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Effects of US interest rate shocks in the emerging market economies: Evidence from panel structural VAR

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Abstract

We examine, using a monthly dataset from 2007 to 2020, the US interest rate shocks' effects on exchange rates, broad money aggregates, and foreign exchange reserves in emerging market economies (EMEs) post global financial crisis. To evaluate the impact of unconventional monetary policy initiatives, we employ Wu-Xia's shadow interest rates. There are two parts to the methodology. The first part focuses on the identification of the unanticipated US interest rate shock in a SVAR model. In the second part, we incorporate the US interest rate shock into the panel structural VAR to analyze its impact on 29 countries from various regions. A positive shock to US interest rates depreciates the exchange rate of EMEs against the US dollar. According to our findings, it results in a decline in the broad money aggregate and foreign exchange reserves. The findings are consistent across multiple EME regions.

Keywords: US interest rate, emerging market economies, shadow rate, panel structural VAR.
JEL classification: C33, E51, E52, E58, F41, F42.

1. Introduction

Interest rates are one of the Federal Reserve's key monetary policy instruments, and through international capital flows, they affect the economic conditions of emerging market economies (EMEs). The post Global Financial Crisis (GFC) era has witnessed a change in the monetary stance of the United States. The Federal Reserve of the US opted to use a series of unconventional monetary policy initiatives. To counter the effects of the zero lower bound (ZLB) on interest rates, extensive purchases of assets were carried out. These measures are also known as quantitative easing (QE) measures, which were implemented in the US

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between the end of 2008 and October 2014, as well as between the second half of 2019 and March 2022 (Dabrowski, 2021). The Fed's interest rates were raised by 225 basis points between December 2015 and December 2018 and then again lowered to zero between July 2019 and March 2020.

The changes in the monetary stance of the US raised concerns in the emerging markets about the spillover effects. The EMEs saw a substantial rise in international capital flows from the implementation of QE in the US. Being so fragile due to their history of inflation, macroeconomic crises, etc., the EMEs have been affected by the Fed's monetary policy decisions, especially regarding the Federal Fund Rates (FFR), or even by announcements of them (Dahlhaus and Vasishtha, 2020). This dependence justifies an examination of the influence of Fed policies on EME economic circumstances.

This study examines the impact of interest rates in the US on the macroeconomic factors of the EMEs by incorporating the QE measure through shadow rates. A shadow rate captures the monetary policy at the ZLB and reflects the effects of unconventional policies. We substitute the shadow interest rates provided by Wu and Xia (2016) for the effective FFR in order to reflect the impact of unconventional monetary policy initiatives. We are interested in studying its effects, particularly on the monetary aggregate, i.e., broad money, exchange rates, and the foreign exchange reserves of the emerging markets. The measure of broad money used here is the monetary aggregate M3 for most countries, and M4 for which the data on the former was not available.

The empirical strategy is to use the panel structural Vector Autoregression (VAR) to assess the macroeconomic spillover effects of the US shadow interest rate on the EMEs. The results conclude that with a positive shock in interest rates in the US, the economies of emerging markets contract. It suggests that the exchange rate of EMs depreciates against the US dollar, broad money declines, and foreign exchange reserves fall. These results are statistically significant.

This article is comparable to studies that investigate the consequences of monetary policy shocks in the United States, such as Barakchian and Crowe (2013), Ivrendi and Yildirim (2013), and Neri and Nobili (2013).

Rey (2015, 2016) asserts that US monetary policy decisions influence the implementation of monetary policy in EMEs. Anaya et al. (2017) also underline the influence of US unconventional policy shocks on the economic and financial conditions of EMEs. In addition, they find that international capital flows are the most important transmission channel.

Iacoviello and Navarro (2019) examined how rising US interest rates affected 50 advanced and developing market economies in a large sample. They examine the means through which global interest rates are transmitted, focusing in particular on the effects of exchange rates regime and trade openness. The focus of the study is on the effects of US interest rate variations on foreign real GDP. "*The exchange rate channel, which contends that higher interest rates in the US might spur greater activity overseas, is based on the idea of demand substitution between local and foreign-produced goods.*" According to the study, a rise in US interest rates, for instance, results in a strengthening of the US dollar due to the unobserved interest parity condition. As a result of the rising value of the dollar, global demand will shift away from US-produced goods and toward foreign goods.

Several recent studies, such as Lim et al. (2014), Kim and Lim (2018), and Bhattarai et al. (2021), employ a VAR-based methodology to examine monetary policy shocks in the US and their spillovers. Bhattarai et al. (2020) examine the impact of US uncertainty shocks on 15 developing countries using a panel VAR. A US uncertainty shock negatively affects the stock prices and exchange rates in the EMEs, in addition to increasing EME country spreads and decreasing capital inflows. It decreases EME output and consumer prices while increasing net exports. It concludes that Latin American EMEs have a larger impact on the external balance than on output and asset prices.

A "flight to safety/quality" phenomenon appears to be triggered by a US uncertainty shock, based on the consequences of financial variables: Despite the increase in uncertainty in the US, investors appear to be pulling capital out of emerging markets that are perceived to be riskier than the US, negatively impacting asset prices such as stock prices and exchange rates in EMEs and driving up their borrowing costs as country spreads vis-à-vis the US widen. Because of the increase in net exports and the drop in capital inflows, one of the avenues through which the effects of the US uncertainty shock spread is through a decline in EME aggregate expenditure.

The effect of quantitative easing in the US on EMEs is evaluated by Bhattarai et al. (2021) using a Bayesian VAR model. The shock is identified before being fed to the panel VAR as an external regressor. Between 2000 and 2013, Lim et al. (2014) examined gross financial inflows into developing nations. They studied the effect of the United States' quantitative easing program on developing nations. The analysis concluded that these policies were conveyed via portfolio balance, liquidity, and confidence channels. Maćkowiak (2007) used SVAR to evaluate macroeconomic changes in eight emerging markets, supporting the claim that monetary policy shocks in the US have an impact on the economies of the emerging markets. He contends that emerging markets are more fragile to external shocks than industrialized economies.

Our paper studies the effect of US interest rates on the macroeconomic condition of the EMEs. The study focuses on the reaction of exchange rates, broad money aggregates, and foreign exchange reserves to changes in US monetary policy. Here, we examine shadow interest rates as a monetary policy instrument in the United States. We first identify US monetary policy shocks in a US SVAR model. We then employ a Panel Structural Vector Autoregression (PSVAR) model, developed by Pedroni (2013), incorporating key economic indicators for 29 emerging markets over the period 2007–2020, and evaluate the dynamic responses of these variables to the shock in US shadow interest rates. Theoretically, a higher US interest rate means that the US dollar will strengthen, which could cause capital to flow out of EMEs.

The structure of the paper consists of six sections. In section 2, we explain the employed data and methodology for the identification of US interest rate shocks, as well as the PSVAR approach and its specifications. In section 3, the spillover effects are discussed. We evaluate the robustness of the estimated responses by identifying US interest rate shocks based on the effective FFR rather than shadow rates in section 4. Since the dataset includes a majority of the European countries, we further check the consistency of the responses of our model by segregating the countries in our dataset into several groupings based on their collective zones/regions and evaluating the results to see if they vary from the former one. Section 5 concludes the study.

2. Data and methodological framework

2.1. Data

For identification of the US interest rate shocks, we use the monthly dataset from 2007 to 2020 on the Industrial Production Index (IPI), Consumer Price Index (CPI), securities held outright by the Federal Reserve, and shadow interest rates of the United States. As mentioned before, we take the shadow rate as an alternative to the effective FFR to incorporate the effects of QE. To account for the zero lower bound and the stimulus provided by the unconventional monetary policy measures that followed the GFC, we employ Wu-Xia (2016) shadow rate for the US interest rate. Their shadow rate estimates are substantially associated with the QE-related asset holdings by the Federal Reserve, as shown by Wu and Zhang (2019), who define the shadow rate as the goal that the Federal Reserve hopes to achieve through bond purchases and sales.

We use a monthly dataset from 2007 to 2020 for a total of 29 emerging economies to examine the spillover effects of US interest rate shocks. The Appendix section contains the list of the nations that were considered for the analysis. The dataset consists of each EME's IPI, CPI, exchange rate, money supply (broad money), and foreign exchange reserves. We use the global database platform CEIC for collecting the data on all the variables. We take the natural log of the variables in the study. The Appendices A–D provides a comprehensive explanation of the creation of the dataset.

To get a more accurate picture of the economic conditions of the EMEs, we incorporate the IPI and CPI in our model. Our focus, however, is on the response of broad money, exchange rates, and total reserves in the emerging markets. The inclusion of emerging market countries in the sample is driven by the availability of comprehensive monthly data. We try to incorporate a wide range of countries from various regions of the world.

Fig. 1 depicts the effective FFR, and the shadow rate provided by Wu-Xia. Following the GFC in 2007, the Federal Reserve in the United States quickly reduced interest rates to just above zero percent. Therefore, for further stimulation of the economy, it resorted to unconventional measures such as large-scale asset purchases, widely known as quantitative easing. The shadow rate captures these effects and can be below the zero lower bound as seen in Fig. 1.

2.2. Methodological framework

2.2.1. Identification of US interest rate shocks

In order to study the effects of US interest rates, we need to examine the reasons behind the changes in interest rates since these causes may have a varied effect on EMEs. The causes can be investigated with the use of the Taylor rule. According to it, the interest rate is set at $r = f(z) + u$, where r is the US interest rate or shadow rate, z is the state of US economy, and u is the monetary policy shock. US interest rates may rise because of z (a strong US economy) or u (monetary policy shocks). Hence, if, for instance, the US interest rate rises due to a monetary policy shock, these unanticipated changes in the US interest rate might result in an outbound

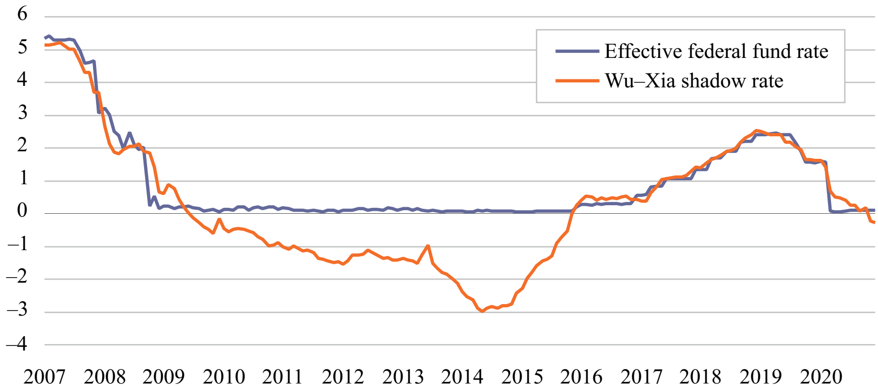

Fig. 1. The monthly effective federal fund rate and Wu-Xia shadow rates, 2007–2020 (%).

Note: In the periods from 2009 to 2016, the shadow rate fell beyond the zero lower bound to capture the stimulus from unconventional monetary policy measures in the US.
Source: Compiled by the author.

capital flow from the EMEs. A different response, however, might occur if the US interest rate increases because the US economy is stable. Basically, a robust US economy may encourage investors to be less risk averse, which would increase capital flows to EMEs (Rey, 2015). The focus of this study is to look at how these unanticipated changes brought on by monetary policy shocks affect the EMEs. To comprehend these effects, we use a US structural VAR (SVAR) model, in which the z variable is a collection of factors representing the stability of the US economy and the residual term, i.e., u, represents the interest rate shocks, as follows:

$$r_t = \alpha_0 + \alpha_1 z_t + u_t, \quad (1)$$

where r_t is the US interest rate, z_t includes contemporaneous and lagged values of log IPI, log CPI, log of securities held outright on the balance sheet of the Federal Reserve and lagged values of interest rates[1]. We estimate the shocks as the unexpected changes in interest rates that are not the result of the stability of the US economy. Our structural identification strategy imposes a Cholesky decomposition of the covariance matrix. In the Cholesky identification criteria, the first factor does not respond to any other variable contemporaneously, the second factor only responds to contemporaneous changes in the first factor, and so on. Although all variables respond to lagged changes in each other. In our SVAR model, we order the shadow rates at the last. The SVAR model includes 6 lags of endogenous variables.

2.2.2. The PSVAR model

To examine the impact of US interest rates on the emerging markets, we use a panel SVAR model. The PSVAR model in our analysis differs from the general

[1] In defining short run restrictions with Cholesky decomposition, the last ordered variable responds to contemporaneous and lagged values of every endogenous variable in the model. It, however, does not affect other variables contemporaneously, so only the lagged values of the last ordered variable affect the other endogenous variables in the model.

specifications of Pedroni in that we first do not demean the endogenous variables in levels and then take their first difference. Instead, we just take the first difference without centralizing the variables. The rationale behind this is that demeaning the endogenous variables does not have any impact on the first differences anyway. So basically, it does not make sense to first demean the endogenous variables in level and then take the differences. Secondly, we consider a mix of panel data sets and pure time series data. The US interest rate shock in our dataset is not a panel variable but a time series one since it does not change between the cross-section units of our analysis, i.e., countries.

Now, consider a panel composed of, $i = 1, ..., N$ countries, each of which consists of $M \times 1$ vector of observed endogenous variables, y_{it}, for $y_{m,it}$, $m = 1, \ldots, M$. We will now take the stationary form to be in terms of the differences of the variables, namely $y_{i,t}$ for facilitating the short-run restrictions on the dynamics. So, we use the following estimation model for our panel data set:

$$B_i y_{i,t} = A_i(L) y_{i,t-1} + \varepsilon_{i,t}, \tag{2}$$

where $A_i(L) = \sum_{s=0}^{S_i} A_{i,s} L^s$ is a lag polynomial allowing for country-specific lag lengths according to the usual information criteria, $i = 1, \ldots, N_t$ and $t = 1, \ldots, T_i$; the i and t subscripts on the time and cross-section dimensions take into account that the panel may be unbalanced; B_i is the coefficient matrix; $\varepsilon_{i,t}$ is the composite white noise shocks for $M \times 1$ vector of endogenous variables, $\varepsilon_{m,it}$, $m = 1, \ldots, M$.

The PSVAR by Pedroni (2013) distinguish the composite shocks into common shocks and idiosyncratic shocks. Hence, the common shocks in our model will be: $\varepsilon_{i,t} = (\bar{\varepsilon}'_{it}, \tilde{\varepsilon}'_{it})'$, where $\bar{\varepsilon}'_{it}$ and $\tilde{\varepsilon}'_{it}$ are $M \times 1$ vectors of common and idiosyncratic white noise shocks respectively. Let Λ_i be an $M \times M$ diagonal matrix with loading coefficients Λ_i, $m = 1, \ldots, M$. Then,

$$\varepsilon_{i,t} = \Lambda_i \bar{\varepsilon}_{it} + \tilde{\varepsilon}_{it}, \tag{3}$$

As mentioned earlier, our model differs from the general PSVAR model since we have US interest rates as pure time series data. Hence, the vector of endogenous variables i.e., $y_{it} = (y_{1,it}, y_{2,it})'$ is a mix of panel data and pure time series data. This means that for $y_{2,it}$, the cross-sectional average is trivially equal to itself. This makes it logically impossible to use it to identify common and idiosyncratic shocks.

The $y_{1,it}$ panel contains the log IPI, log CPI, log exchange rate, log broad money, and log foreign exchange reserves. We follow Cholesky identification criteria by ordering the shadow rate shocks first so that they do not respond to the contemporaneous changes in the factors of the EMEs. The $y_{2,it}$, representing the US interest rate shocks, are the residuals that are estimated from the US SVAR model.

To obtain the structural residuals and responses, we estimate a set of N reduced-form VARs, one for each country i:

$$\begin{aligned} \Delta y_{1,t} &= B_1^{-1} A_1(L) y_{1,t-1} + \varepsilon_{i,t}, \\ &\vdots \\ \Delta y_{N,t} &= B_N^{-1} A_N(L) \Delta y_{N,t-1} + \varepsilon_{N,t}. \end{aligned} \tag{4}$$

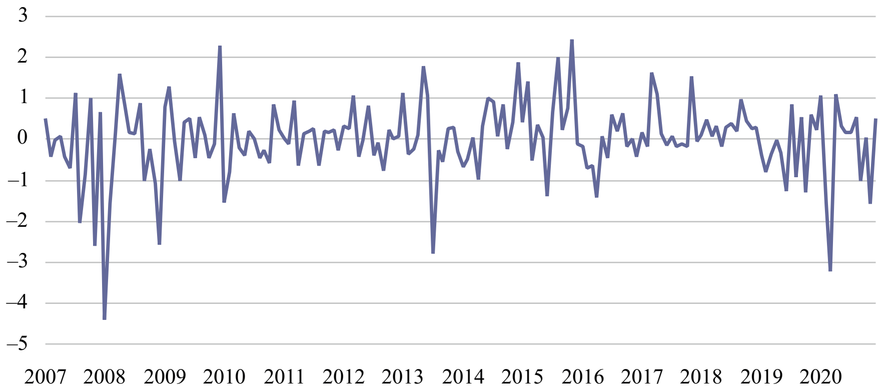

Fig. 2. Plots the unanticipated shocks in the US shadow interest rate, 2007–2020 (%).

Note: The unanticipated shocks are identified from the US SVAR model. The residuals from this model are considered as unanticipated shocks in the shadow rates. The largest contractionary shocks can be seen in 2008, depicting the quantitative easing measures.
Source: Compiled by the author.

3. Empirical results and discussion

3.1. Results from the US SVAR

Fig. 2 depicts the US interest rate shocks identified from the US SVAR model. In the period during 2008, we see the largest contractionary shock which is followed by another shock in 2009. We can also see the shock during the taper tantrum episode in the year 2013. Another episode of a contractionary shock was during the COVID 2019 pandemic.

3.2. Results from the panel SVAR

We are interested in the implications of US interest rates on the economic conditions of the emerging markets. The results from the PSVAR model are reported as impulse response functions (IRFs) in the following panels. The IRFs show how a one-standard deviation shock in one factor affects the other factor and how the effect dissipates over a course of time.

As mentioned earlier, since the US interest rate shock is a pure time-series variable, the idiosyncratic shocks are not relevant as the average effect will be somewhat the same. So, we only pay attention to the common shocks. The following Impulse Response Functions (IRF) show the point-wise median as well as the 25th quantile (as Q1) and 75th quantile (as Q2) confidence intervals (interquantile range) for the response functions of IPI, CPI, exchange rates, broad money, and foreign exchange reserves. It displays the responses of these factors to one-standard deviation shocks.

Fig. 3 shows the impulse responses of the macroeconomic factors of EMEs to a positive shock in the shadow rate. We estimate an immediate negative effect on IPI and an immediate positive effect on CPI. The exchange rates of the EMEs depreciate against the US dollar, indicating capital flow outbound from them. Moreover, the broad money supply and the foreign exchange reserves both decline immedi-

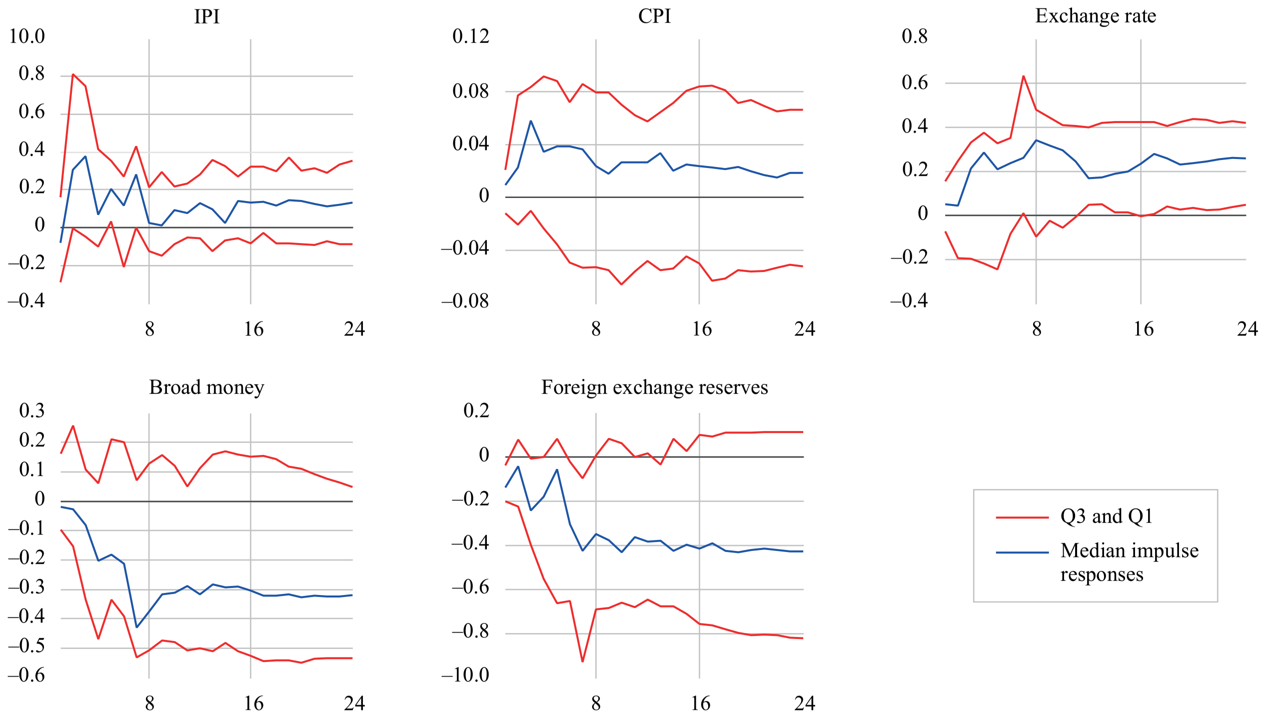

Fig. 3. Impulse response functions to shock in US shadow rates.

Note: The figure depicts the impulse response functions of EMEs to a one-standard deviation shock (positive shock) in the US interest shadow rates. The horizontal axis represents the time period or horizon, while the vertical axis represents the percent of responses. The range between Q3 and Q1 is the interquartile range. The point-wise median impulse responses represent the impact of a positive shock on the IPI, CPI, exchange rate, broad money (M3), and foreign exchange reserves, respectively. The IRFs show how these factors behave over a period of time in accordance with the shock in the US shadow rate.

Source: Compiled by the author.

ately as a response to a positive shock in the shadow rate. This points to a domestic capital outflow from emerging markets. According to our findings, a positive shock in US interest rates has a contractionary effect on the EMEs. The estimates of responses to a negative change will be symmetrical to those of a positive shock.

We now move to focus on the extent of these responses. The exchange rate depreciates by approximately 0.3% in period 3, with one standard deviation positive shock in the shadow rate. Broad money amounts to 0.41% in period 7. The effect on foreign exchange reserves declines to about 0.2% on the impact and finally it hits the negative peak at 0.4% in period 6. These responses reflect capital flight from emerging markets and demonstrate that interest rate shocks in the US create a safe haven situation for investors, causing them to shift to investing in a strong global currency, resulting in the depreciation of EME domestic currencies against the US dollar, a low monetary aggregate, and lower foreign exchange reserves.

4. Extension and robustness

4.1. Extension

In this section, we extend our analysis by addressing the bias in our dataset. The dataset is heavily skewed towards European countries, so the results can be biased in showing the full picture for non-European countries. Hence, we segregate the economies based on their regions, namely, Asia, Europe, and Latin America. The selection of regions is purely based on the number of countries in that region for which the data is available. The rationale behind this is to check if the results deviate across regions and from our earlier analysis as well. Due to the insufficient country count for the Middle Eastern and Sub-Saharan African regions, we do not divide them into sub-parts.

The results for the Asian countries are presented first. Fig. 4 shows the responses to a positive shock in the US shadow rate. Overall, the effects are contractionary in the Asian economies. However, the extent of these responses seems to be larger for foreign exchange reserves and, more importantly, they are sustained for a longer time period. The exchange rate depreciates to 0.3% in period 8, broad money dips to 0.3%, and foreign exchange reserves hit the lowest at –1%. From the IRFs for European economies, the depreciation in exchange rates of domestic currencies against the US dollar is about 0.5% (as seen in Fig. 5). Broad money dips to around 0.45% in period 7. Finally, the foreign exchange reserves fell by 0.55% in period 7. However, the response results from the Latin American economies differ from the above discussed responses. The estimate of the exchange rate shows that it appreciates as an immediate response to a positive shock. It suggests that the responses are rather delayed as the exchange rate depreciates in the later periods (as seen in Fig. 6). The reason for such a deviation might be due to the low number of countries in the region, which prevents us from seeing a rather full picture. Moreover, the responses of broad money and foreign exchange reserves are contractionary, consistent with the former results.

The analysis by dividing the countries in accordance with their regions helps us to see the heterogenous effects on a particular region. The results make it absolutely clear that the interest rates in the US affect the money supply and foreign exchange reserves to decline. It suggests a capital outflow from the emerging markets due to such shocks.

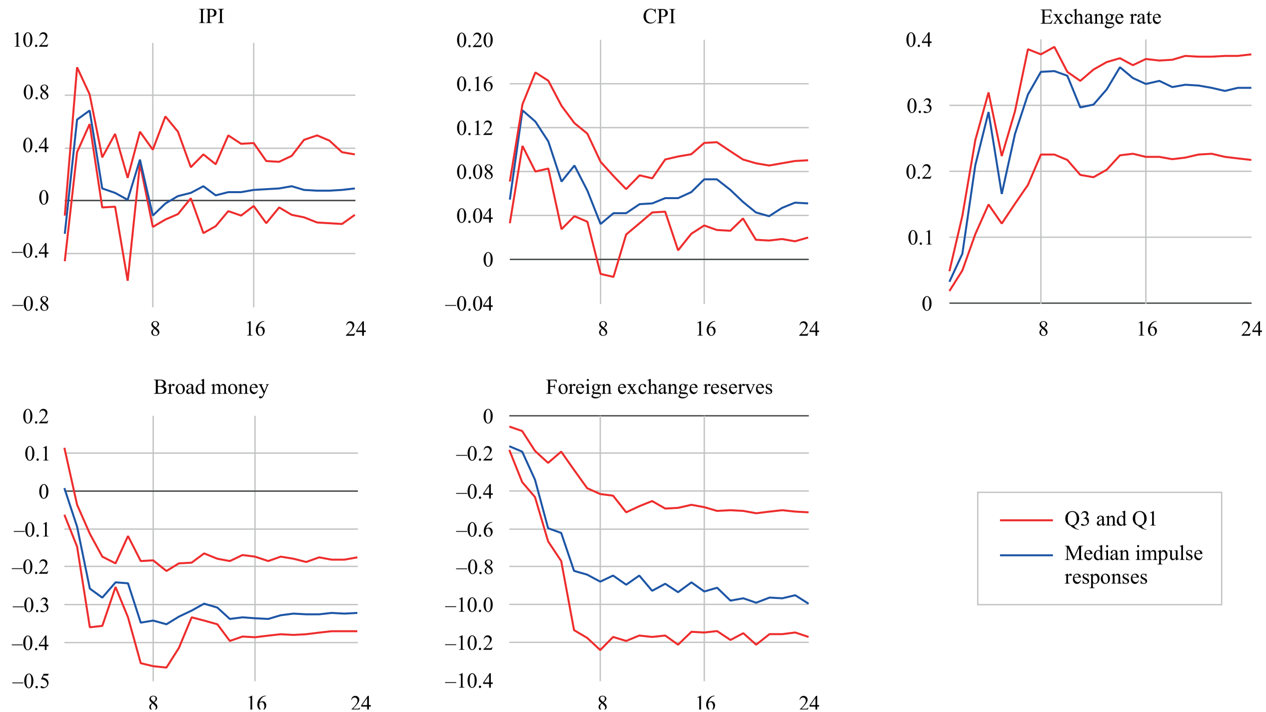

Fig. 4. Impulse response functions to shock in US shadow rate: Asia.

Note: The figure depicts the IRFs to a one-standard deviation shock in US shadow rates for the monthly dataset on EMEs from Asia. The median impulse responses represent the percentage response of an unanticipated positive shock in US shadow rate on the Asian emerging markets over time.
Source: Compiled by the author.

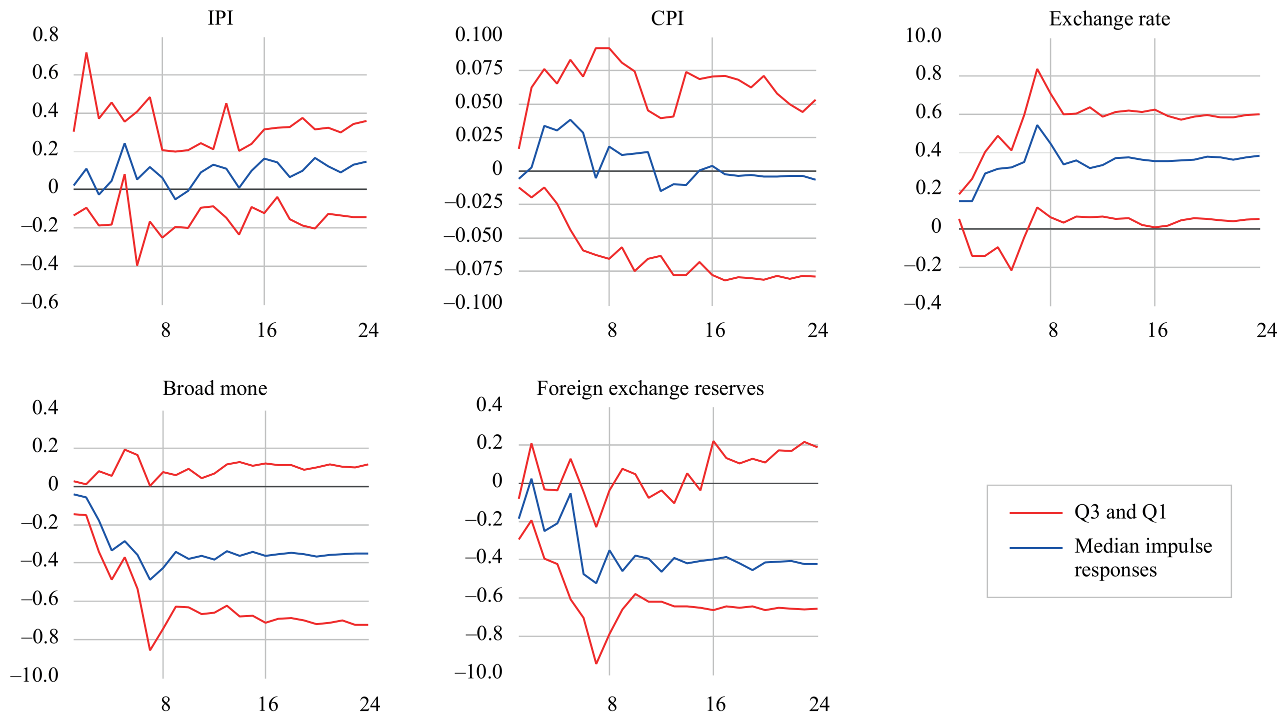

Fig. 5. Impulse response functions to shock in US shadow rates: Europe.

Note: The figure depicts the IRFs to a one-standard deviation positive shock in the US shadow rates for a monthly dataset on EMEs from Europe. The point-wise median responses show the percentage response of macroeconomic factors of European emerging markets due to a positive shock in the US shadow rates over time.
Source: Compiled by the author.

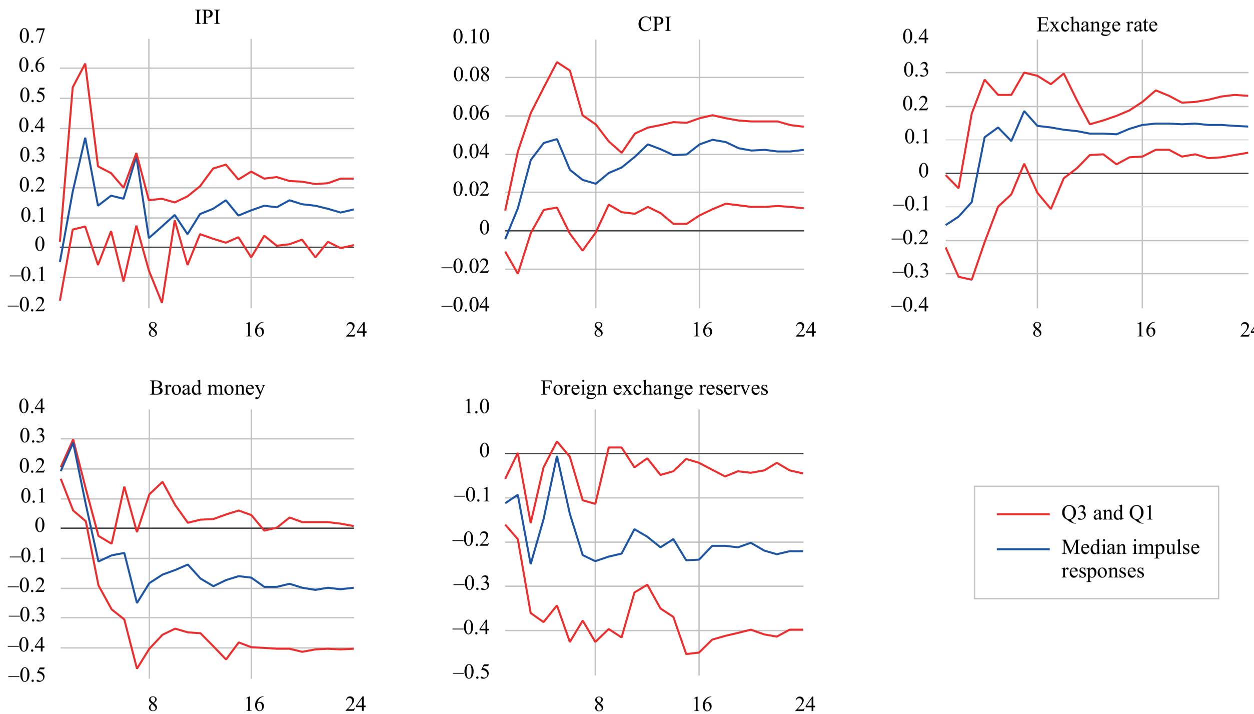

Fig. 6. Impulse response functions to shock in US shadow rates: Latin America.

Note: The figure depicts the IRFs to a one-standard deviation positive shock in US shadow rates for a monthly dataset on EMEs from Latin America. The point-wise median responses are the percentage response of macroeconomic factors due to an unanticipated positive shock in the US shadow rate over time.
Source: Compiled by the author.

4.2. Robustness

Is using the shadow rate for identifying US interest rate shocks really effective? What difference does it make if we use effective FFR to identify US monetary shocks? We assess these by incorporating effective FFR instead of shadow rate in this segment in the US SVAR model. We then consider the residuals as the unanticipated shocks in the US interest rates and use them in the Panel SVAR by following the same procedure. The baseline specifications for both the US SVAR and Panel SVAR models are exactly the same as in the former model. The estimates from this model are presented in the Appendix section. The responses from this approach substantially differ from our earlier results. According to the IRFs, the exchange rate appreciates on the impact, and broad money as well as foreign exchange reserves rise immediately. However, the exchange rate starts depreciating from period 2. Similarly, broad money estimate also shifts direction and declines from period 2 onwards. Finally, the foreign exchange reserves decline from the impact value, although they do not decline below the zero percent point. These results convey the shock responses to be lagged, that is, we see the effects of unanticipated shocks after period 2 and onwards. This comparison highlights the importance of using the shadow rate to identify shocks because the effective FFR cannot fall below zero, so the effects of monetary stimulus would not be reflected in the FFR due to the liquidity trap. Hence, we believe it might not capture the full picture.

5. Conclusion

The announcements made by the chair of the Federal Reserve, Jeremy Powell, in January 2022 with regard to raising interest rates in the upcoming years make it imperative to analyse the implications of this policy change on the economic conditions in the EMEs. Our research focuses primarily on the effects on the money supply, foreign exchange reserves, and the exchange rate.

Keeping in mind the ZLB on interest rates following the Great Recession, we consider the Wu-Xia shadow rate instead of the effective FFR. We investigate the effects on 29 EMEs over the period 2007M1 to 2020M12. Our data set includes log values for the Industrial Production Index, Consumer Price Index, exchange rate, foreign exchange reserves, broad money, and US interest rates.

We first identify the unanticipated shocks in a SVAR model of the US economy. We use the Cholesky decomposition identification scheme to find the residuals from this model and identify these as the unanticipated shocks in the US interest rate. We then incorporate these shocks into the Panel SVAR model to capture the spillover effects of US interest rate shocks on the EMEs.

The findings suggest that with one standard deviation in the US interest rates, the IPI of EMEs declines and CPI rises. We see the exchange rates of the domestic currencies of EMEs depreciating as a response to a shock in US interest rates. The broad money declines substantially on the impact, and finally, the response function of the foreign exchange reserve depicts its estimate falling due to unanticipated shocks. The results are somewhat consistent when we employ the methodology across multiple EMEs by segregating them into groups based on their region/zone, i.e., Asia, Europe, and Latin America. The results for Asia and Europe are in line with our key conclusions. However, for Latin America, the results that we see in our main findings are not on the impact, they are rather delayed. Broad money does not decline on the impact; it first rises and then starts to fall after period 2. The effect on the exchange rate is also delayed for the Latin American region. The model only includes a small number of EMs from this region, which could account for the delayed reaction.

The contribution of the study is two-fold. Firstly, we investigate the effects of US interest rate shocks on a large panel of 29 EMEs by using the shadow rate instead of FFR. The intuition behind using shadow rates is to capture the effects of unconventional monetary policy adopted after the GFC. Shadow rates could be more efficient for analyzing the effects of US monetary policy shocks as it takes into account large-scale asset purchases. Secondly, we focus on the effect on the broad money of the EMs and the heterogeneous effect across multiple regions of the EMEs. A noteworthy point to consider is that these unanticipated shocks do not correspond to a strong and stable US economy. These are the residuals from the model, which is why they are regarded as unanticipated. Moreover, if the changes in interest rates do arise as a result of strong and stable economic conditions in the US, the results may vary as this may induce investors to be risk-takers, which would increase the capital inflows towards the emerging markets. However, the unanticipated shocks make investors turn towards a more stable currency, which ultimately results in a capital outflow from the EMEs.

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Appendix A. Description of variables and their construction

Variable	Construction	Source
Industrial production index	Natural log of industrial production index	CEIC
Consumer price index	Natural log of consumer price index	CEIC
Exchange rate	Natural log of exchange rate against US dollar, period average	CEIC
Broad money	Natural log of money supply, M_3	CEIC
Foreign exchange reserves	Natural log of foreign exchange reserves	CEIC
Securities held outright by the Federal Reserve	Natural log of securities held outright by the Federal Reserve	CEIC
Shadow interest rate	Wu-Xia shadow rate	Federal Reserve Bank of Atlanta
US interest rate	Effective federal fund rate	FRED

Appendix B. List of countries

1. Albania
2. Algeria
3. Azerbaijan
4. Bangladesh
5. Bosnia and Herzegovina
6. Brazil
7. Bulgaria
8. Chile
9. Colombia
10. Costa Rica
11. Croatia
12. Hungary
13. India
14. Kazakhstan
15. Malaysia
16. Mexico
17. Mongolia
18. Montenegro
19. Pakistan
20. Paraguay
21. Philippines
22. Poland
23. Romania
24. Russia
25. Serbia
26. South Africa
27. Tunisia
28. Turkey
29. Ukraine

Appendix C. Robustness results

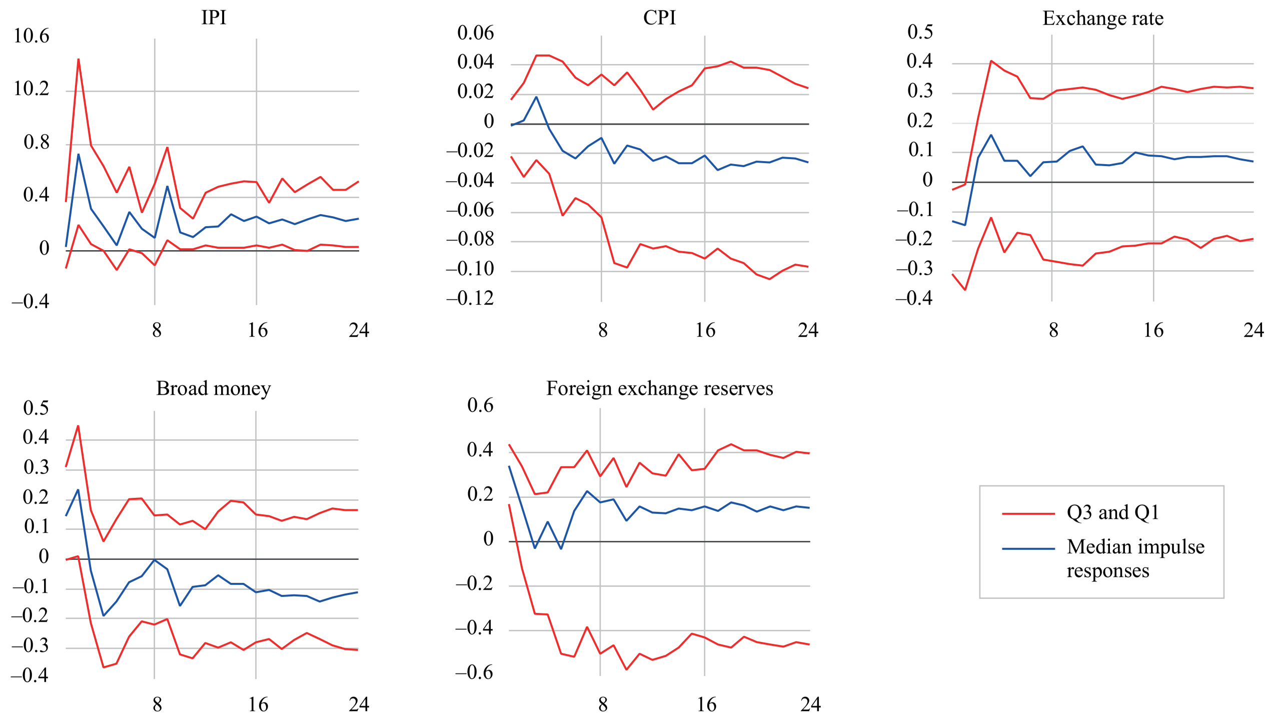

Fig. C1. Impulse response functions to shock in US effective federal fund rate.

Note: The figure depicts the IRFs to a one-standard deviation shock in the effective FFR of the US for a monthly dataset on 29 emerging markets. The identification of unanticipated shocks in US FFR is done in the US SVAR model. The point-wise median responses represent the percentage responses of IPI, CPI, exchange rate, broad money, and foreign exchange reserves of EMEs due to a positive shock in the US FFR over time.

Source: Compiled by the author.

Appendix D. Variance decomposition forecasts

The figures provided below are variance decomposition forecast which depicts the importance of a factor in explaining the other. Thus, here we can examine if the US interest rate is even important for explaining the changes in the macroeconomic factors of the EMEs.

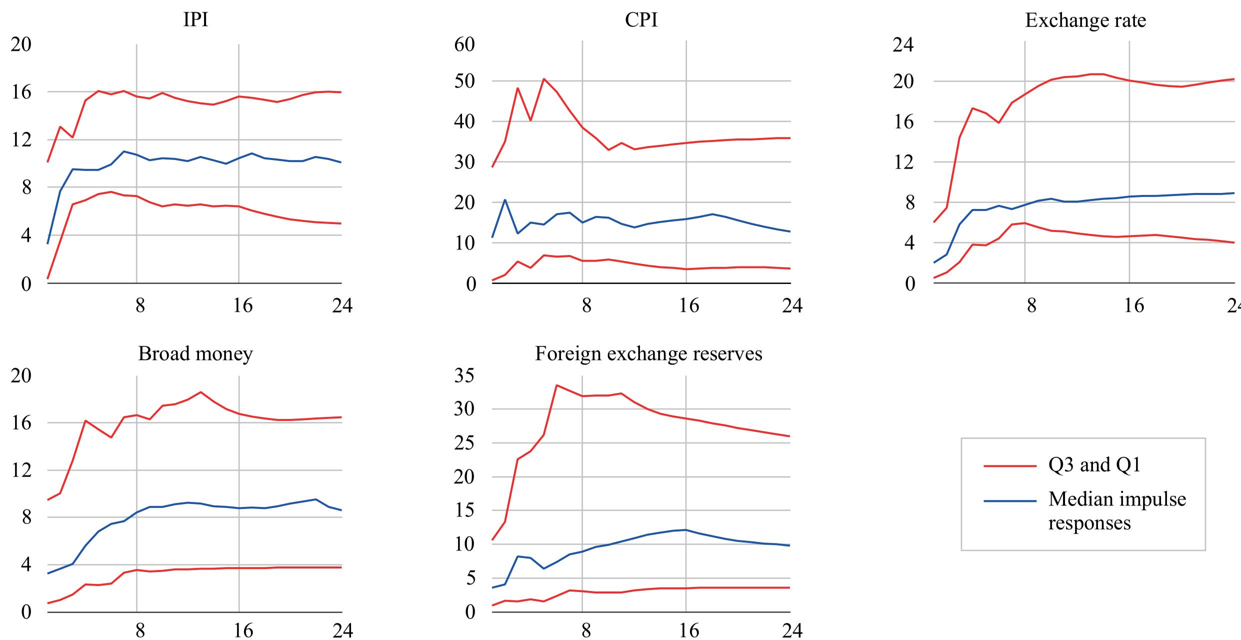

Fig. D1. Variance decomposition forecast due to shock in US shadow rates.

Note: The figure depicts the variance decomposition forecast for 29 EMEs due to unanticipated shock in the US shadow rates. Each plot shows the percentage of median responses due to shock in the US shadow rate with interquartile range.
Source: Compiled by the author.

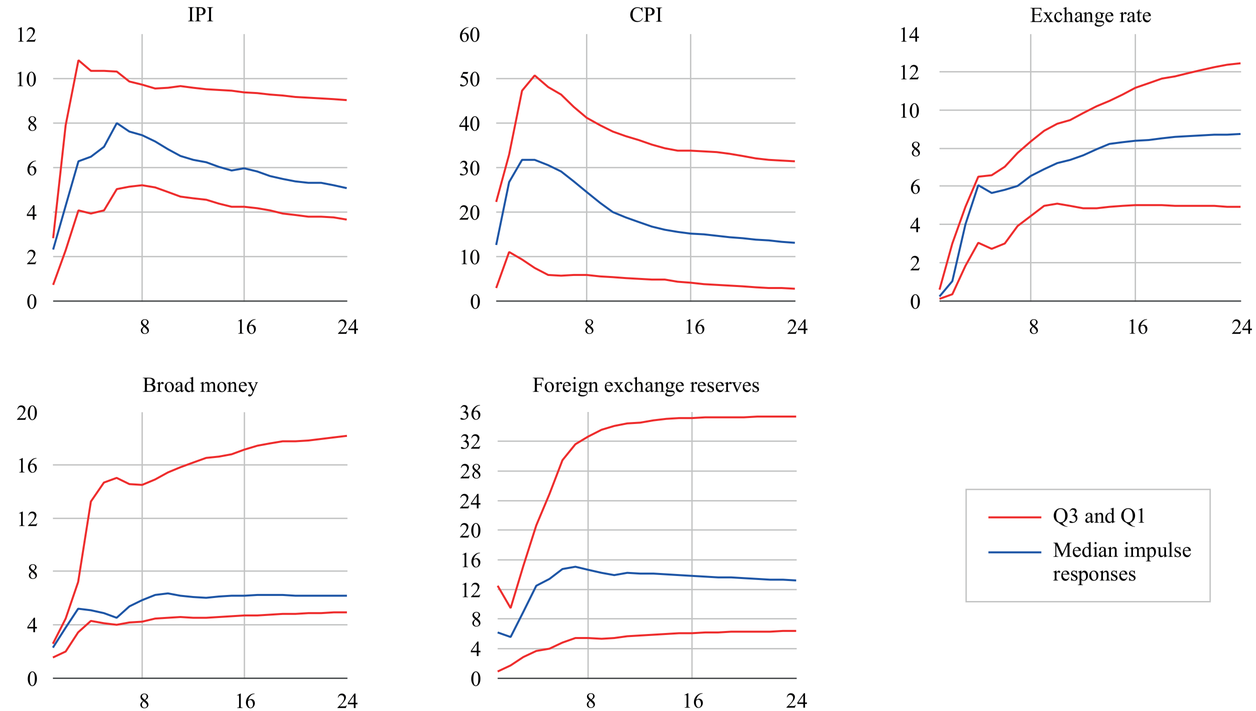

Fig. D2. Variance decomposition forecast due to shock in US shadow rates: Asia.

Note: The figure depicts the variance decomposition forecast for EMEs from Asia due to unanticipated shock in the US shadow rates. Each plot shows the percentage of median responses due to shock in the US shadow rate with interquartile range.
Source: Compiled by the author.

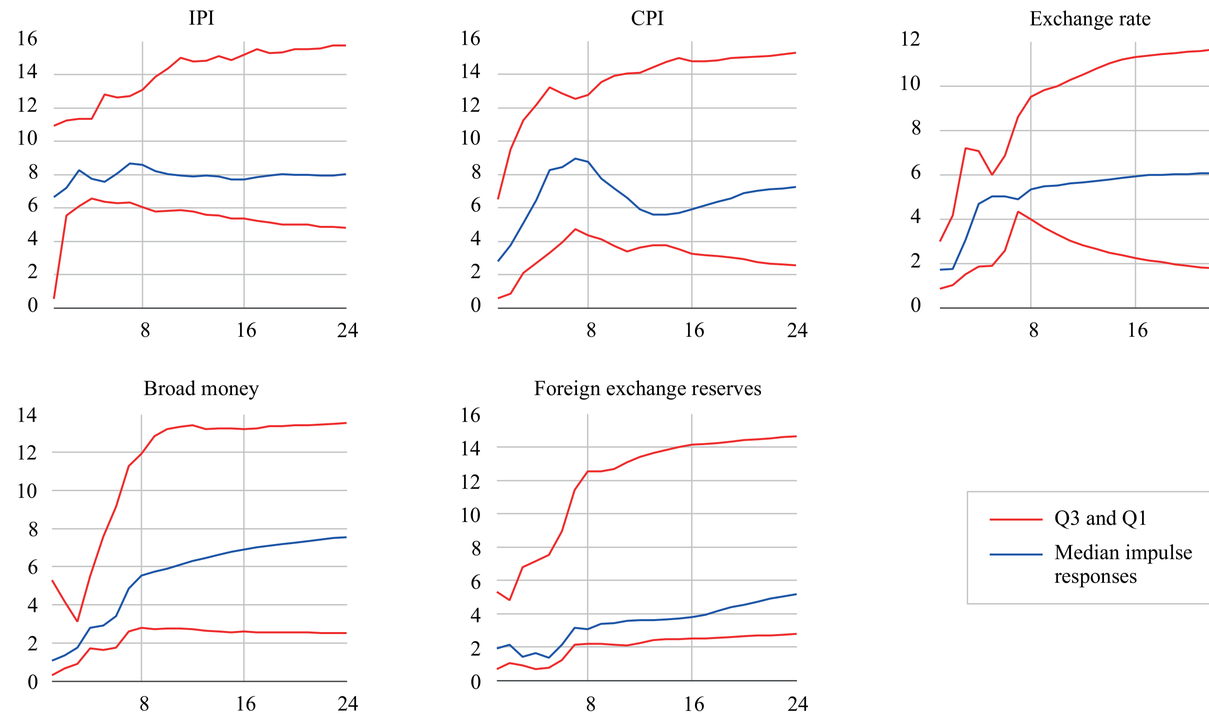

Fig. D3. Variance decomposition forecast due to shock in US shadow rates: Europe.

Note: The figure depicts the variance decomposition forecast for EMEs from Europe due to unanticipated shock in the US shadow rates. Each plot shows the percentage of median responses due to shock in the US shadow rate with interquartile range.

Source: Compiled by the author.

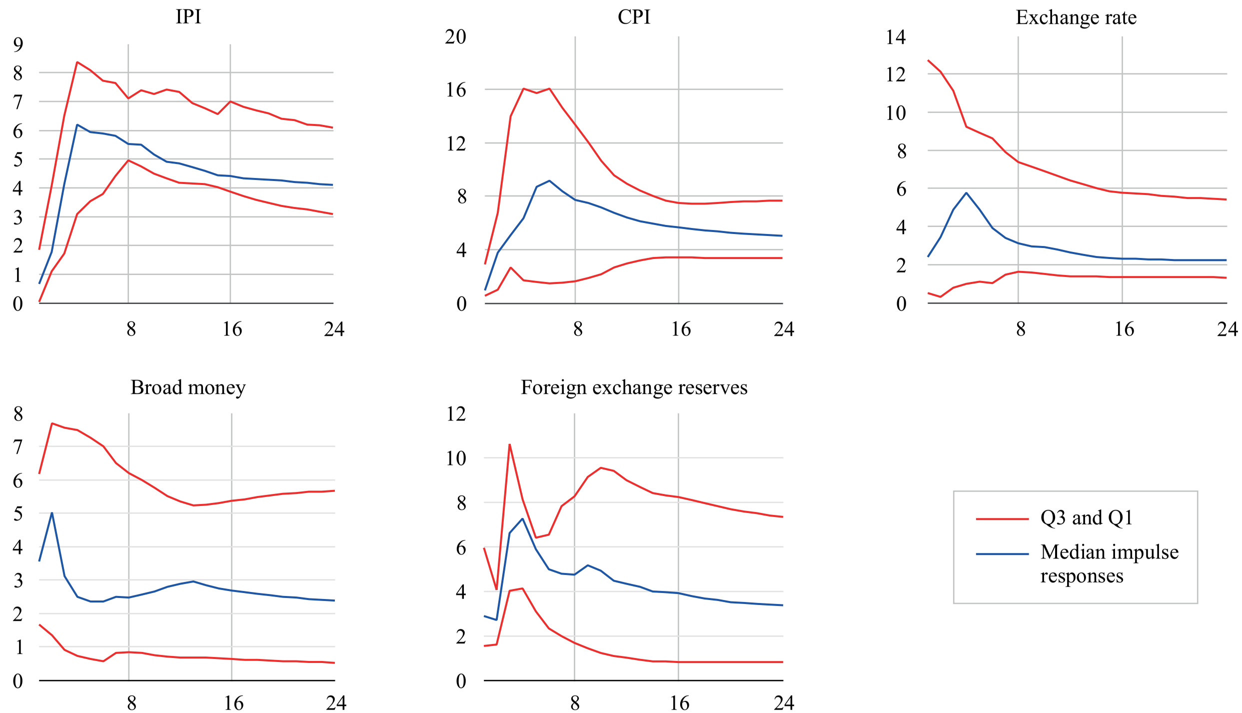

Fig. D4. Variance decomposition forecast due to shock in US shadow rates: Latin America.

Note: The figure depicts the variance decomposition forecast for EMEs from Latin America due to unanticipated shock in the US shadow rates. Each plot shows the percentage of median responses due to shock in the US shadow rate with interquartile range.

Source: Compiled by the author.

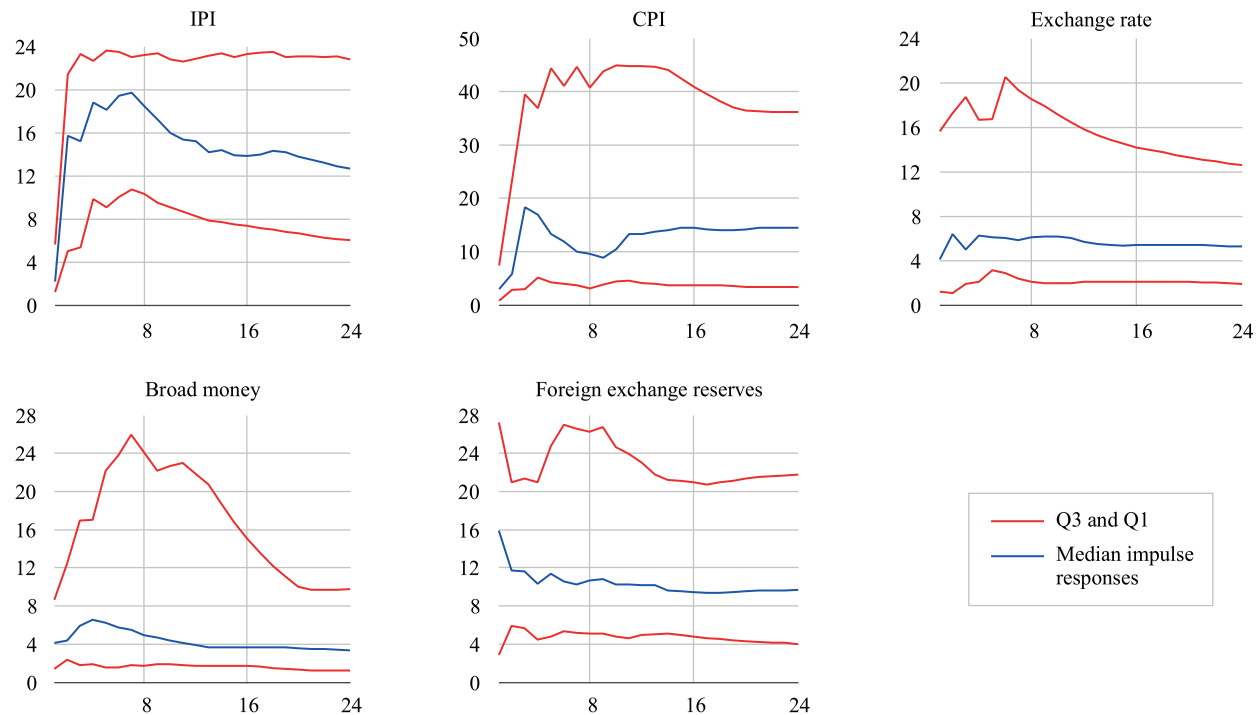

Fig. D5. Variance decomposition forecast due to shock in US effective FFR.

Note: The figure depicts the variance decomposition forecast for 29 EMEs due to unanticipated shock in the US effective FFR. Each plot shows the percentage of median responses due to shock in the US shadow rate with interquartile range.

Source: Compiled by the author.