange rate transmission into the consumption prices in five sectors across those countries. This chapter shows that retail price sensitivity to exchange rates may have increased over the past decade. In particular the argument is as follows. First, pass-through may have declined at the level of import prices, but the result is inconclusive over types of goods and countries. Second, there is evidence that imported input used across sectors has expanded largely, making the costs of imported goods as well as home tradable goods more sensitive to import prices and exchange rate. Third, in contrast to the impact of the increase of imported input used in production process, the pass-through effect of exchange rate to consumption prices has been insulated by the distribution margins. Overall, this chapter argues that the balance effect weighs in favor of increased sensitivity of consumption prices to exchange rates.

Following Campa and Goldberg's (2006) approach, which used a two country-model with wage stickiness and monopolistically competitive producers, this paper argues that distribution, services, and so on, provide some insulation. The larger the distribution share, the lower the pass-through impact is on consumer prices. On the contrary, the larger the imported input component of domestically produced goods, the higher the pass-through effect is.

Conceptually, the exchange rate pass-through depends on several variables including market structure, pricing policies, product substitutability, stickiness of wage and nontradable prices, prevailing exchange rate policy, and inflationary environment (Hyder and Shah 2004; Taylor 2000; Otani, Shiratsuka, and Shirota 2003).

There is a vast literature on the exchange rate pass-through, but this chapter specifically and thoroughly goes into the issue of the role of distribution margins and imported input in exchange rate pass-through. This approach seems convincing and is supported by strong methodology. Here Campa and Goldberg specifically show that distribution margins is not a key contributor to changing pass-through into consumption prices of the imported goods over the past decade. Instead, they argue that imported

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inputs, in the production of both traded and nontraded goods, including distribution services steadily increase, thus increase the predicted sensitivity of retail price to exchange rate. This argument is remarkably interesting because some studies argue that pass-through into import prices of industrialized countries has declined in the past decade (Otani, Shigenori, and Shiratsuka 2003; Marazzi, Sheets, and Vigfusson 2005). These findings are particularly important in enriching the discussion on the impact of exchange rate pass-through to consumption prices.

Now I will go into specific comments:

First, in section 5.2 the authors argue that the exchange rate pass-through into manufacturing industry import prices is relatively low compared to energy and raw materials. This result leads to a question of why the pass-through elasticity of manufacture import prices is rather low, even though it has high imported input shares? On the contrary, the pass-through effect in the raw materials is relatively high, although its imported input is relatively low. Unfortunately, the authors say little on this issue.

Second, this chapter shows that there has been an increase in the pass-through of movement in border prices of imports into the final prices of imported and domestically-produced goods for most countries except for the U.S. and Italy. This finding leads to a question of how we explain this phenomenon in the context of increasing globalization through production net-work and vertical trade/intra-industry trade? Otani, Shigenori, and Shiratsuka (2003), for instance, argue that the pass-through into import prices of industrialized countries has declined due to globalization. As for Japan, they argue that in response to the sharp appreciation of the yen in the mid 1980s, the proportion of the overseas production of Japanese firms increased, as did Japan's re-imports in the 1990s. This phenomenon leads into a decline of exchange rate pass-through in Japanese import prices. I think it will be useful if the authors try to reconcile this contrasting argument.

Third, this chapter shows that pass-through may have declined at the level of import prices, but the results are mixed over the type of goods and countries. I think these mixed findings can be attributed to the increasing globalization through production net-work and vertical trade/intra-industry trade. Thus, it would be useful if the authors try to look at the pass-through effect on countries that are involved in production net-work or vertical trade. By doing this, the authors can reconcile the contrasting argument from Otani, Shigenori, and Shiratsuka.

Fourth, this chapter argues that there has been large expansion of imported input used across sectors, which in turn increased the sensitivity to import price and exchange rates. I think it is very important to observe carefully the impact of increasing imported input to exchange rate pass-through. As pointed out by the authors, it is also of interest to note that the impact of increasing imported input used in the production process can be different if there is vertical or intra-industry trade. Increases in vertical trade also raise the possibility that imported products have value-added that originates in the home market. For example, as shown in the chapter, the U.S. imports of cars from Canada can contain engines that were produced in the United States and eventually re-exported to the United States. Thus, the more important the role of vertical trade, the lower the exchange rate pass-through effect becomes on the consumption prices. As a result, the increase of imported input does not necessarily heighten sensitivity to import prices and exchange rate. On this matter, again the selection of country samples is very important. Looking at the trend of increasing globalization through production-net work, an in-depth study on some particular manufacturing industries—for example electronics or automotive in some East Asian countries like Japan and Korea—is very useful and will give more flavor on the impact of vertical trade into exchange rate pass-through.

Fifth, Taylor (2000) argues the low inflation in the United States during early 2000 has also meant lower persistence of inflation. Conceptually, changes in expectation will reduce the persistence of cost and prices changes. As a result, the volatility in exchange rate is not transmitted into prices. This argument leads into a question of whether the decline in the exchange rate pass-through in the U.S. was due to an inflation (the role of monetary policy) or distribution services? How do we decompose those two effects?

Sixth, what is the role of market shares in the pass-through effect? To maintain the market shares, when there are substitutes available, firms will do some pricing-to-market which will reduce pass-through. I think some comparisons between some competitive and less competitive sectors may be useful to answer this question.

In sum, this chapter is worth reading and offers an important contribution for the study of the role of distribution margins and imported inputs in exchange rate transmission into the consumption prices. This excellent paper also draws some important implications for expenditure switching and trade adjustment from changes in exchange rates over time. In addition, various lessons can be drawn from this paper, particularly in relation to the role of distribution margins and imported input in exchange rate pass-through.

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Comment Kiyotaka Sato

This chapter analyzes an important issue of exchange rate pass-through into domestic prices, that is, what causes differences in the degree of exchange rate pass-through between import prices at the border and domestic consumption goods prices. It is well recognized that the extent of exchange rate pass-through into domestic consumption prices is far lower than the corresponding pass-through rate into import prices at the border. Campa and Goldberg attempt to explain such relative insensitivity of consumer prices to exchange rates by using the model-based approach where (a) the share of imported inputs and (b) distribution costs in importing countries play a key role in import-price transmission to domestic consumption prices.

A straightforward solution to this issue is that consumer prices include nontradable goods as well as tradable goods. If the price of nontradable goods were determined entirely by domestic conditions, domestic consumer prices, including nontradable goods, would become less sensitive to exchange rate changes. Indeed, Campa and Goldberg take this aspect into account by incorporating three types of goods in their model: home nontradable goods, home tradable goods, and imported consumption goods. However, they go further into a discussion of cost components for each type of goods. Specifically, home nontradable and tradable goods are assumed to be produced by using imported inputs. As long as pass-through into the border prices of imports is high, a larger share of imported inputs for production leads to a higher exposure of domestically produced products to exchange rate changes.

More importantly, Campa and Goldberg introduce strategic markup adjustments by domestic distributors as another important factor in the relative insensitivity of consumer prices to exchange rate changes. The retail prices of domestic tradable goods and imported consumption goods include nontradable goods and services as cost components, such as trans-

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portation, local storage, marketing costs, and so on. These distribution costs are assumed to be strategically adjusted by local distributors in response to exchange rate changes if their products are being distributed to compete with other products. Thus, strategic adjustments of distribution margins in the distribution sector are likely to dilute sensitivity of imported consumption goods as well as domestic tradable goods to exchange rate changes.

Another important contribution of this study is to empirically investigate the changing pattern of import inputs share and distribution costs across countries and industries by using input-output tables. It is found that imported input use has grown substantially in the sample countries, while distribution expenditures do not show any clear pattern of changes. Moreover, Campa and Goldberg made a connection between these findings and calibrated pass-through elasticities of domestic consumption goods, and concluded that recent changes in import-price transmission to domestic prices are associated more with the increase in the share of imported inputs than that of distribution expenditures.

Thus, Campa and Goldberg have taken some important steps in an analysis of relative insensitivity of domestic consumption prices to exchange rate changes. In particular, they related calibrated pass-through elasticities with actual changes in both imported input shares and distribution costs, which is a significant advance from the existing studies. While they undoubtedly make an important contribution to the literature, there appears to be room for further improvements in their analysis.

First, although table 5.1 shows the extent of exchange rate pass-through into import prices at the border, it will be more informative if the paper presents the estimates of exchange rate pass-through into consumer prices as well. Since the objective of this study is to investigate what plays a key role in making the degree of pass-through lower in domestically produced goods than in imported goods, we first want to know the pass-through rate into domestic consumer goods and then check the difference in the degree of pass-through between import prices and domestic goods prices.

Second, and more importantly, in their calibration exercise, distribution margins are assumed *inelastic* with respect to exchange rate changes, whereas the strategic adjustments of markup by local distributors play a key role in the model of this paper. Owing to this assumption, the degree of pass-through is affected just by the distribution margins per se (i.e., the *share* of distribution costs in the final price of the products). Indeed, Campa and Goldberg calculated the distribution margin by using the input-output data and found that the distribution margin did not show any clear pattern of changes from 1995 to 2000. However, this does not necessarily mean that the distribution margin does not play a major role. It is more important to consider how distribution margins change in response to exchange rate changes during that period. We also need to check to what extent the effective exchange rates changed in each country during the period. In addition, possible differences in elasticities of distribution margins to exchange rates between imported consumption goods and domestic tradable goods are not fully considered in this study. These aspects are worth considering in further analysis of the relative insensitivity of consumer prices to the exchange rate changes.