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

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.

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

Notes: The solid (long-dashed) black 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 heavy short-dashed blue line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and dashed black 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.

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

NOTES: The solid (long-dashed) black 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 heavy short-dashed blue line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and dashed black 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.

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

NOTES: The solid (long-dashed) black 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 heavy short-dashed blue line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and dashed black 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.

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

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Summary:

Abstract

We analyse exchange rate pass-through into import prices for a large group of 33 emerging and developed economies from 1980:1 to 2010:4. 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; auto-regressive distributed lag

JEL CLASSIFICATIONS: F10; F14; F30; F31.

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① 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, ^{which is that is} a strategy known as *producer currency pricing* (PCP). In this case, ERPT is complete and the price^{that is} 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, ^{which is} a strategy known as *local currency pricing* (LCP). In the context of multiple markets, ^{local currency pricing} 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 ^(M.c.e. or that) ~~is~~ appreciation versus depreciation. Throughout the paper, the term appreciation ^{or respectively} (depreciation) is used to describe an increase ^{or decrease} in the value of the importer's local currency versus the exporter's currency. Our analysis concentrates on ¹ ~~stage~~ ERPT, ^{i.e.} ~~that is~~ pass-through into import prices 'at the dock' or the point of entry ^{into the destination market}. Unlike working with ^{the consumer price index,} ~~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 1980^{quarter 1} to 2010^{quarter 4}. 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

International Monetary Fund's

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) ^{and} 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 ^{that is} demarcated by the existing literature. We adopt recent innovations in asymmetric error correction modelling to investigate the presence of impact ^{and} 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 ^{was} aware of ^{any} ~~no~~ existing empirical application to ^{from} ~~stage one~~ ¹ (or import) ERPT.

Having estimated NARDL models for each importing country, we then estimate an array of panel pass-through models ^{by} using the ^(MGE) Mean Group Estimator ^{that was} 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) ^{and} Gust et al. (2010) ^{and} 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 ^{quite} ~~somewhat~~ consistent with a body of work which argues that larger market size induces stronger competition (Melitz and Ottaviano, 2008).

?An: clarify 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 ² 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 ^m 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 ^{and} 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, ^{which is} a strategy ^{that is} 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) ^{and} 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 ^{can} ~~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 ^{difficult} ~~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^{ed} with US data covering the 1983-2004 and 1978-2000 periods⁽²⁾ respectively, and Bussière (2013) examines the G7⁽²⁾ economies⁽²⁾ from 1980 to 2006. The findings of these studies are mixed. Herzberg et al. ~~cannot~~ ^{could} refute the hypothesis of symmetric short-run import ERPT, ~~while~~ ^{whereas} Pollard and Coughlin⁽²⁰⁰³⁾ ~~document~~ ^{could} short-run sign asymmetry for about half of 30 US industries but the direction is ambiguous. By contrast, Bussière⁽²⁰¹³⁾ ~~finds~~ ^{found} 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~~ ^{found} that depreciations ~~are~~ ^{were} passed⁽²⁾ through more strongly than appreciations for a group of eight Asian economies. In the context of overall ERPT into ~~CPA~~ ^{consumer price index} Delatte and Lopez-Villavicencio (2012) reach^{ed} a similar conclusion based on NARDL models estimated for Germany, Japan, the UK and the US/CA.

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, ^{which is} a kind of nonlinear response^{that is} 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^{to}/1999, Taylor (2000) shows^{ed} that the strength of ERPT is constrained by a low level and volatility of inflation. He provides^{ed} 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~~ ^{EM} bond spreads, among others (e.g. Chew et al. (2011), Nogueira and Leon-Ledesma (2011), Brun-Aguerre et al. (2012), Mallick and Marques (2013) and 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) and Choudhri and Hakura (2015)). ^{Based on the basis of} a large sample of 13 DMs and 28 EMs over the period 1980-2006, Bussière and Peltonen⁽²⁰⁰⁸⁾ ^{ed} show that the short-run exchange rate elasticity of import prices is not

The data that are analysed in the paper and the programs that were used to analyse them can be obtained from <http://wileyonlinelibrary.com/journal/rss-datasets> ^{display, Courier}

higher among EMs than DMs. Similarly, Brun-Aguerre et al. ⁽²⁰¹²⁾ challenge ^{ed} 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 ⁽²⁰¹⁵⁾ meanwhile, analyse ^{ed} a sample of 18 DMs and 16 EMs over the period 1979–2010 and show ^{ed} 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 ^{consumer price index} ~~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 ^{ed} 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 ^{on-line} Appendix.

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 1980 ^{quarter 1} to 2010 ^{quarter 4}. *The Economist* classifies 14 of the economies that we consider as EMs and 19 as DMs. The countries are ^(N) Argentina[†], Australia, Belgium/Luxembourg, Brazil[†], Canada, Chile[†], China[†], Colombia[†], ^{the} Czech Republic[†], Denmark, Finland, France, Germany, Greece, Hong Kong[†], Hungary[†], Ireland, Israel[†], Italy, Japan, Korea[†], Mexico[†], ^{the} 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 $i = 1, 2, \dots, N$, 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 ^{that was} developed by Shin et al. (2014). This framework allows the import price to respond differently to appreciations and depreciations over various horizons: on impact, in the short [#] run and in the long [#] run. The NARDL model for the i th country is estimated ^{by} 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, $P_{i,t}^* = \sum_{j=1}^{J(i)} w_{i,t}^j P_t^{j*}$ ^{fine # fixed 2pt #} where $j = 1, \dots, J(i)$ are the trading partners of importing country i and

$$w$$

$w_{i,t}^j$ is the import share or ratio of the imports in US\$ ^{dollars} received by country i from country j to its total imports. Consequently, $P_{i,t}^*$ measures the 'rest of the world' export price ^{that is} 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 $p_{i,t}$, $p_{i,t}^*$ and $s_{i,t}$ will henceforth denote the natural ^{2 or 3} log of each variable.

Table 1 summarises the distribution of quarterly log ^z 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 ^{from quarter 1 to quarter 4} 1980Q1-2010Q4. In ~~the~~ ¹ 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 ^{with} 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} ~~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, ^{whereas} while the corresponding range for the EMs is ^{from} 31% to 61%. Finally, ~~the~~ ¹ 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 ⁽²⁾ ~~(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 ^{typ} 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 ^{the} cross-section variation in the data. Specifically, we use the ^{MG} ~~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 ^{that are} 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 ^{gross domestic product} output gap, ^{CDP} 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) ^{and} 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 ^{# because of} ^{that are} 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 ^{by} using the following three commodity indices: ⁽ⁱ⁾ the Goldman Sachs Commodity Index; ⁽ⁱⁱ⁾ the Dow Jones-UBS Commodity Index; ⁽ⁱⁱⁱ⁾ the Thomson Reuters/Jefferies CRB Index. For each country, our indicator is constructed by averaging the slope coefficients from the three regressions ^(M) ^{or} negative ^{or} positive values signify a commodity currency ^{respectively} 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 ^{that was} 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. Appendix A provides a detailed data description including the available time span for each variable and the ^{of} data sources that we have consulted.

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:

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

where $s_{i,t} \equiv s_{i,0} + s_{i,t}^+ + s_{i,t}^-$. These partial sum processes effectively separate domestic currency depreciations and appreciations. 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

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

where β_i^+ , β_i^- and γ_i are unknown long-run parameters to be estimated. Note that this asymmetric long-run relationship reduces to the familiar symmetric form if $\beta_i^+ = \beta_i^-$. Equation (3.2) can be rewritten 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 equation (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 :

$$\Delta p_{i,t} = \alpha_i + \rho_i p_{i,t-1} + \theta_i^+ s_{i,t-1}^+ + \theta_i^- s_{i,t-1}^- + \lambda_i p_{i,t-1}^* + \sum_{j=1}^{p-1} \phi_{i,j} \Delta p_{i,t-j} + \sum_{j=0}^{q-1} (\pi_{i,j}^+ \Delta s_{i,t-j}^+ + \pi_{i,j}^- \Delta s_{i,t-j}^-) + \sum_{j=0}^{r-1} \phi_{i,j} \Delta p_{i,t-j}^* + \varepsilon_{i,t} \quad (3.3)$$

where $\varepsilon_{i,t} \sim \text{i.i.d.}(0, \sigma_\varepsilon^2)$. 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 $(\pi_{i,0}^+, \dots, \pi_{i,q-1}^+, \pi_{i,0}^-, \dots, \pi_{i,q-1}^-)'$.

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. (2014) 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 ^{because}

^{of} 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 ^{are}

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 ^{model} (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 $H_0: \rho_i = \theta_i^+ = \theta_i^- = \lambda_i = 0$, ^{whereas}

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 ^{that were} 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 heterogeneous 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

$\pi_{i,j}^+ = \pi_{i,j}^-$, $j = 0, \dots, q-1$ rules out any form of impact or short-run ERPT asymmetry in

country i ^{whereas} 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 $j = 0, \dots, q-1$. Likewise, ^{we} 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 ^(M) in fact, the model is linear ^{# #} in parameters and readily estimable by OLS ordinary least squares.

For each economy $i = 1, 2, \dots, N$, we evaluate several hypotheses relating to different types

of asymmetric ERPT. We begin with the following three hypotheses concerning long-run ERPT

^{1/2 line #} Hypothesis 1 (Zero long-run ERPT for depreciations/appreciations) ^{light face rom unless marked} $H_0^{1+}: \beta_i^+ = 0$ ^{or} $H_0^{1-}: \beta_i^- = 0$ ^{versus} $H_A^{1+}: \beta_i^+ \neq 0$ for depreciations; likewise, $H_0^{1-}: \beta_i^- = 0$ ^{or} $H_A^{1-}: \beta_i^- \neq 0$ for appreciations.

^{1/2 line #} Hypothesis 2 (Complete long-run ERPT for depreciations/appreciations) ^{light face rom unless marked} $H_0^{2+}: \beta_i^+ \geq 1$ ^{or} $H_0^{2-}: \beta_i^- \geq 1$ ^{versus} $H_A^{2+}: \beta_i^+ < 1$ for depreciations; likewise, $H_0^{2-}: \beta_i^- \geq 1$ ^{or} $H_A^{2-}: \beta_i^- < 1$ for appreciations.

^{1/2 line #} Hypothesis 3 (Symmetric long-run ERPT) ^{light face rom unless marked} $H_0^3: \beta_i^+ = \beta_i^-$ ^{versus} $H_A^3: \beta_i^+ \neq \beta_i^-$.

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

^{1/2 line #} Hypothesis 4 (Zero impact ERPT for depreciations/appreciations) ^{light face rom unless marked} $H_0^{4+}: \pi_{i,0}^+ = 0$ ^{or} $H_0^{4-}: \pi_{i,0}^- = 0$ ^{versus} $H_A^{4+}: \pi_{i,0}^+ \neq 0$ for depreciations; likewise, $H_0^{4-}: \pi_{i,0}^- = 0$ ^{or} $H_A^{4-}: \pi_{i,0}^- \neq 0$ for appreciations.

^{1/2 line #} Hypothesis 5 (Complete impact ERPT for depreciations/appreciations) ^{light face rom unless marked} $H_0^{5+}: \pi_{i,0}^+ \geq 1$ ^{or} $H_0^{5-}: \pi_{i,0}^- \geq 1$ ^{versus} $H_A^{5+}: \pi_{i,0}^+ < 1$ for depreciations; likewise, $H_0^{5-}: \pi_{i,0}^- \geq 1$ ^{or} $H_A^{5-}: \pi_{i,0}^- < 1$ for appreciations.

^{1/2 line #} Hypothesis 6 (Symmetric impact ERPT) ^{light face rom unless marked} $H_0^6: \pi_{i,0}^+ = \pi_{i,0}^-$ ^{versus} $H_A^6: \pi_{i,0}^+ \neq \pi_{i,0}^-$.

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

^{1/2 line #} Hypothesis 7 (Zero short-run ERPT for depreciations/appreciations) ^{light face rom unless marked} $H_0^{7+}: \sum_{j=0}^{q-1} \pi_{i,j}^+ = 0$ ^{or} $H_0^{7-}: \sum_{j=0}^{q-1} \pi_{i,j}^- = 0$ ^{fine #} ^{versus} $H_A^{7+}: \sum_{j=0}^{q-1} \pi_{i,j}^+ \neq 0$ for depreciations; likewise, $H_0^{7-}: \sum_{j=0}^{q-1} \pi_{i,j}^- = 0$ ^{or} $H_A^{7-}: \sum_{j=0}^{q-1} \pi_{i,j}^- \neq 0$ for appreciations. ^{fine #}

^{1/2 line #} Hypothesis 8 (Complete short-run ERPT for depreciations/appreciations) ^{light face rom unless marked} $H_0^{8+}: \sum_{j=0}^{q-1} \pi_{i,j}^+ \geq 1$ ^{or} $H_0^{8-}: \sum_{j=0}^{q-1} \pi_{i,j}^- \geq 1$ ^{fine #} ^{versus} $H_A^{8+}: \sum_{j=0}^{q-1} \pi_{i,j}^+ < 1$ for depreciations; likewise, $H_0^{8-}: \sum_{j=0}^{q-1} \pi_{i,j}^- \geq 1$ ^{or} $H_A^{8-}: \sum_{j=0}^{q-1} \pi_{i,j}^- < 1$ for appreciations. ^{fine #}

^{1/2 line #} Hypothesis 9 (Symmetric short-run ERPT) ^{light face rom unless marked} $H_0^9: \sum_{j=0}^{q-1} \pi_{i,j}^+ = \sum_{j=0}^{q-1} \pi_{i,j}^-$ ^{fine #} ^{versus} $H_A^9: \sum_{j=0}^{q-1} \pi_{i,j}^+ \neq \sum_{j=0}^{q-1} \pi_{i,j}^-$ ^{fine #}

All ^{by} 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 ^{model} (3.3). The cumulative dynamic multipliers $m_{i,h}^+$ and $m_{i,h}^-$ trace the evolution of the import price over horizons $h = 0, 1, \dots, H$ 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 the on-line Appendix B). This bootstrap approach serves not only to provide robust small [#]sample inference on asymmetry in ERPT but also enables ^{us} ~~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 ^{that is} 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 ^{that were} 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.

^{Fig. 1} Figure 1 shows the country rankings thus obtained, ^{whereas the on-line} while Appendix C reports the pairwise cross-sectional correlations ^{between} among the different economic variables. The rankings confirm several stylised facts. For example, Argentina and Brazil exhibit high inflation and FX volatility, ^{whereas} while Switzerland and the Scandinavian countries enjoy the highest ^{gross domestic product} 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). ^{CA}

~~(Insert Figure 1 about here)~~

For the g th group which contains $N_g \leq N$ countries, the MG estimator is computed as fol

lows. Let $\hat{\Theta}_i$ denote the vector of estimated NARDL coefficients for country $i = 1, \dots, N_g$. The MG estimator is defined as $\bar{\Theta}^{MG} \equiv \frac{1}{N_g} \sum_{i=1}^{N_g} \hat{\Theta}_i$ with covariance matrix $V(\bar{\Theta}^{MG}) \equiv \frac{1}{N_g(N_g-1)} \sum_{i=1}^{N_g} (\hat{\Theta}_i - \bar{\Theta}^{MG})(\hat{\Theta}_i - \bar{\Theta}^{MG})'$. 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 can 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 $h = 0, 1, \dots, H$ and apply the bootstrap procedure to test for asymmetry, as explained in Appendix B.

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 for brevity.

(A) 4/ Empirical Evidence

(B) 4.1/ Country-by-Country Results

According to the law of one price for traded goods, the existence of a long-run equilibrium relationship between the import price $\{p_{it}\}$, the export price $\{p_{it}^*\}$ and the exchange rate $\{s_{it}\}$ for the i th 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 we fit 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. (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]~~

Table 3
?Au: whiten
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~~ ^{ordinary least squares} 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 ^{seven} EMs). For all ^{except} ~~but~~ one of them, the long-run ERPT with respect to depreciations exceeds that for ^{appreciations} ~~ap~~preciations, 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 ^{nine} EMs, ^{whereas} ~~while~~ the equivalent values in the case of appreciations are 10 and ^{eight} ~~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 ^{between} ~~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: ^{four} DMs and ^{three} EMs show stronger impact ERPT for depreciations than appreciations ^{whereas two} ~~while~~ ^{three} DMs and ^{three} EMs show the reverse pattern. Our tests do not reject the null hypothesis of zero impact ERPT to import prices in the US ^{CA} 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 six DMs and eight EMs, whereas seven DMs and six 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: two DMs and two EMs show stronger short-run ERPT for depreciations, whereas three DMs and three EMs show asymmetry in the opposite direction. The depreciation (appreciation) ERPT is statistically insignificant (or 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 that are

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 $m_{i,h}^+ - m_{i,h}^-$, $h = 0, 1, \dots, H$ 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 eight 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 UK) 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

the #
 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-run and the 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 $LR_i^{asy} \equiv \hat{\beta}_i^+ - \hat{\beta}_i^-$ on various fundamentals of the importing country. 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 we 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 respecification.

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 whereas 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, which are 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 that were documented by Kohlscheen (2010) and with the predictions from several well-known theoretical models (e.g. Dornbusch (1987), Gust et al. (2010) and Kleshchelski and Vincent (2009)). For example, the model that was 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. (2010) developed 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 that was 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 in 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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Supporting information

Additional supporting information may be found in the on-line version of this article.

APPENDIX A: Data Sources

Country	Code	Import Price	Export Price	NEER	NEER daily	Import dependence	FX volatility	Output gap	GDP per capita	Comm. importer	Trade freedom	Inflation
Argentina	AR	9102-1004 (76)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF ME	JPM 9401-1004 (68)	ME	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	INDEC 9901-1004 (48)
Australia	AU	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF AFS	JPM 9401-1004 (68)	ABS	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	ABS 9901-1004 (48)
Belgium	BE	9303-1004 (76)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF BXB	JPM 9401-1004 (68)	BNE	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	BNS 9901-1004 (48)
Bona	BO	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF BSE	JPM 9401-1004 (68)	BSE	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	BSE 9901-1004 (48)
Brazil	BR	9503-1004 (68)	FUNCTEX	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	INE 9901-1004 (48)
Canada	CA	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF CSC	JPM 9401-1004 (68)	CSC	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	INE 9901-1004 (48)
Chile	CL	9503-1004 (68)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF CSC	JPM 9401-1004 (68)	CSC	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	INE 9901-1004 (48)
China	CN	9503-1004 (68)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF CSC	JPM 9401-1004 (68)	CSC	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	INE 9901-1004 (48)
Colombia	CO	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF DNE	JPM 9401-1004 (68)	DNE	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	DANE 9901-1004 (48)
Czech Rep.	CZ	9503-1004 (68)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF CSC	JPM 9401-1004 (68)	CSC	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	INE 9901-1004 (48)
Denmark	DK	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Finland	FI	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF CSC	JPM 9401-1004 (68)	CSC	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
France	FR	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF CSC	JPM 9401-1004 (68)	CSC	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Germany	DE	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Greece	GR	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Hong Kong	HK	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Hungary	HU	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
India	IN	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Indonesia	ID	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Ireland	IE	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Israel	IL	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Italy	IT	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Japan	JP	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Mexico	MX	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Netherlands	NL	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
New Zealand	NZ	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Norway	NO	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Pakistan	PK	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Russia	RU	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Singapore	SG	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
South Africa	ZA	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
South Korea	KR	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Spain	ES	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Sweden	SE	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Switzerland	CH	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Thailand	TH	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
Turkey	TR	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
United Kingdom	UK	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)
United States	US	8001-1004 (124)	IMF	JPM 8001-1004 (124)	JPM 9304-0903 (64)	IMF NSO	JPM 9401-1004 (68)	NSO	IMF 99-10 (12)	G/D/T 88-10 (92)	Fraser 00-09 (10)	NSO 9901-1004 (48)

NOTES: Country codes are standard two-letter ISO codes. Import and export prices are trade-weighted indices and NEER is the nominal effective exchange rate of foreign currencies per unit of domestic currency, as detailed in Section 2. To ensure comparability with the dataset used in Brun-Aguerre et al. (2012), additional export price data for Bolivia, India, Indonesia, Pakistan, Russia, and Turkey were used in the creation of the trade-weighted export price variable for each importing economy (see Brun-Aguerre et al. for further details). Import trade data are obtained from the IMF's *Direction of Trade Statistics*. Import dependence is computed as $ID_{it} \equiv \frac{M_{i,t}}{GDP_{i,t} - X_{i,t}}$, where $M_{i,t}$ is the total value of imports, GDP is nominal output, and $X_{i,t}$ is the total value of country i 's exports. FX volatility is based on the realised standard deviation of daily foreign exchange returns such that $RV_{it}^{FX} \equiv \sqrt{\sum_{j=1}^D [\log(\frac{NEER_{i,t}}{NEER_{i,t-1}})] \times 100]^2}$,

where D is the number of days in each quarter. The output gap is computed as $\frac{GDP_{i,t} - GDP_{i,t}^*}{GDP_{i,t}^*} \times 100$ where trend output, $GDP_{i,t}^*$, is estimated using the HP filter. GDP per capita is denominated in thousands of nominal US\$. The commodity importer and Trade Freedom series are discussed in detail in Section 2. Data sources are indicated by the following abbreviations: G/D/T stands for GSCI/DJ-UBSCI/TR-J CRB; JPM stands for J.P. Morgan; NSO stands for National Statistics Office; ME stands for Ministry of Economics; CM stands for Commerce Ministry; NCB stands for National Central Bank and Fraser stands for The Fraser Institute. All remaining abbreviations are widely known.

APPENDIX B: 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, $\hat{\epsilon}_{i,t}$, $t = 1, \dots, T_i$ and the vector of parameter estimates, $\hat{\Theta}_i$, 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 $\hat{\epsilon}_{i,t}$ with replacement and denote the vector of resampled residuals for country i by $\hat{\epsilon}_{i,t}^{(b)}$, $t = 1, \dots, T_i$.
3. Generate the bootstrap sample for country i , $\Delta p_{i,t}^{(b)}$, $t = 1, \dots, T_i$, by recursion as follows, taking the explanatory variables as given:

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

4. Re-estimate the NARDL model for country i using the bootstrap sample $\Delta p_{i,t}^{(b)}$ to obtain the bootstrap parameter vector, $\hat{\Theta}_i^{(b)}$.
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 $i = 1, 2, \dots, N$.

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 $\bar{\Theta}$ 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 $i = 1, 2, \dots, N$. Now, for each bootstrap sample, $b = 1, 2, \dots, B$, compute the mean of the N country-specific bootstrap coefficient vectors, $\bar{\Theta}^{(b)}$.
9. Compute the cumulative dynamic multipliers for each of the B bootstrap MG parameter vectors, $\bar{\Theta}^{(b)}$, and then compute empirical confidence intervals of any desired width around the MG cumulative dynamic multipliers obtained at step 7 in the usual way.

¹Here 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 C: 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									
Import dependence	-0.248 (0.164)	1								
FX rate volatility	0.330 (0.061)	0.102 (0.571)	1							
Output gap	-0.649 (0.000)	0.208 (0.247)	-0.248 (0.165)	1						
GDP per capita	-0.799 (0.000)	0.017 (0.927)	-0.404 (0.028)	0.580 (0.000)	1					
Commodity importer	-0.310 (0.079)	-0.090 (0.618)	-0.776 (0.000)	0.135 (0.454)	0.344 (0.050)	1				
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			
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		
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	
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

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

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Table 1/ Descriptive Statistics

Country	Data span	EX rate				Import price				Export price			
		Log change (%)		ADF test	KPSS test	Log change (%)		ADF test	KPSS test	Log change (%)		ADF test	KPSS test
		Mean	SD			Mean	SD			Mean	SD		
Emerging markets (N=14)													
Argentina	1991Q2-2010Q4	-0.58	11.75	-2.685	0.254	1.83	10.06	-2.121	0.188	0.66	2.87	-4.578	0.056
Brazil	1996Q3-2010Q4	0.62	8.44	-0.871	0.225	2.41	10.84	-1.636	0.238	0.74	4.28	-1.670	0.194
Chile	1996Q1-2010Q4	-0.05	3.97	-1.370	0.195	0.29	5.61	-1.371	0.162	0.57	3.15	-1.911	0.236
China	1982Q1-2010Q4	1.05	5.25	-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	-1.178	0.221	3.01	3.23	0.190	0.309	0.88	7.06	-1.563	0.258
Czech Republic	1998Q1-2010Q4	-0.94	2.73	-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	-1.288	0.247	0.14	1.10	-0.082	0.258	0.69	4.94	-5.006	0.081
Hungary	1994Q1-2010Q4	1.03	3.55	-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	-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	-1.656	0.198	2.47	6.20	-1.687	0.231	0.40	1.76	-2.355	0.134
Singapore	1980Q1-2010Q4	-0.55	1.82	-2.210	0.173	-0.12	2.30	-1.995	0.298	0.37	3.97	-1.187	0.250
South Africa	1980Q1-2010Q4	1.60	6.23	-1.682	0.201	2.21	3.69	-1.684	0.207	0.28	4.02	-0.431	0.261
South Korea	1980Q1-2010Q4	0.41	5.16	-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	-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	-1.580	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	-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	-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	-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	-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	-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	-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	-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	-3.440	0.086	0.51	2.59	-3.806	0.188	0.54	1.94	-2.893	0.087
Italy	1980Q1-2010Q4	0.46	2.02	-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	-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	-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	-2.389	0.225	0.54	3.55	-3.284	0.215	0.37	3.14	-1.652	0.240
Norway	1980Q1-2010Q4	-0.11	2.19	-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	-2.791	0.089	0.69	4.54	-3.772	0.058	0.40	3.68	-1.937	0.227
Sweden	1980Q1-2010Q4	0.09	2.92	-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	-2.788	0.262	0.00	1.52	-2.891	0.147	0.37	2.31	-2.710	0.124
UK/A	1980Q1-2010Q4	0.00	3.17	-1.523	0.139	0.67	2.18	-2.561	0.191	0.42	2.62	-2.148	0.200
US/A	1980Q1-2010Q4	-0.85	2.77	-1.064	0.263	0.40	2.57	-1.898	0.137	0.44	3.00	-1.191	0.271

SD is the standard deviation.

Deptr(+) 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~~ ^{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} the critical values tabulated by KPSS are used for inferences regarding the KPSS test. ~~at the 10%, 5% and 1% level respectively.~~ ^{whereas} ~~the~~ ^{the}

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Rejection of the null at the 5% level.

Rejection of the null at the 10% level.

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Results for

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Table 2

Results for

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Country		Unrestricted NARDL model				Restricted NARDL models			
		Short- and Long-run asymmetry		Short-run symmetry		Long-run symmetry		Short- and Long-run symmetry	
Countries	EMs	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 Republic		-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
UK		-3.422	5.179	-3.287	5.642	-3.822	5.678	-3.984	6.492
US/A		-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.

§ Rejection of the null hypothesis at the 5% level.
 §§ Rejection of the null hypothesis at the 1% level.

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Table 3 Individual Pass-Through Estimation Results

(A) Long-Run Relationship			(B) Short-Run Dynamics			Diagnostics			
Country	Sample	adjustment speed ρ	pass-through	Wald test long-run symmetry	Impact ERPT	Wald test impact symmetry	cumulative ERPT	Wald test cumulative symmetry	LB(4)
			β^*	$H_0: \beta = \beta^*$	π_0	$H_0: \pi_0 = \pi_0^*$	$\sum_{i=1}^p \pi_i$	$H_0: \sum_{i=1}^p \pi_i = \sum_{i=1}^p \pi_i^*$	
EMs									
Emerging markets (N=14)									
Argentina	1991:04-2010:04	-0.229	0.832	0.060	0.116	70.334	1.083	0.122	0.913
Brazil	1997:04-2010:04	-0.723	0.790	0.555	0.766	0.170	0.950	0.601	0.626
Chile	1996:03-2010:04	-0.665	0.997	0.947	0.683	3.295	1.379	0.357	0.611
China	1982:03-2010:04	-0.078	0.954	0.474	0.468	7.295	0.851	0.608	0.842
Colombia	1982:04-2010:04	-0.011	1.258	1.327	0.402	0.003	0.184	0.281	0.785
Czech Republic	1998:03-2010:04	-0.110	0.712	0.516	0.878	14.874	0.115	0.401	0.772
Hong Kong	1995:03-2010:04	-0.054	1.061	0.959	0.398	2.359	-0.012	0.621	0.706
Hungary	1994:03-2010:04	-0.138	0.524	0.969	0.484	3.033	0.170	1.074	0.794
Israel	1994:03-2010:04	-0.255	0.871	0.871	0.897	1.994	0.762	0.457	0.768
Mexico	1998:03-2010:04	-0.054	1.092	0.264	0.955	0.118	1.067	1.017	0.914
Singapore	1980:03-2010:04	-0.108	0.344	0.406	0.554	13.244	-0.878	0.859	0.428
South Africa	1980:03-2010:04	-0.049	1.024	0.625	0.317	0.002	0.530	0.602	0.495
South Korea	1980:03-2010:04	-0.197	0.407	0.133	0.716	2.549	0.686	0.643	0.785
Thailand	1998:02-2010:04	-0.275	1.510	0.740	0.817	2.383	1.181	0.489	0.840
DMs									
Developed markets (N=19)									
Australia	1980:03-2010:04	-0.098	0.795	0.561	0.722	0.331	0.927	0.996	0.786
Belgium	1993:03-2010:04	-0.165	2.928	0.884	1.688	0.755	1.728	1.085	0.513
Canada	1980:03-2010:04	-0.198	1.013	0.661	0.330	6.261	0.340	0.994	0.295
Denmark	1980:03-2010:04	-0.250	1.535	0.873	1.131	1.382	1.158	0.671	0.843
Finland	1980:03-2010:04	-0.114	0.988	0.585	0.606	5.363	0.370	0.184	0.526
France	1980:03-2010:04	-0.087	0.927	0.680	0.484	2.353	0.180	0.570	0.444
Germany	1980:03-2010:04	-0.088	0.585	0.507	1.138	3.714	1.367	0.318	0.672
Greece	1980:03-2010:04	-0.140	1.316	0.335	0.758	23.336	0.524	-0.819	0.624
Ireland	1980:03-2010:04	-0.146	1.254	1.203	0.670	0.007	0.844	0.739	0.428
Italy	1980:03-2010:04	-0.180	0.774	0.993	0.779	0.157	0.807	1.736	0.492
Japan	1980:03-2010:04	-0.192	0.712	0.709	0.328	4.572	-0.090	0.803	0.509
Netherlands	1980:03-2010:04	-0.127	0.668	0.854	0.847	0.001	0.888	0.995	0.835
New Zealand	1980:03-2010:04	-0.183	0.941	0.956	0.845	6.213	0.761	0.703	0.919
Norway	1980:03-2010:04	-0.082	0.771	0.391	0.498	0.010	0.464	0.774	0.742
Spain	1980:03-2010:04	-0.152	1.030	0.926	0.959	0.328	0.611	0.105	0.186
Sweden	1980:03-2010:04	-0.083	0.518	0.057	0.567	0.039	0.377	0.935	0.434
Switzerland	1980:03-2010:04	-0.097	0.905	0.483	0.321	0.108	0.174	0.249	0.721
UK	1980:03-2010:04	-0.101	1.003	0.723	0.487	1.319	0.387	0.446	0.657
US/A	1980:03-2010:04	-0.120	0.999	0.227	0.179	1.414	-0.152	0.500	0.590

respectively

The estimation sample is the effective sample used in estimation after adjusting for lags and first differences. β^+ is the long-run pass-through associated with a depreciation (appreciation) of the contemporaneous or impact pass-through reflected in the same quarter as the exchange rate shock. π_0^+ is the short-run ERPT one quarter after the exchange rate shock. Where a coefficient is printed in bold 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% levels. Inferences are based on ordinary least squares

Statistical significance at the 5% level.
Statistical significance at the 10% level.

Table 4: Panel Pass-Through Estimation Results

Country groupings	(A) Long-run pass-through				(B) Short-run pass-through			
	Adjustment speed	β^*	t-test	Impact	Deprec	$\pi_0 - \pi_0^*$	Deprec	Cumulative
			between groups	t-test	Asymmetry		Asymmetry	Asymmetry
All (N=33)	-0.168	0.955	1.103	0.644	0.692	0.134	0.609	0.593
Developed (N=19)	-0.137	1.019		0.653	0.702	0.184	0.634	0.601
Emerging (N=14)	-0.211	0.868		0.632	0.679	0.065	0.576	0.581
Import Dependence (Low)	-0.152	0.914	-0.573	0.630	0.543	0.108	0.427	0.559
Import Dependence (High)	-0.185	0.999		0.659	0.850	0.161	0.803	0.628
FX Volatility (Low)	-0.135	1.070	1.741	0.673	0.678	0.178	0.582	0.548
FX Volatility (High)	-0.204	0.832		0.613	0.708	0.086	0.638	0.640
Output Gap (Low)	-0.190	0.951	-0.061	0.652	0.686	0.098	0.611	0.593
Output Gap (High)	-0.145	0.959		0.636	0.699	0.172	0.607	0.593
GDP per Capita (Low)	-0.206	0.933	-0.302	0.674	0.794	0.241	0.693	0.529
GDP per Capita (High)	-0.129	0.978		0.613	0.584	0.020	0.520	0.660
Commodity Importer (Low)	-0.195	0.887	-1.399	0.636	0.692	0.067	0.662	0.623
Commodity Importer (High)	-0.139	1.059		0.652	0.693	0.205	0.553	0.561
Trade Freedom (Low)	-0.164	0.881	-1.045	0.592	0.715	0.161	0.610	0.588
Trade Freedom (High)	-0.172	1.033		0.700	0.667	0.105	0.608	0.597
Size FX Change (Low)	-0.212	0.925	0.409	0.647	0.575	-0.014	0.515	0.658
Size FX Change (High)	-0.133	0.969	0.209	0.648	0.816	0.291	0.710	0.524
Inflation Rate (Low)	-0.206	0.939		0.640	0.625	0.049	0.536	0.691
Inflation Rate (High)	-0.142	0.972	0.253	0.619	0.763	0.224	0.687	0.488
Inflation Volatility (Low)	-0.196	0.936		0.671	0.758	0.208	0.686	0.626
Inflation Volatility (High)					0.623	0.054	0.528	0.557

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 $V(\hat{\theta}^{MG})$. The columns labelled V_i -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% or 1% level.

Statistical significance at the 5% level.

Statistical significance at the 10% level.

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

	(A) Simple regressions				(B) Multiple regressions				(C) Nonlinear regressions			
Constant	0.268 (0.064)	0.366 (0.092)	0.461 (0.180)	0.313 (0.078)	0.252 (0.142)	0.351 (0.081)	0.800 (0.690)	0.283 (0.085)	1.588 (1.055)	1.166 (0.942)	0.224 (0.091)	0.232 (0.083)
Import dependence	0.105 (0.036)								0.129 (0.042)	0.120 (0.039)	3.360 (1.365)	3.890 (1.196)
Emerging		-0.131 (0.141)							-0.007 (0.265)	0.043 (0.237)	-0.051 (0.325)	-0.255 (0.219)
FX rate volatility			-0.043 (0.048)						-0.104 (0.077)	-0.097 (0.074)	-0.256 (0.195)	-0.335 (0.166)
Output gap				0.031 (0.403)					-0.046 (0.516)	-0.140 (0.487)	-1.298 (0.661)	-1.266 (0.633)
gap per capita					0.009 (0.019)				0.021 (0.034)	0.030 (0.031)	0.092 (0.062)	0.070 (0.053)
Commodity importer						0.520 (0.534)			0.155 (1.023)	0.690 (0.804)	-0.132 (2.358)	-1.565 (1.395)
Trade freedom						-0.061 (0.085)			-0.138 (0.113)	-0.107 (0.105)	-0.398 (0.157)	-0.424 (0.150)
Size FX change							0.252 (0.424)		0.938 (0.740)	1.109 (0.525)	4.376 (2.507)	3.329 (2.149)
Inflation rate								-0.004 (0.039)	-0.069 (0.074)		0.030 (0.087)	
Inflation volatility									0.067 (0.103)		-0.126 (0.139)	
Log Likelihood	-12.079	-15.652	-15.671	-16.087	-15.978	-15.603	-15.831	-16.094	-5.987	-6.639	2.764	2.159
Adj R ² (%)	19.097	-0.461	-0.576	-3.206	-2.465	-0.163	-1.557	-2.064	21.198	24.852	53.634	55.910
Prob(F-statistic)	0.006	0.363	0.373	0.939	0.635	0.338	0.481	0.917	0.108	0.053	0.001	0.000

† The number of observations is $N=33$. The dependent variable is the degree of long-run asymmetry estimated as $\hat{\beta}_i^+ - \hat{\beta}_i^-$ for country i , where the $\hat{\beta}_i$ s are the asymmetric long-run parameters from the NARDL models for countries $i = 1, 2, \dots, N$. 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 since 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% levels.

§ Statistical significance at the 5% level.

§§ Statistical significance at the 10% level.

ordinary least squares

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Gross domestic product

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Figure 1 Country Rankings According to Selected Importer Characteristics (Average Values, 1980-2010)

Notes: Each figure 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 pink/blue shading: white and grey shading.

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(US\$ thousands)

quarter 1, quarter 4

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

Notes: The solid (long dashed) black 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 shaded area depicts the difference between these two cumulative dynamic multipliers (i.e. $\frac{1}{1-\alpha}$ computed as a linear combination of the solid and dashed lines) with the shaded region reports the 90% bootstrap confidence interval computed using 5000 bootstrap replications. Tick marks on the horizontal axis indicate quarterly intervals over a 24 quarter horizon.

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

Notes: The solid (long-dashed) black 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 heavy solid (long-dashed) blue line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and dashed black lines) while the shaded region reports its 90% bootstrap confidence interval computed using 5000 bootstrap replications. Tick marks on the horizontal axis indicate quarterly intervals over a 24 quarter horizon.

respectively 1% or 40% hint

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

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The solid (long-dashed) black 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 ~~solid~~ short-dashed blue line depicts the difference between these two cumulative dynamic multipliers (i.e. it is computed as a linear combination of the solid and dashed black lines), while the shaded region reports its 90% bootstrap confidence interval computed using 5000 bootstrap replications. The marks on the horizontal axis indicate quarterly intervals over a 24-quarter horizon.

broken curves, $\sim 60\%$ hat

gross domestic product per capita

Details of the Dataset used in “Heads I Win, Tails You Lose: Asymmetry in Exchange Rate Pass-Through Into Import Prices”
by Raphael Brun-Aguerre, Ana-Maria Fuertes and Matthew Greenwood-Nimmo

Country	Import Price			Export Price			NEER		NEER daily		Import dependence		FX volatility		Output gap		GDP/cap. (annual)		Comm. importer		Trade freedom		Inflation	
Argentina	IMF	91Q2-10Q4 (70)					JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ ME	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	ME	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	INDEC	99Q1-10Q4 (48)
Australia	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ ABS	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	ABS	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	ABS	99Q1-10Q4 (48)
Belgium	IMF	93Q1-10Q4 (72)	IMF		93Q3-10Q4 (72)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ BNB	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	BNB	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	INS	99Q1-10Q4 (48)
Bolivia			IMF		86Q1-10Q4 (95)																			
Brazil	IMF	96Q3-10Q4 (58)	FUNCEX		96Q3-10Q4 (58)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ IBGE	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	IBGE	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	IBGE	99Q1-10Q4 (48)
Canada	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NSO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NSO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Chile	CBC	96Q1-10Q4 (60)			96Q1-10Q4 (60)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ CBC	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CBC	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	INE	99Q1-10Q4 (48)
China	OECD	82Q1-10Q4 (116)	NBSC		95Q3-10Q4 (62)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ SSB	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	JPM	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NBS	99Q1-10Q4 (48)
Colombia	BRC	80Q1-10Q4 (124)	BRC		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ DANE	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	DANE	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	DANE	99Q1-10Q4 (48)
Czech R	CSU	98Q1-10Q4 (52)	CSU		90Q1-10Q4 (84)		JPM	94Q1-10Q4 (68)	JPM	93Q4-09Q3 (64)	IMF/ CSU	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CSU	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Denmark	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NSO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NSO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Finland	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ CSO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CSO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
France	OECD	80Q1-10Q4 (124)	OECD/INSEE		95Q1-10Q4 (59)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ INSEE	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	INSEE	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	INSEE	99Q1-10Q4 (48)
Germany	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NCB	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NCB	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NCB	99Q1-10Q4 (48)
Greece	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NSS	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NSS	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSS	99Q1-10Q4 (48)
Hong Kong	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ HK-CSD	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	HK-CSD	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	CSD	99Q1-10Q4 (48)
Hungary	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	94Q1-10Q4 (68)	JPM	93Q4-09Q3 (64)	IMF/ KSH	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	KSH	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	KSH	99Q1-10Q4 (48)
India			MCI		80Q1-10Q4 (124)																			
Indonesia			NSI		80Q1-08Q4 (116)																			
Ireland	IMF	85Q3-10Q4 (102)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ CSO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CSO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	CSO	99Q1-10Q4 (48)
Israel	IMF	85Q3-10Q4 (103)	IMF		85Q3-10Q4 (102)		JPM	94Q1-10Q4 (68)	JPM	93Q4-09Q3 (64)	IMF/ CBS	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CBS	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	CBS	99Q1-10Q4 (48)
Italy	IMF	80Q1-10Q4 (124)	IMF		86Q3-10Q4 (100)		BIS	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ ISTAT	99Q1-10Q4(48)	BIS	94Q1-10Q4 (68)	ISTAT	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	ISTAT	99Q1-10Q4 (48)
Japan	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ EPA	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	EPA	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	BOJ	99Q1-10Q4 (48)
Mexico	BDM	88Q1-10Q4 (92)	BDM		88Q1-10Q4 (92)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ INEGI	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	INEGI	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	BDM	99Q1-10Q4 (48)
Netherlands	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ CBS	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CBS	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	CBS	99Q1-10Q4 (48)
New Zealand	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NSO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NSO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Norway	NSO	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ CBS	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	CBS	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Pakistan			IMF		80Q1-10Q4 (124)																			
Russia			ESSS		91Q1-10Q4 (80)																			
Singapore	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NSO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NSO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
South Africa	SARB	80Q1-10Q4 (124)	SARB		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ SARB	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	SARB	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
South Korea	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ BOK	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	BOK	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Spain	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ INE	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	INE	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	INE	99Q1-10Q4 (48)
Sweden	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ SCB	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	SCB	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	NSO	99Q1-10Q4 (48)
Switzerland	FSO	80Q1-10Q4 (124)	FCA		97Q1-10Q4 (56)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ SECO	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	SECO	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	SFSO	99Q1-10Q4 (48)
Thailand	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ NESDB	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	NESDB	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	CM	99Q1-10Q4 (48)
Turkey			IMF		97Q1-10Q4 (56)																			
U.K.	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ ONS	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	ONS	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	ONS	99Q1-10Q4 (48)
U.S.	IMF	80Q1-10Q4 (124)	IMF		80Q1-10Q4 (124)		JPM	80Q1-10Q4 (124)	JPM	93Q4-09Q3 (64)	IMF/ BEA	99Q1-10Q4(48)	JPM	94Q1-10Q4 (68)	BEA	99Q1-10Q4 (68)	IMF	99-10 (12)	G/D/T	88-10 (92)	Fraser	00-09(10)	BLS	99Q1-10Q4 (48)

NOTES: Import and export prices are trade-weighted indices and NEER is the nominal effective exchange rate of foreign currencies per unit of domestic currency, as detailed in Section 2 of the paper. To maintain comparability with the dataset used in Brun-Aguerre et al. (2012), additional export price data for Bolivia, India, Indonesia, Pakistan, Russia, and Turkey were used in the creation of the trade-weighted export price variable for each importing economy (see Brun-Aguerre et al., 2012, for further details). Import trade data are obtained from the IMF’s *Direction of Trade Statistics*. Import dependence is computed as $ID_{it} \equiv \frac{M_{i,t}}{GDP_{i,t} - X_{i,t}}$, where $M_{i,t}$ is the total value of imports, GDP is nominal output, and $X_{i,t}$ is the total value of country i ’s exports. FX volatility is based on the realised standard deviation of daily foreign exchange returns such that $RV_{it}^{FX} \equiv \sqrt{\sum_{j=1}^D [\log(\frac{NEER_j}{NEER_{j-1}}) \times 100]^2}$, where D is the number of days in each quarter. The output gap is computed as $\frac{GDP_{i,t} - GDP_{i,t}^*}{GDP_{i,t}^*} \times 100$ where trend output, $GDP_{i,t}^*$, is estimated using the HP filter. GDP per capita is denominated in thousands of nominal US\$. The commodity importer and Trade Freedom series are discussed in detail in Section 2 of the paper. Data sources are indicated by the following abbreviations: G/D/T stands for GSCI/DJ-UBSCI/TR-J CRB; JPM stands for J.P. Morgan; NSO stands for National Statistics Office; ME stands for Ministry of Economics; CM stands for Commerce Ministry; NCB stands for National Central Bank and Fraser stands for The Fraser Institute. All remaining abreviations are widely known.

APPENDIX B: 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, $\hat{\epsilon}_{i,t}$, $t = 1, \dots, T_i$ and the vector of parameter estimates, $\hat{\Theta}_i$, 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 $\hat{\epsilon}_{i,t}$ with replacement and denote the vector of resampled residuals for country i by $\hat{\epsilon}_{i,t}^{(b)}$, $t = 1, \dots, T_i$.
3. Generate the bootstrap sample for country i , $\Delta p_{i,t}^{(b)}$, $t = 1, \dots, T_i$, by recursion as follows, taking the explanatory variables as given:

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

4. Re-estimate the NARDL model for country i using the bootstrap sample $\Delta p_{i,t}^{(b)}$ to obtain the bootstrap parameter vector, $\hat{\Theta}_i^{(b)}$.
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 $i = 1, 2, \dots, N$.

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 $\bar{\Theta}$ 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 $i = 1, 2, \dots, N$. Now, for each bootstrap sample, $b = 1, 2, \dots, B$, compute the mean of the N country-specific bootstrap coefficient vectors, $\bar{\Theta}^{(b)}$.
9. Compute the cumulative dynamic multipliers for each of the B bootstrap MG parameter vectors, $\bar{\Theta}^{(b)}$, and then compute empirical confidence intervals of any desired width around the MG cumulative dynamic multipliers obtained at step 7 in the usual way.

¹Here 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 C: 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									
Import dependence	-0.248 (0.164)	1								
FX rate volatility	0.330 (0.061)	0.102 (0.571)	1							
Output gap	-0.649 (0.000)	0.208 (0.247)	-0.248 (0.165)	1						
GDP per capita	-0.799 (0.000)	0.017 (0.927)	-0.404 (0.020)	0.580 (0.000)	1					
Commodity importer	-0.310 (0.079)	-0.090 (0.618)	-0.776 (0.000)	0.135 (0.454)	0.344 (0.050)	1				
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			
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		
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	
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

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

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