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State-Dependent Exchange Rate Pass-Through

Yan Carrière-Swallow, Melih Firat, Davide Furceri, and Daniel Jiménez

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Prepared by Yan Carrière-Swallow, Melih Firat, Davide Furceri, and Daniel Jiménez*

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ABSTRACT: We estimate how the rate of pass-through from the exchange rate to domestic prices varies across states of the economy and depending on the shocks that drive fluctuations in the exchange rate. We confirm several results from the literature and uncover new facts. Drawing on the experience of a large sample of advanced and emerging market economies over the past 30 years, we document that exchange rate pass-through significantly larger during periods of high inflation and elevated uncertainty. Using a novel identification strategy, we also show that pass-through is higher when exchange rate fluctuations are driven by U.S. monetary policy.

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Author's E-Mail Address:	ycswallow@imf.org, mfirat@imf.org, dfurceri@imf.org, and djimenez@imf.org.

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WORKING PAPERS

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Contents

Introduction

An extensive empirical literature has estimated the sensitivity of domestic prices to fluctuations in the exchange rate. The rate of exchange rate pass-through has been found to have declined significantly over the past several decades, associated with the changing composition of imported goods (Campa and Goldberg 2005), the prevalence of price stability (Choudhri and Hakura 2006), and the increased credibility of monetary policy (Carrière-Swallow and others 2021). It has also been found to depend on the nature of the shock that causes the exchange rate depreciation (Forbes, Hjortsoe, and Nenova 2018; García-Cicco and García-Schmidt 2020).

Do these findings remain valid? The COVID-19 pandemic has led to an unprecedented surge in economic uncertainty (Ahir, Bloom, and Furceri 2022). It has also marked the end of a long period of relatively stable prices initiated in the early 2000s with the widespread adoption of inflation targeting and great moderation. In 2021, pandemic-related supply chain disruptions (Carrière-Swallow and others 2023) and strong demand from unprecedented fiscal and monetary policy expansion pushed inflation above central bank targets in many economies (Gopinath 2022). By early 2022, spiking commodity prices following Russia's invasion of Ukraine had pushed inflation rates up further, reaching multi-decade highs in Australia, Canada, the United States, United Kingdom, European Monetary Union, and many emerging economies in Latin America and Eastern Europe. When the Federal Reserve began tightening its monetary policy more aggressively in mid-2022 to reign in high inflation, the US dollar gained strength against other currencies. Around the world, central banks already dealing with high inflation faced concerns that depreciating currencies could cause additional price pressures. With elevated uncertainty and the resurgence of global inflation, would the low rates of exchange rate pass-through documented in the recent literature prevail?

This paper provides new estimates of conditional exchange rate pass-through into domestic prices. Using a common local projections specification and a large sample of 46 advanced and emerging market economies since 1990, we estimate the exchange rate pass-through into consumer prices, import prices, and inflation expectations and explore how these vary across countries and over time. We explore the role of country-specific characteristics in determining the rate of pass-through, such as the geographic region, level of development, and the share of imports denominated in US dollars. We then condition the responses on the state of the economy, including the stage of the business cycle, degree of economic uncertainty, prevailing level of inflation, and anchoring of inflation expectations. We also consider the role of the sign and size of the currency fluctuation, as well as the source of the shock that provoked it, focusing on the role of US monetary policy.

We uncover several findings that provide insights about the current strength of exchange rate pass-through. First, on average, a depreciation of one percent of the local exchange rate against the US dollar is associated with an increase in domestic prices of 0.16 percent after one year. The result varies substantially across countries, with average pass-through of 0.08 percent after one year in advanced economies and of 0.3 in emerging market economies. Pass-through to import prices materializes more quickly and is more homogeneous across income levels, averaging about 0.7 percent after only one month. Exchange rate fluctuations are also found to pass through to inflation expectations, which rise by 0.08 percentage points after six months, with a stronger response in emerging markets (0.12) than in advanced economies (0.03).

We then use complementary approaches to examine how the rate of pass-through depends on the state of the economy. For each variable capturing a relevant characteristic, we estimate pass-through rates for samples above and below the median, in bins corresponding to quartiles, and in regimes defined using smooth-transition functions. We document that pass-through into consumer prices and inflation expectations are increasing in the level of economic uncertainty, which may reflect that firms are less willing to adjust their mark-ups after suffering an increase in costs during these periods.[1] Pass-through is also increasing in the level of inflation and in the level of disagreement among professional forecasters of inflation. As Dovern, Fritsche, and Slacalek (2012) document, forecasters tend to disagree about future inflation when central bank credibility is weak. Our finding therefore provides additional support for Taylor's (2000) hypothesis that the incidence of the exchange rate is endogenous to the credibility of monetary policy.[2]

Our paper also investigates how pass-through varies according to the share of imports that are invoiced in US dollars. Consistent with Gopinath and others (2020)'s theory of global currency pricing, we find that countries with higher USD invoice share of imports experienced more significant pass-through into import prices.

Like Caselli and Roitman (2019), we uncover non-linear relationships between the magnitude and the direction of exchange rate changes and domestic prices. The rate of exchange rate pass-through rises with the size of the exchange rate fluctuation and materializes faster following depreciations than appreciations. An implication of the latter is that the recovery of a local currency following a depreciation is not followed by offsetting effects on prices until about a year later, leaving strong transitory impacts on inflation.

Finally, we examine how exchange rate pass-through depends on the source of exchange rate fluctuations. Previous papers have estimated shock-dependent pass-through using country-specific Structural Vector Autoregressions (SVAR) models with sign and zero restrictions to identify global and domestic shocks (Forbes, Hjortsoe, and Nenova 2018; Ha, Stocker, and Yilmazkuday 2020). In contrast, to identify the inflationary effects of exchange rate movements provoked by US monetary policy shocks, our identification approach uses a difference-in-differences strategy combined with instrumental variables.

To construct our instrument, we start by using a series of U.S. monetary policy shocks that have been externally identified by Jarociński and Karadi (2020) using the unanticipated change in rates within high-frequency windows around FOMC announcements. This approach to identifying monetary policy shocks has been widely used in the empirical literature since the pioneering work of Kuttner (2001). However, while these monetary policy shocks are thought to be exogenous to the state of the US economy—and, plausibly, to the state of the economy in other

[1] Aruoba and others (2022) show that the pricing decisions of firms depend on whether the uncertainty is realized in the present or is expected to happen in the future. Unfortunately, the uncertainty measure considered in the paper does not allow us to distinguish between these situations.

[2] Chile provides a case in which a gradual increase in monetary policy credibility over the past three decades is thought to have decreased the sensitivity of domestic prices to the exchange rate (Central Bank of Chile 2020; Albagli and others 2021).

countries—they will affect the price level in other economies through multiple channels besides the exchange rate, including by affecting external demand conditions and global commodity prices. Including them as instruments for exchange rate fluctuations would thus violate the exclusion restriction, leaving the first-stage residuals correlated with the second-stage regressor of interest. To isolate their impact on prices through the exchange rate, we employ a difference-in-differences approach as in Nunn and Qian (2014). We include time fixed effects to capture common factors affecting prices across countries, including the average effect of the US monetary policy shocks, and we interact the US monetary policy shocks with country-specific measures of the exchange rate regime and capital account openness. This difference-in-differences estimator provides the relative impact of the exchange rate on prices in economies with an open capital account and flexible exchange rate—where US monetary policy is expected to provoke a movement of the exchange rate through the portfolio investment channel—compared to those with a closed capital account or exchange rate regime that is pegged to the US dollar. In doing so, it allows us to identify the impact of US monetary policy shocks on domestic prices operating through the exchange rate channel *alone*.

The results suggest that the pass-through is about three times larger when exchange rate fluctuations are provoked by U.S. monetary policy shocks than when they are provoked by other drivers. Reassuringly, this result is well aligned with the findings of Forbes, Hjortsoe, and Nenova (2018) and Ha, Stocker, and Yilmazkuday (2020) who employ a different identification strategy and method for estimating impulse-responses. As discussed by Forbes, Hjortsoe, and Nenova (2018), if firms expect a contraction in future demand—as for example, in the case of US monetary tightening—they would be less willing to reduce mark-ups following a currency appreciation and would pass-through higher prices.

Our results have strong implication for policy makers and for economic models using linear estimates of exchange rate pass-throughs. On the policy front, our results suggest that exchange rate movements in 2022 may have stronger impacts on domestic prices than previous estimates would imply and that stronger monetary tightening may be needed to address the resulting inflation pressures. On the modeling front, they suggest that models should be able to generate a larger response of domestic prices to exchange rates for high levels of inflation and uncertainty.

Literature Review

There is vast literature on exchange rate pass-through into prices. In a survey paper, Burstein and Gopinath (2014) explain how variable mark-ups cause insensitivity of prices to exchange rate developments. Then, they review the empirical literature and show that exchange rate pass-through into consumer prices is lower than into import prices at the border and that the pass-through into border prices varies considerably across countries. Also, exchange rate pass-through coefficients vary depending on the time, the country or region. For example, Carrière-Swallow and others (2021) find pass-through coefficient to be 0.12 for advanced economies and 0.6 for emerging economies between 1995 and 2019, whereas Gagnon and Ihrig (2004) report a coefficient of 0.05 for the US.

Previous studies of state-dependent pass-through have yielded several important results. Taylor (2000) put forward the conjecture that the rate of exchange rate pass-through is endogenous to the credibility of the monetary regime, which could be proxied by the degree of price stability that had been recently delivered. Examining the role of the inflationary environment on exchange rate pass-through across a sample of 71 advanced and emerging economies, Choudhri and Hakura (2006) find strong evidence that pass-through rises with average inflation. Using a sample of 62 advanced and emerging market economies, Carrière-Swallow and others (2021) examine the time- and country-varying nature of exchange rate pass-through. They first document a decline in the degree of exchange rate pass-through despite an increase in import content of domestic consumption. In support of Taylor's (2000) conjecture, they find that better-coordinated inflation expectations of professional forecasters—a proxy for the central bank's credibility—are associated with significantly lower rates of exchange rate pass-through into prices.

Recently, Cheikh, Zaied, and Ameur (2023) analyze the influence of geopolitical risk on exchange rate pass-through for the period from September 2020 to August 2022. Using the geopolitical risk (GDP) index of Caldara and Iacoviello (2022) as a threshold, they find that high geopolitical uncertainty around the Ukrainian crisis had likely increased exchange rate pass-through into prices. Our exploration of uncertainty deviates from their approach in important ways. Instead of using a geopolitical uncertainty variable, we employ a country-specific measure that captures a much broader measure of economic uncertainty over a longer period. This allows us to study a much larger sample, rather than having to focus on the recent experience since October 2020.

Gopinath, Itskhoki, and Rigobon (2010) explain the role of the currency of invoicing in determining the rate of exchange rate pass-through into import prices. Gopinath and others (2020) construct a new dataset of bilateral price and volume indices for more than 2,500 country pairs and estimate that pass-through into import prices is increasing in the share of imports that are invoiced in US dollars. This result is consistent with the theoretical argument that prices tend to be sticky in the currency of invoicing, which gives the US dollar a large role in international pricing decisions. In a panel of over 100 countries, Carranza, Galdón-Sánchez, and Gómez-Biscarri (2009) find that exchange rate pass-through is higher in economies that are highly dollarized. They also document evidence that large depreciations provoke strong balance-sheet effects in dollarized economies with fixed exchange rate regimes, which tends to reduce their impact on inflation.

Caselli and Roitman (2019) use a local projections specification to estimate exchange rate pass-through for a panel of 28 emerging markets, focusing on the nonlinearities in the magnitude and direction of exchange rate changes. They find that depreciations are associated with stronger pass-through than appreciations, and that pass-through becomes stronger when the exchange rate depreciates by more than 24 percent over a year.

Our paper also contributes to the literature analyzing the variation in pass-through depending on the sources of shocks generating exchange rate fluctuations. Forbes, Hjortsoe, and Nenova (2018) focus on the United Kingdom and find that different sources of exchange rate shocks affect the price response differently. They develop a SVAR framework for a small open economy and find that exchange rate pass-through is low in response to domestic demand shocks and relatively high in response to domestic monetary policy shocks. Ha, Stocker, and Yilmazkuday (2020) estimate country-specific structural factor-augmented VAR models for 55 economies to study the pass-through from shocks to global and domestic monetary policy, demand, supply, and exchange rate shocks as a function of country characteristics. They find that monetary policy shocks are associated with stronger pass-through than other domestic shocks. Ours is the first study that uses US monetary policy shocks in a difference-in-differences instrumental variables approach to isolate their impact on domestic prices through the exchange rate channel.

The rest of the paper is organized as follows. Section 2 describes the data and explains empirical specifications. Section 3 presents main results and discusses robustness checks. Section 4 concludes.

Data and Empirical Specifications

Data

Our baseline sample contains monthly data from January 1990 to December 2022 and covers 46 countries, of which 28 are classified as advanced economies and 18 as emerging market economies (Tables 1.1 and 1.2). We determine the sample based on the joint availability of country-month observations for consumer prices, import prices, and inflation expectations. In a robustness exercise, we also consider a larger unbalanced sample of 141 countries for which consumer price data are available. Table 2 describes the sources and definitions of all variables used in the paper and Table 3 presents the summary statistics.[3]

We consider several state-dependent variables in our regressions: (i) monthly inflation, computed as the (lagged) yearly change in log consumer prices; (ii) quarterly GDP growth (in deviation from country mean) and output gap (computed using the Hodrick-Prescott filter with a smoothness parameter equal to 1600); (iii) monthly uncertainty indexes from Ahir, Bloom, and Furceri (2022);[4] (iv) a monthly indicator of inflation uncertainty based on the level of disagreement among professional forecasters of inflation from Consensus Forecasts;[5] (v) the average share of imports invoiced in US dollars in each country, from the dataset compiled by Boz and others (2022); and (vi) dollarization rates for EMDEs from Reinhart, Rogoff, and Savastano (2003).[6]

The analysis of shock dependence is based on the monthly U.S. monetary policy shock series from Jarociński and Karadi (2020) that is available from February 1990 to June 2019. The methodology of Jarociński and Karadi

[3] We exclude from all estimations the observations for which the dependent variable lies below the 1st percentile or above the 99th percentile of the sample's empirical distribution. Upon inspection, these observations generally belong to episodes of hyperinflation or economic collapse.

[4] The uncertainty index is available at monthly frequency starting in 2008, and at quarterly frequency before then.

[5] Following Brito, Carrière-Swallow, and Gruss (2018), we calculate the interquartile range across individual forecasts of inflation. For each forecast, we compute a synthetic one-year ahead forecast using a linear combination of the forecasts for the current and next calendar years.

[6] Note that for USD invoice share of imports,forecast disagreement on inflation expectations, and dollarization, we use country average observations since there is a limited variation in these variables over time.

(2020) is closely related to proxy VARs that use high-frequency interest rate surprises as external instruments to identify monetary policy shocks as in Gertler and Karadi (2015). The main difference in these U.S. monetary policy shock series is that they separate out central bank information shocks from monetary policy shocks (Figure A1), and we focus on the latter. Ilzetzki, Reinhart, and Rogoff (2019) provide a measure of anchor currencies and exchange rate arrangements. Using their database, we identify countries with fixed exchange rate regimes that use the US dollar as the anchor. Quinn and Toyoda (2008) compute a measure of capital account openness using granular information about capital and financial account measures reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).[7] They synthesize this information into an annual score that take values between 0 and 100 for each country through 2014, with 0 corresponding to a fully closed capital account and 100 to a fully open capital account.[8]

Empirical Specifications

Baseline Specification

To estimate the average exchange rate pass-through into prices across countries, we follow Jordà (2005) and estimate impulse response functions from local projections as follows:

$$p_{i,t+h} - p_{i,t-1} = \beta_h \Delta ER_{i,t} + \Sigma_{l=0}^{12} \theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \quad (1)$$

where $p_{i,t}$ is the log price index of interest (consumer price index, import price index, or expectations about the future consumer price index) and $\Delta ER_{i,t}$ is the change in the log bilateral exchange rate against the US dollar for country *i* at time *t*. The coefficient β_h denotes the (percent) response of prices to a one percentage point change in local currency against the US dollar at a horizon of *h* months. The vector $M_{i,t}$ contains country-specific control variables and 12 lags of each. Following Burstein and Gopinath (2014), we control for the output gap, lagged inflation, lagged change in exchange rate, as well as the trade-weighted producer price index of export partners.[9] δ_i are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average inflation. δ_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, U.S. monetary policy shocks, world energy and food prices).

Advanced economies (AEs) vs. emerging market and developing economies (EMDEs)

To assess whether the exchange rate pass-through varies across income groups, we estimate the following specification:

$$p_{i,t+h} - p_{i,t-1} = \beta_h^{AE} AE\ \Delta ER_{i,t} + \beta_h^{EMDE} (1 - AE)\ \Delta ER_{i,t} + \Sigma_{l=0}^{12} \theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \quad (2)$$

[7] As a robustness check, we also use updated capital account openness indexes from Chinn and Ito (2006).

[8] The number of countries in the sample drops to 41 for the IV analysis since the Quinn and Toyoda (2008) index is not available for Armenia, Cyprus, Estonia, Slovak Republic, and Slovenia.

[9] The output gap controls for demand-side factors and is defined as the deviation of real GDP from its HP-filtered trend. Trade partners' weighted producer price index is included to control for cost-push shocks.

where AE is equal to 1 if country *i* is an advanced economy (based on the IMF's World Economic Outlook classification) and zero otherwise. β_h^{AE} and β_h^{EMDE} capture the magnitude of the exchange rate pass-through at various horizons *h* for the average advanced and emerging market country, respectively.

State-dependent specification

We consider four alternative specifications to examine whether the exchange rate pass-through varies with the state of the economy. The first two specifications are estimated using the following regressions:

$$p_{i,t+h} - p_{i,t-1} = \beta_h^{high} D_{it} \Delta ER_{i,t} + \beta_h^{low}(1 - D_{it})\Delta ER_{i,t} + \Sigma_{l=0}^{12} \theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \quad (3)$$

where D_{it} is equal to 1 if the state variable (e.g., lagged inflation, output gap, uncertainty) is above the sample median or average. The set of control variables is augmented by the dummy D_{it}. β_h^{high} and β_h^{low} capture the magnitude of the exchange rate pass-through at various horizons *h* when the state variable is relatively high and low, respectively.

The third specification follows Auerbach and Gorodnichenko (2012) and Tenreyro and Thwaites (2016). It is similar to equation 3, but allows the regimes to vary smoothly between high and low states:

$$p_{i,t+h} - p_{i,t-1} = \beta_h^{low} F(z_{it}) \Delta ER_{i,t} + \beta_h^{high}\left(1 - F(z_{it})\right)\Delta ER_{i,t} + \Sigma_{l=0}^{12} \theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t} \quad (4)$$

$$F(z_{it}) = \frac{exp^{-\gamma z_{it}}}{(1 + exp^{-\gamma z_{it}})}, \quad (5)$$

where z is the state variable normalized to have zero mean and a unit variance. That is, $z_{i,t} = \frac{x_{i,t} - \bar{x}}{\sigma_x}$, where $\bar{x}$ is the sample average and σ_x is the standard deviation. $F(z_{it})$ is the corresponding smooth transition function. The weights assigned to each regime vary between 0 and 1 according to the weighting function $F(z_{it})$, so that $F(z_{it})$ can be interpreted as the probability of being in each regime. For instance, $F(z_{it}) \cong 1$ corresponds to a situation when inflation (output gap, uncertainty, etc.) is very low—that is, z reaches the maximum negative value, while $F(z_{it}) \cong 0$ corresponds to a situation when the inflation (output gap, uncertainty, etc.) is very high—that is, z reaches the maximum positive value. This approach is equivalent to the smooth-transition model developed by Granger and Terasvirta (1993). The advantage of this approach is twofold. First, compared with a model in which each exchange rate shock would be interacted with a measure of the regime, it permits a direct test of whether the effect of shocks varies across different regimes. Second, compared to equation (3) it allows the effect of the shocks to change smoothly between low and high regimes by considering a continuum of states to compute the impulse response functions, thus making the response more stable and precise. Also in this case, we augment the set of control to include the smooth transition function.

Finally, the specification uses a non-parametric way to estimate non-linearity in pass-through:

$$p_{i,t+h} - p_{i,t-1} = \beta_h^g I[x_{it} \in G\ ]\Delta ER_{i,t} + \Sigma_{l=0}^{12}\theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \quad (6)$$

where I is an indicator function which assumes value 1 when the state variable x_{it} belongs to a specific bin (quartile) of the distribution, which we refer to as group *G*. Compared to equations (3) and (4), this specification does not impose any functional form to capture non-linearity and allows a better understanding of the specific values of the state variables that affect the magnitude of the pass-through.

Shock-dependent specification

We examine whether the direction (sign) of the change in the bilateral exchange rate produces different pass-through rates by estimating the following specification:

$$p_{i,t+h} - p_{i,t-1} = \beta_h^+ D_{it}^+ \Delta ER_{i,t} + \beta_h^-(1 - D_{it}^+)\Delta ER_{i,t} + \Sigma_{l=0}^{12}\theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \quad (7)$$

where D_{it}^+ is a dummy variable that takes value 1 for an appreciation of the bilateral exchange rate, and zero otherwise.

Next, we examine whether the magnitude of pass-through depends linearly on the size of the bilateral exchange rate movement by including the square of the exchange rate shock:

$$p_{i,t+h} - p_{i,t-1} = \beta_h \Delta ER_{i,t} + \vartheta_h \Delta ER_{it}^2 + \Sigma_{l=0}^{12}\theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \quad (8)$$

where the pass-through elasticity for each level of $\Delta ER_{i,t}$ is given by $\frac{\partial(p_{i,t+h} - p_{i,t-1})}{\partial \Delta ER_{i,t}} = \beta_h + 2\,\vartheta_h$.

Finally, to assess the exchange rate pass-through stemming from exchange rate fluctuations caused by US monetary policy tightening, we adopt a difference-in-differences instrumental variables approach (Nunn and Qian 2014). We start by using externally identified shocks to US monetary policy, $US\ MP\ Shock_t$. While plausibly exogenous to domestic prices and exchange rates, these shocks will affect the domestic price level through several channels other than the exchange rate. To enforce the exclusion restriction, we rely on the theoretical assumption that the exchange rate is mainly affected by US monetary policy shocks through the portfolio investment channel, requiring a flexible exchange rate and relatively open capital account to operate.[10] Our instrument consists of the interaction between U.S. monetary policy shocks a time-varying dummy on exchange rate regime, and the indicator of capital account openness:

$$Instrument_{i,t} = Quinn_i \times Regime_{it} \times US\ MP\ Shock_t. \quad (9)$$

The dummy variable $Regime_{it}$ is equal to 0 when a country's exchange rate regime is a pre-announced peg to the US dollar, and equal to 1 otherwise.[11] The dummy variable $Quinn_i$ is equal to 0 for countries with relatively

[10] We drop countries in "freely floating" exchange rate arrangement classification. To do so, we drop observations with values of the Ilzetzki, Reinhart, and Rogoff (2019) (coarse) measure of 5 and above.

[11] We build the indicator using the Ilzetzki, Reinhart, and Rogoff (2019) coarse index. This index classifies euro area countries in pre-announced peg group due to common currency of Euro, thus we also include the condition of using US dollar as the anchor currency.

closed capital accounts, and to 1 otherwise. Given the predominance of highly open capital accounts in our sample, we construct our dummy variable ($Quinn_i$) using a threshold at the 10th percentile of the cross-country distribution.[12]

Our identification assumption is that the portfolio channel will be a strong conduit for US monetary policy shocks to countries with more open capital accounts and whose exchange rate can fluctuate against the dollar, but not to others. Our instrument variable is equal to 0 (closing the portfolio channel) for country-time observations with less open capital accounts or fixed exchange rate regimes anchored to the US dollar.

The two stages of our IV strategy read as follow:

$$p_{i,t+h} - p_{i,t-1} = \beta_h \, \widehat{\Delta ER_{i,t}} + \Sigma_{l=0}^{12} \theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}, \tag{10}$$

with

$$\Delta ER_{i,t} = \beta_h^1 Instrument_{i,t} + \Sigma_{l=0}^{12} \theta_l^Z M_{i,t-l} + \delta_i + \delta_t + \epsilon_{i,t}. \tag{11}$$

The analysis controls for country and time fixed effects and can therefore be seen as a difference-in-differences estimator, with identification achieved between outcomes for countries with open capital accounts and flexible exchange rate versus those with relatively closed capital accounts or an exchange rate pegged to the US dollar. Importantly, the use of time fixed effects controls for the effect of US monetary policy shocks on domestic inflation that is not mediated through the exchange rate. They also control for other global factors correlated with US monetary policy shocks, including shifts in risk premia. Similarly, the country fixed effects control for time-invariant unobserved characteristics that could be related with the degree of capital account openness. In addition to satisfying the exclusion restriction criteria by construction, our instrument is also strong with an F-test between 10.4 and 11.1 for all estimation horizons (Figure 11C).

Results

Baseline Results

Figure 1 presents the evolution of (log) consumer prices following a one-percent depreciation of the local currency against the US dollar (equivalent to 0.45 standard deviation of the percent change in the bilateral exchange rate). The horizontal axis denotes the number of months following the exchange rate depreciation; the solid line displays the average estimated response, and shaded areas denote 90 and 95 percent confidence bands, respectively. The results suggest currency fluctuations are associated with sizeable and persistent increases in consumer prices. We find that a 10 percent depreciation is associated with an increase in the level of consumer

[12] The Quinn and Toyoda (2008) measure is highly skewed to the left of the distribution in our sample. Figure A2 reports the histogram for the sample distribution. In our sample, the median of the cross-country distribution of the index is 99.6 (100 being the highest possible level of openness). The 10th percentile of the distribution corresponds to an index value of 58, which is close to the cardinal midpoint between fully closed and fully open capital accounts.

prices by about 0.5 percent within one month and rises to about 1.6 percent after one year. This effect is highly statistically significant, and consistent with previous estimates in the literature (Burstein and Gopinath 2014). Figure A4 shows that exchange rate pass-through is slightly higher when the nominal effective exchange rate is used instead of the bilateral exchange rate against the US dollar. The size of the effect almost doubles when we estimate equation (1) using a larger sample of countries (Figure A5). As we will discuss later, this is driven by the higher exchange pass-through in developing economies compared to advanced economies, given the predominance of the former in the larger sample.

These results are robust to alternative thresholds for excluding outliers and alternative lag orders. Recall that in our baseline estimations we exclude dependent variables below the 1st percentile or above the 99th percentile of its empirical distribution. In Figure A11, we replicate Figure 1 for a sample that excludes data below the 5th percentile and above the 95th percentile. We also estimate equation (1) using 6 and 24 lags of the change in consumer prices and bilateral exchange rate, instead of the baseline of 12 lags. In Figure A12, we display the impulse-response function using these alternative lag orders, finding similar pass-through coefficients across horizons.

To understand better the transmission channels of the effect of the exchange rate on domestic prices and their persistence, we present in Figure 2A-C the effects on import prices, core prices, and inflation expectations. Figure 2A reports the response of import prices to exchange rate depreciations. The response is much faster than for consumer prices—it reaches 0.7 percent already after one month—and is also persistent--remaining at 0.7 percent one year after the exchange rate shock. Figure 2B presents the response of core prices, where the pass-through coefficient of 0.08 is about half the level observed for overall consumer prices. Figure 2C reports the response of inflation expectations, which, as expected, is much smaller than for consumer and import prices and peaks at 7 months after the exchange rate shock. The response of expectations is also persistent, with a 10 percent depreciation associated with a 0.7 basis point increase in inflation expectations that lasts at least 12 months.

Heterogeneity across countries

Figure A6 shows the results obtained estimating Equation (2). The top-left panel report the estimated pass-through for AEs and the top right for EMDEs. Looking at the figure, it is immediately evident that the pass-through is much larger (about three times) in EMs than AEs, and the result is robust to using both baseline and large sample (bottom panels). Interestingly, this striking difference is not evident for import prices (Figure A7)—the responses of import prices are similar between AEs and EMDEs, if anything more persistent in the former—but it is striking for core prices (Figure A8) and inflation expectations (Figure A9): a 1 percent depreciation is associated with an increase in core (expected) inflation of 0.5 (0.3) percentage point in AEs compared to 1.3 (1.2) percentage points in EMDEs. This result is consistent with Bems and others (2021) and suggests that central banks in AEs have a stronger ability to keep inflation expectations anchored and mitigate second-round effects following cost-push shocks. This in turn may also affect the large difference in the inflation response between the two groups of countries.

Finally, we estimate a version of equation (2) where we consider region specific dummies. The results reported in Figure A10 show that pass-through is smallest in Asia and Europe, and largest in Latin America. However, the differences in pass-through coefficients across regions are not statistically significant.

State-Dependent Exchange Rate Pass-Through

We begin by presenting the state-dependent results for the level of inflation as the state variable. Figure 3 reports four panels, each corresponding to a separate specification: (i) panel A for the specification with the sample split at the median; (ii) panel B for the specification with the sample split at the average; (iii) Panel C using the semi-parametric approach based on quartiles; and (iv) Panel D for the smooth transition function. For each panel, we report the estimated coefficients, together with the associated 68-percent confidence bands. We plot tighter bands to better highlight the differences in the estimates, but in Table 4 we report formal tests for the difference in coefficients using standard econometric thresholds.

The results reported in Figure 3 and Table 4 suggest that the magnitude of the pass-through is dependent and increasing with the level of inflation, which is consistent with previous evidence (Choudhri and Hakura 2006). In addition, the increase in pass-through does not vary linearly with the level of inflation. This is especially evident in Panel C, where the magnitude is relatively similar across the first three quartiles but becomes significantly larger—both economically and statistically—for the fourth quartile. The fourth quartile corresponds to an initial level of inflation that is above 3.8 percent, which is lower than the level of inflation that most countries have experienced since 2021. This implies that inflation pressures stemming from current appreciations, other things equal, are much larger than previously estimated.

Next, we test whether the rate of pass-through depends on the stage of the business cycle. Figures 4.1 and 4.2 show that the pass-through coefficient is not different across rates of GDP growth or for different levels of the output gap. Indeed, Table 5.1 confirms that the difference across groups is not statistically significant. However, we do find that the pass-through into core prices (Figure A23) or inflation expectations (Figure A31) is stronger when the output gap is larger.

Estimating Equation (2) using the uncertainty index compiled by Ahir, Bloom, and Furceri (2022), Figure 5 shows that exchange rate pass-through is stronger when countries are experiencing higher uncertainty. This finding is robust in all our alternative specifications. Using uncertainty indexes for all countries in our estimation sample, Figure A3 presents the time series for the median, 25th, and 75th percentiles of the cross-country distribution. The figure shows that median uncertainty approached its pandemic high during 2022 following the invasion of Ukraine. The level of uncertainty over the 2020-22 period is approximately double the average value over the period of 2000-10, which is the basis for many of the pass-through estimates in the existing empirical literature.

Using inflation forecast disagreement levels from Consensus Economics, Figure 6 presents that pass-through is significantly higher in countries with higher disagreement on one-year ahead inflation forecasts. The estimation results from quartiles suggest that the largest marginal effects occur when inflation forecast disagreement exceeds the 75th percentile, at which point there is a steep jump in the pass-through coefficient. These episodes of very high forecast disagreement are associated with periods of high and volatile inflation, and capture periods in which central bank credibility was low.

Furthermore, and in line with Boz and others (2019), we find that exchange rate pass-through is higher in countries with a larger share of imports invoiced in US dollars (Figure 7). The size of this difference is economically significant, with the rate of pass-through doubling from 0.1 percent for countries below the sample median to over 0.2 percent for those above the sample median. This evidence is also apparent for pass-through to import prices (Figure A18), which reaches 0.8 percent for countries above the median, but is only 0.5 for those below the median. This finding provides strong evidence in support of the dominant currency pricing theory.

Finally, we find that pass-through is stronger in EMDEs with higher dollarization (Figure 8), in line with the finding reported by Carranza, Galdón-Sánchez, and Gómez-Biscarri (2009). Panels A, B and D show the significantly higher pass-through for more dollarized EMDEs. However, the rise in pass-through with the dollarization is not linear (Panel C), with the response of prices to exchange rate fluctuations being substantially larger when dollarization is above a threshold. Table 9 (quartiles and smooth transition) supports the significant difference in pass-through with dollarization across different groups.

Shock-Dependent Exchange Rate Pass-Through

We now present how the rate of pass-through depends on the source, sign, and size of the exchange rate shocks. Investigating the asymmetry in exchange rate pass-through (appreciation vs. depreciation) by estimating equation (7), Figure 9 suggests that pass-through materializes faster following depreciations than appreciations over the first six months, but their impacts converge within about a year. Table 10 confirms the statistical significance of asymmetry in exchange rate pass-through at short horizons. The strength of this asymmetry is less pronounced than what was documented by Caselli and Roitman (2019), who focused on a sample of emerging market economies. The contrast between Figures 9B and 9C supports the finding that the asymmetry in pass-through is more pronounced in emerging market economies than it is in advanced economies.

Equation (8) includes a quadratic term that allows for the exchange rate pass-through to vary nonlinearly with the size of the exchange rate fluctuation. Figure 10A displays that the coefficient of quadratic term ϑ_h is positive and significant for horizons between 0 and 10 months, implying that the pass-through is stronger when the size of the exchange rate fluctuation is larger. The economic significance of the non-linearity is moderate, with the rate of pass-through after 12 months rising from 0.16 percent for a depreciation of 1 percent, to 0.175 for a depreciation of 10 percent, and to about 0.2 for a depreciation of 25 percent (Figure 10B). The result is broadly in line Caselli and Roitman (2019), who find evidence for a threshold effect by which the rate of pass-through increases for depreciations that exceed 24 percent.

We then instrument for exchange rate fluctuations that are caused by U.S. monetary policy shocks. The first-stage estimation results provide strong evidence on the role of portfolio balance channel. Figure 11 (Panel A) shows that a U.S. monetary policy tightening of 100 basis points causes the exchange rate to depreciate by 4.5 percent more for countries with a flexible exchange rate and open capital account compared to others. This result is consistent with a strong portfolio balance channel following US monetary policy shocks, whereby a declining interest rate differential is associated with capital outflows and a depreciation of the local currency in countries with more open capital accounts and flexible exchange rate. The Kleibergen-Paap rk Wald F-statistic—which is equivalent to the F-effective statistic for non-homoskedastic errors in the case of one endogenous variable and one instrument (Andrews, Stock, and Sun 2019)—varies between 10.4 and 11.1 (Panel C) for horizons between six months and one year, which suggests that our instrument is relatively strong.

To test whether the exclusion restriction holds, for each horizon, we regress the estimated residuals from equation (1) on our instrument for observations in the treatment group of countries with open capital accounts and flexible exchange rates:

$$\epsilon_{i,t} = \beta Instrument_{i,t} + e_{i,t}$$

Under the null hypothesis that the exclusion restriction is valid, β=0. As Table 11 shows, the OLS estimate for β is very close to zero across horizons and is not statistically significant (p-value = 1.000), so we cannot reject the null hypothesis.

Focusing on the second stage, we find that the rate of pass-through deviates from the average coefficients based on our reduced-form specifications. Panel B shows that pass-through is much stronger when exchange rate fluctuations are caused by U.S. monetary policy shocks. The pass-through coefficient is positive and significant by the fifth month, reaching 0.47 after one year. This compares to the average pass-through coefficient from Figure 1 of 0.16 at the same horizon, and is consistent with the finding of Forbes, Hjortsoe, and Nenova (2020) that monetary policy shocks are associated with significantly higher pass-through in a cross-section of countries.

Conclusion

The world economy has recently been hit by three related shocks. Uncertainty reached its historical peak during the COVID-19 pandemic, and after abating, it surged again following Russia's invasion of Ukraine and remains at elevated levels. After decades of widespread price stability, inflation has risen well above central bank targets in most major economies. And finally, the Federal Reserve and European Central Bank have implemented the most aggressive monetary tightening cycle in the past 25 years. These factors have led to a strong depreciation of local currencies against the US dollar in many countries, stoking concerns that pass-through will put additional pressure on prices.

Drawing on the experience of a large sample of advanced and emerging market economies over the past 30 years, we document that the rate of pass-through from the exchange rate to domestic prices is state-dependent.

While pass-through is relatively low on average, it tends to be significantly larger during periods of high inflation and elevated uncertainty. We also estimate how exchange rate pass-through depends on the source of the shock and are the first to do so using a difference-in-difference instrumental variables approach. We find that the rate of pass-through triples when an exchange rate depreciation has been driven by U.S. monetary policy tightening.

Taken together, our results suggest that the magnitude of current exchange rate pass-through into prices is likely to be significantly larger than it has been in the past.

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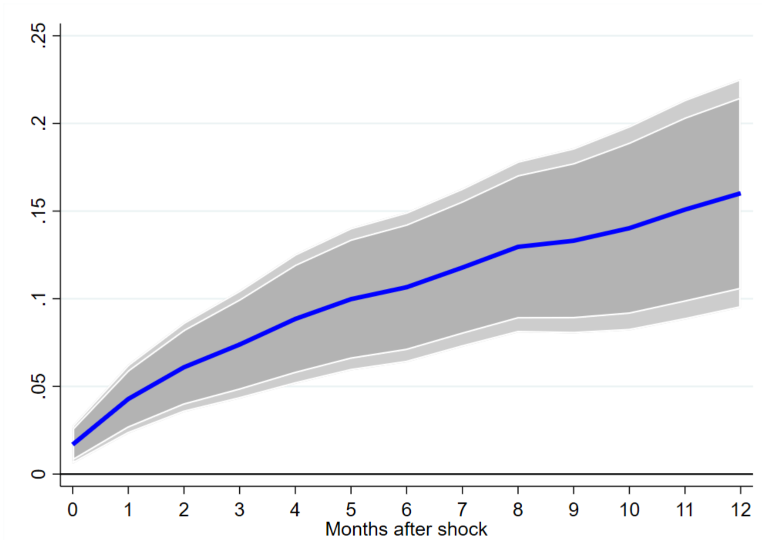
Figures

Figure 1: Average exchange rate pass-through

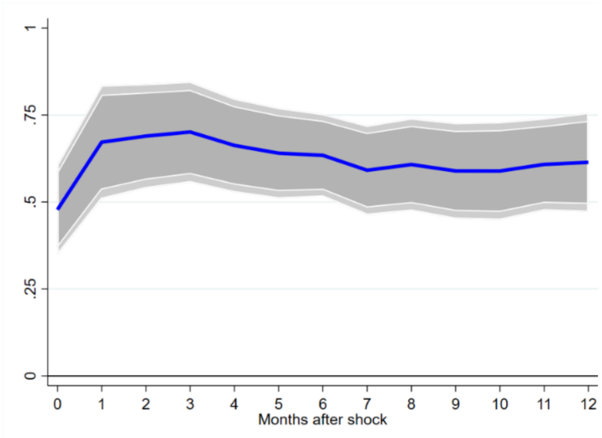
Consumer Prices



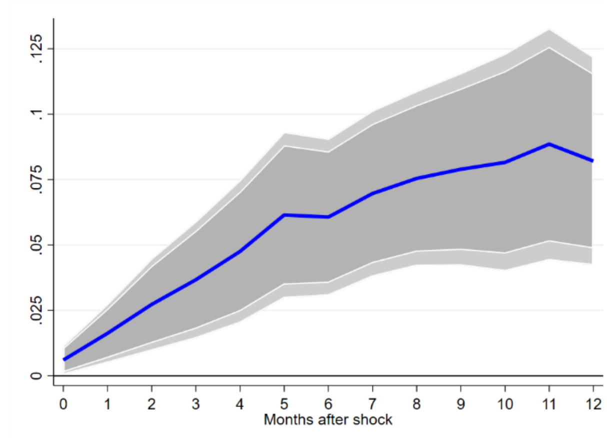
Note: The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on consumer prices in percent. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicates the 95 percent confidence band.

Figure 2: Average exchange rate pass-through to import prices, core prices, and inflation expectations

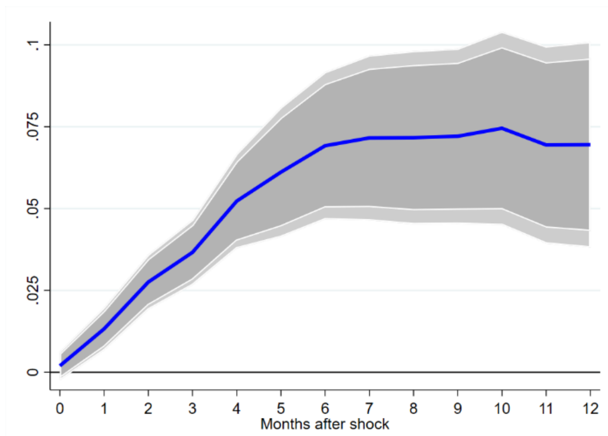
A. Import Prices



B. Core Inflation

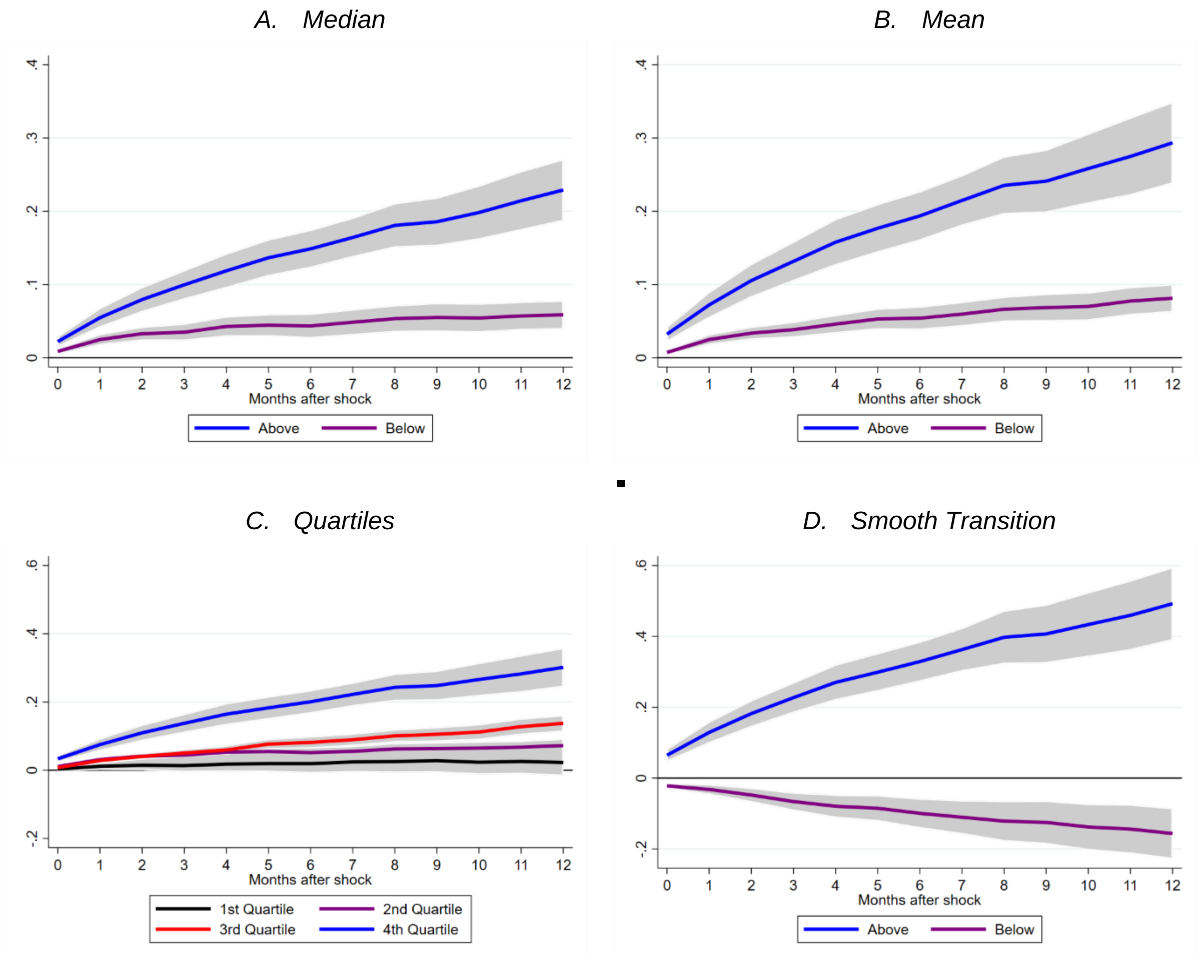


C. Inflation Expectations



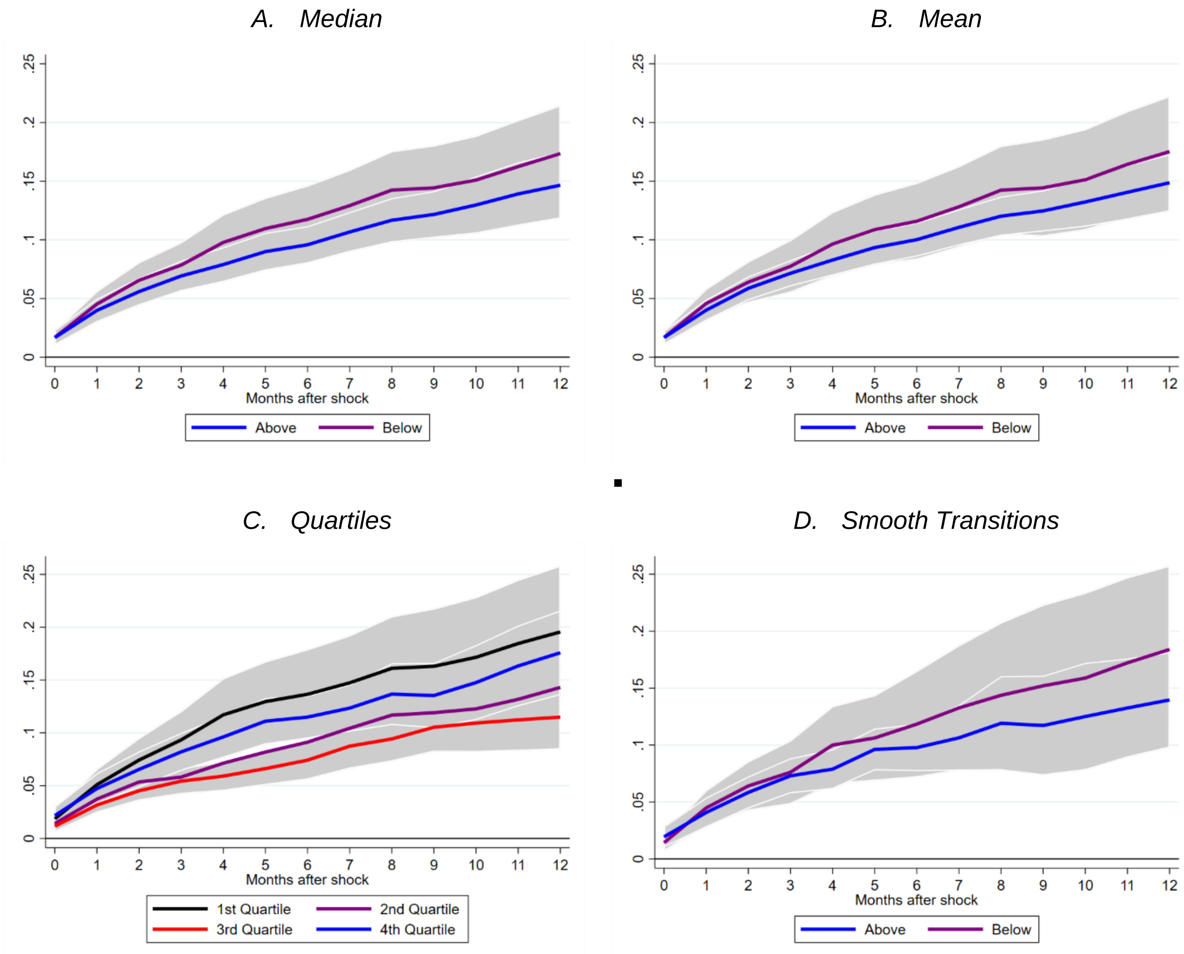
Note: The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on the percent change in import prices (Panel A), core prices (Panel B), and inflation expectations (Panel C). The dark shaded region indicates the 90 percent confidence band; the light shaded region indicates the 95 percent confidence band.

Figure 3: Exchange rate pass-through dependent on the level of inflation



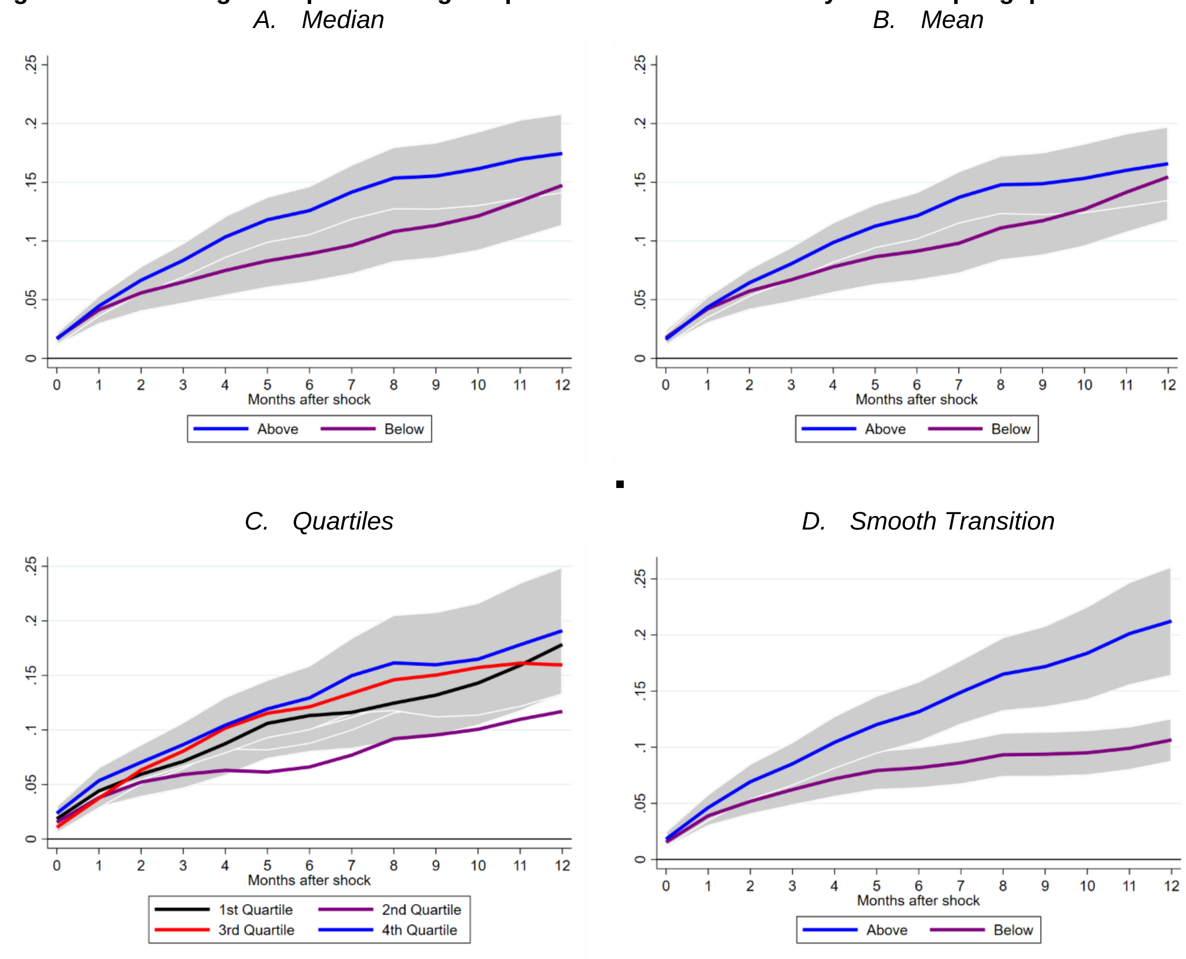
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in consumer prices across different bins based on the level of inflation. The dark shaded region indicates the 68 percent confidence band.

Figure 4.1: Exchange rate pass-through dependent on the business cycle — GDP growth



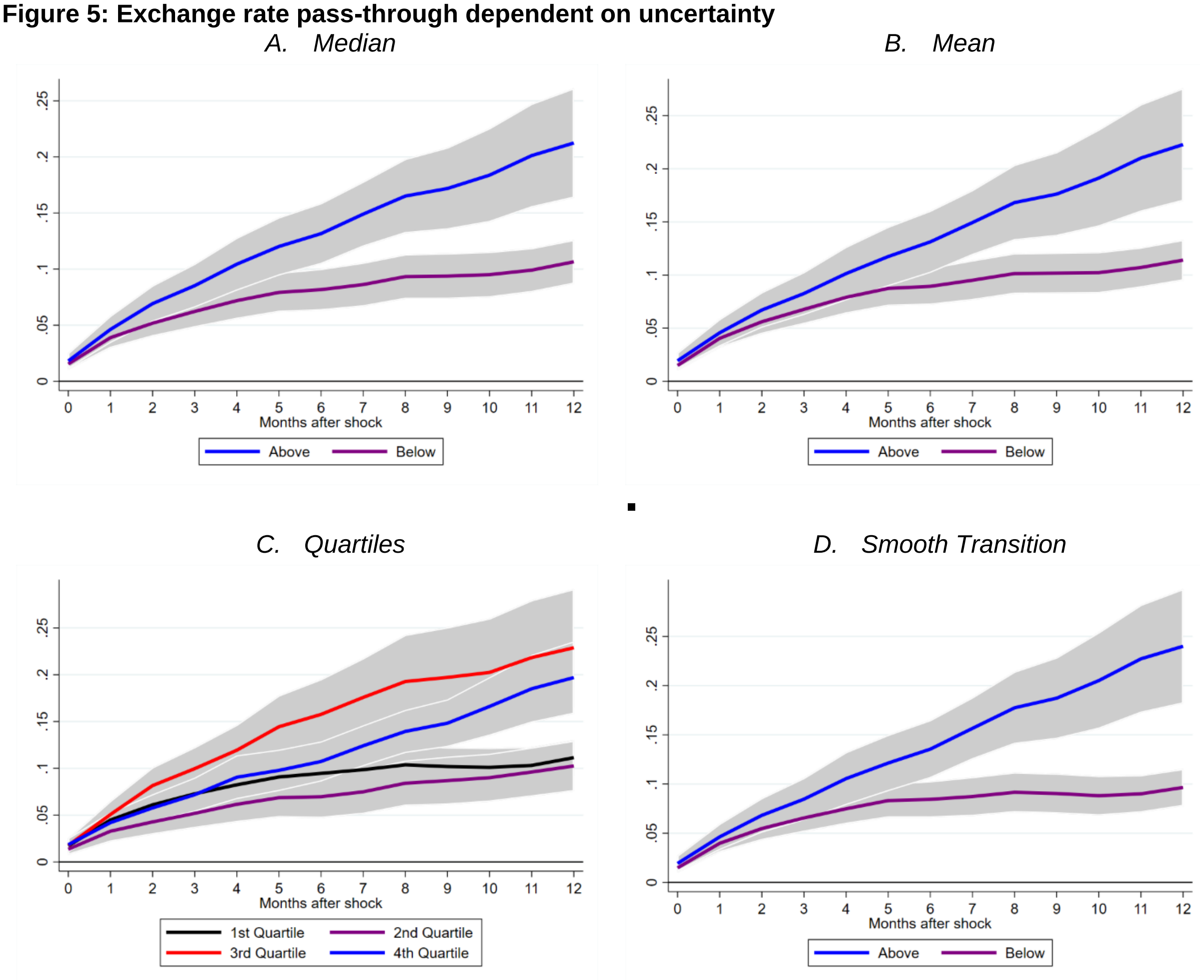
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices across different groups with real GDP growth. Real GDP growth rates are the deviation of quarterly (YoY) rates from country average. The dark shaded region indicates the 68 percent confidence band.

Figure 4.2: Exchange rate pass-through dependent on the business cycle — output gap



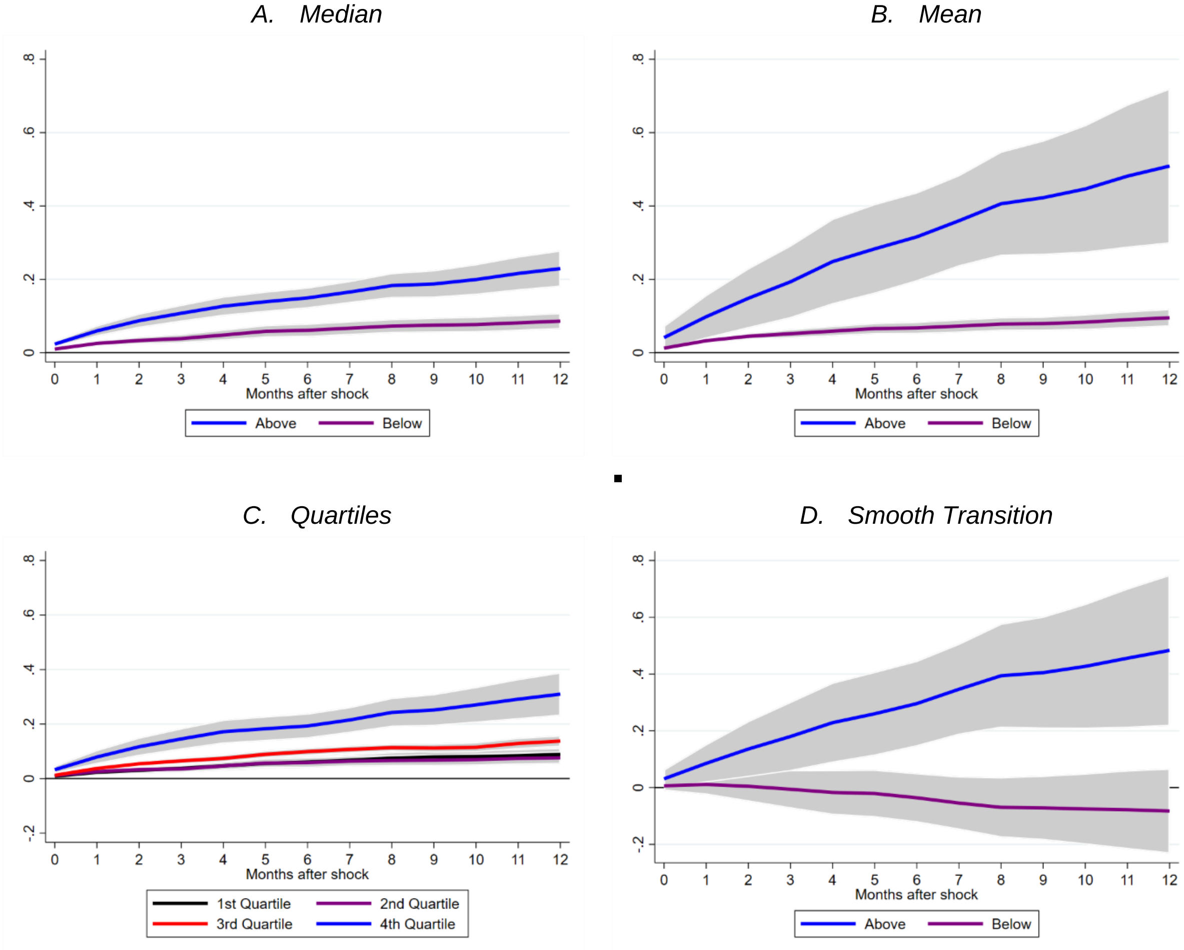
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices across bins of the output gap. Output gap is calculated as the deviation of real GDP from its HP-filtered trend. The dark shaded region indicates the 68 percent confidence band.

Figure 5: Exchange rate pass-through dependent on uncertainty



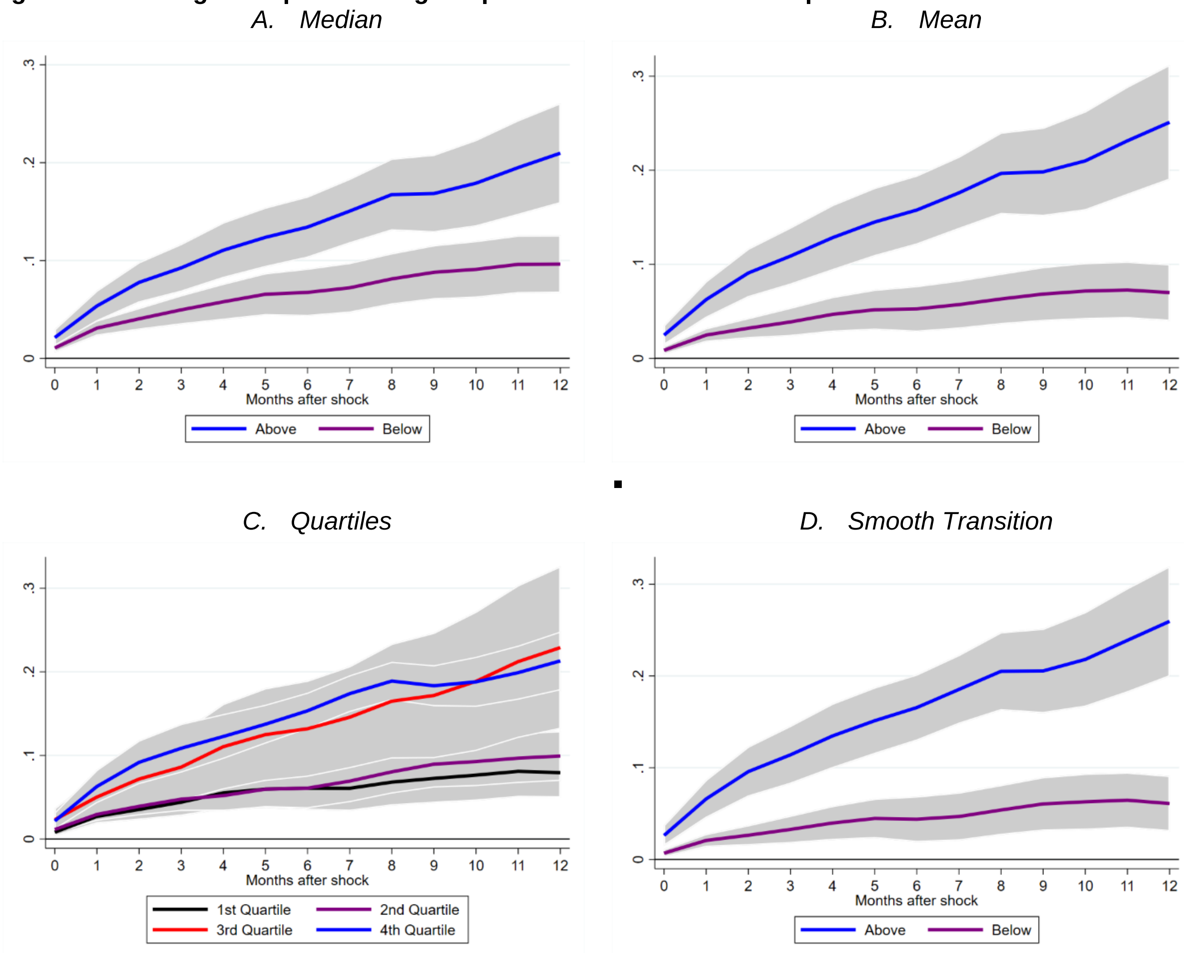
Note: The figures present the impact of a one percent increase (depreciation) in local currency per USD on the percent change in consumer prices across different bins based on the level of uncertainty in the country. Monthly uncertainty series are from Ahir, Bloom, and Furceri (2022). The dark shaded region indicates the 68 percent confidence band.

Figure 6: Exchange rate pass-through dependent on inflation uncertainty — disagreement



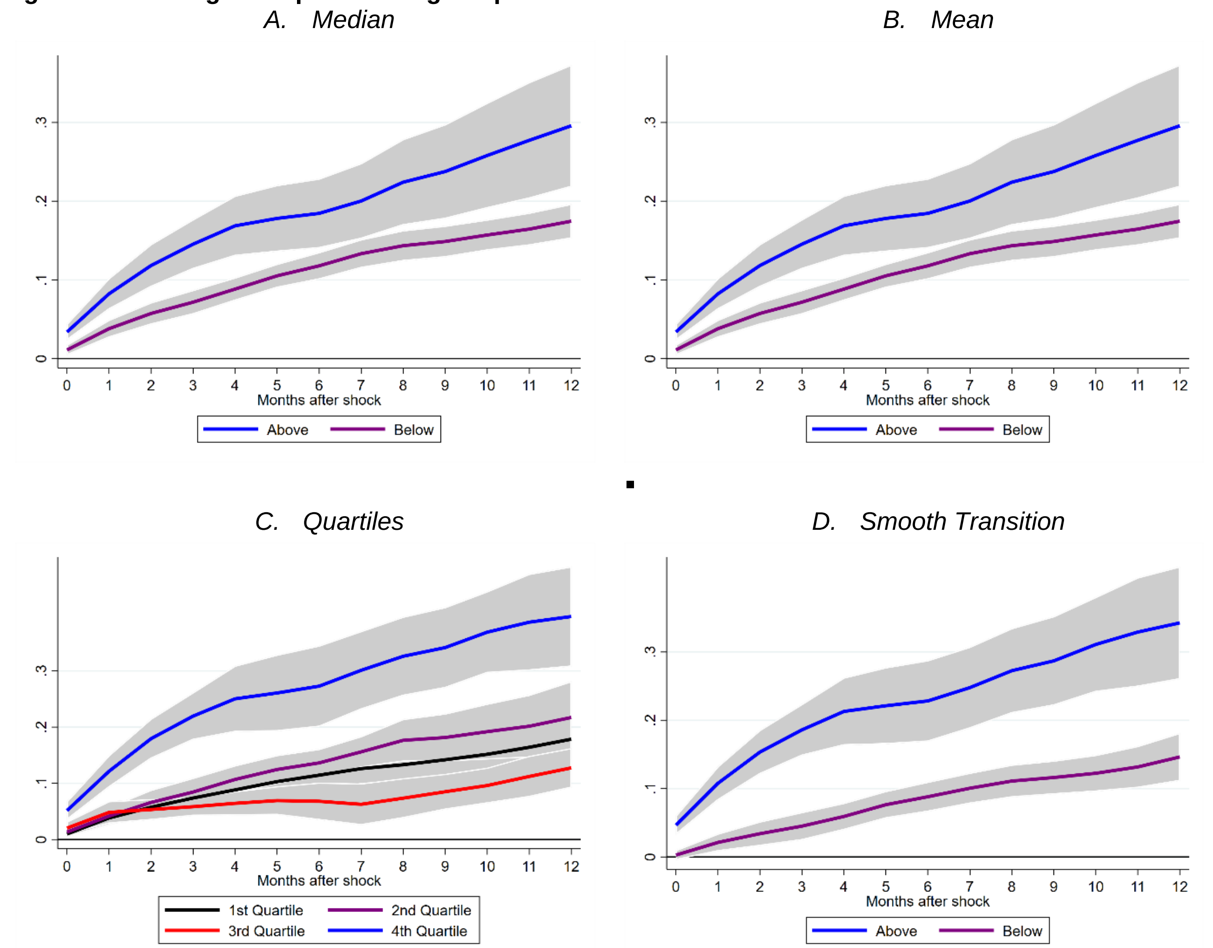
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in consumer prices across different bins based on the degree of disagreement among professional forecasters about inflation 12 months ahead. Disagreement among professional forecasters of inflation is constructed based on survey data from Consensus Economics as described in Brito, Carrière-Swallow, and Gruss (2018). The dark shaded region indicates the 68 percent confidence band.

Figure 7: Exchange rate pass-through dependent on the share of imports invoiced in US dollars



Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in consumer prices across different bins based on the average USD invoice share of imports in a country. Data on the USD invoice share is from Boz and others (2022). The dark shaded region indicates the 68 percent confidence band.

Figure 8: Exchange rate pass-through dependent on dollarization

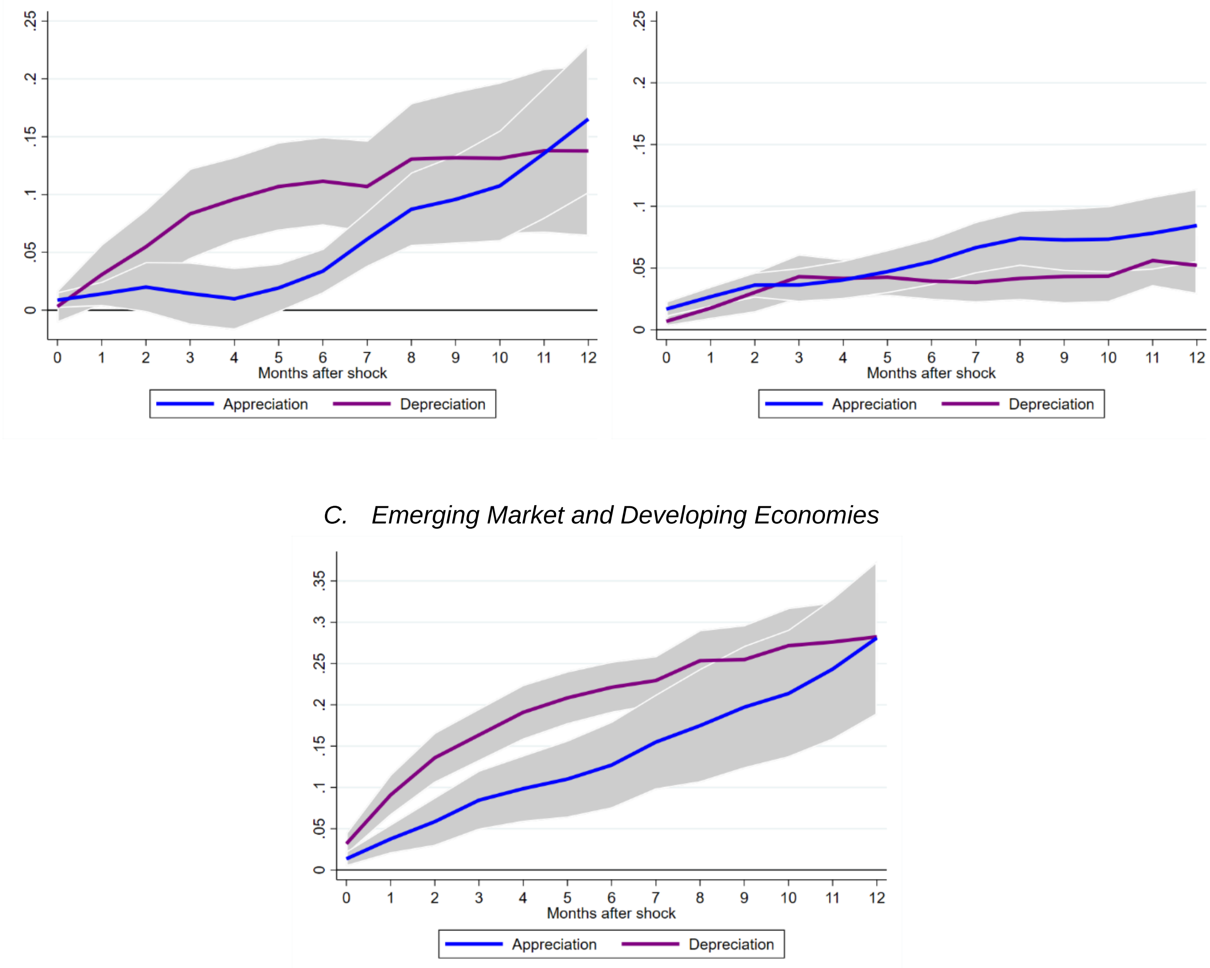


Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in consumer prices across different bins based on average dollarization in a country. Dollarization rates are from Reinhart, Rogoff, and Savastano (2003). The dark shaded region indicates the 68 percent confidence band.

Figure 9: Exchange rate pass-through from currency appreciations and depreciations

A. Full Sample *B. Advanced Economies*

C. Emerging Market and Developing Economies

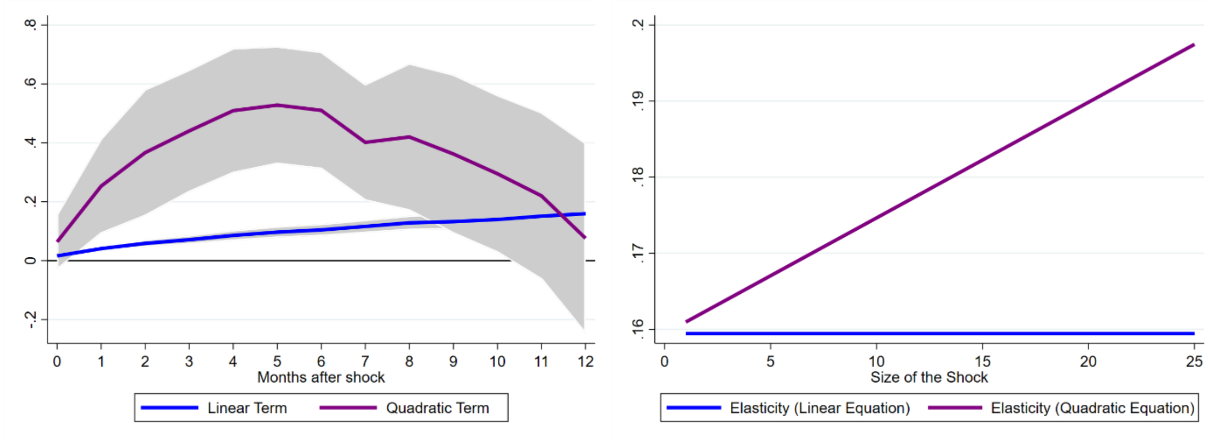


Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices for observations when there is a depreciation (purple) vs appreciation (blue). Panel A uses the full sample, while Panel B and C uses subsamples of advanced economies and emerging market and developing economies, respectively. The dark shaded region indicates the 68 percent confidence band.

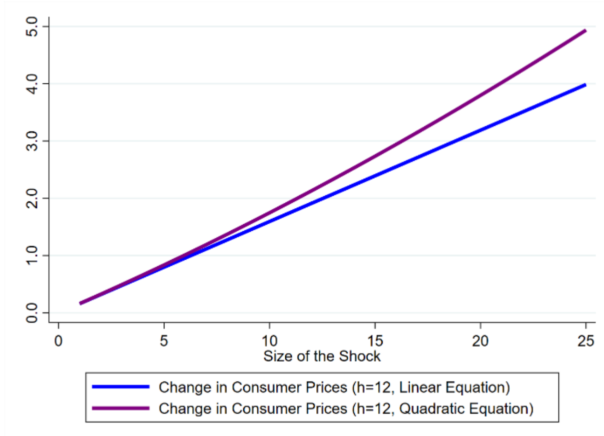
Figure 10: Exchange rate pass-through nonlinearity

A. Linear and quadratic terms

B. ERPT elasticity $\left(\partial\Delta\pi_{i,t+12} / \partial\Delta ER_{it}\right)$



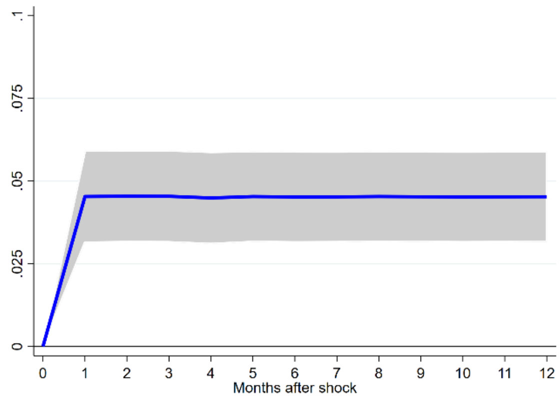
C. Price response to a 1 percent depreciation after 12 months



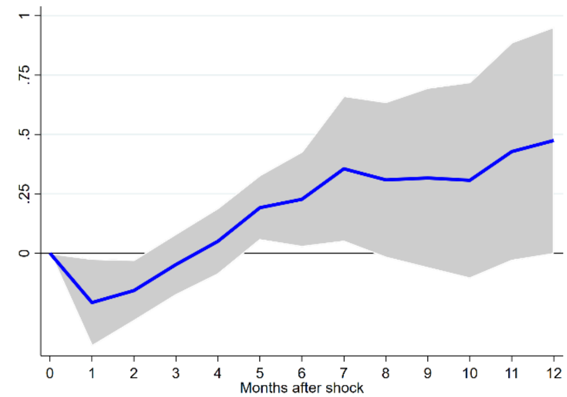
Note: Panel A: Blue line shows the estimated coefficient for the linear term, and the purple line denotes the coefficient of the quadratic term from equation (8). The dark shaded regions indicate the 90 percent confidence band. Panel B: Using the coefficients from estimating equation (8) from the 12-month horizon, we plot the elasticity term $\frac{\partial\Delta\pi_{t+12}}{\partial\Delta ER_t} = \beta_{12} + v_{12} \times 2 \times \Delta ER_{it}$ against the size of the shock varying from 1 percent to 25 percent. Panel C: The purple and blue line presents the percent change in the price level for each size of exchange rate depreciation varying between 1 percent to 25 percent (horizontal axis).

Figure 11: Shock-dependent exchange rate pass-through — U.S. monetary policy shock

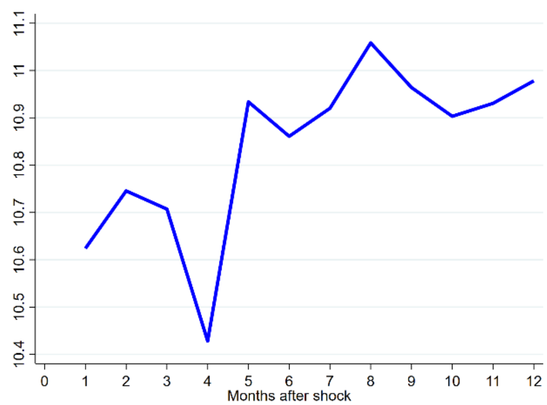
A. First Stage



B. Second Stage



C. F-statistic



Note: Panel A presents the β coefficient from the first-stage estimation of the response of the bilateral exchange rate. The positive coefficient implies a depreciation following a U.S. monetary policy tightening shock. Panel B presents the β_h coefficient from the second stage. The coefficient shows the response of consumer prices following a one percent exchange rate depreciation caused by a shock to U.S. monetary policy. Panel C presents the F-statistic from the first stage.

Tables

Table 1.1: Country sample — advanced economies

Country	Consumer Prices	Import Prices	Inflation Expectations	Country	Consumer Prices	Import Prices	Inflation Expectations
Australia	1990M1-2022M9	1990M1-2022M12	1990M1-2022M12	Japan	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Austria	1990M1-2022M12	2000M1-2022M12	1990M1-2022M12	Korea	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Belgium	1990M1-2022M12	1995M1-2022M12	1990M1-2022M12	Latvia	1990M12-2022M12	2011M1-2022M12	1998M5-2022M12
Canada	1990M1-2022M12	1997M1-2022M12	1990M1-2022M12	Lithuania	1990M12-2022M12	2006M1-2022M12	1998M5-2022M12
Cyprus	1990M1-2022M12	2000M1-2022M12	2004M7-2022M12	Netherlands	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Czech Republic	1991M1-2022M12	1998M1-2022M12	1995M1-2022M12	New Zealand	1990M1-2022M9	1990M1-2022M12	1990M1-2022M12
Denmark	1990M1-2022M12	2007M1-2022M12	1990M1-2022M12	Portugal	1990M1-2022M12	2000M1-2022M12	1990M1-2022M12
Estonia	1992M1-2022M12	1998M1-2022M12	1998M5-2022M12	Singapore	1990M1-2022M12	1990M1-2022M12	1990M11-2022M12
Finland	1990M1-2022M12	1995M1-2022M12	1990M1-2022M12	Slovak Republic	1993M1-2022M12	2009M1-2022M12	1995M1-2022M12
France	1990M1-2022M12	1999M1-2022M12	1990M1-2022M12	Slovenia	1992M1-2022M12	2006M1-2022M12	1995M1-2022M12
Germany	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12	Spain	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Greece	1990M1-2022M12	2000M1-2022M12	1993M6-2022M12	Sweden	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Ireland	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12	Switzerland	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Italy	1990M1-2022M12	1996M1-2022M12	1990M1-2022M12	United Kingdom	1990M1-2022M12	1997M1-2022M12	1990M1-2022M12

Source: Authors' calculations.

Table 1.2: Country sample — emerging market economies

Country	Consumer Prices	Import Prices	Inflation Expectations	Country	Consumer Prices	Import Prices	Inflation Expectations
Argentina	2012M7-2022M12	2004M1-2022M12	1993M3-2022M12	Malaysia	1990M1-2022M12	2001M1-2022M12	1990M11-2022M12
Armenia	1992M12-2022M12	2006M12-2022M12	2007M5-2022M12	Mexico	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12
Brazil	1990M1-2022M12	1990M1-2022M12	1990M1-2022M12	Peru	1990M1-2022M12	1994M1-2022M12	1993M3-2022M12
Bulgaria	1990M5-2022M12	2000M1-2022M12	1995M1-2022M12	Philippines	1990M1-2022M12	1990M1-2022M12	1994M12-2022M12
Chile	1990M1-2022M12	2003M1-2022M12	1993M3-2022M12	Poland	1990M1-2022M12	1996M6-2022M12	1990M11-2022M12
China	1990M1-2022M12	2005M1-2022M12	1994M12-2022M12	Romania	1990M10-2022M12	2000M1-2022M12	1995M1-2022M12
Hungary	1992M1-2022M12	2003M2-2022M12	1990M11-2022M12	Thailand	1990M1-2022M12	1990M1-2022M12	1990M11-2022M12
India	2001M1-2022M12	1990M1-2022M12	1994M12-2022M12	Turkey	1990M1-2022M12	2000M1-2022M12	1995M1-2022M12
Indonesia	1990M1-2022M12	1998M1-2022M12	1990M11-2022M12	Ukraine	1991M8-2022M12	2013M1-2022M12	1995M1-2022M12

Source: Authors' calculations based on data from Haver Analytics and Consensus Economics.

Table 2: Data sources

Definition	Source	Note
Bilateral Exchange Rate	Haver Analytics	Local currency per US dollar
Consumer Price Index	Haver Analytics	
Import Price Index	Haver Analytics	Expressed in local currency
Inflation Expectations	Consensus Economics	Forecasts for period average headline CPI inflation
USD Invoice Share	Boz and others (2022)	
Inflation Uncertainty-Disagreement	Consensus Economics	Synthetic 12-months-ahead (weighted average of current and next year forecasts); interquartile range across individual forecasts
Uncertainty	Ahir, Bloom, and Furceri (2022)	
Output Gap	World Economic Outlook	October 2022 vintage
Dollarization	Reinhart, Rogoff, and Savastano (2003)	Index constructed as a weighted average of three indicators: percentage of bank deposits and domestic debt denominated in foreign currency, and percentage of external debt denominated in foreign currency.

Source: Authors' calculations.

Table 3: Summary statistics

Variable	N	Mean	Std. Dev.	25th Percentile	Median	75th Percentile
Consumer Prices (y/y % change)	12,495	3.08	4.30	1.09	2.24	3.83
Import Prices (y/y % change)	12,495	2.78	9.39	-2.31	1.90	7.04
Inflation Expectations (% one-year ahead)	12,495	3.12	4.07	1.52	2.32	3.52
Exchange Rate (m/m % change)	12,495	0.007	2.22	-1.16	0.01	1.3
Uncertainty Index	12,034	0.19	0.19	0.06	0.14	0.28
USD Invoice Share (%, country average)	7,226	44.01	25.73	22.90	32.60	71.50
Inflation Forecast Disagreement (country average)	10,992	1.19	4.57	0.25	0.38	0.51
GDP Growth (%, deviation from country mean)	12,383	0.71	4.44	0.15	0.72	1.35
Output Gap (deviation from country mean)	12,495	-0.01	2.56	-0.96	0.01	1.16

Source: Authors' calculations.

Table 4: Exchange rate pass-through dependent on the level of inflation

Median		Mean		Quartiles		Smooth Transition	
Horizon	p-value: $\boldsymbol{\beta_{above}} = \boldsymbol{\beta_{below}}$	Horizon	p-value: $\boldsymbol{\beta_{above}} = \boldsymbol{\beta_{below}}$	Horizon	p-value: $\boldsymbol{\beta_4} = \boldsymbol{\beta_1}$	Horizon	p-value: $\boldsymbol{\beta_{above}} = \boldsymbol{\beta_{below}}$
0	.0474105	0	.0060347	0	.0056226	0	.0012703
1	.0143056	1	.0039175	1	.0015159	1	.0005352
2	.0040884	2	.0011165	2	.000742	2	.0001565
3	.000735	3	.000444	3	.0003653	3	.0000479
4	.0007618	4	.000435	4	.0002685	4	.0000651
5	.0001218	5	.0002004	5	.0001326	5	.0000562
6	.0000616	6	.0000924	6	.0000883	6	.0000408
7	.0000511	7	.0000668	7	.0001273	7	.0000531
8	.0001134	8	.0001352	8	.0003488	8	.0002223
9	.0001593	9	.0002317	9	.0006677	9	.0004702
10	.0000997	10	.00019	10	.0005717	10	.0005494
11	.0000731	11	.0002874	11	.0006478	11	.0006707
12	.0000387	12	.0001921	12	.0056226	12	.0004604

Source: Authors' calculations.

Table 5.1: Exchange rate pass-through dependent on the business cycle — GDP

Median		Mean		Quartiles		Smooth Transition	
Horizon	**p-value: $\beta_{above} = \beta_{below}$**	**Horizon**	**p-value: $\beta_{above} = \beta_{below}$**	**Horizon**	**p-value: $\beta_4 = \beta_1$**	**Horizon**	**p-value: $\beta_{above} = \beta_{below}$**
0	.982985	0	.9898194	0	.6363268	0	.688013
1	.4457705	1	.4919272	1	.7429889	1	.847077
2	.2865373	2	.6419416	2	.5360331	2	.8276721
3	.4248433	3	.6967469	3	.525757	3	.9259313
4	.1927809	4	.4772917	4	.3554173	4	.6000378
5	.2009525	5	.4591361	5	.4550534	5	.8174044
6	.2411653	6	.5111349	6	.4966421	6	.7278257
7	.267083	7	.4946286	7	.522891	7	.7308231
8	.2648593	8	.4370991	8	.5816184	8	.8004259
9	.3718133	9	.5320417	9	.5791622	9	.7447321
10	.3937118	10	.5308345	10	.6311103	10	.7630297
11	.3427677	11	.4354202	11	.6569368	11	.7104484
12	.294344	12	.4110838	12	.6835126	12	.6623057

Source: Authors' calculations.

Table 5.2: Exchange rate pass-through dependent on the business cycle — output gap

Median		Mean		Quartiles		Smooth Transition	
Horizon	**p-value: $\beta_{above} = \beta_{below}$**	**Horizon**	**p-value: $\beta_{above} = \beta_{below}$**	**Horizon**	**p-value: $\beta_4 = \beta_1$**	**Horizon**	**p-value: $\beta_{above} = \beta_{below}$**
0	.8934448	0	.7717475	0	.4811032	0	.634372
1	.7040491	1	.866958	1	.5136059	1	.9930422
2	.3442352	2	.5166958	2	.6043662	2	.5772766
3	.1578355	3	.2770652	3	.5260746	3	.298002
4	.0436113	4	.1323937	4	.5118235	4	.131255
5	.0083158	5	.0506011	5	.5745338	5	.0467898
6	.013803	6	.0407052	6	.5120725	6	.0454319
7	.0071019	7	.016679	7	.2186474	7	.0200336
8	.0211437	8	.0497298	8	.2873942	8	.0553419
9	.0299803	9	.0905811	9	.4290803	9	.0877089
10	.0262518	10	.133664	10	.5311815	10	.1096065
11	.0448824	11	.2929897	11	.6064923	11	.2372087
12	.1282696	12	.5525578	12	.7409409	12	.5345007

Source: Authors' calculations.

Table 6: Exchange rate pass-through dependent on uncertainty

Median		Mean		Quartiles		Smooth Transition	
Horizon	**p-value: $\beta_{above} = \beta_{below}$**	**Horizon**	**p-value: $\beta_{above} = \beta_{below}$**	**Horizon**	**p-value: $\beta_4 = \beta_1$**	**Horizon**	**p-value: $\beta_{above} = \beta_{below}$**
0	.5880957	0	.3718478	0	.7731234	0	.4765808
1	.3843448	1	.5070211	1	.6998763	1	.5179365
2	.1584718	2	.3068398	2	.7439929	2	.3407582
3	.1374133	3	.2786394	3	.9413577	3	.2915585
4	.0848247	4	.199067	4	.5746535	4	.1739469
5	.0471255	5	.1316517	5	.5947892	5	.1060873
6	.0243988	6	.0505732	6	.3213933	6	.0396433
7	.0146789	7	.0254071	7	.0704483	7	.0168134
8	.0190963	8	.0280201	8	.0380449	8	.0166313
9	.019077	9	.0252863	9	.0222373	9	.0158466
10	.0204122	10	.0242132	10	.0154449	10	.0165888
11	.0157147	11	.0190391	11	.0080057	11	.0122677
12	.0180473	12	.0182664	12	.0097343	12	.0136534

Source: Authors' calculations.

Table 7: Exchange rate pass-through dependent on inflation uncertainty — disagreement

Median		Mean		Quartiles		Smooth Transition	
Horizon	**p-value: $\boldsymbol{\beta_{above} = \beta_{below}}$**	**Horizon**	**p-value: $\boldsymbol{\beta_{above} = \beta_{below}}$**	**Horizon**	**p-value: $\boldsymbol{\beta_4 = \beta_1}$**	**Horizon**	**p-value: $\boldsymbol{\beta_{above} = \beta_{below}}$**
0	.0630722	0	.3633688	0	.0692543	0	.6191503
1	.0141429	1	.2708939	1	.0243588	1	.4690406
2	.0058679	2	.2130698	2	.0107289	2	.3892342
3	.0030565	3	.1652493	3	.00659	3	.3278306
4	.0026633	4	.1162817	4	.0049741	4	.265217
5	.0030745	5	.0884659	5	.0058829	5	.2261455
6	.0020468	6	.0525583	6	.0056456	6	.1638233
7	.0019027	7	.0322895	7	.0046735	7	.117967
8	.0023572	8	.0321707	8	.0049097	8	.1130785
9	.0038434	9	.0397028	9	.0073214	9	.1289019
10	.0041441	10	.0500864	10	.0078558	10	.1490841
11	.0043905	11	.0585444	11	.0092207	11	.168408
12	.0050509	12	.0643462	12	.0104003	12	.1773222

Source: Authors' calculations.

Table 8: Exchange rate pass-through dependent on the USD invoice share

Median		Mean		Quartiles		Smooth Transition	
Horizon	p-value: $\beta_{above} = \beta_{below}$	Horizon	p-value: $\beta_{above} = \beta_{below}$	Horizon	p-value: $\beta_4 = \beta_1$	Horizon	p-value: $\beta_{above} = \beta_{below}$
0	.1338817	0	.1048452	0	.1856863	0	.0923907
1	.1017968	1	.0491608	1	.0675907	1	.0349717
2	.0620568	2	.0323364	2	.0417131	2	.0223176
3	.0815847	3	.0382197	3	.0406423	3	.0235074
4	.0634481	4	.0329718	4	.031234	4	.0154366
5	.0557801	5	.0186593	5	.0094522	5	.0074035
6	.041473	6	.0117241	6	.0029146	6	.0032803
7	.0319034	7	.0095747	7	.0007625	7	.0023663
8	.0400991	8	.0122956	8	.0009545	8	.0041643
9	.0691922	9	.0227206	9	.0042642	9	.0096105
10	.0675083	10	.0268044	10	.0114821	10	.0114172
11	.0615376	11	.0195544	11	.0085487	11	.0088893
12	.0447393	12	.0128635	12	.0042049	12	.0051024

Source: Authors' calculations.

Table 9: Exchange rate pass-through dependent on dollarization

Median		Mean		Quartiles		Smooth-Functions	
Horizon	p-value: $\beta_{above} = \beta_{below}$	Horizon	p-value: $\beta_{above} = \beta_{below}$	Horizon	p-value: $\beta_4 = \beta_1$	Horizon	p-value: $\beta_{above} = \beta_{below}$
0	.0529531	0	.0763236	0	.0157746	0	.0171973
1	.0442537	1	.0793197	1	.0074105	1	.0098066
2	.0487326	2	.1237284	2	.0038876	2	.0086813
3	.0402635	3	.1472901	3	.004276	3	.0093945
4	.0548164	4	.2243064	4	.0120483	4	.0222137
5	.1009458	5	.3233003	5	.0280131	5	.0478404
6	.1562095	6	.3975906	6	.0373551	6	.0701976
7	.1985772	7	.4728727	7	.0193319	7	.0570036
8	.1704963	8	.4678533	8	.0101371	8	.0389022
9	.1635422	9	.4117139	9	.008479	9	.0320031
10	.1523283	10	.3647319	10	.0062245	10	.0246882
11	.1491007	11	.3729946	11	.0169847	11	.0440612
12	.146401	12	.4218997	12	.0259951	12	.0550723

Source: Authors' calculations.

Table 10: Exchange rate pass-through for appreciations and depreciations

Horizon	p-value: $\beta_{Appreciation} = \beta_{Depreciation}$
0	.5330642
1	.3179867
2	.2368264
3	.1049418
4	.0551027
5	.0322834
6	.0731297
7	.3022735
8	.4300055
9	.5013484
10	.4385757
11	.4272155
12	.5751259

Source: Authors' calculations.

Table 11: Exclusion restriction test result

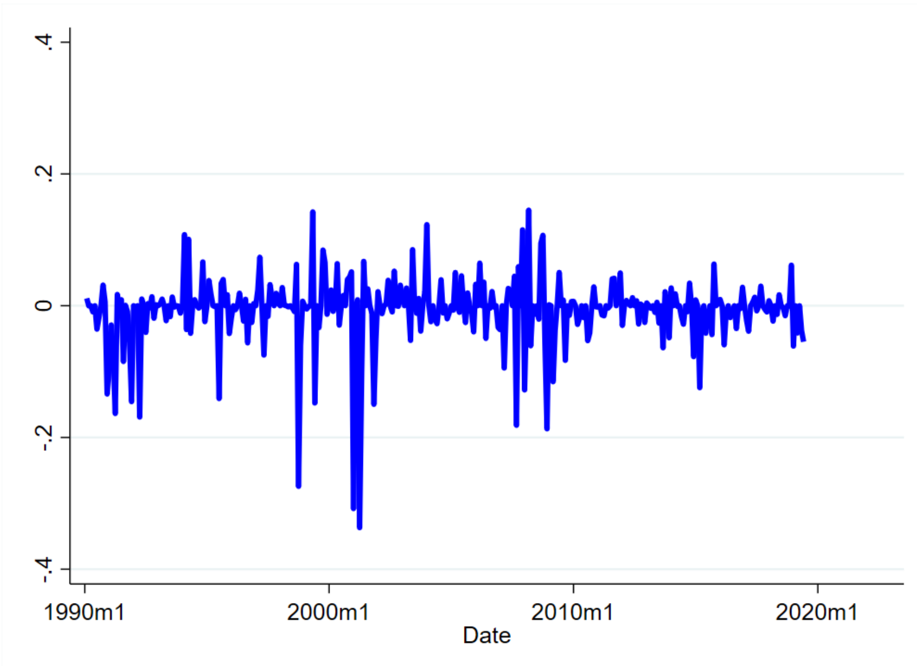
VARIABLES	(h=1) $\epsilon_{i,t}$	(h=2) $\epsilon_{i,t}$	(h=3) $\epsilon_{i,t}$	(h=4) $\epsilon_{i,t}$	(h=5) $\epsilon_{i,t}$	(h=6) $\epsilon_{i,t}$	(h=7) $\epsilon_{i,t}$	(h=8) $\epsilon_{i,t}$	(h=9) $\epsilon_{i,t}$	(h=10) $\epsilon_{i,t}$	(h=11) $\epsilon_{i,t}$	(h=12) $\epsilon_{i,t}$
$Instrument_{i,t}$	-8.6^{-14}	-1.2^{-13}	-1.2^{-13}	-1.3^{-13}	-1.3^{-13}	-1.6^{-13}	-1.7^{-13}	-1.9^{-13}	-1.8^{-13}	-2^{-13}	-2^{-13}	-2.2^{-13}
	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.004	0.004	0.004	0.004
Observations	9,658	9,653	9,648	9,643	9,638	9,633	9,628	9,623	9,618	9,611	9,604	9,597
R-squared	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

*** p<0.01, ** p<0.05, * p<0.1

Note: Robust standard errors in parentheses.

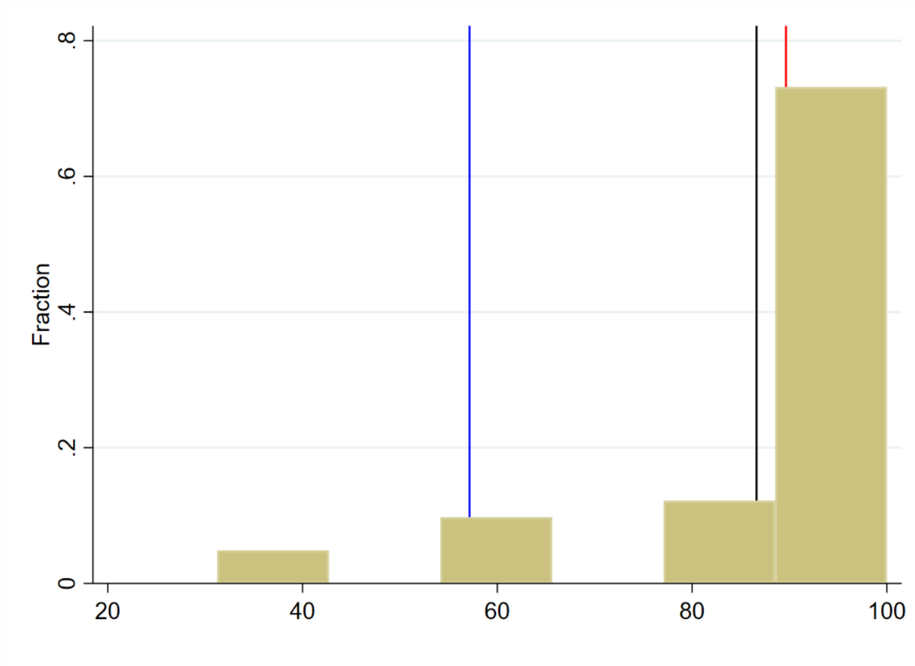
Appendix

Figure A1: Externally Identified U.S. Monetary Policy Shocks



Source: Jarociński and Karadi (2020).

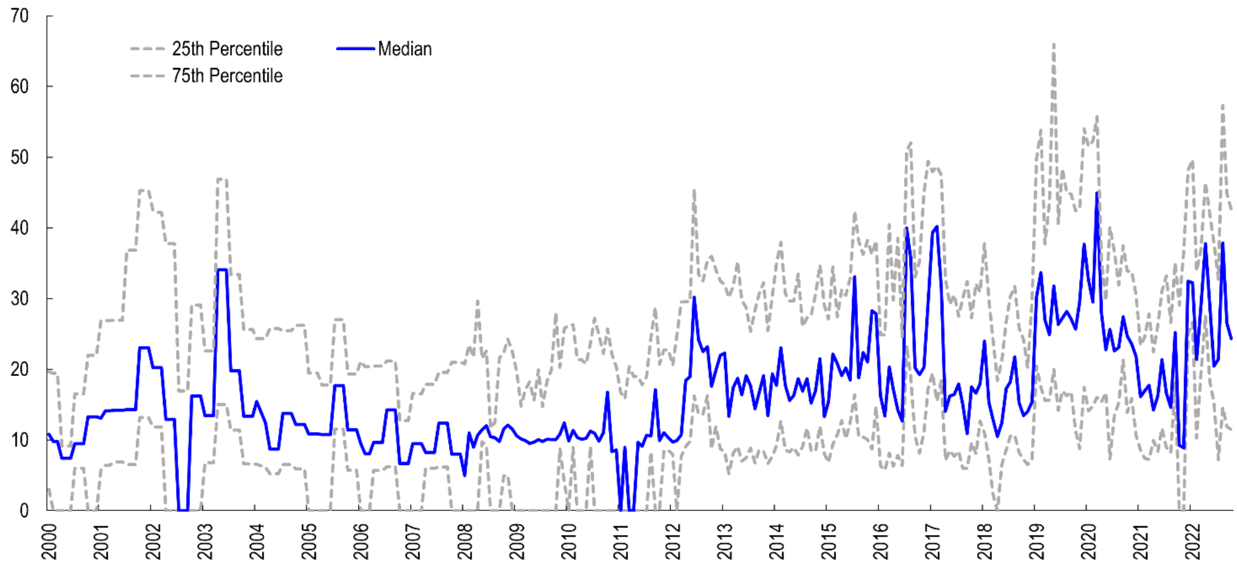
Figure A2: Cross Country Distribution of Quinn and Toyoda (2008) Index



Source: Quinn and Toyoda (2008).

Note: Blue line presents the 10th percentile of the distribution that is used as the threshold while generating the instrument. Black and red lines present the 25th percentile and mean of the distribution, respectively.

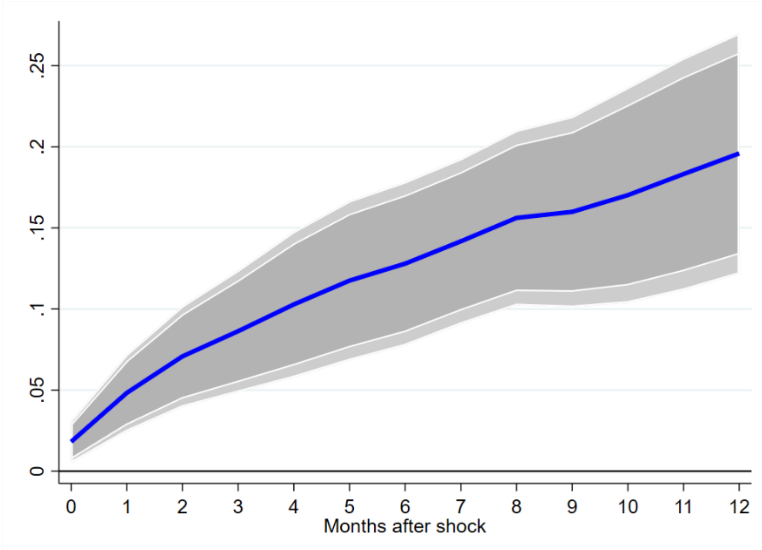
Figure A3: Evolution and distribution of country-level uncertainty



Source: World Uncertainty Index database constructed by Ahir, Bloom, and Furceri (2022).

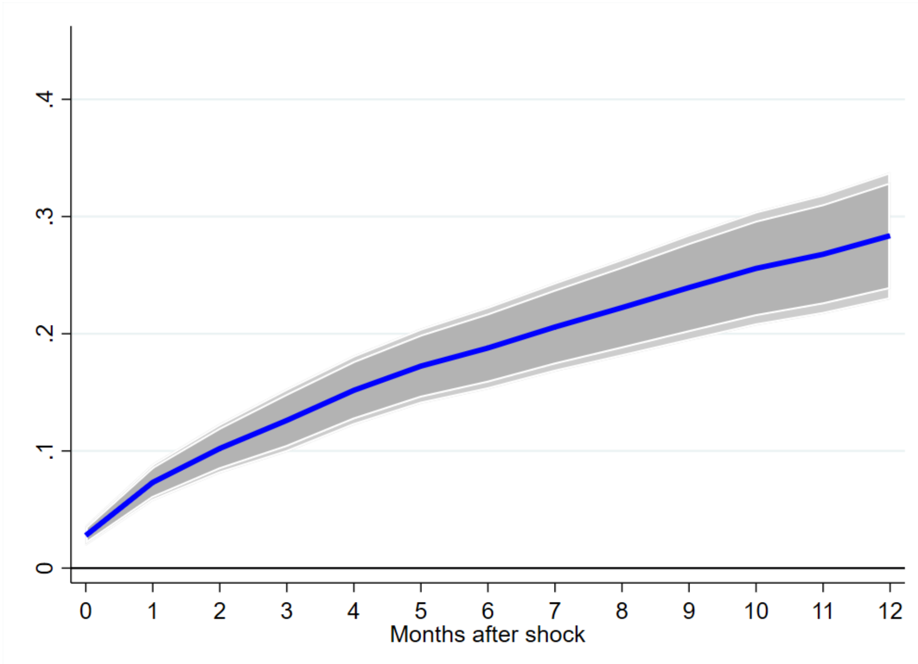
Figure A4: Average exchange rate pass-through — nominal effective exchange rate

Consumer Prices



Note: The solid blue line presents the impact of a one percent increase (depreciation) in nominal effective exchange rate on a percent change in consumer prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

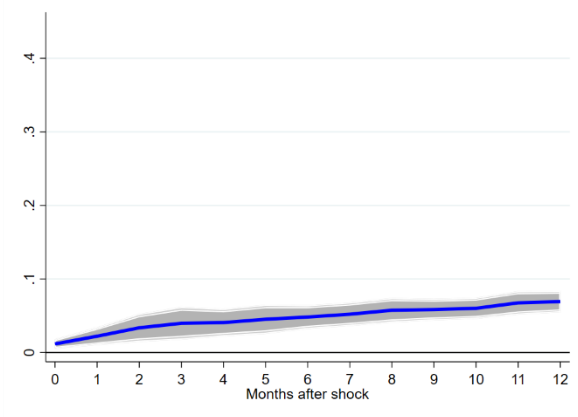
Figure A5: Average exchange rate pass-through to consumer prices (larger sample)



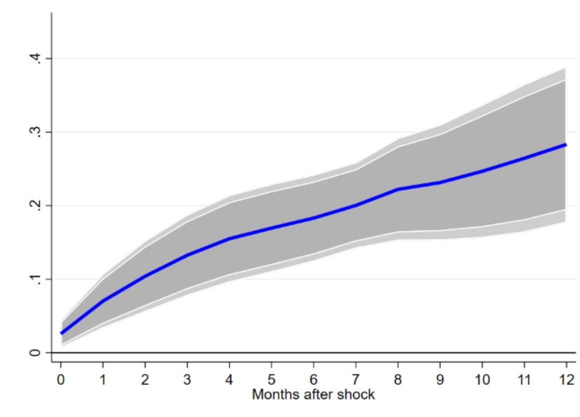
Note: The chart uses data from a larger sample of 141 countries. The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A6: Advanced economies vs Emerging market economies – Consumer prices

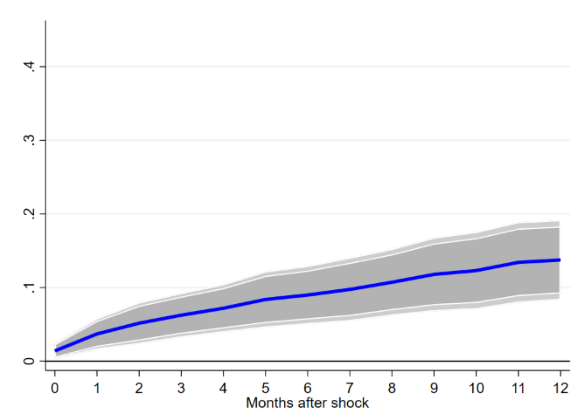
A. Baseline Sample – AEs



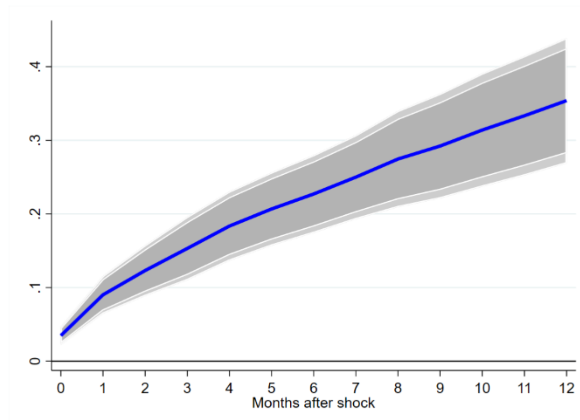
B. Baseline Sample - EMEs



C. Large Sample – AEs



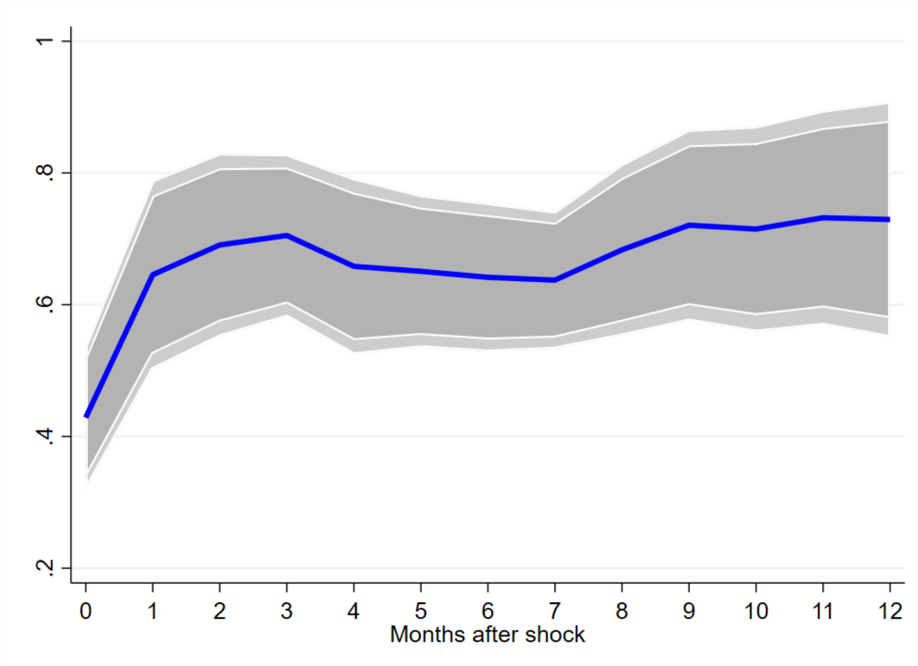
D. Large Sample – EMEs



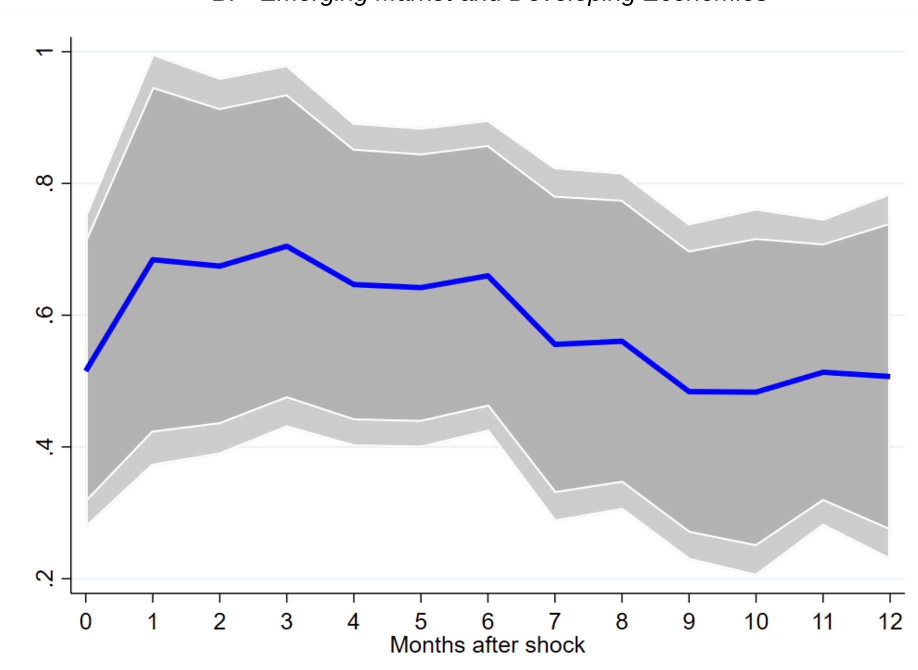
Note: Baseline results are from 46 countries and large sample consists of 141 countries. The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A7: Exchange rate pass-through to import prices

A. Advanced Economies



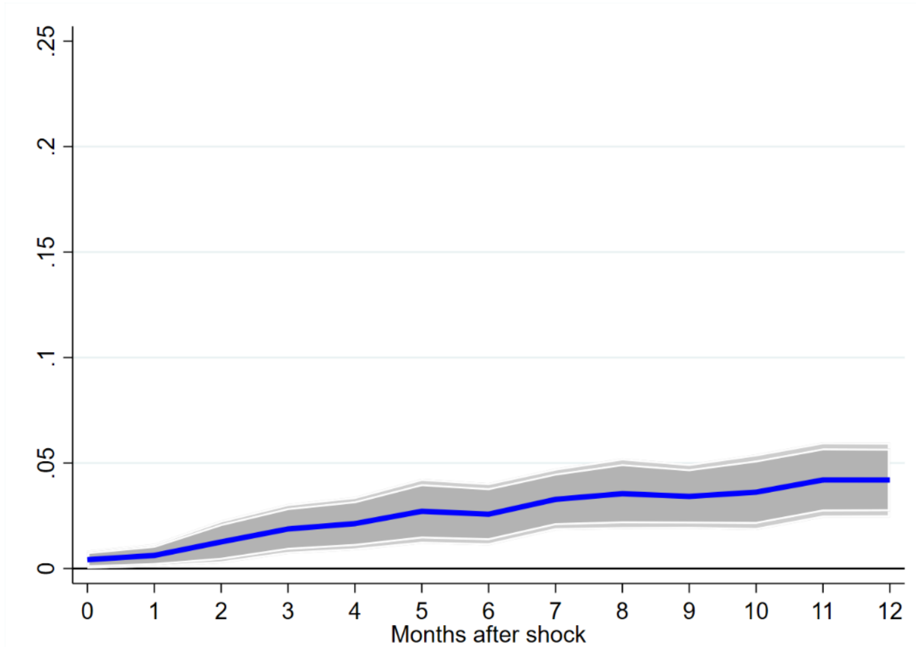
B. Emerging Market and Developing Economies



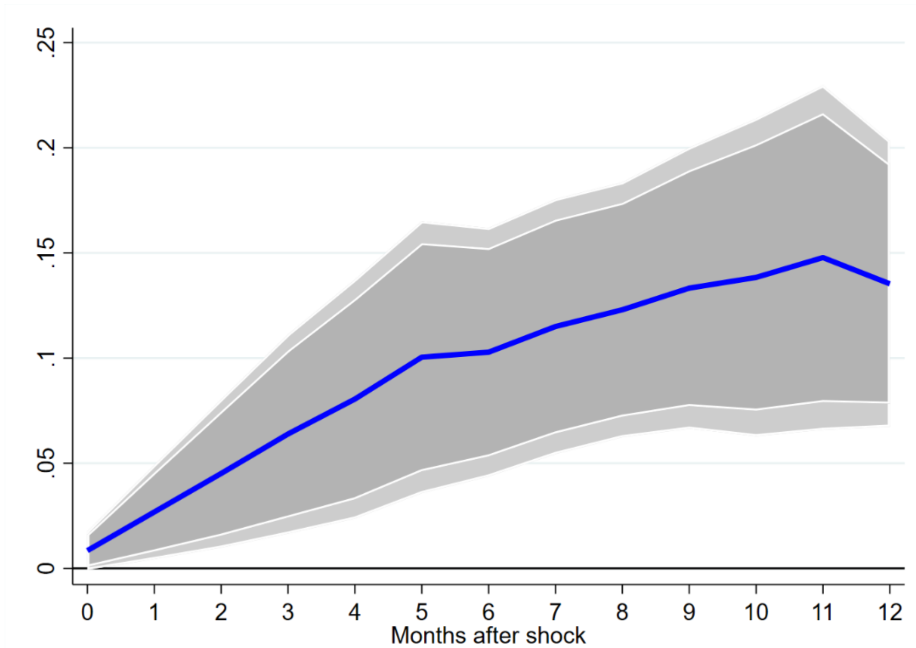
Note: Country sample is shown in Table 1.1 and 1.2. The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A8: Exchange rate pass-through to core prices

A. Advanced Economies



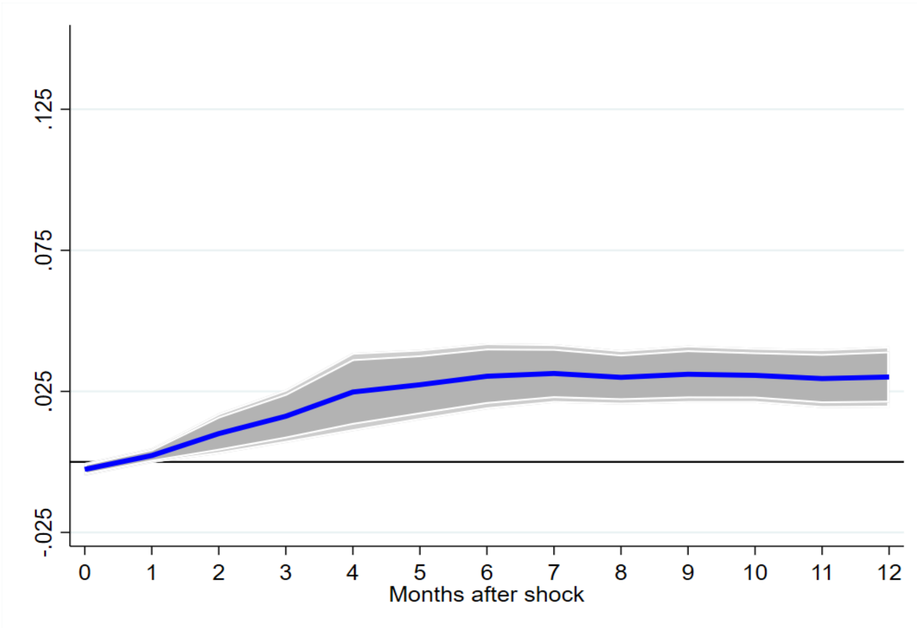
B. Emerging Market and Developing Economies



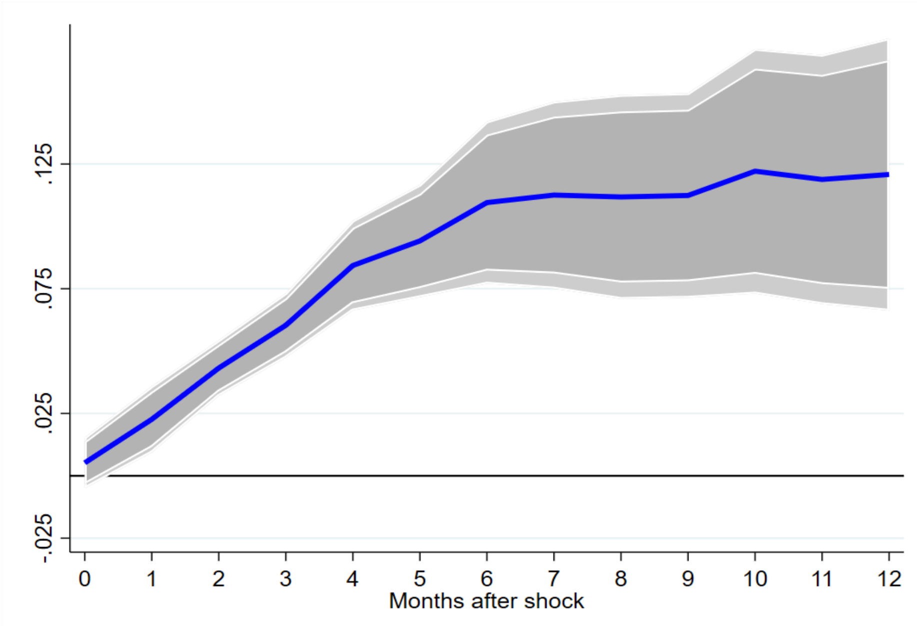
Note: Country sample is shown in Table 1.1 and 1.2. The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A9: Exchange rate pass-through to inflation expectations

A. Advanced Economies



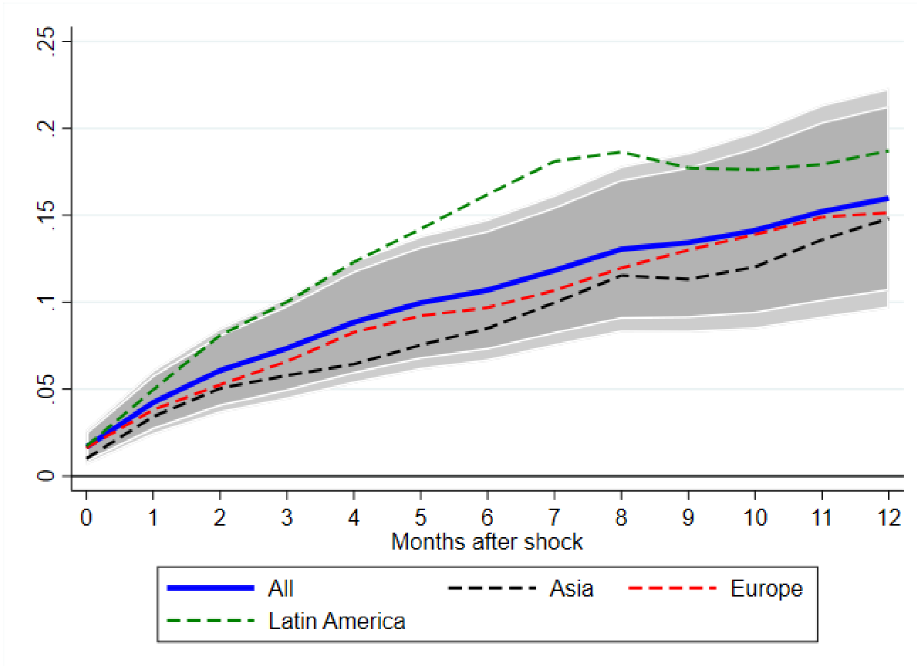
B. Emerging Market and Developing Economies



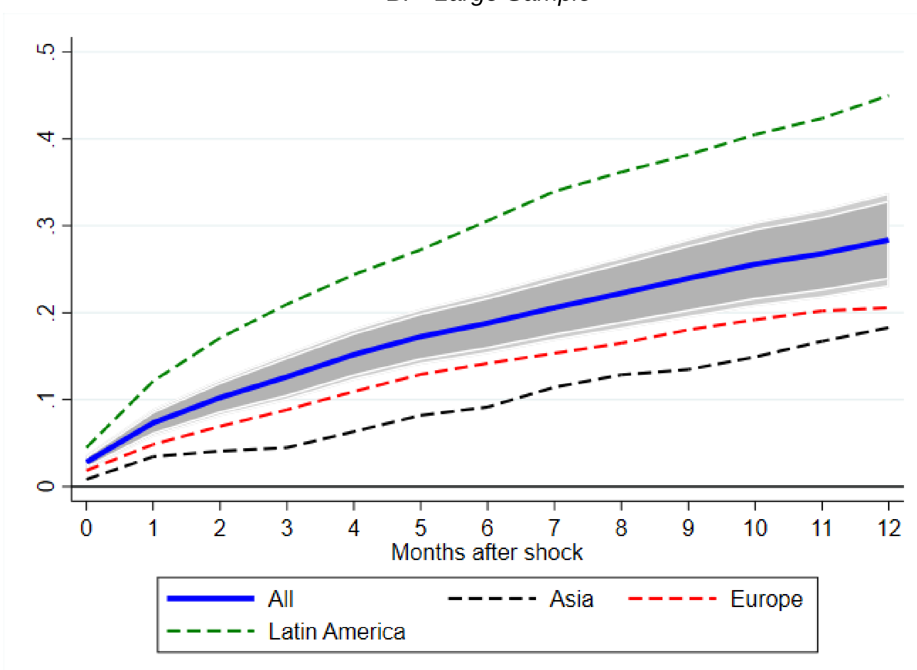
Note: The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A10: Exchange rate pass-through across different regions

A. Baseline

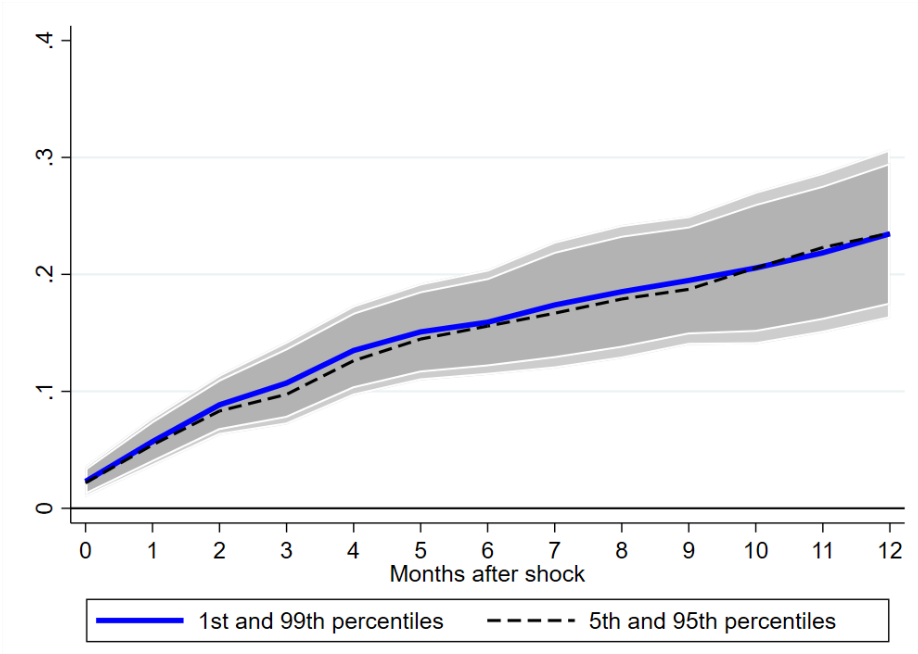


B. Large Sample



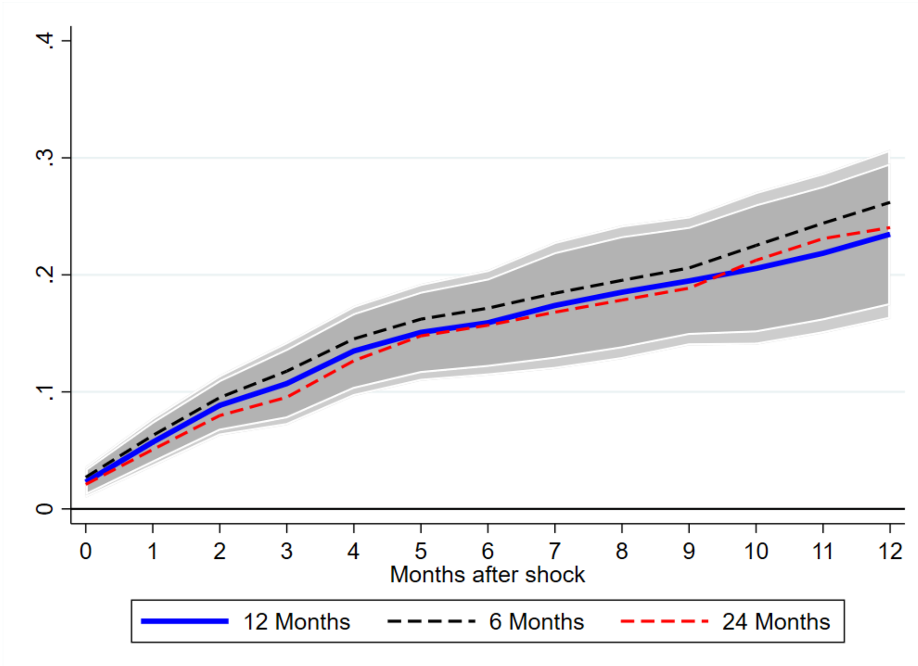
Note: The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A11: Alternative Trimming of Sample



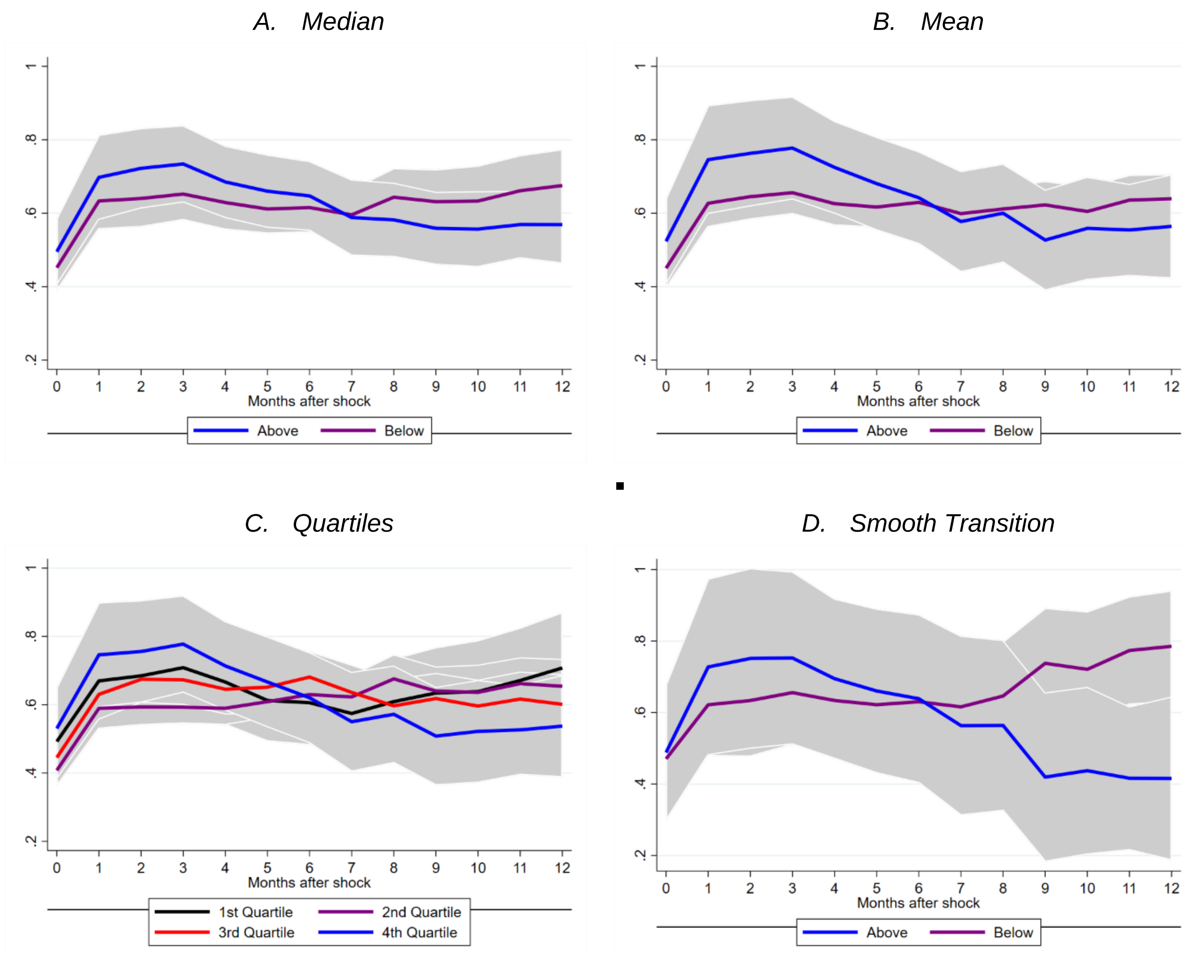
Note: The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

Figure A12: Exchange rate pass-through with alternative lag orders



Note: The solid blue line presents the impact of a one percent increase (depreciation) in local currency/USD on a percent change in consumer prices. The dark shaded region indicates the 90 percent confidence band; the light shaded region indicated the 95 percent confidence band.

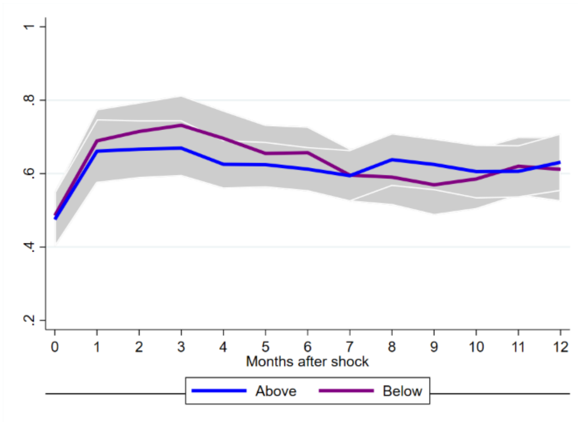
Figure A13: Exchange rate pass-through to import prices



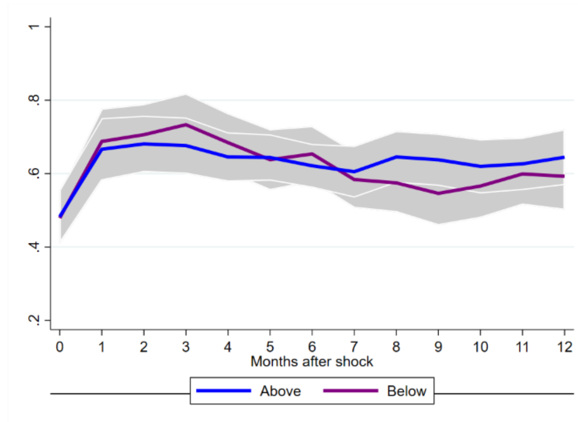
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices across different groups with current inflation. The dark shaded region indicates the 68 percent confidence band.

Figure A14: Exchange rate pass-through to import prices dependent on the business cycle — growth

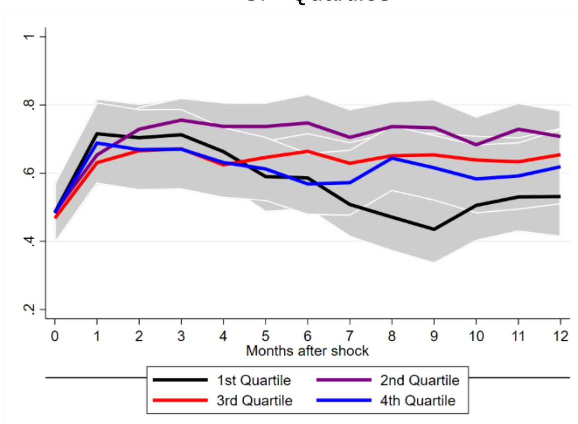
A. Median



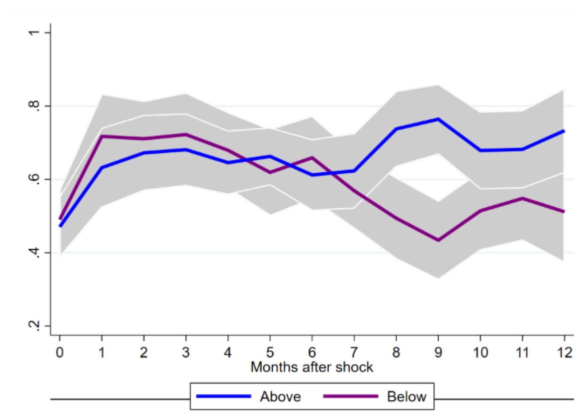
B. Mean



C. Quartiles

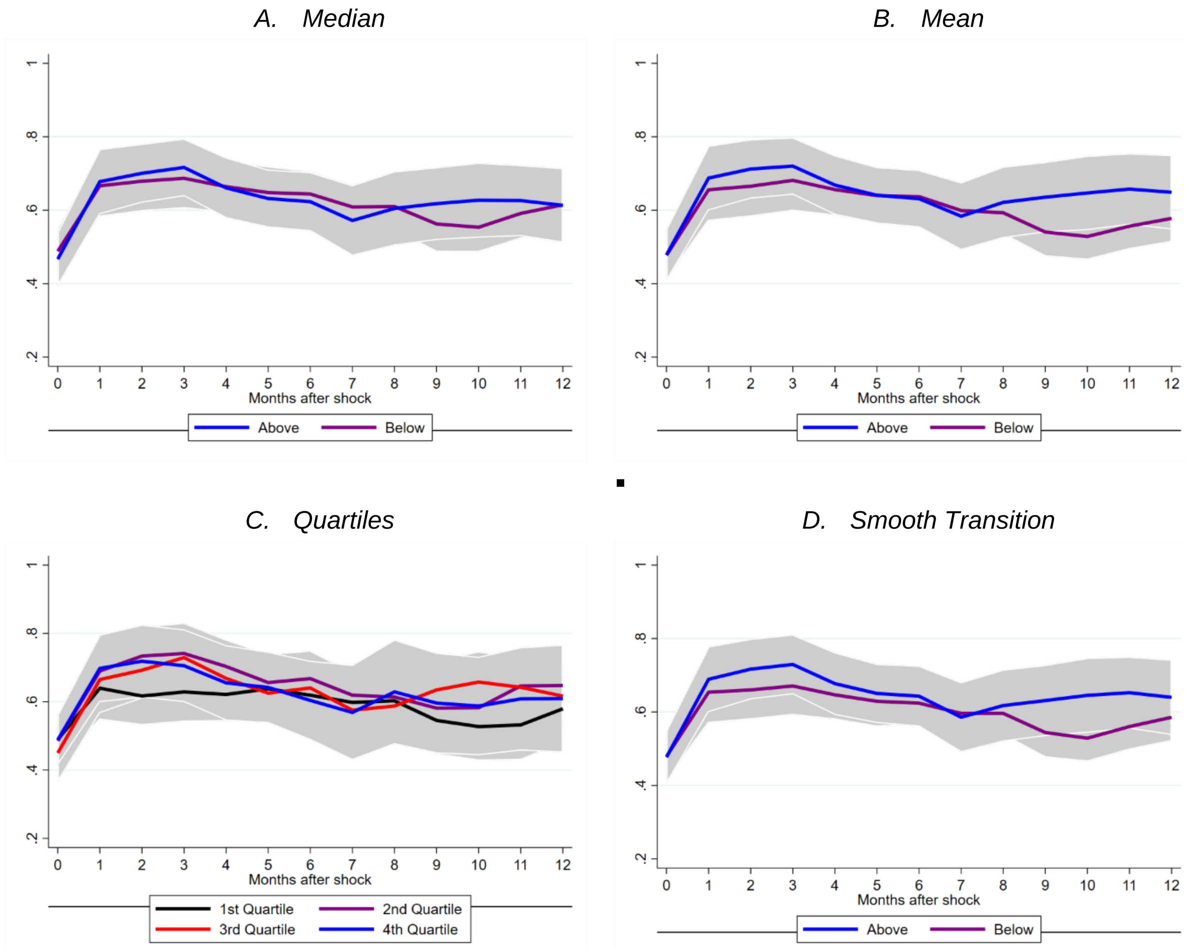


D. Smooth-transitions



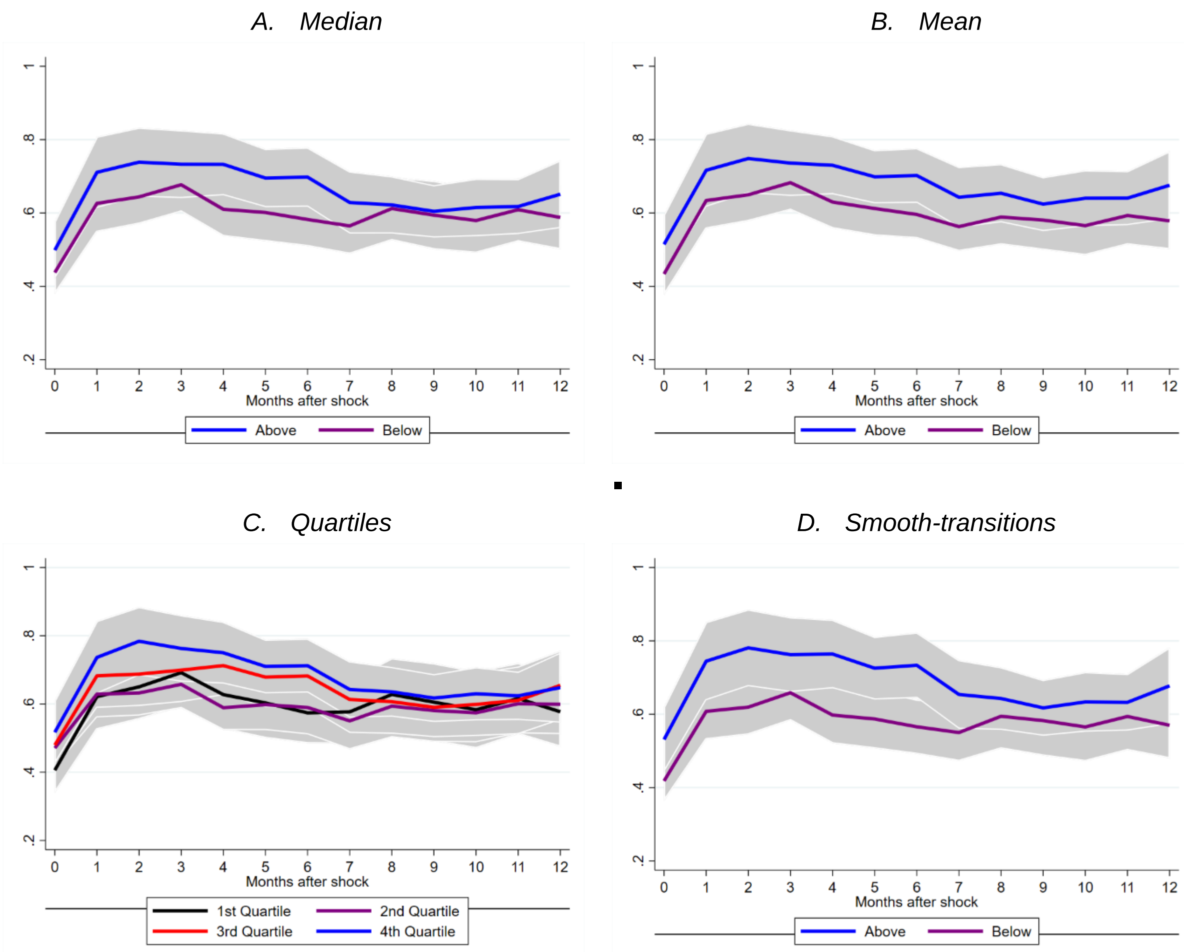
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices across different groups with real GDP growth. Real GDP growth rates are the deviation of quarterly (YoY) rates from country average. The dark shaded region indicates the 68 percent confidence band.

Figure A15: Exchange rate pass-through to import prices dependent on the business cycle — output gap



Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices across different groups with quarterly output gap of country. Output gap series are the deviations of real GDP from their HP-filtered trend. The dark shaded region indicates the 68 percent confidence band.

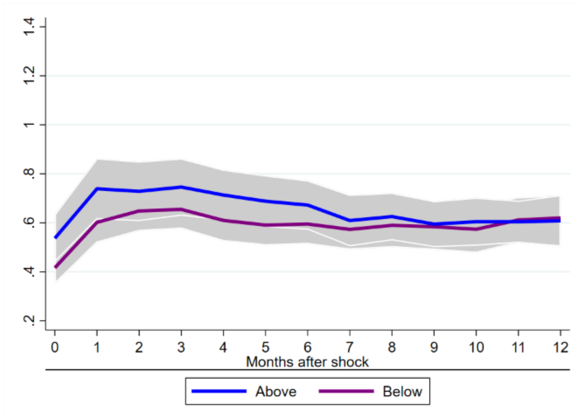
Figure A16: Exchange rate pass-through to import prices dependent on uncertainty



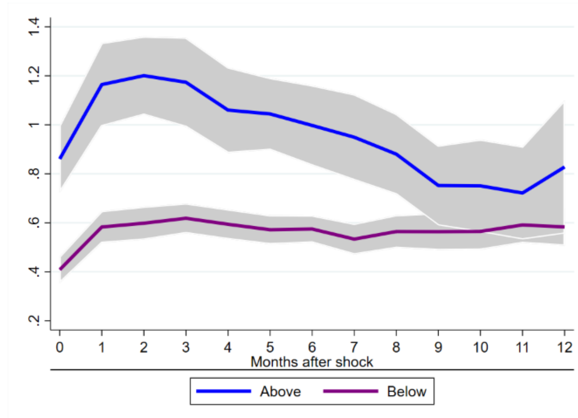
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices across different groups with current uncertainty in the country. Monthly uncertainty series are from Ahir, Bloom, and Furceri (2022). The dark shaded region indicates the 68 percent confidence band.

Figure A17: Exchange rate pass-through to import prices dependent on inflation uncertainty — disagreement

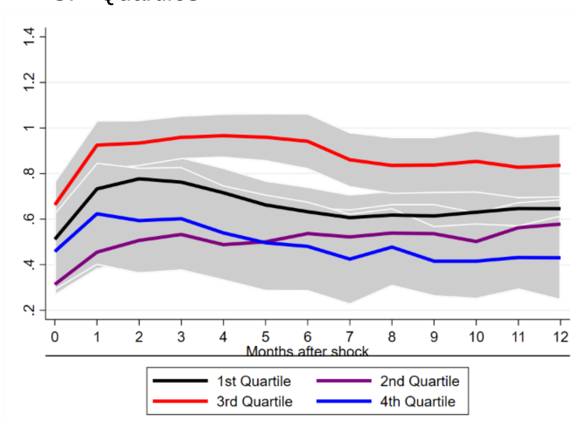
A. Median



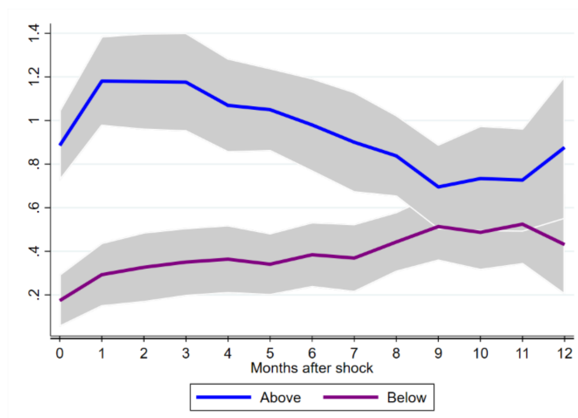
B. Mean



C. Quartiles

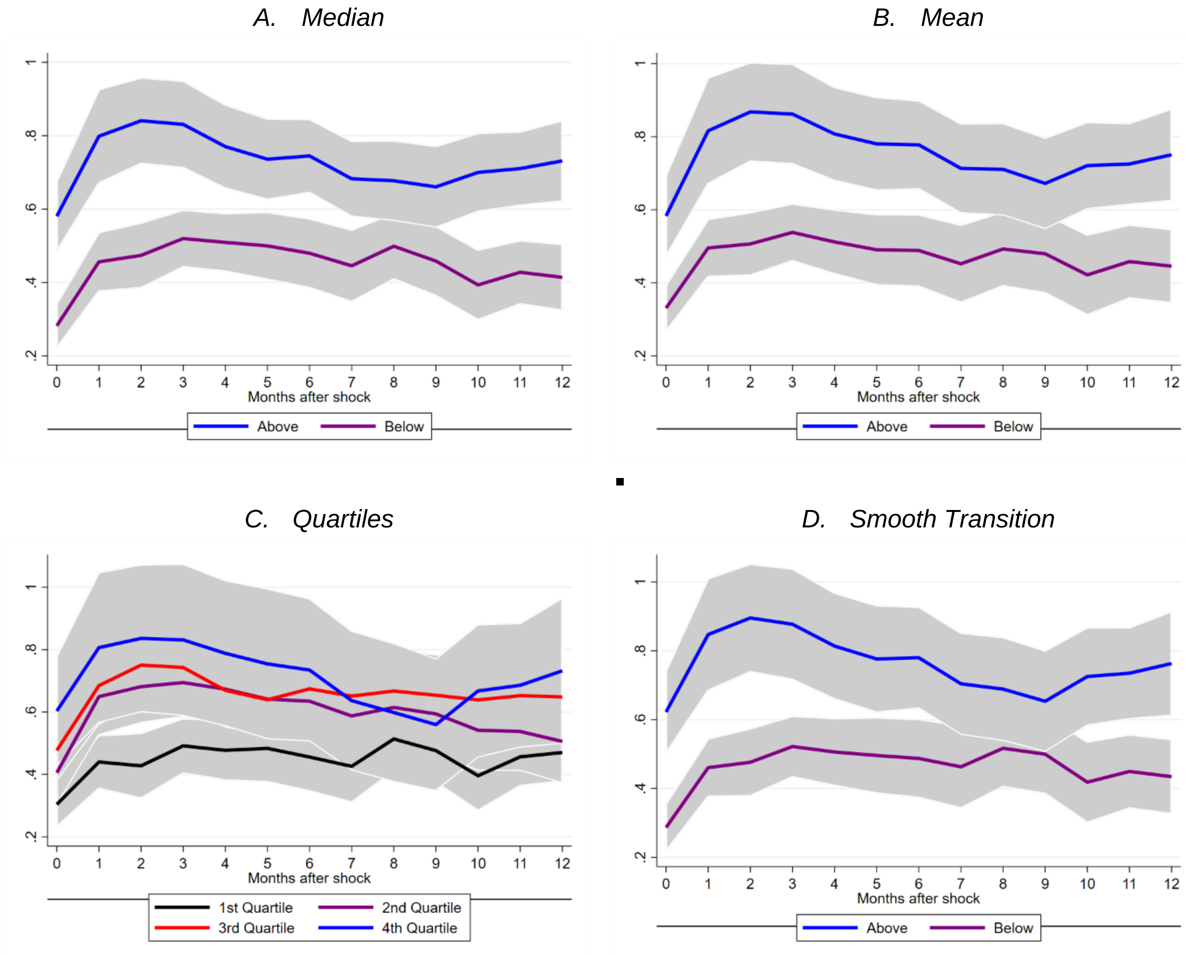


D. Smooth-transitions



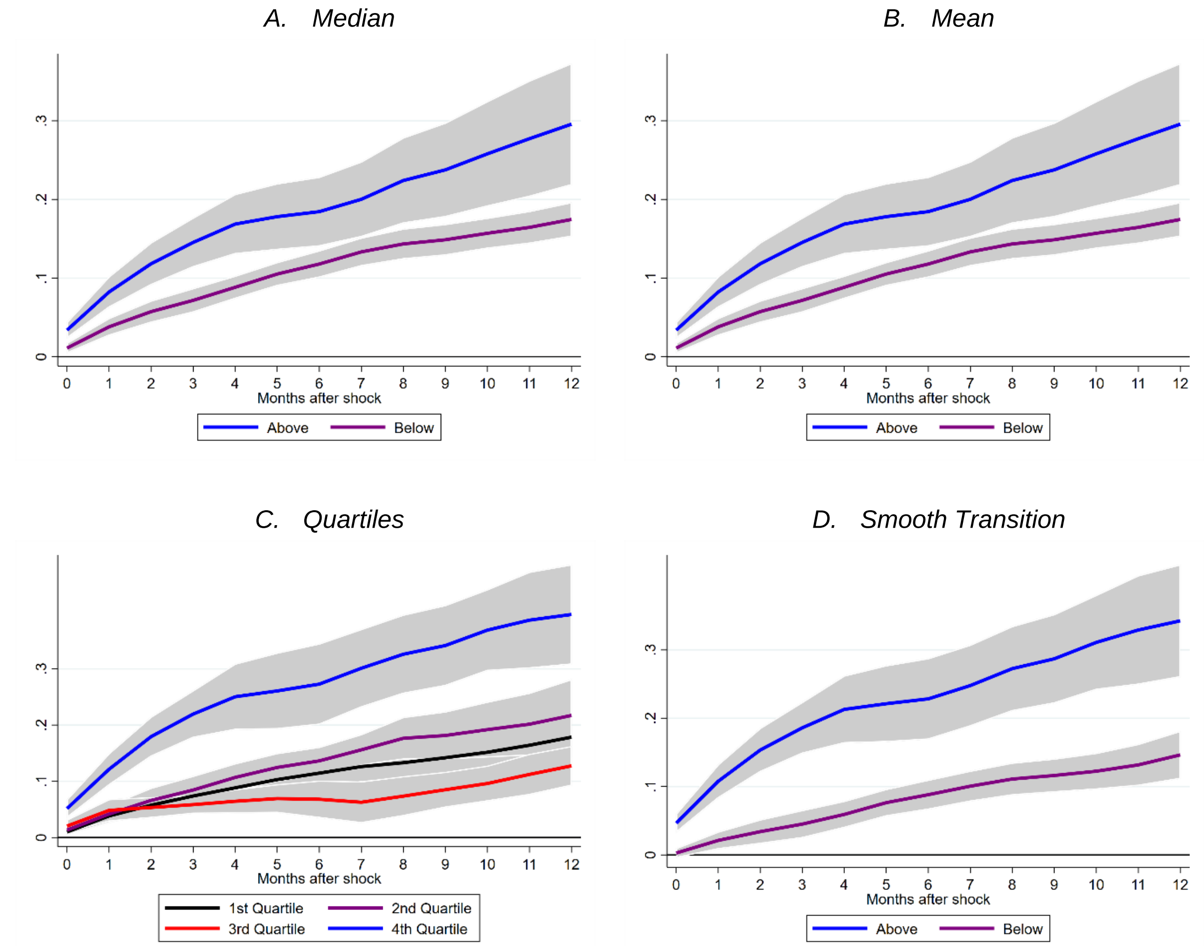
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices across different groups with country level inflation disagreement. Inflation uncertainty series are from Brito et al., (2021). The dark shaded region indicates the 68 percent confidence band.

Figure A18: Exchange rate pass-through to import prices dependent on the USD invoice share



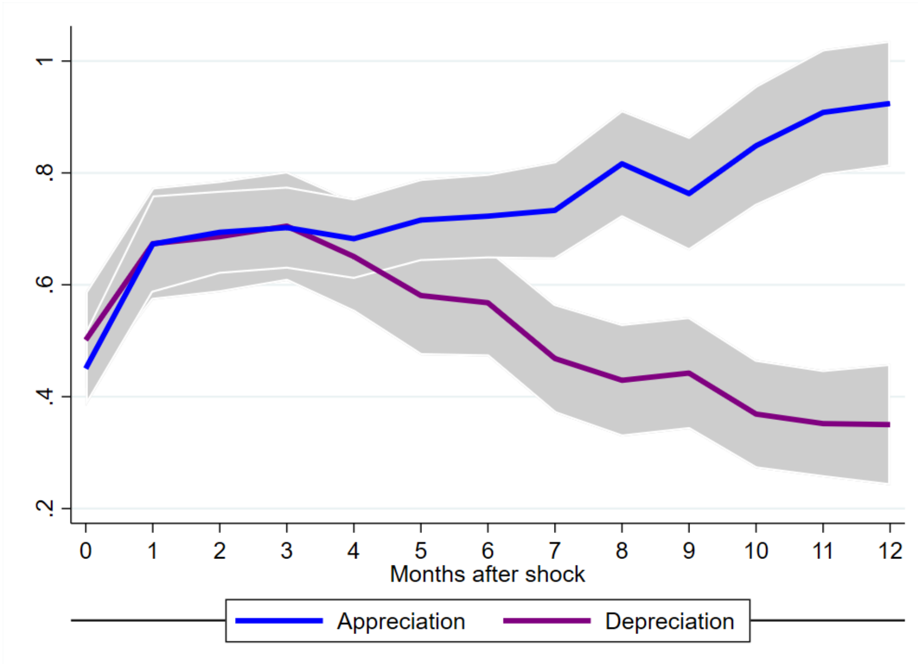
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices across different groups with average USD invoice share of imports in a country. USD invoice share is from Boz and others (2022). The dark shaded region indicates the 68 percent confidence band.

Error! Bookmark not defined.Figure A19: Exchange rate pass-through to import prices dependent on dollarization



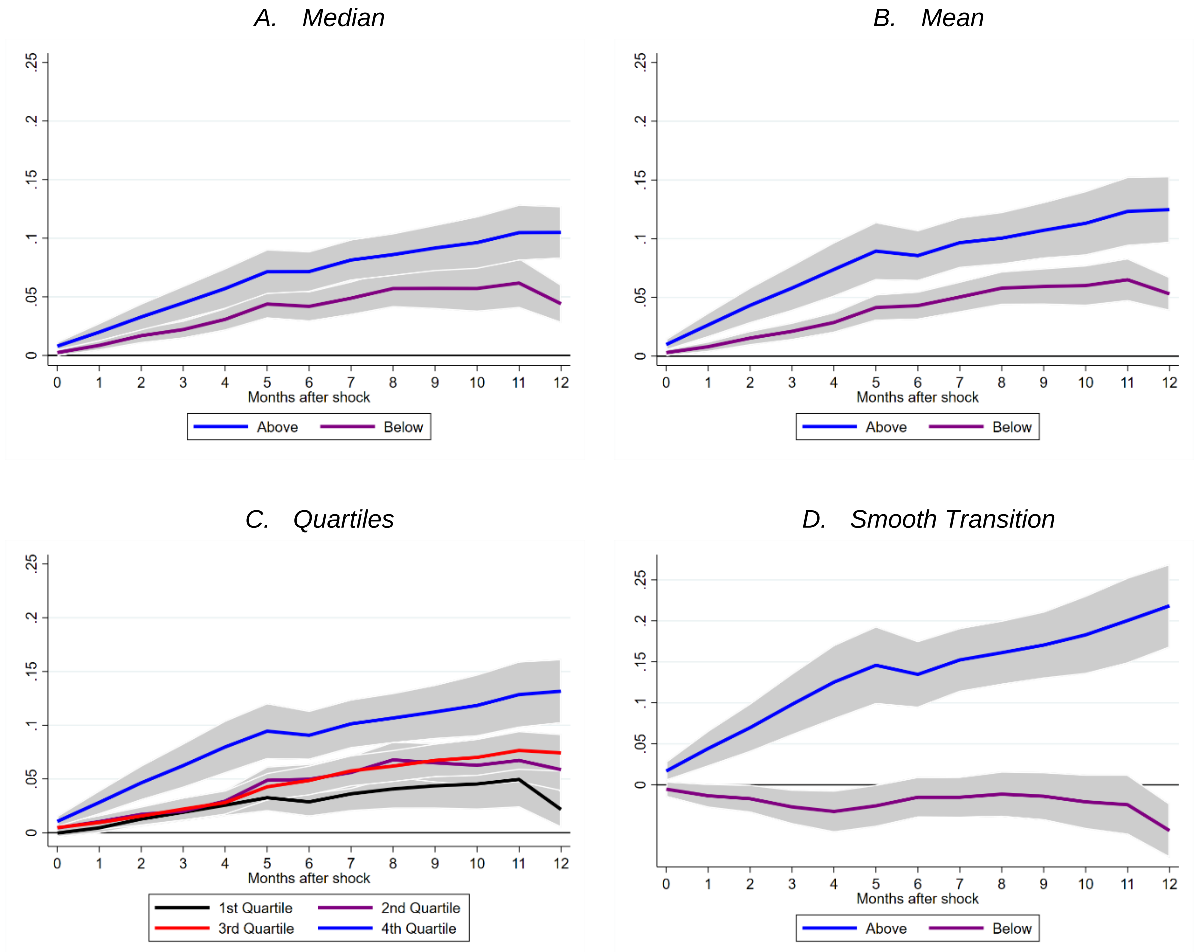
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in import prices across different bins based on average dollarization in a country. Dollarization rates are from Reinhart, Rogoff, and Savastano (2003). The dark shaded region indicates the 68 percent confidence band.

Figure A20: Exchange rate pass-through to import prices following depreciations and appreciations



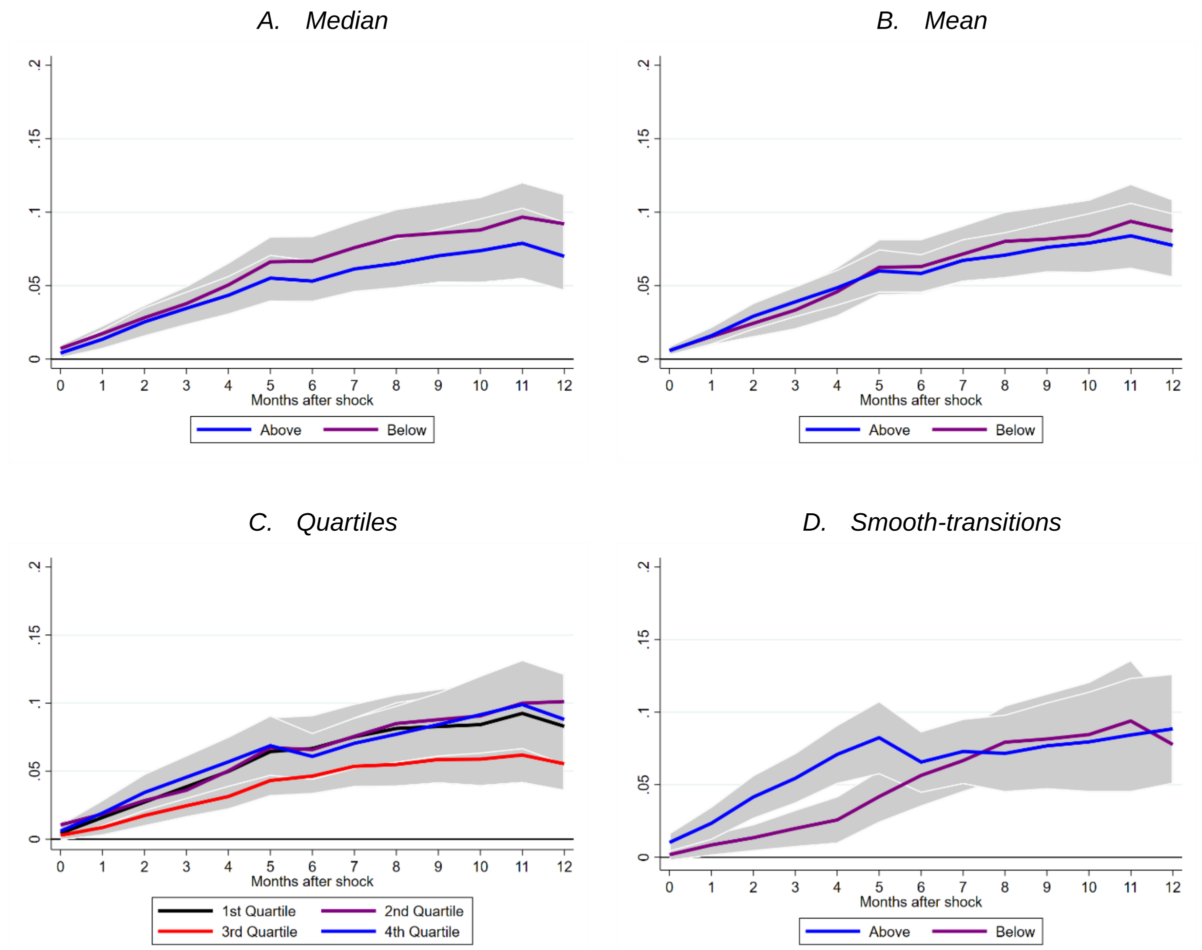
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in import prices for observations when there is a depreciation (purple) vs appreciation (blue). The dark shaded region indicates the 68 percent confidence band.

Figure A21: Exchange rate pass-through to core prices



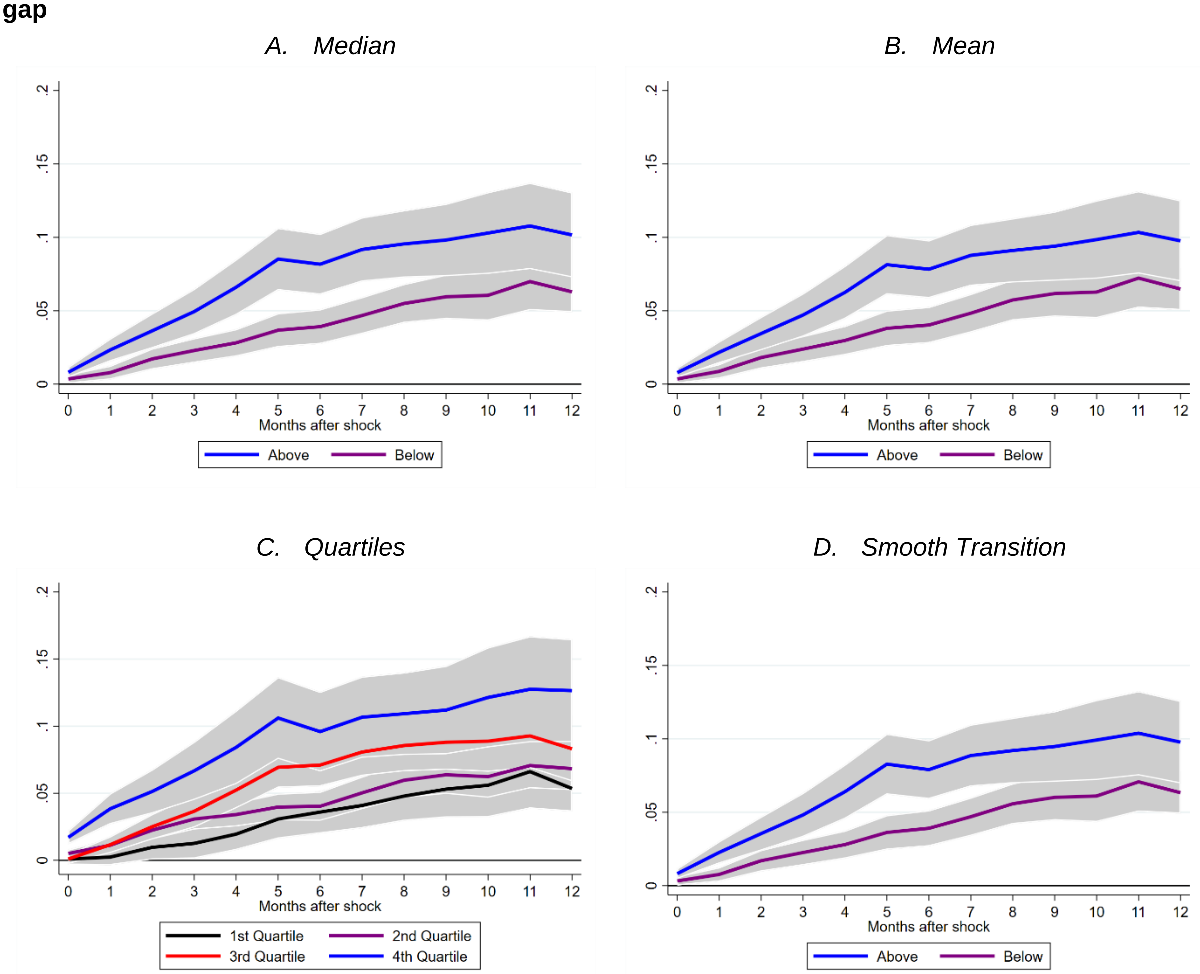
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices across different groups with current inflation. The dark shaded region indicates the 68 percent confidence band.

Figure A22: Exchange rate pass-through to core prices dependent on the business cycle — growth



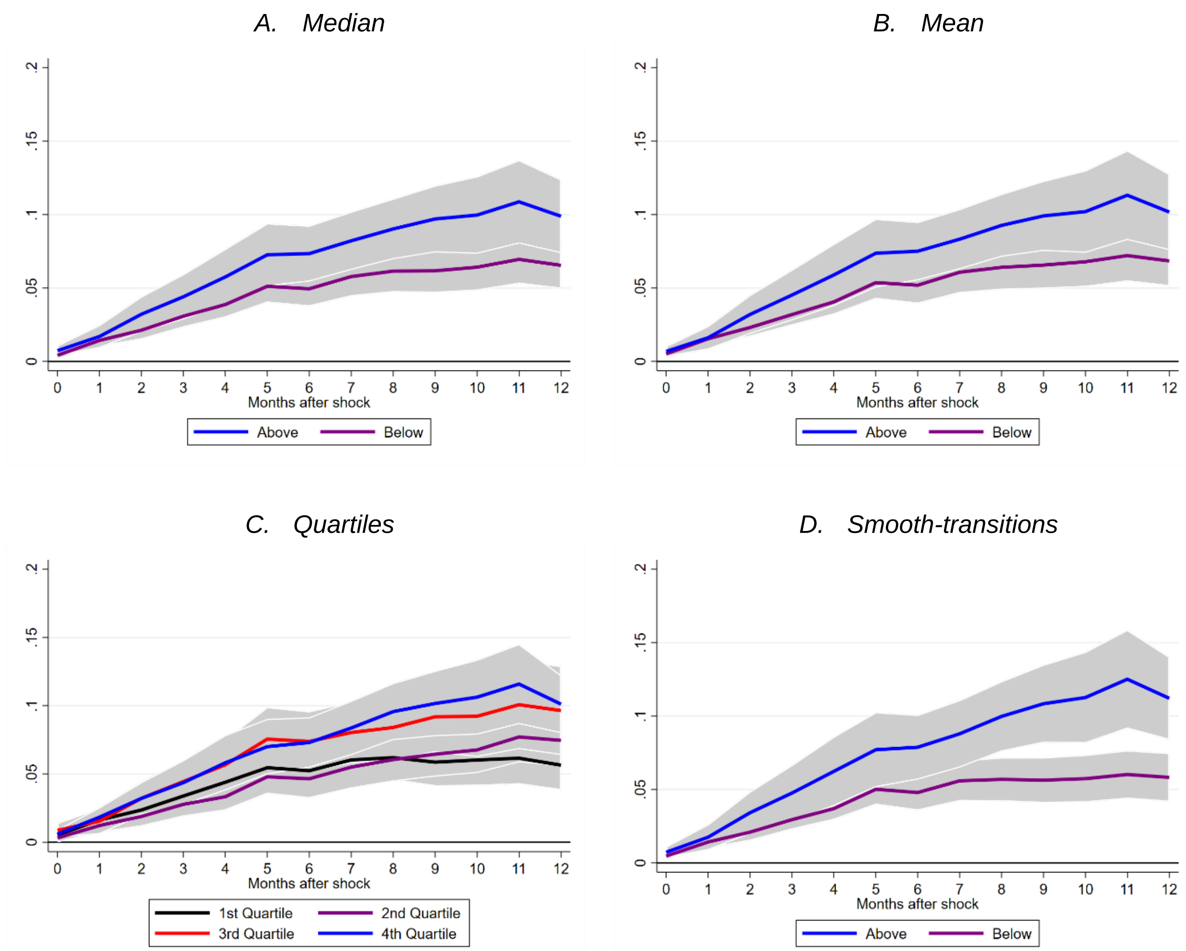
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices across different groups with real GDP growth. Real GDP growth rates are the deviation of quarterly (YoY) rates from country average. The dark shaded region indicates the 68 percent confidence band.

Figure A23: Exchange rate pass-through to core prices dependent on the business cycle — output gap



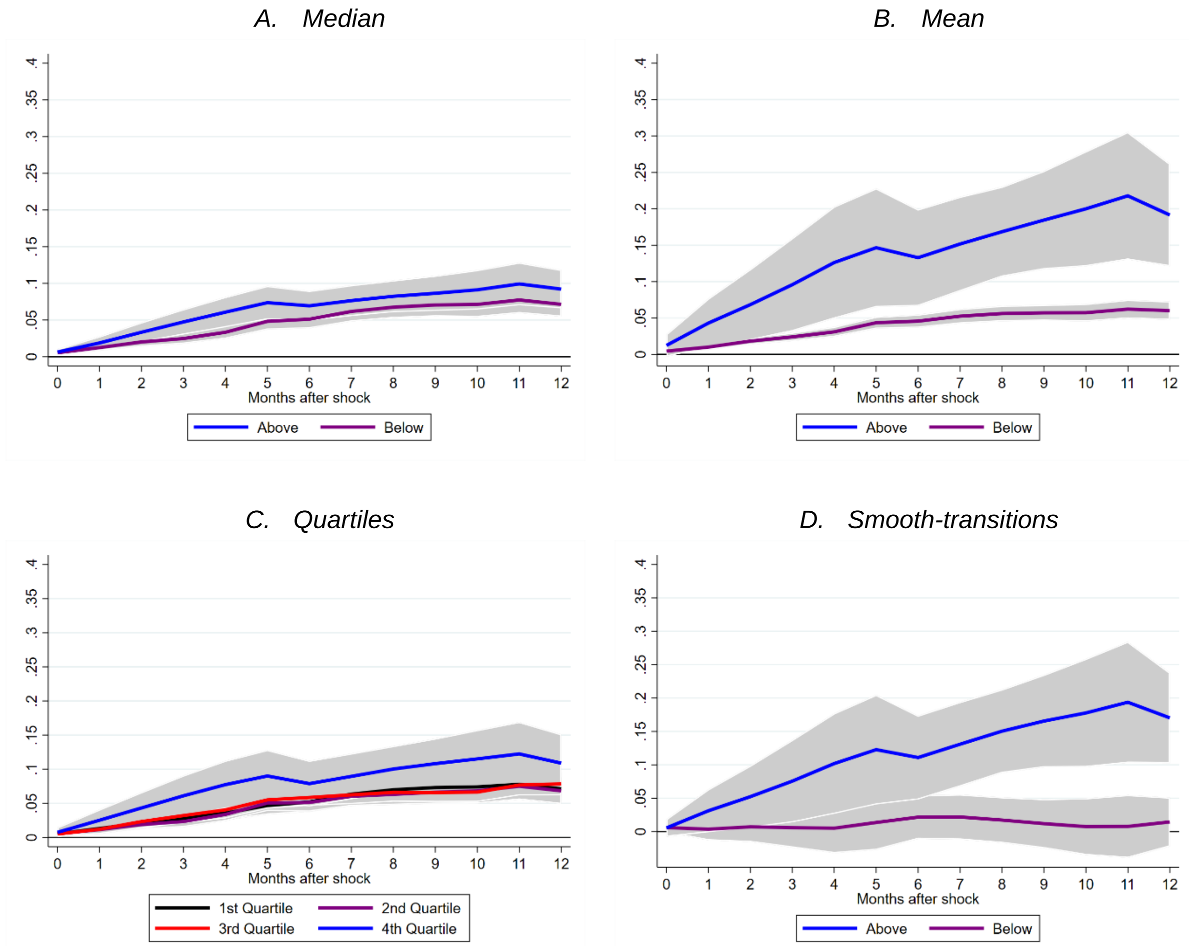
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices across different groups with quarterly output gap of country. Output gap series are the deviations of real GDP from their HP-filtered trend. The dark shaded region indicates the 68 percent confidence band.

Figure A24: Exchange rate pass-through to core prices dependent on uncertainty



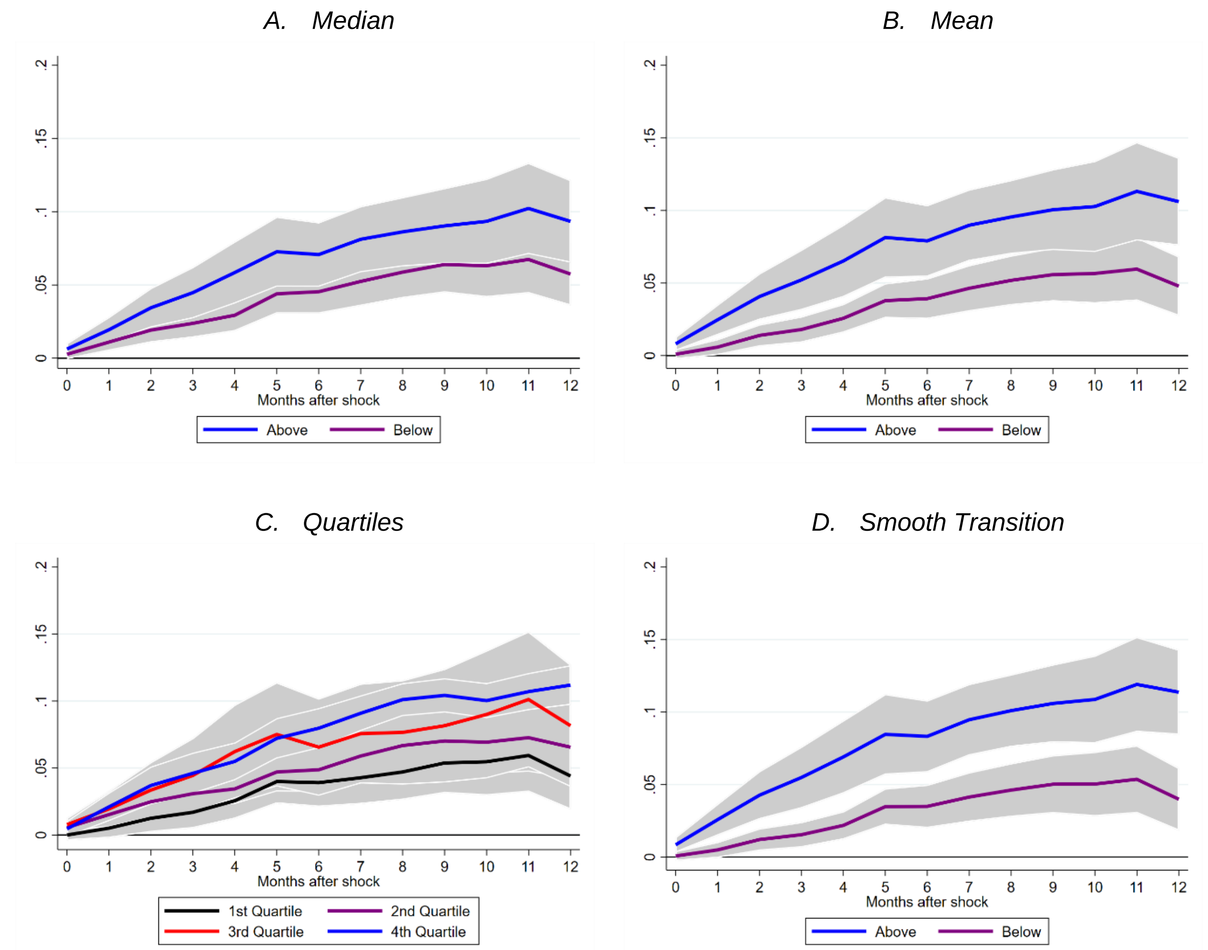
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices across different groups with current uncertainty in the country. Monthly uncertainty series are from Ahir, Bloom, and Furceri (2022). The dark shaded region indicates the 68 percent confidence band.

Figure A25: Exchange rate pass-through to core prices dependent on inflation uncertainty — disagreement



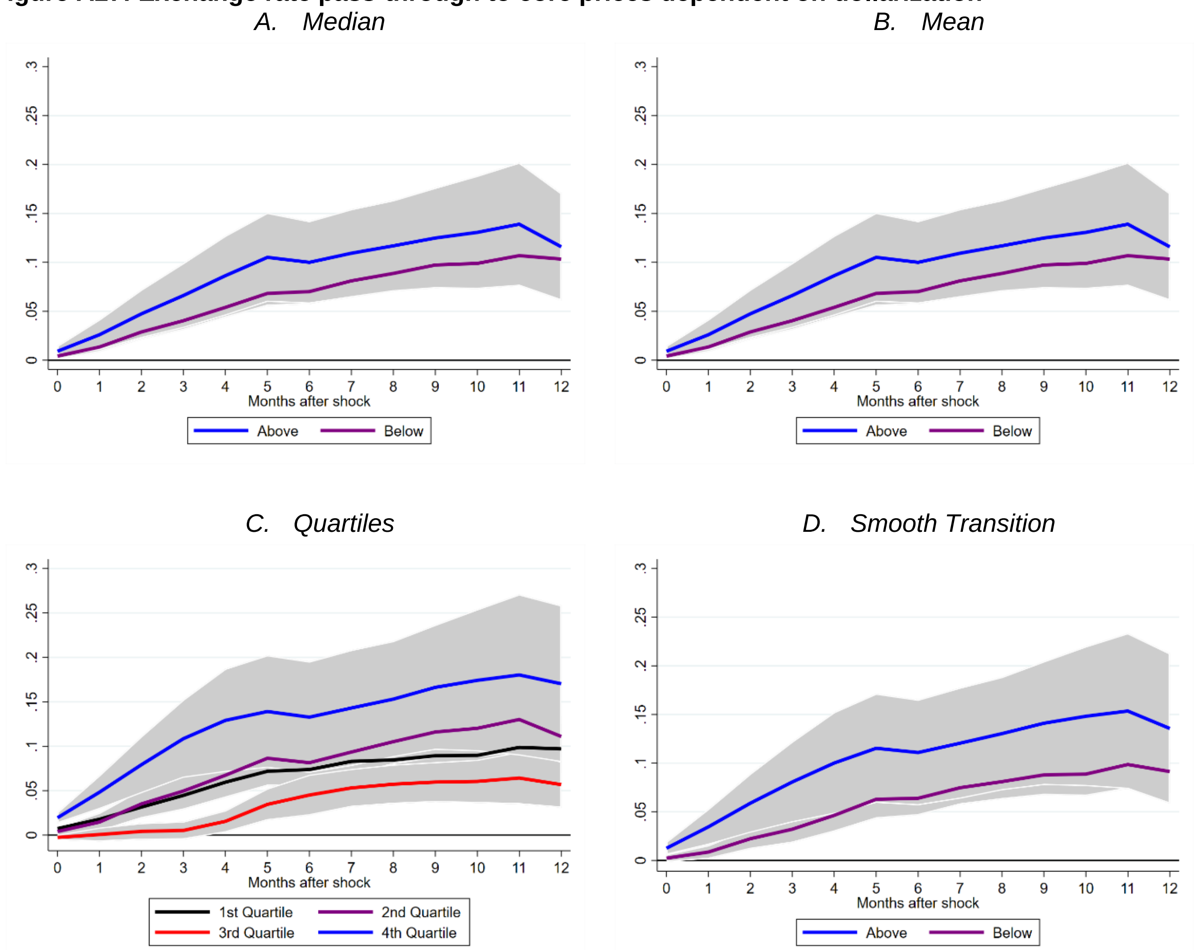
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices across different groups with country level inflation disagreement. Inflation uncertainty series are from Brito et al., (2021). The dark shaded region indicates the 68 percent confidence band.

Figure A26: Exchange rate pass-through to core prices dependent on the USD invoice share



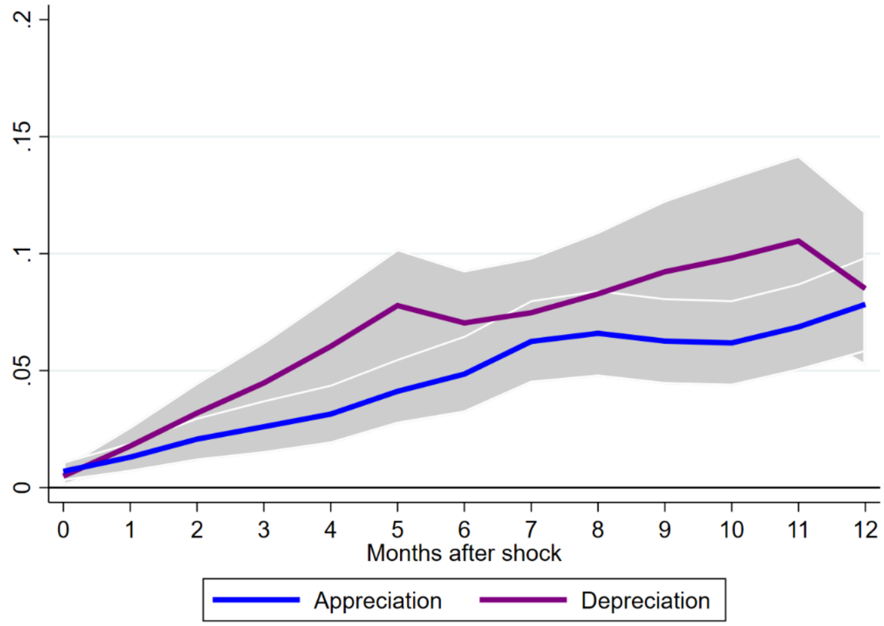
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices across different groups with average USD invoice share of imports in a country. USD invoice share is from Boz and others (2022). The dark shaded region indicates the 68 percent confidence band.

Figure A27: Exchange rate pass-through to core prices dependent on dollarization



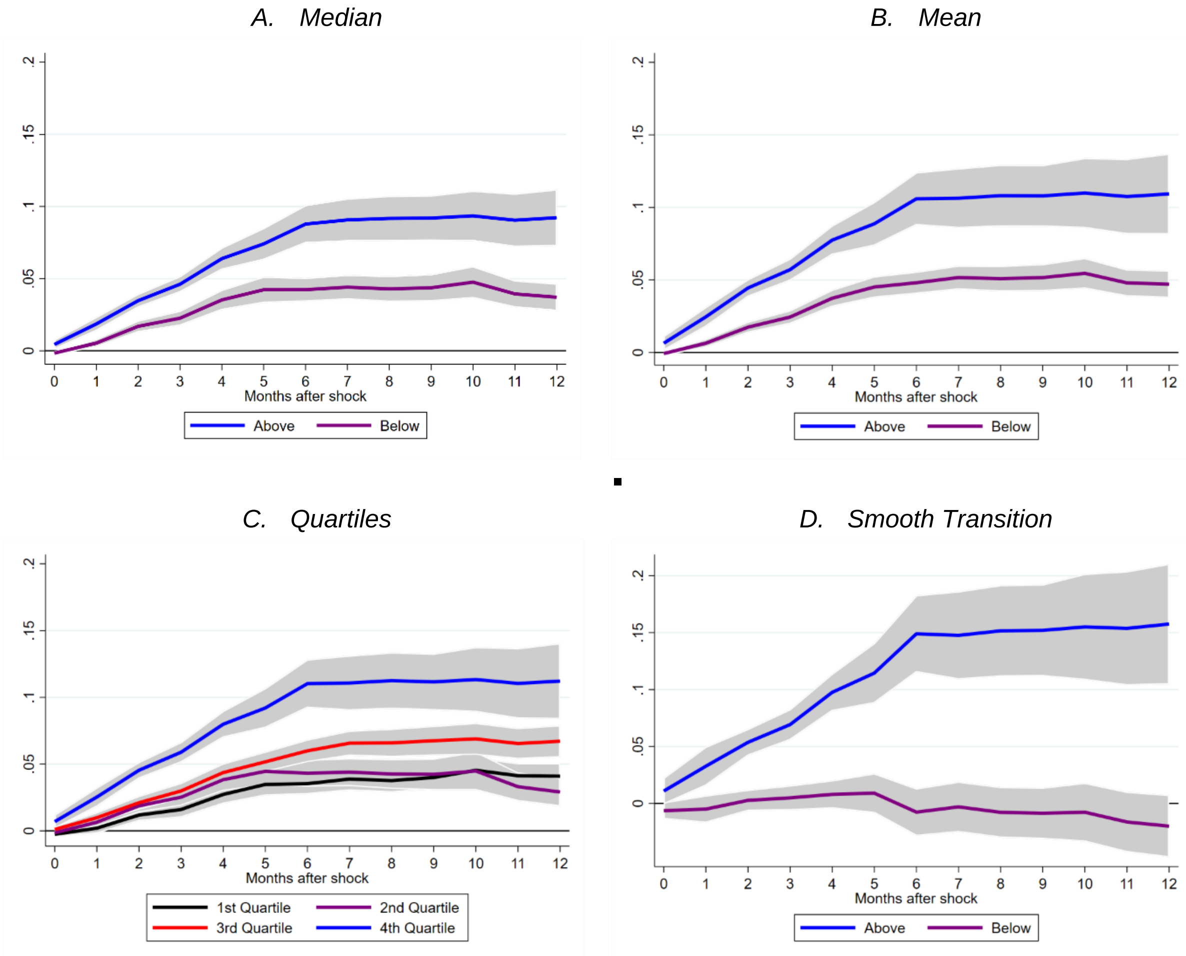
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in core prices across different bins based on average dollarization in a country. Dollarization rates are from Reinhart, Rogoff, and Savastano (2003). The dark shaded region indicates the 68 percent confidence band.

Figure A28: Exchange rate pass-through to core prices following depreciations and appreciations



Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in core prices for observations when there is a depreciation (purple) vs appreciation (blue). The dark shaded region indicates the 68 percent confidence band.

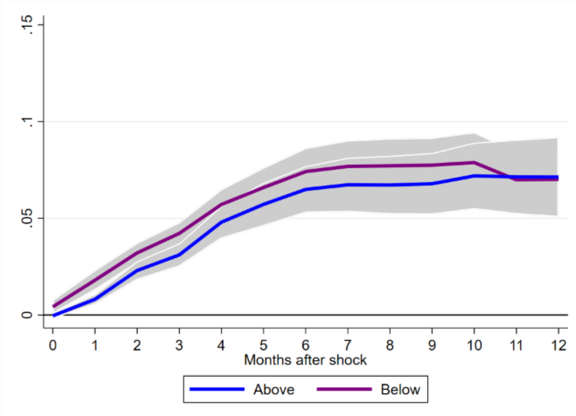
Figure A29: Exchange rate pass-through to inflation expectations dependent on the rate of inflation



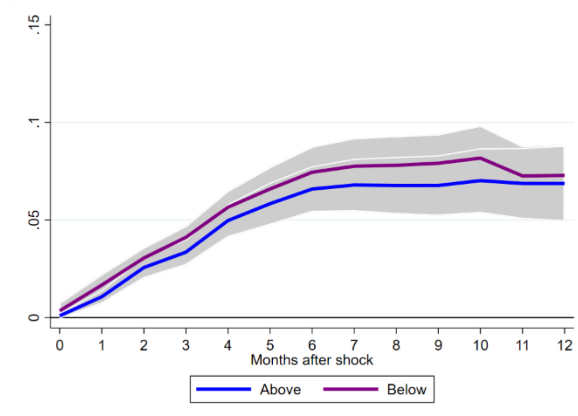
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations across different groups with current inflation. The dark shaded region indicates the 68 percent confidence band.

Figure A30: Exchange rate pass-through to inflation expectations dependent on the business cycle — growth

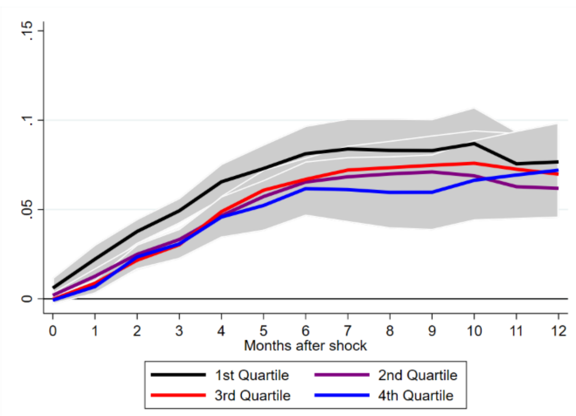
A. Median



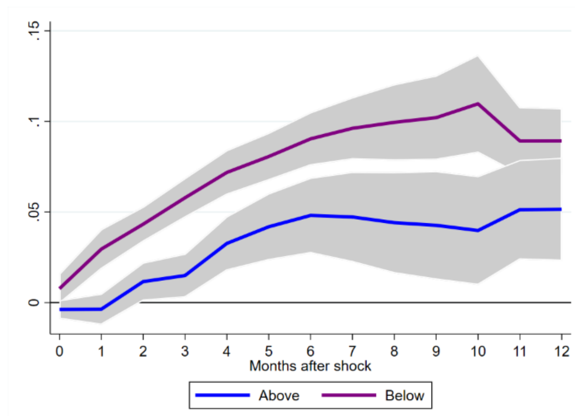
B. Mean



C. Quartiles

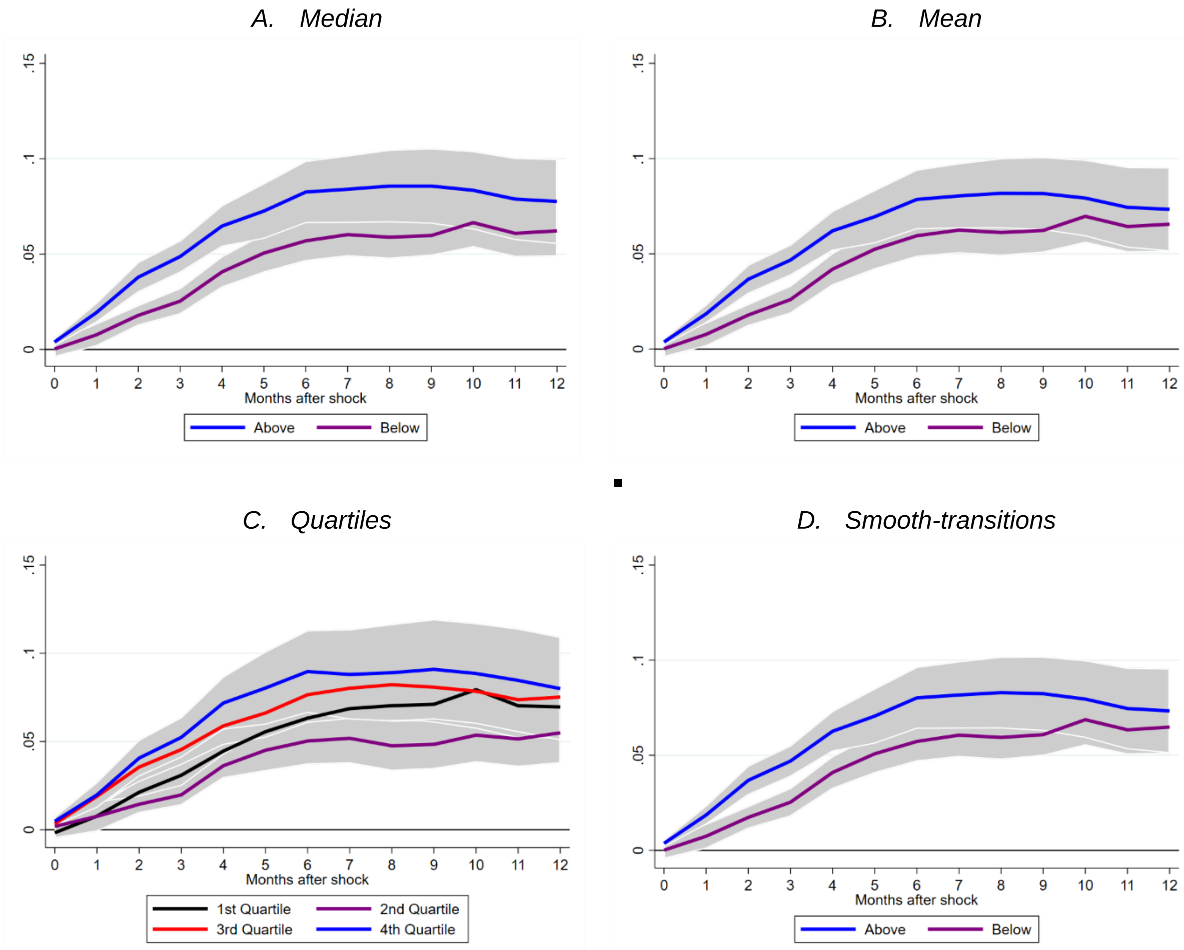


D. Smooth-transitions



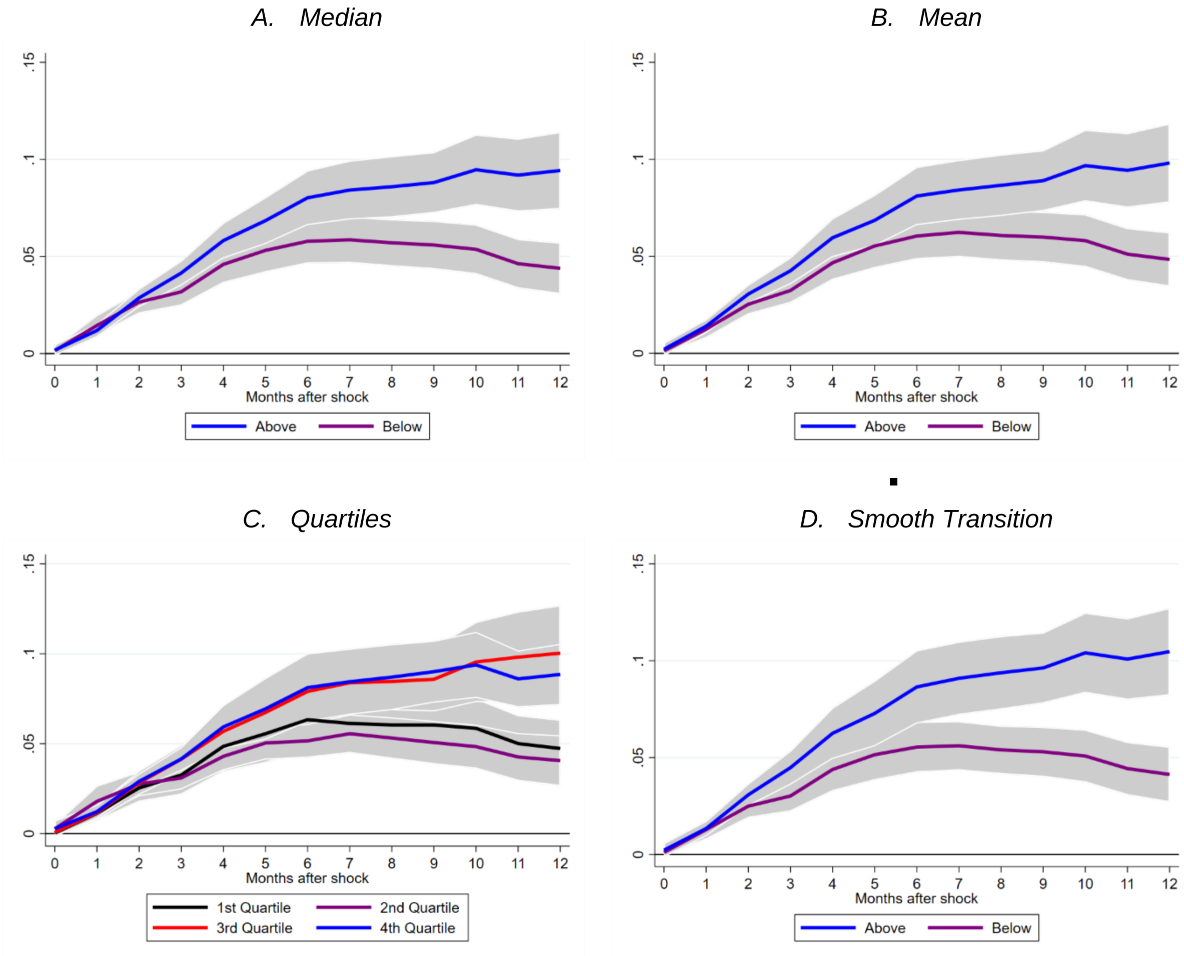
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations across different groups with real GDP growth. Real GDP growth rates are the deviation of quarterly (YoY) rates from country average. The dark shaded region indicates the 68 percent confidence band.

Figure A31: Exchange rate pass-through to inflation expectations dependent on the business cycle — output gap



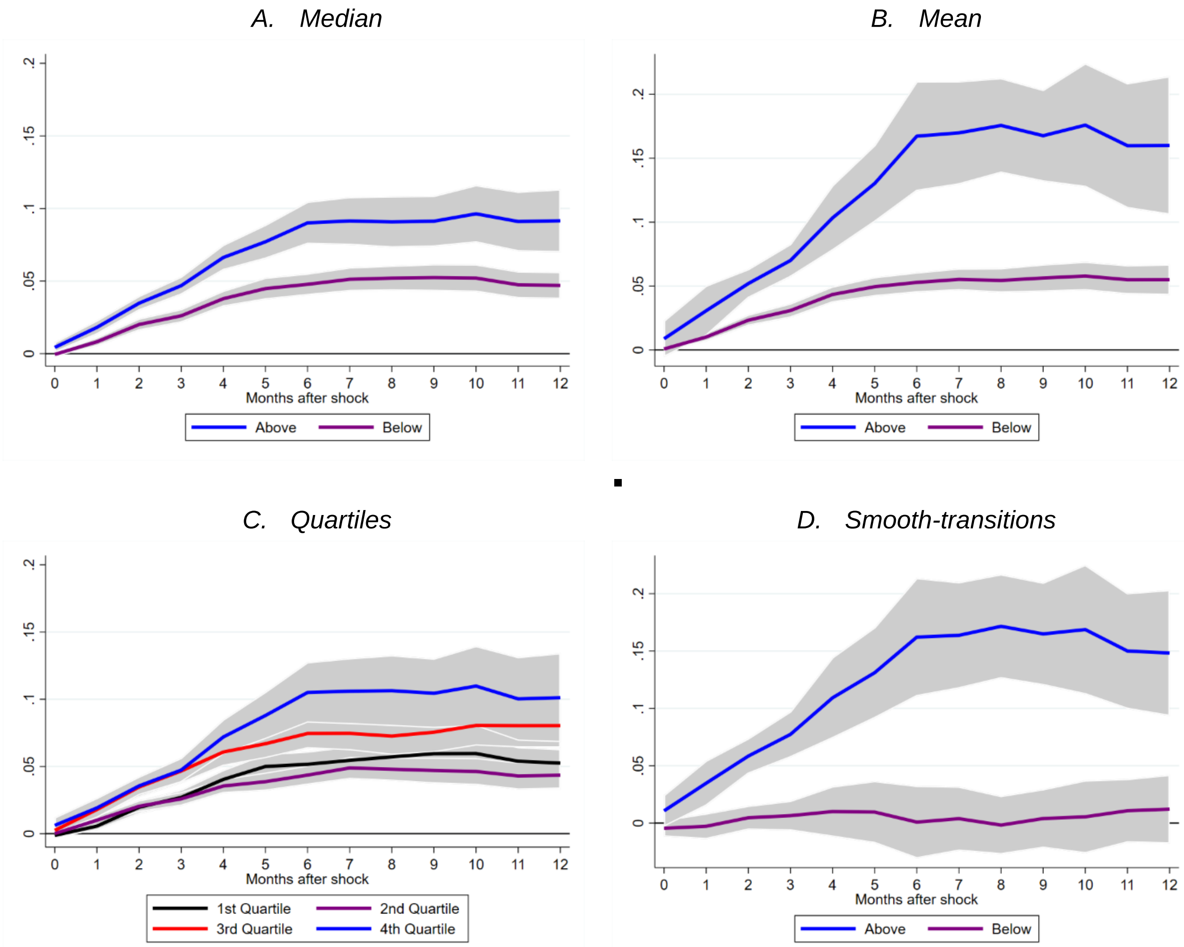
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations across different groups with quarterly output gap of country. Output gap series are the deviations of real GDP from their HP filtered trend. The dark shaded region indicates the 68 percent confidence band.

Figure A32: Exchange rate pass-through to inflation expectations dependent on uncertainty



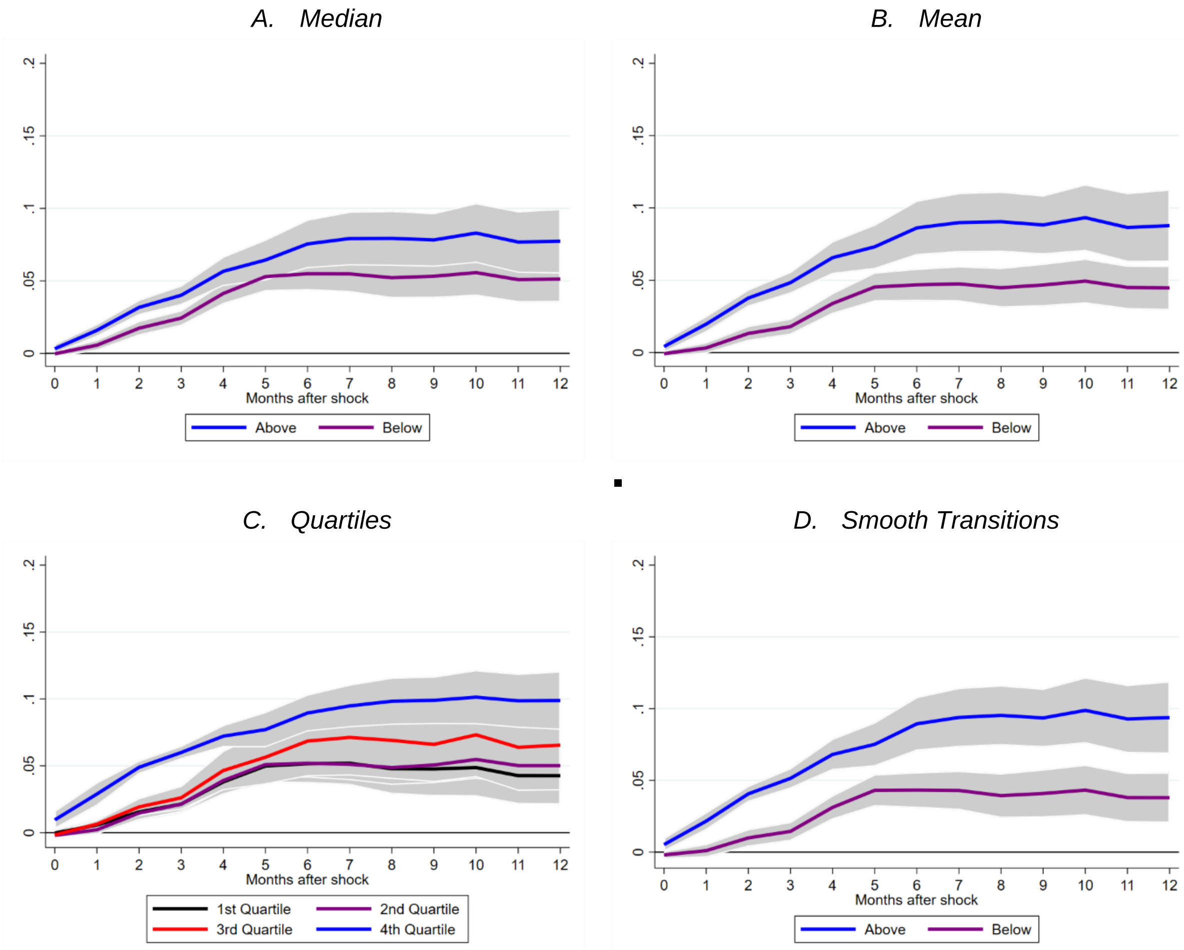
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations across different groups with current uncertainty in the country. Monthly uncertainty series are from Ahir, Bloom, and Furceri (2022). The dark shaded region indicates the 68 percent confidence band.

Figure A33: Exchange rate pass-through to inflation expectations dependent on inflation uncertainty — disagreement



Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations across different groups with country level inflation disagreement. Inflation uncertainty series are from Consensus Economics and constructed per Brito, Carrière-Swallow, and Gruss (2018). The dark shaded region indicates the 68 percent confidence band.

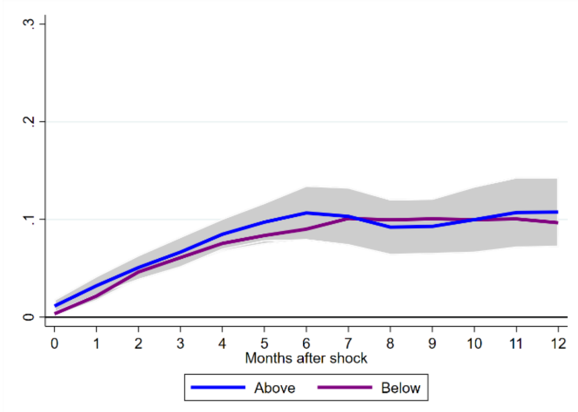
Figure A34: Exchange rate pass-through to inflation expectations dependent on the USD invoice share



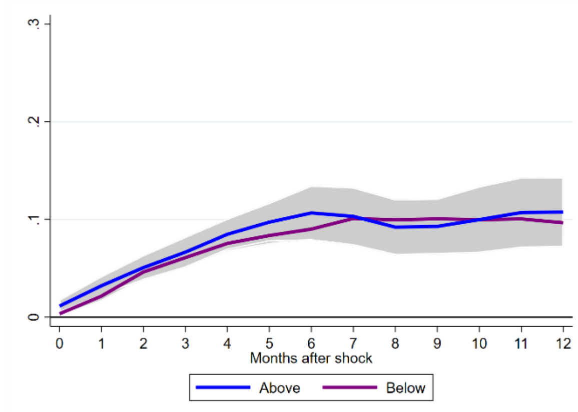
Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations across different groups with average USD invoice share of imports in a country. USD invoice share are from Boz and others (2022). The dark shaded region indicates the 68 percent confidence band.

Figure A35: Exchange rate pass-through to inflation expectations dependent on dollarization

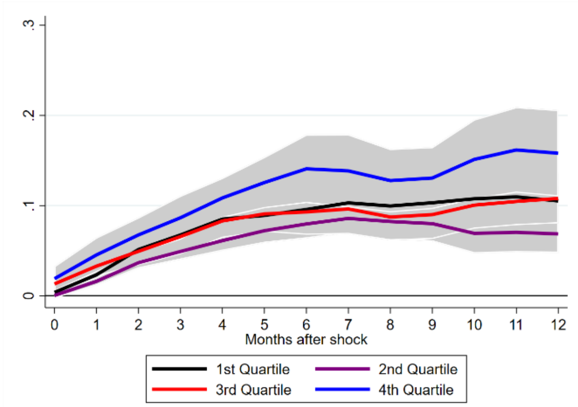
A. Median



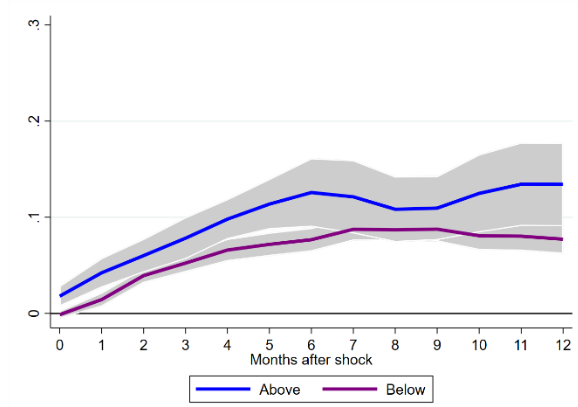
B. Mean



C. Quartiles

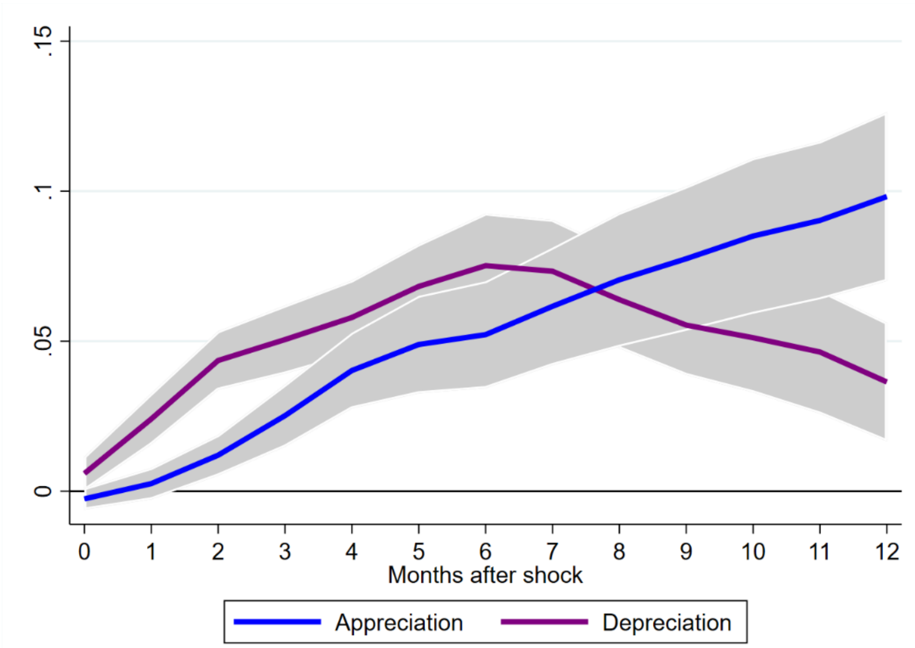


D. Smooth Transition



Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on the percent change in inflation expectations across different bins based on average dollarization in a country. Dollarization rates are from Reinhart, Rogoff, and Savastano (2003). The dark shaded region indicates the 68 percent confidence band.

Figure A36: Exchange rate pass-through to Inflation Expectations following appreciation and depreciation



Note: The figures present the impact of a one percent increase (depreciation) in local currency/USD on a percent change in inflation expectations for observations when there is a depreciation (purple) vs appreciation (blue). The dark shaded region indicates the 68 percent confidence band.

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