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Literature and Data Analysis**

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May 2009

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# **HOW DO EXCHANGE RATES AFFECT IMPORT PRICES? RECENT ECONOMIC LITERATURE AND DATA ANALYSIS**

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## **ABSTRACT**

An important issue for industry competitiveness is the extent to which exchange rate changes affect the prices of imported goods. In theory, a weaker dollar should raise the cost of foreign goods for U.S. consumers and reduce the U.S. demand for imports, while boosting foreign demand for U.S. goods. However, between February 2002 and July 2008, the dollar fell by almost 35 percent against a broad index of foreign currencies, while the prices of import commodities showed much less change. This paper reviews some of the recent economic literature as to why import prices change so little relative to a change in the value of the dollar. Explanations discussed include pricing-to-market, currency invoicing, and cross-border production. Using data for 1999 to 2008, the paper estimates exchange rate pass-through to U.S. import prices for all imports excluding oil, and consumer goods, and for imports from Japan, the European Union (EU), Canada, and the NIEs (Taiwan, Singapore, South Korea, and Hong Kong). The exchange-rate pass-through estimates were found to be low (0.26 for all imports excluding oil and 0.18 for consumer goods). The highest estimates of bilateral exchange-rate pass-through were for imports from Canada (.33) and the EU (.24), and the lowest for imports from Japan (.12) and the NIEs (0.0). An exchange-rate pass-through was also estimated for U.S. import prices from China for a small number of observations from mid-2005 to 2008, the period when the yuan fluctuated against the dollar. The estimated exchange-rate pass-through of 0.41 must be taken with a degree of caution, due to the small sample (14 observations).

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## Introduction

Between February 2002 and July 2008, the dollar fell by almost 35 percent against a broad index of foreign currencies, while the prices of import commodities showed much less, or very little change. For example, the U.S. Department of Labor (DOL), Bureau of Labor Statistics (BLS) price index for all imports excluding petroleum rose by 20 percent, while the price index for imported consumer goods rose by a mere 6 percent.<sup>1</sup> Economists have generally found that prices of imported goods do not usually respond with one-to-one to changes in the exchange rate. This paper will explore some of the reasons why some import prices change so little relative to a change in the value of the dollar.

In theory, a weaker dollar should raise the cost of foreign goods for U.S. consumers, thereby reducing U.S. demand for imports, while boosting foreign demand for U.S. goods by making exports more price-competitive abroad. Thus, a weaker dollar is usually considered to be a key mechanism for increasing the international competitiveness of U.S. producers. However, economic research suggests that the link between the exchange rate and the prices of imported goods is more complex, with fluctuations affecting U.S. import prices to varying degrees, depending on the industry. These studies show that the effect of an exchange rate change depends on firms' price-setting behavior.

This paper examines recent literature and data on the effects of exchange rates on traded goods in the United States. This is an important topic for industry analysis because of the importance of fluctuations in exchange rates for industry competitiveness. Moreover, with the value of the dollar currently reversing course and appreciating against a number of currencies, information on how exchange rate changes affect U.S. production and prices is important to understand future impacts of exchange rates on trade.

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<sup>1</sup> DOL, BLS import price indexes. <http://www.bls.gov/mxp/> (accessed January, 2009).

Exchange rate studies usually focus on the rate of exchange-rate pass-through-- the impact of a change in the exchange rate on prices in the importing country. Pass-through is considered “complete” when the response is one-for-one—e.g., when a 1 percent change in the exchange rate results in a 1 percent change in the import price. A number of exchange-rate pass-through studies have shown that pass-through to U.S. import prices<sup>2</sup> is quite low, and some argue that it has declined in recent years.<sup>3</sup> In addition, pass-through to import prices in many major U.S. trading partners has also been estimated to be less than one, even if somewhat higher than in the United States.<sup>4</sup>

There are three prominent explanations of why exchange-rate pass-through might be low:<sup>5</sup> (1) exporters “price to market” by lowering or raising their profit margins to offset the effects of the exchange rate change; (2) exporters set their prices in the local currency of the importing country and these prices do not fluctuate with the exchange rate, at least in the short run; and (3) cross-border production which leads to lower pass-through when production costs are denominated in different currencies. In addition, Marazzi and Sheets (2007)<sup>6</sup> found a decrease in exchange rate pass-through for product markets in which Chinese exports gained market share, at least through 2004, when the Chinese yuan was pegged to the dollar.

This paper is organized as follows. First, the economic factors determining the extent of exchange-rate pass-through, such as pricing-to-market, currency invoicing, and cross-border trade, are examined in greater detail. The next section reviews econometric estimates of exchange-rate pass-through from recent economic studies. The last section estimates exchange-rate pass-through using recent data from 1999 to 2008 for U.S. aggregate imports (imports excluding oil and consumer goods) and for U.S.

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<sup>2</sup> The price indices examined usually exclude the price of oil, due to its volatility. Some studies also exclude semiconductors and computers, arguing that price determination is different for these industries relative to other consumer goods.

<sup>3</sup> Mishkin (2008). Mishkin’s analysis is based on the work of Marazzi, Sheets, and Vigfusson (2005) and Marazzi and Sheets (2007). On the other hand, Hellerstein, Daly, and Marsh (2006) argue that, although declining, the change has not been very significant.

<sup>4</sup> Ihrig, Marazzi and Rothenberg (2006) estimated an exchange-rate pass-through coefficient for the G-7 countries (Japan, United States, Italy, Germany, France, United Kingdom, and Canada) of 0.4 for the period from 1990-2004.

<sup>5</sup> These are the three main explanations cited by Mishkin (2008). See also Campa and Goldberg (2002) and Marazzi and Sheets (2007).

imports from various U.S. trading partners—Canada, the European Union (EU), Japan, the Newly Industrializing Economies (NIEs—Hong Kong, Singapore, Taiwan, and South Korea). The calculated estimates of exchange-rate pass-through are low, well less than 1, are consistent with other estimates obtained from the literature.

## **Traditional Explanation of Exchange-Rate Pass-Through**

According to standard economic trade theory, if we ignore transport and other border costs, the dollar price of U.S. imports equals the foreign currency export prices converted into dollars ( $E = \$/\text{foreign currency}$ ) for sale in the U.S. market as shown in equation 1 below:

$$(1) P_t^m = E_t P_t^x$$

where  $P_t^m$  is the domestic price in the importing country;

$E_t$  is the nominal exchange rate (domestic currency per unit of foreign exchange); and

$P_t^x$  is the foreign price (in units of foreign currency).

As denoted above, a depreciation of the dollar (increase in  $E_t$ ) must result in a rise in U.S. import prices of the same magnitude, unless there is a decline in the prices foreign producers receive, and vice versa.

The impact of an exchange rate change on import prices is usually defined as the percent change in the local currency import price ( $P_t^m$ ) resulting from a one percent change in the exchange rate between the exporting and importing country ( $E_t$ ). For example, if the dollar falls by 10 percent, equation (1) implies that the import price in the United States in dollars should increase by 10 percent—a pass-through equal to one. If this does not occur, equation (1) suggests that foreign producers must be absorbing some of the decline in the value of the dollar. This is labeled as “incomplete” pass-through of exchange rates to import prices. For example, exporters could lower their export prices by 5 percent. This means that import prices will increase by 5 percent—an exchange rate pass-through of 0.5.

Exchange rate pass-through studies consider the extent to which exchange rate movements are pass-through into trade goods prices, versus absorbed in producer profit margins or mark ups. Why would exporters absorb exchange rate changes in their profit margins? Some of the reasons are discussed below.

## Pricing-to-Market

Krugman (1987) was one of the first economists to suggest that exchange rate changes could be passed through to traded goods prices, or absorbed in producer profit margins or markups (pricing-to-market). Krugman suggested that following a depreciation of an importer's currency, which would otherwise raise the cost of imported goods, the foreign exporter might cut his domestic currency export price to stabilize the price in the importing country's market. This type of strategy could be a temporary one, or a more long-term effort to maintain market share.

The analysis of pricing-to-market considers the following relationships among prices, exchange rates, and costs for differentiated products characterized by monopolistic competition:<sup>7</sup>

$$(2) P_t^m = E_t P_t^x = E_t \text{Mkup}_t^x C_t^x$$

and

$$(3) \text{Mkup}_t^x = P_t^x / C_t^x$$

where  $(C_t^x)$  is the exporters marginal cost, and

$\text{Mkup}_t^x$  is the exporter's markup over marginal cost.

The markup rate could be 2, for example, giving the exporter a profit of 200 percent over marginal cost.

Markup rates are industry specific and depend on the demand curve facing the exporter in a specific country. Exporters facing highly elastic demand curves and competition might reduce their markups in the event the importer's currency depreciates in order to keep importer prices constant and preserve market share. Competition in the import market could arise from domestic producers, or from other import suppliers. On the other hand, an exporter facing few competitors and inelastic demand might

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<sup>7</sup> See, for example, Campa and Goldberg (2002). Pricing-to-market requires differentiated goods so that exporters have a markup over cost to vary with the exchange rate.

pass-through the exchange rate change to maintain his profit margin (markup over cost). However, firms with a high degree of market power might cut into their profit margins (markups), rather than raise prices to prevent new suppliers from entering the market and to avoid the risk of losing market share. The exchange-rate pass-through therefore depends on the structure of demand and competition in the industry.

In the pricing-to-market literature, a question arises as to whether an appreciation of the importer's currency might lead to a higher or lower rate of pass-through than a depreciation. An appreciation of the importer's currency could result in import prices falling and a relatively large exchange-rate pass-through if an exporter wants to build market share. On the other hand, when the importer's currency depreciates, exporters could offset the potential increase in price by reducing their markup to preserve market share.

This question of asymmetric pass-through was studied by Pollard and Coughlin (2004) using import price data for U.S. manufacturing in the aggregate and for 29 individual manufacturing industries. The study included data from 1978 to 2000, when dollar appreciations were more common. Their study found asymmetric behavior for some individual industries, but not for total manufacturing as a whole. According to their estimates, exchange-rate pass-through occurred only when the dollar appreciated (e.g., import prices fell) for apparel, wood products, basic metals, machinery, and "other" manufactured goods. Exchange-rate pass-through occurred only when the dollar depreciated (e.g., import prices rose) for food and beverages and tobacco; paper and publishing; chemicals, refined petroleum, rubber, and plastics. The study found no difference in pass-through for textiles and leather products, nonmetallic minerals (excluding coal and petroleum), fabricated metals, and professional and scientific equipment. The study

also found that import prices were more likely to change in the event of a large exchange rate change (3 percent or greater) than a small change.

## **Cross-Border Production**

The role of cross-border production in exchange-rate pass-through is also evident from equation (2).<sup>8</sup> If firms are using imported inputs, then the exchange rate is also an argument in the exporter's cost function. For example, assume an exporter imports raw materials in dollars that account for 50 percent of production costs, the rest of the production cost is denominated in the exporter's currency, and the dollar depreciates relative to the exporter's currency by 5 percent. The exporter would only have to raise his price by 2.6 percent to generate enough local currency to cover the local costs— an exchange-rate pass-through of .52—because the cost of the raw material is fixed in dollars. If production occurs in several stages in a number of different countries, then production costs are incurred in different currencies. The exchange rate pass-through can be less than 1 as long as all the currencies do not experience the same appreciation/depreciation against the currency of the exporter.<sup>9</sup>

## **Currency Invoicing and Imports**

A closely related phenomenon to the principle of pricing-to-market is local currency pricing (LCP). Exporters can invoice in their own home currency (producer currency pricing—PCP), in the currency of their importer (LCP), or in a third-party currency (“vehicle”currency pricing—VCP).<sup>10</sup> There is a close relationship between PTM and LCP. In the short-run, import prices will stay the same when the exchange rate changes if they are priced in local currency. Thus, invoicing in LCP reduces exchange-rate pass-through, at least in the short run. However, foreign producers could resist increasing the local-currency-denominated prices of their goods in the long term to remain competitive in foreign markets.

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<sup>8</sup> Campa and Goldberg (2002) discuss the role of cross-border production and the exporter's markup.

<sup>9</sup> Mazzani and Sheets (2007).

<sup>10</sup> For a discussion of currency invoicing see Kamps (2006) and Goldberg and Tille (2007).

One of the key decisions that is considered in the choice of currency invoicing is who bears the risk in trade.<sup>11</sup> If exporters use PCP, they avoid any uncertainty in the price they receive for their exports, however the exporter faces demand uncertainty because he does not know how foreign consumers will react to a price change. On the other hand, if the exporter uses LCP, he faces price uncertainty because he does not know the price he will actually receive (in his own currency) when the exchange rate changes.

In theory, if the exporter using LCP adjusts the importer's price to an exchange rate change in the longer run, there should be no difference in exchange-rate pass-through using PCP or LCP, and the pass-through should equal one. However, Gopinath, Itshoki, and Rigobon (2007) suggest that currency invoicing does matter. Using unpublished monthly BLS data for 1994-2005, they estimated the average long-term pass-through for imports priced in dollars to be 0.25, whereas for import goods not priced in dollars, the average pass-through was .95, or almost 1.

According to Goldberg and Tille (2007), exporters consider the competitive structure of the import market in making currency invoicing decisions. Exporters in competitive import markets might prefer to keep their prices stable relative to their rivals and this would argue for LCP. Goldberg and Tille cite this as a "herding" strategy in which the price is set in a currency that is going to keep the demand for the exporter's product relatively stable following an exchange rate change. On the other hand, exporters of highly differentiated products might use PCP because foreign consumers are less likely to shift among various suppliers in the event of a price. The higher the product differentiation and the lower the price sensitivity, exporters will prefer to export in their own currency.<sup>12</sup>

The "herding" strategy also can lead to VCP in which prices are set in a third currency unrelated to bilateral trade. In cases where goods are very close substitutes and consumers can easily shift among suppliers, an exporter may prefer to price in the same currency as the competitors. This is most common in homogeneous commodities, such as metals, minerals, and agricultural commodities, which are

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<sup>11</sup> Kamps (2006) discusses the role of risk in currency invoicing in greater detail.

<sup>12</sup> Kamps (2006) also discusses the various factors affecting currency invoicing decisions.

commonly priced in dollars. Goldberg and Tille cite the low transaction costs and variability in the value of the dollar as factors contributing to the widespread use of the dollar as a vehicle currency.

Because commodity prices are usually set in U.S. dollars, it has been common to report pass-through estimates for consumer goods, or by individual industries, or in the aggregate by including commodity prices in estimated pass-through equations to control for such changes.<sup>13</sup> Commodity prices are highly correlated with changes in the dollar, and are expected to rise when the dollar declines and vice versa.<sup>14</sup> Thus, commodity prices have an indirect effect on exchange rate pass-through to import prices. Pass-through models that control for commodity prices have found that aggregate exchange-rate pass-through is lower compared to estimates that do not control for commodity effects.<sup>15</sup> Mazzani, Sheets, and Vigfusson(2005) estimate that a 1 percent depreciation of the dollar resulted in a 0.8 percent rise in dollar-denominated commodity prices using data from 1972 to 2004.

Data on the use of home currencies in invoicing exports and imports among various countries indicate that the amount of U.S. trade invoiced in the home currency (U.S. dollars) is much higher than the use of home currencies in other countries (figure 1). In regard to imports, Gopinath, Itshoki, and Rigobon (2007) report that in 2004, 93 percent of U.S. imports were priced in dollars, up from 88 percent in 1994.<sup>16</sup> This indicates the strong presence of LCP in U.S. imports. The BLS data also indicated that the share of U.S. imports in the exporter's currency varies by country, with 34 percent from Germany, 13 percent from Japan, and none from developing countries.<sup>17</sup>

The use of the dollar for U.S. exports and as a vehicle currency is shown in figure 2 where for many countries the use of the dollar far exceeds the share of exports destined for the U.S. market. In particular, countries such as South Korea and Thailand use the dollar in over 80 percent of their exports.

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<sup>13</sup> See Mazzani and Sheets (2007) and Hellerstein, Daly, and Marsh (2006).

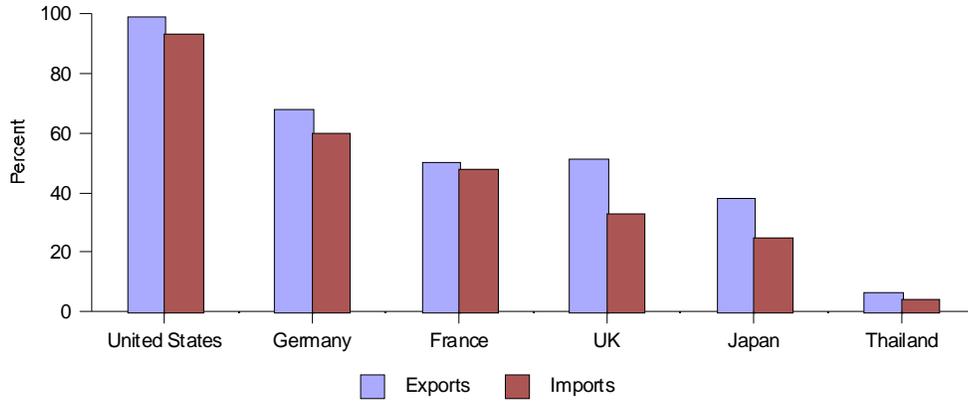
<sup>14</sup> Hellerstein, Daly, and Marsh (2006), p. 6.

<sup>15</sup> Hellerstein, Daly, and Marsh (2006), and Mazzani and Sheets (2007). Their estimates are for U.S. data.

<sup>16</sup> Gopinath, Itshoki, and Rigobon (2007), p. 6.

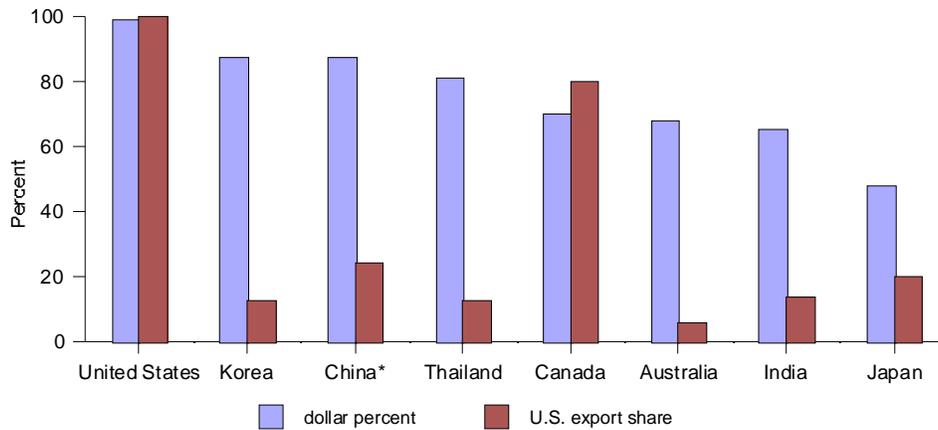
<sup>17</sup> Ibid., p. 4.

**FIGURE 1** Home Currency Invoicing: Exports and imports, various countries, 2003-07



Source: Kamps; Goldberg and Tille; and Bank of Thailand.

**FIGURE 2** Exports: Dollar invoicing, various countries, 2003-2007 and U.S. share of exports, 2007



\*Data are for Chinese exports of textiles only

Source: Goldberg and Tille; Bank of Thailand; Kamps; Bernard; and GTIS, Global Trade Atlas Database.

Goldberg and Tille (2007) note the use of the dollar as a common vehicle currency in exports of manufactures, particularly among Asian countries, and the implications for U.S. export competitiveness. For example, if trade among Asian countries is denominated in dollars, a depreciation of the dollar boosts U.S. exports to Asia, with no contraction in Asian exports to the United States, and it boosts Asian exports that are denominated in dollars. Goldberg and Tille (2007) point out that the use of the dollar as a vehicle currency in international trade can work to limit the response of U.S. exports to a dollar depreciation.<sup>18</sup>

## **Estimates of Exchange-Rate Pass-Through**

Numerous economic studies have examined the extent of exchange-rate pass-through to import prices both in the United States and in foreign countries. These studies measure the sensitivity of movements in merchandise import prices to changes in the U.S. dollar (for exchange-rate pass-through in the U.S. market), after controlling for other factors that influence the evolution of import prices, such as foreign production costs, and in some cases, commodity prices. The following provides a summary of recent studies that have analyzed exchange-rate pass-through and exporter behavior in response to exchange rate changes.

### ***Pass-through in the U.S. Market***

Most exchange rate studies have documented that the exchange rate pass-through to U.S. prices is low, and some have estimated that it has declined in recent years. Using data from 1981 to 1999 for a cross section of manufacturing industries covering 75 percent of non-energy commodities imported into the United States, Olivei (2002) estimated the pass-through rate for the United States to be about 40 percent. However, he estimated the average pass-through to be 0.50 in the 1980's and 0.25 in the 1990s.

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<sup>18</sup> Note that non-U.S. exporters that denominate their products in dollars still have to rebate some part of dollars into local currency to account for local costs. Thus eventually, non-U.S. exporters may have to raise their dollar-denominated prices to account for the fact they will get less local currency when the dollar depreciates against their currencies.

This means that in the 1990s a 10 percent depreciation of the dollar should result in a 2.5 percent increase in import prices of manufactured goods, all other things held constant. Olivei found that there is variation in pass-through, with such industries as primary metals, nonelectrical machinery, and instruments and related products, having higher pass-through.

The more recent study by Marazzi, Sheets, and Vigfusson (2005) documents low and declining pass-through using a data sample from 1972 - 2004. In their analysis, the U.S. pass-through rate fell from 0.7 for a 10-year sample ending in the 1980s, to 0.5 for the 10-year sample ending in the mid-1990s, to 0.12 for the sample ending in the last ten years of the study. The pass-through rates are average responses based on U.S. prices for imports less energy products, computers, and semi conductors, holding commodity prices constant.<sup>19</sup> The exchange rate pass-through for the more recent period including commodity price effects was estimated to be 0.3.<sup>20</sup> The authors also found that exchange rate pass-through tends to occur quite rapidly, with the contemporaneous coefficient and one lag accounting for most of the exchange rate pass-through.<sup>21</sup> The authors cite the increasing role of China in the U.S. market as one of the factors likely contributing to the low exchange-rate pass-through in recent years.

Hellerstein, Daly, and Marsh (2006) estimated aggregate-level exchange-rate pass-through into U.S. prices to be 0.51 using data on imports less petroleum products from 1985 to 2005 (quarter 2) and 0.36 holding commodity effects constant. They also estimated the exchange-rate pass-through at 0.46 from 1995 to 2005 (0.13 holding commodity effects constant).<sup>22</sup> In contrast, to Marazzi, Sheets, and Vigfusson, they found a smaller decline in exchange-rate pass-through, 10 percentage points, in two sub-periods, 1985-94 and 1995-2004, and argue that the difference is not statistically significant. They argue that changes in BLS import price sampling methods to include more data on intrafirm transactions in 1998 could account for some of the decline in estimates of U.S. exchange-rate pass through. Their study

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<sup>19</sup> The authors eliminated petroleum products due to their high price volatility, and computers and semiconductors because it is argued that their prices behave differently due to hedonic price adjustments. However, they note that excluding computers and semiconductors did not significantly affect the results as compared to including these products.

<sup>20</sup> Marazzi, Sheets, and Vigfusson (2005), 3.

<sup>21</sup> Marazzi, Sheets, and Vigfusson (2005), 24.

<sup>22</sup> Hellerstein, Daly, and Marsh (2006), 3.

did find some declines in exchange-rate pass-through for specific industries, such as road vehicles; computers and telecommunications equipment; toys and miscellaneous manufactures; apparel; stone, glass and other nonminerals; furniture; and beverages and tobacco between their two sub-periods.

### ***Behavior of Exporters and Exchange Rate Pass-Through***

As noted earlier, if pass-through is low, exporters are absorbing changes in exchange rate adjustments in their profit margins by adjusting their export prices to offset the effects of the exchange rate change. A number of studies have analyzed the behavior of exporters and how they react to exchange rate movements in the U.S. market. These studies have generally found that export prices are tend to be more sensitive for exports to the U.S. market, thus indicating that PTM or LCP behavior.

Marazzi, Sheets, and Vigfusson (2005) estimated the impact of the U.S. dollar exchange rate on export prices (denominated in the exporter's currency) charged in the U.S. market and found that export prices tend to be relatively more sensitive for exports to the U.S. market. Analyzing export prices for the EU, Canada, Japan, the United Kingdom, and the Asian NIEs, the study found that a 10 percent appreciation of the exporter's currency against the dollar was associated with a 7 percent to 8 percent decline in export prices charged in the U.S. market. This means that U.S. import prices increase 2 to 3 percent—or a pass-through of 0.2 to 0.3. In contrast, the study found that the same exporters vary their export prices to all markets on average 3 percent to 5 percent in response to an exchange rate change. This result means that import prices increase 5 to 7 percent, on average, to all markets in the event of an appreciation of the exporter's currency—a pass-through of 0.5 to 0.7.

Parsons and Sato (2008) investigated exchange rate pass-through by Japanese exporters for three destinations: the United States, the EU, and East Asia using Japanese 9-digit HS data for 27 manufactured products. They examined the change in the Japanese export price (in yen) in response to a bilateral change in the exchange rate using data from 1988 to 2005. The currencies used by Japanese exporters for invoicing exports affected the estimated pass-through coefficients. They noted that the United States largely imports in dollars, but the EU tends to import from Japan in euros, with the yen and dollar

occupying smaller shares. In East Asia, approximately 50 percent of Japanese exports are denominated in yen, but exports in U.S. dollars are also common.

Regression results showed PTM behavior to be more common in the United States, and to a lesser extent the EU. In contrast, they found exchange-rate pass-through to be relatively high in East Asia, meaning that Japanese exporters did not tend to vary their export prices to this group in the event of a bilateral exchange rate change. Parsons and Sato hypothesized that while PTM may not be occurring in the destination currencies in East Asia, Japanese exporters may set their export prices in the region in relation to world prices denominated in dollars. They found PTM in automobiles, and transportation and related parts exports both in the EU and the United States. In addition, they found PTM behavior in steel in the U.S., EU, and the East Asian market.

Fukuda and Ono (2004) investigated the stability of Korean export prices for 19 commodities against changes in the U.S. dollar, Japanese yen, and euro versus the Korean won from 1998 to 2002 using regression analysis. The purpose of this study was to show how the use of a dominant vehicle currency (the dollar) for invoicing exports affects Korean export prices. As noted earlier, payments in U.S. dollars are dominant in East Asian trade. Fukuda and Ono's results showed that export prices in Korea have high correlation with the U.S. dollar (0.837 meaning that a 1 percent change in the won/dollar exchange rate is associated with a 0.8 percent change in won export prices), and modest correlation with the yen and the euro. Moreover, they showed that Korean export prices were highly correlated in terms of the U.S. dollar even in commodities for which Japan had the largest export market share.

Fukuda and Ono's results are consistent with LCP and low ERPT to the U.S. market.<sup>23</sup> They also argue that Korean exporters may choose to sell their products in U.S. dollars since their products are less differentiated and competitive pressures may lead to exporting firms choosing to invoice in dollars, even if the United States is not a trade partner.

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<sup>23</sup> For example, assume the dollar depreciates against the Korean won. If Korean prices are set in U.S. dollars, then we would expect that Korean export prices in won to fall with the dollar depreciation.

## *Exchange-Rate Pass-Through and China*

Bernard (2008) examined the role of exchange rates on Chinese firms, specifically, textile and apparel exporters based on an original survey of over 230 firms in 2006. This study found that Chinese exporters of textiles and apparel receive the majority of their export revenues in dollars (88 percent), while the United States accounts for roughly 24 percent of sales.<sup>24</sup> According to Bernard, the intense competition in textile and apparel markets makes the dollar an attractive vehicle currency, but combined with low margins on exports, places many Chinese firms in a position of substantial exchange rate risk. The study suggests that the most likely response of Chinese textile and apparel exporters in the event of an appreciation of the yuan is to raise export prices due to the lack of alternatives to minimize exchange rate risk.

## **Dollar Exchange Rate Changes and Import Prices: Data Analysis**

Data on U.S. dollar exchange rate changes, aggregate import prices, and prices of U.S. imports from Japan, the NIEs, China, the EU, and Japan are shown in appendix figures A.1 to A.6. Data are import price indices from the BLS and exchange rate data are from the Federal Reserve Board.<sup>25</sup> The exchange rate is dollars per foreign currency unit so that an increase in the exchange rate represents a depreciation of the dollar. One would expect a positive correlation between the exchange rate and import price changes. All data are in natural log first differences, reported on a quarterly basis. The figures show how import price changes have moved with U.S. exchange rate changes from 1999 to 2008. The data do

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<sup>24</sup> Bernard (2008), 6-7.

<sup>25</sup> Board of Governors of the Federal Reserve System, Foreign Exchange Rates.

not take account possible lags in the effect of exchange rate changes on import prices and they do not control for movements in import prices that are unrelated to changes in the exchange rate.

Estimated exchange-rate pass-through coefficients using the data from the appendix figures are shown in table 1. The estimated pass-through coefficient for China should be taken with a degree of caution, as there were only 14 observations available for estimation. The method of estimation, ordinary least squares (OLS), is discussed in Box 1 and the actual regression results are shown in Appendix tables 1 and 2.

**TABLE 1** U.S. imports: Exchange-rate pass-through, 1999-2008

<b>Imports</b>	<b>Products</b>	<b>Exchange-rate pass-through estimate<sup>a</sup></b>	<b>Standard error</b>
All countries	Imports less oil <sup>b</sup>	0.38***	0.133
All countries	Consumer goods	0.20***	0.064
Japan	All products	0.12***	0.038
EU	Manufactures	0.24***	0.066
Canada	Manufacturers	0.33**	0.125
NIEs	All products	0.00	0.011
China <sup>c</sup>	All products	0.41*	0.198

*Source:* Estimated using data from DOL, BLS and the Board of Governors of the Federal Reserve.

<sup>a</sup>Quarterly observations. Estimates are long-run, except for China. Coefficients give the percent change in import price for a 1 percent change in the exchange rate.

<sup>b</sup>Excludes petroleum and petroleum products.

<sup>c</sup>Estimated with only 14 observations, Q3 2005-2008.

\* = significant at the 10 percent level

\*\* = significant at the 2 percent level

\*\*\* = significant at the 1 percent level

**BOX 1** Estimation of exchange-rate pass-through

Based on Campa and Goldberg (2002) and Hellerstein, Daly, and Marsh (2006), the following equation was estimated to obtain the exchange-rate pass-through estimates:

$$P_t = \alpha + \sum_{i=0}^{i=3} a_i E_{t-i} + \sum_{j=0}^{j=3} c_j wp_{t-j} + d_t(\text{U.S. GDP}_t) + \varepsilon_t$$

where:  $P_t$  is an index of U.S. import prices in period  $t$ ;  $\alpha$  is a constant;  $E_{t-i}$  is the U.S. exchange rate (broad-based or bilateral with the specific country, in dollars per foreign currency unit) at time  $t$  minus  $i$ ;  $wp_{t-j}$  is a control for price movements that affect import prices independently of the exchange rate in period  $t-j$ ; U.S.  $GDP_t$  is U.S. gross domestic product (volume basis) in period  $t$  and is included to account for any systematic effects of U.S. demand on import prices; and  $\varepsilon_t$  is a regression error term. The import prices are obtained from the BLS and exchange rates are from the Federal Reserve Board. The variable  $wp_{t-j}$  is measured as foreign wholesale (producer) prices in all equations except the U.S. aggregate import equations (all commodities except oil and consumer goods) where  $wp_{t-j}$  is measured as the percent change in the average world consumer price index. The foreign price indexes and the U.S. GDP data are from the International Monetary Fund, *International Financial Statistics*. All variables are in logarithm first differences, except the world consumer price, which is on a percentage change basis. The exchange rate and the domestic price variables for the NIEs are trade-weighted averages. The exchange rate and foreign price variables are entered in the equations for the current period and with 3 lags. The equations were estimated using ordinary least squares with a correction for serial correlation.

The estimated exchange-rate pass-through for aggregate U.S. imports less oil is very close to the estimate of Marazzi, Sheets, and Vigfusson (2005) and Hellerstein, Daly and March (2006), which were estimated for different time periods. The exchange rate pass-through for consumer goods is slightly higher than the previous studies and includes a period when the Chinese yuan was appreciating against the dollar.

The exchange-rate estimates show a higher pass-through for manufactured imports from Canada and the EU relative to Japan, which is consistent with the study by Parsons and Sato (2008). Most of the exchange rate pass-through for Japan is was found to take place in the first and third quarters. The non-existent exchange-rate pass-through found for the NIEs is consistent with the study by Fukuda and Ono (2004) which showed that East Asian countries tend to set their export prices in dollars across export

markets. The equation for U.S. imports of manufactures from Canada shows a strong relationship with changes in the Canadian producer price index. This may reflect the close relationship between U.S. and Canadian manufacturing and components in terms of imports and prices.

Exchange-rate pass-through was estimated for China, but the regression only includes 14 observations from mid-2005 through the last quarter of 2008. This period corresponds to when the Chinese yuan was allowed to fluctuate against the dollar starting in mid-2005. The estimated exchange-rate pass-through is 0.41, but it must be used with caution because of the small number of observations. The OLS regression for China includes only a one-period lag of the exchange rate and China's producer price index, as well as U.S. GDP. The lags are consistent with Chinese use of LCP in the U.S. market. According to Koopman, Wang, and Wei (2008), some exports from China, such as electronics goods, have very low Chinese value-added. The estimate is consistent with Bernard (2008) who argues that Chinese exporters of products with higher value added have less experience in mitigating exchange rate risk than other Asian exporters and would need to raise export prices over a period in which the yuan would be rising against the dollar.

## **Conclusions**

This paper has examined some of the reasons why U.S. dollar exchange rate changes could result in low pass-through to U.S. import prices. This is an important issue for U.S. trade competitiveness because if exchange rate changes are fully passed through to U.S. import prices, such exchange rate changes could result in increased costs (exchange rate depreciation) or increased competitiveness (dollar appreciation) of domestic producers relative to foreign suppliers. Some of the economic explanations for low exchange-rate pass-through include pricing-to-market, dollar invoicing, and global sourcing. Both

the economic literature, and the data compiled in this report, indicate low exchange-rate pass-through to U.S. import prices, particularly for consumer goods.

Estimates of exchange-rate pass-through in this paper may provide useful information when analyzing the effect of exchange rate changes on U.S. import prices and competitiveness. The estimates indicate that exchange-rate pass-through is low, and varies by import source. The lowest exchange-rate pass-through was found for imports from Asian countries, the NIEs and Japan. Exchange-rate pass-through appears to be highest for the EU and Canada. The higher rate of exchange-rate pass-through for Canada, and a significant association with the Canadian producer price index, may be linked to the interrelated manufacturing processes between Canada and the United States, although this is not explored in the paper.

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**Appendix Table 1** Estimation results for exchange-rate pass-through to U.S. import prices:<sup>a</sup>

	Imports less oil <sup>b</sup>	Consumer goods	Imports from:			
			Canada	EU	Japan	NIEs
U.S. GDP	0.153 (0.306)	-0.143 (0.120)	-0.047 (0.327)	-0.017 (0.275)	0.756 (0.141)	0.055 (0.041)
Foreign price	0.008 (0.006)	0.004 (0.003)	1.203*** (0.304)	0.434 (0.298)	0.281* (0.151)	0.173*** (0.035)
Exchange rate	0.382*** (0.133)	0.205*** (0.064)	0.331** (0.125)	0.238*** (0.066)	0.118*** (0.038)	0.001 (0.011)
Constant	0.000 (0.002)	0.001 (0.001)	0.001 (.003)	0.000 (0.004)	-0.002 (0.001)	-0.002*** (0.000)
N= 39						
R-sq	0.71	0.58	0.82	0.78	0.60	0.77
R-sq adj	0.59	0.44	0.74	0.69	0.44	0.68

*Source:* Author's calculations using OLS regression.

<sup>a</sup>Quarterly observations. Estimates are long-run. Exchange rate coefficients give the percent change in import price for a 1 percent change in the exchange rate. Standard errors are in parentheses. Data are in log differences or percent change.

<sup>b</sup>Excludes petroleum and petroleum products.

\* = significant at the 10 percent level

\*\* = significant at the 2 percent level

\*\*\* = significant at the 1 percent level

**Appendix Table 2** Estimated exchange-rate pass-through to U.S. prices of imports from China:<sup>a</sup>

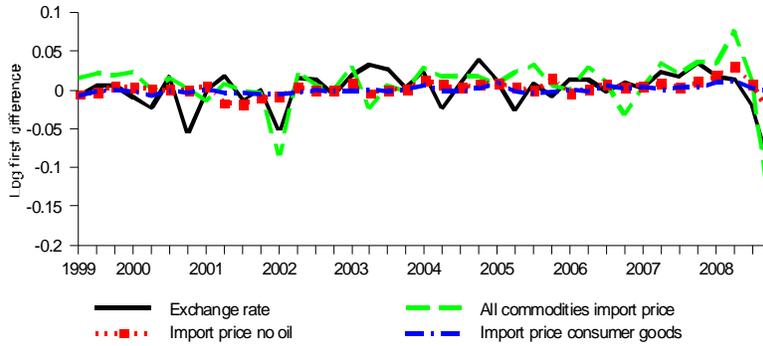
Independent variable	Estimated coefficients and standard errors
U.S. GDP	0.475*
	(0.199)
China producer price (-1)	0.289
	(0.174)
Exchange rate(-1)	0.407*
	(0.198)
<hr/>	
N = 14	
R-sq	0.72
R-sq adj	0.62

Source: Author's calculations using OLS regression.

<sup>a</sup>Quarterly observations. Exchange rate coefficient gives the percent change in import price for a 1 percent change in the exchange rate. Standard errors are in parentheses. Data are in log differences or percent change. The exchange rate and producer price variables include 1 lag only.

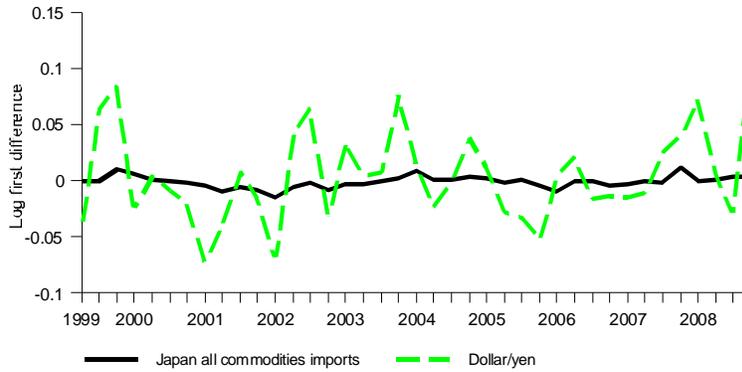
\* = significant at the 10 percent level.

**FIGURE A.1** Change in U.S. exchange rate and U.S. import prices, 1999–2008



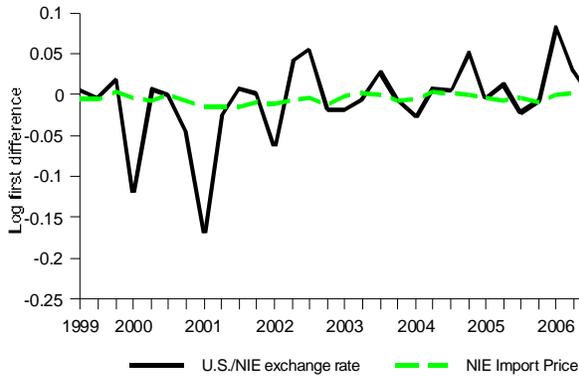
Source: DOL, BLS and Federal Reserve Board. U.S. dollars per foreign currency in terms of a broad basket of currencies.

**FIGURE A.2** Change in U.S. dollar/yen exchange rate and U.S. import prices from Japan, 1999–2008



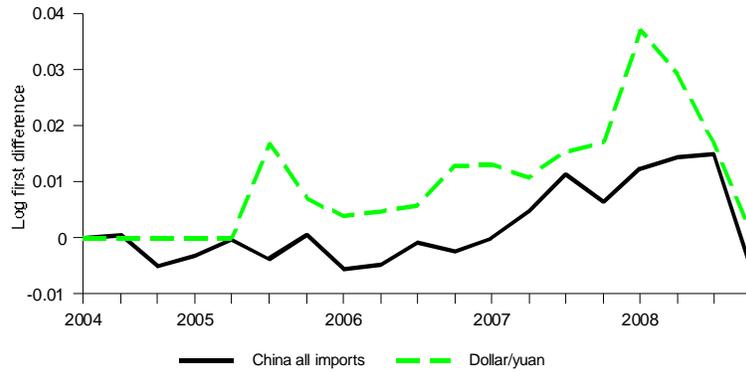
Source: DOL, BLS and Federal Reserve Board. U.S. dollars per yen.

**FIGURE A.3** Change in U.S./Asia NIE exchange rate and NIE import prices, 1999–2008



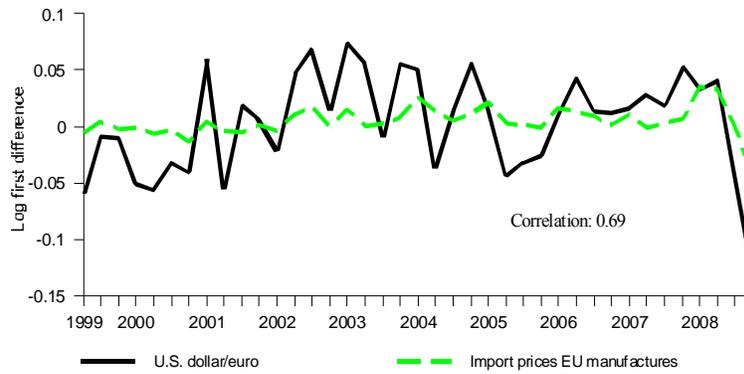
Source: DOL, BLS and Federal Reserve Board. NIEs include South Korea, Taiwan, Singapore, and Hong Kong. Exchange rate is trade-weighted average using one-year lagged chain.

**FIGURE A.4** Dollar/yuan exchange rate and U.S. import prices from China, 2004–2008



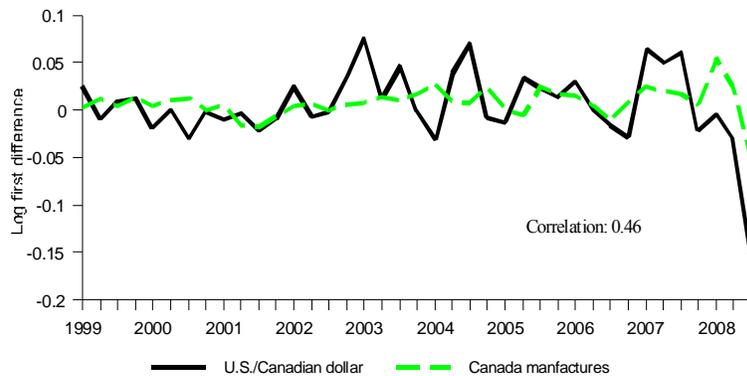
Source: DOL, BLS and Federal Reserve Board.

**FIGURE A.5** Change in dollar/euro exchange rate and U.S. import prices from the EU, 1999–2008



Source: DOL, BLS and Federal Reserve Board.

**FIGURE A.6** U.S./Canadian Dollar exchange rate and Canadian import prices, 1999–2008



Source: DOL, BLS and Federal Reserve Board.