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Monetary Policy Transmission Heterogeneity: Cross- Country Evidence

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Monetary Policy Transmission Heterogeneity: Cross-Country Evidence
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ABSTRACT: This paper revisits the transmission of monetary policy by constructing a novel dataset of monetary policy shocks for an unbalanced sample of 33 advanced and emerging market economies during the period 1991Q2-2023Q2. Our findings reveal that tightening monetary policy swiftly and negatively impacts economic activity, but the effects on inflation and inflation expectations takes time to fully materialize. Notably, there exist significant heterogeneities in the transmission of monetary policy across countries and time, depending on structural characteristics and cyclical conditions. Across countries, monetary policy is more effective in countries with flexible exchange rate regime, more developed financial systems, and credible monetary policy frameworks. In addition, we find that monetary policy transmission is stronger when uncertainty is low, financial conditions are tight and monetary policy is coordinated with fiscal policy—that is, when the stances move in the same direction.

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1. Introduction

The global economy experienced a sharp and severe contraction in early 2020 as a result of lockdowns induced by the onset of the COVID-19 pandemic. In response to this severe downturn, central banks around the world implemented a range of conventional and unconventional monetary policy measures to support the economic activity. However, starting in 2021, inflation rates around the world surged to 30-year high levels, due to supply-side disruptions in the face of resilient demand supported in part by pandemic related policy measures. In response, central banks tightened monetary policy rapidly to tame inflationary pressures. Considering the importance of monetary policy as an immediate stabilization tool, our paper aims providing cross-country evidence on the transmission and heterogeneities of monetary policy from empirical point of view.

The existing literature, both theoretical and empirical, focuses on understanding monetary policy transmission mostly in advanced economies (AEs). There is only a limited literature providing a cross-country examination of how prices and activity respond to monetary policy shocks. Considering the variation in the structure of economies and practices of central banking across economies, it is very important to understand the heterogeneities in monetary policy.

The key challenge in understanding monetary policy transmission is to isolate the exogenous response of macroeconomic variables to monetary policy. Because monetary policy is typically guided by a rule, the largest part of the variation in monetary policy actions is due to the systematic component of monetary policy—that is, the response of the central bank to the current and expected future state of the economy. As discussed by Ramey (2016), identifying the causal effect of monetary policy requires looking at the exogenous deviations from the monetary rule. The key contribution of this paper is to generate a novel measure of monetary policy shocks for a large set of 33 advanced and emerging market economies spanning three decades. We identify monetary policy shocks in two steps. First, we calculate forecast errors in short-term rates by subtracting interest rates forecasts from realized interest rates. Next, we extract the part of these forecast errors that is orthogonal to the state of the economy by regressing the forecast errors on changes and forecasts of growth and inflation, as well as other pre-determined macroeconomic variables. We show that our monetary policy shock series are highly correlated with the shocks generated for the U.S. (Romer and Romer 2004) and the U.K. (Cloyne and Hurtgen 2016) following a similar approach in the literature.

We use these shocks in a local projections framework, to estimate the monetary policy transmission into real GDP and consumer prices and explore how these vary across countries and over time. In particular, we explore the role of country-specific structural characteristics in determining the rate of transmission (such as the geographic region, the exchange rate regime, the level of financial development and the degree of central bank transparency) as well as the state of economy (the level of uncertainty and financial stress, and GDP growth), the sign of the monetary policy shocks (expansionary vs. contractionary) and the complementarity with fiscal policy.

The results provide several insights about the monetary policy transmission into output and prices. First, on average, following a 100 bps monetary policy shocks, real GDP declines by 0.3 percent within two quarters and the effects remain persistent through 8 quarters. As expected, the response of consumer prices materializes slower than real GDP, with the effects being significant only after the second quarter and reaching its peak around the sixth quarter. The significance, size, and the pace of the impulse responses are robust to various specifications on how the shocks are generated and when controlling for fiscal policy and exchange rate changes.

The transmission does not vary substantially across different income levels of countries, with average output and prices responses of 0.2 percent and 0.4 percent in advanced economies and 0.4 percent and 0.2 percent in emerging market economies at their peak within 8 quarters. Across regions, the monetary policy transmission to real GDP is the highest in Asian economies, followed by European and Western Hemisphere economies, whereas price responses are stronger in European economies compared to others, with the weakest transmission in Asian economies.

Focusing on the role of exchange rate channel in monetary policy transmission, we classify countries into two groups based on their exchange rate regimes using the Ilzetzki, Reinhart, and Rogoff (2019) classifications. We document that output responds significantly less in fixed exchange rate regime countries. The results support the argument that muted exchange rate fluctuations following a monetary policy tightening close the expenditure switching channel and generate a limited response in output to monetary policy shocks. Transmission into prices is also weaker in fixed exchange rate regime group, due to weaker responses in output and the absence of secondary effects through the exchange rate pass-through.

We then use complementary approaches to examine how the monetary policy transmission depends on the state of the economy. We document that monetary policy is more effective in countries with higher levels of financial development, which may reflect that credit channel operates more effectively in economies with more advanced financial systems. The credibility and transparency of a central bank also play a key role in the transmission of monetary policy: We find that central banks that are more transparent typically have a stronger impact on prices, due to their substantial influence over inflation expectations, with clear and credible policies helping to anchor public and market expectations about future inflation rates.

Our paper also investigates how the monetary policy transmission varies with the level of economic uncertainty and tightness of financial conditions. Using quarterly uncertainty indexes from Ahir, Bloom and Furceri (2022), we show that the effects of monetary policy shocks on real GDP decreases with level of uncertainty. As Aastveit (2017) and Pellegrino (2021) document, monetary policy shocks are more powerful when uncertainty is low. This is consistent with the real option theory, which suggests that uncertainty not only reduces the levels of investment, hiring, and consumption, but it also makes economic actors less sensitive to changes in business conditions and interest rates (Bloom 2009). In contrast, we find the contractionary effects of monetary policy shocks are stronger when countries are experiencing tighter financial conditions, highlighting the role of financial conditions as a key factor in amplifying the transmission of monetary policy.

We also explore the role of fiscal policy in affecting the transmission of monetary policy. In line with Bianchi (2021) and Beyer et al. (2023), we find that the transmission to both output and prices are stronger when there is monetary and fiscal policy coordination—that is, when fiscal and monetary stances move in the same direction.

Lastly, we expand the analysis of Tenreyro and Thwaites (2016) on the U.S. to 33 countries and estimate non-linear relationships between economic activity and the sign of monetary policy shocks. In line with their findings, we find that contractionary shocks are more powerful than expansionary shocks on GDP. In addition, monetary policy is more effective when contractionary (expansionary) shocks are used during strong (weak) economic episodes.

The rest of the paper is organized as follows. The remaining of the section discusses the relevant literature. Section 2 describes the data and explains the monetary policy shocks construction. Section 3 presents the main results and discusses robustness checks. Section 4 documents the monetary policy heterogeneity. Section 5 concludes.

Literature Review

There is a vast literature on monetary policy transmission. The first strand of literature focuses on the identification of monetary policy shocks, which is mostly concentrated in advanced economies such as the U.S. (e.g., Romer and Romer (2004); Gurkaynak, Sachs and Swanson (2005); Gertler and Karadi (2015); Jarocinski and Karadi (2020); Bauer and Swanson (2023)), the U.K (Miranda-Agrippino and Ricco (2021)), Canada (Champagne and Sekkel (2018)), and Euro Area (Jarocinski and Karadi (2020)). There is also a growing literature identifying monetary policy shocks for multiple countries. Furceri, Loungani, and Zdzienicka (2018) construct annual monetary policy shocks for

32 advanced and emerging market economies and examine the effect of shocks on income inequality. We construct quarterly shock series compared to annual shocks from Furceri, Loungani, and Zdzienicka (2018) to understand the transmission into business cycle variables. Brandao-Marques et al. (2020) investigate the monetary policy transmission for only emerging market economies and find a significant effect on output growth and inflation. Our shocks differentiate from Brandao-Marques et al. (2020) by purging out economic conditions from forecast errors in interest rates rather than only using realized interest rate series. In a recent paper, Choi, Willems, and Yoo (2023) construct monetary policy shocks for 105 countries and analyze how the transmission varies with country and industry characteristics such as collateralization of assets or the durable goods intensity in an industry. Our paper contributes to the literature by documenting how country characteristics, such as central bank transparency and exchange rate regimes, as well as cyclical variables, such as uncertainty, financial conditions, and complementarity of fiscal shocks determines monetary policy transmission across 33 countries spanning three decades.

The second strand of the literature examines the heterogeneity of monetary policy transmission with country characteristics. Taylor (1995) argues that since monetary policy tightening typically appreciate the local currency, these shocks might reduce net exports and aggregate demand. Our findings on the role of the exchange rate regime support this argument, showing that countries with flexible exchange rate regimes experience stronger output and price responses to monetary policy shocks.

Regarding the role of financial development, Havranek and Rusnak (2013) find that developed financial systems provide more opportunities to hedge against monetary surprises in advanced economies, delaying the impact of a policy adjustment. In contrast, Georgiadis (2014) shows that more competitive financial sectors exhibit faster and more complete interest rate pass-through. Our results align with the latter paper, suggesting that a higher level of financial development is associated with a stronger monetary policy transmission.

IMF (2018) and Bems and others (2020) find that when inflation expectations are well anchored and central bank independence is high, monetary policy is more effective at restoring price stability with a lower output cost. Consistent with this literature, our findings suggest that the effect of monetary policy shock on prices is higher for countries with more transparent central bank frameworks.

Finally, our paper adds to the literature on the cyclical and asymmetric nature of monetary policy transmission. There is evidence that policy easing tends to have significant effects on prices but relatively minor effects on economic activity. Conversely, policy tightening is associated with substantial effects on output, particularly during economic booms, but tends to have limited impacts on prices (Tenreyro and Thwaites 2016; Barnichon and Matthes 2018; Angrist, Jordà, and Kuersteiner 2018; Forni and others 2020;). These asymmetric effects could be attributed to several factors such as the presence of downward nominal rigidities (Forni and others 2020); the interaction with fiscal policy, which dampens monetary policy in recessions but reinforces it in expansions (Tenreyro and Thwaites 2016); or the changes in firms' price-setting behavior when inflation increases (Nakamura and Steinsson 2008; Alvarez, Lippi, and Paciello 2011; Albagli, Grigoli, and Luttini 2023). We contribute to this literature by analyzing these channels in a cross-country context and generalizing the results to a larger sample of countries than previously investigated.

2. Data and Monetary Policy Shocks Identification

Data

The first step to construct the monetary policy shocks is to calculate monetary policy surprises—defined as the forecast errors in short term rates. We use Consensus Forecasts (CF) data which provides end-of-month short-term interest rate forecasts . The definition of forecasted interest rate variable varies across countries and time. Although CF database do not include the realized interest rates in their database, they do provide this information in their country-specific reports. We use the corresponding realized short-term interest rates for each country to match CF forecasted interest rate (see Table A1 for details).[1] To ensure that we use the closest interest rate to what CF forecast for each country, we randomly compare our retrieved interest rates with what CF reports in these reports. Our main data sources for realized short-term interest rates are HAVER, CEIC and Bloomberg. Compilation of this data leave us with a sample of 33 economies, both advanced and emerging.[2]

We use CF database for inflation and real GDP growth forecasts, as well. These forecasts are available monthly, and we use one-year ahead, median (across individual forecasters) inflation and real GDP growth forecasts. We use HAVER database for realized quarterly inflation, real GDP growth rates, and nominal effective exchange rates.

[1] For some countries, forecasted interest rate variable changes over time. In such cases, we also change the realized interest rate that we use in forecast error calculations, accordingly.

[2] For countries within the Euro Area (EA), CF dataset provides the European Central Bank's unified policy rate. Additionally, CF offers country-specific macroeconomic indicators, thereby facilitating the identification of both prevailing and anticipated economic conditions within these nations. By leveraging this data, we are able to generate monetary policy shocks that are exogenous to the macroeconomic conditions of individual EA countries. This approach also allows us to include four EA countries (for which CF do not provide policy rate forecasts directly but provides macro-data forecasts) since the date they joined the EA: Austria, Belgium, Portugal, and Ireland.

Although CF is available at the monthly frequency, forecasted short-term interest rates are 3 months ahead and end-of-month. To illustrate, for December 2021 vintage, CF provides the short-term interest rate forecast for March 2022 end-of-month. This approach creates an identification problem as monthly data introduces overlapping forecast horizons, thereby complicating the interpretation of available market information. To overcome this problem, we opted for a quarterly data frequency, utilizing the CF vintages from December, March, June, and September for each respective year-quarter. Then, we compare these forecasts with the end-of-month (quarter) realized interest rates for March, June, August, and December, respectively. This enables us to compute forecast errors on a quarterly basis without the distorting issue of overlapping forecast periods.
We also use various data sources to estimate the heterogeneity in monetary policy transmission: (i) the exchange rate regime classification from Ilzetzki, Reinhart and Rogoff (2019); (ii) the level of financial development from the IMF Financial Development Index Database; (iii) quarterly uncertainty indexes from Ahir, Bloom and Furceri (2022); (iv) a measure of central bank transparency from Dincer, Eichengreen and Geraats (2022); (v) the annual cyclically adjusted primary balance from IMF; and (vi) the financial condition indexes from IMF GFSR.

Monetary Policy Shocks Identification

Monetary policy shocks are identified in two steps. In the first step, following Furceri, Loungani, and Zdzienicka (2018), we calculate quarterly interest rate forecast errors for each country as follows:

$$FE_{j,t} = i_{j,t} - E_{t-1}[i_{j,t}] \quad (1)$$

where $E_{t-1}[i_{j,t}]$ denotes the interest rate forecast made at time t-1 (one-quarter ahead) for the short-term interest rate in country j at time t. By subtracting the forecasted interest rates from the realized interest rates ($i_{j,t}$), we are extracting the information that has been available to market participants preceding that quarter. Therefore, the forecast errors ($FE_{j,t}$) can be seen as monetary policy surprises for that quarter.

The second next step aims to address endogeneity issues. The deviation of the policy rate from its forecasted value may simply reflects policy changes in response to economic surprises during that quarter. For example, a positive forecast error might be due to the reaction of the central bank following an unanticipated acceleration in GDP growth or inflation in that quarter or increases in the expected values of these variables for the following quarters. To overcome this issue, we regress the forecast errors on short-term rates on various macro variables that would arguably be used by monetary policy committees while deciding the path of interest rates. Our specification follows a Taylor rule-type specification similar to Romer and Romer (2004):

$$FE_{j,t} = \alpha_j + \gamma_1 E_t y_{j,t+4} + \gamma_2 \Delta E_t y_{j,t+4} + \gamma_3 E_t \pi_{j,t+4} + \gamma_4 \Delta E_t \pi_{j,t+4} + \sum_{k=1}^{2} \delta_{j,k}^{y} y_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{\pi} \pi_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{i} i_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{NEER} \Delta NEER_{j,t-k} + \epsilon_{j,t} \quad (2)$$

where $E_t y_{j,t+4}$ and $E_t \pi_{j,t+4}$ denote one-year ahead real GDP growth and inflation forecasts in country j at time t, respectively. We also control for changes in the forecasts of these variables ($\Delta E_t y_{j,t+4}$ and $\Delta E_t \pi_{j,t+4}$), besides their two quarters lags. Our baseline specification also includes two quarters lags of end-of-quarter interest rates ($i_{j,t-k}$)Since our sample includes several EMs, we also control for changes in nominal effective exchange rate ($\Delta NEER_{j,t-k}$)by assuming that some central banks consider exchange rate market fluctuations while deciding on interest rates.[3]

After estimating Equation (2) for each country separately, we use the residuals, $\epsilon_{j,t}$, as our identified monetary policy. The timespan of the shocks varies across countries (see Table 1), depending on the availability of the variables in Equation (2). In Appendix and results section, we show three other considered alternatives to Equation (2) to generate monetary policy shocks. The results in the paper are robust to these different specifications.

Comparison with the Shocks from the Literature

We compare our monetary policy shocks with widely used shock series from the literature. Figure A1 compares our U.S. monetary policy shocks with Romer and Romer (2004) shocks and show that two shock series exhibit a very similar pattern and are highly correlated (0.78). Note that our comparison covers 2000Q1-2007Q4 due to data availability. Figure A2 compares our UK monetary policy shocks with those estimated by Cloyne and Hürtgen (2016). Also in this case, the correlation is positive and statistically significant, albeit a bit lower than for the US[4].

[3] The main difference from Romer and Romer (2004) is that they use FOMC Greenbook forecasts for the U.S. whereas we use CF due to cross-country data limitations.

[4] To address concerns about these two countries driving our baseline results, we tested the robustness of our findings by excluding them; the results remained consistent.

3. Monetary Policy Transmission

Empirical framework

To estimate the average monetary policy transmission, we follow Jorda (2005) and estimate impulse response functions from local projections as follows:

$$y_{j,t+h} - y_{j,t-1} = \beta_h MP_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \qquad (3)$$

where $y_{j,t}$ is the variable of interest (log real GDP and log consumer price index) and $MP_{j,t-1}$ is the lag of monetary policy shocks in country j.[5] The coefficient β_h denotes the (percent) response of the variables of interest to 100-basis point exogenous increase in domestic monetary policy shocks at horizon (quarter) h. The vector $Z_{j,t}$ contains 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). We cluster standard errors at the country level.

Results

Figure 1 presents the evolution of (log) real GDP and consumer prices following a 100-bps domestic monetary policy shock. The horizontal axis denotes the number of quarters following the shock; the solid line displays the average estimated response, and the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively.

The results suggest a sizable, significant, and persistent decline in real GDP. We find that a 100-bps monetary policy tightening shock leads to a 0.3 percent decline in real GDP within one quarter, with the effect being persistent and remaining at 0.3 percent 7 quarters after the shock (Panel A). Panels B and C report that the transmission to headline and core inflation is slower, the effects of monetary policy shocks become significant by the second quarter and peak at 6 quarters after the shock. The results are consistent with previous estimates in the literature and DSGE-type models

[5] Our results are robust to using the monetary policy shocks at time *t*.

used by central banks (Romer and Romer (2004); Jarociński and Karadi (2020); and Miranda-Agrippino and Ricco (2021); and Choi and others (2022)). This cross-country evidence on the sluggish response of prices relative to output supports the theoretical literature pointing nominal rigidities in prices generating non-neutrality of monetary policy.[6]

The baseline results are robust to different specifications used to generate the monetary policy shocks in Equation (2): (Model 1) without lags of realized interest rates and change in NEER; (Model 2) with only lags of realized interest rates; (Model 3) with only change in NEER. Table A4 reports the specific equations used for these specifications. Figures A4-6 present the estimation of Equation (3) using shocks from these three specifications (Model 1-3): These alternative shocks also lead to significant monetary policy transmission to output and prices.

Our results are also robust to include changes in fiscal policy and exchange rates. For fiscal policy, we control for the change in cyclically adjusted primary balance in Equation (3). The results reported in Figure A7 are similar to, and not statistically different, from the baseline. Figure A8 shows that the results are also robust to controlling for changes in NEER in Equation (3).

Addressing Price Puzzle

To further validate our identification strategy, we compare the responses of prices to: 1) changes in actual interest rates, 2) forecast errors ($FE_{j,t}$), and 3) our monetary policy shocks ($MP_{j,t}$). Specifically, we estimate Equation (3) using the three variables above, separately.

We show that extracting the forecasts on interest rates and information about the state of the economy from actual interest rates help us addressing the price puzzle—that is, the rise in prices following a contractionary monetary policy shock (Sims 1992). Figure 2 Panel A shows that an increase in interest rates is associated with rises in consumer prices. This result, driven by endogeneity, is widely discussed in the literature and initiated the motivation to generate exogenous monetary policy shocks. Panel B presents the responses of prices to forecast errors from Equation (1). We find that extracting the information from the previous quarter, while reducing the scale of the problem as evidenced by slightly smaller positive magnitudes, does not resolve the price puzzle. Figure 2, Panel B still shows that prices increase following a positive deviation of interest rates from their forecasted values, inconsistent with economic

[6] Figure A1 in Appendix reports the similar response of core prices against the shocks as consumer prices.

theory. This result validates our motivation to estimate Equation (2) on the argument that a deviation of interest rates from forecasts might be endogenous to new information becoming available about the state of the economy. Supporting our argument, Figure 2, Panel C shows that prices decline only following our monetary policy shocks that purge out the current and expected state of economy from forecast errors.

4. Heterogeneity in Monetary Policy Transmission

In this section, we examine the role of structural and cyclical factors as well as the state of the economy on variation in monetary policy transmission.

Role of the Exchange Rate Regime

To assess whether the response of output and prices to monetary policy shocks varies across different exchange rate regimes, we estimate the following specification:

$$y_{j,t+h} - y_{j,t-1} = \beta_h^{fixed} Fixed \times \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{floating} (1 - Fixed) \times \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \quad (4)$$

where Fixed is equal to 1 if country has a fixed exchange rate regime based on the Ilzetzki, Reinhart and Rogoff (2019) classification. The authors provide a measure of anchor currencies and exchange rate arrangements. Using their database, we assign countries in the Fixed group if the country has either a "Pre-announced peg" or "Crawling peg" regime and use the US dollar as the anchor. The rest of the sample is defined as having a floating regime.[7] Note that dummy variables are included separately as control variables when they are time-varying.

Figure 3 shows the results obtained estimating Equation (4). The charts on the right on Panel A and B report the impulse responses in output and prices for fixed exchange rate regimes, and the charts on the left for floating exchange rate. Looking at the figure, it is immediately evident that the monetary policy transmission is stronger in countries with floating exchange rate regimes than fixed exchange rate, which is consistent with exchange rate channel of the monetary policy. Fixed exchange rate regime closes this channel and expenditure switching channel becomes inactive and leads to a limited response in output, and subsequently in prices. Column 1 in Tables A2 and A3 also confirm that the difference between groups is statistically significant.

[7] Note that there are country-time observations with an exchange regime classified as "Wider crawling peg or managed floating". Our baseline analysis does not assign these observations to "Fixed" group. However, the results are robust to including managed floating regimes to the Fixed group as well.

Income and Regional Groups

We also analyze the variation in monetary policy transmission across different economic groups and regions. Interacting monetary policy shocks with the AE and EM dummies, Figure A9 shows that monetary policy shocks have similar effects on output and prices between AEs and EMs. In addition, Figure A10 presents the regional variation in transmission into output and prices. The results suggest that monetary policy shocks have the strongest effect on output (with a high persistence) in WHD countries followed by APD and EUR regions. However, price responses to shocks are insignificant in WHD region, whereas transmission into prices are substantial in EUR followed by a significant but relatively weaker response in APD.

Role of Economic Structures and Institutions

We now examine whether the monetary policy transmission varies with the structure of the economy using the following specification:

$$y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_j \times \mathrm{MP_{j,t-1}} + \beta_h^{low}\left(1 - D_j\right) \times \mathrm{MP_{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \quad (5)$$

where D_j is equal to 1 if the country mean of the state variable (e.g., financial development, central bank transparency, uncertainty) is above the sample mean.[8] β_h^{high} and β_h^{low} capture the magnitude of the monetary policy transmission at various horizons *h* when the state variable is relatively high and low, respectively.

Financial Development

We begin by presenting the state-dependent monetary policy transmission results using the level of financial development as the state variable. Figure 4 reports the response of output (Panel A) and prices (Panel B). For each chart in panels, we report the estimated coefficients, together with the associated 90-percent confidence bands. The results reported in Figure 4 suggest that the monetary policy transmission on both real GDP and consumer prices is dependent and increasing with financial development. Table A2 also confirms the statistical difference in GDP across various horizons between two regimes but the difference in consumer prices is significant only during the first two quarters (Table A3). Consistent with the credit channel of monetary policy, our findings show that a tightening shock generates stronger output and price responses in countries with a higher level of financial development.

[8] We also consider two other specifications: 1) The dummy variables are generated using the median of the state variable and sample; 2) Allowing regimes to vary smoothly between low and high states with smooth-transition functions. The results from these specifications are in Appendix.

Central Bank Transparency

Estimating Equation (5) using the central bank transparency index compiled by Dincer, Eichengreen and Geraats (2022), Figure 5 shows that real GDP responses against the shocks are not significantly different across level of central bank transparency. In contrast, Panel B suggests a stronger monetary policy transmission to prices in countries with higher central bank transparency (the differences in the response are statistically significant Table A3). This finding provides evidence in support of the role of central bank transparency in improving monetary policy transmission through higher credibility and better anchored inflation expectations.

Role of Cyclical Factors, Complementary Policies and State of the Economy

Uncertainty

We consider the following specification to estimate differential responses of output and prices to monetary policy shocks under different states:

$$y_{j,t+h} - y_{j,t-1} = \beta_h^{high} \mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{high}} \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{low}\left(1 - \mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{low}}\right)\mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \quad (6)$$

where $\mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{high}}$ is a dummy variable that takes value 1 when country-time observation is above country mean. Note that the set of control variables is augmented by the dummy $\mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{high}}$.

Using the uncertainty index from Ahir, Bloom and Furceri (2022), Figure 6 shows that monetary policy transmission on output is stronger when countries are experiencing lower uncertainty (the difference is statistically significant by the 6th quarter, Table A2), in line with finding reported by Aastveit (2017) and Pellegrino (2021). This result is consistent with the real option theory, which suggests that uncertainty not only reduces the levels of investment, hiring, and consumption, but it also makes economic actors less sensitive to changes in interest rates (Bloom 2009). In contrast, the monetary policy transmission to prices is not different between different state of economic uncertainty.

Financial Conditions

To examine the role of financial conditions on monetary policy transmission, we use quarterly financial condition indexes from IMF GFSR and follow the same specification from Equation (6). Dummy variable generation slightly differs that we assign country-time observations into high (low) group, if the "lag" financial index is above (below) the country mean to address a potential endogeneity issue.[9] Figure 7 shows that monetary policy transmission to

[9] We also find that monetary policy shocks lead to an increase (a tightening) in financial conditions within a quarter.

output and prices are stronger when countries are experiencing tighter financial conditions (higher financial condition index). The differences in responses between high and low financial condition states are more evident and significant in output responses than price responses. Therefore, the contractionary effects of a monetary policy tightening shock is amplified by tighter financial conditions.

Sign of the Shocks and the Business Cycle

Next, we test whether the monetary policy transmission varies on the stage of business cycle by Estimating Equation (6). We assign country-time observations into high (low) business cycle group, $\mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{high}}$ ($\mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{low}}$), if the output gap in a period is above (below) the country mean.[10] Figure 8 suggests that monetary policy transmission to output is stronger when output gap is below country mean, whereas prices are more responsive to the monetary policy shocks when output gap is high. However, the results mask significant heterogeneity that monetary policy might have been more accommodative when output is below its potential level, and more contractionary when output gap is positive.

To shed light on this concern, we examine whether sign of the monetary policy shocks produces different monetary policy transmission by estimating the following specification:

$$y_{j,t+h} - y_{j,t-1} = \beta_h^{+}\mathrm{D}_{\mathrm{j,t-1}}^{+}\mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{-}\left(1 - \mathrm{D}_{\mathrm{j,t-1}}^{+}\right)\mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4}\theta_k^{Z} Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \qquad (8)$$

where $\mathrm{D}_{\mathrm{j,t}}^{+}$ is a dummy variable that takes value 1 for positive (expansionary) shocks, and zero otherwise.

Figure 9 suggests that contractionary shocks are more powerful than expansionary shocks on GDP, in line with the evidence of Tenreyro and Thwaites (2016) for the U.S[11].

Finally, the following specification uses triple interactions to estimate the differential impacts of expansionary and contractionary shocks with the business cycle:

$$y_{j,t+h} - y_{j,t-1} = \beta_h^{high,+}\mathrm{D}_{\mathrm{j,t-1}}^{+}D_{j,t-1}^{ygap}\mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{high,-}\left(1 - \mathrm{D}_{\mathrm{j,t-1}}^{+}\right)D_{j,t-1}^{ygap}\mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{low,+}\mathrm{D}_{\mathrm{j,t-1}}^{+}\left(1 - D_{j,t-1}^{ygap}\right)\mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{low,-}\left(1 - \mathrm{D}_{\mathrm{j,t-1}}^{+}\right)\left(1 - D_{j,t-1}^{ygap}\right)\mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4}\theta_k^{Z} Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \qquad (9)$$

where $D_{j,t-1}^{ygap}$ is equal to 1 if output gap is above the sample average.

[10] We compute output gap using Hodrick-Prescott filter.

[11] Table A5 in annex depicts the number of positive (expansionary) and negative (contractionary) shocks by country in the sample.

Figure 10 suggests that negative shocks are expansionary when economy is weak, and positive shocks are contractionary when output gap is above average. Therefore, our findings show that monetary policy is more effective when contractionary (expansionary) shocks are used during strong (weak) economic episodes.

Fiscal Policy

We also examine how the fiscal policy stance affect the monetary policy effectiveness. First, we calculate the changes in the cyclically adjusted primary balance to GDP for each country. Then, we generate a dummy variable "tight" ("loose") if the change in the fiscal stance variable is positive (negative). We estimate the role of fiscal by estimating the following specification:

$$y_{j,t+h} - y_{j,t-1} = \beta_h^{tight} \mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{tight}} \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{loose} \left(1 - \mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{tight}}\right) \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t} \qquad (7)$$

where $\mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{tight}}$ is a dummy variable that takes value 1 for tight fiscal stance and zero otherwise. Figure 11 suggests that monetary policy tightening shocks have stronger effects on output and prices when fiscal policy is tighter. The results provide cross-country evidence on how monetary/fiscal coordination helps central banks effectiveness (Bianchi 2021).

Alternative Specifications

As a robustness check, we model interactions considering two alternative specifications. In the first specification, we estimate an equation similar to Equations (5)-(8) but we construct dummies based on the median of the state variable and samples. In a second specification, we use a smooth-transition approach (as in Tenreyro and Thwaites 2016) to allow the response of output and prices to vary smoothly between low and high state regimes. The results obtained with these alternative specifications are similar to, and not statistically different, from the baseline (Appendix Figure A11-20). Finally, and following recent literature on this topic (Bauer and Swanson, 2022; Stock and Watson, 2018) we further check whether our results are consistent when using an instrumental variable approach in our local projection setting where we instrument changes in interest rates with our monetary policy shocks. Figure A21 shows that our baseline results and magnitudes remain robust when using this specification.

Time-variation in monetary policy transmission

To evaluate how monetary policy transmission has changed over time, we employ a rolling-window methodology applied to our baseline specification on Equation (3). Specifically, the rolling windows encompass overlapping periods, shifting forward by one year for each new estimation. For instance, if data starts in 1995, the first rolling window captures data from 1995 to 2009, and the subsequent window shifts to cover 1996 to 2010, continuing until the final window of 2009 to 2023.

Figure A22 reveals that while GDP growth transmission has largely remained stable, the transmission to inflation has weakened in the years post-COVID19 pandemic. Firat and Hao (2023) find that the contribution of supply-driven to aggregate inflation has been substantial during the pandemic, and they show that monetary policy is less effective when inflation is mostly supply-driven. These findings are in line with ours and shed light on why we observe a weakening in monetary policy transmission to prices during recent years.

5. Conclusion

To understand the impact of monetary policy on prices and economic activity, we construct a novel measure of monetary policy shocks across a large set of 33 advanced and emerging market economies spanning three decades. Our findings reveal that tightening monetary policy swiftly impacts economic activity, but the effects on inflation require substantial time to fully materialize.

Importantly, there exist significant heterogeneities in the transmission of monetary policy across countries, contingent upon cyclical conditions and structural characteristics. We show that monetary policy is more effective in countries with more developed financial systems, credible monetary policy frameworks and floating exchange rate systems. In addition, we find that the effects of monetary policy on output are muted during periods of uncertainty and when fiscal operates in the opposite direction. Furthermore, our results suggest that negative shocks are expansionary when economy is weak, and positive shocks are contractionary when output gap is above average.

Our findings are relevant for the design of stabilization policy, as they inform under which conditions monetary policy is more effective in affecting output and inflation. They also highlight the necessity for structural reforms to enhance financial developments, alongside the maintenance of central bank independence and transparency to improve monetary transmission. Finally, they also suggest that models assessing the effectiveness of monetary policy would need to adequately incorporate non-linearity depending on countries structural and cyclical conditions

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Tables

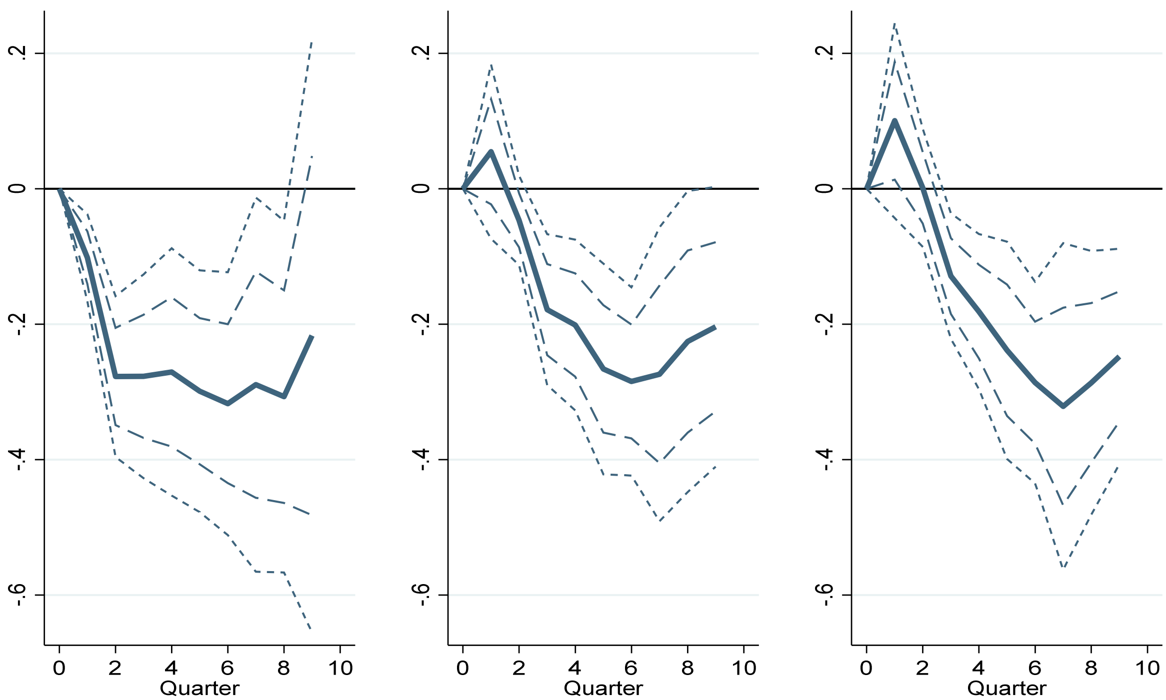
Table 1. Availability of monetary policy shocks by country

Iso3 code	Start	End	Iso3 code	Start	End
AUS	1995q2	2022q4	ITA	1999q2	2023q1
AUT	1998q4	2023q1	JPN	2010q3	2023q1
BEL	1998q4	2023q1	KOR	1995q2	2023q1
BRA	2002q4	2023q1	MEX	2002q4	2023q1
CAN	1991q2	2023q1	MYS	1995q2	2023q1
CHE	1991q2	2022q1	NLD	1999q2	2023q1
CHL	2002q4	2023q1	NOR	2004q2	2023q1
CZE	2008q3	2022q4	NZL	1995q4	2023q1
DEU	1999q2	2023q1	PHL	2009q3	2023q1
ESP	1999q2	2023q1	POL	2008q3	2022q4
FRA	1999q2	2023q1	PRT	1998q4	2023q1
GBR	1991q2	2021q4	SVK	2008q3	2022q4
GRC	1998q4	2023q1	SWE	2004q2	2020q2
HUN	2008q3	2022q4	THA	1999q2	2023q1
IDN	2014q2	2023q1	TUR	2008q3	2022q4
IND	2002q3	2023q1	USA	1991q2	2023q1
IRL	1998q4	2023q1			

Figures

Figure 1. Baseline. Monetary policy transmission to real GDP growth and consumer prices

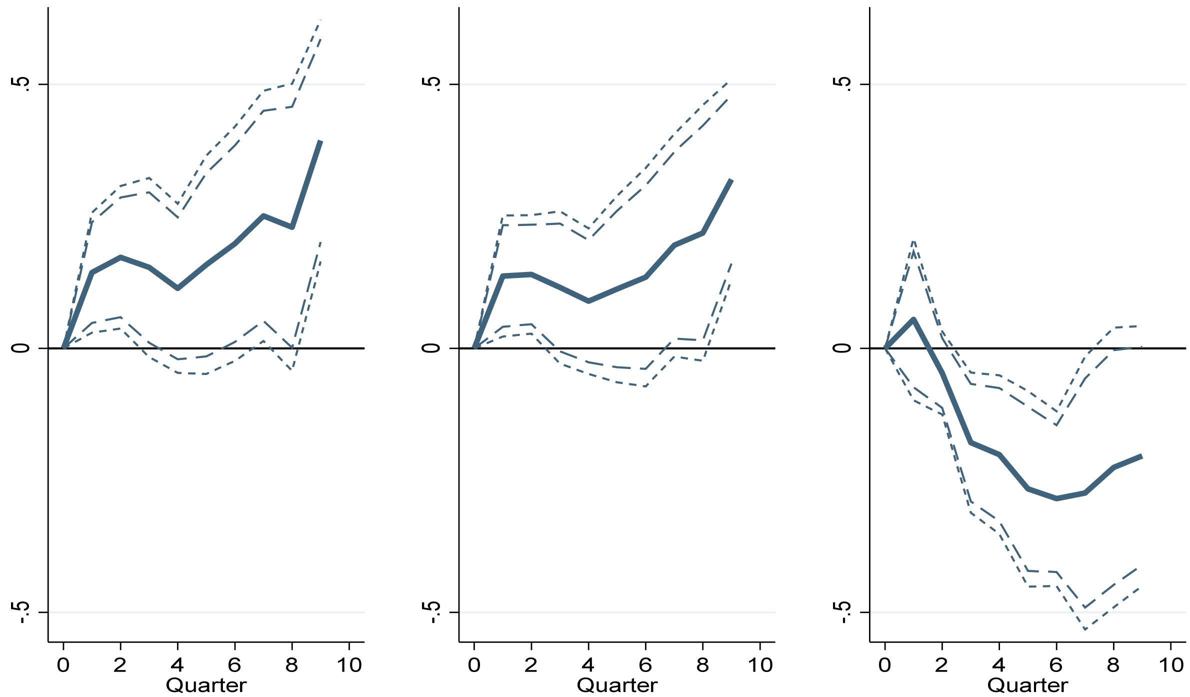
GDP **Headline Inflation** **Core Inflation**



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of h quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons k, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 2. Price puzzle

Raw Interest Rates **Forecast Errors** **Monetary Policy Shocks**

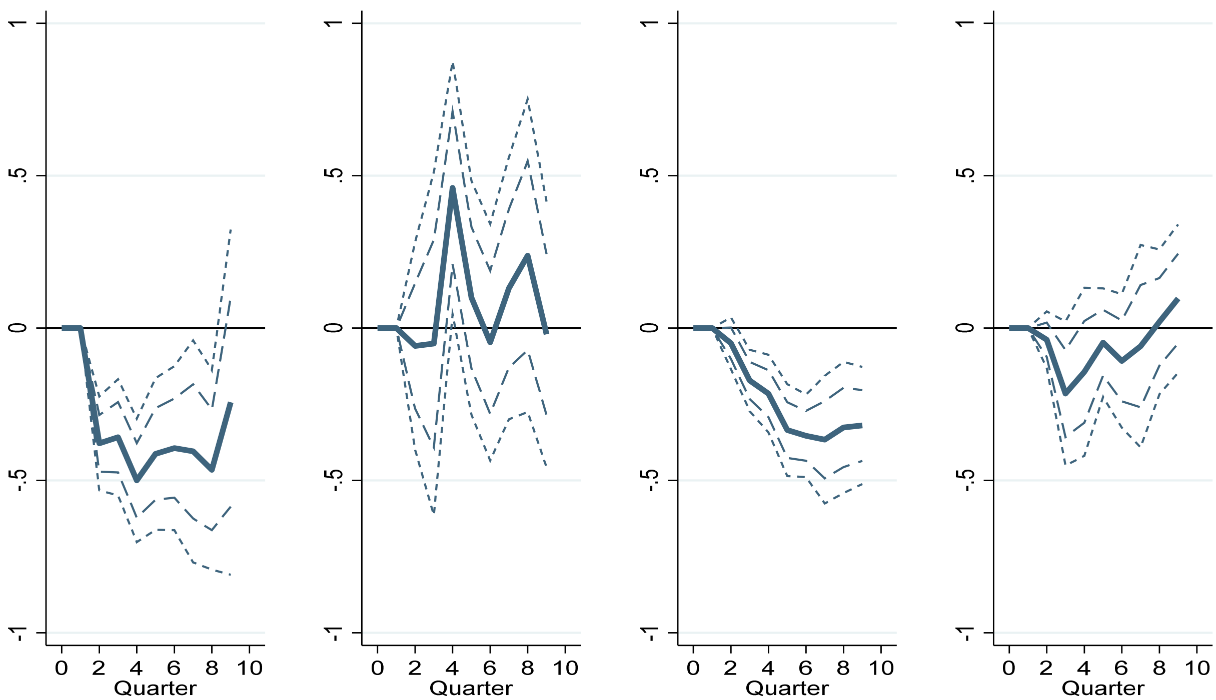


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t}-1} + \sum_{\mathrm{k}=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of changes in interest rates, forecast errors and monetary policy shocks in country *j*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 3. Exchange rate regime

GDP | **Headline Inflation**

Floating | Fixed | Floating | Fixed

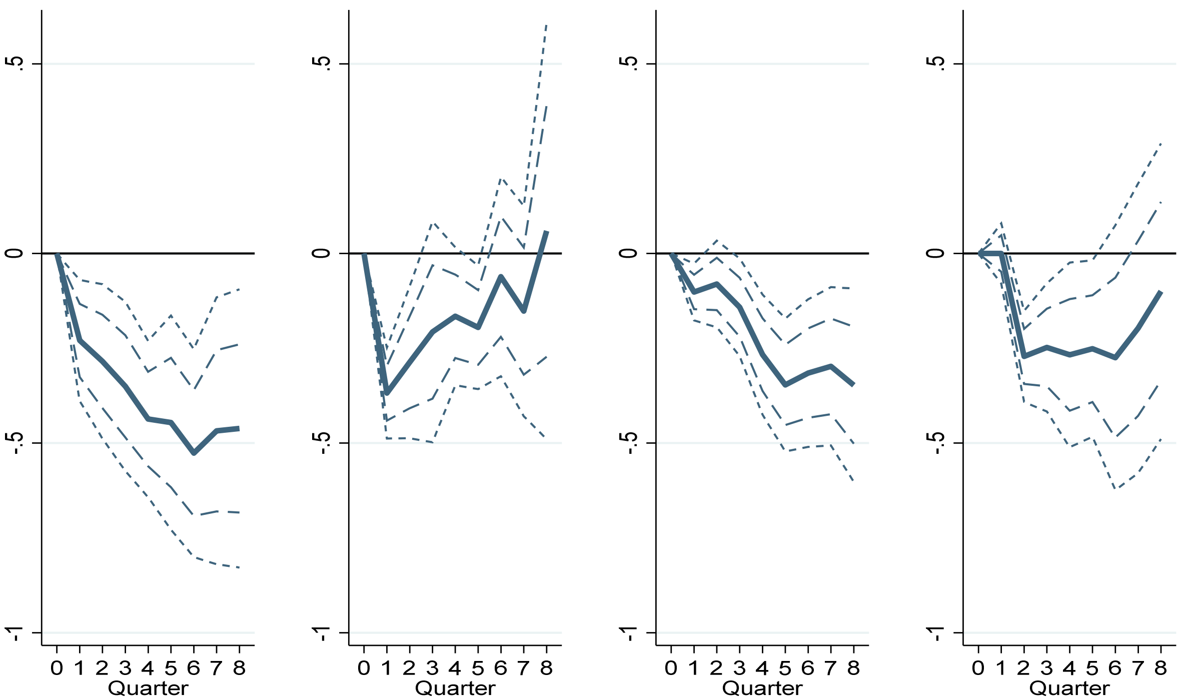


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{fixed} Fixed \times \mathrm{MP}_{j,t-1} + \beta_h^{floating}(1 - Fixed) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. *Fixed* is equal to 1 if country has a fixed exchange rate regime based on Ilzetzki, Reinhart and Rogoff (2019) classifications. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate forβ_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 4. Financial development

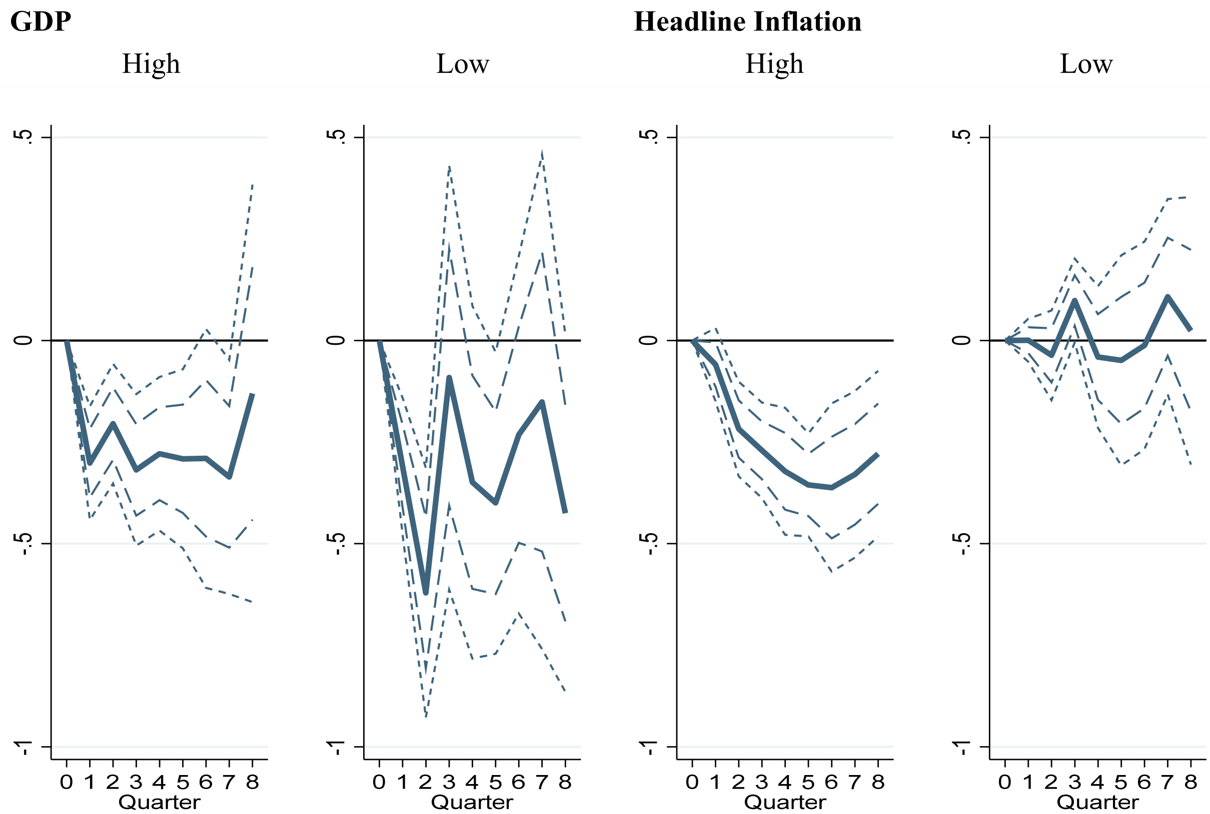
GDP **Headline Inflation**

High Low High Low



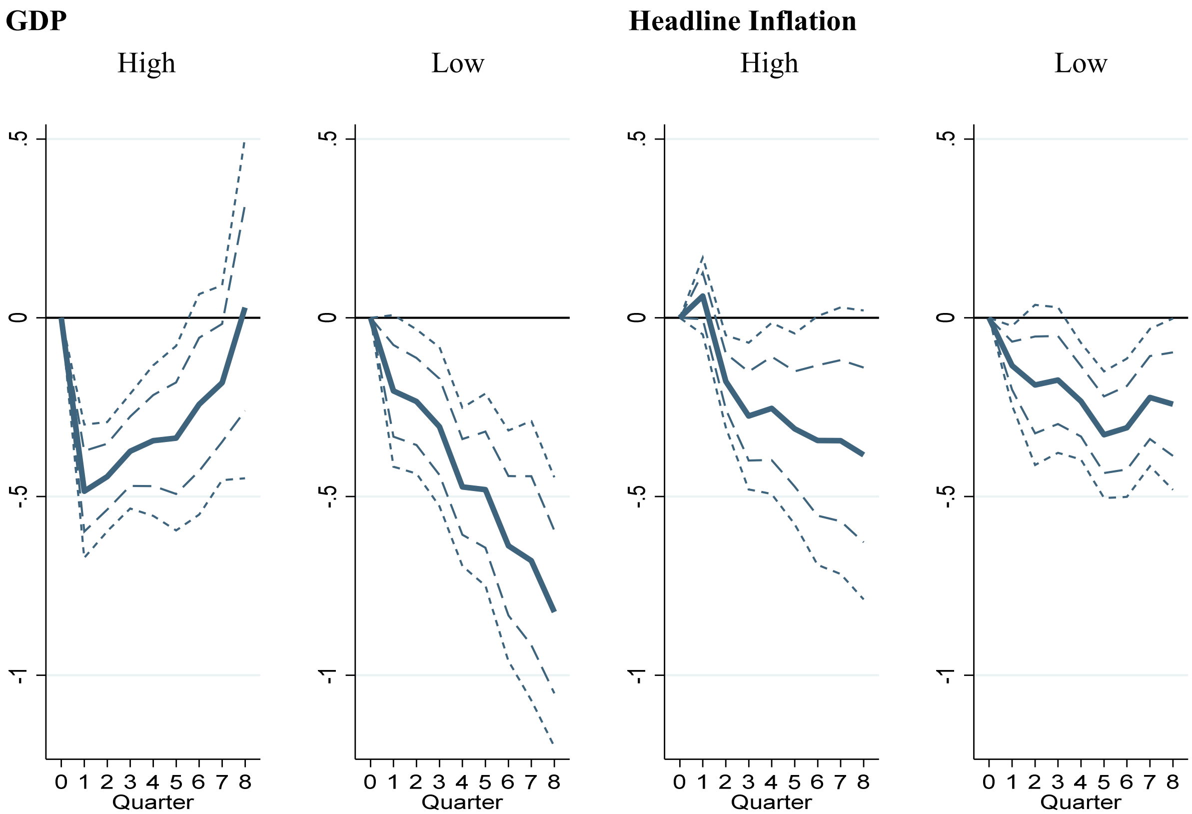
Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if the within country mean of financial development is above the sample mean. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons k, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 5. Central bank transparency



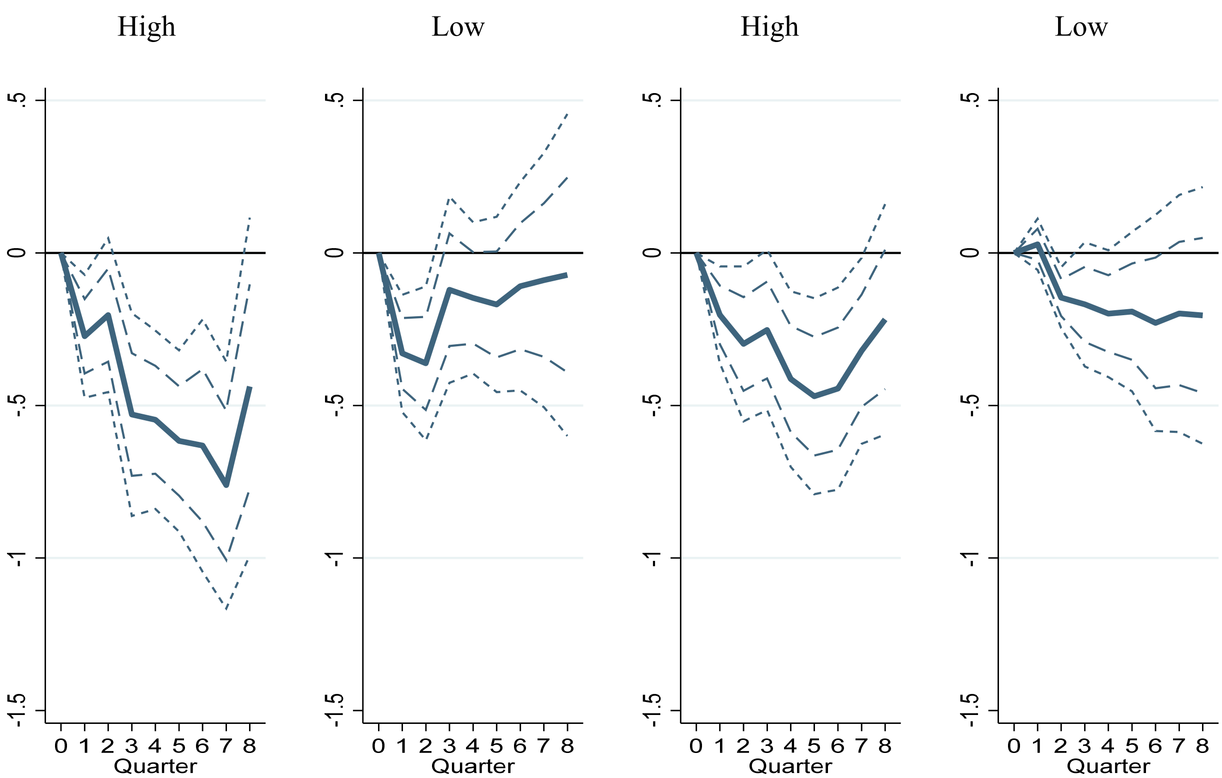
Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if the within country mean of central bank transparency is above the sample mean. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 6. Uncertainty



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{low}(1 - D_{jt}) \times \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if country *i* economic uncertainty is above the sample mean at time *t*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons k, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level..

Figure 7. Financial Conditions Index

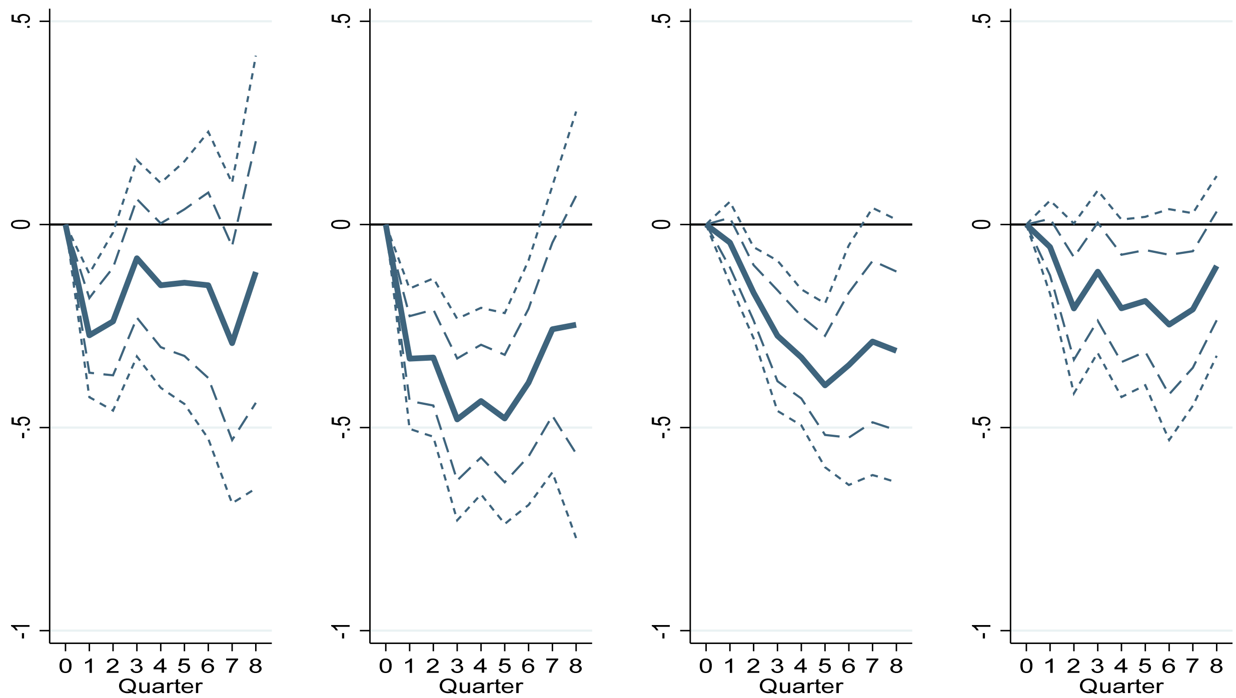


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt-1} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt-1}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt-1} is equal to 1 if country *i,t* financial conditions index is above the sample mean for the previous quarter at time *t*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level..

Figure 8. Business Cycle

GDP **Headline Inflation**

High Low High Low

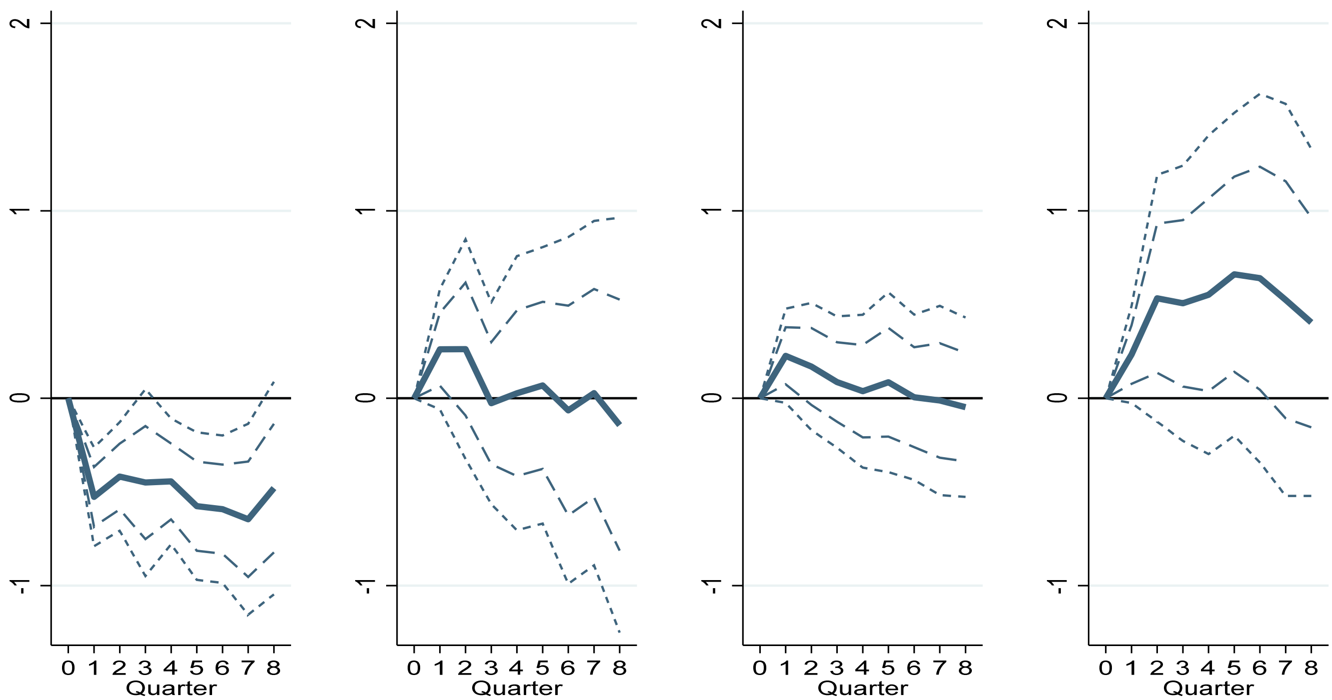


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if country *i* output gap is above the sample mean at time *t*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level..

Figure 9. Positive vs negative shocks

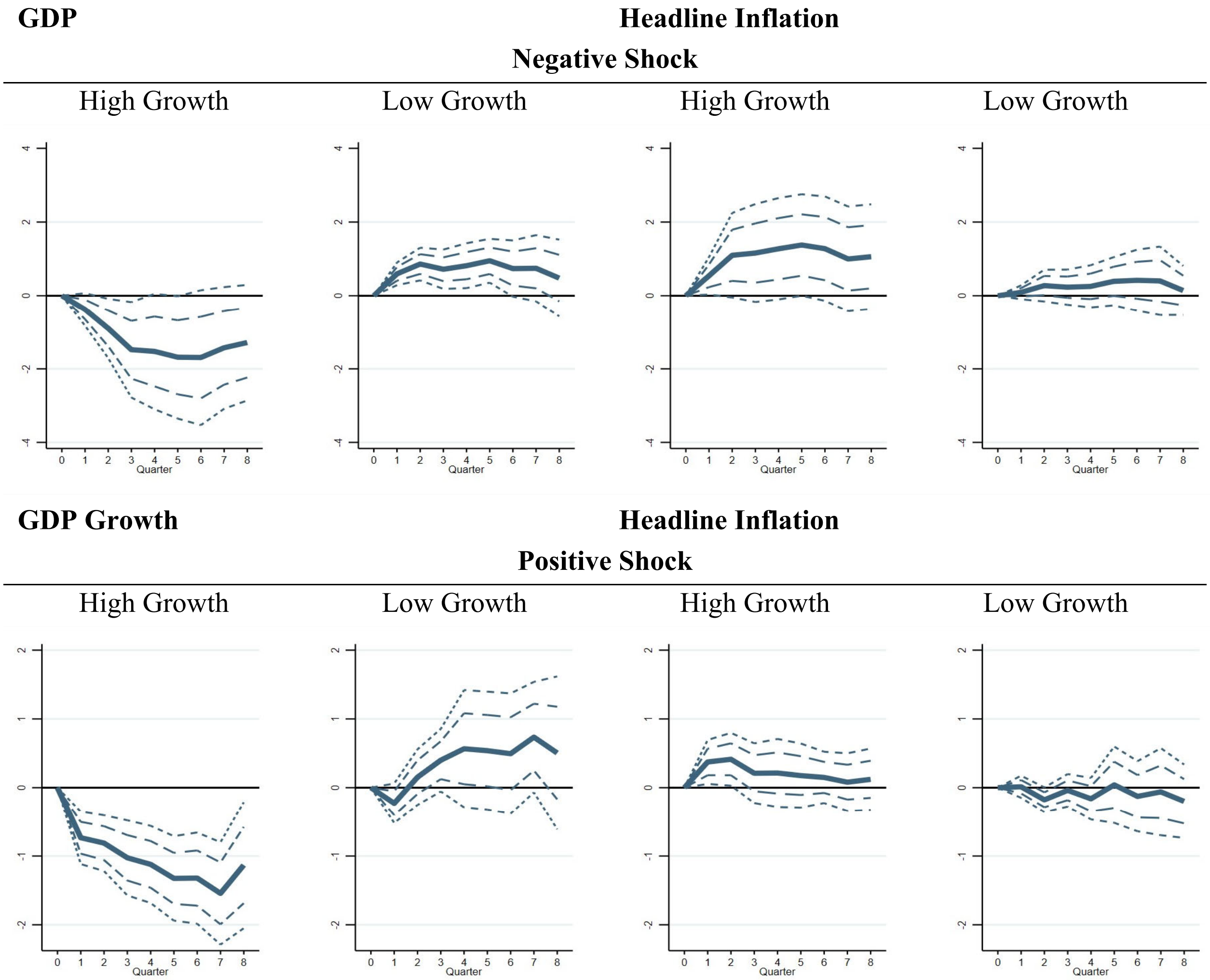
GDP | **Headline Inflation**

Positive | Negative | Positive | Negative



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{+} \mathrm{D}^{+}_{j,t-1} \mathrm{MP}_{j,t-1} + \beta_h^{-}(1 - \mathrm{D}^{+}_{j,t-1})\mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^{Z} Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is a dummy variable that takes value 1 for positive (expansionary) shocks, and zero otherwise. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 10. Sign and business cycles

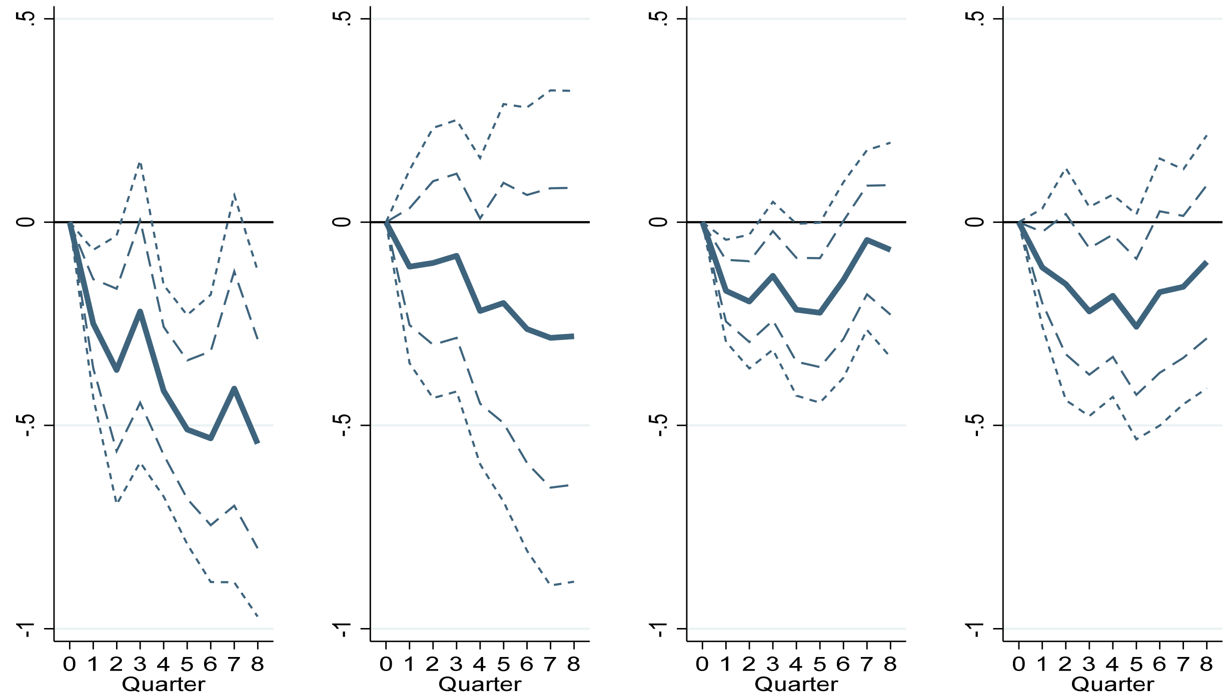


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high,+} \mathrm{D}^+_{j,t-1} D^{ygap}_{j,t-1} \mathrm{MP}_{j,t-1} + \beta_h^{high,-}(1 - \mathrm{D}^+_{j,t-1}) D^{ygap}_{j,t-1} \mathrm{MP}_{j,t-1} + \beta_h^{low,+} \mathrm{D}^+_{j,t-1}(1 - D^{ygap}_{j,t-1}) \mathrm{MP}_{j,t-1} + \beta_h^{low,-}(1 - \mathrm{D}^+_{j,t-1})(1 - D^{ygap}_{j,t-1}) \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. $D^{ygap}_{j,t-1}$ is equal to 1 if output gap is above the sample average. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure 11. Complementarity with Fiscal Policy

GDP | **Headline Inflation**

Tight | Loose | Tight | Loose



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{tight} \mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{tight}} \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{loose}\left(1 - \mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{tight}}\right) \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. $\mathrm{D}_{\mathrm{j,t-1}}^{\mathrm{tight}}$ is a dummy variable that takes value 1 for tight fiscal stance and zero otherwise. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of h quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons k, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Appendix

Table A1. Interest rates forecasted by CF and realized rates sources by country

Iso3 code	CF Latest rate	Realized rates source	Previous CF rate	Realized rates source
AUS	90-day Dealer Bill Rate	CEIC		
AUT	3 month Euro Rate	HAVER		
BEL	3 month Euro Rate	HAVER		
BRA	Overnight Interbank Interest Rate, SELIC	HAVER		
CAN	3 month Treasury Bill Rate	HAVER		
CHE	3 month Swiss Av. Rate (SAR3M)	Bloomberg	3 month Euro-Franc Rate	Bloomberg
CHL	Central Bank Monetary Policy Rate	HAVER	Nominal Central Bank 90-Day Bill Rate (%)	HAVER
CZE	3 Month PRIBOR Interbank Deposit Rate	HAVER		
DEU	3 month Euro Rate	HAVER		
ESP	3 month Euro Rate	HAVER		
FRA	3 month Euro Rate	HAVER		
GBR	3 month SONIA Rate	Bloomberg		
GRC	3 month Euro Rate	HAVER		
HUN	3 month Treasury Bill Rate	Bloomberg		
IDN	3-month Deposit Rate	HAVER		
IND	91-day Treasury Bill Rate	HAVER		
IRL	3 month Euro Rate	HAVER		
ITA	3 month Euro Rate	HAVER		
JPN	3 month Yen TIBOR Rate	HAVER		
KOR	91-day Certificate of Deposit	HAVER		
MEX	28-Day CETES Rate	Bloomberg		
MYS	3-month Interbank Rate	Bloomberg		
NLD	3 month Euro Rate	HAVER		
NOR	3 month Interbank Rate	Bloomberg		
NZL	90-day Bank Bill Rate	Bloomberg		
PHL	91-Day Treasury Bill Rate	HAVER	3-month PHIBOR Interbank Rate	HAVER
POL	3 month Interbank Deposit Rate	HAVER		
PRT	3 month Euro Rate	HAVER		
SVK	3-month Euro Interbank Rate	HAVER	3-month BRIBOR Interbank Deposit Rate	HAVER
SWE	3 month Interbank Rate	HAVER		
THA	3-month Interbank Rate	HAVER		

TUR	Overnight Interbank Interest Rate (%)	HAVER	Overnight Interbank Interest Rate	HAVER
USA	3 month Treasury Bill Rate	HAVER		

Table A2. P values: GDP

Horizon	P values $(\beta_1 = \beta_2)$							
	Exchange Rate System	Financial Development	Central Bank Transparency	Uncertainty	Financial Conditions Index	Asymmetry	Positive shock * business cycle	Negative shock * business cycle
1	0.23	0.26	0.95	0.16	0.76	0.41	0.17	*0.00*
2	0.43	0.99	*0.05*	0.18	0.47	0.76	*0.04*	*0.00*
3	*0.00*	0.51	0.52	0.67	0.18	0.42	*0.01*	*0.02*
4	*0.08*	*0.10*	0.81	0.46	0.16	0.50	*0.04*	*0.03*
5	0.26	0.20	0.70	0.45	0.14	0.42	*0.01*	*0.02*
6	*0.10*	*0.03*	0.86	0.11	0.15	0.35	*0.01*	*0.03*
7	*0.05*	0.23	0.65	*0.09*	0.11	0.43	*0.00*	*0.04*
8	0.56	0.18	0.46	*0.02*	0.33	0.37	*0.03*	*0.06*

Note: Numbers in the table above represent p-values. Those in italic indicates $\rho < 0.1$ signifying rejection of the null hypothesis $(\beta_1 = \beta_2)$.

Table A3. P values: CPI

Horizon	P values $(\beta_1 = \beta_2)$							
	Exchange Rate System	Financial Development	Central Bank Transparency	Uncertainty	Financial Conditions Index	Asymmetry	Positive shock * business cycle	Negative shock * business cycle
1	0.87	*0.08*	0.35	*0.04*	*0.08*	0.14	0.13	0.15
2	0.74	*0.05*	*0.05*	0.95	0.34	0.24	*0.03*	0.15
3	0.68	0.39	*0.00*	0.61	0.70	0.36	0.30	0.17
4	*0.03*	1.00	*0.04*	0.92	0.29	0.44	0.26	*0.10*
5	0.12	0.57	*0.08*	0.94	0.35	0.35	0.61	0.12
6	0.20	0.86	*0.05*	0.88	0.48	0.45	0.29	0.17
7	*0.06*	0.69	*0.01*	0.66	0.71	0.58	0.65	0.30
8	*0.01*	0.35	0.15	0.57	0.98	0.67	0.34	0.22

Note: Numbers in the table above represent p-values. Those in italic indicates $\rho < 0.1$ signifying rejection of the null hypothesis $(\beta_1 = \beta_2)$.

Table A4. Alternative model specifications for monetary policy shocks

Model 1: Baseline excluding purging for lagged interest rates and changes in NEER

$$FE_{j,t} = \alpha_j + \gamma_1 E_t y_{j,t+4} + \gamma_2 \Delta E_t y_{j,t+4} + \gamma_3 E_t \pi_{j,t+4} + \gamma_4 \Delta E_t \pi_{j,t+4} + \sum_{k=1}^{2} \delta_{j,k}^{y} y_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{\pi} \pi_{j,t-k} + \epsilon_{j,t}$$

where $E_t y_{j,t+4}$ and $E_t \pi_{j,t+4}$ denote one-year ahead real GDP growth and inflation forecasts in country *j* at time *t*, respectively. We also control for changes in the forecasts of these variables ($\Delta E_t y_{j,t+4}$ and $\Delta E_t \pi_{j,t+4}$), besides their two quarters lags.

Model 2: Purging only for changes in NEER

$$FE_{j,t} = \alpha_j + \gamma_1 E_t y_{j,t+4} + \gamma_2 \Delta E_t y_{j,t+4} + \gamma_3 E_t \pi_{j,t+4} + \gamma_4 \Delta E_t \pi_{j,t+4} + \sum_{k=1}^{2} \delta_{j,k}^{y} y_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{\pi} \pi_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{NEER} \Delta NEER_{j,t-k} + \epsilon_{j,t}$$

where $E_t y_{j,t+4}$ and $E_t \pi_{j,t+4}$ denote one-year ahead real GDP growth and inflation forecasts in country *j* at time *t*, respectively. We also control for changes in the forecasts of these variables ($\Delta E_t y_{j,t+4}$ and $\Delta E_t \pi_{j,t+4}$), besides their two quarters lags. $\Delta NEER_{j,t-k}$ is a control for changes in nominal effective exchange rate.

Model 3: Purging only for lagged interest rates

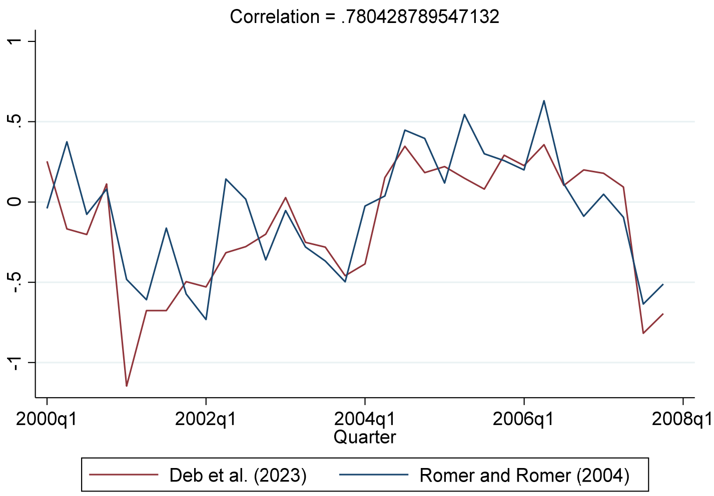
$$FE_{j,t} = \alpha_j + \gamma_1 E_t y_{j,t+4} + \gamma_2 \Delta E_t y_{j,t+4} + \gamma_3 E_t \pi_{j,t+4} + \gamma_4 \Delta E_t \pi_{j,t+4} + \sum_{k=1}^{2} \delta_{j,k}^{y} y_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{\pi} \pi_{j,t-k} + \sum_{k=1}^{2} \delta_{j,k}^{i} i_{j,t-k} + \epsilon_{j,t}$$

where $E_t y_{j,t+4}$ and $E_t \pi_{j,t+4}$ denote one-year ahead real GDP growth and inflation forecasts in country *j* at time *t*, respectively. We also control for changes in the forecasts of these variables ($\Delta E_t y_{j,t+4}$ and $\Delta E_t \pi_{j,t+4}$), besides their two quarters lags. $i_{j,t-k}$ denotes two quarters lags of end-of-quarter interest rates.

Table A5. Number of positive and negative shocks in the sample by country

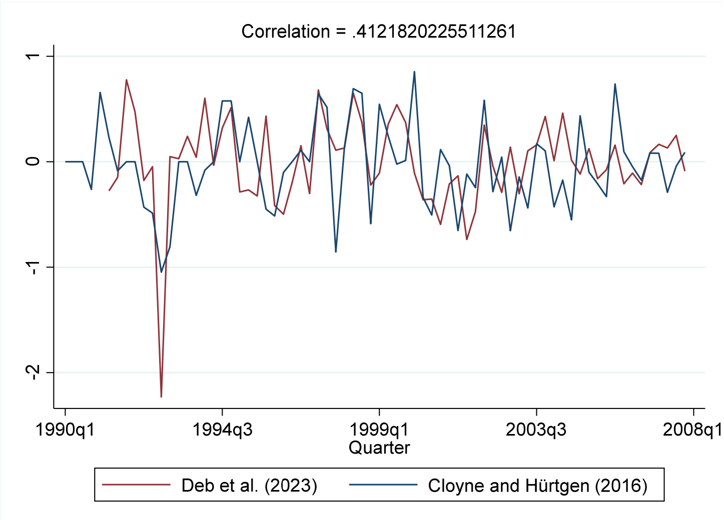
Country	Number of Positive MP shocks	Number of Negative MP shocks	Country	Number of Positive MP shocks	Number of Negative MP shocks
AUS	54	55	ITA	50	44
AUT	42	54	JPN	28	21
BEL	46	50	KOR	54	56
BRA	40	42	MEX	39	43
CAN	57	71	MYS	56	54
CHE	58	64	NLD	46	48
CHL	45	37	NOR	35	39
CZE	31	23	NZL	53	55
DEU	45	49	PHL	29	23
ESP	50	44	POL	28	26
FRA	44	50	PRT	48	48
GBR	68	55	SVK	25	26
GRC	46	50	SWE	28	35
HUN	27	27	THA	52	42
IDN	21	13	TUR	22	32
IND	42	41	USA	70	58
IRL	44	52			

Figure A1. Comparison between our US shocks and Romer and Romer (2004)



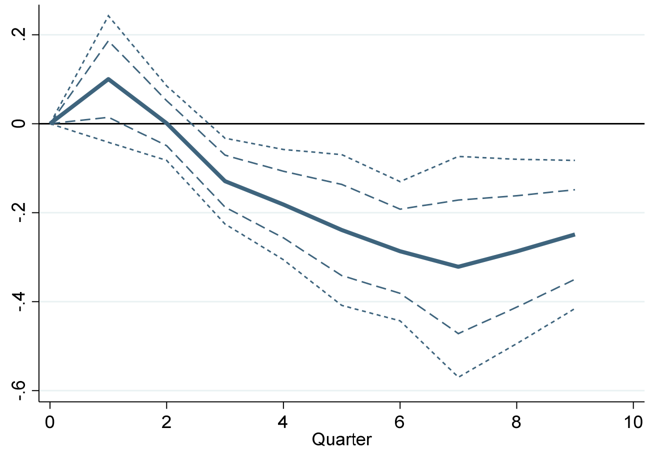
Note: Chart above shows the correlation between our shocks and those constructed by Romer and Romer (2004). For the correlation, we use the simplest specification (Model 1A) since this is the closes to their specification. For rest of results we use this specification augmented to purge the shocks from interest rates lags and nominal effective exchange rate changes as this is relevant specially for the emerging economies and we wanted to keep the shocks consistent throughout the sample.

Figure A2. Comparison between our UK shocks and Cloyne and Hürtgen (2016)



Note: Chart above shows the correlation between our shocks and those constructed by Cloyne and Hürtgen (2016).

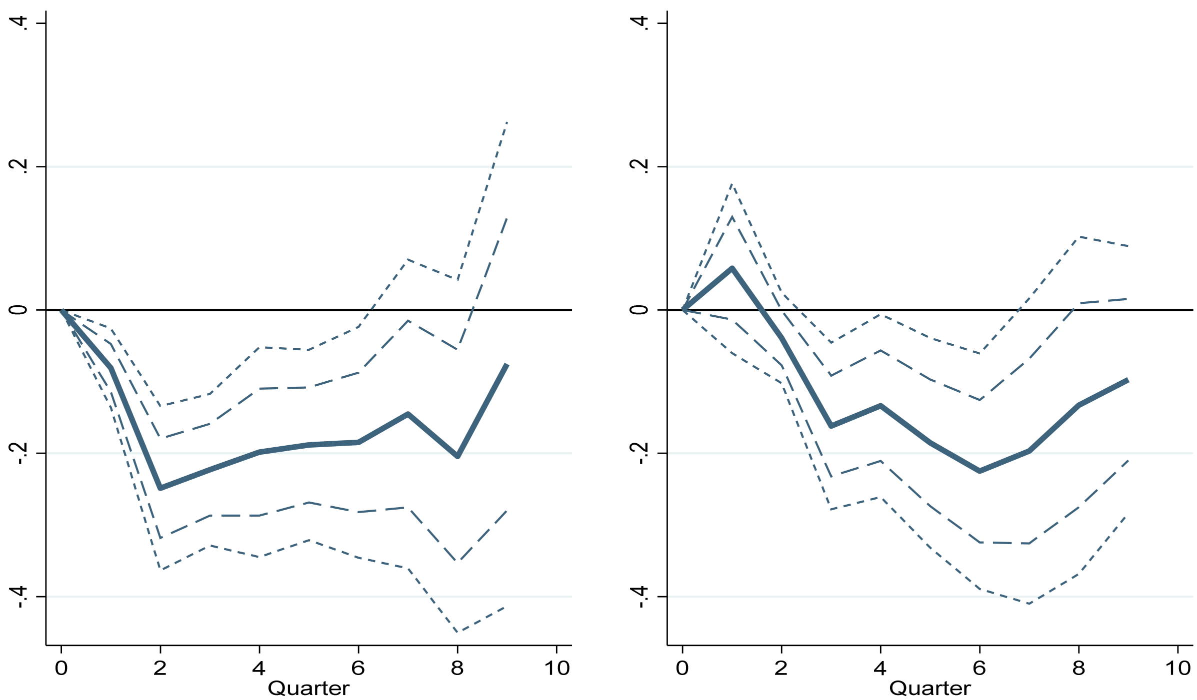
Figure A3. Monetary Policy Transmission to Core CPI



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log core consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A4. Baseline estimation using shocks from Model 1. Not purging for NEER and interest rates.

GDP **Headline Inflation**

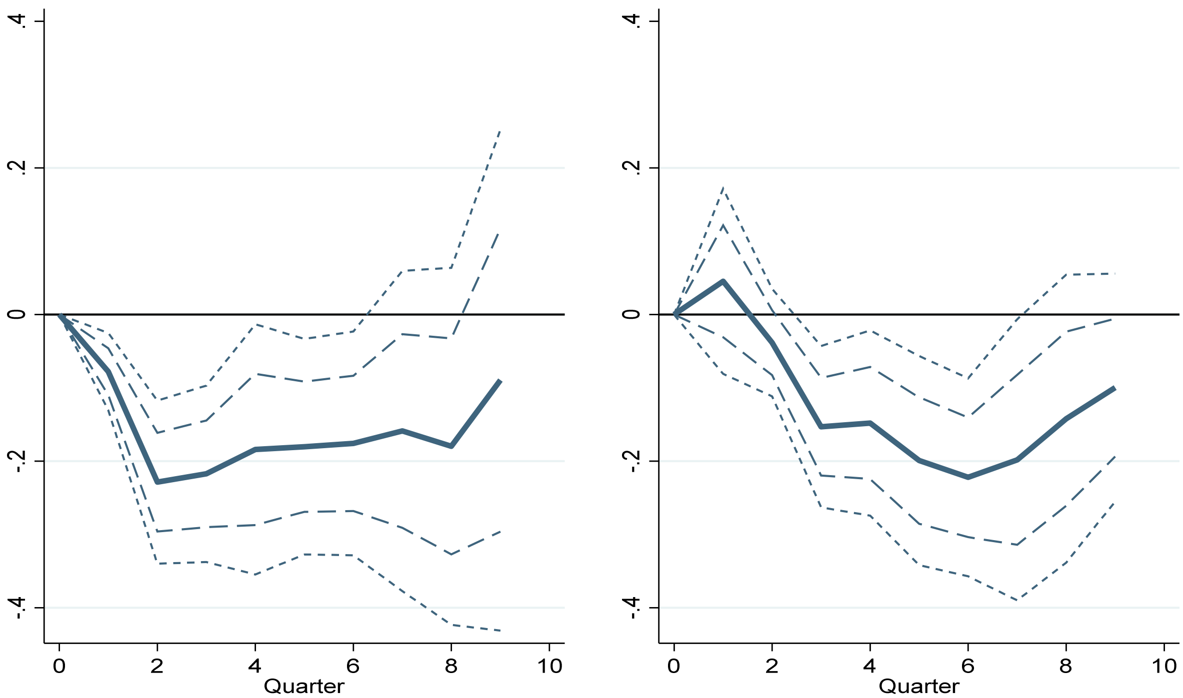


Note:

Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons k, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level..

Figure A5. Baseline estimation using shocks from Model 2 (purging only for changes in NEER)

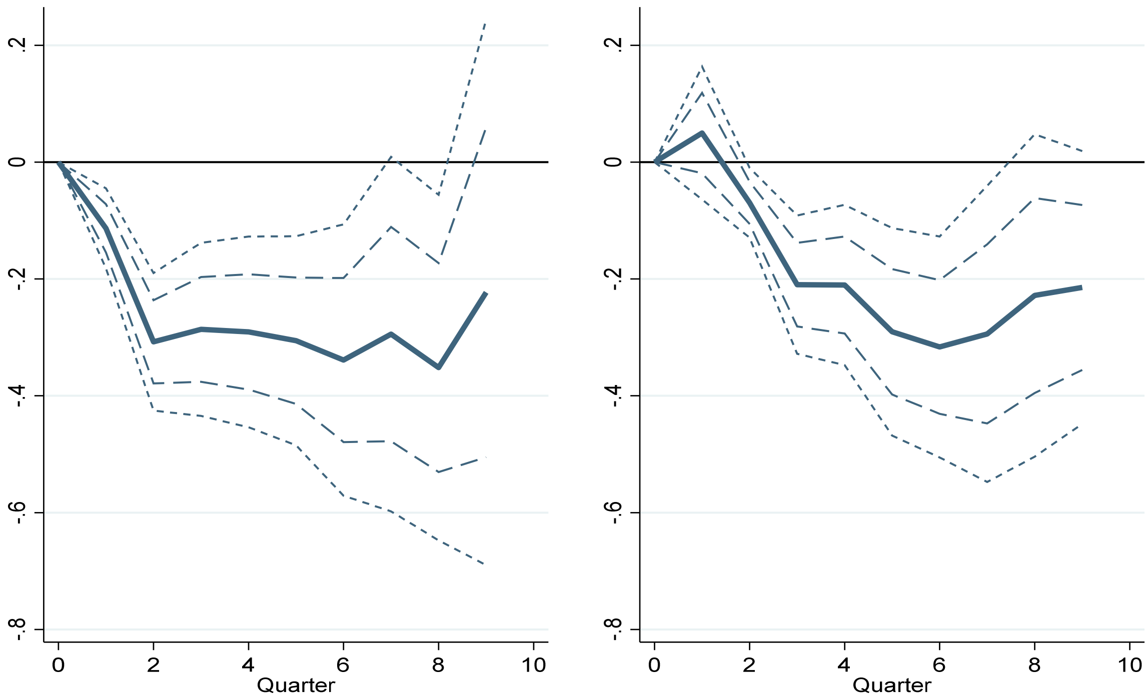
GDP **Headline Inflation**



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons k, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A6. Baseline estimation using shocks from Model 3 (purging only for lagged interest rates)

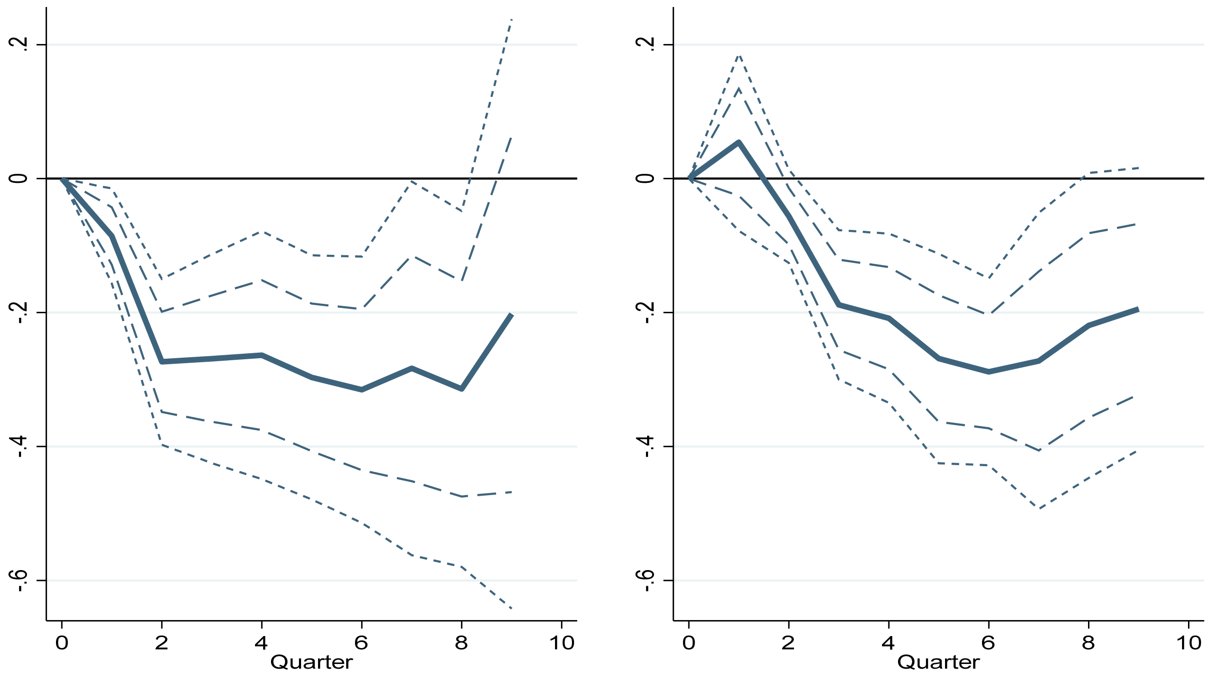
GDP **Headline Inflation**



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A7. Baseline robustness. Controlling for Fiscal Expenditure

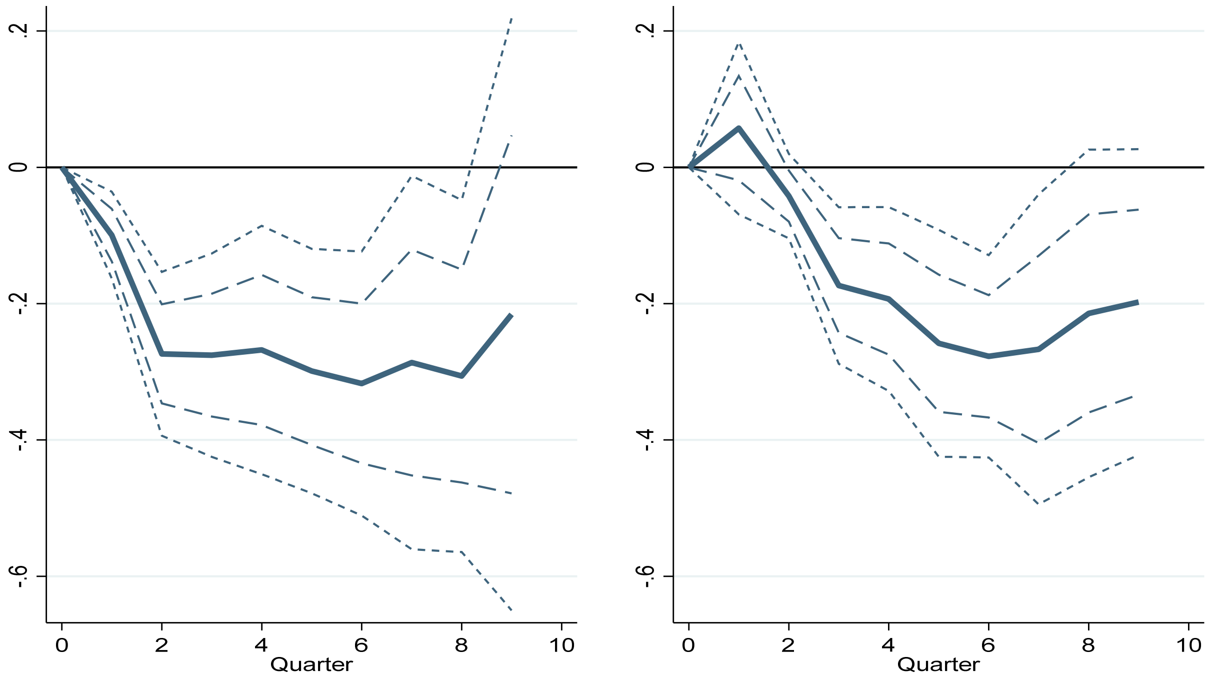
GDP **Headline Inflation**



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \Delta X_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). $\Delta X_{j,t}$ controls for change in cyclically adjusted primary balance. The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A8. Baseline robustness. Controlling for Nominal Effective Exchange Rate

GDP **Headline Inflation**



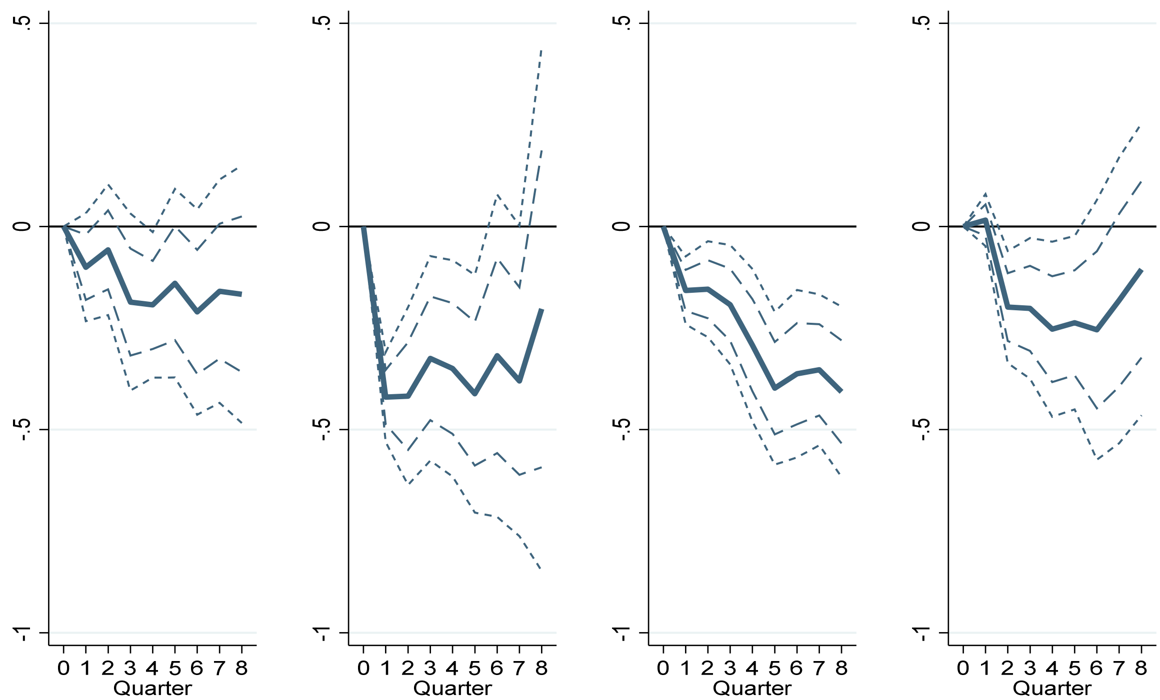
Note:

Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \Delta X_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). $\Delta X_{j,t}$ controls for changes in NEER. The solid line shows the point estimate forβ_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level..

Figure A9. AE vs EM

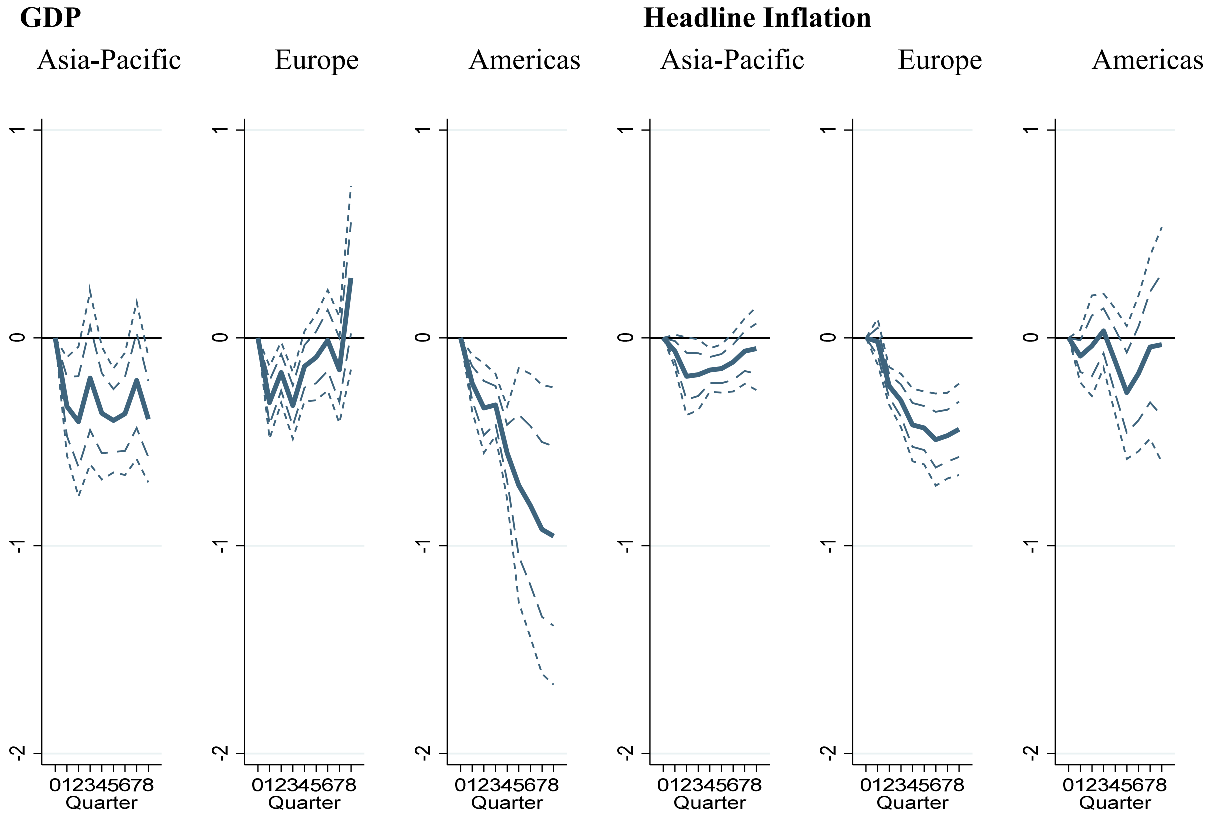
GDP **Headline Inflation**

AEs EMs AEs EMs



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{AEs} AEs \times \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{EMs}(1 - AEs) \times \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. *AEs* is equal to 1 for advanced economies and 0 otherwise. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate forβ_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A10. Regional Variation

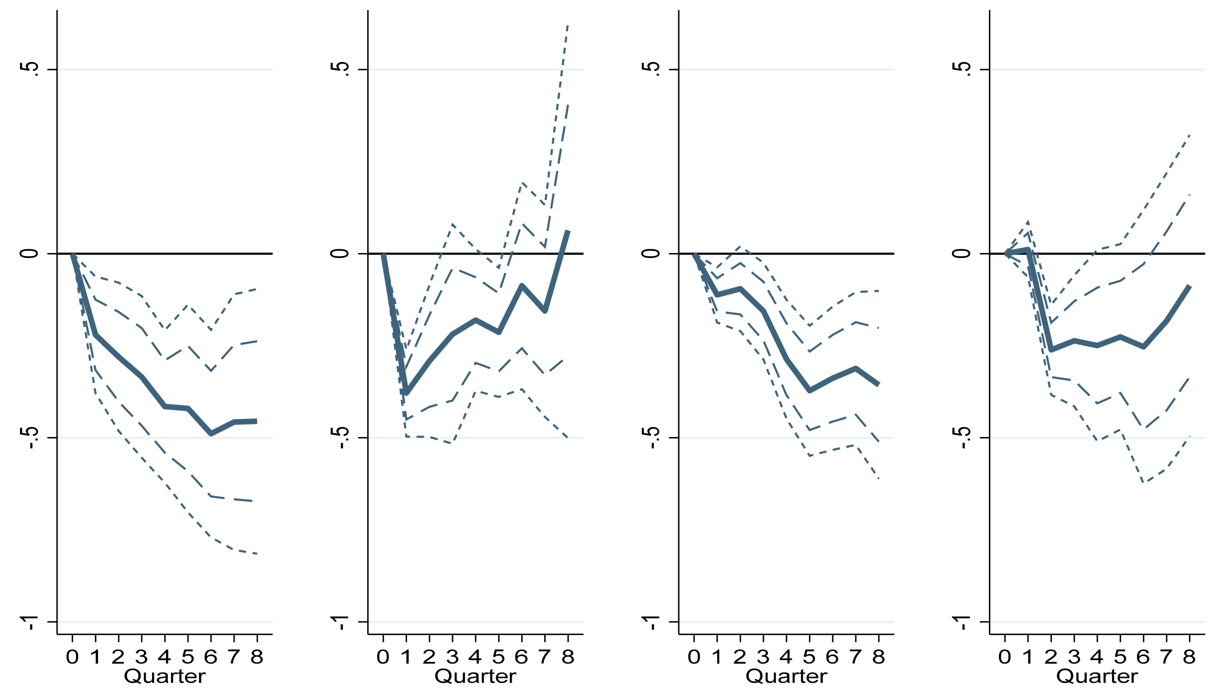


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{APD} APD \times \mathrm{MP}_{j,t-1} + \beta_h^{EUR} EUR \times \mathrm{MP}_{j,t-1} + \beta_h^{WHD}(WHD) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. *APD, EUR, WHD* is equal to 1 for Asia-pacific, European and Americas countries respectively and 0 otherwise. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A11. Financial development (median)

GDP | **Headline Inflation**

High | Low | High | Low

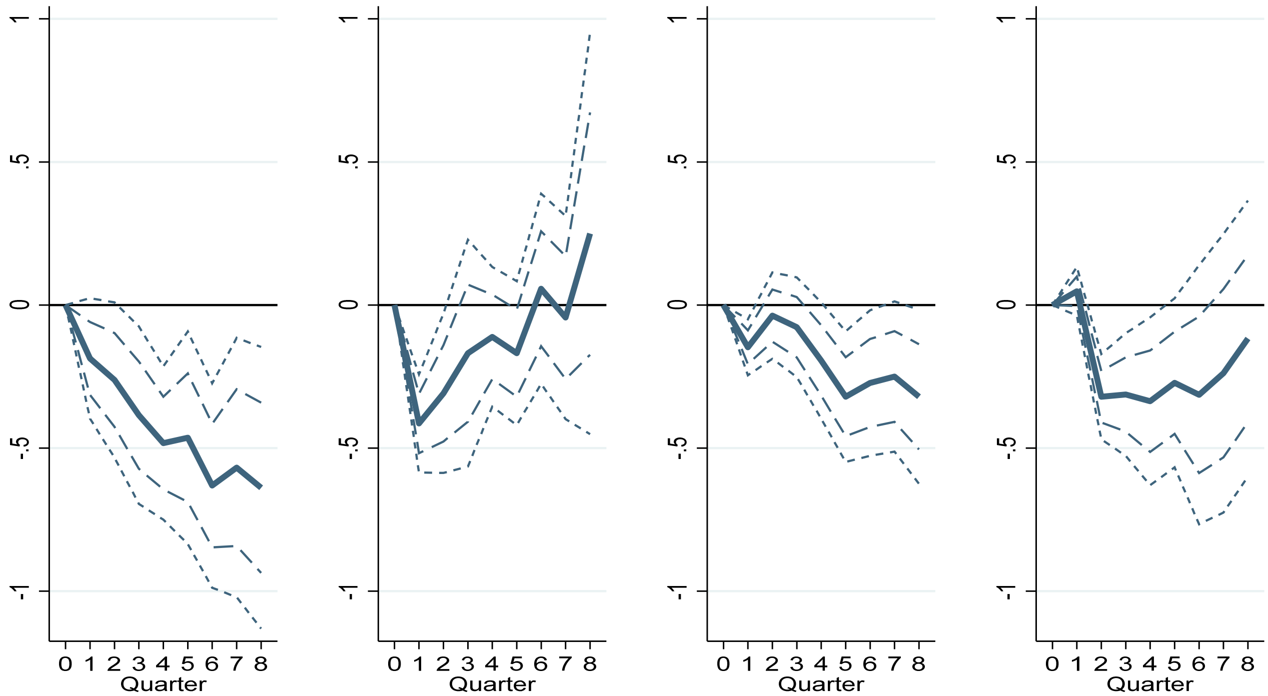


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{low}\left(1 - D_{jt}\right) \times \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if the within country median of financial development is above the sample median. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A12. Financial development (smooth transition function)

GDP **Headline Inflation**

High Low High Low



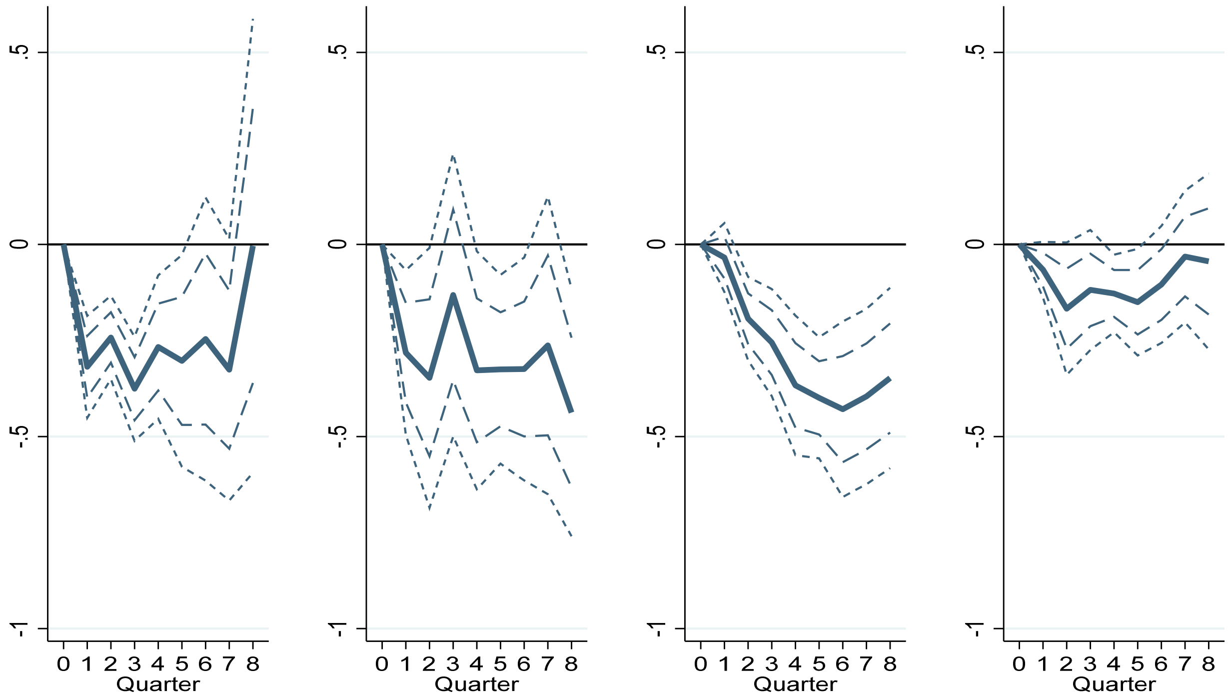
Note:

Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}\left(1 - D_{jt}\right) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to the smooth transition function of financial development is above the sample mean. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A13. Central bank transparency (median)

GDP **Headline Inflation**

High Low High Low

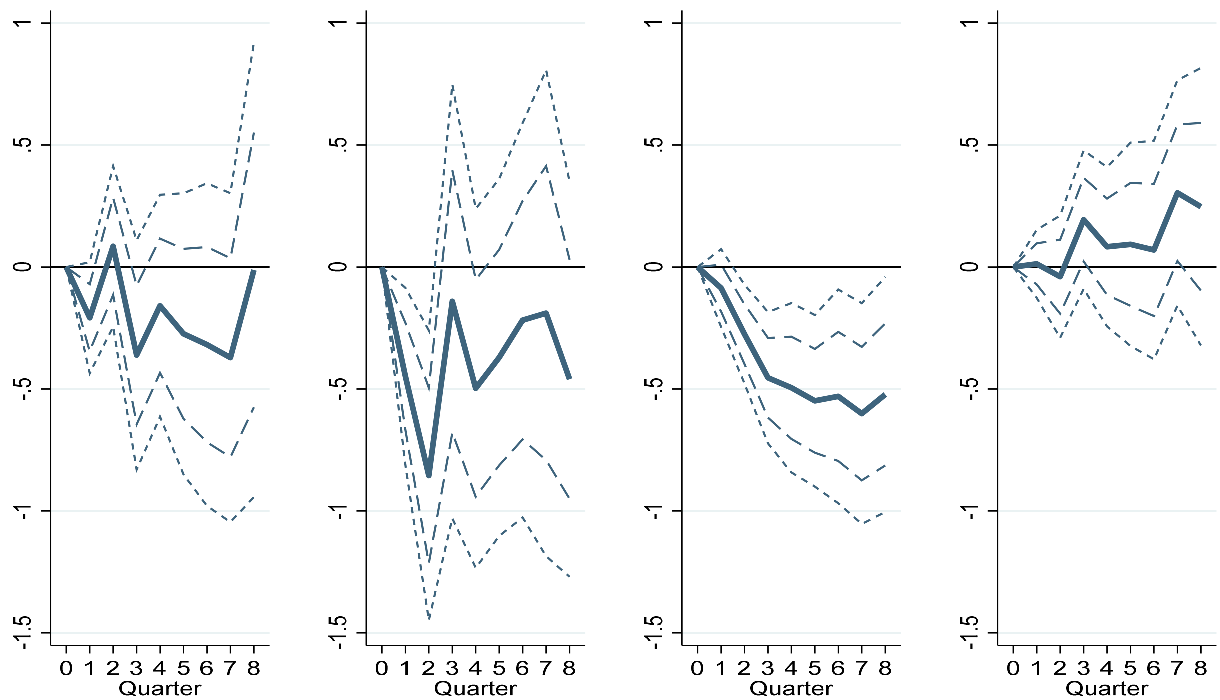


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}\left(1 - D_{jt}\right) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if the within country median of central bank transparency is above the sample median. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A14. Central bank transparency (smooth transition function)

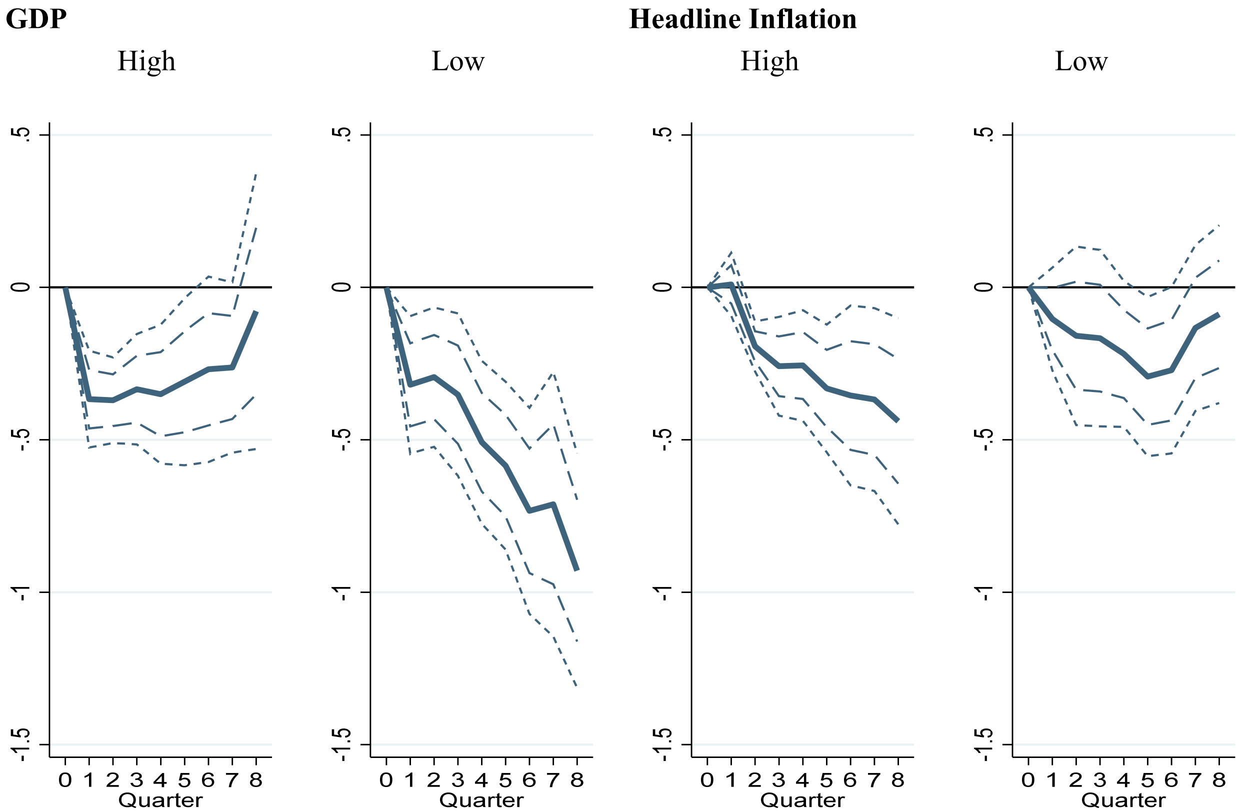
GDP | **Headline Inflation**

High | Low | High | Low



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \text{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt}) \times \text{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to to the smooth transition function of central bank transparency. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A15. Uncertainty (median)

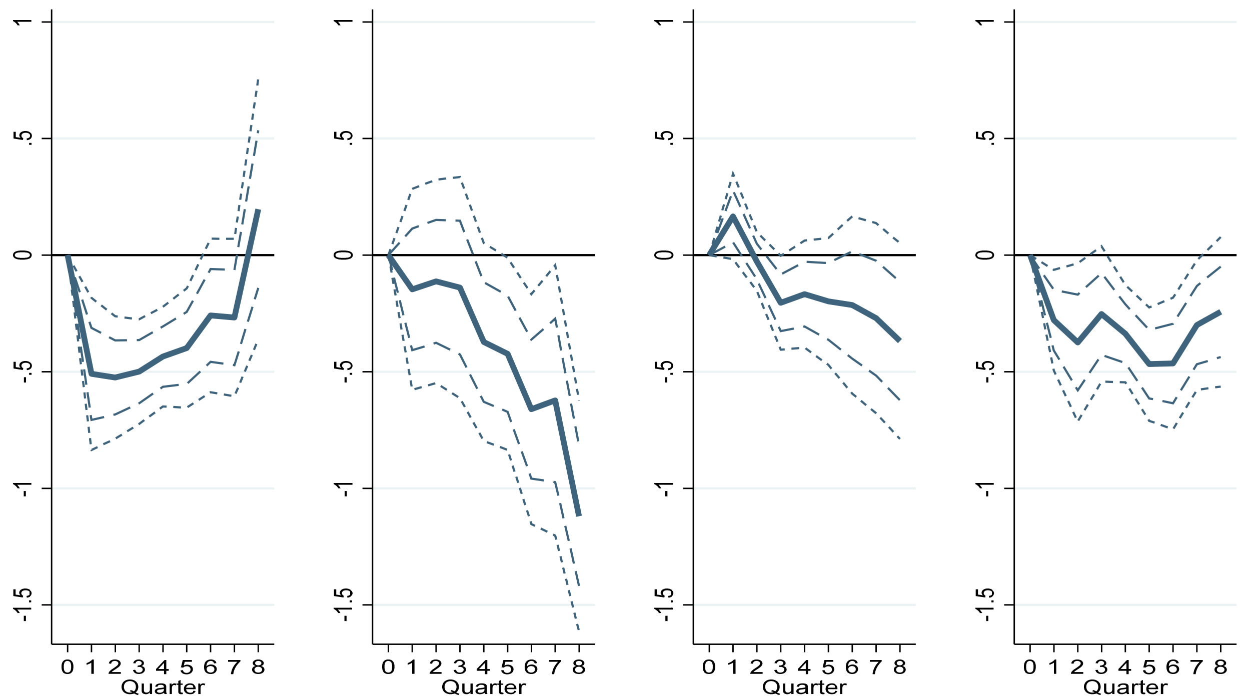


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \text{MP}_{\text{j,t}-1} + \beta_h^{low}(1 - D_{jt}) \times \text{MP}_{\text{j,t}-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if country i economic uncertainty is above the sample median at time *t*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A16. Uncertainty (smooth transition function)

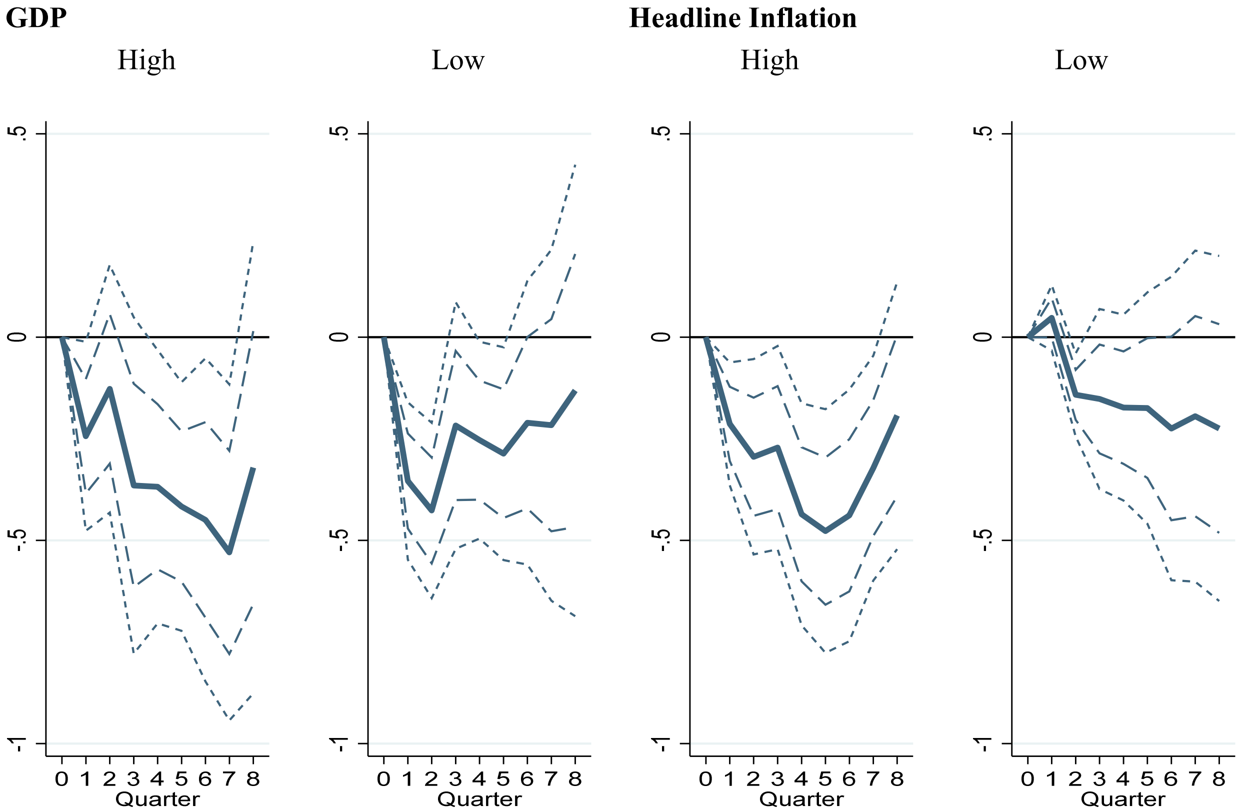
GDP | **Headline Inflation**

High | Low | High | Low



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to the smooth transition function of economic uncertainty. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A17. Financial Conditions Index (median)

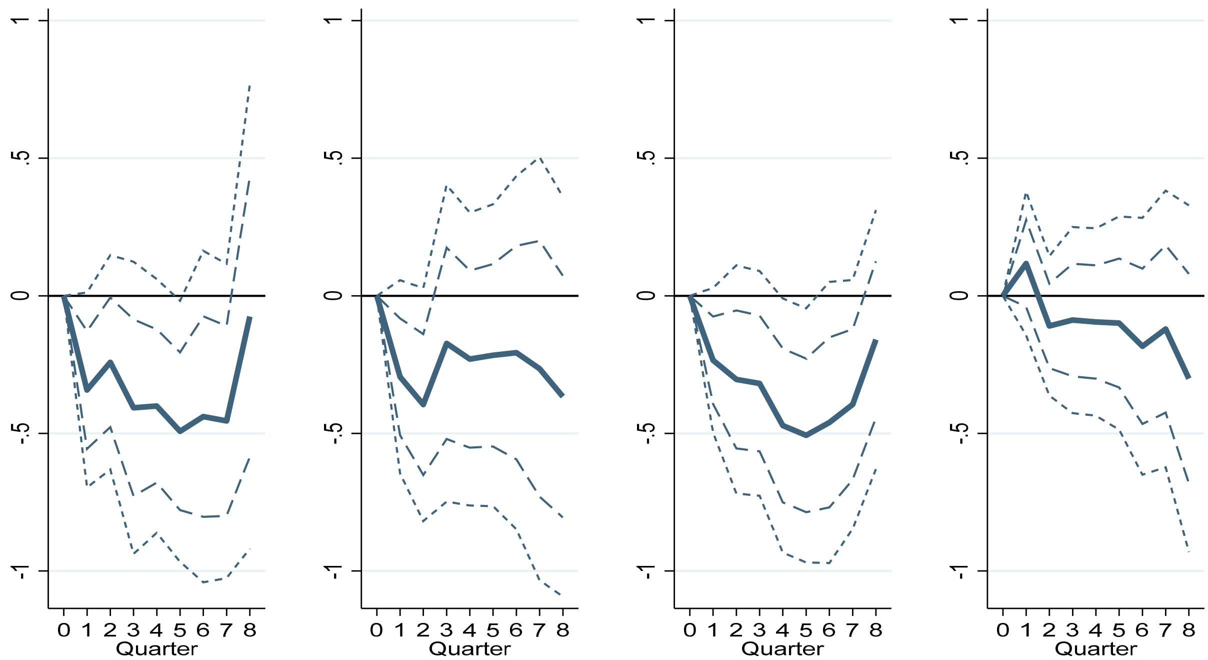


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt-1} \times \text{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt-1}) \times \text{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt-1} is equal to 1 if country *i* financial conditions index is above the sample median for the previous quarter at time *t*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A18. Financial Conditions Index (smooth transition function)

GDP | **Headline Inflation**

High | Low | High | Low

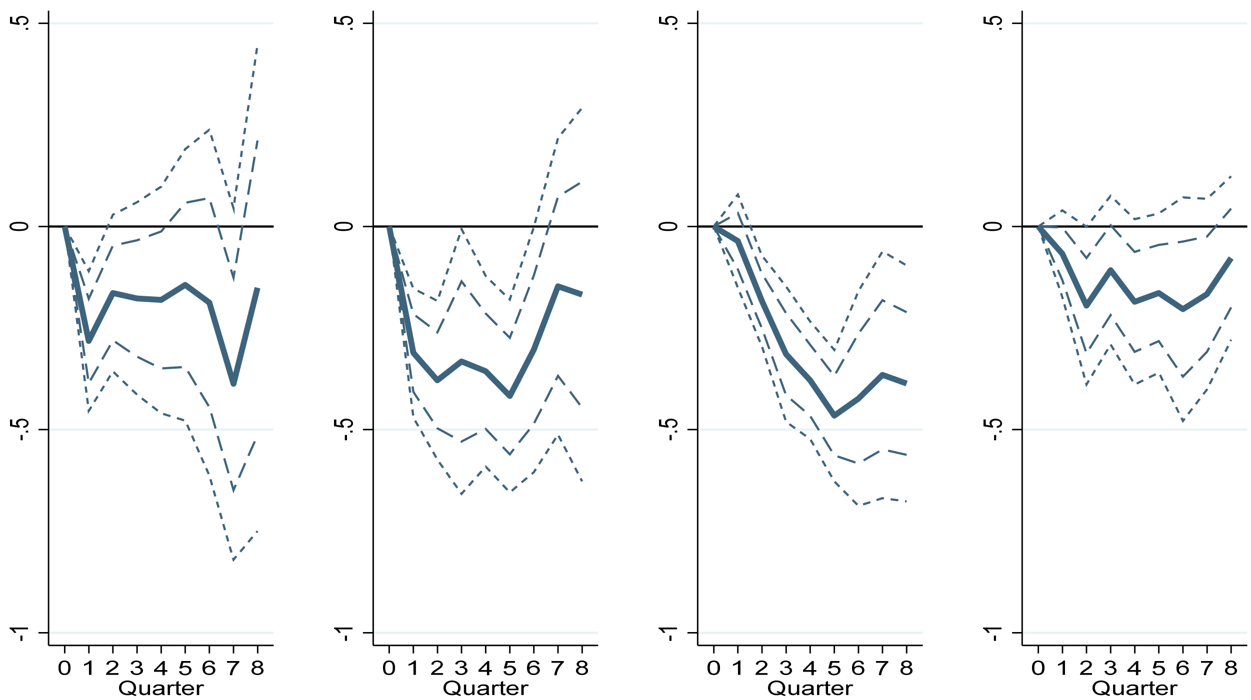


Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt-1} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt-1}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$ is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt-1} is equal to the smooth transition function of the financial conditions index. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A19. Business Cycle (median)

GDP **Headline Inflation**

High Low High Low

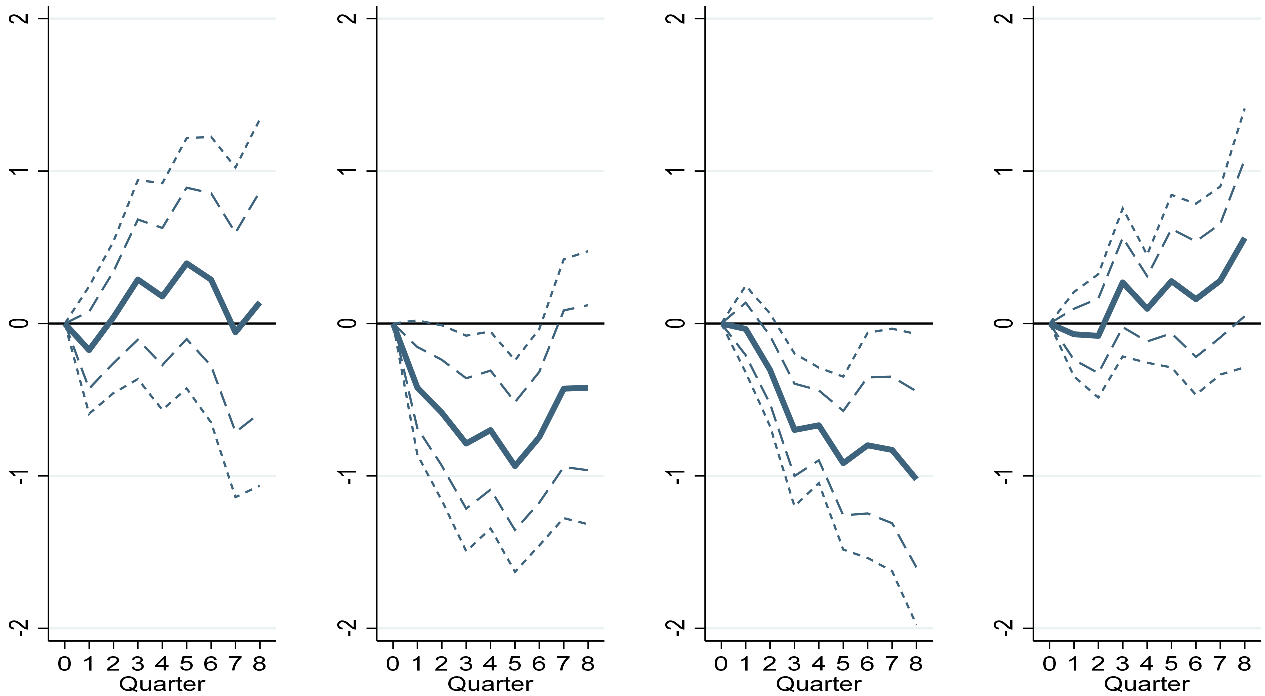


Note:
Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{\mathrm{j,t-1}} + \beta_h^{low}\left(1 - D_{jt}\right) \times \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to 1 if country *i* output gap is above the sample median at time *t*. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

Figure A20. Business Cycle (smooth transition function)

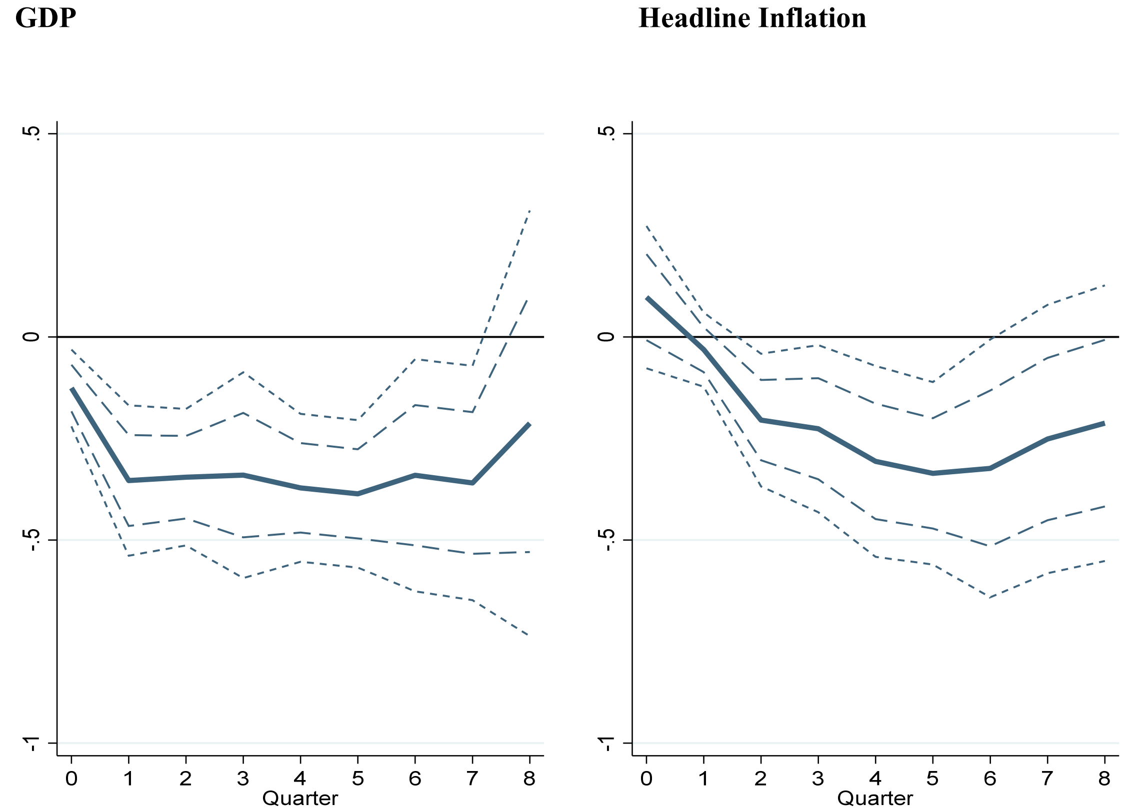
GDP **Headline Inflation**

High Low High Low



Note: Impulse response function based on local projection methods following Jordà (2005) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on the regression $y_{j,t+h} - y_{j,t-1} = \beta_h^{high} D_{jt} \times \mathrm{MP}_{j,t-1} + \beta_h^{low}(1 - D_{jt}) \times \mathrm{MP}_{j,t-1} + \sum_{k=1}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and MP_(j,t-1) is the lag of monetary policy shocks in country *j*. D_{jt} is equal to to the smooth transition function of output gap. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered at country level.

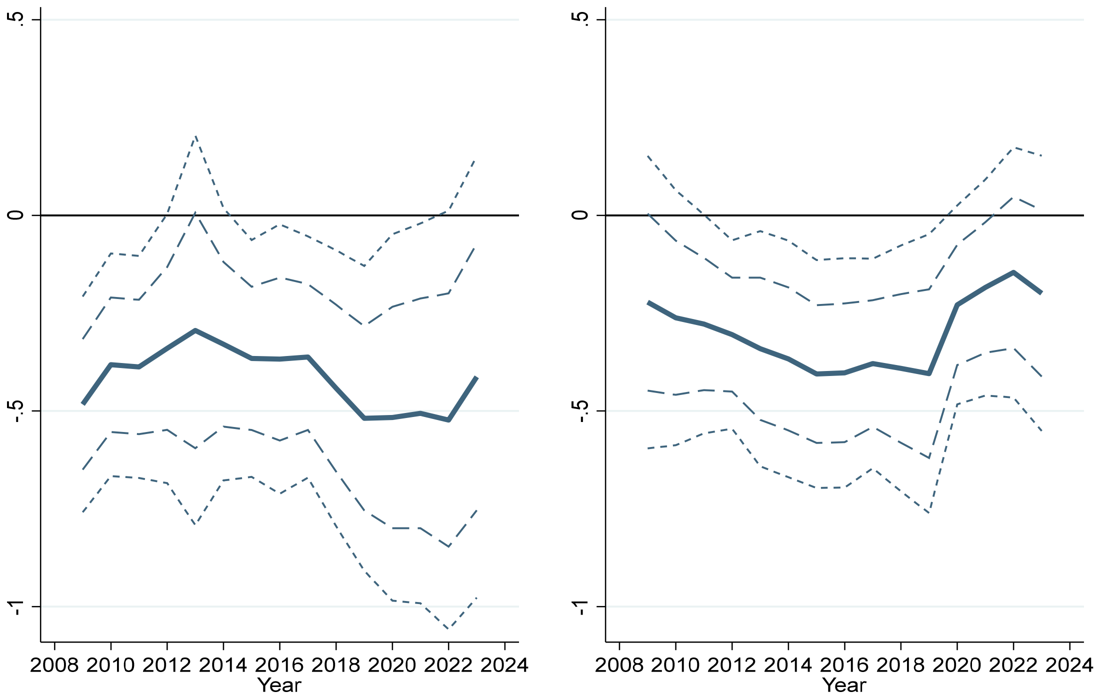
Figure A21. Baseline using LP-IV approach



Note: Impulse response function based on LP-IV methodology similar to Stock and Watson (2018) using an unbalanced panel of quarterly data for 33 countries from 1990 to 2019. Estimates based on following regressions. First stage: $\Delta i_{j,t} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ where $\Delta i_{j,t}$ are changes in interest rates for country *j* at time *t*, $\mathrm{MP}_{\mathrm{j,t-1}}$ is the lag of monetary policy shocks in country *j.* The vector $Z_{j,t}$ contains 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effect and α_t are time fixed effects. Second stage: $y_{j,t+h} - y_{j,t-1} = \beta_h \widehat{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ for different horizons k, where $y_{j,t+h}$is the log real GDP and log consumer price index and $D_{jt}\widehat{MP}_{\mathrm{j,t-1}}$ predicted value of changes in interest rates in country j. The coefficient β_h denotes (percent) response of variables to domestic monetary policy shocks at a horizon of *h* quarters. The vector contains $Z_{j,t}$ 4 lags of dependent variable and monetary policy shocks. α_j are country fixed effects, included to control for time-unvarying unobservable characteristics, as well as for cross-country differences in average dependent variables. α_t are time fixed effects, which account for common time-varying shocks (e.g., VIX, world energy and food prices). The solid line shows the point estimate for β_h for different horizons *k*, while the dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered in countries. The F-statistics are 153, well above the threshold value of 10, indicating statistical significance.

Figure A22. Time-Variation in Monetary Policy Transmission

GDP **Headline Inflation**



Note: Results are based on rolling window regressions with a window size of 60 quarters. We estimate the specification $y_{j,t+h} - y_{j,t-1} = \beta_h \mathrm{MP}_{\mathrm{j,t-1}} + \sum_{\mathrm{k=1}}^{4} \theta_k^Z Z_{j,t} + \alpha_j + \alpha_t + \epsilon_{j,t}$ starting with the initial window of 1995Q1-2009Q4. The x-axis presents the end of each window, for example, 2022 denotes the sample of 2008Q1-2022Q4. We report the β_h from the 6$^{\text{th}}$ quarter of each sample since 6$^{\text{th}}$ quarter is the horizon where the impulse responses reach their peak. The dashed and short-dashed lines are the 68 percent and 90 percent confidence intervals respectively. Standard errors are clustered in countries. Since shocks are available for a short sample for 8 countries, we focus on the results from 25 countries here to keep country sample unchanged across windows.