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In 2007 all ECB publications feature a motif taken from the €20 banknote.

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Abstract

This paper examines the degree of Exchange Rate Pass-Through (ERPT) to prices in 12 emerging markets in Asia, Latin America, and Central and Eastern Europe. Our results, based on three alternative vector autoregressive models, partly overturn the conventional wisdom that ERPT into both import and consumer prices is always higher in "emerging" than in "developed" countries. For emerging markets with only one digit inflation (most notably the Asian countries), pass-through to import and consumer prices is found to be low and not very dissimilar from the levels of developed economies. The paper also finds robust evidence for a positive relationship between the degree of the ERPT and inflation, in line with Taylor's hypothesis once two outlier countries (Argentina and Turkey) are excluded from the analysis. Finally, the presence of a positive link between import openness and ERPT, while plausible theoretically, finds only weak empirical support.

JEL Classification: C32, E31.
Key Words: Exchange Rate Pass-Through, Emerging Markets.

Non-technical summary

Understanding the impact of exchange rate movements on prices is critical from a policy perspective in order to gauge the appropriate monetary policy response to currency movements. Empirical studies have shown that movements in the exchange rate and prices do not go one to one in the short to medium run. An extensive theoretical literature, which has developed over the past three decades, has identified various explanations why exchange-rate pass-through (ERPT) to import and consumer prices is incomplete. Empirical analyses have also provided evidence of considerable cross-country differences in the ERPT. A major argument in this respect was suggested by Taylor (2000), who put forward the hypothesis that the responsiveness of prices to exchange rate fluctuations depends positively on inflation.

This paper examines the degree of ERPT to prices in 12 emerging markets in Asia, Latin America, and Central and Eastern Europe. To achieve this, we employ a modelling strategy that was developed for advanced countries by McCarthy (2000) and applied by Hahn (2003) to the euro area. We estimate vector autoregressive models, which include in the baseline case as variables output, the exchange rate, import and consumer prices, a short-term interest rate, and oil prices. This vector autoregressive approach allows for the likely endogeneity between our variables of interest. Exchange rate shocks are identified by appropriately ordering the variable of interest and applying a recursive identification scheme. As the ordering of the variables may matter, we conduct a sensitivity analysis for different alternative orderings of the variables. For comparison purposes, we also estimate comparable models for a benchmark of developed economies, namely the euro area, the United States and Japan.

Our results confirm that ERPT declines across the pricing chain, i.e. it is lower on consumer prices than on import prices. There is also evidence of low ERPT for developed economies, particularly in the case of the US and, for consumer prices, in Japan. In line with previous studies ERPT is found to be somewhat higher in the euro area than in the US, both for consumer and import prices. Our analysis also partly overturns the conventional wisdom that ERPT is always higher in "emerging" than in "developed" countries. For emerging economies with one-digit level of inflation (most notably the Asian countries in our sample), ERPT is low and not very dissimilar from the levels prevailing in developed economies. More generally, the paper finds broad confirmation for a positive relationship between the degree of the ERPT and inflation, in line with Taylor's hypothesis. This result becomes apparent only after two outlier countries (Argentina and Turkey) are excluded, given the estimation difficulties associated with the severe macroeconomic instability experienced over the sample in these two countries. Finally, the presence of a positive link between import openness and ERPT, while plausible theoretically, finds only weak empirical support.

1. Introduction

Over the past two decades a large economic literature on exchange rate pass-through (ERPT) has developed. Starting from different stand-points, the empirical literature examines the role played by ERPT in small and large economies. Studies conducted for the case of developed countries include Anderton (2003), Campa and Goldberg (2004), Campa et al. (2005), Gagnon and Ihrig (2004), Hahn (2003), Ihrig et al. (2006) and McCarthy (2000). There is also a burgeoning literature applied to emerging market economies, including cross-country comparisons as in Choudhri and Hakura (2006), Frankel et al. (2005) and Mihaljek et al. (2000).

Economists have traditionally made the simplifying assumption that the prices of tradable goods – once expressed in the same currency – are equalised across countries, i.e. that the purchasing-power parity condition (PPP) holds. Empirically, however, this assumption has found in general little support, at least in the case of small samples and in the short to medium run. In line with this evidence, the theoretical literature developed over the past two decades has provided different explanations why the ERPT is incomplete. In his seminal paper, Dornbusch (1987) justifies incomplete pass-through as arising from firms that operate in a market characterised by imperfect competition and adjust their mark-up (and not only prices) in response to an exchange rate shock. Burstein et al. (2003) instead emphasise the role of (non-traded) domestic inputs in the chain of distribution of tradable goods. Burstein et al. (2005) point to the measurement problems in CPI, which ignores the quality adjustment of tradable goods large adjustment in the exchange rate. Another line of reasoning stresses more the role that monetary and fiscal authorities play, by partly offsetting the impact of changes in the exchange rate on prices (Gagnon and Ihrig, 2004). Devereux and Engel (2001) and Bacchetta and van Wincoop (2003) explore instead the role of local currency pricing in reducing the degree of ERPT.

Corroborating these various theoretical approaches, the empirical literature for both advanced and emerging economies has found evidence of incomplete ERPT. These studies also find evidence of considerable differences across countries, leading naturally to the question of what are the underlying determinants of pass-through. Taylor (2000) in particular has put forward the hypothesis that the responsiveness of prices to exchange rate fluctuations depends positively on inflation. The rationale for this involves a positive correlation between the level and persistence of inflation, coupled with a link between inflation persistence and pass-through. The latter link can be expressed as follows: The more persistent inflation is, the less exchange rate movements are perceived to be transitory and the more firms might respond via price-adjustments.

The evidence across different studies appears overall supportive of the Taylor hypothesis. The positive relationship between the degree of pass-through and inflation appears to emerge more

strongly, however, when emerging markets are included in the sample period under review (see in particular the panel data evidence in Choudhri and Hakura, 2006). This may be not surprising, as the theoretical argumentation of Taylor becomes more meaningful for higher rates of inflation.[3]

Another important determinant of ERPT, from a theoretical standpoint is the degree of trade openness of a country. The most immediate connection between the two variables is positive: the more a country is open, the more movements in exchange rates are transmitted via import prices into CPI changes. However, the picture becomes more complex once we take into account that inflation could be negatively correlated with openness, as empirically found by Romer (1993).[4] This gives rise to an indirect channel, whereby openness is negatively correlated with inflation and, taking into account Taylor's hypothesis, the degree of pass-through. The direct and indirect channels go in opposite directions and the overall sign of the correlation between pass-through and openness can thus be either positive or negative.

The present paper reviews the results from the literature, exploring the magnitude of the ERPT and the differences across countries by estimating vector autoregressive (VAR) models for emerging market countries and for the main industrialised economies, i.e. the euro area, the United States and Japan which are used as a control group. A simultaneous equation approach is used in order to allow for potential and highly likely endogeneity between the variables of interest. Simply ignoring such simultaneity, as is often done in single equation approaches, would result in simultaneous equation bias. The chosen modelling framework is, moreover, appealing as it allows one to trace out the dynamic responses of variables to exogenous shocks over time. The literature so far has estimated either single equation models or systems of equations for one specific country, or else set up single equation models for a larger set of countries (e.g. Choudhri and Hakura, 2006, and Mihaljek et al., 2000). In this study instead, we apply our system approach to a considerable number of countries in the world's three main emerging market regions, namely, Asia, Latin America, and Central and Eastern Europe. At the same time, we use the same approach to the three major industrial economies, which ensures comparability across the country results. By estimating each country model over the longest possible time horizon, we moreover aim at the highest possible degree of precision of the pass-through estimates for each country. In this respect, an important ingredient to the analysis has been the creation of a suitable and comparable database for each country at the quarterly frequency, which represents a major challenge given the data availability and quality for emerging market countries. This has also

[3] It is worth noting that exchange rate pass-through may also be higher in emerging markets because the private sector has fewer hedging instruments available. In a not fully competitive environment, this could imply that the exchange rate moves feed more into pricing behaviour.

[4] The author provides a theoretical explanation for this result, relating to the difficulties in pursuing stabilisation policies in small open economies.

helped us meeting the requirements of a system approach based on a relatively high number of variables in order to allow for sufficiently rich dynamics and to avoid omitted variable bias.

We then use our country results to examine the conventional wisdom that ERPT is higher in emerging markets than in industrialised economies and to investigate patterns of exchange-rate pass-through across them in terms of correlations, along the lines of McCarthy (2000) and Choudhri and Hakura (2006). Whether the ERPT is higher or not in emerging markets matters for the determination of the trade balance and also for a country's choice of an exchange rate regime. A relatively high degree of pass-through for developing countries has also been cited as a rationale for the developing countries' well documented "fear of floating". It also matters because low pass-through in emerging markets might suggest that in these countries firm's market power is on the rise and not falling, as globalisation trends might suggest. Emerging market countries, however, present important special features that make it difficult to obtain reliable estimates of ERPT. Several Asian countries have frequently pursued active policies aimed at controlling the exchange rate. Central and Eastern European countries underwent a radical transformation of their economies in the 1990s. Finally, Turkey and several Latin American countries experienced spells of strong macroeconomic instability characterised by very high inflation rates and/or strong exchange and interest rate volatility.

Our results only partly support the prevailing view that the degree of ERPT is higher in emerging markets than in developed countries (using as a benchmark the US, the euro area and Japan). More specifically, we find that in low-inflation emerging economies (notably the Asian economies) pass-through to consumer prices is rather small. In relation to this, the paper is overall supportive of the hypothesis of Taylor, finding evidence of a positive correlation between pass-through and inflation in emerging markets. This connection appears to be statistically significant across all different identification schemes under consideration when two outlier countries are excluded. As in the related literature, the role of openness is found to be, in general, weak, even after controlling for the level of inflation rates.

The rest of the paper is structured as follows. Section 2 and 3 describe the methodology and the data for the countries under consideration. Sections 4 and 5 present the empirical results for the baseline and alternative specifications, respectively. Finally, Section 6 contains our main conclusions.

2. Methodology

The analysis is conducted by using a standard VAR model as in (1),

$$Y_t = c + \sum_{i=1}^{p} \Phi_i Y_{t-1} + \varepsilon_t \qquad (1)$$

where Y_t represents the vector of endogenous variables, c is a vector of constants, Φ_i denotes the matrices of autoregressive coefficients and ε_t is a vector of white noise processes. Identification of the structural shock is achieved by appropriately ordering the variables of interest and applying a Cholesky decomposition to the variance covariance matrix of the reduced form residuals ε_t.

As a starting point of the analysis, a six-variable VAR model similar to those by McCarthy, 2000 and Hahn, 2003, is developed. The baseline VAR model applied to the different countries includes an oil price index, oil_t, an output variable y_t, an exchange rate e_t, an import price index $pimp_t$, a consumer price index cpi_t, and a short-term interest rate i_t. The exchange rate and the two price variables are the key variables in our analysis. The output variable and oil prices are included to capture effects on the real side of the economy. The inclusion of the interest rate allows the money market, including the impact of monetary policy, to influence the pass-through relationship.

In the baseline model the variables are ordered as listed above. The use of a recursive identification scheme implies that the identified shocks contemporaneously affect their corresponding variables and those variables that are ordered at a later stage, but have no impact on those that are ordered before. Hence, it is sensible to order the most exogenous variable, in our case the oil price, first. Oil price shocks may thus affect all other variables in the system contemporaneously but oil prices are not themselves affected contemporaneously by any of the other shocks. The next variables in the system are output and the exchange rate. With this ordering we implicitly assume a contemporaneous impact of the demand shocks on the exchange rate while also imposing a certain time lag on the impact of exchange rate shocks on output. The price variables are ordered next and are thus contemporaneously affected by all of the above mentioned shocks. Following the pricing chain, import prices precede consumer prices allowing for a contemporaneous impact of import price shocks on consumer prices but not vice versa. The interest rate is ordered last, allowing for the money market, and in particular monetary policy, to react contemporaneously to all variables in the model. The baseline specification represents just one of several plausible alternatives in terms of identification and variables included. Hence, we later carry out a sensitivity analysis using two other plausible model formulations.

3. Data description

In this study we focus our analysis on countries from three broad world regions, Asia (China, South Korea, Singapore, Taiwan, and Hong Kong), Central and Eastern Europe (Czech Republic, Hungary, Poland) plus Turkey, and Latin America (Argentina, Chile and Mexico). This selected set of countries is composed of major emerging market countries in these regions.[5] For each country a set of quarterly data was collected, going as far as back in time as possible. The oil price is represented by a crude oil price index denominated in US dollars. The preferred output variable is GDP, although in a few cases we have used industrial production in order to get a longer sample period. For all countries for the exchange rate we employed a nominal effective series. Furthermore, local currency import and consumer prices are included, except for China where we restricted the analysis to consumer prices as an import price series was not available. Finally, the monetary policy instrument is represented by a short term interest rate. As the sample period was determined by data availability,[6] it varies across countries (see the Appendix for a detailed description of the data sources, and the first rows in Tables 1 and 2 for the sample periods employed).

A summary of the average macroeconomic conditions in emerging markets over the sample period for which data is available is given in Table 1. Average inflation was relatively low in the Asian countries, particularly in the cases of Taiwan and Singapore. The latter two countries managed to combine strong real GDP growth, low inflation and a stable nominal effective exchange rate, both in value and volatility terms. Central and Eastern European countries have combined output growth of around 2 and 3% with relatively high but falling rates of inflation. More specifically, disinflation was achieved earlier in the Czech Republic, although in the context of the recessionary forces which persisted for a number of years after the 1997 banking crisis. Over the period under review, which coincides with the return to market economy systems, the Czech Republic, Hungary and Poland have all been subject to a rather sizeable process of real appreciation, partly related to the Balassa-Samuelson effect, but also to the unwinding of the large undervaluation of the early phases of restructuring.

A number of countries experienced instead strong inflationary pressures over the sample period under consideration. Two countries stand out in particular. Uncertain financial macroeconomic conditions weighed on Argentina, which experienced at various points in time in its history prolonged spells of major financial turbulence leading also to hyperinflationary episodes. Strong

[5] The country of relatively large size that has been excluded from the analysis is Brazil, because of the implausible results obtained, extreme high levels of volatility in the data and annualised inflation well above 1000% throughout the period between 1992Q1 and 1994Q4.

[6] We have followed a cascade order, choosing when possible only one institutional source (IMF's *International Financial Statistics*, OECDs' *Main Economic Indicators*, and BIS, in that order) followed by domestic sources (as available frequently via private providers of international data). Particular attention was given to the need of having a consistent dataset and avoiding data discontinuities caused by data compilation errors.

inflationary pressures and high exchange rate volatility prevailed also in Turkey with severe financial difficulties erupting on more than one occasion. Mexico also experienced spells of significant, although comparatively more contained, market turbulence as shown by the high nominal effective exchange rate volatility. Chile managed instead to keep a lower average inflation of about 13% as recorded since 1980. Finally, many emerging market countries in our sample can be described as rather open economies with regard to their trading structure. Taking as a benchmark imports as a percentage of GDP, we find that the most open economies in our sample are, in diminishing order, Hong Kong, Singapore followed by the Czech Republic and Hungary. The larger economies, China and Argentina are found to be relatively closed compared to the other emerging markets in this study.

Table 2 summarises the average macroeconomic conditions in three advanced economies constituting our benchmark of comparison, namely, the US, the euro area and Japan. These economies exhibit low average inflation as well as more stable macroeconomic conditions than emerging markets. On the basis of the inflationary record, among the emerging markets one would probably expect to find the lowest coefficients of pass-through in Asia and the highest in Latin America, with the exception of Chile. The degree of openness, however, might contribute to play a counterbalancing role by dampening the impact on CPI pass-through in relatively closed Latin American economies, while bringing about a positive impact especially in the cases of Hong Kong and Singapore – the countries most open to trade in our sample.

The degree of ERPT in each country is computed by estimating a specification of model (1) for the selected vector of endogenous variables, which takes account of the time series properties of the data. Unit root tests indicated that most variables in the considered countries are non-stationary (only the interest rate was found to be stationary in some cases), while Johansen cointegration tests overall provided only weak evidence of possible long-run equilibrium relationships among the variables in some countries. Given these data properties, a VAR in the first differences of the non-stationary variables represents an appropriate specification of the models. Favouring a VAR in first differences, as opposed to a Vector Error Correction model (VECM), may lead to misspecification, if cointegration would be present. However, our choice also considers that the analysis: (i) focuses on the short-term dynamics as opposed to long-term equilibrium relationships between variables; and (ii) is constrained by the short-sample periods available for some of the emerging market economies. An alternative viable choice would have been a VAR model in the levels of the variables. It is, however, worth saying that also neither the estimation in levels nor the VECM specifications are exempt from problems (see, *e.g.*, Favero, 2001). In the presence of cointegration, the former method would suffer from

overparameterisation and an efficiency loss. The VECM would yield inconsistent estimates if the wrong cointegrating vector is imposed on the model.[7]

More specifically, our VAR model in the first differences of the non-stationary variables includes as variables Δoil_t, $\Delta y_t, \Delta e_t, \Delta pimp_t, \Delta cpi_t$ and finally, depending on the outcome of unit root tests, either i_t or Δi_t. All models are estimated with a constant and seasonal dummies. The lag length of the VAR for each country is determined by looking at various information criteria as well as a number of specification tests. Information criteria are used to help identify optimal lag lengths, but the final decision is based on specification tests applied to the alternative candidate models.[8]

In the next two sections we first discuss the results for the ERPT to domestic prices in the emerging market economies and compare them to those derived for our control group of advanced economies. We subsequently attempt to establish a link between the size of the ERPT across countries and some possible determinants by calculating correlations coefficients. Finally we investigate how robust these results are by applying two alternative identification schemes.

4. Empirical results

The estimates of the ERPT on import and consumer prices for all emerging market countries in our sample are summarised in Tables 3 and 4 for two time horizons, namely after 4 and 8 quarters. For most countries our results appear generally plausible both in terms of CPI and import prices. ERPT is found to decline along the pricing chain, i.e. it is higher for import prices than for consumer prices. In particular, one-year after the shock pass-through to import prices is found to be high and statistically not different from 1 in the cases of Argentina, Chile, Hungary, Mexico, Poland and Turkey, somewhat lower in the Czech Republic and Korea, and rather low in most other Asian countries.[9] ERPT to CPI is found to be the highest in Hungary and Mexico. In Asia, pass-through to CPI is found instead to be low both after four and eight quarters. As regards Singapore, while the point estimates of the coefficients are found to be slightly negative, they are not significantly different from zero.

We then apply the same methodology to the euro area, the US and Japan in order to assess whether the degree of pass-through is higher in emerging markets. Table 5 shows that the

[7] Moreover, Marcet (2005) argues that in several cases cointegration techniques and VARs in levels may not be superior to differencing.

[8] The lag length selected for the emerging market economies is generally four lags, except for Taiwan, the Czech Republic and Hungary (three lags) and Chile (two). On the basis of unit root tests, nominal interest rates are included in differences for Hungary and Korea, and in levels for all other emerging countries. As regards the developed countries, three lags are used for the US model and two for the VAR models for the euro area and Japan, respectively, Interest rates are included as first differences for all three developed economies.

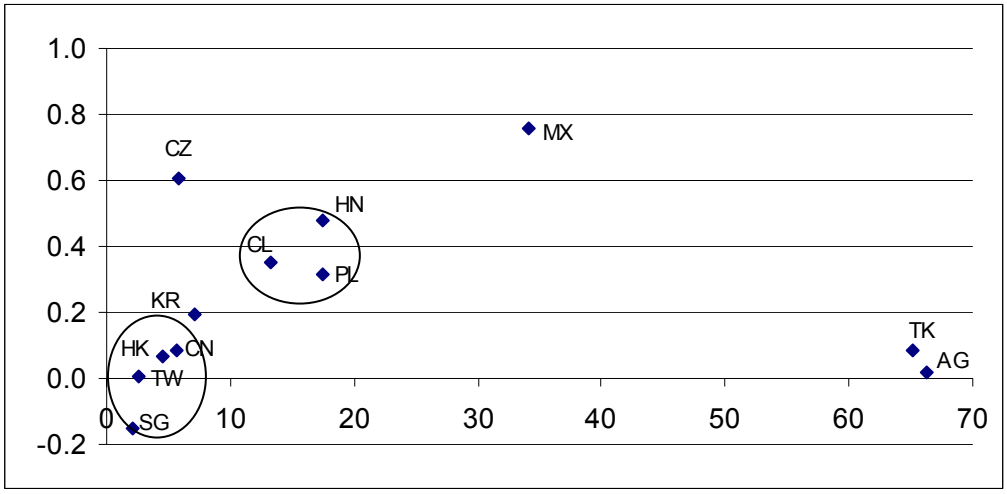
[9] Two years after the shock the estimates are higher, but given the large uncertainty surrounding the estimates in these countries still not statistically different from one.

evidence for the euro area is very much in line with the estimates found by other studies using similar (see Hahn, 2003)[10] or alternative methodologies (see e.g. Anderton, 2003, and Campa et al., 2005, for import prices). The estimates found for the US are in line with the overall consensus that exchange rate pass-through is very low in the United States, both in terms of import and consumer prices (see Gagnon and Ihrig, 2004, for consumer prices). In Japan, exchange rate pass-through to CPI is found to be very small both after four and eight quarters. In terms of import prices, the estimate for Japan is higher than in the euro area and the US, and statistically consistent with full pass-through after one year. Comparing the pass-through estimates of advanced and emerging economies, our results partially overturn the conventional wisdom that the degree of ERPT is always higher in emerging markets than in developed countries. More specifically, we find that in low inflation emerging economies (notably the Asian economies) pass-through to consumer prices is rather low as well.

The next step in our analysis is to obtain some insights on the macroeconomic determinants of ERPT. We begin by exploring whether in line with Taylor's hypothesis there is evidence of a positive correlation between pass-through and inflation. For illustrative purposes we start our analysis by visually inspecting the relationship between the degree of ERPT after one year and inflation for the emerging markets in our sample (see Figure 1).[11]

Figure 1: Consumer Price Pass-Through versus Average Inflation in Emerging Markets

(y-axis: accumulated response of consumer prices to a 1% exchange rate shock after one year; x-axis: average inflation over the estimation period)



Note: The model employed is the baseline model (see main text for details). The countries plotted in the chart are: Argentina (AG), Turkey (TK), Mexico (MX), Czech Republic (CZ), Hungary (HN), Poland (PL), Chile (CL), South Korea (KR), China (CN), , Hong Kong (HK), Taiwan (TW), Singapore (SG).

[10] Different to our analysis Hahn (2003) uses non-oil import prices. As the ERPT to commodities such as oil is known to be particularly high, the finding of a somewhat higher pass-through on total import prices than on non-oil import prices seems consistent.

[11] Similar charts are also available on request from the authors for the 8 quarter horizon under the baseline model as well as for the two alternative scenarios considered in section 4 both at the 4 and 8 quarter horizons.

As shown in Figure 1, two broad sets of countries can be identified. The first set of countries, in which annual inflation was on average less than 10% over the sample, experienced low levels of ERPT (generally less than 10%). A second set of countries, in which average inflation was clearly higher – i.e. between 10 and 20%, was subject to a considerably higher degree of ERPT to consumer prices (about 40%). These sets of countries seem to provide at least broad support of Taylor's hypothesis. Two other countries in our sample, Argentina and Turkey, appear to be clear outliers, since they combine extremely high average inflation rates (of over 60%) and low consumer prices pass-through. Simple visual inspection of the above chart indicates that if these two countries are included in the analysis, Taylor's hypothesis would break down. The VAR methodology is, however, probably inadequate for countries that experienced significant macroeconomic instability as reflected in hyperinflation or very-high inflation rates. Taking the example of Argentina, extending the sample too much signifies including in the analysis large jumps in the financial variables (followed by different speeds of adjustment to more "normal" levels). By restricting the sample period to exclude the high inflation episodes, instead, not only does the data length become very short but also the sample becomes a partial, possibly misleading, snapshot of the high inflation episode. For example one may end up including a period of high inflation, during which the macroeconomic stabilisation is still ongoing, and matching it with a strongly appreciating currency (rebounding from the strong undervaluation typically associated to hyperinflationary episodes). Under these circumstances it becomes therefore very difficult to recover the underlying relationship between exchange rate movements and prices given the unusual dynamic patterns that are expected to arise under such an unstable economic environment. The VAR methodology and more generally all econometric estimations are unlikely to be able to capture any meaningful measures of pass-through if prices, exchange rates and interest rates are excessively volatile. By contrast the economic insight suggested by Taylor appears to find support if we exclude from the sample Turkey and Argentina.

The visual impression of a positive correlation between pass-through and inflation is confirmed by two standard measures of correlation - the Pearson product-moment and Spearman rank correlation coefficients - between the coefficient of pass-through and a number of plausible determinants. The results appear in Table 6. These measures confirm that there is a positive correlation between pass-through and inflation at both four- and eight-quarter time horizons. The correlation coefficient is significant both in the case of the Pearson and Spearman correlation coefficients at both the 4-quarter and 8-quarter horizons at the 1% significance level. Other measures of macroeconomic instability are also positively correlated with ERPT, although the level of significance is generally somewhat smaller. Similarly to Choudhri and Hakura (2006) and McCarthy (2000), we find little evidence of a positive relationship between ERPT to consumer prices and openness. This finding could be seen as surprising in light of the expected positive direct link between these variables, as resulting from the transmission channel from imports to

consumer prices. One way of rationalising the previous puzzling result is to take into account the negative correlation between inflation and openness as reported by Romer (1993). After controlling for inflation, the correlation coefficient between pass-through and openness turns positive, although not statistically significant.

5. Robustness

In this section we assess to what extent our baseline results are sensitive to the choice of the identification scheme and some changes in the variables. We re-estimate the model with two alternative identification schemes, based on two alternative orderings of the variables in the Cholesky decomposition. In the first place, we adopt the following alternative ordering scheme (Alternative 1 model), oil_t, i_t, y_t, e_t, $pimp_t$, cpi_t, where in particular the interest rate is moved before the exchange rate, as proposed for example by Choudhri et al. (2002). This ordering allows for a contemporaneous response of the exchange rate to changes in the monetary policy instrument. This could be explained on the basis of standard carry-trade considerations, whereby higher interest rates make – other things equal - currencies more attractive by exploiting in particular the failures of the arbitrage equation. Estimates of pass-through under this alternative identification scheme are generally very similar to those discussed in the previous section (see Tables 7 and 8). An exception to this is Hungary where estimates of ERPT to both import prices and CPI drop considerably. In terms of import prices, as before one year after the shock the coefficient of pass-through is found to be high and not significantly different from 1 in Argentina, Mexico and Poland. In the case of Chile, the coefficient of import price pass-through is now found to be somewhat lower and closer to the levels of the Czech Republic and Korea one year after the shock (in the region between 0.7 and 0.8). One year after the shock, the degree of import price pass-through remains very low in the cases of Singapore and Taiwan, although in the former case it rises considerably two years after the shock.

In terms of CPI prices, the coefficient of pass-through remains as before almost always smaller than the import price equivalent. The coefficient is now found to be the highest one year after the shock in the Czech Republic, Mexico and Poland. In Asia, ERPT to consumer prices is one more time found to be on the low side. Again, in the case of Singapore, although the point estimates of the coefficients are found to be negative, they are not significantly different from zero. The overall result that all countries characterised by average inflation less than 10% are generally characterised by moderate levels of estimated ERPT still holds. As before Argentina and Turkey stand out for very low pass-through on consumer prices. Excluding these two countries, the positive correlation between pass-through and inflation still is found to be positive after both four and eight quarters, albeit the degree of significance is lower than in the first scenario that we had considered (see Table 9). Other measures of macroeconomic instability are also positively correlated with the degree of ERPT at various different levels of significance at both the first and

second year horizons. Finally, we once more find no evidence of a statistically significant positive relationship between ERPT and openness, even after controlling for inflation.

The second considered alternative model (Alternative 2 model) to our baseline case includes both modifications to the included variables and a further alternative ordering of the variables in the Cholesky decomposition. In the previous models we had included an oil price variable which could be interpreted as capturing supply side effects but also foreign costs and, hence, should have helped to more properly disentangle exogenous exchange rate effects from those of foreign costs. A similar argumentation applies to domestic price developments though. We therefore replace in this alternative model the oil price by domestic producer prices ppi_t, which also takes account of the necessity of a parsimonious model. An alternative variable to use for this purpose might have been wages. This variable, however, is not available for a sufficiently large number of the considered countries. As regards changes to the ordering of the variables, in the Alternative 2 model we take a rather strong theoretical stand-point by assuming that the exchange rate is not contemporaneously affected by the shocks hitting any of the other variables in the system, i.e. it is placed first leading to the following ordering of the variables: e_t, $pimp_t$, y_t, ppi_t, cpi_t i_t. There is a large literature that discusses ERPT on the basis of various structural models, coming to different theoretical conclusions concerning the determination of the exchange rate depending on the underlying assumptions of the model (see for example Marston, 1990, and Devereux et al., 2006). In these models, a particularly crucial role is assumed by whether firms set prices in the local currency where they sell the product or in the currency of where production takes place. While these models provide coherent insights on the concepts of ERPT depending on the various underlying assumptions of the model, they implicitly tend to come to strong conclusions regarding a contemporaneous connection between exchange rates and a subset of plausible fundamentals. All these papers are potentially subject to the critique that macroeconomic variables have little explanatory power for exchange rates in the short to medium run. In particular, it has been difficult to detect mean reversion in real exchange rates – the latter's volatility seeming to be driven by nominal exchange rate developments that are not easy to reconcile with fundamental explanations.[12] In connection with this, the Alternative 2 model allows the exchange rate to be influenced by the shocks to other variables but only with a lag, implicitly assuming that contemporaneously at least other factors (such as 'noise trading' or imperfect information considerations – both of great importance in an emerging market context) tend to dominate.

[12] On the little explanatory power of macro variables for exchange rate determination, see the vast literature stemming from Meese and Rogoff (1983). For an attempt to reconcile a simple structural fundamentalist view and high exchange rate volatility, see for example Devereux and Engel (2001).

Notwithstanding this relatively different model, the results that we obtain are noteworthy similar to those discussed in the previous section (Tables 10 and 11). Pass-through to import prices is found to be close to 1, both after one and two year horizons, in Argentina, Chile, Hungary, Poland, Mexico and Turkey, while is estimated to be much lower in the Asian countries and in the Czech Republic. Consumer prices pass-through is generally found to be lower than import pass-through for all countries and in the case of several Asian countries is close to zero after both one and two year horizon. Repeating the correlation analysis we consistently find evidence of a significantly positive relationship between CPI pass-through and inflation (at the 1% level), after excluding Argentina and Turkey from the sample (see Table 12). The correlation coefficient between CPI-pass-through and the remaining measures of macroeconomic instability is also positive and almost always statistically significant for all time horizons considered. The association between CPI-pass-through and openness is again positive, after controlling for inflation, but not statistically significant.

6. Final remarks

This paper provides empirical evidence on world patterns of ERPT on domestic prices based on vector autoregressive models for a considerable number of countries, including a large number of emerging market countries from three major emerging world regions and a control group of industrialised countries. Across all countries the results point to a decline in the ERPT along the pricing chain. The analysis partly overturns the conventional wisdom that ERPT is always considerably higher in "emerging" than in "developed" economies. For emerging markets with only one-digit annual inflation rates (most notably the Asian countries) ERPT is low and not very dissimilar from the levels of the ERPT in developed economies. Taking a more general perspective, we find that the connection between pass-through and inflation is statistically significant when two outlier countries (Argentina and Turkey), for which the results appear to be unreliable, are excluded. In addition, the evidence of a positive correlation between pass-through and openness appears to be weaker than that between pass-through and inflation, even after controlling for the level of inflation.

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Appendix: Data sources

The emerging markets data used in this paper covers a maximum sample period between 1975:1 to 2004:1 (see first row of Table 1). For the euro area, US and Japan, the sample period starts in 1983:1. The exact sample for each emerging country, depending on data availability, is described in the first row of Table 1. The corresponding sources are as follows:

Nominal Oil Price: IMF's *International Financial Statistics* - henceforth IFS -, UK Brent price in US dollars (line 11276).

Output: We use Gross Domestic Product for Hong Kong, South Korea, Singapore, Hungary, Turkey, Chile (from IFS, line 99bvp), Japan and Mexico (OECD), euro area (from ECB's Area Wide Model - henceforth AWM; see Fagan et al., 2005), Taiwan and Argentina (national sources), and the US (from IFS, line 99bvr). Due to lack of data availability, we opt for industrial production data in the cases of China (national source), Czech Republic (OECD) and Poland (IFS line 66).

Nominal Effective Exchange Rate: We use nominal effective rates from IFS (line nec) for all emerging market countries but Hong Kong, South Korea, Singapore and Taiwan (BIS), Turkey Mexico (OECD) and Argentina (JP Morgan). For the US and Japan, we use IFS (line neu) data, and for the euro area AWM data.

Import Price Index: We use data on import prices (of goods only) from IFS (line 76) for US, Japan, South Korea, Singapore, Hungary and Poland, and from alternative sources in the following cases: euro area (ECB data), Taiwan, Argentina, and Mexico (national sources). In the case of Chile, we combine import prices data from IFS line 76 until 1995:4, and thereafter Banco de Chile import deflator data. Owing to lack of data availability, we use import deflator data for the Czech Republic (OECD OEO), and IFS import unit values (line 75) for Hong Kong and Turkey. We have no access to import prices-related data for the full sample in the case of China.

Consumer Price Index: We use CPI data from IFS (line 64) for all countries but euro area (HICP data from AWM), Hong Kong (BIS), China and Taiwan (national sources).

Producer Price Index: We use PPI data from IFS (line 62) for all countries but Hong Kong, Taiwan, Argentina and China (national sources).

Short-term Interest Rate: We use money market rates for the US, Japan, South Korea, Singapore, Poland, Turkey, Argentina, (from IFS, line 60b), euro area (AWM), Hong Kong (from BIS), and Taiwan (from Central Bank of China). We use Treasury bill rates for Hungary and Mexico (from IFS, line 60c), and bank deposit rates for China, the Czech Republic and Chile (from IFS, line 60l).

Imports/GDP: To compute this ratio we use nominal series for imports (of goods and services, with the exception of China where they include only goods) and GDP. We use nominal import data from IFS (line 99b) for all countries except the euro area (ECB), China, Singapore, and Taiwan (national sources). We use nominal GDP data from IFS (line 98c) for all countries except for the euro area (Eurostat), China, Singapore, and Taiwan (national sources).

Table 1

Selected summary indicators for emerging markets over the estimated sample period
(in annualised average percentage rates - unless otherwise noted)

	Asia					CEECs and Turkey				Latin America		
	China	**Hong Kong**	**Korea**	**Singapore**	**Taiwan**	**Czech Rep.**	**Hungary**	**Poland**	**Turkey**	**Argentina**	**Chile**	**Mexico**
sample period	91Q1 04Q1	86Q1 04Q1	76Q4 04Q1	75Q1 04Q1	80Q2 04Q1	93Q1 04Q1	88Q4 03Q3	91Q1 03Q4	89Q1 03Q4	89Q1 04Q1	80Q1 03Q4	80Q1 03Q4
av inflation	5.7	4.5	7.0	2.1	2.5	5.8	17.4	17.4	65.1	66.4	13.2	34.0
av neer depreciation	2.9	1.3	4.6	-0.4	0.3	-1.8	7.9	9.5	53.9	8.6	-0.6	27.3
av int. rate (% per annum)	6.0	6.2	12.3	4.8	6.3	5.3	19.9	21.5	68.8	726742.7	20.9	35.3
sd inflation	11.6	5.9	8.1	3.6	5.5	5.6	15.1	16.6	40.9	25922.9	12.1	46.2
sd neer rate of change	13.5	10.8	34.6	8.1	11.1	9.7	15.0	16.8	162.6	1135.8	29.9	252.6
sd int. rate (% per annum)	3.6	3.1	5.2	2.7	4.6	2.4	8.7	7.4	33.4	5045048.5	13.5	26.7
average output growth	14.1	4.8	5.5	7.1	6.4	2.2	2.9	3.2	5.4	1.9	4.4	2.6
imports/GDP (%)	19.1	132.2	34.0	64.7	44.3	62.9	50.9	28.5	25.4	10.2	27.9	21.1

Notes: For China, Hungary and Poland industrial production is used instead of real GDP.
A positive/negative sign for exchange rate changes means depreciation/appreciation.

Table 2. Imports/GDP			
Summary indicators for US, Japan, euro area *(in annualised percentage rates - unless otherwise noted)*			
	US	**Japan**	**euro area**
sample period	83Q1 04Q1	83Q1 04Q1	83Q1 03Q4
av inflation	3.1	0.9	3.0
av neer depreciation	1.6	-3.2	-0.1
sd inflation	1.6	2.6	1.8
sd neer rate of change	14.0	18.2	10.1
average output growth	3.4	2.5	2.2
sd output growth	2.4	3.6	2.1
imports/GDP (%)	9.0	11.8	11.7

Notes: A positive/negative sign for exchange rate changes means depreciation/appreciation.
Imports/GDP in the euro area refers to extraregional-trade.

Table 3
Accumulated response to a 1% exchange rate shock
Baseline model

Accumulated response of import prices (in %)

	China	Hong Kong	Korea	Singapore	Taiwan	Czech Rep.	Hungary	Poland	Turkey	Argentina	Chile	Mexico
4 quarters	--	0.43	0.78	0.13	0.12	0.72	1.26	0.86	0.91	0.87	1.00	1.54
8 quarters	--	0.93	0.57	0.76	-0.12	0.48	1.77	1.30	1.76	1.23	0.82	1.99

Note: See main text for description of baseline model. Sample size as in first row of Table 1.

Table 4
Accumulated response to a 1% exchange rate shock
Baseline model

Accumulated response of consumer prices (in %)

	China	Hong Kong	Korea	Singapore	Taiwan	Czech Rep.	Hungary	Poland	Turkey	Argentina	Chile	Mexico
4 quarters	0.08	0.07	0.19	-0.15	0.01	0.61	0.48	0.31	0.09	0.02	0.35	0.76
8 quarters	0.77	0.37	0.13	-0.06	0.01	0.77	0.91	0.56	0.12	0.04	0.35	1.39

Note: See main text for description of baseline model. Sample size as in first row of Table 1.

Table 5
Accumulated response to a 1% exchange rate shock
Baseline model

	Accumulated response of import prices (in %)			*Accumulated response of CPI (in %)*		
	US	**Japan**	**euro area**	**US**	**Japan**	**euro area**
4 quarters	**0.24**	**1.14**	**0.60**	**0.01**	**0.02**	**0.07**
8 quarters	**0.38**	**1.05**	**0.72**	**0.02**	**0.04**	**0.13**

Note: See main text for description of baseline model. Sample size as in first row of Table 2.

Table 6
Correlation of Exchange-Rate Pass-Through to CPI With Selected Variables
Baseline model

	Pearson Correlations		*Spearman Correlations*	
	T=4	***T=8***	***T=4***	***T=8***
av inflation	0.78 ***	0.79 ***	0.87 ***	0.73 ***
av neer depreciation	0.61 **	0.73 ***	0.28	0.47
sd inflation	0.70 **	0.79 ***	0.70 **	0.70 **
sd neer rate of change	0.62 **	0.66 **	0.54	0.33
import/GDP				
- raw measure	-0.31	-0.28	-0.36	-0.32
- controlling for inflation	0.04	0.07	0.25	0.38

Note: */**/*** denotes correlations are significant at the 10/5/1% level using a one-tailed test of positive correlation. Tests of significance for the Spearman correlations are based on quantiles of Spearman's rho in Conover (1999).
In the case where correlations with openness are controlled by inflation we use the residuals from the equations relating both exchange-rate pass-through to CPI and import/GDP to inflation.

Table 7
Accumulated response to a 1% exchange rate shock
Alternative 1 model

Accumulated response of import prices (in %)

	China	Hong Kong	Korea	Singapore	Taiwan	Czech Rep.	Hungary	Poland	Turkey	Argentina	Chile	Mexico
4 quarters	--	0.53	0.75	0.10	0.19	0.73	0.75	0.91	0.36	0.86	0.77	1.44
8 quarters	--	1.05	0.51	0.70	-0.11	0.59	0.74	1.21	0.85	1.30	0.39	1.81

Note: See main text for description of alternative 1 model. Sample size as in first row of Table 1.

Table 8
Accumulated response to an exchange rate shock
Alternative 1 model

Accumulated response of consumer prices (in %)

	China	Hong Kong	Korea	Singapore	Taiwan	Czech Rep.	Hungary	Poland	Turkey	Argentina	Chile	Mexico
4 quarters	0.07	0.15	0.12	-0.17	0.03	0.55	0.07	0.30	0.08	0.02	0.11	0.60
8 quarters	0.76	0.41	0.01	-0.09	0.02	0.72	0.06	0.53	0.10	0.39	-0.05	1.11

Note: See main text for description of alternative 1model. Sample size as in first row of Table 1.

Table 9
Correlation of Exchange-Rate Pass-Through to CPI With Selected Variables
Alternative 1 model

	Pearson Correlations		*Spearman Correlations*	
	T=4	***T=8***	***T=4***	***T=8***
av inflation	0.62 **	0.52 *	0.56 **	0.41
av neer depreciation	0.56 **	0.60 **	0.27	0.44 *
sd inflation	0.62 **	0.64 **	0.48 *	0.49 *
sd neer rate of change	0.61 **	0.60 **	0.39	0.19
import/GDP				
- raw measure	-0.15	-0.15	-0.18	-0.39
- controlling for inflation	0.13	0.08	0.18	0.12

Note: */**/*** denotes correlations are significant at the 10/5/1% level using a one-tailed test of positive correlation. Tests of significance for the Spearman correlations are based on quantiles of Spearman's rho in Conover (1999).
In the case where correlations with openness are controlled by inflation we use the residuals from the equations relating both exchange-rate pass-through to CPI and import/GDP to inflation.

Table 10
Accumulated response to a 1% exchange rate shock
Alternative 2 model

Accumulated response of import prices (in %)

	China	Hong Kong	Korea	Singapore	Taiwan	Czech Rep.	Hungary	Poland	Turkey	Argentina	Chile	Mexico
4 quarters	--	0.54	0.70	-0.30	0.25	0.58	1.50	0.80	0.97	1.12	0.93	1.48
8 quarters	--	1.05	0.46	0.28	0.09	0.23	2.20	0.99	1.70	0.65	0.67	1.94

Note: See main text for description of alternative 2 model. Sample size as in first row of Table 1.

Table 11
Accumulated response of consumer prices to a 1% exchange rate shock
Alternative 2 model

Accumulated response of consumer prices (in %)

	China	Hong Kong	Korea	Singapore	Taiwan	Czech Rep.	Hungary	Poland	Turkey	Argentina	Chile	Mexico
4 quarters	-0.05	0.15	0.18	-0.25	-0.03	0.56	0.61	0.25	0.05	0.07	0.31	0.72
8 quarters	0.07	0.41	0.12	-0.24	-0.04	0.50	1.20	0.49	0.10	0.25	0.25	1.32

Note: See main text for description of alternative 2 model. Sample size as in first row of Table 1.

Table 12
Correlation of Exchange-Rate Pass-Through to CPI With Selected Variables
Alternative 2 model

	Pearson Correlations		*Spearman Correlations*	
	T=4	***T=8***	***T=4***	***T=8***
av inflation	0.75 ***	0.85 ***	0.88 ***	0.83 ***
av neer depreciation	0.58 *	0.75 ***	0.33	0.45
sd inflation	0.63 **	0.76 ***	0.68 **	0.71 **
sd neer rate of change	0.55 **	0.63 **	0.55 **	0.42
import/GDP				
- raw measure	-0.15	-0.09	-0.20	-0.10
- controlling for inflation	0.20	0.31	0.41	0.58 **

Note: */**/*** denotes correlations are significant at the 10/5/1% level using a one-tailed test of positive correlation. Tests of significance for the Spearman correlations are based on quantiles of Spearman's rho in Conover (1999).
In the case where correlations with openness are controlled by inflation we use the residuals from the equations relating both exchange-rate pass-through to CPI and import/GDP to inflation.

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