The inflation process

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Abstract

This paper documents three major and favourable inflation dynamics in emerging market economies (EMEs). First, the level of inflation has moderated in EMEs and has been broadly stable since the early 2000s. Second, inflation persistence has declined over the past decade. Third, EME exchange rate pass-through, both short-term and long-term, has also declined after the financial crisis. In addition, the paper shows that the role of global factors on inflation is larger for EMEs that are more open to trade.

Keywords: Inflation, exchange rate pass-through

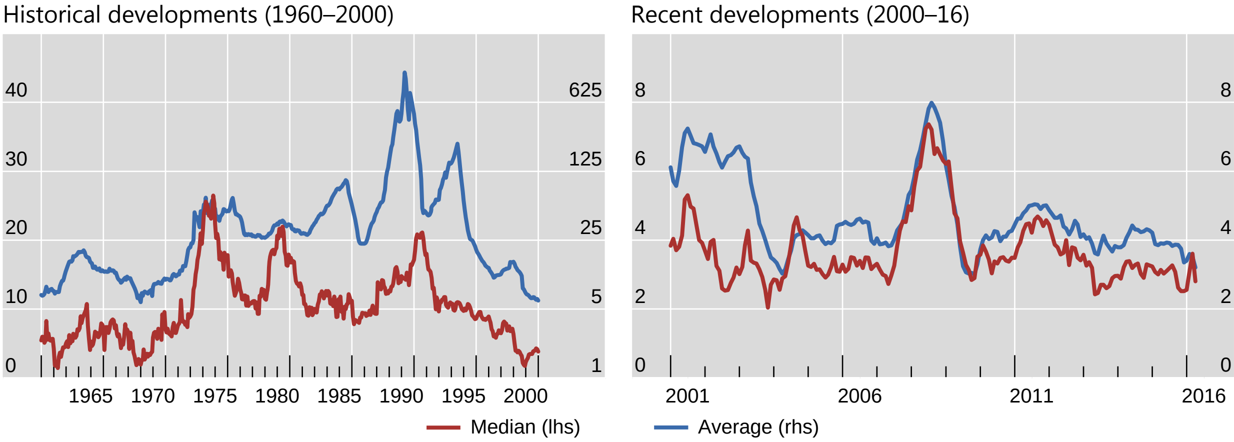
JEL classification: E31, E58, F31

Introduction

Inflation has moderated in emerging market economies (EMEs) since the 1990s (Graph 1). The decline is similar to, but steeper than, that in advanced economies. This is in stark contrast with the previous few decades: in the 1970s the two oil crises raised inflation rates in many EMEs; and in the 1980s average inflation accelerated further, with some experiencing hyperinflation (left-hand panel). Yet, after the mid-1990s average inflation began to slow, and by the 2000s it was fluctuating in a narrow and stable range (right-hand panel).

EME inflation[1] has moderated to low levels from historical highs

In per cent — Graph 1



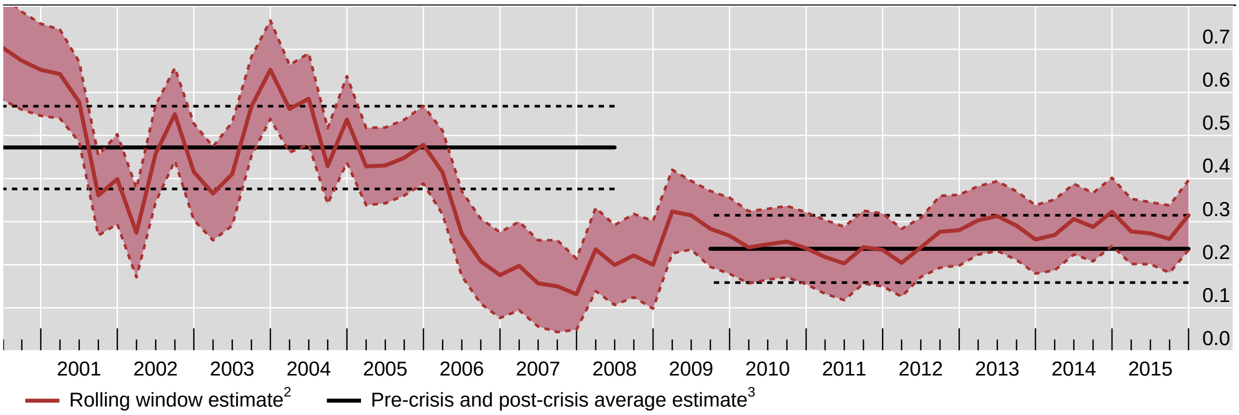
[1] Year-on-year change in consumer price index. Unweighted median and average for Algeria, Argentina, Brazil, China, Chile, Colombia, the Czech Republic, Hungary, Hong Kong SAR, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Singapore, South Africa, Thailand and the United Arab Emirates since January 1960 or later depending on data availability.

Sources: CEIC; Datastream; Global Financial Data; national data.

Inflation persistence also seems to have declined over the past 15 years (Graph 2, red trend line). The rolling estimates suggest that persistence started to recede even before the financial crisis, though assessing the significance of such changes is difficult over shorter horizons. Yet, persistence is clearly lower in the broad post-crisis period than in the pre-crisis period (compare black solid lines and dotted confidence bands). Lower inflation persistence is usually interpreted positively because it implies that past inflation trends have less of an effect on inflation, facilitating its control.[1]

[1] Of course, when thinking about monetary policy, one is interested in endogenous inflation persistence, ie the degree to which past inflation drives current inflation, and not in accidental or purely statistical inflation persistence, such as that arising from persistent shocks. Reflecting this, the baseline estimation controls for some likely shocks: the business cycle, global factors such as the shock of oil price movements or the financial crisis (through time fixed effects), and exchange rate movements. That said, the decline in persistence is present even if these controls are excluded. Furthermore, it is robust to different specifications.

Inflation persistence has also declined over the past decade[1] Graph 2



[1] Persistence is defined as the autoregressive coefficient δ from the equation A1 in the Appendix. [2] Results for six-year rolling window. [3] Results for periods Q1 2000–Q2 2008 (pre-crisis) and Q3 2009–Q4 2015 (post-crisis).

Sources: Jašová et al (2016); IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

Declining persistence is broadly consistent with the questionnaire responses: seven responding EMEs found that persistence declined while only two reported an increase – with 10 reporting roughly no change (for details, see Appendix Table A1). Yet, these responses also highlight that the averages, for both the level and the persistence of inflation, are not necessarily representative for all EMEs.

In principle, the moderation of inflation and the fall in its persistence are good news. But while this might imply easier central bank control or better anchored expectations, other factors, less influenced by central banks, may also have been at work. In fact, our understanding of the inflation process, even in advanced economies, is highly imperfect (BIS (2015) and the Bank of Korea note by Chang, Choi and Park in this issue). And, as some economists have highlighted, inflation has displayed confounding dynamics that are not captured by conventional models (Faust and Leeper (2015)).

This paper explores the inflation process in EMEs. It discusses analytic issues along two dimensions: short vs long-term and local vs global. To understand changes over time and across EMEs, we examine four selected drivers: (1) Phillips curve output gap responses (as a short-term domestic driver); (2) exchange rate pass-through (as a short-term global driver); (3) age structure (as a long-term domestic driver); and (4) trade (as a long-term global driver).

Potential inflation drivers

When thinking about the factors driving inflation, two dimensions might be useful: domestic and global factors, on the one hand, and short-term (ie business cycle) and long-term (ie low-frequency) factors, on the other (Table 1). A typical New Keynesian model would consider domestic drivers that exert their effect over the business cycle (top left-hand cell). The standard Phillips curve, in its most parsimonious form, includes inflation expectations as well as wage or output gaps. In addition, simple extensions for small open economies often include the exchange rate or import prices to account for relevant international effects.

However, it seems that inflation is increasingly shaped by global factors – and these global factors are not necessarily fully captured by the exchange rate. For instance, there is evidence that inflation has become less reactive to domestic factors and more susceptible to global ones (eg Borio and Filardo (2007) and the Central Bank of Malaysia note by Singh in this issue). These global effects can work at both high and low frequencies. Global food and commodity prices seem to operate on a frequency similar, though not identical, to that of the business cycle (top right-hand cell). For instance, they pushed inflation up and down in many EMEs around the global financial crisis. Yet, global factors can, in principle, work at lower than business cycle frequencies: for instance, the increased contestability of labour and goods markets associated with the entry of former communist countries in the trading system as well as with technological development (bottom right-hand cell).

Potential inflation drivers — Table 1

	Domestic	*Global*
Short-term (high-frequency, business cycle horizon)	Phillips curve	Exchange rates, commodity prices (oil and food), invoicing and funding currencies
Long-term (low-frequency)	Demographics, education, (female) labour force participation, labour share of income, credit cycles	Trade, globalisation, technology, (global demographics)

Furthermore, some domestic drivers might also shape inflation over the longer term. Researchers, like Faust and Leeper (2015), have highlighted long-run changes in age structure (demographics), education, (female) labour force participation, the labour share of income and credit cycles as potential drivers. While not uncontroversial, thinking about these drivers could be especially relevant for EMEs, as these factors often evolve faster there than in advanced economies.

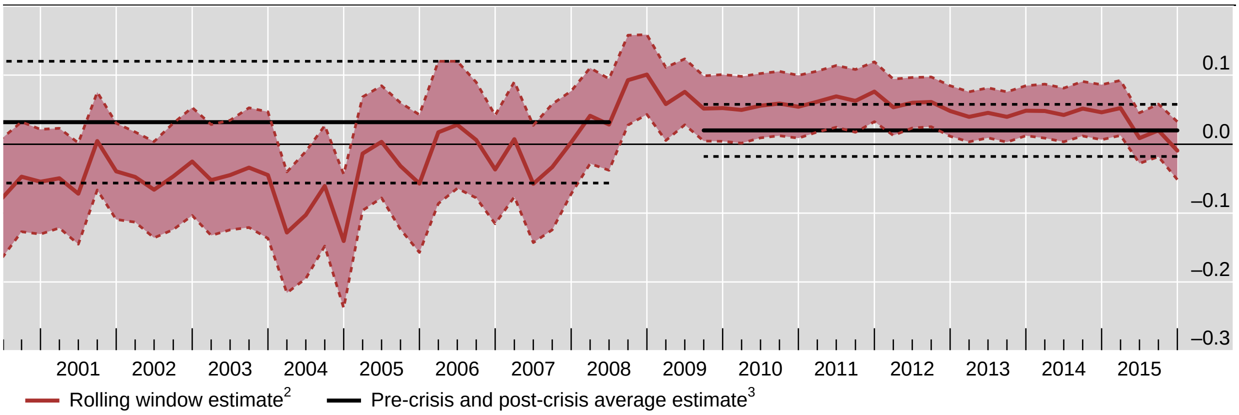
In what follows, we structure the discussion along these two dimensions. In particular, we examine: (1) Phillips curve output gap responses as a short-term domestic driver; (2) exchange rate pass-through as a short-term global driver; (3) age structure as a long-term domestic driver; and (4) trade as a long-term global driver.

II.1 Phillips curve output gap responses

Evidence is accumulating that in advanced economies the Phillips curve has flattened, ie that inflation has become less responsive to domestic slack. Is this true of EMEs?

Indeed, the impact of the domestic output gap seems to be mostly insignificant for EMEs as a group (Graph 3, red trend line). The rolling window estimates tend to be insignificant or only marginally significantly different from zero (red dotted confidence band). Furthermore, both the pre- and post-crisis estimates show that the output gap responses are consistently statistically insignificant, though the post-crisis estimates seem to be suggest this more precisely (black lines and dotted black confidence intervals). These results are consistent with the conjectures in Borio and Filardo (2007) and in the Central Bank of Malaysia note by Singh in this issue.

The impact of the domestic output gap in inflation seems insignificant Graph 3



[1] The impact of the domestic output gap is defined as the coefficient ϕ from the equation A1 in the Appendix. [2] Results for six-year rolling window. [3] Results for periods Q1 2000–Q2 2008 (pre-crisis) and Q3 2009–Q4 2015 (post-crisis).

Sources: Jašová et al (2016); IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

While for the "average" EME, the domestic output gap does not seem to be statistically significant, this result should be treated cautiously. First, as usual, much heterogeneity remains across EMEs.[2] Second, and more importantly, although the estimates generally hover around zero, the response is marginally statistically different from zero in many subperiods (see red confidence band of rolling window estimates for in the 2005–07 and 2010–2015 periods).

II.2 Exchange rate pass-through

Main trends in pass-through

Given recent large exchange rate depreciations in many EMEs, the question naturally arises: to what degree do exchange rate movements pass through to inflation? And has this pass-through changed?

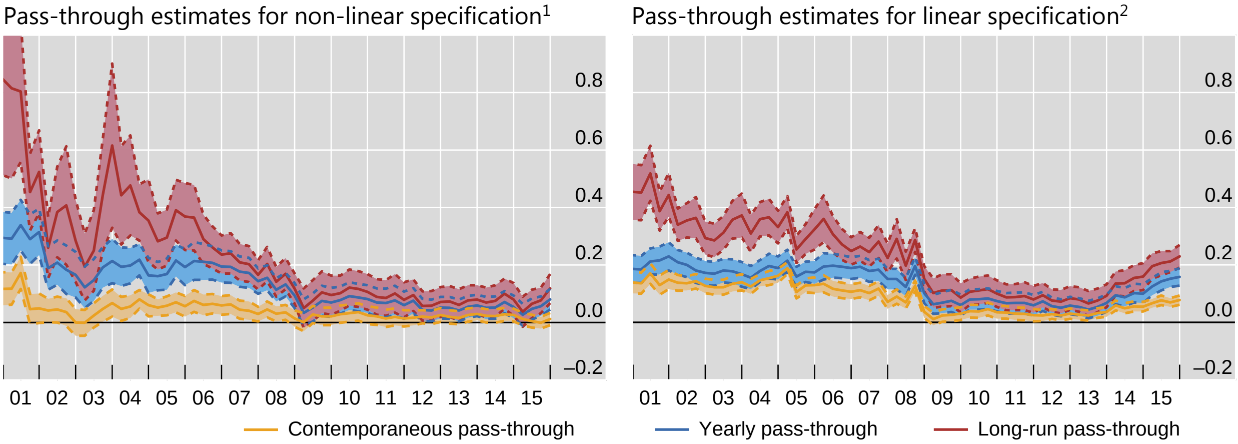
Traditionally, exchange rate pass-through, over both the short and the long term, has been higher for EMEs than for advanced economies. That said, a key facilitator of this higher pass-through was higher, more volatile and more persistent inflation. When inflation is low and stable, prices and wages tend to be stickier, which in turn reduces the pass-through (Taylor (2000)). Indeed, Choudhri and Hakura (2006) and Devereux and Yetman (2010) find a positive and statistically significant relationship between the pass-through to domestic prices and the average inflation rate across

[2] For instance, the note from the Monetary Authority of Singapore by Meng in this issue shows that domestic output drives inflation significantly in Singapore over the full 1994–2013 period – and this result might also generalise to the post-crisis period.

countries and periods. Hence, the observed moderation in average inflation rates (Graph 1) along with the decline in inflation persistence over the past decades (Graph 2) would suggest a smaller pass-through in EMEs.[3]

Pass-through declined post-crisis

Nominal effective exchange rate pass-through to consumer prices, six-year rolling windows — Graph 4



[1] Pass-through results are derived from the equation A1 in the Appendix. [2] Pass-through results are based on the same method as explained in the Appendix excluding quadratic and cubic changes in exchange rates, ie. $\pi_{it} = \alpha_i + \beta_t + \delta\pi_{it-1} - \sum_{j=0}^{3}\gamma_j \Delta NEER_{it-j} + \phi ygap_{it} + \varepsilon_{it}$.

Sources: Jašová et al (2016); IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

Indeed, average EME exchange rate pass-through estimates, both short-term and long-term, have declined post-crisis (Graph 4, left-hand panel). This basic pattern does not depend on the precise specification, including the length of the estimation window. It is similar for all three pass-through estimates: the contemporaneous (yellow line), the yearly (blue line) and the long-run (red line). Furthermore, the levels and patterns of the pass-through estimates are almost identical whether we use changes in the nominal exchange rate or the US dollar bilateral exchange rate (see details in Jašová et al, 2016). Interestingly, the note from the Magyar Nemzeti Bank by Gábriel, Molnár and Várhegyi identifies a similar decline in pass-through – although there it starts slightly later, around 2010.

However, controlling for non-linearities is crucial to properly assess the extent of recent pass-through developments. Exchange rate movements increased during and after the taper tantrum (ie after May 2013). These larger exchange rate movements are expected to pass through stronger to consumer prices 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 after the taper tantrum (Graph 4, right-hand panel) – while such an increase is not visible in models that take non-linearities into account (left-hand panel).

[3] Conversely, as the Central Bank of Malaysia note by Singh in this issue also shows, more openness and more market-based price determination can increase pass-through.

The questionnaire responses are broadly consistent with the panel estimates. Ten EMEs found weakening pass-through and only two a strengthening one; five respondents saw no change (see Appendix Table A1 for country-specific details).

Furthermore, the questionnaire responses and the country papers confirm that EME experiences are likely to be heterogeneous.[4] Hence, our results above should only be read as broad, cross-country trends which might provide guidance for all EMEs. Yet, repeating the analysis for subsamples, such as EMEs with free-floating exchange rates, inflation targeting regimes or large shares of commodity exports, suggest that the main trend of declining pass-through is present broadly among EMEs (results available upon request). Of course, smaller differences remain. For instance, inflation targeters have seen a larger than average fall in pass-through under all three time horizons, which confirms the findings in eg Choudhri and Hakura (2006) that inflation targeting regimes can moderate the extent of pass-through. Yet, these country group estimates should be treated cautiously as the estimates are becoming less stable as we shrink the sample size.

While the above results indicate a clear trend in pass-through, some caution is warranted in interpreting them. The analysis largely assumes that the response to the exchange rate is invariant to the factors driving it.[5] Unfortunately, many forms of heterogeneity cannot be fully controlled in a macroeconomic panel setup. For instance, evidence is accumulating that pass-through might be larger for global shocks than for country-specific shocks (Forbes (2015)). The analysis aims to control for this by including time fixed effects to capture global shocks. However, this control is imperfect: it cannot capture the impact of the global shock that affects EMEs differently.[6]

Foreign currency debt and exchange rate pass-through

As noted earlier, there is considerable variation in exchange rate pass-through across countries or groups thereof. Here we ask the question whether foreign currency debt can be one of the sources of this heterogeneity.

Theoretically, FX debt can influence exchange rate pass-through via, for instance, the "risk-taking channel" of exchange rates. Fluctuations in exchange rates alter the riskiness and availability of credit by affecting the strength of those companies that borrow in foreign currency (Bruno and Shin (2014)). This, in turn, may also influence pricing behaviour. Indeed, in their Jackson Hole paper Gilchrist and Zakrajsek (2015) find that financial conditions, in their case largely linked to domestic debt, have such

4 For instance, the note from the Central Bank of the Republic of Turkey by Kılınç, Tunç and Yörükoğlu shows that pass-through seems to be higher in Turkey than in Mexico and links this observation to different sizes of current account deficits.

5 For instance, exchange rate movements which are perceived to be more persistent are likely to have a larger pass-through, as the note from the Czech National Bank by Skořepa, Tomšík and Vlček argues.

6 Furthermore, excluding global shocks this way also implies that the estimates are derived only from cross-sectional variation – and the resulting omission of time variation means also that the analysis might underestimate the full extent of pass-through. Running our specification without time fixed effects suggests that excluding time variation indeed lowers the estimates. When global shocks enter the estimates, the estimated pass-through increases. Yet, the basic pattern – the post-crisis drop and post-taper tantrum jump – remains broadly unchanged. For details see Jašová et al (2016).

an effect. They find that, during the 2008 financial crisis, while financially constrained firms increased their prices, unconstrained ones decreased theirs.

We estimate an extended version of the equation in the footnote of Graph 4 and find that the level of FX debt is associated with higher exchange rate pass-through.[7] In particular, we extend the model by including the interaction of the level of FX debt (percentage of GDP) and the percentage change in the nominal effective exchange rate (ΔNEER), alongside the level of FX debt and the policy interest rate as additional explanatory variables.[8] We add policy rates because the level of FX debt can also influence the policy rates due to financial stability concerns. The results show that the coefficient of the interaction term is significantly negative, which indicates higher pass-through for higher FX debt levels.[9]

II.3 Age structure and inflation

Demographic change, particularly in the age structure of the population, may also influence inflation over the long term. Reflecting this, there is much discussion about the impact of the ageing and retirement of baby boomers in the United States. Understanding the impact of a changing age structure is also relevant for EMEs. The casual distinction between "young" EMEs and "old" advanced economies is, if not a myth, an overgeneralisation. For instance, the Korean population is already older than the US population – and the Chinese and Brazilian populations will be so in five and fifteen years, respectively.[10]

These changes in the age structure might affect inflation dynamics. Former Governor of the Bank of Japan Shirakawa (2011a,b) suggested that the rising population share of the old can drastically weaken the economic outlook, which in turn could exert deflationary pressures. In a similar view, President Bullard of the Federal Reserve Bank of St Louis (Bullard et al (2012)) argued that the old's preference for lower inflation can reduce inflation in ageing societies. Faust and Leeper (2015) also discuss age structure as a potential, though not well understood, inflation driver.

Indeed, some researchers have found a seemingly robust empirical correlation between age structure and inflation in advanced economies (Juselius and Takáts (2015b)).[11] Accordingly, a larger share of the dependent population (ie young and old) is inflationary (ie associated with higher inflation), and a larger share of the

[7] We do a similar analysis with credit growth instead of the level of FX debt. The results show that, during depreciation periods, more credit growth is associated with lower pass-through. The findings provide additional support to the importance of financial conditions in price level dynamics.

[8] To better identify the risk-taking channel, it is necessary to run the regressions with bilateral exchange rates as well.

[9] We find suggestive evidence from sectoral analysis by using the questionnaire responses that provide the sectoral level price, credit and FX debt level. In particular, we find that, for the manufacturing sector, the level of FX debt is associated with higher pass-through. For agriculture, we do not find significant results. We could not perform the analysis for the other sectors due to data availability.

[10] Population age measures as median age; projections from United Nations (2015).

[11] Estimates using data on 22 advanced economies over the 1955–2010 period. The uncovered relationship is robust in subsamples and subperiods, including in the most recent (1995–2010) period. It also holds under different estimation techniques (see also Aksoy et al (2015) for a simpler setting).

working age population deflationary (ie associated with lower inflation).[12] To see this relationship, consider the left-hand panel of Graph 5.[13] The horizontal axis lists the age cohorts: 0–4 years old, then 5–9 years old, etc. The vertical axis shows the inflationary impact of the respective cohort. For instance, the inflationary impact of the 10–14 age cohort is around 0.5%. This means that an increase in the population share of the 10–14 cohort by 1 percentage point will increase inflation by 0.05 percentage points.[14] The inflationary impact of the full population age structure can be obtained by multiplying, one by one, each cohort's impact by the share of that cohort in the population – and summing these up for all cohorts. The impact of the young and the old is inflationary (positive values) and that of the working age cohorts disinflationary. The narrow confidence band (dotted line) shows that the estimates are precise.

Firmly identifying a similar low-frequency impact for EMEs is not feasible because the long-term inflation series include huge shocks, such as episodes of crises and hyperinflation (Graph 1). These large shocks would mask any slow-moving, relatively small changes, such as the impact of age structure. Yet, the age structure impact might not be completely irrelevant for EMEs. Combining the age cohort impact estimates obtained for advanced economies with the age structure of EMEs prevailing today, the resulting effect could explain around one third of the cross-sectional variation of average inflation across EMEs over the last three years (Graph 5, right-hand panel). Importantly, this prima facie evidence suggests that age structure should not be entirely dismissed as a potential factor.

The potential impact of age structure on inflation is relevant for policymakers for two main reasons. The relative importance of demographics is naturally greater at low inflation rates. And Juselius and Takáts (2015b) also find that it can explain a large part of the observed inflation persistence and trend decline in their sample of advanced economies.

12 While population growth, especially that of the working age population, also seems relevant, its effect is small and its inclusion does not affect the age structure results.

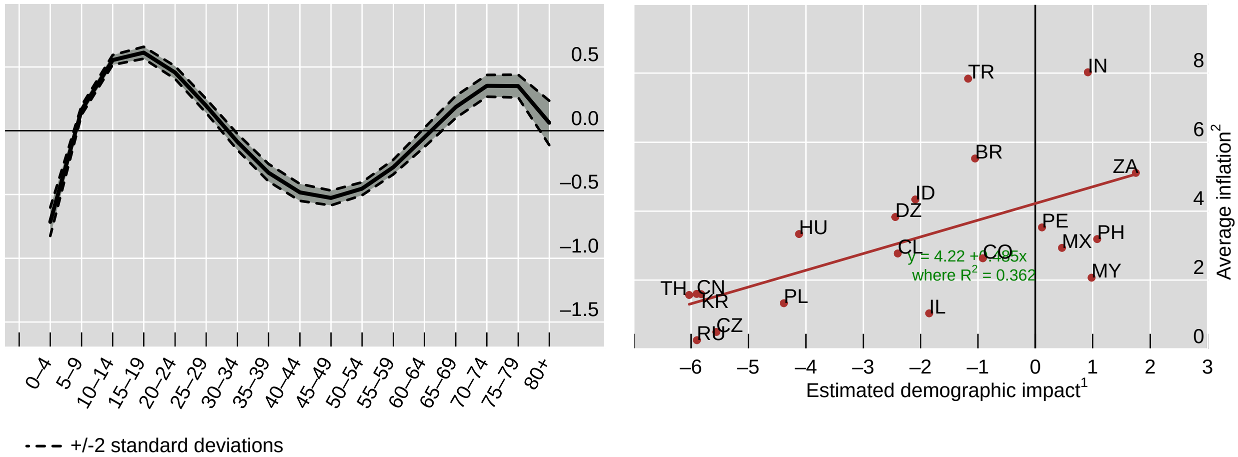
13 The smooth pattern reflects the population polynomial technique from Fair and Dominguez (1991). Important, simple age cohort estimates, though econometrically not ideal, show a very similar picture.

14 As total population share adds up to 100%, we implicitly assume in this example that the coefficients on the cohorts with declining population share are zero.

Age structure and inflation: a puzzling link

In per cent | Graph 5

Advanced economy data suggest a link between age structure and inflation… | …and the link is not refuted in EME data either



[1] Estimates are obtained by applying the age cohort coefficients estimated for advanced economies to 2014 age cohort data from emerging market economies. [2] Average inflation over 2012–14.

AE = United Arab Emirates; AR = Argentina; BR = Brazil; CL = Chile; CN = China; CO = Colombia; CZ = Czech Republic; DZ = Algeria; HU = Hungary; ID = Indonesia; IL=Israel; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; PE = Peru; PH = Philippines; PL = Poland; RU = Russia; SA = Saudi Arabia; TH = Thailand; TR = Turkey; ZA = South Africa

Sources: Juselius and Takáts (2015a); United Nations (2015); BIS data.

II.4 Globalisation and inflation

Undoubtedly, over the past 15 years, central banks across the EMEs have become more credible, and that has played the key role in affecting the dynamics of inflation. At the same time, EMEs have become much more integrated into the global economy through both trade and financial channels. It is natural to expect that globalisation also has some role in the inflation process through higher competitive pressures, lower tradable goods prices and the increased role of global factors.

There is growing evidence consistent with this hypothesis. For instance, by using an advanced country data set, Borio and Filardo (2007) find that global factors (measured by the global output gap) are important in explaining domestic inflation and that the influence of global factors has been increasing.[15] Similarly, Pain et al (2006) find that globalisation has contributed to lower inflation in OECD countries. In a disaggregated industry-level analysis, Auer et al (2013) find that European producer prices fall more than 3.2% when lower-wage-country manufacturing volumes rise by 1% above trend. On the other hand, Bernanke (2007) and Kohn (2006) argue that the effects of globalisation on US inflation dynamics are likely to be small.

While most of the evidence regarding the influence of globalisation on inflation is from advanced country studies, it is reasonable to expect similar effects for EMEs.

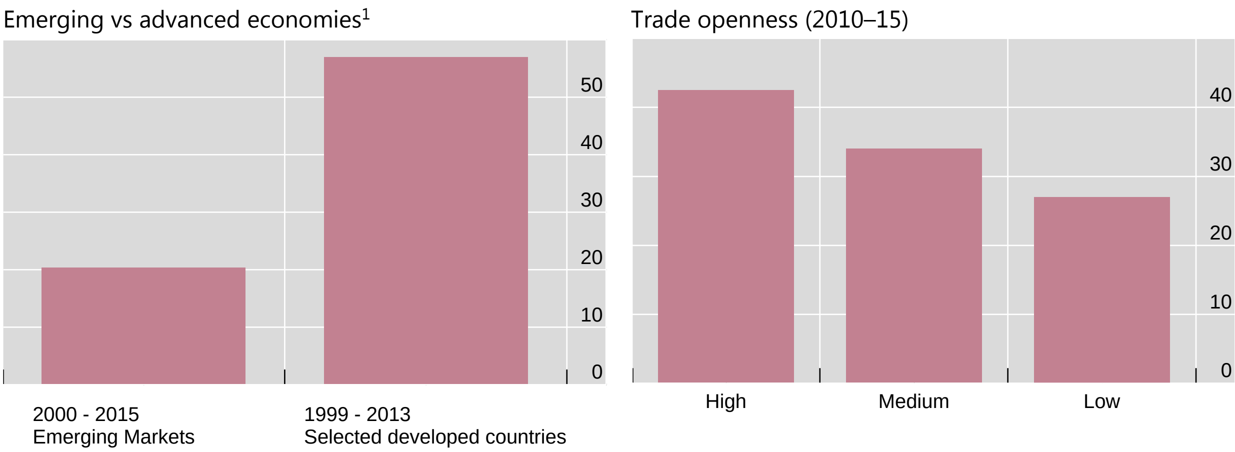
[15] More recent references are BIS (2014).

With larger trade flows, markets became more competitive, making deviations of tradable goods prices from the prices in other markets less likely. That said, the share of inflation variance explained by the first principal component (the common factor across EMEs) has increased only slightly, from 21% in 2000–07 to 23% in 2010–15. Moreover, it remains half as large as the corresponding value for the advanced economies (Graph 6, left-hand panel). This could reflect the large diversity among EMEs. As Graph 6 (right-hand panel) shows, in the EMEs that are most open to trade, the common factor is as important for inflation as in the advanced economies. As trade openness declines, the role of the common component also declines.

Variance explained by the first principal component[1]

In per cent

Graph 6



[1] Emerging economies: Algeria, Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Turkey and the United Arab Emirates. Advanced economies: Australia, Canada, France, Germany, Italy, Japan, Spain, Sweden, Switzerland, the United Kingdom and the United States. Total trade/GDP between 2010 and 2015 is the measure of trade openness. The eight countries with the largest values of total trade/GDP are in the "high" group, with the next eight countries in the "medium" group and the remainder in the "low" group.

Source: BIS (2014).

We extend the panel estimates presented in the previous sections to explore the role of globalisation in inflation dynamics. In particular, we interpret the time dummies in the regression as global factors that are common to the emerging economies that we have in the data. In theory, time dummies should capture global factors including global slack, but also oil, energy and food prices, which are very important for the inflation processes of most EMEs.[16] To analyse the role of trade openness, we gradually increase the trade openness of the sample by incrementally excluding observations that correspond to lower trade openness (lower trade/GDP). For each level of exclusion, we estimate the model with and without time dummies.

Our results are consistent with the hypothesis that trade integration increases the role of global factors (Graph 7, left-hand panel). Specifically, the values on the

[16] We should note that the coefficient of time dummies gives only the average response to various shocks. The effects of specific shocks may vary.

horizontal axis represent the minimum trade/GDP ratio included in the sample. The values on the vertical axis represent the fit of the model with time dummies relative to the one without. We find that adding time dummies improves the fit more as the sample becomes more trade-open.

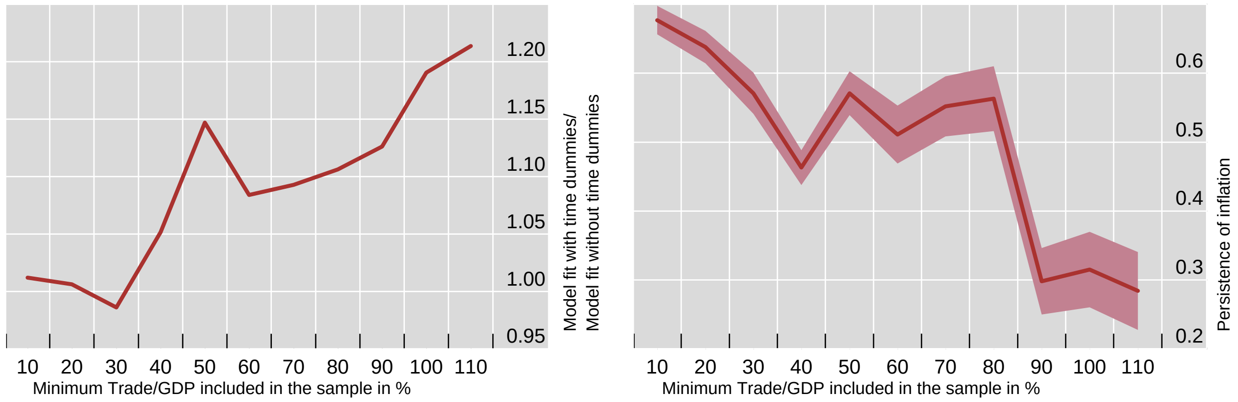
One other important finding emerges from the analysis: inflation persistence declines considerably as trade openness increases (Graph 7, right-hand panel). This supports the argument that globalisation increases competitiveness and makes price deviations from other countries less likely.

Trade openness and inflation[1]

Graph 7

Do global factors explain inflation better for economies that are more trade-open?[2]

Globalisation and inflation persistence



[1] Results are derived from the equation $\pi_{it} = \alpha_i + \beta_t + \delta\,\pi_{it-1} + \gamma_1 \Delta NEER_{it} + \gamma_2 \Delta NEER_{it-1} + \gamma_3 \Delta NEER_{it-2} + \gamma_4 \Delta NEER_{it-3} + \lambda ygap_{it} + \varepsilon_{it}$, where α_i are country fixed effects and β_t time (quarter) fixed effects; π_{it} is the log change in CPI in country *i* in quarter *t;* $\Delta NEER_{it}$ is the log change in the nominal effective exchange rate in country *i* in quarter *t;* and $ygap_{it}$ is the output gap. The estimates are obtained in a dynamic panel-data setup using the generalised method of moments following Arellano and Bond (1991) and Roodman (2006) for Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey . [2] The fit of the model is calculated by dividing the variance of the predicted values to data. On both graphs, the horizontal axis denotes the minimum trade/GDP ratio included in the data.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; Bloomberg; CEIC; Datastream; national data; BIS calculations.

Appendix graphs and tables

Inflation persistence and exchange rate pass-through after the financial crisis — Table A1

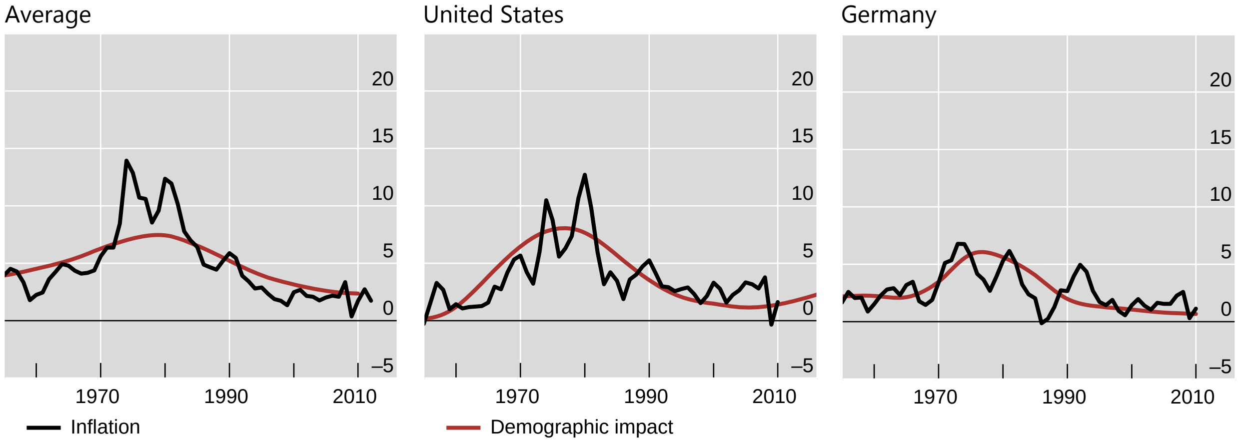
Country	In the post-2008 period, did inflation persistence…			In the post-2008 period, did exchange rate pass-through…		
	…weaken (become less persistent)?	…remain stable?	…strengthen (become more persistent)?	…weaken (become less persistent)?	…remain stable?	…strengthen (become more persistent)?
Algeria						
Argentina						
Brazil						
Chile		X[1]			X[5]	
China	X			X		
Colombia		X			X	
Czech Republic		X			X	
Hong Kong SAR						
Hungary	X			X		
India			X	X		
Indonesia		X		X		
Israel	X[2]			X[6]		
Korea		X[3]		X[7]		
Malaysia	X				X	
Mexico		X		X		
Peru			X			X
Philippines	X[4]			X[8]		
Poland		X		X		
Russia		X				X
Saudi Arabia		X			X[9]	
Singapore						
South Africa	X			X		
Thailand	X			X		
Turkey		X			X	
United Arab Emirates						

[1] There is some evidence that core inflation has become more persistent since mid-2013. A rolling AR(1) and AR(2) process is estimated for inflation and core inflation to evaluate the evolution of inflation persistence. [2] Slightly – depends on sample. [3] Empirical evidence on inflation persistence in the post-2008 period is mixed. According to a standard TVP autoregressive model, the change in inflation persistence depends on which measure of inflation is used: inflation persistence based on headline CPI is estimated to have increased in the post-2008 period, whereas inflation persistence based on core CPI is estimated to have remained unchanged. Meanwhile, if a standard TVP autoregressive model is augmented with stochastic volatility, inflation persistence is estimated to remain unchanged in the post-crisis period regardless of the measure of inflation. [4] Based on the estimates of the BSP Center for Monetary and Financial Policy, the coefficient of lagged inflation in the Phillips curve (ie measure of inflation persistence) declined from 0.489 in the 2002–08 period to 0.389 between 2009 and Q2 2015. This implies that inflation persistence in the Philippines weakened between these periods. [5] See Justel and Sansone (2015). [6] This was actually mainly due to a drop in dollar indexation of housing in 2007. [7] Estimation results based on various empirical models suggest that exchange rate pass-through declined in the post-2008 period. [8] Exchange rate pass-through in the post-2008 period weakened; coefficient declined from 0.07 (ie in 2002–08) to –0.15 (ie from 2009 to Q2 2015). [9] Indirect pass-through.

Source: National data.

Age structure credibly explains the evolution of low-frequency inflation

Benchmark specification, in per cent — Graph A1



Source: Juselius and Takáts (2015b).

Appendix: Estimating exchange rate pass-through

Reported exchange rate pass-through results based on Jašová et al. (2016).[17] The exchange rate pass-through model is specified as:

$$\pi_{it} = \alpha_i + \beta_t + \delta\pi_{it-1} - \sum_{j=0}^{3} \gamma_j \Delta NEER_{it-j} - \sum_{k=0}^{3} \mu_k \Delta NEER_{it-k}^2 - \sum_{l=0}^{3} \nu_l \Delta NEER_{it-l}^3 + \phi ygap_{it} + \varepsilon_{it} \quad \text{(A1)}$$

Here, π_{it} denotes log differences in quarterly seasonally adjusted consumer price indices (CPI) in country i in quarter t; $ygap_{it}$ is the domestic output gap, calculated by employing a standard univariate Hodrick-Prescott filter with a standard smoothing parameter. The real GDP series start in 1994 Q1 or later, depending on data availability; ΔNEER is the (change in the log of) the nominal effective exchange rate (BIS data). The estimation period is Q1 1994 – Q4 2015. 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 panel contains 23 EMEs: Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Mexico, Malaysia, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey. We control for country heterogeneity that may arise from different historical inflation developments, and exchange rate and monetary policy regimes, by including country fixed effects, denoted as α_i. Moreover, the model includes time fixed effects β_t to control for global factors. However, panel estimates only reflect average trends and hence should be treated with caution in drawing conclusions about an individual country, particularly in the context of the heterogeneous emerging economies.

To estimate the pass-through we use a technique that accounts for potential endogeneity of exchange rate movements (GMM). Recent studies emphasise that it is useful to account for common shocks that affect both inflation and exchange rates (Shambaugh, 2008; Forbes, 2015; Aron and Muellbauer, 2014). The robustness of these results is also tested by using within-group estimator (as reported in Jašová et al. (2016)).

The model works with contemporaneous exchange rate changes and three additional lags. This structure enables to capture exchange rate pass-through over the period of one year and is consistent with optimal lag structure tests (Akaike and Bayesian information criteria).

The linear part of the exchange rate pass-through is estimated in three versions: contemporaneous, yearly, and long-run. Contemporaneous exchange rate pass-through is defined as the quarterly coefficient in the model, i.e. γ_0. Yearly pass-through is defined as the sum of yearly coefficients, i.e. $\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3$. Long-run pass through is defined as yearly pass-through divided by one minus the coefficient on lagged inflation, i.e. $(\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3)/(1\text{-}\,\delta)$. Since an increase in the NEER

[17] For more details on methodology and robustness see Jašová et al (2016).

reflects an appreciation of the local exchange rate, these coefficients enter the equation with a negative sign.

The core analysis is performed using rolling regressions, where the window in the main specification is set to six years. These results are robust to different rolling window sizes as well as full window estimates.

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