Exchange Rate Pass-Through: What Has Changed Since the Crisis?*

Martina Jašová,[a] Richhild Moessner,[b,c] and Előd Takáts[b]
[a]Barnard College, Columbia University, United States
[b]Bank for International Settlements
[c]CESifo

We study how exchange rate pass-through to CPI inflation has changed since the global financial crisis. We have three main findings. First, exchange rate pass-through in emerging economies decreased after the financial crisis, while exchange rate pass-through in advanced economies has remained relatively low and stable over time. Second, we show that the declining pass-through in emerging markets is related to declining inflation. Third, we show that it is important to control for non-linearities when estimating exchange rate pass-through. These results hold for both short-run and long-run pass-through and remain robust to extensive changes in the specifications.

JEL Codes: E31, E58, F31.

1. Introduction

Exchange rate pass-through is again at the center of economic policy and central bank thinking (Forbes 2014, 2015). We have to understand how the observed large exchange rate movements translate to

*We would like to thank Paul Beaudry, Claudio Borio, Ingo Fender, Enisse Kharroubi, Emanuel Kohlscheen, Aaron Mehrotra, Philip Turner, Hyun Song Shin, Christian Upper, Fabrizio Zampolli, and seminar participants at the BIS, Charles University, De Nederlandsche Bank, the National Institute of Economic and Social Research, the Swiss National Bank, University of Hagen, University of Oxford, and University of Warwick for useful comments and discussions. We would also like to thank Emese Kuruc for excellent research assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS. Author e-mails: mjasova@barnard.edu, richhild.moessner@bis.org, elod.takats@bis.org.

consumer price inflation, especially as inflation remains well below central bank targets in many advanced economies. From the perspective of some emerging market economies (EMEs), another question arises on how large exchange rate movements affect inflation, especially when it is already above target. In addition, as Plantin and Shin (2016) find, exchange rate pass-through can affect the financial risk-taking channel of monetary policy.

In this paper we aim to provide an overall picture of how exchange rate pass-through has evolved for both advanced and emerging market economies. We find that exchange rate pass-through in emerging economies on average decreased after the financial crisis, and that this decline in pass-through is linked to declining inflation. By contrast, in advanced economies, where inflation has tended to be consistently low, exchange rate pass-through has also remained low. Yet, in spite of the recent decline in emerging economies, pass-through estimates are still lower in advanced economies than in emerging economies. The results are consistent with the implications of the menu cost theory of price setting: when inflation is higher, exchange rate changes are passed through more quickly and to a larger extent because firms have to adjust prices frequently anyway (see further Taylor 2000 for a sticky price setup).

We also confirm that the results hold robustly. The pattern of declining pass-through in EMEs and low pass-through in advanced economies holds similarly for contemporaneous (quarterly), yearly, and long-run pass-through estimates. This pattern also does not depend on the length of rolling window estimates: three-, four-, five-, six-, and eight-year rolling windows all show the same pattern. The results are also not dependent on the econometric methodology: while our main methodology uses an Arellano and Bover (1995) and Blundell and Bond (1998) type of system GMM panel estimates, the pattern remains under difference GMM and within-group estimators. While we control for time fixed effects to ensure that common global shocks do not affect the estimates, the results also hold when dropping these fixed effects and explicitly controlling for the global business cycle or oil prices.

We also find that controlling for non-linear effects of exchange rate movements can be crucial when estimating exchange rate pass-through: as one would expect based on the menu cost theory, larger exchange rate movements have a stronger chance to overcome the menu cost of price changes and thereby are more likely to be passed through to consumer prices. Hence, naive linear estimates of pass-through would show an increase in emerging markets after the taper tantrum when exchange rate volatility increased sharply. However, we show that this increase disappears when one properly controls for non-linearities.

The contribution of our paper to the literature is threefold. First, we document the overall pattern of more than twenty years of exchange rate pass-through developments for a large group of economies. We report that the pass-through has been low and stable in advanced economies, and higher but declining in emerging economies. The advanced economy results extend the link found earlier, for instance, by Engel (2002) and Devereux and Yetman (2008), between low pass-through and low inflation in advanced economies in the post-crisis data set. As for the EMEs, our results on declining pass-through extend the earlier finding in Mihaljek and Klau (2008), Aleem and Lahiani (2014), and Lopez-Villavicencio and Mignon (2016) to a more recent period and/or to a larger set of economies. Our finding of a recent decline in linear pass-through slightly contrasts with De Gregorio (2016), who finds that pass-through for large depreciations in the 2008–15 period was lower than in the 1970s but comparable to the 1990s.[1] These results might be reconciled by the fact that we consider linear pass-through when controlling for non-linearities, while De Gregorio (2016) considers the full effects of large depreciations.

Second, we provide solid empirical evidence for a causal link between lower inflation and lower pass-through in emerging market data, as was proposed in Calvo and Reinhart (2002) and Choudhri and Hakura (2006). Our results can also be seen as extending the analysis of the low inflation/low pass-through link from advanced economies in the 1990s of Takhtamanova (2010) to emerging markets in the 2000s.

[1]Importantly, we do not exclude the possibility that the link between lower pass-through and lower inflation works through more credible monetary policy, as Bailliu and Fujii (2004) and Gagnon and Ihrig (2004) argued for advanced economies.

Third, we provide evidence that larger exchange rate movements lead to disproportionally larger price changes. Therefore, it is useful to control for non-linearities when estimating pass-through, especially when exchange rate volatility is changing in the sample period. One crucial example is the period after the taper tantrum when exchange rate volatility increased—and the inclusion of such periods in a naïve linear setup can misleadingly suggest an increase in pass-through. This result confirms the findings in Bussière (2013), Cheikh and Rault (2015), and Alvarez, Lippi, and Passadore (2017) of the relevance of non-linearity and provides additional support to control for non-linearities to exclude the possibility that linear pass-through estimates pick up changes in exchange rate volatility. This result is also consistent with evidence in Campa and Goldberg (2005) and Kohlscheen (2010) that pass-through to consumer prices and import prices, respectively, is higher for countries with greater nominal exchange rate volatilities.

Furthermore, the results also have policy relevance when thinking about changing global conditions for monetary and economic policy setting. The average low pass-through levels today imply that central banks in general should have less "fear of floating," at least from an inflation perspective. Yet, the lower pass-through in emerging markets also implies that the exchange rate channel of monetary policy might be less effective to affect inflation than before the financial crisis. Finally, the results further reinforce the importance of price stability by showing that lower inflation also reduces pass-through. In fact, there might be a positive feedback loop: lower pass-through could in turn further contribute to price stability.

However, the results should be read with appropriate caveats. Importantly, our results apply only for groups of countries, and not for individual economies. Hence, our results do not offer direct implications for individual countries. Furthermore, our setup is necessarily limited to macroeconomic factors and only captures time-invariant microeconomic factors, such as pricing power, through country fixed effects. Finally, our approach does not distinguish between exogenous and endogenous exchange rate shocks—and this distinction might matter, as Shambaugh (2008) and Forbes, Hjortsoe, and Nenova (2015) show. However, we mitigate this problem by consistently controlling for global shocks through time fixed effects.

The remainder of the paper is organized as follows. The second section outlines the methodology, and the third section introduces the data. The fourth section discusses the results, and the fifth section presents robustness checks. Finally, the sixth section concludes.

2. Estimation Methodology

We estimate exchange rate pass-through based on the following hybrid New Keynesian Phillips-curve framework, using dynamic panel regression with system GMM,

$$\pi_{it} = \alpha_i + \beta_t + \rho E_t \pi_{it+1} + \delta \pi_{it-1} - \sum_{j=0}^{3} \gamma_j \Delta NEER_{it-j} - \sum_{k=0}^{3} \mu_k \Delta NEER_{it-k}^2 - \sum_{l=0}^{3} \nu_l \Delta NEER_{it-l}^3 + \phi y_{it} + \varepsilon_{it}. \quad (1)$$

Here, π_{it} denotes log differences in quarterly seasonally adjusted consumer price indexes (CPI) in country i in quarter t; y_{it} is the domestic output gap in country i in quarter t; $\Delta NEER_{it}$ is the (change in the log of) the nominal effective exchange rate; α_i are country fixed effects; and β_t are time (quarter) fixed effects.

We choose a hybrid New Keynesian Phillips-curve framework, which also includes a forward-looking inflation expectations term, $E_t \pi_{it+1}$, in order to be consistent with the New Keynesian Phillips-curve framework which has commonly been used in macroeconomic and monetary policy analysis for capturing inflation dynamics (Clarida, Galí, and Gertler 1999; Smets 2003; Woodford 2003; Levin and Moessner 2005).

In our benchmark specification, we exclude inflation expectations by setting $\rho = 0$ in equation (1), in order for our results to be more easily comparable with both (i) the earlier empirical cross-country exchange rate pass-through literature and (ii) the pass-through literature focusing on import prices, as neither literature has generally included inflation or import price expectations. We also estimate pass-through using the hybrid New Keynesian Phillips-curve framework of equation (1) including the forward-looking inflation expectations term, $E_t\pi_{it+1}$, in order to be consistent with the hybrid New Keynesian Phillips-curve framework commonly used in monetary policy analysis for analyzing inflation dynamics. Later we check and find that our main results are robust to the inclusion of the forward-looking inflation expectations according to the hybrid New Keynesian framework (see tables 1 and 2).

We are not assuming that the inflation expectations formation process within the hybrid New Keynesian Phillips-curve framework is the same for advanced and emerging economies. Since we estimate the specifications separately for advanced and for emerging economies, we allow for the coefficients on lagged inflation and on inflation expectations to differ between advanced and emerging economies.

Most of the cross-country empirical exchange rate pass-through literature has not used a New Keynesian Phillips-curve framework including inflation expectations, but has been based on a backward-looking generic specification of Goldberg and Knetter (1997) (e.g., Mihaljek and Klau 2008; Lopez-Villavicencio and Mignon 2016). A recent paper has used a New Keynesian Phillips-curve framework for cross-country panel estimation of exchange rate pass-through in advanced economies (Takhtamanova 2010). Takhtamanova (2010) states about her paper that "much of the existing research focuses on the relationship between movements in nominal exchange rates and import prices. A smaller but equally important strand of the literature concentrates on the macroeconomic exchange rate pass-through to aggregate price indices (Bachetta and van Wincoop 2003, Campa and Goldberg 2006, Gagnon and Ihrig 2004). This paper also focuses on the relationship between aggregate prices and inflation, but departs from existing studies by using a Phillips curve framework to analyze exchange rate pass-through." To the best of our knowledge, our paper is the first to provide empirical evidence for a causal link between lower CPI inflation and lower exchange rate pass-through for a large separate emerging country sample using a New Keynesian Phillips-curve framework, when including the period after the global financial crisis.

To capture any non-linearities in the exchange rate pass-through, we extend the specification to include quadratic and cubic changes in exchange rates. The exchange rate terms are presented with a negative sign, given that in the original series local exchange rate depreciation is reflected as a decrease in the nominal effective exchange rate (NEER). The model works with contemporaneous exchange rate change and three additional lags to capture exchange rate pass-through over the period of one year. Furthermore, the specification also satisfies the optimal lag structure based on Akaike and Bayesian information criteria. We present estimates for advanced and emerging economies separately. We also include country fixed effects to control for unobserved country heterogeneity. Moreover, we include time fixed effects to control for global factors driving inflation.

Our estimation assumes a non-linear structure, since the underlying pass-through process may be non-linear (Bussière 2013; Cheikh and Rault 2015). Such non-linearity might arise due to menu costs, i.e., due to the presence of non-negligible costs of adjusting prices. Firms might prefer to avoid these menu costs when exchange rate moves are small, but they could be forced to adjust prices for larger exchange rate movements (Forbes 2014). Alternatively, firms might absorb small changes in input prices but not large ones. Non-linearities might also be explained by imperfect competition which would lead to observationally similar results.

Our estimation period is 1994:Q1–2017:Q4. To estimate equation (1), we use generalized method of moments (GMM) following Arellano and Bover (1995) and Blundell and Bond (1998). This method has been widely used to deal with panel data with endogenous explanatory variables, and in our case it is able to control for common shocks that affect both inflation and exchange rates (Shambaugh 2008; Aron and Muellbauer 2014; Forbes 2015). The benchmark model uses system GMM technique with two to eight lags of log NEER changes, the output gap, and lags of log CPI changes as GMM instruments for levels and first-differences equations. We also repeat the estimates with difference GMM and within-group estimators for robustness.

Based on equation (1), we estimate linear contemporaneous, yearly, and long-run exchange rate pass-through. Contemporaneous linear exchange rate pass-through is defined as the coefficient on the contemporaneous log change in the NEER in equation (1), i.e., γ_0. Yearly linear pass-through is the sum of the coefficients on log changes in the NEER over four quarters, i.e., $\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3$. Linear long-run pass-through is defined as yearly pass-through divided by one minus the coefficient on lagged inflation, i.e., $(\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3)/(1 - \delta)$.

3. Data

We analyze quarterly time-series data for twenty-two emerging[2] and eleven advanced[3] economies over the period 1994:Q1–2017:Q4.

We focus on exchange rate pass-through (ERPT) to consumer price inflation. To do so, we use log differences in quarterly seasonally adjusted consumer price indexes (CPI) as our dependent variable.

We use several explanatory variables. The exchange rate series are chosen as the Bank for International Settlements (BIS) NEER broad indexes available from 1994, with 2010 as the indexes' base year. In the regression analysis we use log differences in the average quarterly NEER indexes. In our definition, an increase in the NEER implies an appreciation of the local exchange rate. Later, we also use log differences in average quarterly bilateral U.S. dollar exchange rates.

We also control for the business cycle by including measures of the output gap. The underlying real GDP series are taken from national sources. The output gap is calculated by employing the standard univariate Hodrick-Prescott filtering method with the smoothing parameter λ set to 1,600 for all available quarterly GDP data. For the analysis, we use the data starting in 1994:Q1 or later depending on their availability.[4]

In addition, we use control variables for some global factors, namely oil prices and the global output gap. For oil prices we use average quarterly West Texas Intermediate (WTI) crude oil spot prices in U.S. dollars transformed into quarterly log changes. The global output gap is calculated according to the same methodology

[2] Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Mexico, Malaysia, Peru, the Philippines, Poland, Russia, Singapore, South Africa, Thailand, and Turkey.

[3] Australia, Canada, Denmark, the euro area, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States.

[4] Data are available since 1995:Q1 for Hungary, Israel, and Poland; since 1996:Q1 for Chile and the Czech Republic; since 1996:Q2 for India; and since 1998:Q1 for the Philippines.

as the domestic output gap, and is computed from national data as a weighted average.

In some specifications, we also include inflation expectations to evaluate the pass-through according to a New Keynesian Phillips-curve setup. The end-year inflation expectations are taken from Consensus Economics. We estimate the expectation series with a quarterly frequency by subtracting realized quarterly inflation from the forecasts (Q2 and Q3), using end-year figures (Q4), or linearly interpolating end-year's estimates (Q1).

Appendix 1 provides a detailed description of the data, including additional information on data availability.

4. Results

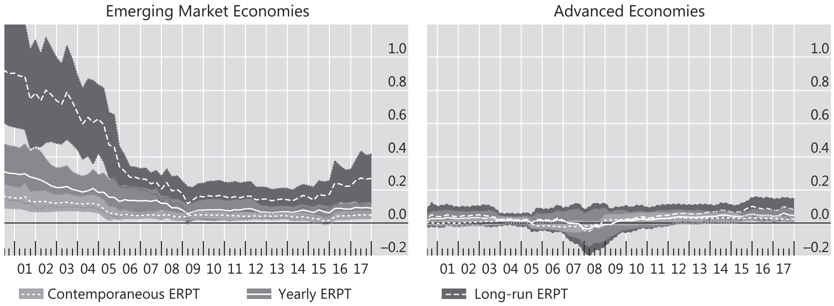
4.1 Evolution of Pass-Through

As a first step, we run the benchmark regression, equation (1) excluding inflation expectations (setting $\rho = 0$), on six-year windows to assess the evolution of pass-through over time (figure 1). We run the regression separately for emerging markets (left-hand panel) and advanced economies (right-hand panel).

For emerging markets (left-hand panel), all three pass-through measures (contemporaneous, yearly, and long run) decline strongly from the pre-crisis levels after the financial crisis. A similar declining pattern also holds when choosing different rolling windows (see figure 4 in appendix 2). Interestingly, there is some small-scale pickup in pass-through in the last two years. Looking into this result, it turns out that the pickup is almost entirely driven by a single country, Argentina, and it is almost eliminated when Argentina is excluded from the estimation (see figure 7 in appendix 2). This might be supporting our main hypothesis, i.e., the causal link between inflation and pass-through, as Argentina experienced a high rate of inflation in this period.

For advanced economies (right-hand panel, figure 1), all three pass-through measures (contemporaneous, yearly, and long run) remain relatively stable, at low levels, throughout our estimation period. This results again holds for different rolling windows (see figure 5 in appendix 2).

Figure 1. Exchange Rate Pass-Through (baseline specification, six-year rolling windows)



4.2 Post-Crisis Decline in Pass-Through in EMEs

In order to evaluate whether the decline in pass-through in emerging economies after the financial crisis was indeed significant, we add to the benchmark equation a dummy variable for the post-crisis period. The dummy variable D_t takes the value of one in the post-crisis period (2009:Q3–2017:Q4) and zero in the pre-crisis period (1994:Q1–2008:Q2)—while we omit the volatile crisis years.[5] In sum, we estimate the following equation:

$$\begin{aligned}\pi_{it} &= \alpha_i + \beta_t + \rho E_t \pi_{it+1} + \delta \pi_{it-1} - \sum_{j=0}^{3} \gamma_j \Delta NEER_{it-j} \\ &\quad - \sum_{k=0}^{3} \mu_k \Delta NEER^2_{it-k} - \sum_{l=0}^{3} \nu_l \Delta NEER^3_{it-1} + \varphi y_{it} \\ &\quad + \rho_D D_t E_t \pi_{it+1} + \delta_D D_t \pi_{it-1} - \sum_{j=0}^{3} \gamma_{jD} D_t \Delta NEER_{it-j} \\ &\quad - \sum_{k=0}^{3} \mu_{kD} D_t \Delta NEER^2_{it-k} - \sum_{l=0}^{3} \nu_{lD} D_t \Delta NEER^3_{it-1} \\ &\quad + \varphi_D D_t y_{it} + \varepsilon_{it}. \qquad (2)\end{aligned}$$

[5]In the presented specifications we omit the crisis period (2008:Q3–2009:Q2). However, the results are robust to including the crisis years, i.e., when D_t is set to one for the period 2008:Q3–2017:Q4 and zero otherwise. These results are available upon request from the authors.

In our benchmark specification, exactly as in our benchmark specification of equation (1), we exclude inflation expectations by setting $\rho = \rho_D = 0$ in equation (2) (see columns 1–3 and 5–7 of table 1). For robustness, we also estimate equation (2) including the inflation expectation terms (see columns 4 and 8 of table 1). Table 1 shows that the decrease in linear coefficients of the pass-through in emerging markets after the crisis is statistically significant at the 5 percent level for all three pass-through measures (contemporaneous, yearly, and long run); see the coefficient estimates of the post-crisis interaction dummy in column 1 of table 1. By contrast, this pass-through appears to increase slightly, and mostly only at the 10 percent significance level, in advanced economies in the post-crisis period.

For all three pass-through horizons, these results are consistent with the results reported in figure 1. Table 1 shows that, pre-crisis, an exchange rate appreciation of 10 percent in EMEs was associated with an average decrease in consumer prices of around 2.3 percent within the same year; post-crisis, a 10 percent appreciation was associated with a lower decrease in consumer prices of 0.9 percent. The estimates of table 1 also demonstrate that the conclusion is robust to different control variables for global factors, namely to using changes in oil prices or the global output gap instead of time fixed effects; see columns 2 and 3. Table 1 also shows that the results are robust to including inflation expectations to evaluate the pass-through according to the New Keynesian Phillips-curve setup of equation (1) (see column 4 of table 1).

For advanced economies, some results seem to suggest an increase in pass-through especially when measured over the one-year or long-run horizons (see columns 5–8). While all pre-crisis pass-through estimates do not appear to be significantly different from zero, we report some positive and statistically significant post-crisis pass-through estimates. Yet, one should be careful when interpreting this: the increase in advanced economies is not robust (as, for instance, the EME post-crisis decline is). Furthermore, the magnitude of the increase is also smaller.

4.3 Pass-Through and Inflation

The large and significant decline in emerging market pass-through requires explanation: what has changed that could account for it?

Table 1. How Did the ERPT Change in the Post-Crisis Period? (pass-through coefficients, based on equation (2))

	Emerging Market Economies				Advanced Economies			
Explanatory Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Exchange Rate Pass-Through (Pre-crisis)								
Contemporaneous ERPT	0.120***	0.116***	0.117***	0.104***	0.00470	−0.000989	−0.00380	0.00594
	(0.0341)	(0.0315)	(0.0312)	(0.0331)	(0.00595)	(0.00534)	(0.00763)	(0.00570)
Yearly ERPT	0.231***	0.222***	0.223***	0.230***	0.00592	−0.00646	−0.0127	0.00413
	(0.0785)	(0.0741)	(0.0740)	(0.0737)	(0.00736)	(0.00893)	(0.0137)	(0.0123)
Long-Run ERPT	0.712***	0.717***	0.719***	0.585***	0.00878	−0.00921	−0.0184	0.0627
	(0.150)	(0.140)	(0.141)	(0.136)	(0.0115)	(0.0121)	(0.0185)	(0.0192)
Post-Crisis Interaction Dummy								
D_t*Contemporaneous ERPT	−0.0764**	−0.0753**	−0.0810***	−0.0675*	0.0182*	0.0214**	0.00691	0.0185*
	(0.0328)	(0.0294)	(0.0284)	(0.0328)	(0.00893)	(0.00845)	(0.00837)	(0.00973)
D_t*Yearly ERPT	−0.146**	−0.150**	−0.155**	−0.148**	0.0417*	0.0573**	0.0408	0.0453*
	(0.0670)	(0.0634)	(0.0627)	(0.0640)	(0.0194)	(0.0209)	(0.0228)	(0.0233)
D_t*Long-Run ERPT	−0.143**	−0.142**	−0.146**	−0.128**	0.0483*	0.0630**	0.0432	0.0498
	(0.0685)	(0.0601)	(0.0591)	(0.0580)	(0.0253)	(0.0246)	(0.0250)	(0.0284)
Exchange Rate Pass-Through (Post-crisis)								
Contemporaneous ERPT + D_t*Contemporaneous ERPT	0.0434***	0.0404***	0.0359**	0.0362***	0.0229**	0.0204**	0.00311	0.0245**
	(0.0126)	(0.0110)	(0.0128)	(0.0111)	(0.00839)	(0.00667)	(0.00970)	(0.00796)
Yearly ERPT + D_t*Yearly ERPT	0.0856***	0.0713***	0.0676***	0.0825***	0.0476***	0.0509***	0.0281	0.0494***
	(0.0171)	(0.0183)	(0.0201)	(0.0170)	(0.0131)	(0.0132)	(0.0170)	(0.0137)
Long-Run ERPT + D_t*Long-Run ERPT	0.247***	0.193**	0.180**	0.152***	0.0886***	0.0833***	0.0446	0.0869***
	(0.0797)	(0.0689)	(0.0719)	(0.0274)	(0.0251)	(0.0181)	(0.0248)	(0.0231)

(continued)

Table 1. (Continued)

Explanatory Variables	Emerging Market Economies (1)	(2)	(3)	(4)	Advanced Economies (5)	(6)	(7)	(8)
Lagged Dependent Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inflation Expectations	No	No	No	Yes	No	No	No	Yes
Control Variables for Local Factors[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables for Global Factors	Time Fixed Effects	ΔOil Prices$_t$	Global Output Gap$_t$	Time Fixed Effects	Time Fixed Effects	ΔOil Prices$_t$	Global Output Gap$_t$	Time Fixed Effects
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,889	1,889	1,889	1,889	957	957	957	907
Number of Countries	22	22	22	22	11	11	11	11
Sargan Test[b]	0.972	1	1	0.965	0.0752	0.695	0.604	0.0439
Hansen Test[b]	1	1	1	1	1	1	1	1
Serial Correlation Test[c]	0.435	0.477	0.488	0.353	0.0319	0.0811	0.196	0.0273

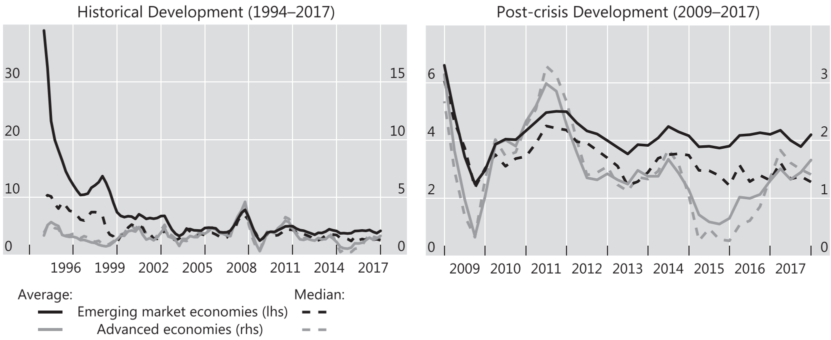
Notes: System GMM estimation using Arellano and Bover (1995) and Blundell and Bond (1998) dynamic panel estimator. Robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Full results are reported in online appendix table A1.

[a]Control variables for local factors include domestic output gap in all specifications.

[b]Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

[c]Reports p-values for the null hypothesis that the errors in the first-difference regression exhibit no second-order serial correlation.

Figure 2. Inflation Dynamics (consumer prices, year-on-year changes, in percent)



Sources: National data, authors' calculations.

Our hypothesis is that the level of inflation affects the level of pass-through. Such a hypothesis is consistent with the menu cost theory of price setting: when inflation is higher, exchange rate changes are passed through more quickly and to a larger extent because firms have to adjust prices frequently anyway.

Indeed, inflation has declined substantially in emerging markets in the years preceding the financial crisis, i.e., around the time when estimated pass-through fell too (figure 2). While EME inflation was generally high in the 1990s, it fell rapidly afterwards (solid black line, left-hand panel). However, in spite of the fall, EME inflation levels tended to remain higher than advanced economy levels even after the financial crisis (right-hand panel).

Having seen that average inflation fell around the time when pass-through fell, we move to formally test whether lower inflation can indeed explain the decline in pass-through in EMEs. To do so, we formally estimate equation (3),[6]

[6]The four-lag structure ensures that we do not interact contemporaneous inflation and exchange rate terms. However, this is not critical for our results; the results remain robust under fewer lags.

$$\pi_{it} = \alpha_i + \beta_t + \rho E_t \pi_{\mathrm{i}t+1} + \delta \pi_{it-1} - \sum_{j=0}^{3} \gamma_j \Delta NEER_{it-j} - \sum_{k=0}^{3} \mu_k \Delta NEER^2_{it-k} - \sum_{l=0}^{3} \nu_l \Delta NEER^3_{it-1} + \varphi y_{it} - \sum_{j=0}^{3} \gamma_{j\pi} \pi_{it-4} \Delta NEER_{it-j} - \sum_{k=0}^{3} \mu_{k\pi} \pi_{it-4} \Delta NEER^2_{it-k} - \sum_{l=0}^{3} \nu_{l\pi} \pi_{it-4} \Delta NEER^3_{it-1} + \varepsilon_{it}. \quad (3)$$

In our benchmark specification, exactly as in our benchmark specification of equation (1), we exclude inflation expectations by setting $\rho = 0$ in equation (3) (see columns 1–3 and 5–7 of table 2). For robustness, we also estimate equation (3) including the inflation expectation terms (see columns 4 and 8 of table 2).

The results, shown in detail in table 2, suggest that lower inflation can indeed explain lower pass-through at least at the yearly or long-run horizons. This can be seen, as the coefficient on the interaction term of linear exchange rate changes with lagged inflation is positive and significant for EMEs at these horizons.

The results provide evidence that lower inflation can induce firms to decide to adjust prices more slowly in response to exchange rate changes, consistent with the existence of menu costs. These results are robust to using changes in oil prices or the global output gap as controls for global factors instead of using time fixed effects (see columns 2 and 3). The results are also robust to including inflation expectations within the New Keynesian framework, with the interaction term for both yearly and long-run pass-through again remaining significant (see column 4 of table 2).[7]

[7]The fact that our EME pass-through estimates show a slight increase in the last two years when we include Argentina in the sample, but not when we exclude it from the sample, lends further support to this link, as Argentina experienced a relatively high rate of inflation in this period.

Table 2. Lower Inflation/Lower Pass-Through in Emerging Markets (pass-through coefficients, based on equation (3))

	Dependent Variable: Inflation$_t$							
	Emerging Market Economies				Advanced Economies			
Explanatory Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Exchange Rate Pass-Through								
Contemporaneous ERPT	0.0655***	0.0581***	0.0524***	0.0607***	0.00476	0.00569	0.000809	0.00580
	(0.0179)	(0.0179)	(0.0185)	(0.0144)	(0.00510)	(0.00405)	(0.00677)	(0.00527)
Yearly ERPT	0.126***	0.109***	0.107***	0.125***	0.0187*	0.0166**	0.00277	0.0220*
	(0.0318)	(0.0265)	(0.0287)	(0.0289)	(0.00911)	(0.00710)	(0.0111)	(0.0101)
Long-Run ERPT	0.271***	0.246***	0.237***	0.291***	0.0292*	0.0249*	0.00402	0.0339*
	(0.0705)	(0.0707)	(0.0734)	(0.0446)	(0.0150)	(0.0120)	(0.0163)	(0.0170)
Inflation Interaction								
Inflation$_{t-4}$*Contemporaneous ERPT	0.921	0.936	0.973	0.775	1.582	0.979	−0.278	1.668
	(0.614)	(0.602)	(0.611)	(0.576)	(1.285)	(0.868)	(1.287)	(1.261)
Inflation$_{t-4}$*Yearly ERPT	1.741*	1.775*	1.830*	1.712*	1.026	0.643	−0.200	0.972
	(0.921)	(0.938)	(0.943)	(0.845)	(1.333)	(1.034)	(1.070)	(1.401)
Inflation$_{t-4}$*Long-Run ERPT	3.737*	4.014*	4.059*	3.163*	1.601	0.966	−0.291	1.500
	(1.254)	(1.312)	(1.288)	(1.178)	(1.935)	(1.464)	(1.577)	(2.047)

(*continued*)

Table 2. (Continued)

Explanatory Variables	Dependent Variable: $Inflation_t$							
	Emerging Market Economies				Advanced Economies			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged Dependent Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inflation Expectations	No	No	No	Yes	No	No	No	Yes
Control Variables for Local Factors[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables for Global Factors	Time Fixed Effects	ΔOil $Prices_t$	Global Output Gap_t	Time Fixed Effects	Time Fixed Effects	ΔOil $Prices_t$	Global Output Gap_t	Time Fixed Effects
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,977	1,977	1,977	1,977	1,001	1,001	1,001	951
Number of Countries	22	22	22	22	11	11	11	11
Sargan Test[b]	0.860	0.997	0.990	0.941	0.211	0.922	0.608	0.204
Hansen Test[b]	1	1	1	1	1	1	1	1
Serial Correlation Test[c]	0.514	0.520	0.587	0.401	0.0847	0.0843	0.683	0.0872

Notes: System GMM estimation using Arellano and Bover (1995) and Blundell and Bond (1998) dynamic panel estimator. Robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Full results are reported in online appendix table A2.

[a]Control variables for local factors include domestic output gap in all specifications.

[b]Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

[c]Reports p-values for the null hypothesis that the errors in the first-difference regression exhibit no second-order serial correlation.

The estimated impact of lower inflation on lowering pass-through is also economically significant. The results imply that 1 percentage point lower inflation lowers the long-term average pass-through exchange rate move by around 0.3–0.4 percentage point. This is a sizable impact, as the average pass-through of such a 10 percent exchange rate move is around 2.7 percentage points.

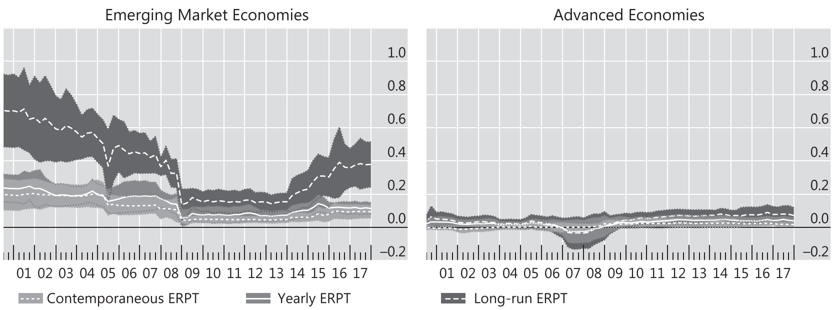
Our paper is not the first to provide empirical evidence for a causal link between lower inflation and lower exchange rate pass-through in emerging economies. Earlier evidence on this has been found for consumer prices by Choudhri and Hakura (2006) for a combined sample of emerging and developing countries, and by Devereux and Yetman (2008) for a combined sample of advanced, emerging, and developing countries. But to our knowledge our paper is the first to provide cross-country empirical evidence for a causal link between lower CPI inflation and lower exchange rate pass-through for a large separate emerging country sample when including the period after the global financial crisis using a New Keynesian Phillips-curve framework. Such evidence has also been found in Lopez-Villavicencio and Mignon (2016) for fifteen emerging economies, but not using a New Keynesian framework as in our paper.

4.4 Omitting Non-linearity

For comparison, we also present pass-through estimates when omitting the non-linear terms in the benchmark specification of equation (1) excluding inflation expectations (setting $\rho = 0$). The aim of the exercise is to demonstrate that omitting these non-linear terms can cause pass-through estimates to pick up the impact of exchange rate volatility. This exercise is very relevant, as non-linear terms are often neglected in the literature.

The basic pattern in linear pass-through over time is broadly similar for both emerging markets and advanced economies (figure 3). Pass-through is declining in emerging markets (left-hand panel), while it remains low and stable in advanced economies (right-hand panel). However, the linear pass-through estimates show a steady increase after mid-2013, i.e., following tapering of asset purchases by the Federal Reserve and the increase of exchange rate volatility in emerging markets. These larger exchange rate movements are expected to pass through more strongly to consumer prices

Figure 3. Pass-Through Omitting Non-linear Terms (baseline specification without non-linear terms, six-year rolling windows)



than smaller movements, because they are more likely to overcome the menu costs associated with price changes. Consequently, simple linear pass-through estimates, which ignore these non-linearities, would suggest some increase in pass-through in EMEs after tapering by the Federal Reserve, while such an increase is not visible to this extent in the specification that takes non-linearities into account (figure 1).

This underlines the importance of controlling for non-linearities. Furthermore, when estimating the benchmark specification of equation (1) excluding inflation expectations (setting $\rho = 0$), the coefficients on some of the non-linear terms are significant for EMEs (see online appendix table A1, available at www.ijcb.org).

Our paper is not the first to supply cross-country evidence that larger exchange rate movements lead to disproportionally larger price changes. Cross-country evidence on this has previously been found for import prices in G-7 economies by Bussière (2013) and for CPI inflation by Alvarez, Lippi, and Passadore (2017) for a sample of advanced and emerging economies (neither of these papers uses a New Keynesian Phillips-curve framework). To our knowledge our paper is the first to find evidence of non-linearity in exchange rate pass-through to consumer prices using a New Keynesian framework for a large emerging country sample and including the post-crisis period. Kohlscheen (2010) finds that pass-through to consumer prices for EMEs is higher for countries with greater nominal exchange rate volatilities, using bivariate VARs, and Campa and Goldberg (2005) find that pass-through to import prices is higher for countries with greater nominal exchange rate volatilities.

5. Robustness

Next we extend our analysis to check the robustness of the main findings.

First, we change the size of the rolling window from six to eight, five, four, and three years in the main specification of equation (1) excluding inflation expectations (setting $\rho = 0$) and report the results in figures 4 and 5 in appendix 2. We find that for all horizons (contemporaneous, yearly, and long run) the pattern for EMEs of lower linear pass-through post-crisis is robust to the length of the estimation window, for all the window sizes considered. Similarly, the pattern that the pass-through has been relatively stable in advanced economies is preserved for different rolling window sizes.

Second, we present the results for the main specification of equation (3) excluding inflation expectations (setting $\rho = 0$) when using log changes in bilateral exchange rates against the U.S. dollar, instead of in NEERs (table 3 and appendix figure 6). The reason is, as Gopinath (2016) found, that the pass-through might work through the invoicing currency, typically the U.S. dollar (USD), and not through the effective exchange rates. We find that the patterns of the pass-through estimates are roughly similar whether we use changes in the nominal exchange rate or the U.S. dollar bilateral exchange rate, though some of our results are actually stronger when using U.S. dollar bilateral exchange rates. For EMEs, the inflation interaction terms appear somewhat larger and more significant than in case of the NEERs (see table 3 and online appendix table A3). In particular, when using the U.S. dollar bilateral exchange rates, the inflation interaction term also becomes significant for contemporaneous pass-through. Moreover, the coefficients on the inflation interaction terms are slightly larger for yearly and long-run pass-through, and more significant, namely at the 5 percent level, than when using NEERs.

Third, our results also remain robust to changes in the empirical estimation techniques. While our benchmark specification was

Table 3. Lower Inflation/Lower Pass-Through with USD Bilateral Exchange Rates (pass-through coefficients, based on equation (3) excluding inflation expectations)

	Dependent Variable: Inflation_t			
	Emerging Market Economies		Advanced Economies	
	NEER	Bilateral USD Exchange Rate	NEER	Bilateral USD Exchange Rate
Explanatory Variables	**(1)**	**(2)**	**(3)**	**(4)**
Exchange Rate Pass-Through				
Contemporaneous ERPT	0.0655***	0.0410**	0.00476	0.00657
	(0.0179)	(0.0190)	(0.00510)	(0.00489)
Yearly ERPT	0.126***	0.0922***	0.0187*	0.0206**
	(0.0318)	(0.0209)	(0.00911)	(0.00653)
Long-Run ERPT	0.271***	0.184***	0.0292*	0.0329**
	(0.0705)	(0.0508)	(0.0150)	(0.0112)
Inflation Interaction				
Inflation_{t-4}*Contemporaneous ERPT	0.921	1.201*	1.582	0.694
	(0.614)	(0.661)	(1.285)	(0.625)
Inflation_{t-4}*Yearly ERPT	1.741*	2.061**	1.026	0.644
	(0.921)	(0.870)	(1.333)	(1.122)
Inflation_{t-4}*Long-Run ERPT	3.737*	4.123**	1.601	1.030
	(1.254)	(1.077)	(1.935)	(1.677)
Lagged Dependent Variable	Yes	Yes	Yes	Yes
Inflation Expectations	No	No	No	No
Control Variables for Local Factors	Domestic Output Gap	Domestic Output Gap	Domestic Output Gap	Domestic Output Gap
Time Fixed Effect	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Observations	1,977	1,977	1,001	910
Number of Countries	22	22	11	10
Sargan Test[a]	0.860	0.636	0.211	0.182
Hansen Test[a]	1	1	1	1
Serial Correlation Test[b]	0.514	0.528	0.0847	0.0721

Notes: System GMM estimation using Arellano and Bover (1995) and Blundell and Bond (1998) dynamic panel estimator. Robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Full results are reported in online appendix table A3.

[a]Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

[b]Reports p-values for the null hypothesis that the errors in the first-difference regression exhibit no second-order serial correlation.

system GMM, the results remain materially unchanged when using difference GMM and within-group estimators (table 4). This suggests that the methodological choice is not critical for our results. In all three cases we also test for different lag structures of instrumental variables to confirm that the results do not depend on the instrument lag choice (table A5 in the online appendix). Furthermore, the basic pattern—the post-crisis decrease for EMEs and relative stability of pass-through for advanced economies—remains unchanged for all three pass-through horizons.

Furthermore, we also modify the main specification to allow for asymmetry in pass-through for exchange rate depreciations and appreciations. However, we do not find evidence for consistent asymmetries when estimating the exchange rate pass-through separately for depreciations and appreciations.

5.1 Caveats

However, the results should be read with appropriate caveats. Importantly, they apply only for groups of countries, and not for individual economies. In particular, while we see a large drop in pass-through for emerging markets as a group after the financial crisis, some emerging economies could still have experienced stable or even increasing pass-through. Similarly, in spite of the stable average results, different pass-through trends might prevail in some advanced economies.

Furthermore, our setup is limited to macroeconomic factors, while microeconomic factors, such as price competition or pricing to market, might also play a role in determining pass-through (Campa and Goldberg 2005). For instance, the more oligopolistic/less price taking behavior is, the weaker pass-through from input prices (which might be affected by exchange rate movements) to final prices is. However, these concerns are mitigated by the fact that our setup captures the time-invariant microeconomic factors by the country fixed effects. Further mitigation, as Forbes (2015) argues, is that these structural microeconomic differences might matter less than thought earlier: recent pass-through estimates for the United Kingdom do not show much difference between goods with differing import content, or between economic sectors with different tradability or degree of international competition.

Table 4. Lower Inflation/Lower Pass-Through: Different Methodologies (pass-through coefficients, based on equation (3) excluding inflation expectations)

	Dependent Variable: $Inflation_t$					
	Emerging Market Economies			Advanced Economies		
	System GMM	Difference GMM	Within-Group Estimator	System GMM	Difference GMM	Within-Group Estimator
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
Exchange Rate Pass-Through						
Contemporaneous ERPT	0.0655***	0.0567***	0.0569***	0.00476	0.00340	0.00340
	(0.0179)	(0.0170)	(0.0168)	(0.00510)	(0.00482)	(0.00480)
Yearly ERPT	0.126***	0.112***	0.112***	0.0187*	0.0283***	0.0283***
	(0.0318)	(0.0267)	(0.0265)	(0.00911)	(0.00530)	(0.00528)
Long-Run ERPT	0.271***	0.208***	0.210***	0.0292*	0.0340***	0.0340***
	(0.0705)	(0.0537)	(0.0529)	(0.0150)	(0.00708)	(0.00705)
Inflation Interaction						
$Inflation_{t-4}$ *Contemporaneous ERPT	0.921	0.921	0.915	1.582	2.305*	2.305*
	(0.614)	(0.605)	(0.598)	(1.285)	(1.121)	(1.116)
$Inflation_{t-4}$*Yearly ERPT	1.741*	1.861**	1.845**	1.026	2.216*	2.216*
	(0.921)	(0.891)	(0.878)	(1.333)	(1.121)	(1.216)
$Inflation_{t-4}$*Long-Run ERPT	3.737*	3.465**	3.449**	1.601	2.656*	2.656*
	(1.254)	(1.071)	(1.057)	(1.935)	(1.380)	(1.374)

(continued)

Table 4. (Continued)

	Dependent Variable: $Inflation_t$					
	Emerging Market Economies			Advanced Economies		
	System GMM	Difference GMM	Within-Group Estimator	System GMM	Difference GMM	Within-Group Estimator
Explanatory Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Lagged Dependent Variable	Yes	Yes	Yes	Yes	Yes	Yes
Inflation Expectations	No	No	No	No	No	No
Control Variables for Local Factors	Domestic Output Gap	Domestic Output Gap	Domestic Output Gap	Domestic Output Gap	Domestic Output Gap	Domestic Output Gap
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,977	1,955	1,977	1,001	990	1,001
Number of Countries	22	22	22	11	11	11
Sargan Test[a]	0.860	0.567		0.211	0.010	
Hansen Test[a]	1	1		1	1	
Serial Correlation Test[b]	0.514	0.551		0.0847	0.317	
Within R^2			0.813			0.465

Notes: Robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
[a]Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.
[b]Reports p-values for the null hypothesis that the errors in the first-difference regression exhibit no second-order serial correlation.

Another caveat arises due to new limitations in monetary policy, namely reaching the zero lower bound and in some cases outright negative interest rates. To the degree that this constrains monetary policy, pass-through could be affected. Having said that, this constraint is unlikely to affect our main conclusion: First, there is no such constraint in emerging markets where we see a larger decline in pass-through. Second, pass-through estimates seem to remain low in advanced economies even under low interest rates. Yet, this issue highlights that one should not be complacent about low pass-through in advanced economies: the slight and not very robust increase in pass-through in some of our estimates shown for advanced economies could warrant further investigation and research in light of these policy constraints.

Finally, our approach does not distinguish between exogenous and endogenous exchange rate shocks—and this distinction might matter, as Shambaugh (2008) and Forbes, Hjortsoe, and Nenova (2015) show. However, we consciously control for global factors, either through time fixed effects or explicitly, in order to consistently exclude global shocks.[8] On the one hand, this exclusion of global factors is reassuring: the results are not contaminated by shifting global shocks. On the other hand, this also implies that the inclusion of global shocks could add further dynamics in principle—though our tests suggest that removing the time-fixed effects does not materially affect the main results.[9]

6. Conclusions

We studied how exchange rate pass-through has changed since the global financial crisis. We found that exchange rate pass-through to CPI inflation in emerging economies decreased in the wake of the financial crisis, and that this decline in pass-through in emerging economies is linked to declining inflation. By contrast, exchange rate pass-through in advanced economies has remained relatively stable

[8]The dynamic panel estimates in the baseline specification include time fixed effects, and thereby the pass-through estimates are derived only from the cross-sectional variation.

[9]We explored this point above by running our specification without time fixed effects for robustness (see columns 2, 3, 6, and 7 of tables 1 and 2 for robustness).

over time, at a lower level than in emerging economies. These results hold for both short-run and long-run pass-through. The results are found to be robust to a range of controls and specifications.

The results have policy relevance, particularly when assessing broad changes in how exchange rate changes are transmitted to consumer prices in the global economy. Providing such a global context might help thinking about monetary policy in many countries, even if the pass-through estimates are not directly applicable to any individual country. In this regard, the generally low pass-through levels today imply that central banks in general should "fear" less the "floating" of their exchange rates, at least from an inflation perspective. Yet, the lower pass-through in emerging markets also implies that the exchange rate channel of monetary policy might be less effective to affect inflation than before the financial crisis.

Finally, the results further confirm the importance of price stability by showing that lower inflation, among its other benefits, also reduces exchange rate pass-through to consumer prices.

Appendix 1. Data Sources

Table 5. Data Sources

Variable	Description	Source
	Inflation	
Consumer Price Index	Quarter-on-quarter log changes, seasonally adjusted.	Datastream National Data BIS
	Exchange Rates	
Nominal Effective Exchange Rate	Nominal effective exchange rate indexes are calculated as geometric weighted averages of bilateral exchange rates. Broad indexes comprise sixty-one economies, with data from 1994. Quarterly averages, quarter-on-quarter log changes.	BIS
Bilateral USD Exchange Rates	Bilateral U.S. dollar exchange rate against local currency. Quarterly averages, quarter-on-quarter log changes.	National Data BIS
	Control Variables for Local Factors	
Domestic Output Gap	Standard Hodrick-Prescott filter applied on quarterly real GDP series. GDP in levels; domestic currency units.	National Data BIS Authors' calculations
Inflation Expectations	Quarter-on-quarter inflation expectations. Data are derived from yearly Consensus surveys' inflation expectations by assuming constant inflation over the coming quarters within the year.	Consensus Economics Datastream National Data BIS Authors' caculations
	Control Variables for Global Factors	
Oil Prices	West Texas Intermediate (WTI) crude oil spot price. Quarterly averages, quarter-on-quarter log changes.	Bloomberg
Global Output Gap	Standard Hodrick-Prescott filter applied on quarterly real GDP series.	National Data BIS Authors' calculations

Appendix 2. Robustness Checks

Figure 4. Pass-Through to Emerging Market Economies (baseline specification with different rolling window sizes)

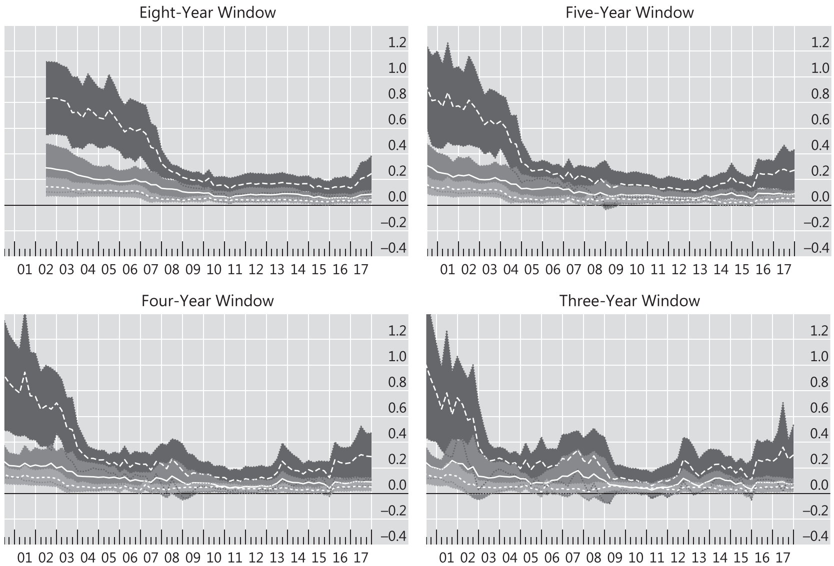


Figure 5. Pass-Through to Advanced Economies (baseline specification with different rolling window sizes)

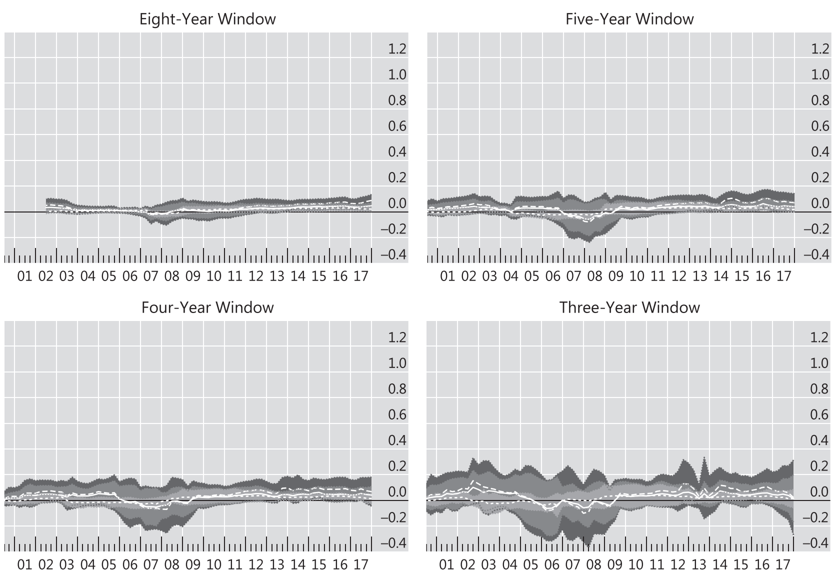


Figure 6. Pass-Through Using Bilateral USD Exchange Rate (six-year rolling windows, based on equation (1) without inflation expectations)

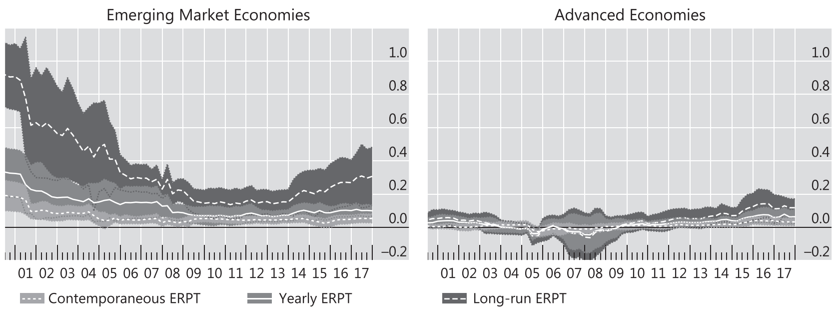
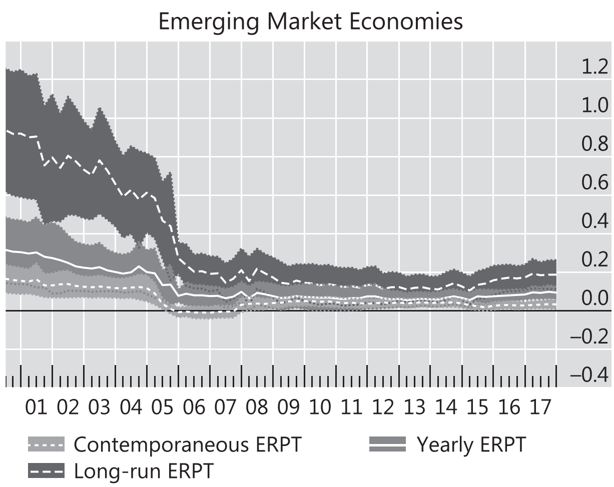


Figure 7. Pass-Through to Emerging Market Economies, excluding Argentina (baseline specification, six-year rolling windows)



References

Aleem, A., and A. Lahiani. 2014. "Monetary Policy Credibility and Exchange Rate Pass-Through: Some Evidence from Emerging Countries." *Economic Modelling* 43 (December): 21–29.

Alvarez, F., F. Lippi, and J. Passadore. 2017. "Are State- and Time-Dependent Models Really Different?" *NBER Macroeconomics Annual 2016*, Vol. 31, ed. M. Eichenbaum and J. A. Parker, 379–457 (chapter 5). University of Chicago Press.

Arellano, M., and O. Bover. 1995. "Another Look at the Instrumental Variable Estimation of Error-Components Models." *Journal of Econometrics* 68 (1): 29–51.

Aron, J., and J. Muellbauer. 2014. "Exchange Rate Pass-Through in Developing and Emerging Markets." VOX CEPR Policy Portal. Available at http://voxeu.org/article/exchange-rate-pass-through-developing-and-emerging-markets.

Bachetta, P., and E. van Wincoop. 2003. "Why Do Consumer Prices React Less than Import Prices to Exchange Rates?" *Journal of the European Economic Association* 1 (2–3): 662–70.

Bailliu, J., and E. Fujii. 2004. "Exchange Rate Pass-Through and the Inflation Environment in Industrialized Countries: An Empirical Investigation." Working Paper No. 2004-21, Bank of Canada.

Blundell, R., and S. Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87 (1): 115–43.

Bussière, M. 2013. "Exchange Rate Pass-Through to Trade Prices: The Role of Nonlinearities and Asymmetries." *Oxford Bulletin of Economics and Statistics* 75 (5): 731–58.

Calvo, G., and C. Reinhart. 2002. "Fear of Floating." *Quarterly Journal of Economics* 117 (2): 379–408.

Campa, J., and L. Goldberg. 2005. "Exchange Rate Pass-Through into Import Prices." *Review of Economics and Statistics* 87 (4): 679–90.

———. 2006. "Distribution Margins, Imported Inputs, and the Sensitivity of the CPI to Exchange Rates." Staff Report No. 247, Federal Reserve Bank of New York.

Cheikh, N., and C. Rault. 2015. "The Pass-Through of Exchange Rate in the Context of the European Sovereign Debt Crisis." CESifo Working Paper No. 5550.

Choudhri, E., and D. Hakura. 2006. "Exchange Rate Pass-through to Domestic Prices: Does the Inflationary Environment Matter?" *Journal of International Money and Finance* 25 (4): 614–39.

Clarida, R., J. Galí, and M. Gertler. 1999. "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 37 (4): 1661–1707.

De Gregorio, J. 2016. "Large Depreciations: Recent Experience in Historical Perspective." Working Paper No. 16-8, Peterson Institute for International Economics.

Devereux, M., and J. Yetman. 2008. "Price-Setting and Exchange Rate Pass-Through: Theory and Evidence." Available at http://www.bankofcanada.ca/wp-content/uploads/2010/08/Devereux_Yetman-v3.pdf.

Engel, C. 2002. "The Responsiveness of Consumer Prices to Exchange Rates: A Synthesis of Some New Open Economy Macro Models." *The Manchester School* 70 (Supplement): 1–15.

Forbes, K. 2014. "The Economic Impact of Sterling's Recent Moves: More than a Midsummer Night's Dream." Speech given at the 100 Women in Hedge Funds event, London, October 1.

———. 2015. "Much Ado about Something Important: How Do Exchange Rate Movements Affect Inflation?" Speech given at the 47th Money, Macro and Finance Research Group Annual Conference, Cardiff, September 11.

Forbes, K., I. Hjortsoe, and T. Nenova. 2015. "The Shocks Matter: Improving our Estimates of Exchange Rate Pass-Through." Discussion Paper No. 43, Bank of England External MPC Unit.

Gagnon, J., and J. Ihrig. 2004. "Monetary Policy and Exchange Rate Pass-Through." *International Journal of Finance and Economics* 9 (4): 315–38.

Goldberg, P., and M. Knetter. 1997. "Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature* 35 (3): 1243–72.

Gopinath, G. 2016. "The International Price System." In *Inflation Dynamics and Monetary Policy.* Proceedings of the 2015 Economic Policy Symposium sponsored by the Federal Reserve Bank of Kansas City, held in Jackson Hole, Wyoming, August 27–29.

Kohlscheen, E. 2010. "Emerging Floaters: Pass-throughs and (Some) New Commodity Currencies." *Journal of International Money and Finance* 29 (8): 1580–95.

Levin, A., and R. Moessner. 2005. "Inflation Persistence and Monetary Policy Design: An Overview." ECB Working Paper No. 539.

Lopez-Villavicencio, A., and V. Mignon. 2016. "Exchange Rate Pass-through in Emerging Countries: Do the Inflation Environment, Monetary Policy Regime and Institutional Quality Matter?" CEPII Working Paper No. 2016-07.

Mihaljek, D., and M. Klau. 2008. "Exchange Rate Pass-Through in Emerging Market Economies: What Has Changed and Why?" *BIS Papers* (35): 103–30.

Plantin, G., and H. S. Shin. 2016. "Exchange Rates and Monetary Spillovers." BIS Working Paper No 537.

Shambaugh, G. 2008. "A New Look at Pass-Through." *Journal of International Money and Finance* 27 (4): 560–91.

Smets, F. 2003. "Maintaining Price Stability: How Long is the Medium Term?" *Journal of Monetary Economics* 50 (6): 1293–1309.

Takhtamanova, Y. 2010. "Understanding Changes in the Exchange Rate Pass-Through." *Journal of Macroeconomics* 32 (4): 1118–30.

Taylor, J. 2000. "Low Inflation, Pass-Through, and the Pricing Power of Firms." *European Economic Review* 44 (7): 1389–1408.

Woodford, M. 2003. *Interest and Prices.* Princeton, NJ: Princeton University Press.