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EXCHANGE RATE PASS THROUGH TO IMPORT PRICES: PANEL EVIDENCE FROM EMERGING MARKET ECONOMIES.

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1. Introduction

The interaction of exchange rates and the prices of traded goods have been extensively studied in the field of international economics (see Isard, 1977, Krugman, 1987, Menon, 1996, Goldberg and Knetter, 1997, and Betts and Devereux, 2001). If pass through is less than complete we have evidence of pricing in the local currency of importers or Pricing To Market (PTM). Incomplete pass through can be due to market structure and product differentiation. In an imperfectly competitive market, firms can charge a mark-up over marginal costs to earn above normal profits in the long run. This mark-up varies depending on the degree of substitution between domestic and imported goods based on the extent of market segmentation (see Krugman, 1987). PTM is important since it can lead to higher exchange rate volatility and a fall in international risk sharing (Betts and Devereux, 2001), both of which emerging economies may be particularly prone to. This paper examines the extent of exchange rate pass through to import prices in emerging market economies.

There has been some work examining the extent to which pass through for industrialized countries. For example, Menon (1996) studied the exchange rate pass through to the import prices of motor vehicles in USA, taking account of nonstationarity. His findings show that exchange rate pass through is incomplete, even in the long run. The possible explanation is two fold: the presence of quantity restrictions and pricing practices by multinational firms. In the 1990s, many emerging countries had undergone liberalization of trade restrictions, increased openness and the shift to market determined exchange rate system. This resulted in substantial fluctuations in their respective domestic currencies vis-à-vis the US dollar. Indeed exchange rate fluctuations may have contributed to the changing structure of trade among emerging economies (see Campa and Goldberg, 2004).

The effect of exchange rate fluctuations on emerging market trade patterns is an interesting case study. Consequently this paper examines the relationship between import prices and the exchange rates among emerging economies in Asia and Latin America. In particular, we would like to test the extent of exchange rate pass through on import prices. This paper seeks to make three important contributions to the literature. Firstly, using a stylized model we examine a panel data set of Asian and Latin American countries. Secondly, this study extends the existing literature by examining exchange rate pass through for a panel of emerging economies using the Pooled Mean Group Estimation. This allows us to differentiate the short and long run impact of exchange rate pass through on the import prices in a panel context and also statistically test whether individual countries respond equivalently. Thirdly, we seek to extend the literature on asymmetric responses of import prices to currency appreciations and depreciation to a panel setting. Previous studies conducted by Webber (2000), Bahroumi (2005) and Khundrakpam (2007) have dealt with asymmetric pass through using individual country estimation.

The rest of the paper is organized as follows. Section 2 describes the empirical literature. Section 3 lays out the model and explains the channels of transmission of the exchange rate pass through to import prices. Section 4 discusses the data and Section 5 outlines the empirical methodology. Section 6 explains the results and in Section 7 the conclusions are laid out.

2. Literature Review

The existing literature on exchange rate pass through to prices can be delineated into three different strands. First generation models based on the Law Of One Price (LOOP) explicitly modelled domestic price as a function of exchange rates, see for example Isard (1977) and Goldberg and Knetter (1997). These models imply that deviations from the Law Of One Price (LOOP) could explain, to some extent, incomplete pass through. Second generation models modelled exchange rate pass through by employing the lagged values of the exchange rates as explanatory variables (for example, see Ohno, 1989). Such an approach may reflect only strategic pricing behaviour of firms as they ignore the role of tradable input costs on the extent of pass through. The third generation models did not necessarily assume perfect competition by utilising Pricing To Market (PTM), thereby capturing low pass through (see Athukorala and Menon 1994, Menon, 1996 and Doyle, 2004). Krugman (1987) suggested PTM could arise due to difference in international trade standards or imperfect competition. Researchers have either hypothesized a full pass through effect underlying the assumption of perfect competition (price takers). Or alternatively have assumed imperfect competition and have modelled export prices based on PTM or local-currency pricing mechanism.

Therefore, PTM is useful rationalising incomplete exchange rate pass through. In this regard, Marston (1990) studied the pricing behaviour of Japanese exporting firms. He finds strong evidence of pricing to market since Japanese exporters will charge a different export price in yen relative to domestic prices. Also, Marston finds that PTM was not linear, since the price differential was higher during periods of appreciation of the yen. He concluded that the firms resorted to pricing to market behaviour in a planned manner to maintain their export price competitiveness. Menon (1996) provides evidence of incomplete exchange rate pass through for the small-open economy case of Australia taking account of potential data non-stationarity. Indeed, his findings show that exchange rate pass through is incomplete even in the long run. He suggests incomplete pass through is due to the presence of quantity restrictions and pricing practices by multinational firms. Furthermore, Wickramasinghe (1999) studied the exchange rate pass through phenomenon in Japanese manufacturing import prices taking account of nonlinearities. He found strong evidence of significantly different degree of pass through from appreciation and depreciations of the yen.

Taylor (2000) examines the extent of pass through from, for example, exchange rate changes to import prices, in a low inflation environment, like the Great Moderation. He maintains that lower exchange rate pass through may occur due to lower inflation rates and this represents a decline in the pricing power of firms. A recent study on the causes for lower pass through was conducted by Giovanni (2002) who examined the response of American manufactured import prices to changes in exchange rates. His results indicated a low exchange rate pass through in the nineties which implies that appreciation of the U.S. dollar was not translated into a reduction in import prices. However, he also claims that the costs of advertising and other allowances were not represented in the true unit price of imports. Another recent study on Norwegian import prices was conducted by Bach (2002). He re-examined the robustness of the results in Naug and Nyomen (1996) and concluded that differences in the data and construction of variables contributed to the differences in the results. Bach's work does not support the hypothesis of a pricing to market effect and suggests that long run pass through of changes in exchange rates and import prices are complete.

However, there has been only a limited amount of literature analyzing the short run and long run impact of the exchange rate pass through on the import prices across emerging economies. Sahminan (2002) examined the exchange rate pass through among South East Asian countries adopting an error correction approach. His results showed that in the short run for Thailand, domestic demand and foreign price had significant effect on import price. But for Singapore, only the foreign price had significant impact on import price. Whereas, the exchange rate did not display significant effect on import prices for both the countries.

Webber (2000) considers asymmetries in pass through by illustrating that many Asian currencies did not transmit the fall in import prices after the crisis as they had done during the crisis. Khundrakpam (2007) investigated the exchange rate pass through phenomenon to domestic prices in India during the post reform period (i.e., since 1991) and found no clear evidence of a decline in the degree of pass through rate. He also concluded that there existed an asymmetry of pass through during the reform period. This could have been due to several factors including increased liberalisation, lower tariffs and quantity restrictions on trade. Apart from these, rising inflation expectations during the late nineties also contributed to the higher pass through in the long run.

The notion that monetary policy influences exchange rate pass through was also evidenced by Ito et al. (2005) who dealt with the exchange rate pass through effects to import prices, producer prices and consumer prices for a few East Asian countries. Their main findings are that firstly, crisis affected countries like Indonesia, Korea and Thailand exhibited large pass through rates to domestic prices. Particularly for Indonesia, both short run and long run pass through rates were found to be large. However, monetary policy changes also had contributed to the pass through of exchange rates to consumer prices in Indonesia.

Kun and Zhanna (2008) studied the exchange rate pass through phenomenon to import prices for four Asian countries, viz., Korea, Malaysia, Singapore and Thailand. Firstly, the degree of pass through is different across countries which highlights the importance of heterogeneity. Singapore exhibited higher exchange rate pass through, which could be due two following. Exchange rate targeting results in lower exchange rate volatility and subsequently higher trade openness. Higher trade openness could get translated into higher pass through rates onto import prices. Secondly, in general, degree of exchange rate pass through was higher on import prices, medium on producer prices (PPI) and low on consumer prices (CPI). We next present the theoretical model and then discuss the empirical approach.

3. Theoretical Model

Our model of import price determination closely follows the previous literature by Fujii (2004), Bailliu and Fujii (2004) and Khundrakpam (2007). This allows for a role for the exchange rate, general costs and also the mark-up, in the determination of import prices. In an imperfectly competitive market, the representative foreign firm exports its product to a domestic country. The domestic firm's demand function is expressed as $Q_t\left(P_t^M, P_t^d, E_t\right)$, P_t^M is the price of imported good in domestic currency, P_t^d is the price of the domestic competing good and E_t is the total expenditure on all goods. We can outline a linear relationship for import prices (P_t^M) based upon the static profit maximisation problem of the foreign firm:

$$\underset{P_t^M}{Max}\ \Pi_t^f = S_t^{-1} P_t^M Q_t - C_t\left(Q_t, W_t\right) \tag{1}$$

Where, $C_t\left(Q_t, W_t\right)$ is the firm's total cost that is a function of the output (Q_t) and the input costs (W_t). Π_t^f denotes profits accrued by the representative foreign firm expressed in the foreign currency.

The foreign firm chooses import prices such that it maximises profits. Hence, maximising equation (1) with respect to import price P_t^M gives the first order condition as:

$$\frac{\partial \Pi_t^f}{\partial P_t^M} : S_t^{-1} Q_t + S_t^{-1} P_t^M \left(\frac{\partial Q_t}{\partial P_t^M} \right) - \left(\frac{\partial C_t \left(Q_t, W_t \right)}{\partial Q_t} \right) \left(\frac{\partial Q_t}{\partial P_t^M} \right) = 0 \qquad (2)$$

where, $\frac{\partial C_t \left(Q_t, W_t \right)}{\partial Q_t}$ denotes the marginal cost (MC_t). Therefore, following the derivation in the appendix, the first order condition can be rewritten to provide a function of import prices:

$$P_t^M = S_t MC_t \mu_t \qquad (3)$$

Where μ_t is the mark-up in the domestic country over the marginal cost, defined as $\mu_t = \eta_t / (\eta_t - 1)$, while η_t is the elasticity of demand for output. Therefore, price in each market is determined in part by the respective mark-up over the marginal cost.

As previous works such as Marston (1990), Pollard and Coughlin (2004) and Campa, Goldberg and Minguez (2005) have shown, the phenomenon of exchange rate pass through occurs by the simultaneous transmission of changes in marginal costs and mark-up factors via the exchange rates onto import prices. Firstly, a depreciation in the domestic currency should increase the foreign currency price of imports, thereby raising domestic import prices. Secondly, a rise in the marginal costs in foreign currency terms should also lead to an increase in import prices through the cost channel as the firms would be looking to recover the cost of production by charging higher prices. Thirdly, based on pricing to market by the foreign firms, any increase in the mark-up factors would be associated with a rise in the domestic demand and this would translated into a rise in the import price. It is also an empirical matter as to whether each of these factors have an impact upon import prices, whether the effect is similar across countries, equivalent in the long and short run and linear. To this matter we now turn.

4. Data

We examine pass through in 14 emerging economies: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, India, Indonesia, Malaysia, Mexico, Pakistan, Philippines, Thailand and Venezuela. The sample period is 1980-2004. The variables included in our study are import prices, nominal effective exchange rates, a foreign marginal cost measure, domestic demand measure as a proxy for mark-up factor and the locally available import substitute goods price index. Data availability can be limited when studying emerging economies. Data on import prices (P_t^M) was taken from IMF *International Financial Statistics* database with a common base period of the year 2000 = 100. Import prices are measured in domestic currency terms. Nominal Effective Exchange Rate (S_t) index for each of the countries in our sample was also taken from IMF *International Financial Statistics* database and rebased to the year 2000 = 100. The Nominal Effective Exchange Rate is the weighted average of the bilateral exchange rate defined as the number of units of domestic currency per unit of foreign currency; therefore a depreciation is a rise in S_t. As Ito et al. (2005) point out the importance of changes in import composition across diversified trading partners in examining the movement of the exchange rate pass-through over time, nominal effective exchange rates are preferred to bilateral rates.

A measure of foreign marginal costs is difficult to obtain, especially for emerging economies. In this regard several authors such as Bahroumi (2005), Khundrakpam (2007) and Fujii (2004) have shown that proxies for foreign marginal cost measures (MC_t) can be constructed from a measure of the wholesale price movements of the major trade partners of any country.[3] We followed this method in our

[3] Foreign Marginal Cost (MC_t) is constructed by removing the Nominal Effective Exchange Rate ($NEER_t$) and domestic Wholesale Price Index (WPI_t) from the Real Effective Exchange Rate ($REER_t$). Hence, MC_t = ($REER_t$

study. Some studies (see Khundrakpam, 2007, and Bahroumi 2005) on exchange rate pass through have constructed the domestic mark-up factors (μ_t) using measures of elasticity of demand. Therefore mark-up factors indirectly depend upon domestic demand conditions. Indices of domestic demand such as industrial production were employed by Khundrakpam (2007) and Gross Domestic Product in Bahroumi (2005). We considered Gross Domestic Product as proxy to represent domestic demand (E_t) in our study. It was taken from the World Bank *World Development Indicators* database.

The financial crises that hit both Latin American and Asian economies led to drastic changes to their respective monetary policy and exchange rate targeting measures. Balance of payments crises and chronic inflation were the main problems facing several Latin American economies such as Argentina, Brazil, Bolivia, Colombia, Ecuador, Mexico and Venezuela during our sample. During the 1980s Argentina's economy was characterised by hyperinflation which led to dollarisation of its national currency. In 1991, the peso to dollar convertibility plan reduced inflation and the resulting exchange rate appreciation led to relative price distortions. During the period from 1982 to 1988, a shortage of foreign exchange reserves has been reflected in a series of devaluations of the Chilean currency by nearly 50% of its value. However, since the early 1990s several free trade agreements were signed by Chile which led to increased trade and growth. Colombia has had persistently higher level of import prices during the 1980s and 1990s due to inflation persistence. Taylor (2000) states that lower and more stable rates of inflation among inflation targeting economies is a crucial factor behind the slowing down of import prices and thereby lower exchange rate pass

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$\times\, WPI_t)/NEER_t$. The exchange rate is defined as domestic currency per unit of foreign currency. Therefore a rise in the exchange rate indicates a domestic currency depreciation. In our study both the indices $REER_t$ and $NEER_t$ are based on unit labour costs as given in Bank for International Settlements database and WPI_t was taken from the IMF *International Financial Statistics*. Bailliu and Fujii (2004) have adopted a variation of the above using country specific unit labour cost measures.

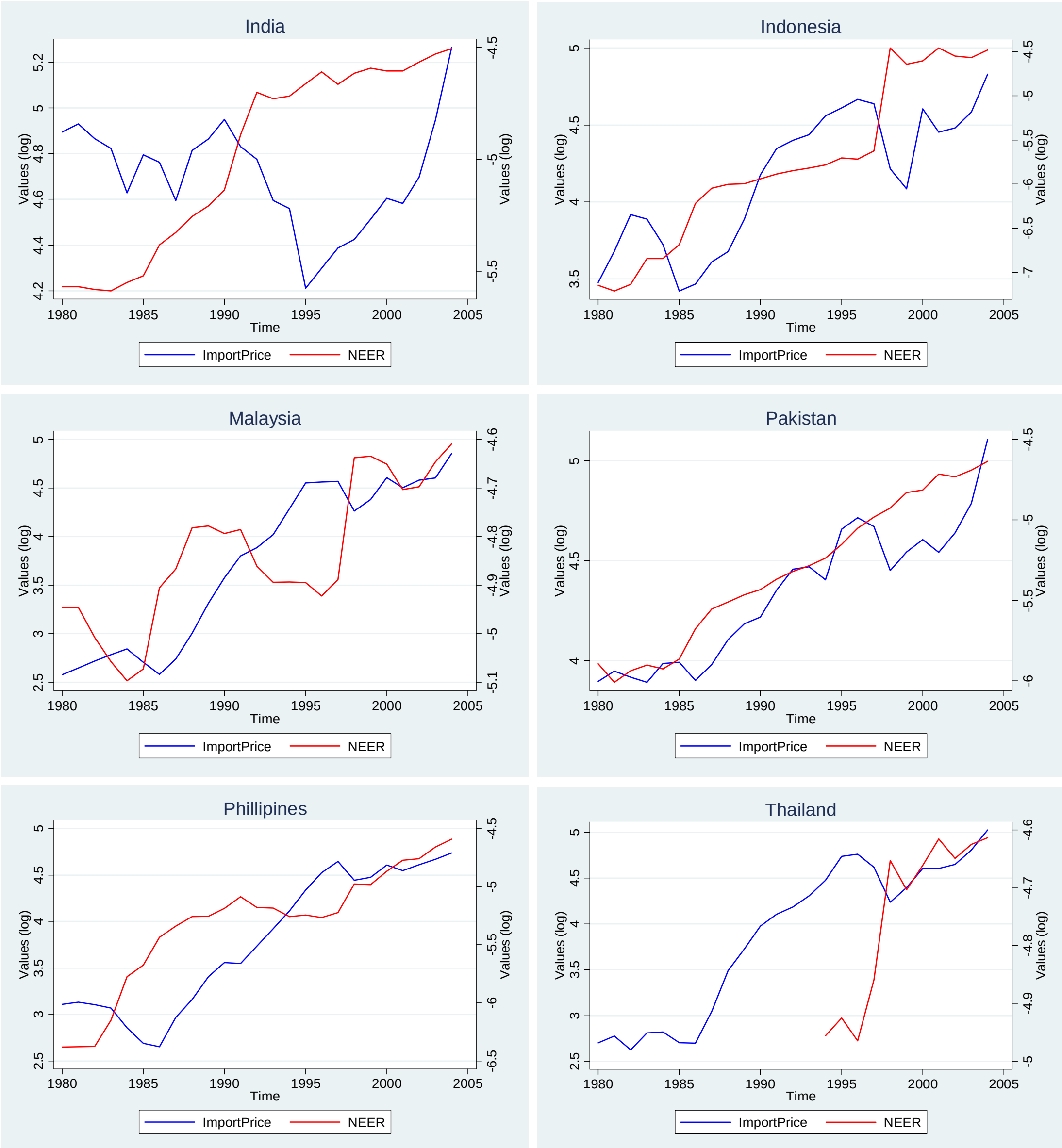
through. Bolivian trade was characterised by price stability during the 1990s, but import prices rose largely on account of devaluation of Brazilian currency and the Argentinean crisis. External debt, high inflation and stagnating GDP in Ecuador led to exchange rate depreciation. Import prices nearly doubled during the two decades 1980-2000. As expected dollarization lowered transaction costs but increasing inflation reduced the price competitiveness of the trade.

Campa (2002) states that increased exchange rate volatility and speculation about the Mexican Peso led to its depreciation which resulted in increased import prices. Economic reforms on several fronts including a shift to the market determined exchange rate system since 1991 and dismantling of import tariffs and quantity restrictions resulted in increased trade openness. Economic crisis during the early 1980s in Venezuela was corrected by resorting to currency devaluation and shifting to a multi-tier exchange rate system, increased agricultural subsidies and import protectionism. But during the late 80s and early 90s the drop in the price of oil could not generate enough exports to sustain foreign debts. This led to adopting a floating exchange rate system which brought down the currency value further vis-à-vis the US dollar.

Most of the Asian economies in our study experienced a shift from fixed to flexible exchange rate systems during the 1990s. This is a common reason for increased inflation and exchange rate pass through. As Khundrakpam (2007) reports, the depreciation of India's exchange rate slowed down but there was an increase in the inflation along with import prices since the late 1990s. Indonesian Rupiah depreciated by nearly 50% of its value during 1997. Loss of price competitiveness due to depreciation led to sharp rise in inflation and remained higher than other Asian economies upto 2003. According to Webber (2000) the Malaysian Ringitt lost about

Figure 1. Import Prices and Nominal Effective Exchange Rates (NEER)

Figure 1 contd. Import Prices and NEER



34% of its value just during 1996-1997 due to the crisis and the import prices registered a growth of about 32% during the same period. Much of the increases in import prices of petroleum and agricultural products in Pakistan were due to deteriorating terms of trade since the mid 1990s. Chan (2008) has noted that Philippines is characterised by high exchange rate volatility which resulted in high pass through onto its import prices followed by consumer price indices. Thailand had a fixed exchange rate regime prior to 1997 coupled with moderate inflation rates. A sudden shift to a flexible system in 1997 resulted in a 25% depreciation of the Baht. Its maximum effect was on increases in import prices followed by producer prices and consumer prices.

5. Econometric Methodology

In this section we review empirical methods utilised in the empirical component of this paper. We firstly consider panel unit root tests as proposed by Im, Pesaran and Shin (2003), we discuss the panel data estimation methods adopted, then present our linear specification for testing pass through. Finally we outline how we account for asymmetric effects.

5.1 Panel Unit Root Tests

In this study we use the panel unit root test from Im, Pesaran and Shin (2003) (IPS) to test for potential non-stationarity in a panel context. Although our subsequent methods are robust to a mixture of stationary and non-stationary regressors, they are not robust to stationary dependent variable and non-stationary regressors. We start with a first order AutoRegressive AR (1) process for the panel time series y_{it} of the form:

$$y_{it} = \rho_i y_{it-1} + X_{it}\delta + u_{it}, \tag{4}$$

where $i = 1,2,...,N$ cross section units that are observed over T time periods $t = 1,2,...,T$. The matrix X_{it} represents the exogenous variables in the model and include any fixed effects or individual trends. ρ_{it} are the autoregressive coefficients and u_{it} are the error terms that are mutually independent. If $\rho_{it} < 1$, y_{it} is considered to be weakly stationary. But, if $\rho_{it} = 1$, y_{it} contains a unit root. There are other variants of this AR (1) form that combine the individual unit root tests to arrive at a panel specific result. The panel unit root test proposed by Im et al. (2003) typically allows the ρ_{it} to vary across cross sections. The t-statistic (IPS) test is based on a separate Augmented Dickey Fuller (ADF) regression for each cross section.

$$y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{p_i} \varphi_{ij} \Delta y_{it-1} + \mathbf{x}'_{it}\delta + u_{it} \tag{5a}$$

$$u_{it} = \sum_{j=1}^{p_i} \varphi_{ij} \Delta u_{it-j} + \varepsilon_{it} \tag{5b}$$

This process tests the null hypothesis $H_0 : \rho_i = 1$ for all *i* against $H_\alpha : \rho_i < 1$ for at least one *i*. The t-bar test statistic is the average for the ρ_i from the ADF regressions.

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{\rho_i} \tag{6}$$

In the general case where the lag order in equation (5a) is non zero for some cross sections, Im, Pesaran and Shin (2003) show that $\bar{t}_{NT}$ asymptotically follows the standard normal distribution as is given as $W_{t_{NT}} \sim N(0,1)$.

5.2 Pooled Mean Group Estimation

We taken advantage of the available data for each of the countries in our study, and construct a panel data set. Pesaran et al. (1999) and Schich and Pelgrin (2002) have emphasized the importance of the right choice of econometric methodology in dealing with panels data. Pesaran et al. (1999) proposed the Pooled Mean Group Estimation (PMGE) and this is advantageous since it incorporates both long run and short run effects by adopting an Autoregressive Distributive Lag (ARDL) structure and estimating this as an Error Correction Model. The short run coefficients are estimated by averaging the cross sectional estimates while the long run coefficients are pooled since economic theory typically have stronger implications for long run relationships rather than dynamics of adjustment as is the case in this study. The homogeneity of long run coefficients is tested by a joint Hausman test, which is distributed as χ^2.

Pesaran et al. (1999) state that irrespective of the order of integration of the explanatory variables (i.e. whether I(0) or I(1)), by taking sufficient lags in the ARDL structure, we can still trace the effect of the explanatory variables on the dependent variable, and thereby can overcome the problem of spurious regression. Also the error correction mechanism (ECM) integrates the short run dynamics and the long run equilibrium without losing crucial information about the long run. The PMGE is based on an autoregressive distributed lag ARDL (*p*, *q*, *q*… *q*) model of the type

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{it-j} + \sum_{j=0}^{q} \delta'_{ij} \mathbf{x}_{it-j} + \omega_i + u_{it} \tag{7}$$

Where $\mathrm{x}_{it}\left(k \times 1\right)$ is the vector of explanatory variables for group *i*, ω_i represents the fixed effects, λ_{ij} are the scalars which are the coefficients of the lagged dependent variables and δ_{it} are $\left(k \times 1\right)$ coefficient vectors. *T* must be large enough to accommodate the estimation for every cross section.

Again equation (7) can be conveniently re-parameterized as:

$$\Delta y_{it} = \varphi_i y_{it-1} + \beta'_i \mathbf{x}_{it} + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta y_{it-j} + \sum_{j=0}^{q-1} \delta^{*'}_{ij} \Delta \mathbf{x}_{it-j} + \omega_i + u_{it} \tag{8}$$

where

$$\varphi_i = \left(\sum_{j=1}^{p} \lambda_{ij} - 1 \right) = -\left(1 - \sum_{j=1}^{p} \lambda_{ij} \right), \beta_i = \sum_{j=0}^{q} \delta_{ij}, \lambda^*_{ij} = -\sum_{m=j+1}^{p} \lambda_{im} \text{ and } \delta^*_{ij} = -\sum_{m=j+1}^{q} \delta_{im} \tag{9}$$

As the PMGE technique adopts the autoregressive distributed lag model (ARDL) in estimating a dynamic relationship between the dependent variable and the explanatory variables, in our study the ARDL model could be specified as;

$$\Delta y_{it} = \varphi_i y_{it-1} + \beta'_i \mathbf{x}_{it} + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta y_{it-j} + \sum_{j=0}^{q-1} \delta^{*'}_{ij} \Delta \mathbf{x}_{it-j} + \omega_i + u_{it} \tag{10}$$

Where y_{it}, the dependent variable is the import price and X_{it} is the vector of explanatory variables for group *i*.

5.3 Empirical Specification

We now move to an empirical examination of pass through. Following Gil-Pareja (2003), Khundrakpam (2007) and Bahroumi (2005), the empirical long run relationship to be estimated in our study is based upon equation (3) and is laid out in logarithmic terms

$$ln\, P_t^M = \alpha_0 + \alpha_1\, ln\, S_t + \alpha_2\, ln\, MC_t + \alpha_3\, ln\, \mu_t + \varepsilon_t \qquad (11)$$

From before import prices P_t^M are a function of S_t, the nominal effective exchange rate, MC_t, marginal costs, and domestic demand, μ_t. Additionally in equation (11) we have the error disturbance term, ε_t, and a constant, α_0. We expect the following relationship between the explanatory variables and the dependent variable. A rise in the exchange rate, a domestic currency depreciation, will be associated with an increase in import prices as foreign goods become more expensive (i.e. $\alpha_1 > 0$). As foreign exporters engage in pricing to market by covering their marginal costs of production in imperfectly competitive markets, an increase in the foreign marginal costs increases the import price (i.e. $\alpha_2 > 0$). Finally, favourable domestic demand conditions should induce the foreign firms to charge higher import prices, therefore the coefficient α_3 is expected to be positive.

5.4 Exchange Rate Asymmetry

Our benchmark approach assumes a linear relationship between the exchange rate and import prices. Following several authors including Menon (1996), Wickramasinghe (1999), Webber (2000) and Khundrakpam (2007) we introduced dummy variable for the possible asymmetries in the exchange rate appreciation and depreciation. Interaction of the dummy variable with the exchange rate can be expressed in the following manner:

$$S_t = \left(\alpha_1 + \alpha_2 D_t\right) S_t$$

$$= \alpha_1 S_t + \alpha_2 D_t \times S_t \qquad (12)$$

The dummy variable assumes a value of 1 for the periods of appreciation (a fall in S_t) and 0 for periods of depreciation and can be described in the following manner:

$$D_t = 0 \text{ if } \Delta S_t > 0 \text{ and } D_t = 1 \text{ if } \Delta S_t < 0 \qquad (13)$$

Interaction of the dummy variable with the exchange rate in equation (12) yields

$$lnP_t^M = \alpha_0 + \alpha_1 lnS_t + \alpha_2 lnS_t \times D_t + \alpha_3 lnMC_t + \alpha_4 \ln \mu_t + \varepsilon_t \qquad (14)$$

In the above equation (14), the interaction term is expected to capture asymmetry in the exchange rate fluctuations. If its coefficient (i.e. α_2) has a positive sign then the effect of depreciation of exchange rates on import prices are greater than appreciations. Conversely, a significant and negative coefficient on the interaction variable implies greater effect of appreciations on the import prices.

6. Results

6.1 Panel Unit Root Results

Before we proceed with our panel regressions for pass through we firstly identify whether our series are stationary. Our panel unit root test results based upon Im et al. (2003) are set out in Table 1, for both levels and first differences and with different deterministic components. The results show that P_t^M was stationary for both levels and first differences. S_t was found to be stationary under both specifications, therefore we reject the null hypothesis of unit root in Table 1. Also for MC_t we reject the null of unit root. E_t turned out to be consistently stationary throughout all different specifications. Therefore we can be confident that our panel regressions are not unbalanced and not suffering from a spurious regression problem. We now proceed with the main results of the paper.

Table 1. Panel Unit Root Results

	Level [1]	Level [2]	First Difference [1]	First Difference [2]
lnP_t^M	-4.710* [p=0.01]	-4.711* [0.00]	-19.687* [0.00]	-19.657* [0.00]
$ln\,S_t$	-5.530* [0.01]	-5.759* [0.00]	-9.528* [0.01]	-9.509* [0.02]
$ln\,MC_t$	-4.160* [0.00]	-4.257* [0.00]	-15.021* [0.02]	-14.996* [0.07]
$ln\,E_t$	-3.592* [0.00]	-3.626* [0.02]	-18.863* [0.00]	-18.839* [0.03]

Note: This table contains panel unit root results from the Im et al. W-stat (2003). Specification [1] indicates intercept only and [2] indicates trend and intercept. Time period is 1980-2004 for 14 countries. Probability value are square brackets, we reject at the 5% significance level the null of non-stationarity when the p-value is less than 0.05, and mark this with an asterisk (*). P_t^M is Import Prices. S_t is the Nominal Effective Exchange Rate. MC_t is Foreign Marginal Cost. E_t denotes the domestic demand.

6.2 Combined Panel Results

To assess the degree of pass through in a panel of 14 emerging economies, we use Pesaran et al. (1999) Pooled Mean Group Estimation (PMGE). This allows us to differentiate long and short run effects and also panel heterogeneity. In Table 2, we present basic PMGE regression results for exchange rate pass through to import prices. Pesaran et al. (1999) emphasizes that we should account for the common factors across countries, therefore we present raw and cross sectionally demeaned our data. PMGE uses an ARDL model and the lag length was determined by Schwarz Bayesian Information Criteria (SBC).

We firstly consider the impact of the exchange rate on the import prices in a linear model in the first two columns of results in Table 2. In the long run for both raw and demeaned data indicate that the exchange rate S_t has a positive and significant effect on import prices (i.e. estimated coefficient = 0.03 and t-statistic = 2.29). A depreciation in the domestic currency would result in a higher import price for the importing country in the long run. Pass through is far from complete but using the more appropriate demeaned data suggests the pass through effect is significant in the long

Table 2. Panel Regression Results

	Raw Data	Demeaned	Raw Data	Demeaned
Long Run Coefficients				
$ln\, S_t$	0.013 (t=1.180)	0.030* (2.286)	0.053* (2.958)	1.851* (7.526)
$ln\, MC_t$	0.103* (6.164)	-0.006 (-0.494)	0.011 (0.213)	4.264* (8.514)
$ln\, E_t$	1.043* (10.865)	1.272* (8.745)	1.796* (7.706)	0.211* (3.706)
$ln\, S_t \times D_t$			0.038* (4.161)	0.018* (11.738)
Short Run Coefficients				
Error Correction	-0.483* (-3.310)	-0.530* (-4.851)	-0.348* (-3.942)	-0.122* (-2.169)
$\Delta\, ln\, S_t$	-0.493* (-2.665)	-0.190 (-1.621)	-0.271 (-1.087)	-0.617* (-3.154)
$\Delta\, ln\, MC_t$	0.150 (0.391)	-0.459* (-2.112)	-0.004 (-0.705)	-0.092 (-0.516)
$\Delta\, ln\, E_t$	4.027* (2.016)	3.185* (2.243)	0.808 (0.059)	1.826 (0.957)
$\Delta ln\, S_t \times D_t$			-0.013* (-3.700)	0.003* (3.200)
Hausman Test	4.19 [pval = 0.24]	1.60 [pval = 0.66]	20.09 [pval = 0.00]	42.84 [pval = 0.00]
Number of Obs.	279	279	279	279

Notes: This table presents Pooled Mean Group Estimates for a panel of the total manufacturing sector. T-values are in parentheses. Time period is 1980-2004. The panel consists of fourteen emerging economies. Asterisk indicates significance at the 5% level. Specifications include raw data and cross section demeaned data and SBC determined lag length. Hausman test examines the long run homogeneity of the panel, probability values less than 0.05 reject the null hypothesis. Dependent variable is logged import price.

run. With a Hausman Test statistic value of 1.60, the null hypothesis could not be rejected. This suggests that we can pool our long run results and there is not significant difference in a linear specification in our panel of 14 countries. The short run coefficient is negative but insignificant for an average of short run coefficients. This emphasizes that pass through operates in the long run to a greater extent. Additionally it is worthwhile discussing the impact of costs and our mark up proxy on import prices. While the latter, in the form of domestic demand, is significant and the appropriate sign, marginal costs do no play an important role in the long run. The error correction term is significant and the right sign.

These results suggest that we can pool our 14 countries based upon a linear specification. However, a linear specification may not be appropriate given evidence from Marston (1990) and Webber (2000) of important non-linearities. Consequently we asses asymmetric pass through effects from depreciations and appreciations. To do so we use $S_t \times D_t$ an interaction variable which intends to capture asymmetry in the pass through of exchange rates to import prices. The results for this panel are given in Table 2 in columns three and four, for raw and demeaned data. We find evidence of significant pass through effects in the long run. And an important asymmetric effect. This result coincides with other works such as Webber (2000), Pollard and Coughlin (2004) and Khundrakpam (2007). Unfortunately the Hausman test statistic for the cross sectionally demeaned results rejected the long run null hypothesis of common pass through effects. For this reason and also to further examine the different responses between regions we split the panel into Latin America and Asia respectively.

6.3 Results for Latin America

Panel regression results for the extent of pass through for eight Latin American countries are presented in Table 3. Under a simple linear specification, which does not differentiate appreciations and depreciation, we find that pass through was positive, significant and incomplete in column two, with cross sectionally demeaned data. There were also important roles for marginal costs and demand. The Hausman test indicates that Latin American is consistently homogeneous. The asymmetric exchange rate effect is positive (in column four) but the linear exchange rate effect is only significant at the 10% level. This highlights an important asymmetric exchange rate effect in the long run for Latin American countries. Hence we extent single country studies to a panel context (see Webber, 2000, Khundrakpam 2007). Asymmetry could be due to: marketing

Table 3. Panel Regression Results for Latin America

	Raw Data	Demeaned	Raw Data	Demeaned
Long Run Coefficients				
$ln\, S_t$	0.010 (t=0.889)	0.036* (3.678)	0.049* (3.075)	0.025 (1.726)
$ln\, MC_t$	0.100* (5.453)	-0.027* (-3.292)	0.120* (3.423)	-0.026* (-2.553)
$ln\, E_t$	5.453* (9.450)	0.599* (1.964)	2.557* (11.650)	0.916* (3.863)
$ln\, S_t \times D_t$			0.028* (3.651)	0.020* (2.475)
Short Run Coefficients				
Error Correction	-0.689* (-4.519)	-0.635* (-4.083)	-0.582* (-5.141)	-0.401* (-3.283)
$\Delta\, ln\, S_t$	-0.538* (-3.635)	-0.187* (-2.182)	-0.375* (-3.687)	-0.088 (-1.879)
$\Delta\, ln\, MC_t$	-0.470* (-2.064)	-0.357 (-1.477)	-0.070* (-5.104)	-0.010* (-3.280)
$\Delta\, ln\, E_t$	4.734 (1.506)	2.708 (0.706)	23.076 (1.859)	2.210* (5.007)
$\Delta ln\, S_t \times D_t$			0.017* (2.810)	0.008* (3.238)
Hausman Test	5.94 [pval = 0.11]	6.41 [pval = 0.09]	9.00 [pval = 0.06]	7.43 [pval = 0.11]
Number of Obs.	164	164	164	164

Notes: This table presents Pooled Mean Group Estimates for a panel of the total manufacturing sector. T-values are in parentheses. Time period is 1980-2004. The panel consists of eight Latin American countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico and Venezuela. Asterisk indicates significance at the 5% level. Specifications include raw data and cross section demeaned data and SBC determined lag length.. Hausman test examines the long run homogeneity of the panel, probability values less than 0.05 reject the null hypothesis. Dependent variable is logged import price.

structure, production technology switching and market share (see, Foster and Baldwin, 1986, Ware and Winter, 1988 and Marston, 1990).

6.4 Results for Asia

Table 4 presents the split panel results for Asia under the linear and the asymmetric models. In the long run, the estimates for S_t were positive and significant under all the models. The estimates for the variable MC_t in the long run were positive although not statistically significant throughout the specifications. In the short run, the co-efficient of MC_t displayed statistical significance in both the extended model

Table 4. Panel Regression Results for Asia

	Raw Data	Demeaned	Raw Data	Demeaned
Long Run Coefficients				
$ln\, S_t$	0.675* (t=9.360)	0.308* (7.115)	0.637* (5.980)	0.877* (4.480)
$ln\, MC_t$	0.093 (0.273)	0.184 (1.108)	0.476 (1.320)	1.314* (3.210)
$ln\, E_t$	2.286* (8.351)	0.915* (2.523)	1.902* (6.740)	1.090* (2.477)
$ln\, S_t \times D_t$			0.018 (1.690)	0.080* (2.592)
Short Run Coefficients				
Error Correction	-0.504* (-3.919)	-0.563* (-2.854)	-0.373* (-4.604)	-0.208* (-4.773)
$\Delta\, ln\, S_t$	-0.436 (-1.523)	-0.139 (-1.000)	-0.827* (-3.200)	-0.021 (-0.116)
$\Delta\, ln\, MC_t$	0.802 (1.268)	0.106* (1.978)	0.177* (3.434)	-0.274* (2.004)
$\Delta\, ln\, E_t$	7.035 (1.397)	5.172 (1.185)	1.004 (0.164)	0.227* (4.325)
$\Delta ln\, S_t \times D_t$			-0.007* (-3.205)	-0.012* (3.142)
Hausman Test	7.66 [pval = 0.05]	1.68 [pval = 0.64]	N.A.	N.A.
Number of Obs.	130	130	130	130

Notes: This table presents Pooled Mean Group Estimates for a panel of the total manufacturing sector. T-values are in parentheses. Time period is 1980-2004. The panel consists of six Asian countries: India, Indonesia, Malaysia, Pakistan, Philippines and Thailand. Asterisk indicates significance at the 5% level. Specifications include raw data and cross section demeaned data and SBC determined lag length. Hausman test examines the long run homogeneity of the panel, probability values less than 0.05 reject the null hypothesis. NA is Not Available. Dependent variable is logged import price.

specifications. However, its estimates under demeaned specification of the extended model which shows negative sign could indicate some asymmetric interaction with the exchange rates in the short run.

A prominent result from Table 4 is that the estimates for E_t was positive and significant across all both the models and specifications. This indicates the significance of the effect of domestic demand on the import prices in the long run. The interaction variable was included only under the extended model and had consistently positive coefficients for the long run. It was also of a greater magnitude than in Latin American countries. This may explain the failure of the Hausman test in Table 2 and hence regional differences in response to the exchange rate. Unfortunately we only have evidence of poolability for Asian economies with a linear specification so we can not rule out further heterogeneity in Asian countries in their responses to asymmetry.

7. Conclusions

Several studies dealt with the phenomenon of exchange rate pass through and indicate that the presence of complete pass through in the long run and incomplete partial pass through in the short run. Firms react in different ways to the changes in the exchange rates, which results in asymmetric pass through rates across countries. Our paper firstly sets up a simple optimising model of import price determination before examining the long run exchange rate pass through phenomenon to import prices among a panel of 14 emerging economies. The results under the combined panel indicate that the exchange rate pass through effect onto import prices positive although incomplete.

We also note important asymmetric effects. These robustify our results for potential heterogeneous responses by testing poolability across countries. While exchange rate pass through appears to be similar for all countries within a linear framework, this is not the case once we take account of asymmetries. Given that these were significant this encouraged use to investigate different responses across our two regions Latin America and Asia.

Once we investigated our regional grouping evidence we find strong evidence in favour of a relatively weak but homogeneous asymmetric pass through effect for Latin American in the long run. This suggests that only depreciations of the domestic currency lead foreign firms to increase local currency prices, possibly in an attempt to retain profit margins. For Asian economies we find evidence of a stronger pass through effect compared to Latin America for both appreciation and depreciations. Any evidence of strong asymmetric depreciation effects may affect Asian economies differently. In conclusion, our results extend previous works on emerging economies like Bahroumi (2005) and Khundrakpam (2007) to a panel setting. Furthermore our results suggest an important role for marginal costs and demand as determinants of import prices. We also arrive at one general conclusion that there are important and, to some extent, homogeneity in the long run exchange rate pass through phenomenon in emerging market economies.

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Appendix

This appendix derives our stylised model of the determinants of import prices, based upon foreign firm profits, Π_t^f. Our model starts with the expression for firm profits based upon revenue from imports to the domestic economy, minus costs of production. Hence foreign firm profits are:[4]

$$\Pi_t^f = S_t^{-1} P_t^M Q_t - C_t\left(Q_t, W_t\right) \tag{A1}$$

Taking the partial derivative of equation (A1) with respect to import prices P_t^M, and by using the chain rule we get the first order condition as in equation (A2):

$$\frac{\partial \Pi_t^f}{\partial P_t^M} = S_t^{-1} Q_t + S_t^{-1} P_t^M \left(\frac{\partial Q_t}{\partial P_t^M} \right) - \left(\frac{\partial C_t\left(Q_t, W_t\right)}{\partial Q_t} \right) \left(\frac{\partial Q_t}{\partial P_t^M} \right) = 0 \tag{A2}$$

where, $\frac{\partial C_t\left(Q_t, W_t\right)}{\partial Q_t}$ indicates marginal cost.

Multiplying and dividing the first term in equation (A2) with $\left(\frac{\partial Q_t}{\partial P_t^M} \right) P_t^M$ gives us

$$\frac{S_t^{-1} Q_t P_t^M}{P_t^M} \left(\frac{\partial Q_t}{\partial P_t^M} \right) \left(\frac{\partial P_t^M}{\partial Q_t} \right) + S_t^{-1} P_t^M \left(\frac{\partial Q_t}{\partial P_t^M} \right) - \left(\frac{\partial C_t\left(Q_t, W_t\right)}{\partial Q_t} \right) \left(\frac{\partial Q_t}{\partial P_t^M} \right) = 0 \tag{A3}$$

Factoring out the common term $\left(\frac{\partial Q_t}{\partial P_t^M} \right)$ from equation (A3) gives us the following expression

$$\left(\frac{\partial Q_t}{\partial P_t^M} \right) \left[\left\{ S_t^{-1} \left(\frac{Q_t}{P_t^M} \left(\frac{\partial P_t^M}{\partial Q_t} \right) \right) P_t^M + S_t^{-1} P_t^M - \left(\frac{\partial C_t\left(Q_t, W_t\right)}{\partial Q_t} \right) \right\} \right] = 0 \tag{A4}$$

[4] The variables are defined in the main text.

The term $\left(\frac{Q_t}{P_t^M}\left(\frac{\partial P_t^M}{\partial Q_t}\right)\right)$ in the equation (A4) is the inverse of the elasticity of Q_t with respect to P_t^M. Therefore $\left(\frac{Q_t}{P_t^M}\left(\frac{\partial P_t^M}{\partial Q_t}\right)\right)$ can be written as $\left(\frac{1}{\eta_t}\right)$.

where, $\eta_t = -\left(\frac{P_t^M}{Q_t}\left(\frac{\partial Q_t}{\partial P_t^M}\right)\right)$.

Equation (A4) can be rewritten as

$$\left(\frac{\partial Q_t}{\partial P_t^M}\right)\left[\left\{-\left(\frac{S_t^{-1}P_t^M}{\eta_t}\right)+S_t^{-1}P_t^M-\left(\frac{\partial C_t\left(Q_t,W_t\right)}{\partial Q_t}\right)\right\}\right]=0 \qquad \text{(A5)}$$

Again factoring out $S_t^{-1}P_t^M$ from equation (A5), we get

$$\left(\frac{\partial Q_t}{\partial P_t^M}\right)\left[S_t^{-1}P_t^M\left\{1\text{-}\frac{1}{\eta_t}\right\}-\left(\frac{\partial C_t\left(Q_t,W_t\right)}{\partial Q_t}\right)\right]=0 \qquad \text{(A6)}$$

$$\left(\frac{\partial Q_t}{\partial P_t^M}\right)\left[\frac{S_t^{-1}P_t^M}{\mu_t}-\left(\frac{\partial C_t\left(Q_t,W_t\right)}{\partial Q_t}\right)\right]=0 \qquad \text{(A7)}$$

Where, $\mu_t = \eta_t/(\eta_t - 1)$ refers to the mark-up factor over marginal cost.

$$P_t^M = S_t\mu_t\left[\left(\frac{\partial C_t\left(Q_t,W_t\right)}{\partial Q_t}\right)\right] \qquad \text{(A8)}$$

Where, $\left(\frac{\partial C_t\left(Q_t,W_t\right)}{\partial Q_t}\right)$ is the marginal cost (MC_t).

Finally, equation (A8) can be rewritten as $P_t^M = S_t MC_t \mu_t$ which is the equation (3) in the text.