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Abstract

Exchange rate pass-through (ERPT) is broadly defined as the percentage change in domestic prices in the importing nation's currency due to a one percent change in the exchange rate between the trade partners. While the bulk of the literature to date on ERPT has focused on the US and other industrial countries, this paper examines the analytical and empirical literature on ERPT with particular reference to Asia. It is generally believed that since Asian economies are highly trade-dependent they are potentially susceptible to ERPT into domestic inflation. Particular attention is paid to production sharing -- which is a key characteristic of trade in Asia -- and its consequent implications for ERPT.

Keywords: Asia, Exchange Rate Pass-through (ERPT), Market share, Pricing-to-Market (PTM), Production Sharing

JEL Classification: *E31, F31, F41, O53*.

1. Introduction

Exchange rate pass-through (ERPT) refers to the transmission of exchange rate changes into import (export) prices of specific goods in the destination market currency price of goods. ERPT is said to be partial or incomplete if the import price rises by less than 1 percent, as the exporters absorb a portion of the exchange rate change. This may arise, for instance, because firms engage in pricing-to-market (PTM), which effectively implies that firms with market power in a segmented market are able to sell the same product at different prices in different markets (Dornbusch 1987, Krugman 1987; also see the survey by Goldberg and Knetter 1997).

The issue of ERPT is particularly important in view of its policy implications for small and open economies. Specifically, if ERPT is low, use of any exchange rate based adjustments to improve the trade balance for these economies may be rendered less effective, an issue that has been of some concern in the case of the persistent US trade deficit despite secular declines in the US dollar.[1] Conversely, low ERPT implies that small and open economies may be less concerned about the potential inflationary consequences of exchange rate fluctuations.[2] The degree of ERPT has implications for transmission of shocks in Asian nations characterized by high levels of intra-regional trade.

While ERPT is most appropriately analyzed at the disaggregated micro level, the term is often also examined at a much broader macro level, i.e. how exchange rate

[1] Of course, there may be other real sector consequences of exchange rate changes via, for instance, balance sheet effects.

[2] Low ERPT also has implications for the transmission of shocks (for instance, see Betts and Devereux, 2001).

changes feed into the aggregate import prices or even the overall consumer price index (CPI) or wholesale price indices (WPI). ERPT into CPI and WPI is typically lower than ERPT into import prices. This is because they include non-tradables and wholesalers and retailers in the importing nation change domestic prices and absorb most of the exchange rate change in their profit or loss margins.

The bulk of the ERPT literature to date has been focused on the US and other industrial countries. However, given the extent of openness of Asian economies to international trade flows, the factors determining the extent of ERPT into domestic prices is naturally a key area of policy interest to the region. This paper examines the analytical and recent empirical literature on ERPT with particular reference to Asia. The present analysis attempts to survey and synthesize the existing findings. We also outline some further areas of research in ERPT pertinent to Asia. The remainder of the paper is organized as follows. The next section offers an overview of the determinants of ERPT. Section 3 first develops a simple framework to analyze EPRT and then goes on to review some of the empirical literature on ERPT in Asia. Section 4 considers the issue of production sharing, which is a key characteristic of trade in Asia, and its consequent implications for ERPT. Section 5 offers a few concluding remarks on areas for future research.

2. What does the Analytical Literature on ERPT Tell us?

There is a voluminous body of literature which has helped rationalize the factors that affect the extent of ERPT into domestic prices.

First, at the micro-level is the nature of the goods/industries under consideration. If exporters do not face much competition then mark-ups/prices of the exporters may be somewhat less responsive to fluctuations in the value of the exporter's currency against the buyers. In this situation exchange rate changes are fully passed on to the buyers' currency (see Section 3.1 for a simple formalization of this). Conversely, if the destination market is highly competitive, firms may try and guard their market share by absorbing exchange rate changes by accepting lower mark-ups. The willingness to accept lower domestic unit prices in turn leads to lower levels of ERPT. In a pioneering study, Knetter (1993) found differences in industries to be critical in explaining different degrees of ERPT. For example, exports to certain US industries such as autos, alcoholic beverages showed higher PTM and corresponding lower ERPT as exporters try and maintain market share. More broadly, studies have consistently found that manufactured goods experience lower ERPT than agriculture products (Campa and Goldberg 2005; also see Marazzi et al. 2005).

Second is the duration of exchange rate changes. For instance, Meurers (2003) undertake Blanchard-Quah decompositions to identify permanent and temporary exchange rate changes in the US, Japan, Germany, France and Italy. The author finds that ERPT tends to be almost complete in the long run with persistent exchange rate shocks. On the other hand, if the exchange rate change is temporary (depreciation in the importing country, for instance), an exporter may be more willing to accept a temporary cut in profit margins to maintain market share given the possibility of hysterisis effects (also see Froot and Klemperer 1989).

Third is the direction of exchange rate changes. The existing literature suggests that the response of exporters to exchange rate changes is often asymmetric, depending on whether the exchange rate appreciates or depreciates. A weakening of the destination market's currency causes the exporter to reduce its export price and keep the importing nation's product price more or less stable, consequently implying lower ERPT. However, when the exporters' currency depreciates, exports become relatively cheaper in the destination market. This may create an incentive for exporters to maintain their export prices or, in some cases, even to reduce their own currency price and amplify the impact of their currency depreciation (so as to gain market share), leading to a higher ERPT (Pollard and Coughlin 2003, Madhavi 2002).

Fourth is the size of the exchange rate changes. When the magnitude of the exchange rate change is small, firms are generally willing to absorb it and keep domestic prices unchanged due to the costs associated with changing prices. Apart from the actual menu costs of small and frequent price variations, according to Krugman (1987), when a firm announces a price it has to honor its announcements. Thus, the unexpected changes in costs caused by temporary fluctuations that are not "too large" may not be passed on in terms of higher prices as firms do not want to lose reputation.[3] The importance of the size of exchange rate changes on ERPT into import prices in the US has been empirically confirmed by Pollard and Coughlin (2003) and others.

[3] If large exchange rate changes lead to sharp contractions (for instance, because of balance sheet effects following devaluation), there is less likely to be much if any ERPT (see Burnsetin et al. 2002). Thus, Goldfajn and Werlang (2000) also emphasize the importance of business cycles in determining the extent of ERPT, i.e. firms are more willing to pass-through increases in costs during a boom.

Fifth, the degree of ERPT into aggregate import prices may be affected by various macroeconomic variables. A recognized fact has been the general decline in the extent of ERPT in many years since the late 1980s for industrial countries. Following Taylor (2000), it is generally believed that ERPT rates are endogenous to a nation's monetary policy and monetary stability. The more stable is a country's monetary policy and the lower its inflation the lower will be the extent of ERPT. This thesis has been confirmed by Gagnon and Ihrig (2004) using macro level data for industrial countries as well as by Choudri and Hakura (2006), Frankel et al. (2005) and others. In related work, Devereux and Engel (2001) argues that if exporters set their prices in the currency of the country that has stable monetary policy (i.e. local currency pricing as opposed to producer currency pricing), then ERPT into import prices in local currency terms will be low for countries with low monetary and exchange rate variability.[4]

Campa and Goldberg (2005) test the importance of changes in macroeconomic variables and the extent of ERPT into aggregate import prices for 25 OECD nations for the period 1975-1999. The authors find that the lower the average rate of inflation and the less variable is the exchange rate, the lower is the corresponding extent of ERPT. However, these macro factors play a minor role in affecting ERPT compared to the changing composition of a nation's imports away from raw materials and energy imports towards manufacturing imports. Otani et al. (2003) also highlight the importance of changing product composition as being among the main factors in explaining differing

[4] There is a burgeoning literature on the issue of "Local currency pricing" (LCP) which is a mainstay of the New Open economy macroeconomics. Closely related to the issue of LCP is the choice by firms to hedge against exchange rate changes (for instance, see Mann 1986).

rates of ERPT over time in Japan, while Marazzi et al. (2005) stresses its importance in the case of the US.[5]

In addition to the above, it is generally acknowledged that ERPT tends to be greater in lower income economies and relatively smaller and more open ones where there is a high share of traded goods, high import content,[6] limited domestic substitutes (thus limiting the extent of "flight from quality" *a la* Burnstein et al. 2007), and high degree of integration with the global trading system.[7] This inevitably makes much of developing Asia potentially more vulnerable to ERPT than other parts of the world, particularly vis-à-vis industrial countries.[8] We turn to Asia specifically in the next section.

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[5] In addition to changing product composition, the authors also emphasize the role of competition from China as being a factor limiting the extent of ERPT into US import prices. In fact, Marazzi et al. (2005) do not find either the size of direction of exchange rate movements as having been significant determinants of import prices pass-through in the US. Ganapolsky and Vilan (2005) also do not find evidence of this asymmetry in the case of US import prices between 1993: M12 and 2004: M12.

[6] However, if the country is simultaneously importing and exporting to the same country, ERPT will be lower. See Sections 3.1 and 4.2 for a formalization of this.

[7] Using a data set on the cross-country (76 countries) prices of 8 specific goods (Marlboro Cigarettes, Coca Cola, Cognac, Gilbey's gin, Time Magazine, Kodak Color Film, Cointreau Liqueur and Martini & Rossi Vermouth) for the period 1990-2001, Frankel et al. (2005) test some of the foregoing factors. They arrive at the conclusion that while there is strong evidence that ERPT is slower and smaller in lower income countries, there is much weaker evidence in relation to the size effects. They also find transport and tariff barriers to have been important factors determining the extent of ERPT.

[8] It is harder to say *a priori* whether Asia is potentially more susceptible to ERPT than Latin America in view of the relatively lower degree of monetary stability and higher consequent inflation rates in the latter. For instance, in a 71-country panel study of transmission of exchange rate changes into consumer prices between 1980 and 1988, Goldfajn and Werlang (2000) find ERPT to be highest in Latin America. Kamin and Klau (2003) find broadly similar regional differences in the extent of ERPT.

3. What does the Empirical Literature on ERPT in Asia Tell us?

Given the extent of openness of Asian economies to international trade flows, the factors determining the extent of ERPT into domestic prices and inflation is naturally a key area of policy interest. Nonetheless, while many of the foregoing hypotheses have been tested in the US and industrial country contexts, relatively sparse work has been undertaken for Asia. In what follows below we highlight some of the relatively recent empirical literature on ERPT in Asia. We first discuss studies using aggregate studies then focus on more disaggregate or industry-specific studies. As will be apparent, the survey of studies includes both EPRT of imports as well as of exports. The latter is a measure of the extent – or lack thereof – of pricing to market (PTM). If a change in exchange rate is fully transmitted into export prices in the exporter's currency then there is full PTM and consequently no pass-through into the importer's prices. To aid in the discussion of empirical studies below (Sections 3.2 and 3.3), we develop a stylized framework of ERPT and PTM (Section 3.1).

3.1 A Simple Framework to Understand ERPT

We consider two countries trading a single good Y, with country A being the importing nation and country B the exporting one. Let E_B^A be the bilateral exchange rate defined as the number of units of A's currency per unit of B's.

Assuming law of one price (LOP) holds in relative terms:

$$\frac{\Delta \ln P_Y^A}{\Delta \ln E_B^A} = \frac{\Delta \ln P_Y^B}{\Delta \ln E_B^A} + 1 \qquad (1)$$

where P_Y^A = price of Y in local currency of A. P_Y^B = price of Y in the currency of B, with all variables being expressed in log form. So, ERPT into A's currency is given by eq. (1). ERPT for B in its own currency is given by the first term on the right hand side of eq. (1).

If $\frac{\Delta \ln P_Y^B}{\Delta \ln E_B^A} = 0$, this implies no PTM by exporters of B into their currency denominated prices and consequently full pass-through to A's imports. On the other hand, if $\frac{\Delta \ln P_Y^B}{\Delta \ln E_B^A} = -1$, this implies full PTM by exporters in country B, and consequently zero pass-through into A's imports.

Assuming imperfect competition, we can write P_Y^B more generally as:

$$\ln P_Y^B = \ln MC_Y^B + \ln[MKP_Y^B(E_B^A)] \qquad (2)$$

where *MC*= marginal costs and *MKP*= exporters mark-up, both in logs.

The literature generally assumes that *MC* is constant to a change in exchange rate and *MKP* varies with exchange rate. Specifically, $-1 < \frac{\Delta \ln MKP_Y^B}{\Delta \ln E_B^A} < 0$. So the greater the PTM by exporters in country B, the more willing they are to raise mark-ups in response

to a depreciation in their country's currency. In other words, as $\frac{\Delta \ln MKP_Y^B}{\Delta \ln E_B^A} \to -1.$ $\frac{\Delta \ln P_Y^B}{\Delta \ln E_B^A} \to -1$ and therefore, $\frac{\Delta \ln P_Y^A}{\Delta \ln E_B^A} \to 0.$[9]

We now assume that country B imports intermediate goods from country A. In this situation we have $\ln MC_Y^B = \ln[MC_Y^B(E_B^A)]$ and $-1 < \frac{\Delta \ln MC_Y^B}{\Delta \ln E_B^A} < 0$, i.e. a depreciation of country B's currency increases the costs of procuring intermediate goods from A. The more reliant is B on imported intermediate goods from A and greater the import elasticity, the more likely that $\frac{\Delta \ln MC_Y^B}{\Delta \ln E_B^A} \to -1.$ In this case, $\frac{\Delta \ln P_Y^B}{\Delta \ln E_B^A} \to -1.$ This scenario, whereby country B is exporting the final good to its partner nation A while simultaneously importing intermediate goods, is referred to as the "production sharing". With this pattern of trade, production sharing reduces the extent of ERPT to the importing country. While we revisit the issue of production sharing more formally in Section 4.1, in the remainder of this section we survey some of the recent empirical literature on EPRT in Asia.

3.2 Selected Aggregate-level Studies on ERPT in Asia

Ito et al. (2005) examines the extent of ERPT into both aggregate import prices and consumer prices (CPI) for eight East Asian countries during the period 1986: Q1 - 2004: Q2. The authors use a first differenced model with a lag of the effective exchange rate up to four periods. They find that the ERPT estimates into import prices to be high

[9] Of course if $\frac{\Delta \ln MKP_Y^B}{\Delta \ln E_B^A} < -1$ then $\frac{\Delta \ln P_Y^A}{\Delta \ln E_B^A} < 0$, i.e. there is more than full ERPT.

and significant for four economies, viz. Hong Kong (49 percent), Indonesia (100 percent), Japan (99 percent), and Thailand (166 percent, i.e. more than full ERPT). The estimates for the other three economies (Korea, Singapore and Taiwan) were insignificant. Inevitably, the ERPT into consumer prices was found to be relatively lower than import prices, but among the countries, it was highest for Indonesia (57 percent), followed by Thailand (26 percent), Singapore (20 percent), the Philippines (15 percent) and Korea (13 percent).

From a methodological perspective, the above analysis uses single equation estimation technique. Under this framework the estimating equation uses the import prices as the dependent variable and the exchange rate as the independent variable, with the co-efficient of exchange rate (either the nation's bilateral or effective) giving the extent of pass-through. Moreover, cost conditions in the exporters market, the price of domestic substitute goods in the importing nation as well as a proxy for demand shifters for imports, like the importing nation's Gross Domestic Product or Industrial Production are used as other control variables. The other methodology in the empirical literature uses a systems approach. Unlike a single equation specification which assumes exchange rate changes to be exogenous, the VAR methodology does not a priori assume any exogenous variable and treats each variable as endogenous. VAR analysis is generally used for measuring pass-through into a nation's aggregate CPI, PPI or import price. This approach allows one to analyze the impact of macroeconomic shocks on import prices or CPI.

Using such a VAR analysis, Ito et al. (2005) also examine the effects of exchange rate changes, monetary policy, demand shocks (proxied by the output gap) and supply shocks (proxied by oil price change) on aggregate prices (CPI, PPI) and import prices for

the period 1995: M1 – 2004: M8. The impulse response functions show the response of import prices to all four variables is highest, followed by the PPI and then the CPI.[10] The authors also conduct a variance decomposition analysis to determine the relative importance of these four variables on domestic prices. Exchange rate shocks account for 40 percent of the variation in CPI for both Indonesia and Korea, but less than 20 percent in the cases of Malaysia, Singapore and Thailand. As for import prices, exchange rate shocks account for 50 percent of variation in import prices in Korea, 20 percent in Indonesia and Thailand, and only 10 percent in Singapore's import prices. The relatively low ERPT in the case Singapore, which is a small and open economy, is somewhat of a puzzle in the first instance. Part of this puzzle may be explained by the high level of production sharing in Singapore's trade and domestic production as highlighted in Section 3.1 (also see Section 4.2).[11]

Using a similar VAR methodology, Kang and Wang (2003) analyze the effect of exchange rate changes on both import prices and CPI for Japan, Singapore, Korea and Thailand during the period 1991: M1 to 2001: M12. The impulse response functions show that for all the four countries, the response of import prices to changes in exchange rates is higher than the corresponding response of CPI. Moreover, for the post-crisis period (1998-2001), both import as well as consumer prices in Korea and Thailand appear to have responded more to exchange rate changes, while there was no difference

[10] The magnitude of response to these shocks for Indonesia appears to be larger than the other economies.

[11] Abeysinghe and Tan (1998) examine the relationship between export and import prices for Singapore and find a high degree of correlation and co-integration among export prices of final goods and import prices of intermediate goods for major commodity categories between 1980: Q1and 1993: Q4.

pre and post crisis for Japan and Singapore. This may be explained by the fact that Japan and Singapore were not as impacted by the crisis in a structural sense (i.e. directly) as were Korea and Thailand. In fact, a variance decomposition analysis shows that the contribution of exchange rate shocks in explaining variations in both import prices and CPI changes is higher for the post-crisis period in Korea and Thailand. The authors contend that the adoption of a free-floating exchange rate regime – and consequent temporary exchange rate fluctuations -- by these two economies after the currency crisis may have been a further reason for the amplified ERPT in the post-crisis period.[12]

McCarthy (2000) adopts a VAR approach to measure pass-through into aggregate import prices, CPI and PPI for Japan and other industrial countries during 1976: Q1-1998: Q4. The impulse response function shows that the response of import prices to exchange rate changes is greater than for PPI, while it is insignificant for CPI. The variance decomposition analysis shows that a variation in prices due to one percent exchange rate shock is about 6 percent for import prices and PPI but only 1.8 percent for CPI.

Sasaki (2002) examines the export pricing behavior of Japanese exporters to the US, Asia and the European Union (EU) by estimating PTM elasticities using monthly bilateral export price data for the period 1990-1995. PTM is found to be highest for Japan's exports to the US and lowest to Asia. Specifically, Japanese exporters to the US market absorb about 50 percent of the yen-dollar exchange rate changes in their own

[12] On the other hand, it has been suggested that the greater the degree of exchange rate flexibility the lower will be ERPT as firms may be less willing to pass on exchange rate changes to their customers when there is a chance that they will be subsequently reversed. The role of exchange rate regimes on ERPT is clearly an issue in need of further research (for instance, see Steel and King 2004).

currency denominated export prices, while for the EU and Asia the PTM elasticities are relatively lower at 0.24 and 0.32, respectively. In all likelihood, this result is due to the relatively large size and high level of competition in the US market where exporters attempt to maintain their market share and are prepared to accept low mark-ups.[13] Another reason for the relatively low ERPT of Japanese exports (i.e. high PTM) to the US might be because of the large-scale dollar invoicing of Japanese exports to the US (about 84 percent of Japan's exports in the US is invoiced in dollars).[14]

Webber (1999) examines the nexus between bilateral exchange rates with USD and import prices in nine countries in the Asia-Pacific region, viz. Korea, Pakistan, the Philippines, Malaysia, Singapore, Japan, Australia and New Zealand. Using the Johansen co-integration methodology the author finds a long-run stable linear relationship between import prices and exchange rates for seven of the nine countries from 1978-1994, though the ERPT estimates vary between countries. ERPT is highest for the lowest income countries, Pakistan (109 percent) and the Philippines (89.6 percent), while ERPT is partial for the other six nations, ranging from 25 to 50 percent.[15] Notwithstanding macro level differences between countries, the author surmises that the different ranges of ERPT for the countries are due to the different varieties of goods imported by the countries.

[13] The paper also examines the effect of unexpected exchange rate changes in export prices.

[14] See Sato (1999) for a discussion of currency invoicing of Japanese trade and the dominance of the US dollars in East Asian intraregional trade. Also see Giovannini (1988) and Fukuda and Ji (1994) for formalization of the impact of currency invoicing on the extent of ERPT,

[15] The estimates of ERPT for the other countries are as follows: Korea (40.3 percent), Australia (26.3 percent), Japan (44.8 percent) and New Zealand (35.9 percent). The estimated EPRT for Singapore was 77.1 percent, far higher than most other estimates for the city-state.

This emphasizes the need for studies using more disaggregated data (i.e. at industry or product levels). Section 3.2 studies disaggregated level analysis of ERPT in Asia[16].

3.2 Selected Disaggregate-level Studies on ERPT in Asia

3.2.1 Japan

In one of the earlier works on pass-through at the disaggregate level (SITC 4-digit) involving any Asian nation, Marston (1990) examines the pricing behavior of Japanese exporters. The author estimates PTM elasticity for 17 products in the transportation and electrical machinery industry between 1980: M2 and 1987:M12. The impact of trade weighted real effective exchange rate on export-domestic price margin is found to be significant. PTM elasticities for selected products are -- small passenger cars (0.52), tires and tubes (1.03), trucks (0.41), color TVs (0.51), Tape recorders (0.95) and microwave ovens (0.28). This suggests that Japanese exporters partially pass-through exchange rate changes in foreign prices of their exports, apart from tires and tubes.

Takagi and Yoshida (2001) estimate the ERPT for Japanese exports and imports with selected East Asian trading partners, viz. Indonesia, Malaysia, the Philippines, Singapore, and Thailand, as well as for Germany and the US. The authors estimate ERPT using monthly export and import unit value series obtained from Japanese customs data spanning 1988: M1 - 1999: M6 for 20 (11 exports and 9 imports) at the 9-digit level of industrial commodities. Using a dynamic panel data and applying a fixed effects model for these categories aggregated together, as well as for the countries combined, the

[16] In particular we consider two papers each on Japan, Korea, Hong Kong, South East Asia and India. There are no papers to out knowledge that have examined ERPT in China, clearly an important area of future research.

estimated ERPT for Japanese exports into the destination market currency is almost complete (0.97), while the ERPT into Japanese imports is almost non-existent (only 0.01). On a bilateral country basis, for the individual commodity groupings, ERPT for Japanese exports in the majority of the cases is found to be complete or very high (i.e. low degree of PTM);[17] while for Japanese imports, ERPT is either absent or far from complete.[18] This suggests that foreign importers attempt to maintain price stability in yen terms while pricing their exports in Japanese markets, while in contrast, Japanese exporters also maintain their unit prices stable in yen terms.

The authors go on to examine the impact of the Asian currency crisis on the pricing behavior by comparing ERPT estimates during the pre-crisis periods (from 1988: M1 to 1997: M6) with the entire sample period. They find little difference in ERPT before and after the crisis for most products and for most countries except for some imports to Malaysia. For these Asian countries, Japan is their dominant trade partner. In other words, exporters in these countries tend to preserve or increase their market share by actively PTM. This may explain the low Japanese import ERPT (also see Sato 1999, 2003).

Otani et al. (2003) estimate ERPT into Japanese import prices using monthly data for the period Jan 1978: M1 - 2002: M10. Using the IMF's nominal effective exchange rate for Japan and employing a seemingly unrelated regression (SUR) estimation methodology, the authors find ERPT elasticities into aggregate prices for the entire time

[17] The exceptions are electricity boards to US and microscopes to Germany, where the ERPT rates are 30 percent and 42 percent, respectively.

[18] The exceptions are wooden seats (75 percent) and wooden furniture (47 percent) from the US, appliance parts from Germany (53 percent) and wooden furniture from Singapore (93 percent).

period to be complete. This appears to be at odds with the Takagi and Yoshida (2001) results noted above which examined ERPT for a shorter and more recent period (1988: M1 - 1999: M6). In fact, once Otani et al. (2003) decompose the time period into two sub-samples -- 1978: M1 - 1989: M12 and 1990: M1 – 2001: M10 -- they find a decline in ERPT in the 1990s at both the aggregate level as well as for most product categories.[19] The fact that the decline in ERPT occurred both in aggregate and disaggregate data implies that changing composition of Japan's imports is unlikely to be a key factor in explaining the declining ERPT in aggregate prices. An interesting hypothesis put forward by the authors for their finding is the rapid appreciation of the yen in the mid 1980s which consequently led to a rise in Japanese FDI and overseas production by Japanese firms. The subsequent increase in intrafirm trade and re-imports may have led to firms absorbing price changes internally and transferring the impact on margins between firms, thus reducing the extent of ERPT. The impact of FDI on ERPT is clearly an issue in need of further research.[20]

3.2.2 Korea

Turning from Japan to the only other Asian OECD member, Korea, Lee (1997) estimates ERPT of the industry-specific real exchange rate into Korean import prices from OECD nations for the period 1980: Q1 - 1990: Q4. Specific ERPT elasticities are

[19] These results are robust to variations in estimation techniques and data series. The ERPT coefficients for 8 disaggregated commodities vary; it is highest for Fuels (1.46), followed by Material (1.11), Metals (0.92), Others (0.81), Food (0.79), Chemicals (0.78) and Machinery (0.76).

[20] Sato (1999) briefly highlights the importance of Japanese multinationals and its role in pricing and trade invoicing with regard to Japan's trade with the rest of East Asia.

estimated for 24 industries. The ERPT estimates range between 0.43 for Iron and steel and 0.92 for leather and fur; the average pass-through elasticity for all manufacturing imports is 0.38. The author also finds that the more concentrated the industries the smaller is the ERPT, as would be due to more competition.

Lee (1995) examines the response of export prices by Korean manufactures to nominal effective exchange rate changes into 16 industries, including auto, television sets, refrigerators, silk fabrics, car tires, Integrated circuits for the period 1980: Q1 – 1990: Q4. The PTM estimates are automobiles (0.65), CTV (0.53) and tires (1.12), confirming that Korean firms seem to engage in active pricing strategies when exporting (other than tires).

Athukorala (1991) also studies ERPT for Korean manufacturing exports in textiles, clothing and footwear, metal products and machinery and transport equipment for the period 1980: Q1 – 1989: Q1. Using a polynomial distributed lag model the author finds pass-through into foreign prices for the nominal effective exchange rate to be around 28 percent.

Adopting a similar methodology, Yang and Hwang (1994) estimate ERPT of the real sectoral exchange rate to Korean export prices in 6 manufacturing sectors for the period 1976: M12 – 1990: M12. ERPT estimates range between 18 percent and 60 percent -- textiles (18 percent), chemical (19 percent), machinery (25 percent), metal products (41 percent), mineral products (46 percent) and wood (60 percent).

3.2.3 Hong Kong

While most of the country-specific studies in Asia have been concentrated on Japan and Korea, there are a few other studies on specific economies in Asia. For instance, Parsley (2003) estimates ERPT into import prices for Hong Kong. The author estimates ERPT for 21 disaggregate 5-digit SITC imports from Hong Kong's top eight non-China exchange rate trading partners (viz. Germany, the Netherlands, France, United Kingdom, Taiwan, Japan, Singapore and Australia) spanning the period 1992-2000. The results indicate a high degree of ERPT of between 80 to 95 percent for the nominal exchange rate and 70 to 85 percent for the real exchange rate.[21]

3.2.4 Southeast Asia

Parsons and Sato (2005) estimates ERPT for four Southeast Asian countries, Indonesia, Thailand, Malaysia, and the Philippines for 27 export commodities at the HS 6-digit level of dissagregation and to 13 destination (export) markets for 1999-2004.[22] Using a pooled regression model for each good they do not find any ERPT for the majority of the goods for all the countries. With export prices denominated in the exporter's currency, their findings of insignificant exchange rate co-efficient, confirms the notion that small open economies are predominantly price takers in world markets, but could also reflect the fact that these economies invoice their exports in US dollars.

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[21] The country-specific ERPT estimates for the nominal exchange rate were -- Germany (1.36), UK (0.24), Taiwan (0.97), Japan (0.86), Singapore (1.58) and Australia (0.05). ERPT estimates for the real exchange rate were -- Germany (1.26), the Netherlands (1.09), France (1.13), UK (0.26), Taiwan (0.52), Japan (0.62), Singapore (1.28), Australia (0.02).

[22] The destination markets for these countries were Australia, Canada, China, France, Germany, Hong Kong, Indonesia, Japan, Korea, Malaysia, Singapore, Thailand, UK and the US.

Sasaki (2005) examines the effects of changes in the US dollar and Japanese yen on import prices at both the aggregate level and for finer goods for selected Asian economies, viz. Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, and Thailand for the period 1973: M2 - 2000: M12[23]. Empirically, at the aggregate level, changes in the US dollar appear to have been passed through to the import prices of the Asian countries, while there is little evidence of ERPT of Japanese yen changes into import prices for the Southeast Asian economies[24]. However, at the disaggregate commodity level there is significant ERPT for the Asian economies for imports from Japan for color photo papers and golf balls.[25] From a policy perspective, the paper recommends that Asian nations adopt a currency basket of the Japanese yen and the US dollar as changes in both these currencies affect their import prices.[26]

3.2.5 India

Mallick and Marques (2006) examine the extent of PTM in the case of India's exports. They estimate ERPT into export prices of 34 SITC 2-digit commodities for the period 1980-2001 using the trade-weighted normal exchange rate of the Indian rupee

[23] The North Asian economies of Taiwan, Korea and Hong Kong are also included in the study.

[24] From the US, ERPT into import prices of these nations were Hong Kong (0.52), Indonesia (0.28), Korea (0.29), Malaysia (0.19), the Philippines (0.90), Singapore (0.40), Thailand (0.91, Taiwan (1.67). ERPT coefficients of imports from Japan for the Asian nations were insignificant except for Hong Kong (0.04), Malaysia (-0.10) and Taiwan (0.06).

[25] Interestingly, for US imports from Japan, yen changes appear to have little impact on US import prices. This suggests that Japanese exporters price their exports in US dollars and engage in PTM to maintain their market share in a competitive market like the US. However, this conclusion is at odds with some of the other studies of Japanese ERPT noted previously.

[26] Also see Rajan 2002, Williamson 2005 for discussions of the virtues of a currency basket regime for Asia.

comprising of India's top 36 trading partners. Given that the Indian economy has been going through a significant liberalization program in 1991 (see Rajan and Sen, 2002) -- with a reduction in tariff rates, removal of capital controls and movement towards a managed floating exchange rate -- the authors estimate ERPT coefficients for two sub-periods (1980-1990 and 1991-2001) to detect any significant differences in pricing behavior by Indian exporters. The average ERPT into foreign prices of India's exports in the pre-liberalization period was 0.20, while for the post-liberalization period it was 0.65. During the former sub-period the authors do not find any ERPT for most commodity categories with the exceptions of clothing (47 percent) and footwear (40 percent). This suggests that during the pre-liberalization period, India acted predominantly like a small, price-taking country in world markets. For the post-liberalization period, significant ERPT was found for most categories of products, ranging from 12 percent to 79 percent. ERPT estimates for individual products are: Clothes (46 percent), Cotton (79 percent), Iron ore (12 percent), Manufacturing metals (23 percent), Spices 19 (percent), Tobacco (15 percent), Transportation equipment (28 percent) and Yarn (49 percent). The authors argue that liberalization allowed India to gain some price-making power in some of these industries. In their opinion, this is because of the increasing share of manufacturing in India's exports (which rose from 68 percent of merchandise exports in 1986-87 to 76 percent in 2001-02).[27] However, this conclusion is at odds with much of the other literature examined above which has argued that ERPT into import prices has declined

[27] In another paper, Mallick and Marques (2005) estimates the ERPT of the dollar-rupee exchange rate into both India's import and export prices for 9 SITC 1-digit commodities for the period 1980-2001. Using panel data estimations, the average ERPT for imports is about 82 percent, and that for exports into dollar prices was 22 percent.

over the years largely because of the changing composition of domestic trade towards manufactured goods.

4. ERPT and the Role of Production Sharing

When thinking about trade in manufactured goods, especially in Asia, it is important to pay close attention to the role of cross-border "production sharing". This refers to the dispersion of separate production blocks of an integrated production process across different countries.[28] Thus, trade no longer just involves final goods and services, but also the international exchange of parts and components (PCAs).[29] The presence of production sharing suggests that it is insufficient to merely consider ERPT at a disaggregated commodity level (let alone at a macro level); it is especially important to consider ERPT at the level of the corresponding intermediate good.

4.1 A Simple Model

As noted in Section 3.1, the simplest form of production sharing is bilateral in nature, whereby a representative firm in country B exports the final good (Y) to country A, while simultaneously procuring the parts and components (X) from country A.[30] In such a situation depreciation of B's currency (and ignoring PTM behavior for the

[28] The literature on production sharing has used an array of terms to describe this phenomenon, including "recycling comparative advantage", "production fragmentation", "super-specialization', vertical specialization", and "slicing the value chain".

[29] Over the last decade production sharing based trade has expanded at a faster rate than growth in world trade and world GDP. See Athukorala, 2005, Athukorala and Nobushi, 2006 and Ng and Yeats, 2001, 2003 for excellent descriptions of trends and patterns of international production fragmentation.

[30] US-Mexico trade is a good case in point.

moment) raises the country's exports of good Y but concurrently increases the imported input price of good X. Thus, changes in domestic costs following a currency change is higher with production sharing than without it, resulting in the firm in country B altering its foreign currency price of exports to a lesser extent. In other words, even without pro-active pricing-to-market (PTM) strategies or local currency pricing (LCP), one would expect lower ERPT a priori with production sharing. While this reasoning is intuitive, to help formalize thoughts, let us consider a stylized model of production sharing and ERPT with two-country trade and involving a single firm in each country.

We assume that firm B has some market power in the sense that by varying its price in its own currency it can affect the A currency price of Y. We assume B to be a labor abundant nation with a perfectly elastic labor supply, such that any increase in labor demand can be met at the given wage rate. Let the cost of parts and components X be denoted by P^B_x . This is in firm B's currency. The production function for good Y is assumed to be of simple Cobb-Douglas form:

$$Y = aL^{\alpha} X^{\beta} \tag{3}$$

where a is a constant and both $\alpha, \beta \in (0,1)$ and $\alpha + \beta = 1$.

The demand function faced by firm B is given as:

$$Y = b(P_Y^B)^{-1/\sigma} \tag{4}$$

where σ is a constant and the inverse of the elasticity of demand and $\sigma \in (0,1)$.

Firm B's profit function is given by

$$\pi = P_Y^B Y - w^B L - P_X^B X \tag{5}$$

Plugging eqs. (3) and (4) into (5), we obtain optimal input demand L* and X*. Substituting this in the production function (in log form) we have:

$$\ln Y = \ln a + \alpha \ln L^* + \beta \ln X^* \tag{6}$$

Using eq. (6) in the demand price equation

$$\ln P_Y^B = \ln c - \sigma \ln Y \quad \text{where } c = \left(\frac{1}{b}\right)^{-\sigma} \tag{7}$$

Let E_B^A be A's currency per unit of B's currency. The price of Y in A's currency is:

$$P_Y^A = E_B^A P_Y^B \tag{8}$$

or, in log form, $\ln P_Y^A = \ln E_B^A + \ln P_Y^B$.

We define EPRT as the extent of change in the bilateral exchange rate between A and B into the price of good Y denominated in A's currency. Differentiating, P_Y^A with

respect to the exchange rate E_B^A (i.e. equation (8) in log form), we arrive at the expression for EPRT:

$$ERPT = 1 - \sigma \frac{d \ln P_X^B}{d \ln E_B^A} \left[\frac{[\beta - \alpha\phi]}{[\beta(1-\sigma) - 1 - \phi(1-\sigma)\alpha]} \right] \tag{9}$$

where $\phi = \frac{(1-\sigma)\alpha}{\beta(1-\sigma)-1}$ and $-1 < \phi < 0$.

Eq. (9) illustrates that if the price of X remains unchanged following country B's exchange rate change with A then the second term is zero and we have complete pass-through. However if the increased demand for X, due to depreciation of country B's currency, raises the price of X, it further increases costs for firm B. It can be easily shown that the second term is now negative (see Annex 1) and pass-through is incomplete. Figure 1 captures this point via a rise in MC curve. The initial equilibrium is at point 0 where MR intersects the MC curve with the price being P^B_Y. The rise in costs following B's currency depreciation shifts the MC curve outwards and raises the price of Y in B's currency to $1^{/}$ (or $P^{/B}_{Y no\ ps}$).

We now introduce production sharing by assuming that the firm in Country B import parts and components X from the firm in Country A, priced at P_X^A, which B takes as given.

The profit function for firm B is:

$$\pi = P_Y^B Y - w^B L - \frac{P_X^A}{E_B^A} X \tag{10}$$

Following the similar sequence we arrive at the pass-through expression.

$$ERPT = 1 - \sigma \frac{d \ln P_X^A}{d \ln E_B^A} \left[\frac{[\beta - \alpha\phi]}{[\beta(1-\sigma) - 1 - \phi(1-\sigma)\alpha]} \right] + \sigma \frac{[\beta - \alpha\phi]}{[\beta(1-\sigma) - 1 - \phi(1-\sigma)\alpha]} \tag{11}$$

Given that $\alpha, \beta, \sigma \in (0,1)$ and $-1 < \phi < 0$ and $-1 < \frac{[\beta - \alpha\phi]}{[\beta(1-\sigma) - 1 - \phi(1-\sigma)\alpha]} < 0$

(also see Annex 1).

Thus from eq. (11), it is apparent that ERPT is lower than standard trade. The weaker currency of B raises exports of Y. This in turn leads to an increased demand for components X thereby raising production costs of firm B. Moreover, B's currency depreciation makes imported components X now more expensive. The latter effect as a result of fragmentation of the production process is captured by the third term on the right hand side of eq. (11), which was absent in the situation of standard trade. This point can be intuitively grasped with the help of Figure 1 again. When B's currency depreciates, the costs rise more than without production sharing, shifting the MC curve outwards to $MC^{/}_{Y\,ps}$. The new equilibrium for firm B is at 2 with the domestic currency price of Y being $2^{/}$ or $P^{/B}_{Yps}$ compared to $P^{/B}_{Ynops}$ without production sharing. As firm B absorbs more of the exchange rate change in its own price of Y, this leads to lower ERPT into the price of good Y in A's currency. As discussed in Section 3.1, effectively an exchange rate change

now enters the exporters marginal costs, an effect that would be absent with production sharing, hence leading to lower ERPT.

The analysis has thus far implicitly assumed full ERPT at the input level (good X). Ghosh (2006) considers more pro-active pricing behavior of a firm in country A exporting input X to country B. With production sharing, country A's currency appreciation increases its imports of good Y which in turn leads to a rise in demand for intermediate good X by country B. If this puts upward pressure on domestic production costs in country A, firms in country A will raise the price of good X. This in turn increases costs for the firms in country B and hence lowers ERPT for the final good Y. The even higher input prices in the upstream sector implies further rise in costs for firm B. It follows from eq. (11) ERPT is lower for final good Y. With production sharing, the higher the PTM at the level of the intermediate good, the lower is the ERPT for the final good.[31]

4.2 Related Literature

The issue of production sharing and ERPT is a relatively under-researched area and there is consequently scant related literature in the area. Gron and Swenson (1996)

[31] Another form of production sharing could involve three nations, when country B imports the intermediate good from country C and then exports the final good to country A. This may be quite pertinent for Asia where more technologically advanced Asian nations like Japan, Taiwan, Singapore, Korea produce the technology intensive inputs which are then used in assembly operations in the relatively lower wage Asian countries such as China, India or Vietnam and then shipped to destination markets like the US. In such a situation if country B's currency moves in the same direction with both countries A and C, the results boil down to the 2-country case. However, if country B's currency appreciates with respect to country C but depreciates with respect to country A, then the cheaper imported input price could moderate production costs, leading to more ERPT for final good Y.

show that incomplete ERPT occurs when multinational firms are able to acquire inputs from different sources internationally, hence allowing them to adjust their input prices in response to exchange rate changes. Webber (1995) develops a partial equilibrium model of import ERPT in the presence of imported inputs. He also incorporates the role of currency invoicing. Not surprisingly, he shows that ERPT is incomplete or partial when imports are procured from another country and invoiced in a third nation's currency.

Athukorala and Menon (1994) examine ERPT for Japanese manufacturing exports that are characterized by the use of imported intermediate inputs for the period 1980: Q1 – 1992: Q1. As Japanese exports rely heavily on imported inputs, the authors estimate ERPT by separating out the direct PTM effects and the impact of exchange rate changes on input costs. Their results show that ERPT is lower when the impact of exchange rate changes on imported input costs are taken into account.

Aksoy and Riyanto (2000) considers two vertically integrated markets, one for final goods and the other for intermediate goods. In their theoretical model, if there is vertically separated production then the firm producing the final good imports its intermediate good. In contrast, if there is vertical integration, the downstream firm obtains the input from its own upstream input supplier at the internal transfer price. The author show that pass-through is lower in the former case.

5. Concluding Observations

This paper has surveyed available empirical evidence on the extent of exchange rate pass-through (ERPT) in selected Asian economies. It is apparent that results on the degree of ERPT depends on the time period horizon of analysis. This said, overall, on a

country-by-country basis, it appears that ERPT is highest for developing Asian economies like Thailand and Indonesia and somewhat lower for developed economies like Japan. Beyond level of economic development, an interesting area for research would be the extent to which ERPT is impacted by a nation's macroeconomic fundamentals such as money supply growth, inflation rate and type of exchange rate regime.

Exchange rate regimes in Asia span a wide spectrum. A number of smaller Asian economies appear to prefer some form of single currency pegs. This is true of Hong Kong, SAR (currency board arrangement pegged to the US dollar), Brunei (currency board arrangement pegged to the Singapore dollar) and Bhutan and Nepal (pegged to the Indian Rupee). In contrast, Bangladesh, Sri Lanka, and the crisis-hit economies of Indonesia, Korea, Philippines, and Thailand officially operate flexible exchange rate regimes. The flexible exchange rates in the four East Asian countries are accompanied by inflation targeting frameworks. A number of other Asian countries like India, Pakistan, Singapore, Taiwan and Vietnam have adopted a variety of intermediate regimes (currency baskets, crawling bands, adjustable pegs, and such). Both China and Malaysia in July 21, 2005 officially shifted to what may be best referred to as a more mechanical version of a currency basket regime (i.e. keeping the trade-weighted exchange rate within a certain band as a goal in and of itself). Overall therefore, it is readily apparent that "one-size does not necessarily fit all" when it comes to the choice of exchange rate regimes in Asia (Rajan 2006). As such Asia provides an ideal setting to analyze the role of exchange rate regimes on ERPT.

In the final analysis, while the extent of ERPT has important macroeconomic implications, it is predominantly a microeconomic phenomenon. This consequently implies the need to pay more attention to ascertaining ERPT at the disaggregated level rather than at the broad macro level. At the disaggregated level, it is especially important to focus more research efforts on the role of production sharing and its implications for ERPT. Given that the literature on ERPT and standard trade in Asia is relatively limited, it is not surprising that the empirical literature connecting fragmented trade with ERPT is virtually non-existent. For future empirical research on ERPT in the context of cross-border production sharing involving Asia the challenge lies in compilation of export (import) quantity and price data for both final goods and parts and components.

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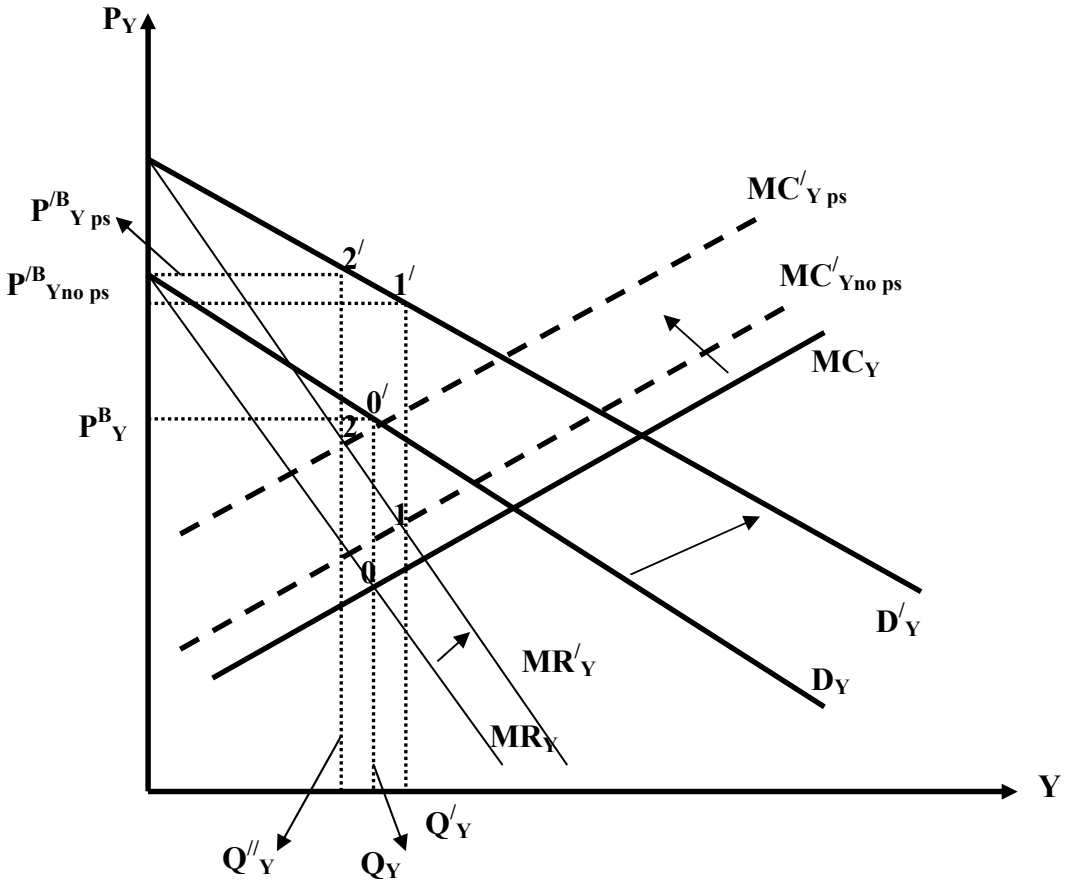
Figure 1
2-country Production Sharing:
Country B's Currency Depreciates vis-à-vis Country A



Summary table:

	Equilibrium point	Price	Quantity
Initial	**0**	P^B_Y	Q_Y
Without production sharing	**1**	$P^{/B}_{Yno\ ps}$	$Q^{/}_Y$
With production sharing	**2**	$P^{/B}_{Y\ ps}$	$Q^{//}_Y$

Annex 1

The ERPT expression eq. (9) is

$$ERPT = 1 - \sigma \frac{d \ln P_X^B}{d \ln E_B^A} \left[\frac{[\beta - \alpha\phi]}{[\beta(1-\sigma) - 1 - \phi(1-\sigma)\alpha]} \right]$$

$(1-\sigma)\alpha > 0$. (A1)

$-1 < \beta(1-\sigma) - 1 < 0$. (A2)

It follows from (A1) and (A2) that since $\phi = \frac{(1-\sigma)\alpha}{\beta(1-\sigma)-1}$ it must be that $-1 < \phi < 0$.

Given this, we consider the second term of the pass-through expression. The numerator is: $\beta - \alpha\phi > 0$. (A3)

Turning to the denominator,

$\phi(1-\sigma)\alpha < 0$ (A4)

So $0 < \{-\phi(1-\sigma)\alpha + \beta(1-\sigma)\} < 1$ (A5)

i.e. it is positive and lying between 0 and 1.

Now the entire denominator, the expression is:

$-1 < [\{-\phi(1-\sigma)\alpha + \beta(1-\sigma)\} - 1] < 0$ (A6)

and lies between 0 and -1.

Thus it follows from (A3) and (A6) that the second term in the ERPT expression is negative.