Buy Foreign While You Can: The Cheap Dollar and Exchange Rate Pass-Through

EDUARDO J.J. GANAPOLSKY AND DIEGO VILÁN

Ganapolsky is a research economist and assistant policy adviser and Vilán is a senior economic analyst in the regional section of the Atlanta Fed's research department. *They thank Tom Cunningham and John Robertson for their comments and Kelley Heinsman for research assistance.*

During 2004, even though the dollar depreciated against several major trading partners' currencies, the U.S. trade deficit increased, fueled mainly by the high level of imports. Basic economic intuition would tell us that a cheaper dollar would make U.S. imports more expensive and that Americans should thus import less, but it seems that a cheaper dollar did not lead to proportionately more expensive imports.

This article presents evidence on the degree of exchange rate pass-through (ERPT) for a wide variety of import categories using monthly data for the period December 1993–December 2004.[1] To provide a broad picture of the incidence of the ERPT phenomenon, the analysis first decomposes domestic import prices to their foreign price and exchange rate components. Some econometric exercises then test for the presence of ERPT in selected import categories. These categories are different from those generally used in other studies in many ways, but perhaps most importantly in their level of disaggregation.

In general, the data show low ERPT at the monthly frequency over the last decade. The ERPT elasticity of total imports' prices averages 18 percent—that is, for every 1 percent the dollar depreciates (appreciates), the price of imports increases (decreases) 0.18 percent although this average varies considerably across categories.

Items defined as capital goods or consumer goods consistently have low ERPT. On the other hand, most of the results suggest that the dollar's value does not affect the prices of products in the industrial supplies and materials category.

Like previous studies, this study finds a generalized downward trend in ERPT elasticities for the main import categories. At a more disaggregated level, however, the analysis finds several instances of a reversion toward higher ERPT during the last months of 2004.

The article begins with a brief review of the empirical literature and a simple decomposition of the import prices data. The presentation of the theoretical model used and its empirical counterpart emphasizes how to interpret the regressions' output. The article then describes the data used in the estimations, analyzes the empirical results, and summarizes the main results.

A Review of the Literature

The economic literature generally supports the partial ERPT hypothesis that only a portion of exchange rate movements will translate into import price changes. Goldberg and Knetter (1997), who provide a comprehensive treatment of the issue, report that previous studies had found lower ERPT in the United States than in other countries. In this respect, they point out that the size of the destination market appears to be important.

More recently, Campa and Goldberg (2002) provide cross-country and time-series evidence for a group of twenty-five Organisation for Economic Co-operation and Development member countries during the 1975–99 period. They also find low pass-through elasticities, both in the short and long run, for the United States. Furthermore, their paper suggests the degree of pass-through has fallen over time, a decline that is explained mainly by the changing composition of the import bundle.[2]

Olivei (2002) provides estimates of exchange rate pass-through for several import categories for the period 1981–99. The paper reports a substantial degree of variation in ERPT across groups and finds no asymmetric response to appreciations and depreciations.

Finally, Marazzi, Sheets, and Vigfusson (2005) find that ERPT to U.S. core import prices declined considerably during the past decade. Apart from previous explanations (a shift toward low pass-through goods in the composition of the import bundle), their study suggests that a geographical reorientation of U.S. imports, a more competitive international market fostered by the presence of China, or the existence of more hedging in the exchange rate markets could explain the phenomenon. Also, the study agrees with the others in that the decline in ERPT seems to be a generalized phenomenon across countries.

A Preview of the Facts

As mentioned earlier, even though the real exchange rate has been depreciating for some time, the trade deficit has not narrowed accordingly but, on the contrary, has kept increasing.

Figure 1 breaks down the trade deficit, imports, and exports into the main categories of traded goods that compose them. The graphs show that the acceleration of the trade deficit's growth rate is coincident with the rapid increase of deficits in consumer goods and industrial supplies and materials. The acceleration of these deficits is due to rapid growth in imports that is not matched by export growth. Imports of capital goods have also been increasing rapidly, but they have been matched by a prompt increase in their exports.

We study import prices at different levels of aggregation, examining the aggregate price index of total imports, the price indexes of the three main import categories (industrial supplies and materials, consumer goods, and capital goods); and,

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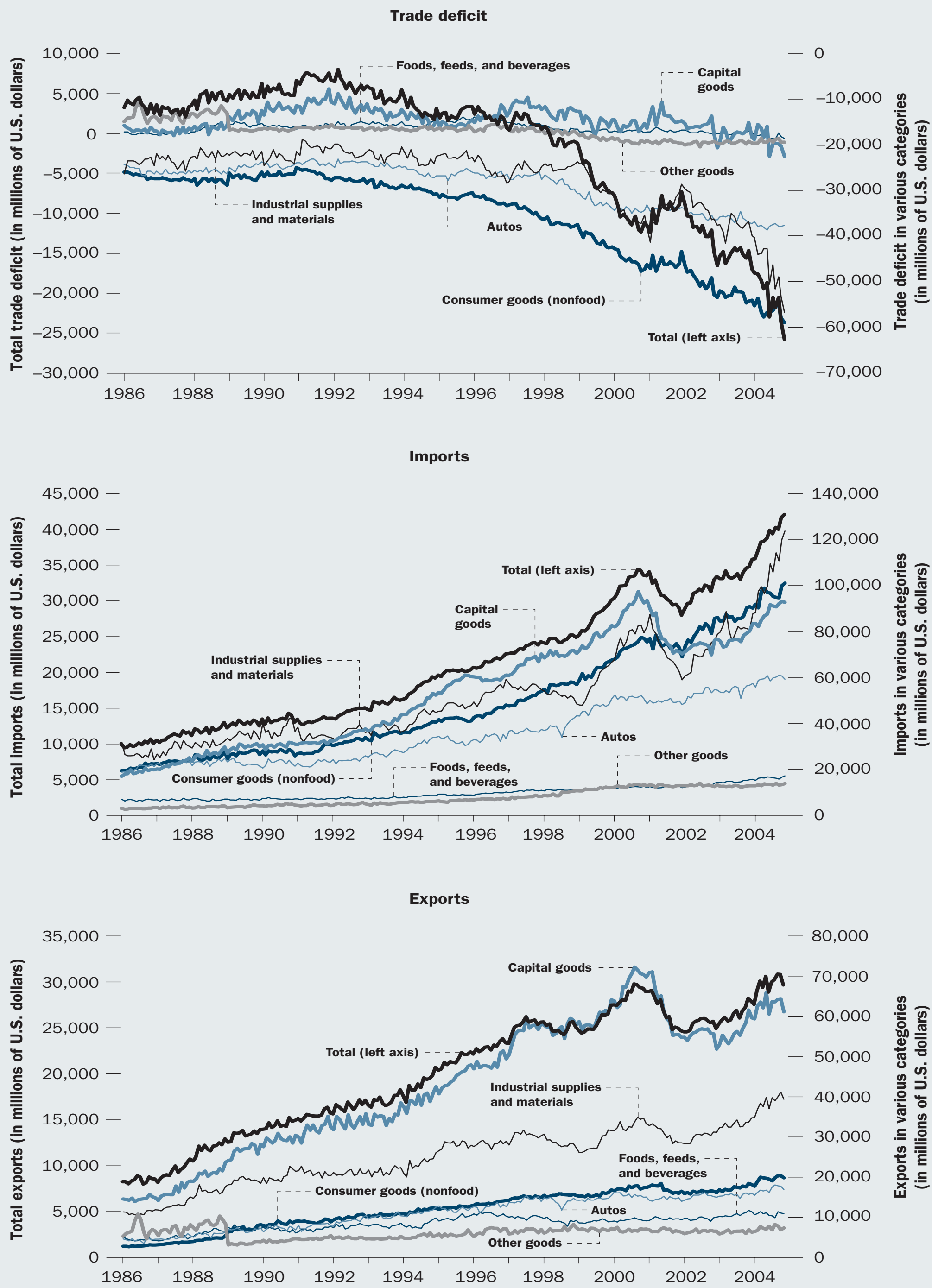
1. Pass-through can be defined as the percentage change in local currency domestic prices resulting from a 1 percent change in the exchange rate. For the purposes of this study, we focus on the pass-through into domestic import prices.
2. Pass-through elasticities are stable along import categories, but a change toward lower pass-through categories has occurred in the past few years.

Figure 1
The U.S. Trade Deficit, Imports, and Exports



Note: Consumer goods and capital goods do not include autos.

Source: Haver Analytics

Table 1
Pass-Through and No Pass-Through Frequencies

	Whole sample		Depreciation		Appreciation	
	Pass-through	No pass-through	Pass-through	No pass-through	Pass-through	No pass-through
Total industrial supplies and materials	0.371	0.629	0.362	0.638	0.378	0.622
Plastic materials	0.511	0.489	0.544	0.456	0.378	0.622
Organic chemicals	0.405	0.595	0.614	0.386	0.486	0.514
Iron and steel mill products	0.435	0.565	0.579	0.421	0.500	0.500
Finished metal shapes	0.415	0.585	0.528	0.472	0.492	0.508
Crude oil	0.397	0.603	0.667	0.333	0.541	0.459
Fuel oil	0.435	0.565	0.596	0.404	0.514	0.486
Petroleum products, other	0.450	0.550	0.544	0.456	0.554	0.446
Gas–natural	0.415	0.585	0.642	0.358	0.523	0.477
Bauxite and aluminum	0.450	0.550	0.561	0.439	0.527	0.473
Lumber	0.527	0.473	0.439	0.561	0.500	0.500
Shingles and wallboard	0.511	0.489	0.404	0.596	0.541	0.459
Capital goods except automotive	0.667	0.333	0.672	0.328	0.662	0.338
Electrical apparatus	0.504	0.496	0.544	0.456	0.311	0.689
Industrial machines, other	0.427	0.573	0.614	0.386	0.419	0.581
Computer accessories	0.878	0.122	0.070	0.930	0.122	0.878
Computers	0.797	0.203	0.170	0.830	0.138	0.862
Semiconductors	0.641	0.359	0.333	0.667	0.216	0.784
Telecom equipment	0.626	0.374	0.298	0.702	0.230	0.770
Civilian aircraft	0.000	1.000	0.800	0.200	0.500	0.500
Medicinal equipment	0.511	0.489	0.491	0.509	0.311	0.689
Photo, service machinery	0.473	0.527	0.544	0.456	0.392	0.608
Consumer goods	0.417	0.583	0.448	0.552	0.392	0.608
Apparel, household goods–cotton	0.420	0.580	0.316	0.684	0.419	0.581
Furniture, household goods	0.382	0.618	0.509	0.491	0.500	0.500
Other household goods	0.511	0.489	0.386	0.614	0.338	0.662
Toys, games, sporting goods	0.420	0.580	0.316	0.684	0.351	0.649
TVs, VCRs, etc.	0.703	0.297	0.094	0.906	0.200	0.800
Gems, diamonds	0.117	0.883	0.295	0.705	0.280	0.720
Household appliances	0.496	0.504	0.351	0.649	0.297	0.703
Footwear	0.359	0.641	0.526	0.474	0.473	0.527
Pharmaceutical preparations	0.500	0.500	0.528	0.472	0.323	0.677
Writing and art supplies	0.521	0.479	0.455	0.545	0.420	0.580
Apparel, textiles–non-wool or cotton	0.458	0.542	0.340	0.660	0.338	0.662

Note: The sample period is December 1993 to December 2004. Frequencies represent the ratio between the number of times a particular event occurred and the total number of events.

Source: Authors' calculations based on data from the BLS; category names are based on BEA end-use categories.

finally, at the most disaggregated level, the price indexes of the items that make up to two-thirds of each category.

Table 1 reports for each item the frequency with which the monthly changes of the exchange rate and the domestic price move in the same or different directions, defining these events as "pass-through" or "no pass-through." The frequencies are computed using the import price indexes published by the U.S. Bureau of Labor

Statistics (BLS) and the inverse of the broad nominal dollar index published by the Board of Governors of the Federal Reserve System.[3] Then we identify the items for which pass-through or no pass-through constitutes the bulk of the cases, setting two-thirds as our threshold.[4] This exercise is performed for the whole sample, and the sample is also divided between depreciations and appreciations to determine whether any sign of asymmetric ERPT occurs.

The results do not show strong evidence in favor of either the pass-through or the no pass-through hypothesis. For the entire sample, we find clear evidence of no pass-through for just two items in the consumer goods category (apparel/household goods–cotton and gems, diamonds).

While industrial supplies and materials show low correlation between foreign prices and exchange rates, capital goods and consumer goods show highly negative correlation coefficients.

For the split sample, we seem to uncover different behaviors of some prices during depreciation and appreciation events. For example, within the industrial supplies and materials category, one item (crude oil) shows evidence of pass-through when the dollar depreciates but no evidence of price reduction when the dollar appreciates. The capital goods category presents some interesting observations. Four items (computer accessories, computers, semiconductors, and telecom equipment) demonstrate no pass-through during depreciations but show pass-through during appreciations. Finally, within the consumer goods category three items (toys, games, sporting goods; TVs, VCRs, etc.; and apparel, textiles–non-wool or cotton) do not pass through when the dollar depreciates.

Figure 2 shows the decomposition of the monthly change of the dollar price of imported goods into its two components: (1) the change in the foreign currency price of the goods and (2) the change in the dollar price of foreign currencies. To construct this figure, we computed the monthly change of the domestic price and exchange rate indexes and obtained the monthly change of the goods' foreign currency price as a residual by purging the exchange rate variation from the domestic import price.

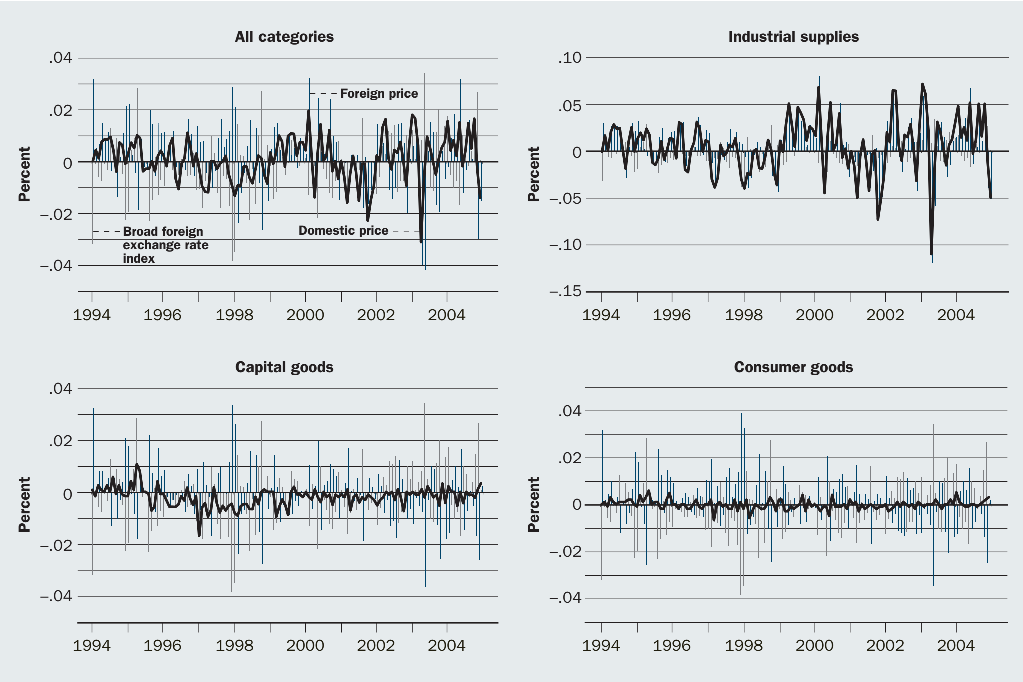
The figure suggests that most of the changes in the aggregate import price index are driven by the industrial supplies and materials import index while consumer goods and capital goods import prices remain quite flat. Decomposing those variations shows that in the consumer goods and capital goods cases, dollar depreciations (appreciations) are matched fairly closely by reductions (increases) in the foreign price, and therefore the dollar price of these categories shows little ERPT. On the other hand, the foreign price of industrial supplies and materials seems more volatile and less related to changes in the nominal exchange rate. In other words, the volatility of foreign prices is wiping out any possibility of ERPT.

These observations are very important to interpreting the potential sources of a low ERPT coefficient. On one hand, it could be the result of a highly negative correlation between nominal exchange rates and foreign prices. On the other hand, it could result from the combination of a very low correlation between nominal exchange

3. This index is expressed in the amount of foreign currency per unit of dollar; we inverted it to measure dollars per unit of foreign currency. Thus, dollar depreciation (appreciation) is a positive (negative) change in the nominal exchange rate index.

4. This test for the ERPT hypothesis is not very stringent given that we define as pass-through any movement in the same direction, independent of the magnitude, of both exchange rates and domestic import prices. As a result, we put the full and partial ERPT concepts together under the pass-through definition.

Figure 2
Import Price Decomposition



rates and foreign prices, with a much larger volatility of the latter. However, only in the first case could low ERPT be interpreted as the outcome of foreign firms adjusting markups in response to exchange rate variations.

To identify the sources of low ERPT, Table 2 computes the correlations between domestic import price changes and nominal exchange rate changes as well as the correlations between foreign import price changes and nominal exchange rate changes. The results are broadly consistent with those derived from Figure 2 for more aggregated data.

In general, evidence supports the partial ERPT hypothesis; the correlation between domestic prices and exchange rates tends to be low. However, when we try to rationalize the sources of the low degree of ERPT, we detect some differences across categories. While industrial supplies and materials show low correlation between foreign prices and exchange rates, capital goods and consumer goods show highly negative correlation coefficients. Indeed, this pattern also holds true at the more disaggregated level. Within industrial supplies and materials, all but three items show low correlation; within capital goods, all but one item show highly negative correlation; and finally, within consumer goods, all the items show strong and negative correlation.

Those facts could be interpreted as favoring the explanation of variable markups in the consumer goods and capital goods cases. Interestingly, the buffering effect of markups seems to unwind for industrial supplies and materials, where foreign prices move independently from exchange rates.

We complement those observations with the results of Granger causality tests, reported in Table 3.[5] In general, we find causality in the Granger sense from exchange rates to domestic import prices for capital goods and consumer goods, but we failed to find any causal relationship for industrial supplies and materials.

Table 2
Import Price and Nominal Exchange Rate Correlations

	Domestic price	Foreign price	Depreciation Domestic price	Depreciation Foreign price	Appreciation Domestic price	Appreciation Foreign price
Total industrial supplies and materials	0.130	–0.285	0.011	–0.255	0.203	–0.107
Plastic materials	0.184	–0.622	0.171	–0.449	0.064	–0.490
Organic chemicals	–0.038	–0.670	–0.194	–0.610	–0.172	–0.629
Iron and steel mill products	0.123	–0.368	0.112	–0.310	0.077	–0.187
Finished metal shapes	0.138	–0.751	0.038	–0.655	0.174	–0.511
Crude oil	0.107	–0.061	–0.009	–0.115	0.270	0.147
Fuel oil	0.003	–0.111	0.012	–0.074	0.079	0.014
Petroleum products, other	0.054	–0.125	0.045	–0.066	0.155	0.008
Gas–natural	0.223	0.132	0.077	0.011	0.044	–0.019
Bauxite and aluminum	0.020	–0.465	0.019	–0.353	0.158	–0.163
Lumber	–0.052	–0.343	–0.145	–0.336	0.177	–0.033
Shingles and wallboard	–0.080	–0.448	–0.194	–0.436	0.225	–0.058
Total capital goods except automotive	0.244	–0.953	0.119	–0.920	0.041	–0.892
Electrical apparatus	0.147	–0.817	0.096	–0.759	–0.097	–0.688
Industrial machines, other	0.231	–0.895	0.212	–0.766	0.033	–0.864
Computer accessories	0.042	–0.825	–0.068	–0.754	–0.166	–0.742
Computers	0.121	–0.460	0.068	–0.430	–0.033	–0.332
Semiconductors	0.105	–0.718	0.124	–0.616	0.181	–0.400
Telecom equipment	0.003	–0.899	0.113	–0.749	–0.070	–0.886
Medicinal equipment	0.200	–0.913	0.041	–0.844	–0.035	–0.869
Photo, service machinery	0.194	–0.847	0.251	–0.682	0.060	–0.760
Total consumer goods	0.168	–0.986	0.163	–0.969	–0.065	–0.973
Apparel, household goods–cotton	–0.094	–0.951	–0.051	–0.909	–0.002	–0.876
Furniture, household goods	0.228	–0.920	0.102	–0.913	0.264	–0.715
Other household goods	0.119	–0.956	–0.041	–0.924	0.091	–0.898
Toys, games, sporting goods	–0.090	–0.956	–0.201	–0.931	–0.079	–0.887
TVs, VCRs, etc.	0.018	–0.879	–0.061	–0.804	0.095	–0.731
Gems, diamonds	0.192	–0.882	–0.148	–0.954	0.139	–0.583
Household appliances	0.124	–0.954	0.327	–0.907	–0.114	–0.902
Footwear	0.090	–0.958	0.121	–0.924	–0.114	–0.906
Pharmaceutical preparations	0.185	–0.850	0.129	–0.722	–0.011	–0.795
Writing and art supplies	0.138	–0.928	–0.104	–0.910	0.015	–0.805
Apparel, textiles–non-wool or cotton	–0.011	–0.949	0.022	–0.896	0.159	–0.871

Note: The sample period is December 1993 to December 2004.

Source: Authors' calculations based on data from the BLS and the Board of Governors of the Federal Reserve System; category names are based on BEA end-use categories.

A Framework to Estimate Exchange Rate Pass-Through

Theoretical grounds. The literature defines ERPT as "the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries" (Goldberg and Knetter 1997, 1248).

5. We test whether causality in the Granger sense exists in either direction between changes in the nominal exchange rate and changes in the domestic import prices. The direction of causality that concerns us is the one that goes from exchange rates to domestic import prices.

Table 3
Granger Causality Tests

	Granger causality tests		
	E to ...	... to E	Number of observations
Total imports	0.502	1.490	130
Total industrial supplies and materials	0.617	0.404	130
Plastic materials	2.859*	0.551	130
Organic chemicals	0.900	4.078	130
Iron and steel mill products	0.128	0.014	130
Finished metal shapes	2.932***	0.703	117
Crude oil	0.099	0.352	130
Fuel oil	0.818	0.402	130
Petroleum products, other	0.531	2.088	130
Gas–natural	0.832	1.627	117
Bauxite and aluminum	2.126	2.094	130
Lumber	0.217	2.275	130
Shingles and wallboard	0.042	3.568**	130
Total capital goods except automotive	26.125***	1.098	130
Electrical apparatus	5.450***	0.816	130
Industrial machines, other	26.495***	0.041	130
Computer accessories	3.686**	0.266	130
Computers	0.740	1.031	117
Semiconductors	3.418**	4.716***	130
Telecom equipment	0.727	0.899	130
Medicinal equipment	12.825***	0.451	130
Photo, service machinery	25.204***	0.010	130
Total consumer goods	11.683***	0.232	130
Apparel, household goods–cotton	0.397	2.394*	130
Furniture, household goods	3.350**	0.057	130
Other household goods	2.220	4.078	130
Toys, games, sporting goods	0.274	0.376	130
TVs, VCRs, etc.	0.415	0.086	117
Gems, diamonds	1.193	0.012	93
Household appliances	2.578*	0.425	130
Footwear	4.575***	0.542	130
Pharmaceutical preparations	17.639***	0.328	117
Writing and art supplies	4.897***	0.776	130
Apparel, textiles–non-wool or cotton	1.124	0.530	117

Note: The reported values are F-statistics for estimations with two lags. *,**, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The sample period is December 1993 to December 2004.

Source: Authors' calculations

If the law of one price holds, then exchange rate changes will always pass in full to domestic import prices. This result would also be maintained in the aggregate if purchasing power parity holds.[6] But if either the law of one price or purchasing power parity (PPP) fails in any of their versions, then the possibility of having partial ERPT arises.

If P is the price in local currency of the imported goods, E is the nominal exchange rate, and P^* is the price in foreign currency of the imported goods (including transportation, distribution, resale costs, etc.), then PPP implies that

$$P = E \cdot P^*.$$

If P^* is independent of E, any change in E will fully transmit into P; this rationale is the essence of full ERPT.

However, P^* might depend on E:

$$P = E \cdot P^*(E),$$

and therefore the change in P for a given change in E will depend on the behavior of P^*.

We can assume that goods markets are not perfectly competitive and then write P^* as being formed by two components, a markup and the marginal cost of producing (and delivering) the good. Thus, we should reformulate the previous statement: If the markup and the marginal cost of the exporter/producer are both independent of E, then exchange rate movements would fully pass through into domestic import prices. Nonetheless, if either of them are related to E, changes in the exchange rate would imply that ERPT is partial.

Evidence in the literature, both at theoretical and empirical levels, indicates that markups and marginal costs would in fact depend on E. Using imperfect competition models, Dornbusch (1987) shows how markup can adjust in response to changes in the exchange rate. Baldwin and Krugman (1989) and Bernard and Jensen (2004) present evidence on the existence of sunk costs to start an export business (advertising, setting up a distribution chain, conducting R&D specific for a market, etc.), which would also help explain markup changes.[7]

Regarding changes in the marginal costs, according to Feenstra (1989) the exchange rate can enter the cost function directly through the price of imported inputs or indirectly through a change in the scale triggered by the response of demand in the destination market. Burstein, Neves, and Rebelo (2003) show that distribution costs are an important component of retail prices of tradable goods, and, given that distribution activities use nontradables, these could be affected by movements in the exchange rate.

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6. In Goldberg and Knetter (1997), the absolute version of the law of one price means that "identical products sell for the same common-currency price in different countries." On the other hand, the relative version means that "the common-currency prices for a particular product change in the same way in the two countries."

   In regard to purchasing power parity, theory requires that the law of one price holds for all the goods in the economy. The absolute version of the law of one price also requires the absence of nontradable goods, and the relative version needs constant nontradable goods prices.
7. A foreign firm would not raise prices or leave the market and allow other firms to enter as soon as it observes the exchange rate falling. Instead, it would absorb the depreciation by reducing its margins. Vice versa, when the exchange rate increases, the foreign firm would revamp its margins without reducing prices in local currency. Obviously, the buffering effect of margins has a limit. On the downside, at some point the foreign firm will decide the effort is no longer productive and will start raising prices. On the upside, when other firms see the thick margins, they will be tempted to sink some resources to enter the market, driving prices and margins down.

In sum, we postulate the following import price equation, which is broadly consistent with those behind the empirical exercises in the rest of the literature:

$$(1) \quad P = E \cdot [\psi(E,.) \cdot c(E,.)],$$
$$\psi(E,.) \equiv \frac{P^*(E,.)}{c(E,.)},$$

where $\psi(.)$ is the markup that foreign firms charge on their costs and $c(.)$ is their marginal costs.

As mentioned earlier, markup depends on market characteristics and demand conditions in the importing country, and, given the relationship of the latter with the value of the local currency, it depends indirectly on exchange rates. The cost of the imported product depends on the price of domestic and foreign inputs and the scale of production, so then it also depends in some way on exchange rates.

Empirical counterpart. The empirical implementation of the underlying model in most of the literature follows the regression equation presented in Goldberg and Knetter (1997), which varies from study to study depending on the question the researchers seek to answer and the data they draw on:

$$(2) \quad p_t = \alpha + \beta \cdot e_t + \delta \cdot x_t + \gamma \cdot z_t + \varepsilon_t,$$

where all the variables are in logarithmic form, p_t is the domestic price of an imported product, e_t is the nominal exchange rate, x_t is a measure of the foreign costs, z_t denotes some controls, and ε_t is an error term.

In the general setup, domestic import prices (in local currency) are mainly driven by three variables: (1) the nominal exchange rate, (2) foreign exporters' costs, and (3) domestic demand (directly through its effect on markup and indirectly through the effects on scale and thus exporters' costs).

Campa and Goldberg (2002) use as proxies for exporters' costs both an aggregate measure of labor costs in the trading partners and real gross domestic product (GDP) in the domestic country, with the latter trying to capture the effect of demand on the scale and thus on marginal costs. Olivei (2002) combines the nominal exchange rate and foreign exporters' costs by computing real exchange rates specific for each category of goods. Regarding demand conditions, this study controls for the price of alternative goods with domestic price indexes and for the expenditure on the imported good and its alternatives with U.S. industrial production indexes. Finally, Marazzi, Sheets, and Vigfusson (2005) rely on foreign consumer price indexes (CPI) and producer price indexes (PPI) to capture exporters' costs and use an index of primary commodities prices to represent the price of alternative goods, which in turn affects domestic demand.

The analysis in this article uses the same underlying framework. Like Goldberg and Knetter (1997) and Campa and Goldberg (2002), this article considers nominal exchange rate movements as opposed to real exchange rates.[8] On the other hand, we share with Olivei (2002) and Marazzi, Sheets, and Vigfusson (2005) the way we control for foreign costs, using cost proxies specific to each good category, derived either from foreign CPI or PPI; in this article, however, we construct our own indexes. We also share with Olivei the fact that we include U.S. production indexes to control for the state of the business cycle in each sector and use domestic price indexes as proxies for the prices of alternative goods.

We estimate equation (2) in first differences by using ordinary least squares and recursive least squares methods; specifically,

$$(3)\quad \Delta p_t = a + b_1 \cdot \Delta e_t + b_2 \cdot \Delta x_t + b_3 \cdot \Delta z_t + v_t,$$

where Δ indicates the first-difference operator, v_t is the regression residual, and a and b_i are the estimated coefficients.

It is apparent from equation (3) that the estimated coefficient b_1 is not an estimator of the pass-through elasticity given by β in equation (2). In Appendix A we show that b_1 is estimating a quadratic function of the true pass-through elasticity. Therefore, the estimated pass-through elasticities should be computed as the square root of b_1.

To test for the presence of asymmetries in the pass-through elasticities, we estimate a slightly different version of equation (3):

$$(4)\quad \Delta p_t = a + b_1 \cdot \Delta e_t + b_2 \cdot \Delta x_t + b_3 \cdot \Delta z_t + b_4 \cdot \Delta e_t D_t + v_t,$$

where D_t is a dummy variable that captures the depreciation events.[9]

In equation (4) we incorporate the interaction term with the aim of testing whether the degree of ERPT is the same or different during depreciation and appreciation events. So in this case b_1 estimates some function of the ERPT elasticity when the dollar appreciates, and $(b_1 + b_4)$ estimates the same function when the dollar depreciates. Thus, our asymmetry test consists of assessing whether b_4 is significantly different from zero; if it is, we can reject the hypothesis that ERPT is symmetric.

Data Description

Import prices and quantities. This article uses monthly import price data from the BLS for the period December 1993–December 2004. The BLS reports price indexes at different levels of aggregation: (1) aggregate import price index (level 1), (2) price index per import category (level 2) (for example, industrial supplies and materials), and (3) price index per item within each import category (level 3) (for example, fuel oil).

In this article we work with the three level 2 categories that contribute the most to total imports. Level 3 items are selected so that they explain two-thirds of imports of the corresponding level 2 category. We use annual import data from the U.S. Bureau of Economic Analysis (BEA) for 2002, 2003, and 2004 and from the U.S. Census Bureau for 2001.

In some cases a BEA import category does not exactly match the description of a BLS import price category. To reconcile this difference we use our judgment in attempting to find an equivalent category. Table 4 shows all the cases in which the category names from the BEA do not exactly match those from the BLS.

Nominal exchange rates. The Board of Governors of the Federal Reserve System constructs three nominal exchange rate indexes: Broad, Major, and Other Important Trading Partners (OITP). The Broad index includes twenty-six currencies from the United States' main trading partners, the Major index includes the seven

8. Olivei (2002) directly considers the real exchange rate. Marazzi, Sheets, and Vigfusson (2005) consider it indirectly given that they restrict the nominal exchange rate and the foreign price index coefficients to be the same ($\beta = \delta$).

9. The dummy variable takes the value 1 if the nominal exchange rate depreciates and 0 if it appreciates or remains unchanged.

Table 4
BEA and BLS Category Matching

BEA category	BLS category
Crude oil	Crude
Bauxite and aluminum	Bauxite, alumina, aluminum and products thereof
Finished metal shapes	Finished metal shapes and advanced manufacturing
Industrial supplies, other	Industrial supplies (aggregate)
Lumber	Lumber and other unfinished building materials
Shingles and wallboard	Selected building materials
Medical equipment	Scientific and medical machinery
Photo, service machinery	Photo and other service industry machinery
Toys, games, sporting goods	Toys, shooting and sporting goods
Household appliances	Household and kitchen appliances
Footwear	Footwear of leather, rubber, or other material
Writing and art supplies	Other products (notions, writing supplies, tobacco products, etc.)

most important currencies, and the remaining nineteen are included in the OITP index. All these indexes are denominated in units of foreign currency per unit of dollar.

We use these time series at a monthly frequency. The results reported in this article are based on the Broad index; we also perform some of the exercises with the Major index, but they are robust to this change.

Cost proxies. We construct three types of foreign cost proxies for each item and category in the study. The first index is constructed with monthly data from the International Financial Statistics (IFS). Following Campa and Goldberg (2002), we take advantage of the fact that the IFS reports both the real and the nominal exchange rate per country adjusted by labor costs (*reu* and *neu* series), and we derive an approximate measure of the trading partners' costs.[10]

The other two indexes are both weighted averages of foreign price indexes, yet one is built by combining foreign PPI and wholesale price indexes (WPI) while the other is constructed entirely from foreign CPI. The data we use are monthly. The weights are constructed from the relative importance of each country in the trade volume of each item using the historical monthly import volumes per country from the U.S. Department of Commerce.

Industrial production. We use monthly industrial production (IP) indexes constructed by the Board of Governors under the North American Industry Classification System (NAICS). Since both the IP indexes and the trade data from the Commerce Department are built under the NAICS, we must use our judgment to reconcile these variables with the BEA end-use classification system. Table 5 indicates how these categories are matched. In some instances a NAICS category is repeated (for example, computers and computer accessories), and in some others, because no appropriate match is available, we use a category index (a level 2 index). This more aggregate index is able to capture an average of all the changes occurring in a particular sector. We drop out only one item (civilian aircraft) within capital goods because of a lack of sufficient data.

Domestic prices. For domestic prices of imported goods, we use two types of indexes: industrial PPI for the items within industrial supplies and materials and capital goods and the urban CPI for all the final goods items within consumer goods. In this case also we must use our judgment when matching the import price items with the categories used as proxies of domestic prices. Table 6 details how all items are matched.

Table 5
BEA and NAICS Category Matching

BEA category	NAICS IP category
Plastic materials	Plastics material and resin NAICS=325211
Organic chemicals	Organic chemicals NAICS=32511
Iron and steel products	Iron and steel products NAICS=3311
Finished metal shapes	Fabricated metal products NAICS=332
Crude oil	Crude oil NAICS=211111
Fuel oil	Distillate fuel oil NAICS=32411
Petroleum products, other	Petroleum and coal products NAICS=324
Gas–natural	Natural gas NAICS=211111
Bauxite	Alumina and aluminum production and processing NAICS=3313
Lumber	Wood products NAICS=321
Shingles and wallboard	Plywood and misc. wood products NAICS=3212
Industrial supplies, other	Level 2 industrial supplies IP index
Electrical apparatus	Electrical equipment, appliances, and components NAICS=335
Industrial machines, other	Machinery, except electrical NAICS=33
Computer accessories	Computer and peripheral equipment NAICS=3341
Computers	Computer and peripheral equipment NAICS=3341
Semiconductors	Semiconductor and other electronic components NAICS=3344
Telecom equipment	Communications equipment NAICS=3342
Civilian aircraft	Aircraft and parts NAICS=336411
Medicinal equipment	Medical equipment and supplies NAICS=3391
Photo, service machinery	Level 2 capital goods IP index
Apparel, household	Apparel and leather goods NAICS=3152
Furniture, household	Household and institutional furniture NAICS=3371
Other household goods	Furniture and related products NAICS=337
Toys, games, sporting goods	Level 2 consumer goods IP index
TVs, VCRs, etc.	Audio and video equipment NAICS=3343
Gems, diamonds	Level 2 consumer goods IP index
Household appliances	Household appliances NAICS=3352
Footwear	Apparel and leather goods NAICS=3152
Pharmaceutical preparations	Pharmaceutical and medicine NAICS=3254
Writing and art supplies	Paper NAICS=3221
Apparel, textiles	Textiles and products NAICS=313

To test for the presence of unit roots in all the data, we use the augmented Dickey-Fuller methodology. Because most of the time series in our data set were nonstationary at the 1 percent level of significance, we estimate our models in first differences.

Results

Table 7 summarizes the results obtained from estimating equation (3). The first column shows the ERPT elasticities obtained from estimating a simple statistical relationship between domestic import prices and exchange rates. The next three columns present the ERPT elasticities estimated using equation (3) for different specifications of the foreign cost: broad, PPI/WPI-based, and CPI-based proxies. The final column gives the estimated ERPT elasticity that we find when using the PPI/WPI-based specification with one more control variable—the domestic price index—which acts as a proxy of the prices of competing goods.

10. The exact derivation and the underlying assumptions are provided in Appendix B.

Table 6
Import Prices and Domestic PPI/CPI Matching

BEA category	CPI/PPI category	Index
Total industrial supplies and materials	Intermediate materials: less food and feeds	PPI
Plastic materials	Plastic resins and materials	PPI
Organic chemicals	Basic organic chemicals	PPI
Iron and steel mill products	Steel mill products	PPI
Finished metal shapes	Fabricated structural metal products	PPI
Crude oil	Crude petroleum	PPI
Fuel oil	Gasoline	PPI
Petroleum products, other	Petroleum products, refined	PPI
Gas–natural	Natural gas (to pipelines)	PPI
Bauxite and aluminum	Primary nonferrous metals (excluding precious)	PPI
Lumber	Lumber	PPI
Shingles and wallboard	Building paper and board	PPI
Industrial supplies, other	Intermediate materials: less food and feeds	PPI
Total capital goods except automotive	Capital equipment	PPI
Electrical apparatus	Electrical industrial apparatus	PPI
Industrial machines, other	Capital equipment	PPI
Computer accessories	Computer peripheral equipment and parts	PPI
Computers	Electronic computers	PPI
Semiconductors	Capital equipment	PPI
Telecom equipment	Telephone and telegraph equipment	PPI
Medicinal equipment	X-ray and electro medical equipment	PPI
Photo, service machinery	Capital equipment	PPI
Total consumer goods	CPI-U-All	CPI
Apparel, household goods–cotton	Window and floor covering and other linens	CPI
Furniture, household goods	Furniture and bedding	CPI
Other household goods	Other household equipment and furnishings	CPI
Toys, games, sporting goods	Average of sporting goods and toys categories	CPI
TVs, VCRs, etc.	Video and audio	CPI
Gems, diamonds	Jewelry and watches	CPI
Household appliances	Household appliances	CPI
Footwear	Footwear	CPI
Pharmaceutical preparations	Medical care commodities	CPI
Writing and art supplies	Stationery, stationery supplies, gift wrap	CPI
Apparel, textiles–non-wool or cotton	Apparel	CPI

The results are robust across different specifications except for industrial supplies and materials, where both the overall category and its related items change substantially when the model is specified with CPI-based proxies.[11]

We find strong evidence in favor of the partial ERPT hypothesis at the more aggregated levels. In our best (PPI/WPI-based) specification, the total imports category shows an average short-run elasticity of 18 percent for the entire December 1993–December 2004 period. At level 2, the industrial supplies and materials category is more elastic than the level 1 counterpart, but it is statistically significant only in the PPI/WPI-based specification, averaging 29 percent during the sample period. Capital goods and consumer goods are both less elastic than the level 1 counterpart (8 percent and 13 percent, respectively), and, interestingly, they are statistically significant across all specifications.

Table 7
Pass-Through Elasticities

		Economic models			
		Foreign costs			
	Statistical model	Broad-based	PPI/WPI–based	CPI-based	Domestic prices
Total imports	0.156*	0.169**	0.177**	0.170**	0.000
Total industrial supplies and materials	0.241	0.263	0.291*	0.269	0.169
Plastic materials	0.210**	0.215**	0.238***	0.215**	0.189**
Organic chemicals	–0.106	–0.105	–0.104	–0.120	–0.177
Iron and steel mill products	0.227	0.228	0.194	0.201	0.179
Finished metal shapes	0.154***	0.152*	0.161	0.156	0.148
Crude oil	0.357	0.347	0.384	0.360	0.170
Fuel oil	0.121	0.139	0.265	0.220	–0.226
Petroleum products, other	0.223	0.226	0.262	0.222	0.056
Gas–natural	0.693**	0.698**	0.700**	0.695**	0.218
Bauxite and aluminum	0.094	0.129	0.100	0.120	–0.097
Lumber	–0.168	–0.168	–0.146	–0.144	0.258*
Shingles and wallboard	–0.184	–0.162	–0.182	–0.150	0.114
Total capital goods except automotive	0.128***	0.130***	0.136***	0.134***	0.135***
Electrical apparatus	0.146***	0.149*	0.149*	0.145*	0.148*
Industrial machines, other	0.153*	0.154***	0.153***	0.148***	0.152*
Computer accessories	0.075	0.084	0.082	0.089	0.084
Computers	0.186	0.182	0.153	0.164	0.166
Semiconductors	0.139	0.138	0.141	0.138	0.142
Telecom equipment	0.026	–0.008	0.057	0.049	0.065
Medicinal equipment	0.134**	0.131**	0.131**	0.133**	0.132**
Photo, service machinery	0.158**	0.169***	0.170***	0.174***	0.169**
Total consumer goods	0.084**	0.085**	0.084**	0.084**	0.083**
Apparel, household goods–cotton	–0.082	–0.083	–0.083	–0.087	–0.066
Furniture, household goods	0.143***	0.141***	0.141***	0.138***	0.141*
Other household goods	0.090	0.087	0.086	0.091	0.096
Toys, games, sporting goods	–0.077	–0.082	–0.080	–0.081	–0.076
TVs, VCRs, etc.	0.026	0.035	–0.014	0.026	–0.038
Gems, diamonds	0.143*	0.148**	0.149**	0.153**	0.146*
Household appliances	0.092	0.095	0.091	0.089	0.112*
Footwear	0.076	0.077	0.082	0.080	0.082
Pharmaceutical preparations	0.153**	0.149**	0.148***	0.143*	0.127
Writing and art supplies	0.108	0.112	0.105	0.110	0.105
Apparel, textiles–non-wool or cotton	–0.029	–0.036	–0.030	–0.031	–0.025

Note: *,**, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The elasticities are computed from the estimation of the coefficient b_1 in equation (3).

Source: Authors' calculations

11. We believe the proxy we use for the prices of competing goods is not as precise in this case. Within the industrial supplies and materials category, most of the items are commodities or very standardized products, so domestic prices and import prices refer to almost the same good and are therefore highly correlated.

Table 8
ERPT Differentials (ERPT Depreciation Minus ERPT Appreciation)

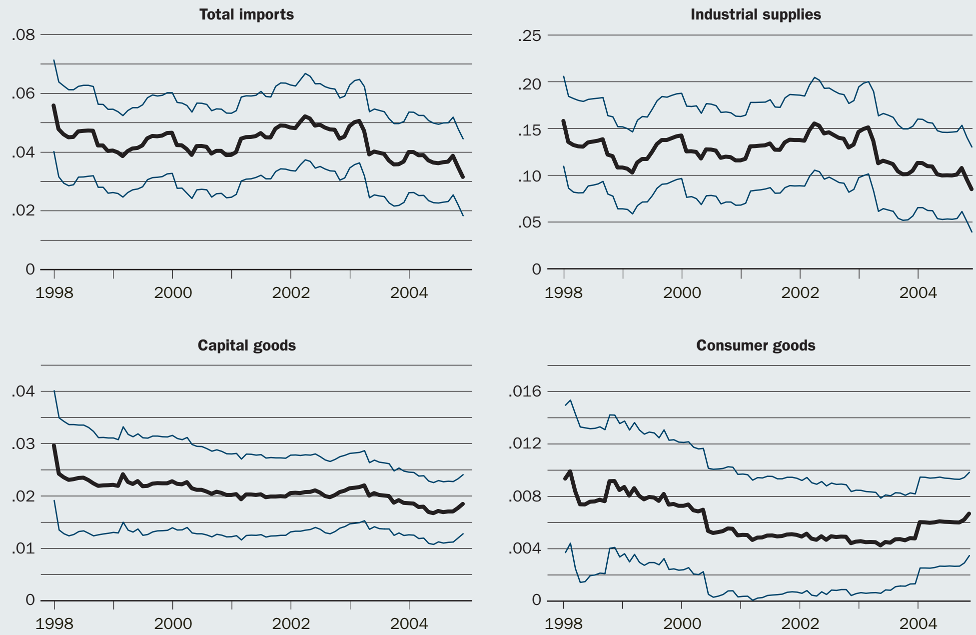
		Economic models			
		Foreign costs			
	Statistical model	Broad-based	PPI/WPI–based	CPI-based	Domestic prices
Total imports	–0.228	–0.243	–0.271***	–0.249	
Total industrial supplies and materials	–0.444	–0.482*	–0.523**	–0.487*	–0.362
Plastic materials	0.211	0.184	0.157	0.195	0.184
Organic chemicals	–0.331	–0.342*	–0.331	–0.317	–0.321*
Iron and steel mill products	–0.090	–0.110	0.048	–0.088	–0.168
Finished metal shapes	–0.223	–0.205	–0.224	–0.242	–0.224
Crude oil	–0.756	–0.716	–0.779	–0.734	–0.445
Fuel oil	–0.446	–0.294	–0.526	–0.465	–0.061
Petroleum products, other	–0.312	–0.320	–0.357	–0.318	0.370
Gas–natural	–0.683	–0.686	–0.680	–0.688	–0.395
Bauxite and aluminum	–0.268	–0.287	–0.238	–0.256	–0.210
Lumber	–0.550*	–0.565*	–0.592*	–0.630**	–0.083
Shingles and wallboard	–0.518**	–0.520**	–0.549**	–0.532**	–0.300
Total capital goods except automotive	–0.062	–0.062	–0.061	–0.083	–0.058
Electrical apparatus	0.142	0.138	0.148	0.156	0.135
Industrial machines, other	0.178	0.169	0.176	0.176	0.174
Computer accessories	–0.145	–0.149	–0.151	–0.151	–0.140
Computers	0.042	0.129	0.121	0.163	0.191
Semiconductors	–0.144	–0.122	–0.100	–0.117	–0.095
Telecom equipment	0.150	0.183	0.151	0.146	0.082
Medicinal equipment	–0.099	–0.060	–0.101	–0.097	–0.134
Photo, service machinery	0.203	0.181	0.188	0.179	0.181
Total consumer goods	0.119	0.113	0.119	0.124	0.115
Apparel, household goods–cotton	–0.019	0.033	–0.008	–0.044	0.130
Furniture, household goods	–0.150	–0.147	–0.148	–0.148	–0.152
Other household goods	–0.147	–0.152	–0.148	–0.148	–0.096
Toys, games, sporting goods	–0.142	–0.130	–0.140	–0.148	–0.140
TVs, VCRs, etc.	–0.142	–0.110	–0.125	–0.152	–0.120
Gems, diamonds	–0.234	–0.215	–0.260*	–0.228	–0.257
Household appliances	0.224***	0.213***	0.222***	0.229***	0.171
Footwear	0.143	0.139	0.139	0.149	0.139
Pharmaceutical preparations	0.120	0.121	0.118	0.054	0.064
Writing and art supplies	–0.165	–0.157	–0.161	–0.147	–0.160
Apparel, textiles–non-wool or cotton	0.019	–0.043	–0.027	–0.024	–0.034

Note: *,**, and *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The elasticities are computed from the estimation of the coefficient b_4 in equation (4).

Source: Authors' calculations

At the most disaggregated level we cannot reject the non-pass-through hypothesis in the majority of cases. As we point out earlier, the estimations of ERPT elasticities for industrial supplies and materials are not very robust; nevertheless, we find that the plastic materials item is consistently significant, with a degree of pass-through in the range of 19 percent to 24 percent. Within capital goods, we find statistically significant partial ERPT for several items: electrical apparatus (15 percent); industrial machines, other (15 percent); medicinal equipment (13 percent); and photo, service

Figure 3a
Evolution of ERPT Coefficients for All Categories, January 1998–December 2004



Note: The graphs show recursive estimations of equation (3), using the PPI/WPI specification from Table 7. The thin lines show one-standard-deviation bounds.

machinery (17 percent). Finally, within consumption goods, the three items that are consistently significant are furniture (14 percent); gems, diamonds (15 percent); and pharmaceutical preparations (15 percent).

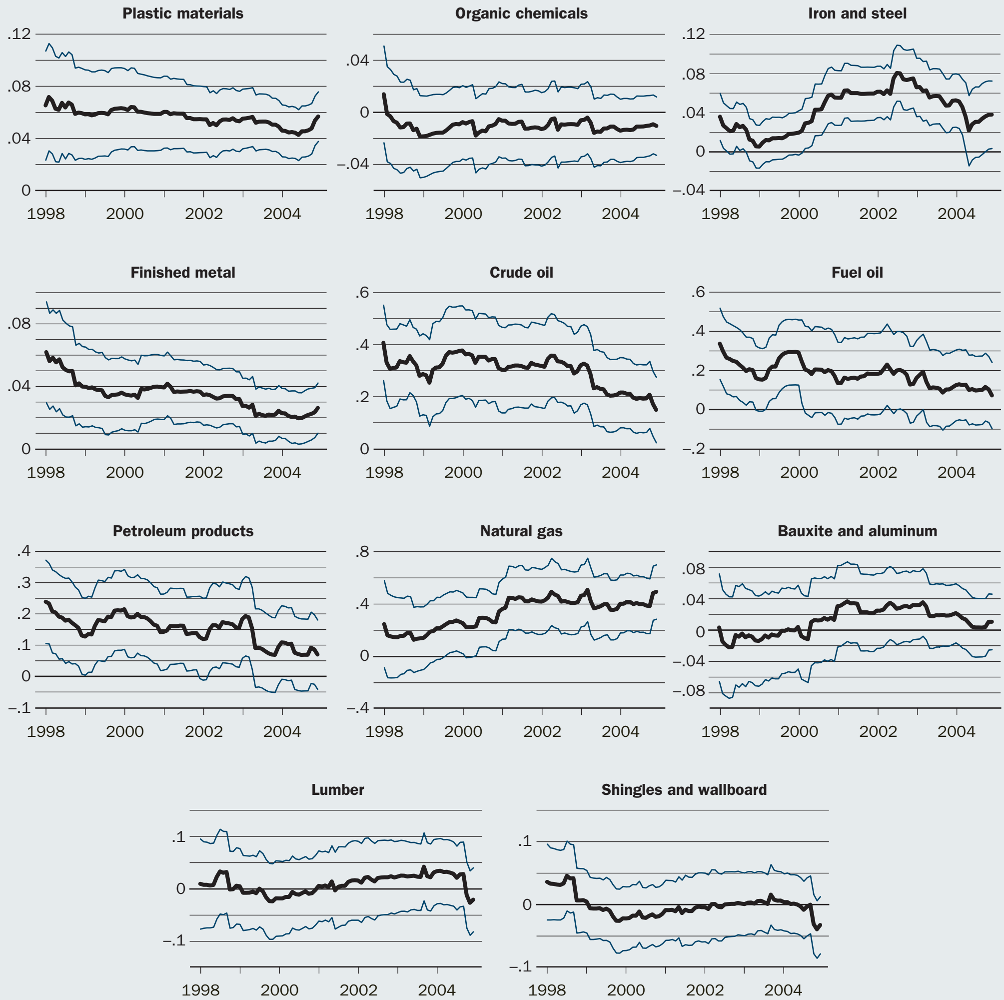
Table 8 shows the differential ERPT elasticities obtained from estimating equation (4). As in the rest of the literature, our study finds no evidence of asymmetric pass-through in the vast majority of cases. Thus, from our econometric exercises we conclude that the degree of pass-through is the same whether the exchange rate depreciates or appreciates, a finding that contradicts some of the preliminary ideas described earlier.

In general, we cannot reject the hypothesis of zero differentials. Only three items (lumber, shingles and wallboard, and household appliances) evidence different behavior, but in all of them the ERPT coefficients are not significant, either overall or during appreciation events. Furthermore, as in the previous table, the results for the first two items, which fall in the industrial supplies and materials category, are not robust across all specifications.

Finally, we estimate equation (3) using recursive least squares. This technique implies equation (3) is estimated repeatedly using a larger sample each time. We start with a sample size of $t = 48$ and then generate a vector of $(T - 48)$ coefficients by adding one new observation to the sample until $t = T$. We report these vectors in Figures 3a–3d, which plot the path of the ERPT coefficients and one-standard-deviation bounds.[12]

12. The charts show the evolution of the coefficients as they come from the regression, which should be transformed to be read as elasticities.

Figure 3b
Evolution of ERPT Coefficients for Industrial Supplies, January 1998–December 2004

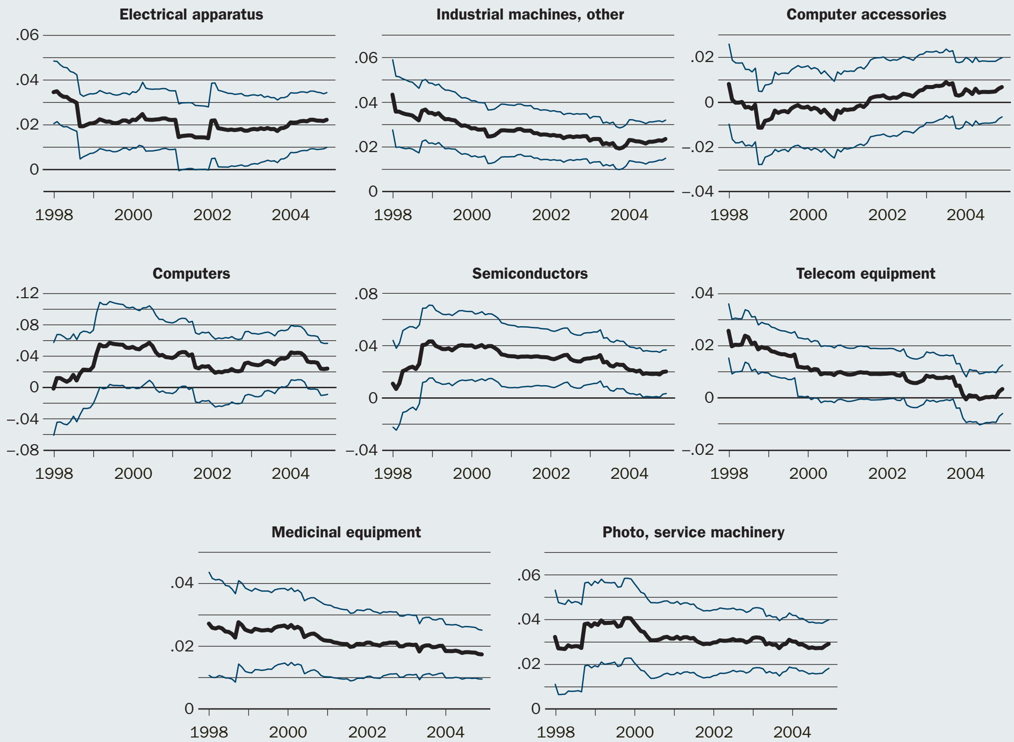


Note: The graphs show recursive estimations of equation (3), using the PPI/WPI specification from Table 7. The thin lines show one-standard-deviation bounds.

The figures show that the degree of pass-through of total imports has a slightly downward trend during the analysis period. However, the behavior of its components is very heterogeneous. While industrial supplies and materials (Figure 3b) closely resemble the aggregate pattern (Figure 3a) over the period, the other two categories present a change in the trend in the last months of 2004, when both capital goods (Figure 3c) and consumer goods (Figure 3d) prices increase their sensitivity to exchange rate movements.

The heterogeneity is more evident among the components of each category. Within industrial supplies and materials, items such as natural gas, bauxite and aluminum, and lumber have a definite upward trend. Among the components of capital goods, all but computers and medicinal equipment show slight increases in

Figure 3c
Evolution of ERPT Coefficients for Capital Goods, January 1998–December 2004



Note: The graphs show recursive estimations of equation (3), using the PPI/WPI specification from Table 7. The thin lines show one-standard-deviation bounds.

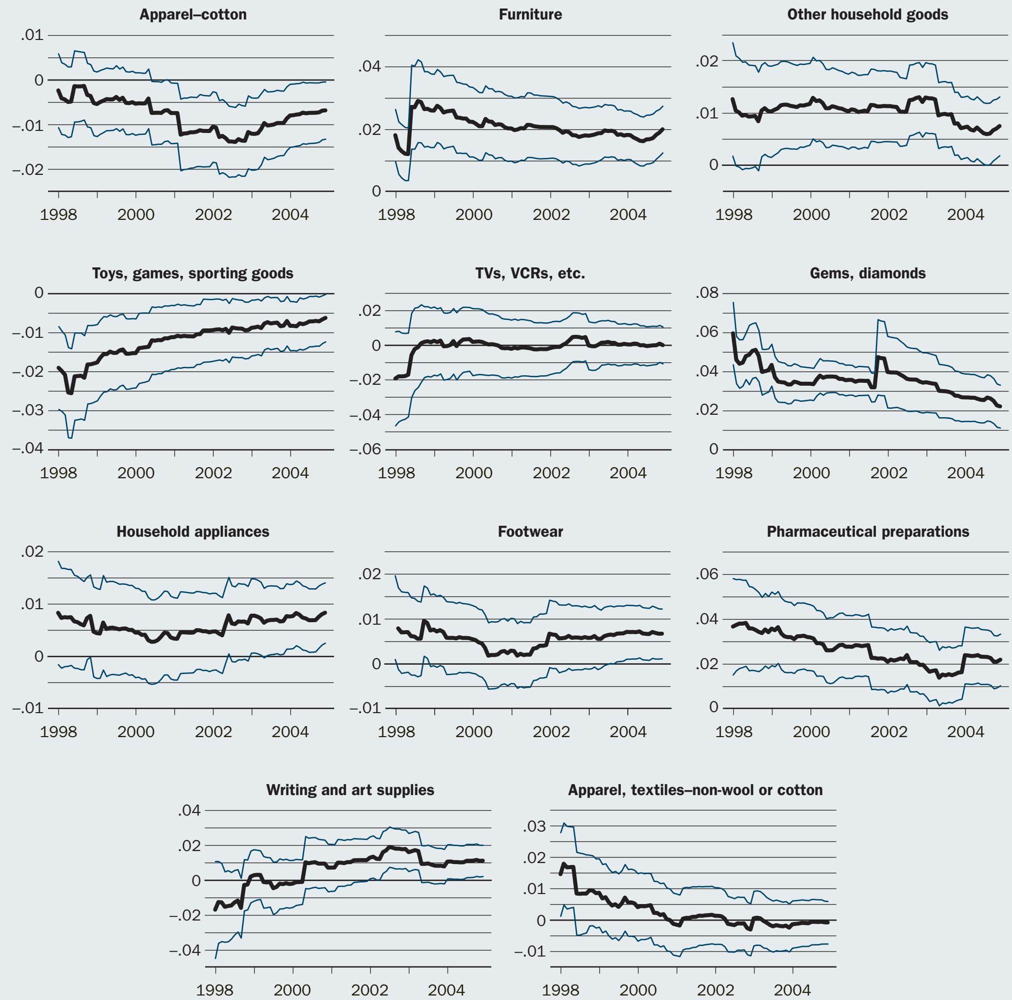
their ERPT coefficients during the last months, but in most of the cases the coefficients are drifting down over the whole period. In the last category, consumer goods, variables are trending down (furniture; other household goods; gems, diamonds; pharmaceutical preparations; and apparel, textiles–non-wool or cotton), up (toys, games, sporting goods and writing and art supplies), or showing no trend (apparel–cotton; TVs, VCRs, etc.; household appliances; and footwear). During the final months of 2004, however, almost all the items show a stable or an upward trend in the ERPT coefficient.

Conclusion

This article seeks to answer the question of why the dollar's depreciation has not stopped the trade deficit from deepening in the past few years. Is it that the products the United States imports have not become more expensive? Or is it that even when imports are more expensive we buy them anyway?

The answer seems to be yes in both cases. On the one hand, prices of capital and consumer goods have not absorbed much of the movements in the exchange rate (either depreciations or appreciations) during the past ten years and consequently have remained fairly stable. On the other hand, even though prices of industrial supplies and materials have been rising, we have continued to import them.

Figure 3d
Evolution of ERPT Coefficients for Consumer Goods, January 1998–December 2004



Note: The graphs show recursive estimations of equation (3), using the PPI/WPI specification from Table 7. The thin lines show one-standard-deviation bounds.

A third question inevitably arises: Will this performance continue in the future? To answer this question, we turn to the analysis of the behavior of some import price indexes during the past decade.

Overall, our results show that exchange rate movements are translated only slightly into changes in the domestic price of imports at a monthly frequency. The ERPT elasticity of total imports' prices averages 18 percent although there is a considerable degree of variation across import categories.

We find that capital and consumer goods consistently have low degrees of ERPT. In these categories, dollar depreciations (appreciations) appear to be matched fairly closely by reductions (increases) in the foreign price of these products. We believe this observation exposes in part the behavior of foreign exporters, suggesting that they alter their profit margins in response to exchange rate changes. Our results also suggest that the dollar's value does not affect either the domestic or the foreign price of the imports of industrial supplies and materials, revealing the absence of a buffering effect from foreign margins.

As previous studies have found, we also find a downward trend in ERPT elasticities for the main import categories (see Taylor 2000; Yang 1997; Swamy and Thurman 1994). However, this trend is not evident at the more disaggregated levels, where a reversion toward higher ERPT may be observed during 2004.

This last observation is crucial for responding to the third question. It suggests that some foreign firms have stopped absorbing exchange rate depreciations. After a long period of a falling dollar, margins have become slim, and the chances of continuing with the same strategy of price adjustment have been reduced (see Greenspan 2005). Hence, to be able to survive, some foreign exporters are likely to start passing through exchange rate depreciations to domestic import prices, and we would then see the cheaper dollar feeding into some domestic import prices. Under this scenario, our response to the third question would be "probably not."

Obviously, we are looking at just one side of the coin. While the capital account remains positive, the current account, and in turn the trade balance, will remain negative. Consequently, the dollar's depreciation might continue, the import bundle might change, and we would still observe low ERPT into the aggregate index of domestic import prices.

Appendix A

Recovering ERPT Elasticities from Regression Coefficients

From equation (2), the coefficient β is the elasticity of domestic import prices to the nominal exchange rate (ERPT):

$$\beta = \frac{d\log P_t}{d\log E_t} = \frac{\frac{1}{p}dP}{\frac{1}{E}dE} = \frac{dP}{dE}\cdot\frac{E}{P} = \eta_{P,E}.$$

The estimated coefficient b_1 in equation (3) is

$$b_1 = \frac{d\Delta\log P_t}{d\Delta\log E_t} = \frac{d\log P_t - d\log P_{t-1}}{d\log E_t - d\log E_{t-1}}$$

$$= \frac{\frac{1}{P_t}dP - \frac{1}{P_{t-1}}dP}{\frac{1}{E_t}dE - \frac{1}{E_{t-1}}dE} = \frac{\frac{P_{t-1}-P_t}{P_{t-1}}}{\frac{E_{t-1}-E_t}{E_{t-1}}}\cdot\frac{dP}{dE}\cdot\frac{E_t}{P_t}.$$

Using the above definition for the ERPT,

$$b_1 = \frac{\frac{\Delta P_t}{P_{t-1}}}{\frac{\Delta E_t}{E_{t-1}}}\cdot\eta_{P,E} = \frac{\Delta P_t}{\Delta E_t}\cdot\frac{E_{t-1}}{P_{t-1}}\cdot\eta_{P,E} \cong (\eta_{P,E})^2.$$

Appendix B
Deriving a Cost Proxy from the IFS Exchange Rate Series

The IFS provides real effective exchange rate (REER) based on unit labor cost. The index is defined as the nominal exchange rate times a ratio of unit labor costs:

$$\text{(B1)} \quad reu = neu \cdot \frac{\omega^*}{\omega},$$

where *reu* is the REER adjusted by labor costs, *neu* is the nominal exchange rate, and ω^* and ω are the foreign and domestic normalized unit labor costs, respectively. These costs are defined as the ratio of hourly compensation in manufacturing to measured labor productivity in that sector:

$$\text{(B2)} \quad \omega = \frac{hw}{\ell}; \quad \omega^* = \frac{hw^*}{\ell^*},$$

where *hw* is the hourly wage and ℓ is the measure of productivity in each sector. Adding up all the sectors, it is possible to obtain an index, ω, for the country's entire manufacturing sector. The IFS reports this index for several countries, based on data availability.

Inserting equations (B2) into (B1) and rearranging the terms, we obtain

$$hw^* = \frac{reu}{neu} \cdot hw \cdot \frac{\ell^*}{\ell}.$$

If we assume that the ratio of productivities among the United States and its major trading partners is not significantly altered during the period under study (normalized to 1), then

$$\frac{\ell^*}{\ell} = 1.$$

Thus, it is straightforward to obtain an expression to estimate the proxy of the exporter's foreign costs:

$$hw^* = \frac{reu}{neu} \cdot hw.$$

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