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Heads I Win, Tails You Lose: Asymmetry in Exchange Rate Pass-Through Into Import Prices*

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Abstract

We analyse exchange rate pass-through into import prices for a large group of 33 emerging and developed economies from 1980Q1 to 2010Q4. Our error correction models permit asymmetric pass-through for currency appreciations and depreciations over three horizons of interest: on impact, in the short run and in the long run. We find that depreciations are typically passed-through more strongly than appreciations in the long-run, suggesting that exporters may exert a degree of long-run pricing power. This asymmetry is stronger in economies which are more import dependent but is moderated by freedom to trade and a positive output gap. Given that this pass-through asymmetry is welfare-reducing for consumers in the destination market, a key macroeconomic implication is that import-dependent economies, in particular, can benefit from trade liberalisation.

Keywords: Exchange Rate Pass-Through; Asymmetry; Nonlinear ARDL Model; Random Coefficients Panel Data Model; Emerging Markets.

JEL Classifications: F10; F14; F30; F31.

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1 Introduction

A substantial literature has studied the transmission of exchange rate fluctuations into the prices of internationally-traded goods. Interest in the analysis of exchange rate pass-through (ERPT) is motivated by its relevance for understanding the likely effects of monetary policy interventions and its role in informing important debates on the international transmission of economic cycles, global trade imbalances and the optimality of alternative exchange rate regimes. Two polar cases are illustrative. First, exporters may exercise pricing power by maintaining the export price fixed in their own currency as a markup over marginal costs, a strategy known as *producer currency pricing* (PCP). In this case, ERPT is complete and the price faced by importing firms in their local currency will fully reflect exchange rate movements. At the other extreme, the price paid by importers in their own currency will be insulated from fluctuations in the exchange rate (zero ERPT) if exporters choose to fully absorb any exchange rate shock within their operating margins, a strategy known as *local currency pricing* (LCP). In the context of multiple markets, LCP typically manifests as 'pricing-to-market' behaviour.

Under the assumption of perfectly competitive and frictionless markets, the law of one price indicates that all exchange rate shocks, irrespective of their size and sign, are rapidly and completely reflected in import prices. This view is embedded within many New Open-Economy Macroeconomic models that have informed debates on the optimal conduct of monetary policy and its welfare implications. However, the evidence suggests that, in practice, exporting firms often operate in imperfectly competitive markets and that ERPT is sluggish and incomplete.

We study asymmetric ERPT with respect to the direction of exchange rate changes — that is, appreciation versus depreciation. Throughout the paper, the term appreciation (depreciation) is used to describe an increase (decrease) in the value of the importer's local currency versus the exporter's currency. Our analysis concentrates on *stage one* ERPT, that is, pass-through into import prices 'at the dock' or the point of entry into the destination market. Unlike working with *overall* ERPT into a broad price index like CPI, our approach obviates the need to control for confounding factors such as local transportation costs, storage costs and marketing costs.

We make several contributions to the literature, starting with our dataset. We examine a large unbalanced panel dataset covering 14 emerging markets (EMs) and 19 developed markets (DMs) over a maximum time period of 1980Q1 to 2010Q4. We are unaware of any prior paper on directional asymmetry that has considered such a representative cross-section of countries. The inclusion of many EMs in our sample reflects their growing importance in international trade. The IMF's *Direction of Trade Statistics* reveals that the proportion of world exports accounted for by EMs doubled from 1990 to 2010. Furthermore, rather than relying on common proxies for the foreign export price such as foreign producer price indices (e.g., Bussière, 2013; Marazzi et al., 2005) or foreign headline consumer price indices (e.g., Marazzi and Sheets, 2007), we construct an effective export price index for each importing country as a trade-weighted combination of the foreign export prices that it faces.

Our estimation framework also extends the frontier demarcated by the existing literature. We adopt recent innovations in asymmetric error correction modelling to investigate the presence of impact, short- and long-run asymmetries in import ERPT. Specifically, in the first stage of our analysis, we use the nonlinear autoregressive distributed lag (NARDL) modelling framework of Shin et al. (2014) to estimate ERPT elasticities on a country-by-country basis. This methodology is not without precedent in the literature on *overall* (or consumer price) ERPT behaviour, where Delatte and Lopez-Villavicencio (2012) have used NARDL models to study overall ERPT for a group of four DMs. However, at the time of writing, we are aware of no existing empirical application to *stage one* (or import) ERPT.

Having estimated NARDL models for each importing country, we then estimate an array of panel pass-through models using the Mean Group Estimator proposed by Pesaran and Smith (1995). This involves identifying desired groups of importing countries and then averaging the relevant country-specific NARDL parameter estimates to jointly exploit the time and cross-section variation in the data, thereby achieving more precise estimation and inference. Finally, we employ cross-sectional regressions in order to relate directional ERPT asymmetry to the economic characteristics of the importing market.

Our analysis suggests that depreciations are passed-through to import prices more vigorously than appreciations over the long-run. Interestingly, we observe no clear distinction between EMs and DMs in this regard, which suggests that the 'fear of floating' among many EMs has no basis in import price ERPT behaviour. We also find a positive link between the extent of the long-run ERPT asymmetry and *import dependence*, which is a proxy for import penetration. This strongly suggests that the pricing decisions of exporting firms are related to the extent of their market power. However, the link between ERPT asymmetry and import dependence is weaker for importing economies that enjoy greater trade freedom and/or a positive output gap. The moderating effect of *trade freedom* on ERPT asymmetry is consistent with a branch of the theoretical literature which contends that greater openness enhances market competition (e.g., Daniels and VanHoose, 2013; Gust et al., 2010; Kleshchelski and Vincent, 2009). Meanwhile, the positive link between long-run ERPT asymmetry and the *output gap* suggests that exporters may act to enhance their market share in fast growing economies. The moderating effect of the output gap on ERPT asymmetry is somewhat consistent with a body of work which argues that larger market size induces stronger competition (Melitz and Ottaviano, 2008).

This evidence speaks to policymakers and complements a prolific theoretical and empirical literature on goods price behaviour. The pattern of asymmetry that we uncover is consistent with downward nominal rigidity in import prices. To borrow a phrase from Peltzman (2000), the fact that prices rise faster than they fall adversely affects both realised and expected inflation, particularly in countries where the share of imports in consumption is large. Such asymmetric ERPT behaviour impairs the ability of exchange rate changes to correct international trade imbalances and complicates the conduct of monetary policy. However, our results also yield a natural policy implication — importing countries may limit the scope for exporters' rent-seeking asymmetric ERPT behaviour by promoting greater freedom to trade.

Our paper is closely related to two strands of the ERPT literature. First, there is a theoretical literature about the asymmetric response of exporters to appreciations/depreciations. The *capacity constraints* theory contends that exporting firms operating at full capacity cannot accommodate the surge in demand resulting from an appreciation of the importer's currency. Thus, exporters may rationally choose to retain appreciations by widening their markups, a strategy consistent with short-run downward import price stickiness. The *market share* theory posits that foreign firms seeking to gain or defend market share may absorb depreciations of the importer's currency while passing-through appreciations in order to quote competitive prices (e.g. Krugman, 1987; Marston, 1990). Naturally, the degree of *competition* is expected to play a role as exporters operating in weakly competitive markets may systematically pass-through depreciations to preserve their markups (Bussière, 2013). Finally, the *technology switching* model of Ware and Winter (1988) suggests that exporters can afford to pass-through appreciations and absorb depreciations if they are able to strategically switch between foreign and domestic sources of production inputs and to alter the type of production technology. However, since technology switching (even at no cost) takes time to be implemented and contracts with input providers are likely to have fixed terms, this mechanism is hard to reconcile with short-run asymmetries.

Our paper is also related to an empirical literature about directional (or sign) asymmetry in import ERPT. This literature is still rather sparse. Most empirical models accommodate only short-run directional asymmetry and focus exclusively on a single country or a very small cross-section of countries. To mention a few, Herzberg et al. (2003) analyses the UK from 1975 to 2001, Marazzi et al. (2005) and Pollard and Coughlin (2004) work with US data covering the 1983-2004 and 1978-2000 periods, respectively, and Bussière (2013) examines the G7 economies from 1980 to 2006. The findings of these studies are mixed. Herzberg et al. cannot refute the hypothesis of symmetric short-run import ERPT, while Pollard and Coughlin document short-run sign asymmetry for about half of 30 US industries but the direction is ambiguous. By contrast, Bussière finds that depreciations tend to be passed more strongly than appreciations in the short-run. To the best of our knowledge, Webber (2000) is the only study of *long-run* directional asymmetry in import ERPT. By estimating a cointegrated vector autoregressive model that focuses on long-run asymmetry, Webber finds that depreciations are passed-through more strongly than appreciations for a group of eight Asian economies. In the context of *overall* ERPT into CPI, Delatte and Lopez-Villavicencio (2012) reach a similar conclusion based on NARDL models estimated for Germany, Japan, the UK and the US.

Our exploration of the factors determining the extent of long-run asymmetry in import ERPT builds on the existing literature which investigates the main drivers of the strength of ERPT. Several studies have shown that ERPT is stronger for large exchange rate changes, a kind of nonlinear response typically associated with menu costs (Pollard and Coughlin, 2004; Posedel and Tica, 2009; Przystupa and Wrobel, 2011; Ben Cheikh, 2012; Bussière, 2013). Macroeconomic risk has also been identified as a factor influencing ERPT. Using US data from 1969–1999, Taylor (2000) shows that the strength of ERPT is constrained by a low level and volatility of inflation. He provides an elegant theoretical explanation based on the link between pricing power and the persistence of costs and other firms' price changes. Supporting empirical evidence has been provided by Choudhri and Hakura (2006). A raft of other macrofinancial factors have also been considered in the literature for their role in determining the strength ERPT, including the output gap, output growth and emerging market bond spreads, among others (e.g. Chew et al., 2011; Nogueira and Leon-Ledesma, 2011; Brun-Aguerre et al., 2012; Mallick and Marques, 2013; Ben Cheikh and Rault, 2014).

Finally, our finding that the long-run asymmetry in import ERPT does not differ significantly between DMs and EMs challenges some of the historical explanations of the fear of floating (Calvo and Reinhart, 2002). However, ours is not the first paper to do so. A substantial body of research challenges the received wisdom that exporters treat EMs less favourably than DMs in terms of ERPT (e.g., Bussière and Peltonen, 2008; Brun-Aguerre et al., 2012; Choudhri and Hakura, 2015). Based on a large sample of 13 DMs and 28 EMs over the period 1980–2006, Bussière and Peltonen show that the short-run exchange rate elasticity of import prices is not higher among EMs than DMs. Similarly, Brun-Aguerre et al. challenge the view that import ERPT has been universally falling in DMs but not in EMs in their analysis of 19 EMs and 18 EMs over the period 1980–2009. Choudhri and Hakura, meanwhile, analyse a sample of 18 DMs and 16 EMs over the period 1979–2010 and show that average import ERPT over short- and long-run horizons is comparable for both groups. Similar results have been established in the context of overall ERPT into CPI by Choudhri and Hakura (2006), Ca'Zorzi et al. (2007), Mihaljek and Klau (2008), Kohlscheen (2010) and Frankel et al. (2012).

The remainder of the paper is organised as follows. Section 2 discusses the data and Section 3 explains the methodology. The empirical results are presented in Section 4. Section 5 concludes. Further details of the dataset and methodology are provided in the Appendices and in a separate online data supplement.

2 Data Description

Our analysis is based on a comprehensive unbalanced panel data set covering $N = 33$ importing economies over a maximum sample period of 1980Q1 to 2010Q4. *The Economist* classifies 14 of the economies that we consider as EMs and 19 as DMs. The countries are: Argentina†, Australia, Belgium/Luxembourg, Brazil†, Canada, Chile†, China†, Colombia†, Czech Republic†, Denmark, Finland, France, Germany, Greece, Hong Kong†, Hungary†, Ireland, Israel†, Italy, Japan, Korea†, Mexico†, Netherlands, Norway, New Zealand, Singapore†, South Africa†, Spain, Sweden, Switzerland, Thailand†, the UK, and the US, where each EM is identified by a dagger symbol. Collectively, these countries accounted for 69% of world imports in 2010, with 48% due to the DMs and 21% to the EMs.

Our analysis unfolds in three stages. First, for each country $i = 1, 2, \ldots, N$, we estimate the elasticity of import prices to exchange rate changes (hereafter, the ERPT elasticity). In order to test for asymmetric ERPT, we adopt the NARDL framework developed by Shin et al. (2014). This framework allows the import price to respond dfferently to appreciations and depreciations over various horizons: on impact, in the short-run and in the long-run. The NARDL model for the ith country is estimated using time-series data on the import price, export price and exchange rate for that country. The *import price*, $P_{i,t}$, is an index capturing the domestic price of imported goods and services at the dock. The *export price* $P^*_{i,t}$, is an effective index that measures the foreign price of goods and services traded into country i from the rest of the world. We compute this index as a relative trade-weighted average of export price indices,

$P_{i,t}^* = \sum_{j=1}^{J(i)} w_{i,t}^j P_t^{j*}$ where $j = 1, ..., J(i)$ are the trading partners of importing country i, and $w_{i,t}^j$ is the import share or ratio of the imports in US$ received by country i from country j to its total imports. Consequently, $P_{i,t}^*$ measures the 'rest-of-the-world' export price faced by country i. The *exchange rate* is defined as the local (importer's) currency price of a unit of foreign (exporter's) currency, which we measure as $S_{i,t} = 1/NEER_i$, where $NEER_i$ is the nominal effective exchange rate index of foreign currency per unit of domestic currency. The lower case notation p_{it}, $p_{i,t}^*$ and $s_{i,t}$ will henceforth denote the natural log of each variable.

Table 1 summarises the distribution of quarterly log changes, $\Delta s_{i,t}$, $\Delta p_{i,t}$ and $\Delta p_{i,t}^*$, for each country. Note that the panel is unbalanced with a maximum span of 1980Q1–2010Q4. In the table, we report summary statistics over the available sample period for each country. Unsurprisingly, we observe considerably more volatility for EMs than DMs. The largest standard deviation of $\Delta s_{i,t}$ among the EMs is 11.75% (Argentina) compared to a much lower value among the DMs of just 4.54% (Japan). We observe a relatively close correspondence between the volatility of the exchange rate and the volatility of the import price — indeed, considering the 33 markets in our sample, the cross-section correlation between the standard deviation of $\Delta s_{i,t}$ and that of $\Delta p_{i,t}$ is 0.85. The two columns labelled 'depr(+)' and 'appr(-)' in Table 1 record the percentage of the sample quarters in which the domestic currency appreciates and depreciates, respectively. For the DMs, the proportion of quarterly depreciations ranges from 34% to 65% across countries, while the corresponding range for the EMs is 31% to 61%. Finally, the table reports results for two well-known unit root tests applied to the logarithmic exchange rate, import price and export price variables. In the augmented Dickey-Fuller (ADF) test the null hypothesis is unit root behaviour and the alternative hypothesis is stationarity (Dickey and Fuller, 1979). In the KPSS unit root test of Kwiatkowski et al. (1992), the aforementioned null and alternative hypotheses are reversed. In conjunction with (unreported) results of the two tests applied to quarterly log changes, the reported test statistics indicate that the three main variables in our study ($s_{i,t}$, $p_{i,t}$ and $p_{i,t}^*$) are first–difference stationary.

[Insert Table 1 around here]

In the second stage of our analysis, we employ panel data estimation methods in order to exploit both the time and cross-section variation in the data. Specifically, we use the Mean Group estimator of Pesaran and Smith (1995). To obtain a set of baseline results, we begin by studying the full panel of $N = 33$ countries. Subsequently, we group the countries into smaller subpanels. For example, we obtain separate panel ERPT estimates for the group of 19 DMs and for the group of 14 EMs. Testing for the equality of the ERPT estimates associated with these two groups allows us to investigate whether the extent of import ERPT depends on the level of economic and financial development of the importing economy.

In the final stage of our analysis, we estimate cross-section regressions to identify the main forces that drive the directional asymmetry in ERPT. Various fundamentals of the importing economy such as the level of economic development (DM versus EM), import dependence, FX volatility, the output gap, GDP per capita and the level and volatility of inflation are natural candidates. These variables have been used in the existing literature that has sought to explain variation in the extent of (symmetric) ERPT across countries and/or time periods (e.g. Taylor, 2000; Campa and Goldberg, 2005; Choudhri and Hakura, 2006; Brun-Aguerre et al., 2012).

We consider two additional variables that may drive the directional asymmetry in ERPT. First, given that the demand for commodities is highly inelastic in the short-run due to habit formation, sunk costs and the costs associated with technology-switching, international commodity markets may be particularly prone to rent-seeking behaviour on the part of exporters. Specifically, exporters selling to heavily commodity-import dependent markets may elect to pass-through depreciations more strongly than appreciations. Accordingly, our first additional variable is a *net commodity importer* indicator that we construct by regressing quarterly exchange rate changes, Δs_{it}, on a constant and quarterly changes in a broad commodity index, ΔC_t. Three regressions are run per country using the following three commodity indices: (i) the Goldman Sachs Commodity Index; (ii) the Dow Jones–UBS Commodity Index; and (iii) the Thomson Reuters/Jefferies CRB Index. For each country, our indicator is constructed by averaging the slope coefficients from the three regressions — negative (positive) values signify a commodity currency (net commodity importer). Second, we evaluate the role of *trade freedom*, which captures the extent of frictions to international trade introduced by tariff structures, trade quotas, inefficient and/or corrupt administration and capital controls. To measure trade freedom, we use item 4 of the Economic Freedom of the World index compiled by Gwartney et al. (2012). This is an index bounded between 0 and 10 where higher values signify greater freedom of trade. Trade liberalisation may encourage stronger market competition which, in turn, imposes discipline on exporters' pricing policies, reducing the scope for opportunistic pass-through behaviour. A detailed data description including the available time span for each variable and the data sources that we have consulted is available online via the journal website.

3 Methodology

3.1 Country Pass-Through Models

For each country in our sample, the time dimension is sufficient to allow us to estimate separate time-series models, thereby accommodating full heterogeneity across countries in the pass-through estimates. We adopt the NARDL modelling framework of Shin et al. (2014) which requires the following partial sum decomposition of the log of the effective exchange rate

$$s_{i,t}^{+}=\sum_{j=1}^{t}\Delta s_{i,j}^{+}=\sum_{j=1}^{t}\max\left(\Delta s_{i,j},0\right),\ s_{i,t}^{-}=\sum_{j=1}^{t}\Delta s_{i,j}^{-}=\sum_{j=1}^{t}\min\left(\Delta s_{i,j},0\right), \tag{3.1}$$

where $s_{i,t}\equiv s_{i,0}+s_{i,t}^{+}+s_{i,t}^{-}$. These partial sum processes effectively separate domestic currency depreciations ($s_{i,t}^{+}$) and appreciations ($s_{i,t}^{-}$). The initial value, $s_{i,0}$, can be set to zero without loss of generality. A sign asymmetric long-run ERPT relationship can be formalised as

$$p_{i,t}=\beta_i^{+}s_{i,t}^{+}+\beta_i^{-}s_{i,t}^{-}+\gamma_i p_{i,t}^{*}+u_{i,t}, \tag{3.2}$$

where β_i^{+}, β_i^{-} and γ_i are unknown long-run parameters to be estimated. Note that this asymmetric long-run relationship reduces the familiar symmetric form if $\beta_i^{+}{=}\beta_i^{-}$. Equation (3.2) can be re-written as $u_{i,t}=p_{i,t}-p_{i,t}^{e}$ where $p_{i,t}^{e}\equiv\beta_i^{+}s_{i,t}^{+}+\beta_i^{-}s_{i,t}^{-}+\gamma_i p_{i,t}^{*}$ is the equilibrium path of the import price for country i conditional on the exchange rate and export price levels. When written in this form, it is clear that the stationary zero-mean error process, $u_{i,t}$, represents the deviations of country i's import price from its long-run equilibrium path. Following Shin et al. (2014), embedding (3.2) within an ARDL(p,q,r) model yields the following NARDL(p,q,r) model for the aggregate import price change faced by country i at time t

$$\begin{aligned}\Delta p_{i,t} &= \alpha_i+\rho_i p_{i,t-1}+\theta_i^{+}s_{i,t-1}^{+}+\theta_i^{-}s_{i,t-1}^{-}+\lambda_i p_{i,t-1}^{*}\\ &+ \sum_{j=1}^{p-1}\varphi_{i,j}\Delta p_{i,t-j}+\sum_{j=0}^{q-1}\left(\pi_{i,j}^{+}\Delta s_{i,t-j}^{+}+\pi_{i,j}^{-}\Delta s_{i,t-j}^{-}\right)+\sum_{j=0}^{r-1}\phi_{i,j}\Delta p_{i,t-j}^{*}+\varepsilon_{i,t}\end{aligned} \tag{3.3}$$

where $\varepsilon_{i,t}\sim i.i.d.(0,\sigma_i^2)$. The parameters of interest are the long-run ERPT elasticities given by $\beta_i^{+}=-\theta_i^{+}/\rho_i$ in the case of depreciations and by $\beta_i^{-}=-\theta_i^{-}/\rho_i$ in the case of appreciations, as well as the impact and short-run ERPT elasticities for depreciations and appreciations which are collected in the vector $(\pi_{i,0}^{+},\ldots,\pi_{i,q-1}^{+},\pi_{i,0}^{-},\ldots,\pi_{i,q-1}^{-})'$.

Equation (3.3) is equivalent to the error correction representation of the conditional model given in equation (9.10) of Shin et al. (2014). Following Pesaran and Shin (1998) and Pesaran et al. (2001), Shin et al. note that the NARDL model provides unbiased estimation and inference for the long-run parameters even in the presence of weakly endogenous non-stationary explanatory variables. However, interpretation of the short-run parameters may be compromised by such endogeneity. Consequently, as with most empirical studies of ERPT in the existing literature, our analysis is predicated on the premise that changes in the import price do not contemporaneously affect exchange rates or export prices. This is a mild assumption in the present context due to the quarterly frequency of our data. Of course, a large rise in import prices may ultimately increase inflation, potentially prompting a reaction from the monetary authority and impacting upon the exchange rate. However, this mechanism is unlikely to operate within one quarter, not least because most central banks refer to year-on-year inflation measures and inflation data is typically released at relatively low frequency and with a non-negligible delay. Nevertheless, we stress that no such assumption is required when interpreting the long-run parameters.

The statistical significance of the long-run equilibrium component in (3.3) can be assessed using the F_{PSS} test statistic of Pesaran et al. (2001) or the t_{BDM} test statistic of Banerjee et al. (1998). The former is a non-standard F-test of the restriction H_0: $\rho_i = \theta_i^+ = \theta_i^- = \lambda_i = 0$, while the latter is a non-standard t-test of the single restriction H_0: $\rho_i = 0$ against the alternative H_A: $\rho_i < 0$. For both tests, we employ the critical value bounds tabulated by Pesaran et al. (2001) which are valid for variables with mixed order of integration. Shin et al. (2014) note that such flexibility is important in the context of NARDL models given that partial sum decompositions may exhibit a variety of time-series properties.

The NARDL model (3.3) is well suited to the empirical analysis of pass-through behaviour. It accommodates heterogenous asymmetries with respect to appreciations and depreciations over various horizons: on impact, in the short-run and in the long-run. In addition, it nests a number of simpler pass-through models. For instance, one may impose the restriction $\beta_i^+ = \beta_i^-$, which implies that long-run ERPT is symmetric in country i. Similarly, one may impose various restrictions on the short-run components of the model. For instance, the pairwise restriction $\pi_{i,j}^+ = \pi_{i,j}^-$, $j = 0, \ldots, q-1$ rules out any form of impact or short-run ERPT asymmetry in country i while the alternative and somewhat weaker additive restriction $\sum_{j=0}^{q-1} \pi_{i,j}^+ = \sum_{j=0}^{q-1} \pi_{i,j}^-$ implies that the short-run ERPT dynamics for country i are symmetric when evaluated over the lag structure $j = 0, \ldots, q-1$. Likewise, one may impose the restriction $\pi_{i,0}^+ = \pi_{i,0}^-$ which implies that impact ERPT is symmetric with respect to depreciations and appreciations in country i. A particularly important feature of the NARDL model is that this flexibility does not come at a high cost in terms of computational difficulty — in fact, the model is linear-in-parameters and readily estimable by OLS.

For each economy $i = 1, 2, \ldots, N$, we evaluate several hypotheses relating to different types of asymmetric ERPT. We begin with the following three hypotheses concerning *long-run* ERPT:

Hyp. 1 ***(Zero long-run ERPT for depreciations/appreciations)*** *H_0^{1+}: $\beta_i^+ = 0$ vs. H_A^{1+}: $\beta_i^+ \neq 0$ for depreciations; likewise, H_0^{1-}: $\beta_i^- = 0$ vs. H_A^{1-}: $\beta_i^- \neq 0$ for appreciations.*

Hyp. 2 ***(Complete long-run ERPT for depreciations/appreciations)*** *H_0^{2+}: $\beta_i^+ \geq 1$ vs. H_A^{2+}: $\beta_i^+ < 1$ for depreciations; likewise, H_0^{2-}: $\beta_i^- \geq 1$ vs. H_A^{2-}: $\beta_i^{1-} < 1$ for appreciations.*

Hyp. 3 ***(Symmetric long-run ERPT)*** *H_0^3: $\beta_i^+ = \beta_i^-$ vs. H_A^3: $\beta_i^+ \neq \beta_i^-$.*

Next, the following three hypotheses are formulated to investigate *impact* ERPT:

Hyp. 4 ***(Zero impact ERPT for depreciations/appreciations)*** *H_0^{4+}: $\pi_{i,0}^+ = 0$ vs. H_A^{4+}: $\pi_{i,0}^+ \neq 0$ for depreciations; likewise, H_0^{4-}: $\pi_{i,0}^- = 0$ vs. H_A^{4-}: $\pi_{i,0}^- \neq 0$ for appreciations.*

Hyp. 5 ***(Complete impact ERPT for depreciations/appreciations)*** *H_0^{5+}: $\pi_{i,0}^+ \geq 1$ vs. H_A^{5+}: $\pi_{i,0}^+ < 1$ for depreciations; likewise, H_0^{5-}: $\pi_{i,0}^- \geq 1$ vs. H_A^{5-}: $\pi_{i,0}^- < 1$ for appreciations.*

Hyp. 6 ***(Symmetric impact ERPT)*** *H_0^6: $\pi_{i,0}^+ = \pi_{i,0}^-$ vs. H_A^6: $\pi_{i,0}^+ \neq \pi_{i,0}^-$.*

Finally, we consider the following three hypotheses concerning cumulative *short-run* ERPT:

Hyp. 7 ***(Zero short-run ERPT for depreciations/appreciations)*** *H_0^{7+}: $\sum_{j=0}^{q-1} \pi_{i,j}^+ = 0$ vs. H_A^{7+}: $\sum_{j=0}^{q-1} \pi_{i,j}^+ \neq 0$ for depreciations; likewise, H_0^{7-}: $\sum_{j=0}^{q-1} \pi_{i,j}^- = 0$ vs. H_A^{7-}: $\sum_{j=0}^{q-1} \pi_{i,j}^- \neq 0$ for appreciations.*

Hyp. 8 ***(Complete short-run ERPT for depreciations/appreciations)*** *H_0^{8+}: $\sum_{j=1}^{q-1} \pi_{i,j}^+ \geq 1$ vs. H_A^{8+}: $\sum_{j=0}^{q-1} \pi_{i,j}^+ < 1$ for depreciations; likewise, H_0^{8-}: $\sum_{j=0}^{q-1} \pi_{i,j}^- \geq 1$ vs. H_A^{8-}: $\sum_{j=0}^{q-1} \pi_{i,j}^- < 1$ for appreciations.*

Hyp. 9 ***(Symmetric short-run ERPT)*** *H_0^9: $\sum_{j=0}^{q-1} \pi_{i,j}^+ = \sum_{j=0}^{q-1} \pi_{i,j}^-$ vs. the alternative H_A^9: $\sum_{j=0}^{q-1} \pi_{i,j}^+ \neq \sum_{j=0}^{q-1} \pi_{i,j}^-$.*

All of these hypotheses will be assessed in our empirical analysis below using standard asymptotic t tests and Wald tests. In addition, we implement the bootstrap testing procedure of Shin et al. (2014), which is based on cumulative dynamic multipliers obtained recursively from the parameters of the levels representation of (3.3). The cumulative dynamic multipliers $m_{i,h}^{+}$ and $m_{i,h}^{-}$ trace the evolution of the import price over horizons $h = 0, 1, \ldots, H$ in response to a unit depreciation and appreciation, respectively, of the domestic currency in period $h = 0$. Therefore, the linear combination $m_{i,h}^{+} - m_{i,h}^{-}$ measures the ERPT asymmetry at horizon h. Bootstrap confidence bands around $m_{i,h}^{+} - m_{i,h}^{-}$ can be used to test whether the asymmetry at horizon h is statistically significant (an overview of the computational details may be found in Appendix A). This bootstrap approach serves not only to provide robust small-sample inference on asymmetry in ERPT but also enables one to test for asymmetry at any desired horizon.

3.2 Panel Pass-Through Estimation

By exploiting both the time variation and the cross-section variation in the data, panel estimation of the ERPT coefficients should yield more precise estimates and more reliable inference than country-by-country NARDL estimation, which only exploits the time variation in the sample. The Mean Group (MG) estimator of Pesaran and Smith (1995) can be described in the present context as an equally-weighted average of the country-specific NARDL model estimates. As such, this panel estimation approach amounts to a flexible random-coefficients formulation of the NARDL equation (3.3) that allows for full country-heterogeneity in the parameters.

We initially consider a group composed of the full set of available countries ($N_g = N = 33$). Subsequently, we form alternative groups by ranking the countries in our sample according to the economic factors discussed in Section 2. Let us take inflation to illustrate our approach. We first compute the mean rate of inflation over time for each country in our sample. We then rank the countries from low to high inflation and, accordingly, define an above-mean or 'high' inflation group of countries and a below-mean or 'low' inflation group.

Figure 1 shows the country rankings thus obtained, while Appendix B reports the pairwise cross-sectional correlations among the different economic variables. The rankings confirm several stylised facts. For example, Argentina and Brazil exhibit high inflation and FX volatility, while Switzerland and the Scandinavian countries enjoy the highest GDP per capita. Our net commodity importer indicator successfully separates the commodity currency countries (including Australia, Brazil, Canada, Chile, New Zealand, Norway and South Africa) from the major net commodity importers (such as China, Hong Kong, Japan and the US).

[**Insert Figure 1 about here**]

For the gth group which contains $N_g \leq N$ countries, the MG estimator is computed as follows. Let $\hat{\mathbf{\Theta}}_i$ denote the vector of estimated NARDL coefficients for country $i = 1, ..., N_g$. The MG estimator is defined as $\bar{\mathbf{\Theta}}^{MG} \equiv \frac{1}{N_g}\sum_{i=1}^{N_g}\hat{\mathbf{\Theta}}_i$ with covariance matrix $V(\bar{\mathbf{\Theta}}^{MG}) \equiv \frac{1}{N_g(N_g-1)}\sum_{i=1}^{N_g}(\hat{\mathbf{\Theta}}_i - \bar{\mathbf{\Theta}}^{MG})(\hat{\mathbf{\Theta}}_j - \bar{\mathbf{\Theta}}^{MG})'$. It is worth noting that the MG approach presumes that the long-run parameters of interest are $E(-\theta^+/\rho)$ and $E(-\theta^-/\rho)$ instead of $E(-\theta^+)/E(\rho)$ and $E(-\theta^-)/E(\rho)$. For a more detailed discussion, see Pesaran and Smith (1995). Based on the MG estimator, we are able to test Hypotheses 1 to 9 at the group level using standard asymptotic tests. We also compute asymmetric cumulative dynamic multipliers at the group level for depreciations and appreciations at horizons $h = 0, 1, ..., H$ and apply Shin et al.'s (2014) bootstrap procedure to test for asymmetry, as explained in Appendix A.

Lastly, for robustness, we also employ Swamy's (1970) random coefficients estimator which weights the country-specific parameter estimates according to their precision. However, in practice, the covariance matrix of the Swamy estimator is not positive definite for some country groupings in which case we follow Swamy's suggestion and replace it with the MG covariance matrix. The results are qualitatively similar using both the MG and Swamy estimators so we only present the former here to conserve space.

4 Empirical Evidence

4.1 Country-by-Country Results

According to the law of one price for traded goods, the existence of a long-run equilibrium relationship among the import price (p_{it}), the export price (p^*_{it}) and the exchange rate (s_{it}) for the ith country prevents them from drifting apart over prolonged periods. The cointegration test results shown in Table 2 provide strong evidence in favour of cointegration and, therefore, also support the established practice of employing error correction models to study ERPT behaviour (e.g., Banerjee et al., 2008; Brun-Aguerre et al., 2012; Campa et al., 2008; Delatte and Lopez-Villavicencio, 2012). For most countries, one or both of the t_{BDM} and F_{PSS} tests applied to the general NARDL model (3.3) rejects the null hypothesis of no long-run equilibrium. The evidence changes somewhat when one fits a more restrictive specification which imposes long-run and/or short-run symmetric ERPT. An important example is the US, where the F_{PSS} test provides strong evidence in favour of asymmetric cointegration under the general NARDL model but yields no evidence of linear cointegration in the nested model where one imposes long-run symmetry. This reflects Shin et al.'s (2014) observation that, if the true unobserved long-run relationship is asymmetric, then failure to recognise this asymmetry in an empirical model is likely to confound efforts to test for the existence of a long-run equilibrium path.

[Insert Table 2 about here]

The estimation results of the NARDL model (3.3) for each country in our sample are reported in Table 3. We adopt the lag structure $p = q = r = 2$ for all countries since it is generally sufficient to whiten the residuals. There are just two cases (Hungary and Chile) in which the Ljung-Box portmanteau test indicates residual autocorrelation with this lag structure. However, the use of Newey-West robust standard errors does not materially change the significance of the ERPT coefficients in either case. Consequently, we rely on OLS standard errors for all countries. The NARDL(2,2,2) model fits the data reasonably well as reflected by the degrees-of-freedom adjusted explanatory power, $\bar{R}^2$, which ranges from 0.428 (Singapore) to 0.914 (Mexico) for EMs, and from 0.274 (Spain) to 0.786 (Australia) for DMs.

[Insert Table 3 about here]

Our results indicate that *long-run* ERPT is asymmetric in 18 countries (11 DMs and 7 EMs). For all but one of them, the long-run ERPT with respect to depreciations exceeds that for appreciations, i.e. $\hat{\beta}_i^+ > \hat{\beta}_i^-$. The null hypothesis of complete long-run depreciation pass-through is not rejected for 19 DMs and 9 EMs, while the equivalent values in the case of appreciations are 10 and 8, respectively. This asymmetry suggests that, in the long-run, exporters may be reluctant or unable to absorb adverse exchange rate fluctuations (depreciations of the importer's currency) within their operating margins. One plausible explanation is that exporters exercise pricing power by choosing to pass depreciations through to import prices (thus keeping margins constant) while profiting from appreciations by keeping import prices constant (thus increasing their markups). Such behaviour could only be sustained in the long-run in the presence of imperfect competition among exporters, which may arise if firms can maintain product differentiation by means of innovation, quality enhancements or technological progress. Alternatively, our results could reflect either tacit or explicit price collusion among exporters regarding their response to exchange rate fluctuations or an ability to exploit import dependence.

Turning to the *impact* ERPT, we observe asymmetry for 12 countries with no obvious distinction between developed and emerging markets: 4 DMs and 3 EMs show stronger impact ERPT for depreciations than appreciations while 2 DMs and 3 EMs show the reverse pattern. Our tests do not reject the null hypothesis of zero impact ERPT to import prices in the US with respect to depreciations. This suggests that exporters may treat US importers relatively favourably, a finding which is consistent with several previous studies including Campa and Goldberg (2005) and Marazzi et al. (2005). We observe complete impact ERPT for less than half of the total cross-section of countries. Depreciations are fully passed-through on impact for 6 DMs and 8 EMs, while 7 DMs and 6 EMs exhibit complete impact ERPT for appreciations.

Finally, the null hypothesis of zero cumulative *short-run* ERPT can be rejected for 11 EMs and 14 DMs in the case of depreciations and for 11 EMs and 16 DMs in the case of appreciations. We find evidence of cumulative short-run ERPT asymmetry for 10 countries in total, with no clear distinction between developed and emerging economies: 2 DMs and 2 EMs show stronger short-run ERPT for depreciations, while 3 DMs and 3 EMs show asymmetry in the opposite direction. The depreciation (appreciation) ERPT is statistically insignificant (significant) both on *impact* and in the *short-run* for the US. This is a natural finding, as one would expect to observe pricing-to-market in a country as important as the US

Figures 2 and 3 plot the cumulative dynamic multipliers associated with a unit depreciation ($m^+_{i,h}$) and appreciation ($m^-_{i,h}$) of the exchange rate on a country-by-country basis. The linear combination $m^+_{i,h} - m^-_{i,h}$, $h = 0, 1, ..., H$ is shown together with its 90% bootstrap confidence band. Comparing the dynamic multipliers across countries reveals a general pattern. In many cases, we observe $m^+_{i,h} - m^-_{i,h} > 0$ for horizons of roughly 8 quarters or more, reflecting our earlier observation that long-run ERPT for depreciations typically exceeds that for appreciations. Meanwhile, evidence of short-run asymmetry is far less common across countries and, where it is observed, its direction is considerably more mixed.

[Insert Figures 2 and 3 about here]

In several cases, the evolution of $m^+_{i,h} - m^-_{i,h}$ shows an initial overshooting followed by a reversal — depreciations are passed through less strongly than appreciations in the immediate short-run before the pass-through of depreciations gradually strengthens as time passes. Countries in which this pattern is observed include Canada, Hong Kong, Japan, Singapore and the US. This group includes some of the most lucrative export markets in the world, which are populated with well-informed and affluent agents that enjoy considerable freedom to trade. In such favourable markets, exporters may exhibit a greater willingness to absorb adverse exchange rate fluctuations into their markups in the short-run in order to preserve or gain market share.

Cases where asymmetric pass-through is confined to the long-run include many DMs (e.g., Australia, Belgium, Denmark, Finland, Sweden, Switzerland and the U.K.) as well as South

Korea which is among the most developed of the EMs. Most of these economies are wealthy, relatively small and with well-established import markets. By contrast, we find that depreciations are passed-through to import prices more strongly than appreciations over both the short- and long-run for countries such as Argentina, China, Greece, Israel and Thailand. Many of these markets suffer from weak institutions and are subject to a variety of restrictive trade regulations. Exporters selling in these countries may thus face a relatively low degree of competition and may perceive few obstacles to their pursuit of short-run rent-seeking ERPT strategies. A final set of countries including Chile, Colombia, Ireland, Italy, Mexico, the Netherlands, New Zealand and South Africa exhibit roughly symmetric pass-through both in the short- and long-run. Members of this group are generally either net commodity exporters or re-export locations.

4.2 Panel Results

Table 4 reports panel ERPT coefficients and hypothesis tests for an array of country groups, as described in Section 3.2 and in Figure 1. The corresponding cumulative dynamic multipliers are plotted in Figure 4. A result that resonates across country groups is that depreciation ERPT is generally complete and significantly stronger than appreciation ERPT in the long-run. This suggests that, over long horizons and in the aggregate, exporters are keen to appropriate appreciations by widening their margins and keeping the import price unchanged. By contrast, they tend to pass depreciations onto their customers, leading to a rise in import prices.

[**Table 4 and Figure 4 around here**]

Analysing the *long-run* ERPT elasticities, we find little difference across country groups. For instance, t-tests between groups reported in Table 4 suggest no distinction between the long-run ERPT elasticities of high versus low inflation economies, or high versus low per capita GDP economies. This is also apparent in the cumulative dynamic multipliers shown in Figure 4. The only statistically significant difference that we uncover (and only at the 10% level) arises in the case of high versus low FX volatility countries — stronger depreciation ERPT comes hand-in-hand with lower FX volatility. This is broadly consistent with the evidence in Devereux and Engel (2002) which links high FX volatility and local currency pricing (or low ERPT).

The panel estimation results in Table 4 reveal some evidence of *impact* asymmetry but no evidence of *short-run* cumulative asymmetry for any of the country groups considered. Where impact asymmetry is significant, the contemporaneous effect of a depreciation on import prices exceeds that of an appreciation (i.e. $\pi^+ - \pi^- > 0$), a pattern which is again suggestive of weak competition. This occurs in three groups which include low GDP per capita countries, countries that on average experience large FX changes, and countries with low inflation.

To sum up, both the country-by-country NARDL analysis and the panel analysis suggest that depreciations are passed-through more vigorously than appreciations in the long-run. To date, however, the majority of existing studies have modelled the long-run equilibrium relationship between exchange rates, import prices and export prices as symmetric.

4.3 Determinants of Long-Run Asymmetric Pass-Through

We now seek to explain the cross-section variation in long-run ERPT *asymmetry* by regressing the estimated long-run ERPT asymmetry measure $\widehat{LR}_i^{asy} \equiv \hat{\beta}_i^{+} - \hat{\beta}_i^{-}$ on various fundamentals of the importing country. $\widehat{LR}_i^{asy}$ is positive in 27 out of 33 countries. Consequently, we interpret a positive slope coefficient for a given regressor as evidence that a marginal increase in its value will cause exporters to exercise greater pricing power by increasing the extent to which they pass-through depreciations more strongly than appreciations. Table 5 reports the results.

[**Table 5 around here**]

Section A of the table provides baseline univariate regression results. Although one must remain cognisant of the risk of omitted variable bias in such simple specifications, it appears that import dependence is the most prominent factor driving the directional ERPT asymmetry — greater import dependence magnifies the extent of long-run ERPT asymmetry. The multivariate regressions reported in Section B of the table confirm the central role of import dependence in explaining cross-country variation in ERPT asymmetry. Furthermore, to ensure that the potential endogeneity of the rate of inflation and/or its volatility does not contaminate our results, we report an additional multivariate regression excluding both of these regressors. Such endogeneity may arise if, for example, asymmetric ERPT favouring depreciations over appreciations influences the general price level and thereby impacts upon both the rate of inflation and its volatility. Our main results are robust to this model re-specification.

The role of import dependence as a driver of long-run ERPT asymmetry has a clear theoretical rationale. Import dependence is a good proxy for import penetration which, in turn, measures the degree of competition that exporters face from domestic firms. Higher import penetration means lower domestic competition faced by foreign firms. Consequently, our evidence that the higher the import dependence, the greater the extent to which depreciations are passed-through relative to appreciations can be viewed as an extension of the finding by An and Wang (2011) that countries with a higher import share tend to experience stronger import ERPT. Indeed, An and Wang's baseline result is also apparent in the panel estimation results that we report in Table 4 — the mean of $\hat{\beta}^{+}$ and $\hat{\beta}^{-}$ for the high import dependence group is 0.83 while it is just 0.77 for the low import dependence group.

In order to further explore the role of *import dependence*, we estimate a nonlinear regression where import dependence is interacted with all of the other economic factors that we consider. The results, shown in Section C of Table 5, reveal that the positive association between import dependence and long-run ERPT asymmetry is moderated by increases in the importing economy's *freedom to trade*. This is consistent with the empirical results documented by Kohlscheen (2010) and with the predictions from several well-known theoretical models (e.g. Dornbusch, 1987; Gust et al., 2010; Kleshchelski and Vincent, 2009). For example, the model proposed by Dornbusch suggests that exporters exercise less pricing power in markets where the degree of competition is strong. Given that open trade policies allow both domestic and exporting firms to contest the local market, it follows that greater trade freedom should lead to more intense competition. Similarly, Gust et al. develop an open-economy dynamic general equilibrium model where factors that lead to greater trade integration — such as lower per-unit trade costs — improve the relative competitiveness of a foreign exporter in the domestic market, allowing the exporter to increase its markup over costs. As its markup increases, the foreign firm finds it optimal to vary its markup more and its price less in response to exchange rate movements.

The *output gap* also moderates the extent of the directional long-run ERPT asymmetry. This may reflect opportunistic behaviour by exporters, where they exhibit a higher willingness to quote competitive prices and gain market share in countries which are at a favourable stage of their business cycle. This finding is consistent with the evidence provided by Chew et al. (2011) based on standard linear pass-through models allowing for business cycle effects, which suggest that exporters strategically adopt lenient pricing strategies when the importing economy is growing above potential. Finally, these cross-sectional regressions confirm our previous finding that EMs and DMs do not differ significantly in terms of the extent of long-run ERPT asymmetry.

5 Summary and Policy Implications

A thorough understanding of the extent and nature of ERPT into import prices is central to the analysis of global trade imbalances, the conduct of monetary policy, and the appropriate choice of exchange rate regime. Although the literature on the subject is ample, no existing study has investigated sign asymmetry in the response of import prices to exchange rate changes over various horizons (impact, short-run and long-run) for a large sample that includes both developed and emerging economies. In this paper, we have sought to fill this gap in the literature.

We find that long-run ERPT is generally stronger for depreciations than appreciations, a pattern that is consistent with rent-seeking behaviour by exporting firms. Exporters exercise pricing power by passing depreciations through to import prices while preserving their markups, and by keeping import prices constant following appreciations while their markups increase. The extent of the asymmetry increases with the import dependence of the destination market but is moderated if the importer enjoys greater freedom-to-trade and/or a more positive output gap. These findings suggest that weak competition structures in international trade allow exporters to appropriate rents by exploiting exchange rate fluctuations. Not only is this likely to be welfare-reducing for consumers but it also induces an upward skew in the response of import prices to exchange rate fluctuations which translates into downward nominal price rigidity and may hinder the conduct of inflation-targeting monetary policy.

Our results raise concerns about exporters' market concentration and pricing-to-market behaviour, issues that are difficult to regulate in a multi-jurisdictional environment. However, an important policy implication from our analysis is that trade liberalisation may be an effective tool to mitigate opportunistic asymmetric ERPT behaviour. Furthermore, our results indicate that the extent of asymmetric ERPT does not differ between developed and emerging economies, which provides indirect evidence that the fear of floating of many emerging economies may be unwarranted from an import price perspective. This being the case, by allowing their exchange rates to float and by relaxing trade barriers, policymakers in emerging economies may gain greater freedom to conduct policy in accordance with domestic stabilisation goals.

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APPENDIX A: Bootstrap Confidence Bands for Multipliers

The cumulative dynamic multipliers and the associated non-parametric bootstrap intervals plotted in Figures 2 and 3 are computed as follows:

1. Estimate the NARDL model (3.3) for country i by OLS to obtain the regression residuals, $\hat{\boldsymbol{\epsilon}}_{i,t}$, $t = 1, ..., T_i$ and the vector of parameter estimates, $\widehat{\boldsymbol{\Theta}}_i$, from which the cumulative dynamic multipliers $m^+_{i,h}$ and $m^-_{i,h}$ are computed. Note that the sample length for country i is denoted T_i to reflect the differences in the estimation samples across countries detailed in Table 1.

2. Resample from $\hat{\boldsymbol{\epsilon}}_{i,t}$ with replacement and denote the vector of resampled residuals for country i by $\hat{\boldsymbol{\epsilon}}^{(b)}_{i,t}$, $t = 1, ..., T_i$.

3. Generate the bootstrap sample for country i, $\Delta p^{(b)}_{i,t}, t = 1, ..., T_i$, by recursion as follows, taking the explanatory variables as given:

$$\begin{aligned}\Delta p^{(b)}_{i,t} &= \widehat{\alpha}_i + \widehat{\rho}_i p^{(b)}_{i,t-1} + \widehat{\theta}^+_i s^+_{i,t-1} + \widehat{\theta}^-_i s^-_{i,t-1} + \widehat{\lambda}_i p^*_{i,t-1} \\ &+ \sum_{j=1}^{p-1} \widehat{\varphi}_{i,j} \Delta p^{(b)}_{i,t-j} + \sum_{j=0}^{q-1} \left(\widehat{\pi}^+_{i,j} \Delta s^+_{i,t-j} + \widehat{\pi}^-_{i,j} \Delta s^-_{i,t-j} \right) + \sum_{j=0}^{r-1} \widehat{\phi}_{i,j} \Delta p^*_{i,t-j} + \widehat{\varepsilon}^{(b)}_{i,t}\end{aligned}$$

4. Re-estimate the NARDL model for country i using the bootstrap sample $\Delta p^{(b)}_{i,t}$ to obtain the bootstrap parameter vector, $\widehat{\boldsymbol{\Theta}}^{(b)}_i$.

5. Compute the cumulative dynamic multipliers for country i using the bootstrap parameter vector.

6. Repeat steps 2–5 B times and compute empirical confidence intervals of any desired width around the cumulative dynamic multipliers obtained at step 1 in the usual way. Repeat the process for all countries $i = 1, 2, \ldots, N$.

The panel cumulative dynamic multipliers and the associated confidence bands plotted in Figure 4 can be computed as follows:[1]

7. Compute the mean of the N country-specific pass-through parameter estimates $\bar{\boldsymbol{\Theta}}$ from which the panel dynamic multipliers can be obtained.

8. Note that steps 2–4 have already been carried out B times for the full set of countries $i = 1, 2, \ldots, N$. Now, for each bootstrap sample, $b = 1, 2, \ldots, B$, compute the mean of the N country-specific bootstrap coefficient vectors, $\bar{\boldsymbol{\Theta}}^{(b)}$.

9. Compute the cumulative dynamic multipliers for each of the B bootstrap MG parameter vectors, $\bar{\boldsymbol{\Theta}}^{(b)}$, and then compute empirical confidence intervals of any desired width around the MG cumulative dynamic multipliers obtained at step 7 in the usual way.

[1]Here we discuss the simple case in which the MG estimator averages over the NARDL parameter estimates for *all* countries in the sample. Generalisation to the case where one averages over a subset of the countries follows easily.

APPENDIX B: Pairwise Correlations between the Country Drivers

	Emerging	Import dependence	FX rate volatility	Output gap	GDP per capita	Commodity importer	Trade freedom	Size FX change	Inflation rate	Inflation volatility
Emerging	1.000									
Import dependence	-0.248 (0.164)	1.000								
FX rate volatility	0.330 (0.061)	0.102 (0.571)	1.000							
Output gap	-0.649 (0.000)	0.208 (0.247)	-0.248 (0.165)	1.000						
GDP per capita	-0.799 (0.000)	0.017 (0.927)	-0.404 (0.020)	0.580 (0.000)	1.000					
Commodity importer	-0.310 (0.079)	-0.090 (0.618)	-0.776 (0.000)	0.135 (0.454)	0.344 (0.050)	1.000				
Trade freedom	-0.449 (0.009)	-0.153 (0.395)	-0.536 (0.001)	0.407 (0.019)	0.604 (0.000)	0.351 (0.045)	1.000			
Size FX change	0.406 (0.019)	-0.044 (0.807)	0.610 (0.000)	-0.413 (0.017)	-0.464 (0.006)	-0.604 (0.000)	-0.466 (0.006)	1.000		
Inflation rate	0.494 (0.004)	0.186 (0.300)	0.629 (0.000)	-0.350 (0.046)	-0.600 (0.000)	-0.658 (0.000)	-0.576 (0.001)	0.669 (0.000)	1.000	
Inflation volatility	0.608 (0.000)	-0.139 (0.439)	0.379 (0.030)	-0.594 (0.000)	-0.525 (0.002)	-0.271 (0.127)	-0.384 (0.027)	0.719 (0.000)	0.656 (0.000)	1.000

NOTES: For each pair of drivers x_A and x_B, the figures reported represent the estimated correlation $\rho_{A,B} = corr(x_{A,i}, x_{B,i})$ for $i = 1, 2, \ldots, 33$ where $x_{A,i}$ and $x_{B,i}$ represent the time average (mean) of drivers x_A and x_B for the ith country. p-values are reported in parentheses.

Table 1: Descriptive Statistics

Countries	Data span	FX rate: Log change (%) Mean	StDev	Depr(+)	Appr(-)	FX rate: Log level ADF test Ho: I(1)	KPSS test Ho: I(0)	Import price: Log change (%) Mean	StDev	Import price: Log level ADF test Ho: I(1)	KPSS test Ho: I(0)	Export price: Log change (%) Mean	StDev	Export price: Log level ADF test Ho: I(1)	KPSS test Ho: I(0)
Emerging markets (N=14)															
Argentina	1991Q2-2010Q4	-0.58	11.75	40.51	59.49	-2.696	0.254 ***	1.83	10.08	-2.191	0.188 **	0.66	2.87	-4.578 ***	0.056
Brazil	1996Q3-2010Q4	0.62	8.44	41.38	58.62	-0.871	0.226 ***	2.41	10.84	-1.636	0.239 ***	0.74	4.28	-1.670	0.194 **
Chile	1996Q1-2010Q4	-0.05	3.97	46.67	53.33	-1.370	0.195 **	0.29	5.61	-1.371	0.152 **	0.57	3.15	-1.911	0.236 ***
China	1982Q1-2010Q4	1.05	5.26	50.00	50.00	-1.124	0.290 ***	1.36	5.38	-0.950	0.297 ***	0.35	3.46	-3.143	0.139 *
Colombia	1982Q1-2010Q4	1.28	4.53	61.02	38.98	-1.178	0.221 ***	3.01	3.23	0.190	0.309 ***	0.88	7.06	-1.563	0.258 ***
Czech Rep.	1998Q1-2010Q4	-0.94	2.73	30.77	69.23	-2.627	0.062	-0.12	2.03	-1.695	0.092	1.19	5.16	-1.876	0.152 **
Hong Kong	1995Q3-2010Q4	0.13	1.57	50.00	50.00	-1.268	0.247 ***	0.14	1.10	-0.092	0.259 ***	0.69	4.94	-5.006 ***	0.081
Hungary	1994Q1-2010Q4	1.03	3.55	59.70	40.30	-1.970	0.212 **	1.52	3.21	-2.799	0.238 ***	0.52	2.98	-3.598 **	0.108
Israel	1994Q1-2010Q4	0.27	3.26	52.24	47.76	-1.490	0.174 **	0.90	3.19	-1.089	0.172 **	0.55	1.98	-2.399	0.122 *
Mexico	1988Q1-2010Q4	1.77	6.92	59.78	40.22	-1.656	0.199 **	2.47	6.20	-1.687	0.231 ***	0.40	1.76	-2.355	0.134 *
Singapore	1980Q1-2010Q4	-0.55	1.62	30.89	69.11	-2.210	0.173 **	-0.12	2.30	-1.995	0.299 ***	0.37	3.97	-1.187	0.250 ***
South Africa	1980Q1-2010Q4	1.60	6.23	57.72	42.28	-1.682	0.201 **	2.21	3.69	-1.664	0.207 **	0.28	4.02	-0.431	0.261 ***
South Korea	1980Q1-2010Q4	0.41	5.16	49.59	50.41	-2.706	0.060	0.77	5.88	-1.192	0.173 **	0.31	4.83	-0.589	0.254 ***
Thailand	1998Q2-2010Q4	-0.01	3.93	49.06	50.94	-2.657	0.156 **	0.65	5.14	-3.248 *	0.064	0.50	5.11	-2.318	0.174 **
Developed markets (N=19)															
Australia	1980Q1-2010Q4	-0.03	4.42	44.72	55.28	-1.590	0.238 ***	0.55	3.43	-1.754	0.287 ***	0.28	2.31	-2.029	0.205 **
Belgium	1993Q1-2010Q4	-0.26	1.27	41.67	58.33	-2.037	0.081	0.73	2.90	-2.766	0.092	0.60	2.95	-2.440	0.091
Canada	1980Q1-2010Q4	-0.34	2.44	44.72	55.28	-1.656	0.175 **	0.50	2.89	-2.050	0.215 **	0.44	1.86	-3.074	0.113
Denmark	1980Q1-2010Q4	-0.25	1.55	43.90	56.10	-2.690	0.176 **	0.36	2.57	-4.051 ***	0.094	0.43	2.27	-2.377	0.174 **
Finland	1980Q1-2010Q4	-0.35	2.31	35.77	64.23	-3.420 *	0.056	0.50	2.34	-3.095	0.067	0.50	2.85	-1.657	0.237 ***
France	1980Q1-2010Q4	-0.24	1.57	41.46	58.54	-2.913	0.124 *	0.38	1.92	-4.677 ***	0.125 *	0.42	2.50	-2.093	0.205 **
Germany	1980Q1-2010Q4	-0.68	1.71	36.59	63.41	-1.022	0.312 ***	0.06	2.65	-2.377	0.141 *	0.39	2.92	-1.638	0.248 ***
Greece	1980Q1-2010Q4	1.00	2.99	65.04	34.96	-2.398	0.313 ***	2.31	3.33	-3.214 *	0.331 ***	0.35	4.86	-2.068	0.252 ***
Ireland	1980Q1-2010Q4	-0.09	2.09	41.46	58.54	-3.440 *	0.086	0.51	2.59	-3.806 **	0.198 **	0.54	1.94	-2.893	0.087
Italy	1980Q1-2010Q4	0.46	2.02	56.10	43.90	-1.274	0.261 ***	0.97	5.14	-3.603 **	0.097	0.40	3.60	-1.937	0.250 ***
Japan	1980Q1-2010Q4	-1.43	4.54	43.09	56.91	-1.812	0.304 ***	-0.45	5.60	-1.679	0.282 ***	0.56	4.26	-1.805	0.256 ***
Netherlands	1980Q1-2010Q4	-0.44	1.49	34.15	65.85	-1.511	0.278 ***	0.05	2.78	-2.029	0.190 **	0.45	3.06	-2.033	0.202 **
New Zealand	1980Q1-2010Q4	0.34	3.70	50.41	49.59	-2.389	0.229 ***	0.54	3.55	-3.284 *	0.215 **	0.37	3.14	-1.652	0.240 ***
Norway	1980Q1-2010Q4	-0.11	2.19	41.46	58.54	-2.102	0.249 ***	0.34	2.05	-2.876	0.231 ***	0.46	2.70	-2.761	0.090
Spain	1980Q1-2010Q4	0.00	1.88	47.97	52.03	-2.791	0.069	0.69	4.54	-3.772 **	0.058	0.40	3.68	-1.937	0.227 ***
Sweden	1980Q1-2010Q4	0.09	2.92	40.65	59.35	-2.980	0.101	0.85	2.58	-3.297 *	0.060	0.46	2.63	-2.536	0.170 **
Switzerland	1980Q1-2010Q4	-0.78	2.34	37.40	62.60	-2.788	0.262 ***	0.00	1.52	-2.691	0.147 **	0.37	2.31	-2.710	0.124 *
U.K.	1980Q1-2010Q4	0.00	3.17	43.90	56.10	-1.523	0.139 *	0.67	2.18	-2.561	0.191 **	0.42	2.62	-2.148	0.200 **
U.S.	1980Q1-2010Q4	-0.85	2.77	39.02	60.98	-1.084	0.263 ***	0.40	2.57	-1.898	0.137 *	0.44	3.00	-1.191	0.271 ***

NOTES: Depr(+) records the percentage of quarters over the sample period during which the exchange rate change is positive; Appr(-) records the percentage of quarters when it is negative. ADF is the Augmented Dickey-Fuller test for the null that the variable is integrated of order one, I(1), against the alternative of I(0) behaviour. KPSS is the Kwiatkowski-Phillips-Schmidt-Shin test for the I(0) null against the I(1) alternative. The ADF and KPSS test equations include both a constant and a linear time trend and the lag order of the test equations is selected using the modified AIC criterion. The bandwidth for the KPSS test is based on the Newey-West estimator using the Bartlett kernel. Inferences regarding the ADF test employ the MacKinnon critical values while the critical values tabulated by KPSS are used for inferences regarding the KPSS test. *, ** and *** denote rejection of the null at the 10%, 5% and 1% level, respectively.

Table 2: Cointegration Test Results

	Unrestricted NARDL		Restricted NARDL models					
	SR & LR asymm.		SR symmetry		LR symmetry		SR & LR symm.	
Countries	BDM test	PSS test	BDM test	PSS test	BDM test	PSS test	BDM test	PSS test
Emerging markets (N=14)								
Argentina	-3.505 *	3.936	-3.127	6.165 **	-1.547	1.801	-1.446	5.192 **
Brazil	-4.865 ***	7.398 ***	-5.223 ***	8.280 ***	-5.137 ***	8.944 ***	-5.409 ***	10.018 ***
Chile	-4.076 **	4.815 *	-3.997 **	4.215 *	-4.147 ***	6.457 ***	-4.037 **	5.729 **
China	-2.173	3.533	-2.259	3.314	-0.729	3.118	-1.181	3.115
Colombia	-1.400	2.693	-1.265	3.053	-1.968	3.625	-1.986	4.073
Czech Rep.	-2.765	2.332	-3.016	3.019	-2.775	3.039	-2.842	3.135
Hong Kong	-1.475	5.346 **	-2.007	4.003	-2.004	7.183 ***	-2.454	5.432 **
Hungary	-3.171	4.899 **	-2.776	4.141 *	-3.131	4.852 **	-2.736	3.933
Israel	-2.963	2.853	-2.882	2.683	-2.388	2.705	-2.412	2.656
Mexico	-1.230	4.406 *	-1.217	4.581 *	-1.017	5.749 **	-1.016	5.994 **
Singapore	-2.942	3.424	-2.702	2.711	-2.951	4.565 *	-2.885	3.553
South Africa	-1.985	1.752	-1.915	1.695	-1.981	2.144	-1.903	2.051
South Korea	-4.079 **	4.446 *	-4.163 ***	5.130 **	-1.917	1.541	-1.792	1.908
Thailand	-3.159	2.655	-2.998	2.292	-1.417	0.785	-1.522	0.820
Developed markets (N=19)								
Australia	-2.147	2.700	-2.143	2.754	-1.328	2.548	-1.273	2.584
Belgium	-1.939	1.651	-1.931	1.644	0.205	0.365	0.140	0.454
Canada	-4.468 ***	6.034 **	-4.234 ***	5.764 **	-3.429 *	5.161 **	-3.404 *	5.418 **
Denmark	-4.030 **	5.438 **	-4.600 ***	7.615 ***	-2.778	4.174 *	-3.612 **	6.670 ***
Finland	-3.500 *	3.275	-3.382 *	3.225	-2.562	2.459	-2.151	1.971
France	-3.630 **	5.063 **	-3.670 **	4.974 **	-4.110 ***	6.493 ***	-4.160 ***	6.359 **
Germany	-1.973	3.578	-2.088	3.762	-1.977	4.807 *	-2.134	5.041 **
Greece	-3.625 **	7.523 ***	-2.360	5.310 **	-2.225	6.942 ***	-1.953	6.272 **
Ireland	-3.253 *	4.223 *	-3.292 *	4.325 *	-3.767 **	5.648 **	-3.800 **	5.779 **
Italy	-3.441 *	4.088	-3.309 *	3.903	-3.552 **	5.476 **	-3.437 *	5.241 **
Japan	-4.316 ***	4.890 **	-4.151 ***	4.522 *	-4.400 ***	6.579 ***	-4.043 **	5.725 **
Netherlands	-2.990	4.246 *	-3.031	4.429 *	-2.956	5.587 **	-3.009	5.833 **
New Zealand	-3.361 *	4.288 *	-3.223 *	4.305 *	-3.366 *	5.733 **	-3.207	5.637 **
Norway	-2.469	2.499	-2.386	2.397	-1.923	2.309	-1.925	2.386
Spain	-3.568 **	4.381 *	-3.550 **	4.429 *	-4.056 **	5.609 **	-4.096 **	5.723 **
Sweden	-2.311	2.900	-2.444	2.755	-1.684	2.973	-1.735	2.635
Switzerland	-3.167	3.628	-3.187	3.702	-2.961	3.464	-2.967	3.316
U.K.	-3.422 *	5.179 **	-3.287 *	5.642 **	-3.822 **	5.678 **	-3.984 **	6.492 ***
U.S.	-3.088	5.132 **	-3.005	4.513 *	-0.388	2.713	-0.468	2.290

NOTES: PSS denotes the Pesaran et al. (2001) F-test of the null hypothesis $\rho = \beta^+ = \beta^- = \theta = 0$ against the alternative of joint significance. BDM denotes the Banerjee et al. (1998) t-test of the null hypothesis $\rho = 0$ against the one-sided alternative $\rho < 0$. In both cases, the null hypothesis indicates the absence of a long-run levels relationship. The relevant critical values tabulated by Pesaran et al. for the BDM t-test are -3.21 (10%), -3.53 (5%) and -4.10 (1%). The equivalent values for the PSS F-test are 4.14 (10%), 4.85 (5%) and 6.36 (1%). *, ** and *** denote rejection of the null at the 10%, 5% and 1% level, respectively.

Table 3: Individual Pass-Through Estimation Results

			A. Long-Run Relationship			B. Short-Run Dynamics						C. Diagnostics	
			Long-Run ERPT		Wald test for	Impact ERPT		Wald test for	Cumulative ERPT		Wald test for		
		Adj. speed	Depr.	Appr.	LR symmetry	Depr.	Appr.	impact symm.	Depr.	Appr.	cumulative symm.		
Countries	Sample	ρ	β^+	β^-	$H_0: \beta^+ = \beta^-$	π_0^+	π_0^-	$H_0:\ \pi_0^+ = \pi_0^-$	$\sum_j \pi_j^+$	$\sum_j \pi_j^-$	$H_0:\ \sum_j \pi_j^+ = \sum_j \pi_j^-$	Adj R^2	LB(4)
Emerging markets (N=14)													
Argentina	1991Q4-2010Q4	-0.229 ***	0.832 ***	0.060	57.424 ***	**1.070** ***	0.116	70.334 ***	**1.083** ***	0.122	32.169 ***	0.913	0.926
Brazil	1997Q1-2010Q4	-0.723 ***	0.790 ***	0.555 ***	3.021 *	**0.929** ***	**0.766** **	0.170	**0.950** ***	**0.601**	0.380	0.626	0.833
Chile	1996Q3-2010Q4	-0.665 ***	**0.997** ***	**0.947** ***	0.208	**1.421** ***	**0.683** ***	3.295 *	**1.379** ***	0.357	3.272 *	0.611	0.008
China	1982Q3-2010Q4	-0.078 **	**0.954** ***	0.474 ***	13.976 ***	**0.975** ***	0.468 ***	7.295 ***	**0.851** ***	0.608 ***	0.955	0.842	0.321
Colombia	1982Q1-2010Q4	-0.011 *	**1.258** ***	**1.327**	0.002	0.408 ***	0.402 ***	0.003	0.184 ***	0.281 **	0.333	0.785	0.604
Czech Rep.	1998Q3-2010Q4	-0.110 ***	**0.712** *	0.516 **	0.348	0.094	**0.878** ***	14.874 ***	0.115	0.401 **	1.204	0.772	0.818
Hong Kong	1995Q3-2010Q4	-0.054 *	**1.061** ***	**0.959** ***	0.131	0.136 *	0.398 ***	2.359	-0.012	0.621 ***	7.192 ***	0.706	0.457
Hungary	1994Q3-2010Q4	-0.138 ***	0.524 **	**0.969** ***	2.896 *	0.484 ***	**0.897** ***	3.033 *	0.170	**1.074** ***	8.125 ***	0.794	0.000
Israel	1994Q3-2010Q4	-0.255 ***	**1.092** ***	**0.871** ***	5.450 **	**0.958** ***	0.685 ***	1.994	**0.762** ***	0.457 **	1.685	0.768	0.440
Mexico	1988Q3-2010Q4	-0.054	**0.642** *	**0.264**	0.766	**0.955** ***	**0.900** ***	0.118	**1.067** ***	**1.017** ***	0.046	0.914	0.979
Singapore	1980Q3-2010Q4	-0.108 ***	0.344	0.406 ***	0.114	-0.643 ***	0.554 ***	13.244 ***	-0.878 ***	**0.859** ***	13.783 ***	0.428	0.814
South Africa	1980Q3-2010Q4	-0.049 **	**1.024** ***	**0.625**	0.949	0.322 ***	0.317 ***	0.002	0.530 ***	0.602 ***	0.213	0.495	0.230
South Korea	1980Q3-2010Q4	-0.197 ***	0.407 ***	0.133	40.607 ***	**1.000** ***	0.716 ***	2.549	0.686 ***	0.643 ***	0.039	0.785	0.251
Thailand	1998Q2-2010Q4	-0.275 ***	**1.510** ***	**0.740** **	20.899 ***	**1.397** ***	**0.817** ***	2.383	**1.181** ***	0.489 *	1.883	0.840	0.027
Developed markets (N=19)													
Australia	1980Q3-2010Q4	-0.098 **	**0.795** ***	0.561 ***	15.286 ***	0.722 ***	0.784 ***	0.331	**0.927** ***	**0.996** ***	0.209	0.786	0.944
Belgium	1993Q3-2010Q4	-0.165 **	**2.628** ***	**0.884** *	16.043 ***	**1.688** ***	**0.984** ***	0.755	**1.728** **	**1.085** **	0.341	0.513	0.295
Canada	1980Q3-2010Q4	-0.198 ***	**1.013** ***	0.661 ***	10.651 ***	0.330 **	**0.988** ***	6.261 **	0.340	**0.994** ***	2.842 *	0.499	0.843
Denmark	1980Q3-2010Q4	-0.250 ***	**1.535** ***	**0.873** ***	23.759 ***	**1.131** ***	**0.684** ***	1.382	**1.158** ***	**0.671** **	0.809	0.526	0.182
Finland	1980Q3-2010Q4	-0.114 ***	**0.988** ***	**0.585** **	9.305 ***	0.606 ***	0.133	5.363 **	0.370 **	0.184	0.513	0.444	0.672
France	1980Q3-2010Q4	-0.087 ***	**0.927** ***	0.680 ***	1.111	0.484 ***	0.114	2.353	0.180	0.570 ***	1.615	0.624	0.428
Germany	1980Q3-2010Q4	-0.088 **	**0.585**	0.507 **	0.020	**1.138** ***	0.362 **	3.714 *	**1.367** ***	0.318	3.449 *	0.433	0.492
Greece	1980Q3-2010Q4	-0.140 ***	**1.316** ***	0.335 *	24.504 ***	0.758 ***	-0.778 ***	23.336 ***	0.524 ***	-0.819 **	10.733 ***	0.509	0.835
Ireland	1980Q3-2010Q4	-0.146 ***	**1.254** ***	**1.203** ***	0.098	0.670 ***	0.648 ***	0.007	**0.844** ***	**0.739** ***	0.096	0.484	0.919
Italy	1980Q3-2010Q4	-0.180 ***	**0.774** ***	**0.893**	0.062	**0.779** ***	**1.074** **	0.157	**0.807** **	**1.736** **	0.933	0.309	0.742
Japan	1980Q3-2010Q4	-0.192 ***	**0.712** ***	0.709 ***	0.000	0.328 **	**0.842** ***	4.572 **	-0.090	**0.803** ***	7.647 ***	0.688	0.186
Netherlands	1980Q3-2010Q4	-0.127 ***	**0.669** *	**0.854** ***	0.327	**0.847** ***	**0.862** ***	0.001	**0.888** **	**0.995** ***	0.028	0.434	0.141
New Zealand	1980Q3-2010Q4	-0.183 ***	**0.941** ***	**0.956** ***	0.094	0.845 ***	0.459 ***	6.213 **	0.761 ***	0.703 ***	0.075	0.721	0.657
Norway	1980Q3-2010Q4	-0.082 ***	**0.771** *	**0.391**	3.202 *	0.498 ***	0.521 ***	0.010	0.464 ***	**0.774** ***	0.915	0.290	0.179
Spain	1980Q3-2010Q4	-0.152 ***	**1.030** **	**0.826** ***	1.004	**0.959** ***	**0.598** *	0.328	**0.748** *	**0.105**	0.568	0.274	0.340
Sweden	1980Q3-2010Q4	-0.083 **	**0.518**	0.057	6.306 **	0.567 ***	0.532 ***	0.039	0.611 ***	0.377 *	0.935	0.572	0.556
Switzerland	1980Q3-2010Q4	-0.097 ***	**0.905** ***	0.483 ***	3.032 *	0.321 ***	0.267 ***	0.108	0.174	0.249 **	0.101	0.490	0.237
U.K.	1980Q3-2010Q4	-0.101 ***	**1.003** ***	**0.723** ***	9.707 ***	0.487 ***	0.335 ***	1.319	0.387 ***	0.446 ***	0.112	0.590	0.408
U.S.	1980Q3-2010Q4	-0.120 ***	**0.999** ***	0.227 ***	32.343 ***	0.179	0.429 ***	1.414	-0.152	0.500 ***	5.173 **	0.665	0.486

NOTES: The estimation sample is the effective sample used in estimation after adjusting for lags and first differences. β^+ (β^-) is the long-run (LR) pass-through associated with a depreciation (appreciation). π_0^+ (π_0^-) is the contemporaneous or impact pass-through which occurs in the same quarter as the exchange rate shock. $\sum_j \pi_j^+$ and $\sum_j \pi_j^-$ for $j = 0, 1$ represent the sum of the short-run ERPT parameters on impact and in the subsequent quarter in the case of depreciations and appreciations (respectively). Where a coefficient is printed in bold face it is statistically greater than or equal to unity (indicating full pass-through) at the 5% level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. Inferences are based on OLS standard errors.

Table 4: Panel Pass-Through Estimation Results

		A. Long-run pass-through						B. Short-run pass-through					
								Impact			Cumulative		
Country groupings	Adj. speed ρ	Depr. β^+	t-test between groups	Appr. β^-	t-test between groups	Asymm. $\beta^+ - \beta^-$	t-test between groups	Depr. π_0^+	Appr. π_0^-	Asymm. $\pi_0^+ - \pi_0^-$	Depr. $\sum_j \pi_j^+$	Appr. $\sum_j \pi_j^-$	Asymm. $\sum_j \pi_j^+ - \sum_j \pi_j^-$
All (N=33)	-0.168 ***	**0.955** ***		0.644 ***		0.311 ***		0.692 ***	0.559 ***	0.134	0.609 ***	0.593 ***	0.017
Developed (N=19)	-0.137 ***	**1.019** ***	1.103	0.653 ***	0.183	0.366 ***	0.969	0.702 ***	0.518 ***	0.184	0.634 ***	0.601 ***	0.032
Emerging (N=14)	-0.211 ***	**0.868** ***		0.632 ***		0.236 ***		0.679 ***	0.614 ***	0.065	0.576 ***	0.581 ***	-0.005
Import Dependence (Low)	-0.152 ***	**0.914** ***	-0.573	0.630 ***	-0.267	0.284 ***	-0.389	0.543 ***	0.435 ***	0.108	0.427 ***	0.559 ***	-0.132
Import Dependence (High)	-0.185 ***	**0.999** ***		0.659 ***		0.339 ***		0.850 ***	0.690 ***	0.161	**0.803** ***	0.628 ***	0.174
FX Volatility (Low)	-0.135 ***	**1.070** ***	1.741 *	0.673 ***	0.544	0.397 ***	1.307	0.678 ***	0.499 ***	0.178	0.582 ***	0.548 ***	0.034
FX Volatility (High)	-0.204 ***	0.832 ***		0.613 ***		0.219 ***		0.708 ***	0.621 ***	0.086	0.638 ***	0.640 ***	-0.002
Output Gap (Low)	-0.190 ***	**0.951** ***	-0.061	0.652 ***	0.147	0.299 **	-0.177	0.686 ***	0.588 ***	0.098	0.611 ***	0.593 ***	0.019
Output Gap (High)	-0.145 ***	**0.959** ***		0.636 ***		0.324 ***		0.699 ***	0.527 ***	0.172	0.607 ***	0.593 ***	0.014
GDP per Capita (Low)	-0.206 ***	**0.933** ***	-0.302	0.674 ***	0.560	0.260 ***	-0.747	0.794 ***	0.553 ***	0.241 *	0.693 ***	0.529 ***	0.164
GDP per Capita (High)	-0.129 ***	**0.978** ***		0.613 ***		0.365 **		0.584 ***	0.565 ***	0.020	0.520 ***	0.660 ***	-0.140
Commodity Importer (Low)	-0.195 ***	0.857 ***	-1.399	0.636 ***	-0.145	0.221 ***	-1.326	0.692 ***	0.625 ***	0.067	0.662 ***	0.623 ***	0.040
Commodity Importer (High)	-0.139 ***	**1.059** ***		0.652 ***		0.406 ***		0.693 ***	0.488 ***	0.205	0.553 ***	0.561 ***	-0.008
Trade Freedom (Low)	-0.164 ***	0.881 ***	-1.045	0.592 ***	-1.000	0.289 ***	-0.310	0.715 ***	0.555 ***	0.161	0.610 ***	0.588 ***	0.022
Trade Freedom (High)	-0.172 ***	**1.033** ***		0.700 ***		0.334 ***		0.667 ***	0.563 ***	0.105	0.608 ***	0.597 ***	0.011
Size FX Change (Low)	-0.127 ***	**0.983** ***	0.409	0.647 ***	0.061	0.336 ***	0.369	0.575 ***	0.590 ***	-0.014	0.515 ***	0.658 ***	-0.143
Size FX Change (High)	-0.212 ***	**0.925** ***		0.641 ***		0.284 ***		0.816 ***	0.526 ***	0.291 **	0.710 ***	0.524 ***	0.186
Inflation Rate (Low)	-0.133 ***	**0.969** ***	0.209	0.648 ***	0.066	0.322 ***	0.161	0.625 ***	0.577 ***	0.049	0.536 ***	0.691 ***	-0.155
Inflation Rate (High)	-0.206 ***	**0.939** ***		0.640 ***		0.299 ***		0.763 ***	0.539 ***	0.224	0.687 ***	0.488 ***	0.199
Inflation Volatility (Low)	-0.142 ***	**0.972** ***	0.253	0.619 ***	-0.464	0.353 ***	0.627	0.758 ***	0.550 ***	0.208 *	0.686 ***	0.626 ***	0.060
Inflation Volatility (High)	-0.196 ***	**0.936** ***		0.671 ***		0.266 ***		0.623 ***	0.568 ***	0.054	0.528 ***	0.557 ***	-0.029

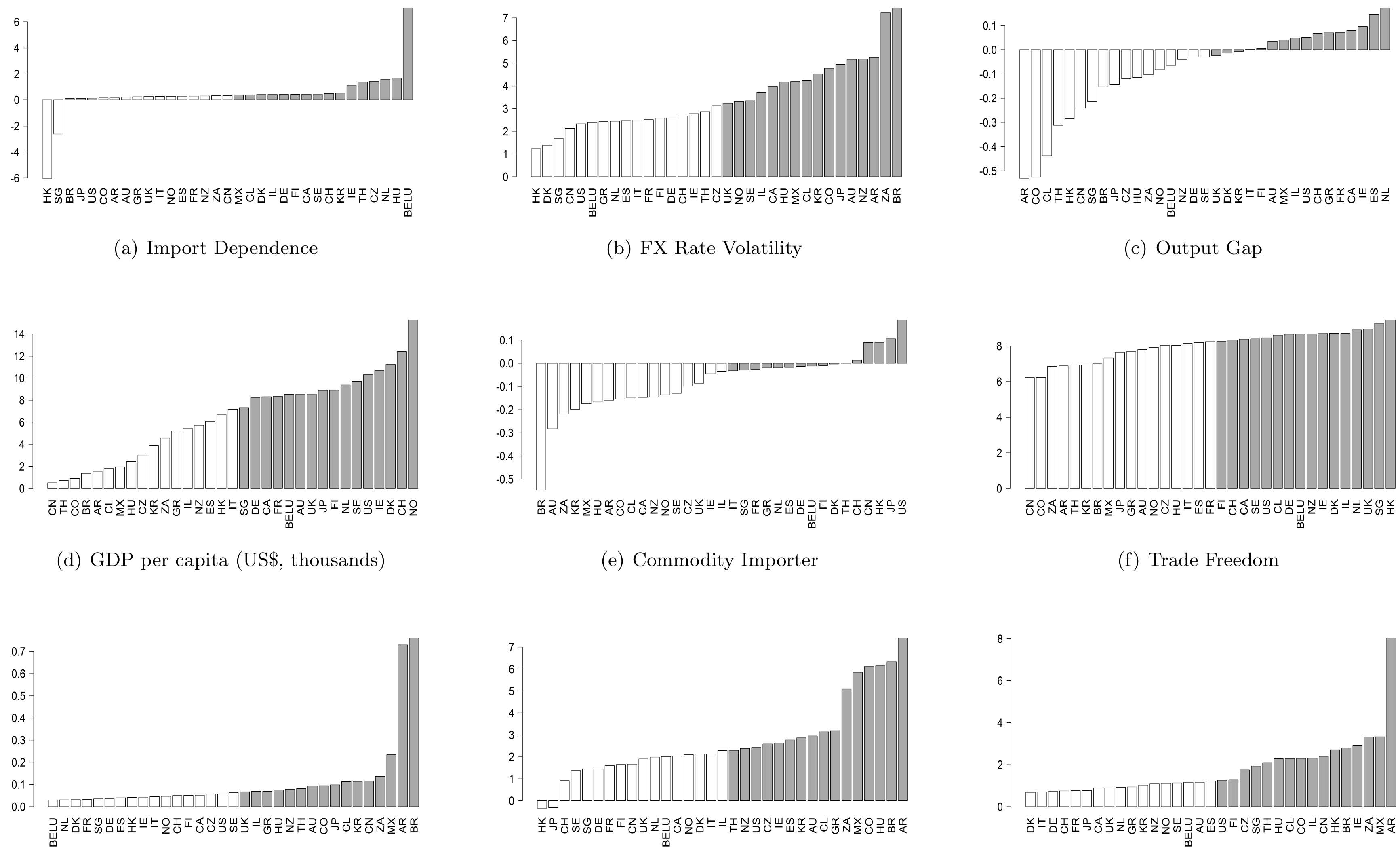
NOTES: In all cases, the 'low' and 'high' cohorts include 17 and 16 countries, respectively. These cohorts are selected by ranking the countries in the sample according to the corresponding economic criteria as shown in Figure 1. The panel estimates are obtained by applying the Mean Group estimator to the country-specific NARDL models in (3.3) and inferences are based on the Mean Group covariance matrix $V(\bar{\mathbf{\Theta}}^{MG})$. The columns labelled "t-test between groups" report standard t-statistics for the equality of the associated panel coefficients in the relevant groups outlined in the first column. Where a coefficient is printed in bold face it is statistically greater than or equal to unity (indicating full pass-through) at the 5% level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 5: Analysis of Country Variation in Long-Run Pass-Through Asymmetry

	A. Simple regressions										B. Multiple regressions		C. Nonlinear regressions		
Constant	0.268 ***	0.366 ***	0.461 **	0.313 ***	0.252 *	0.351 ***	0.800	0.283 ***	0.322 **	0.269 **	1.568	1.166	Constant	0.224 **	0.232 ***
	(0.064)	(0.092)	(0.180)	(0.078)	(0.142)	(0.081)	(0.690)	(0.085)	(0.128)	(0.116)	(1.055)	(0.942)		(0.091)	(0.083)
Import	0.105 ***										0.129 ***	0.120 ***	Import dependence	3.360 **	3.890 ***
dependence	(0.036)										(0.042)	(0.039)		(1.365)	(1.196)
Emerging		-0.131									-0.007	0.043	Emerging x	-0.051	-0.255
		(0.141)									(0.265)	(0.237)	Import dependence	(0.325)	(0.219)
FX rate			-0.043								-0.104	-0.097	FX rate volatility x	-0.256	-0.335 *
volatility			(0.048)								(0.077)	(0.074)	Import dependence	(0.195)	(0.166)
Output gap				0.031							-0.046	-0.140	Output gap x	-1.298 *	-1.266 *
				(0.403)							(0.516)	(0.487)	Import dependence	(0.661)	(0.633)
GDP					0.009						0.021	0.030	GDP per capita x	0.092	0.070
per capita					(0.019)						(0.034)	(0.031)	Import dependence	(0.062)	(0.053)
Commodity						0.520					0.155	0.690	Commodity importer x	-0.132	-1.565
importer						(0.534)					(1.023)	(0.804)	Import dependence	(2.358)	(1.395)
Trade							-0.061				-0.138	-0.107	Trade freedom x	-0.398 **	-0.424 ***
freedom							(0.085)				(0.113)	(0.105)	Import dependence	(0.157)	(0.150)
Size FX								0.252			0.938	1.109 **	Size FX change x	4.376 *	3.329
change								(0.424)			(0.740)	(0.525)	Import dependence	(2.507)	(2.149)
Inflation									-0.004		-0.069		Inflation rate x	0.030	
rate									(0.039)		(0.074)		Import dependence	(0.087)	
Inflation										0.024	0.067		Inflation volatility x	-0.126	
volatility										(0.052)	0.103		Import dependence	(0.139)	
Log Likelihood	-12.079	-15.652	-15.671	-16.097	-15.978	-15.603	-15.831	-15.913	-16.094	-15.988	-5.987	-6.639	Log Likelihood	2.764	2.159
Adj. R^2 (%)	19.097	-0.461	-0.576	-3.206	-2.465	-0.163	-1.557	-2.064	-3.189	-2.528	21.198	24.852	Adj. R^2 (%)	53.634	55.910
Prob (F-statistic)	0.006	0.363	0.373	0.939	0.635	0.338	0.481	0.557	0.917	0.649	0.108	0.053	Prob (F-statistic)	0.001	0.000

NOTES: The number of observations is N=33. The dependent variable is the degree of long-run asymmetry estimated as $\widehat{\beta}_i^+ - \widehat{\beta}_i^-$ for country i, where the β_i's are the asymmetric long-run parameters from the NARDL models for countries $i = 1, 2, \ldots N$. The regressors include a dummy variable (*Emerging*, which is equal to 1 for EMs and 0 for DMs) and economic variables which are entered as time-averages over the longest common time period for all countries. Inferences are based on OLS standard errors which are reported in parentheses as the Breusch-Pagan-Godfrey heteroskedasticity test was insignificant at all standard levels in all cases. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Figure 1: Country Rankings According to Selected Importer Characteristics (Average Values, 1980Q1–2010Q4)



(a) Import Dependence

(b) FX Rate Volatility

(c) Output Gap

(d) GDP per capita (US$, thousands)

(e) Commodity Importer

(f) Trade Freedom

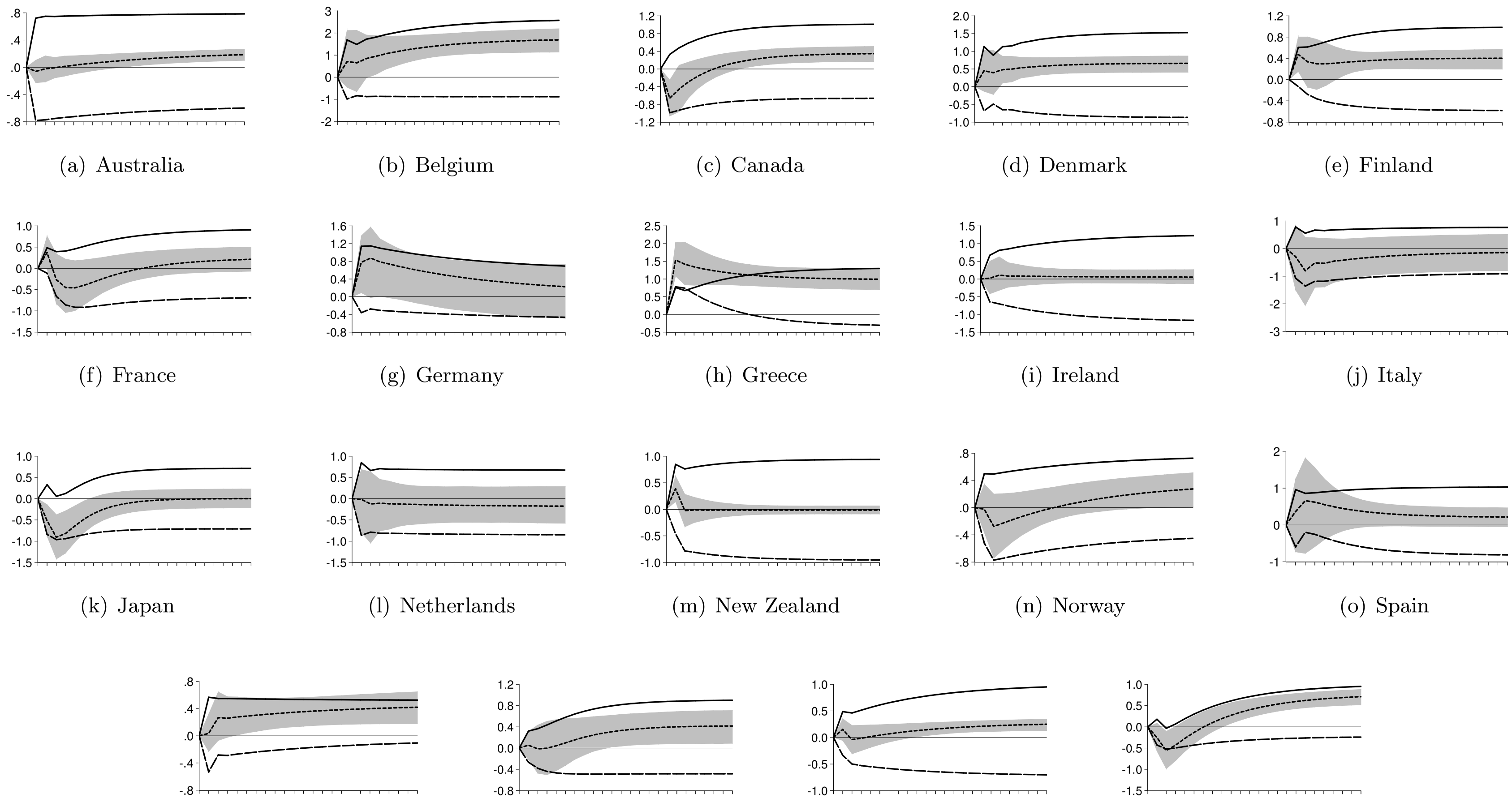
(g) Size FX Change

(h) Inflation Rate

(i) Inflation Volatility

NOTES: Each panel ranks the countries in our sample according to the mean value of the named driver over the largest common time period for all countries. In each case, the countries are partitioned into two groups which are identified by white/gray shading.

Figure 2: Cumulative Dynamic Multipliers from the Unrestricted NARDL(2,2,2) Model (Equation 3.3) – Developed Markets



(a) Australia (b) Belgium (c) Canada (d) Denmark (e) Finland

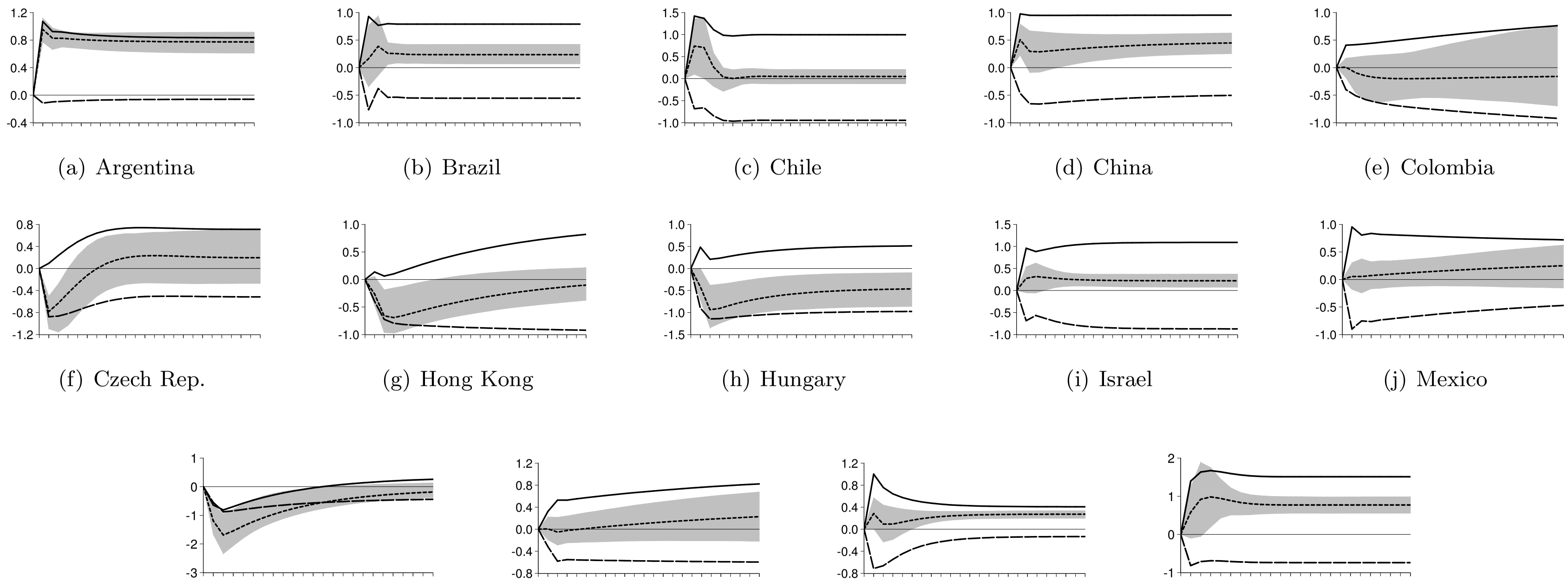
(f) France (g) Germany (h) Greece (i) Ireland (j) Italy

(k) Japan (l) Netherlands (m) New Zealand (n) Norway (o) Spain

(p) Sweden (q) Switzerland (r) United Kingdom (s) United States

Notes: The solid (long-dashed) line shows the cumulative dynamic multiplier effect of a one percent depreciation (appreciation) of the exchange rate on the import price, measured in percentage points on the vertical axis. The short-dashed line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and long-dashed lines) while the shaded region reports its 90% bootstrap confidence interval computed using 5,000 bootstrap replications. Tick marks on the horizontal axis indicate quarterly intervals over a 24 quarter horizon.

Figure 3: Cumulative Dynamic Multipliers from the Unrestricted NARDL(2,2,2) Model (Equation 3.3) – Emerging Markets



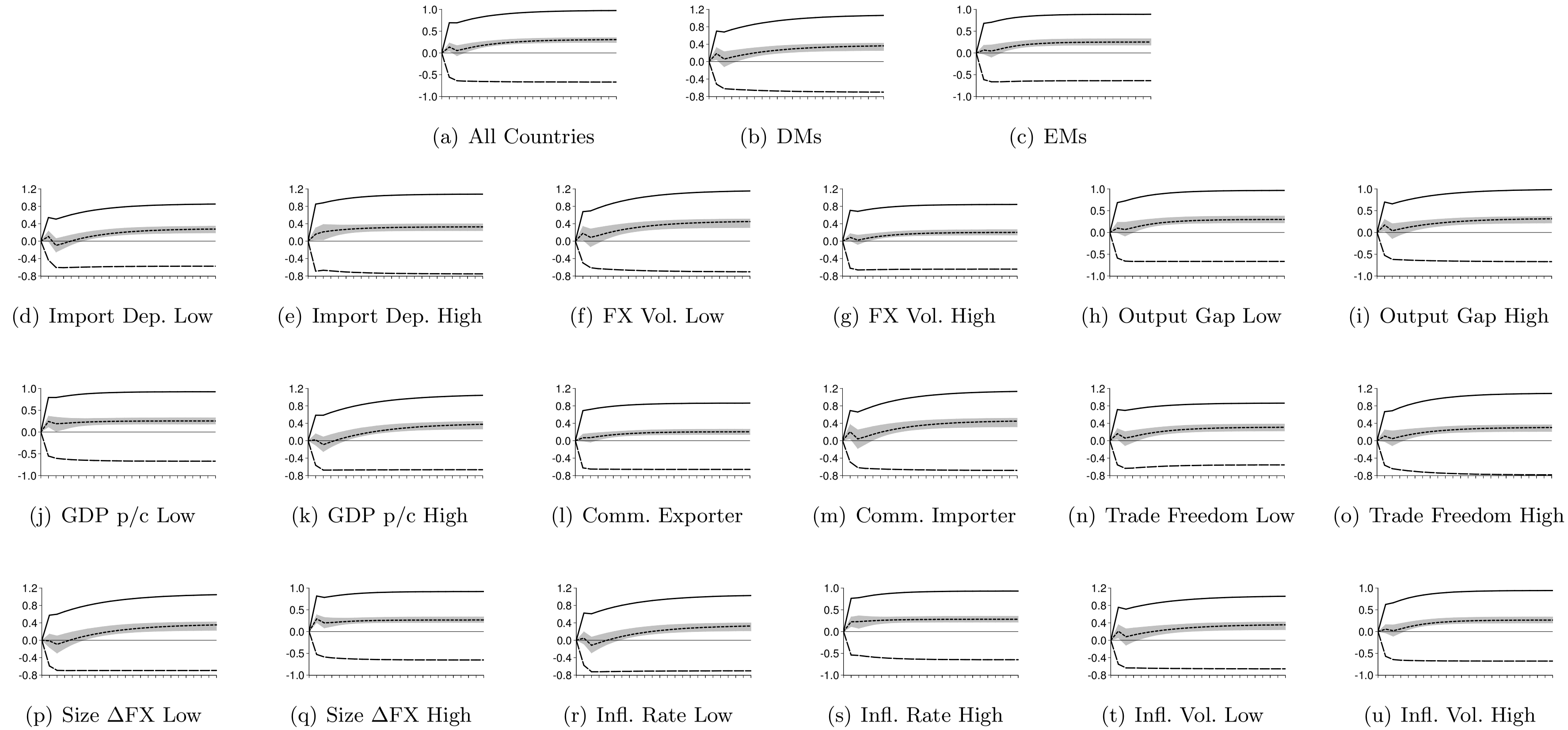
(a) Argentina (b) Brazil (c) Chile (d) China (e) Colombia

(f) Czech Rep. (g) Hong Kong (h) Hungary (i) Israel (j) Mexico

(k) Singapore (l) South Africa (m) South Korea (n) Thailand

NOTES: The solid (long-dashed) line shows the cumulative dynamic multiplier effect of a one percent depreciation (appreciation) of the exchange rate on the import price, measured in percentage points on the vertical axis. The short-dashed line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and long-dashed lines) while the shaded region reports its 90% bootstrap confidence interval computed using 5,000 bootstrap replications. Tick marks on the horizontal axis indicate quarterly intervals over a 24 quarter horizon.

Figure 4: Cumulative Dynamic Multipliers for Selected Country-Groups Computed by Mean-Group Estimation



(a) All Countries; (b) DMs; (c) EMs

(d) Import Dep. Low; (e) Import Dep. High; (f) FX Vol. Low; (g) FX Vol. High; (h) Output Gap Low; (i) Output Gap High

(j) GDP p/c Low; (k) GDP p/c High; (l) Comm. Exporter; (m) Comm. Importer; (n) Trade Freedom Low; (o) Trade Freedom High

(p) Size ΔFX Low; (q) Size ΔFX High; (r) Infl. Rate Low; (s) Infl. Rate High; (t) Infl. Vol. Low; (u) Infl. Vol. High

Notes: The solid (long-dashed) line shows the cumulative dynamic multiplier effect of a one percent depreciation (appreciation) of the exchange rate on the import price, measured in percentage points on the vertical axis. The short-dashed line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and long-dashed lines) while the shaded region reports its 90% bootstrap confidence interval computed using 5,000 bootstrap replications. Tick marks on the horizontal axis indicate quarterly intervals over a 24 quarter horizon.