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Effectiveness of monetary policy in stabilising food inflation: Evidence from advanced and emerging economies

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Abstract

In the backdrop of several episodes of high and volatile food inflation in emerging economies, a wealth of literature emphasises on broad range of monetary and exchange rate policies to stabilise food inflation by moderating demand pressure. While the theoretical literature mainly focus on welfare-maximising monetary policy, there exists hardly any empirical consensus on effectiveness of monetary policy to stabilise food inflation. Very recently, a limited strand of empirical literature has attempted to shed light in this arena. The present study attempts to contribute in this literature by analysing effectiveness of monetary policy shock to stabilise food inflation in a panel of developed and emerging economies. We find that an unexpected monetary tightening has a positive and significant effect on food inflation in both advanced and emerging economies. Our findings suggest that in the backdrop of inflationary pressure stemming from the food sector, a monetary tightening may turn out to be destabilising for the food as well as overall inflation in the economy.

JEL Classification: E31, E52, E58, C51

Keywords: Food inflation, Monetary policy, Emerging economies, Panel Vector Auto-Regression.

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1 Introduction

In the backdrop of several episodes of high and volatile food inflation in advanced and emerging economies in the recent past, a wealth of literature emphasises on broad range of monetary and exchange rate policies to stabilise food inflation by moderating demand pressure. This strand of theoretical literature based on Dynamic General Equilibrium Models mainly focus on optimal monetary policy, i.e, whether the central bank should target core or headline inflation facing inflation pressure originated in food sector. From the perspective of social welfare maximisation, the literature suggests core inflation targeting, taking into account the pass-through effect from food to non-food inflation under complete financial market hypothesis(Aoki, 2001). The headline CPI inflation targeting is advocated when financial market is incomplete (Anand and Prasad, 2010; Anand et al., 2015), and food constitutes a large share of the consumption basket, be it a non-traded good (Soto, 2003; Pourroy et al., 2016) or an imported one (Catao and Chang, 2015). Stabilising consumption by stabilising the relative price of food to non-food (Aoki, 2001; Soto, 2003; Pourroy et al., 2016), the real income of farmers (Anand and Prasad, 2010; Anand et al., 2015) and the real exchange rate (Catao and Chang, 2015) allows the economy to attain the highest level of welfare in this class of models.

While the theoretical literature in general suggests a stabilising role of optimal monetary policy for food prices, there exists limited empirical exploration on the effectiveness of monetary policy to control food inflation. Very recently, a limited strand of empirical literature has attempted to shed light in this area. (Frankel, 2008; Akram, 2009; Scrimgeour, 2014; Hammoudeh et al., 2015). All these empirical investigation mainly focus on US, a large advanced economy. Frankel (2008) is the only study providing insights on this issue for other advanced economies and a few selected emerging economies as well. To our knowledge, rigorous empirical evidence from emerging economies on the impact of monetary policy on food inflation is still a void in the literature.

The present study attempts to fill this gap in the literature by analysing effectiveness of monetary policy shock to stabilise food inflation in a panel of developed and emerging economies. Theoretically, the channel for monetary policy to reduce food inflation is by moderating the aggregate demand. However, impact of a monetary tightening on food inflation will be lower compared to the effect on non-food inflation due to Engel's Law. Further, countries with a high share of consumption basket assigned to food and a large section of population consuming food around the subsistence level, may

not have significant effect of a policy rate rise on food consumption. Rather, the effect of monetary policy tightening will be perceived at a much greater extent on non-food consumption and prices. Hence, effectiveness of monetary policy to stabilise food inflation may crucially depend on the consumption pattern of the economy and the stage of development it belongs to.

We find that an unexpected monetary tightening has a positive and significant effect on food inflation in both advanced and emerging economies. Monetary tightening increases the price of capital intensive non-food products via cost channel of monetary policy transmission (Barth and Ramey, 2001; Chowdhury et al., 2006; Gaotti and Secchi, 2006; Henzel et al., 2009). Durable goods, which can be bought against loan also becomes expensive following an interest rate hike. As a result, households substitute consumption of non-food items by food, causing an upward pressure on food prices. For emerging economies having large share of food in the consumption basket and a large share of population consuming food at far below the satiation point, this effect is large compared to advanced economies.

The monetary tightening leads to a decline in core inflation in emerging economies, although the effect is not significant. With significant positive effect on food inflation and a large share of food in the consumption basket, the impact on aggregate inflation of monetary tightening is also found to be positive in emerging economies. However, we find price-puzzle effect for core and aggregate inflation in advanced economies.

The unexpected monetary tightening has significant negative effect on growth rate of real consumption, investment and GDP in advanced economies as expected. In emerging economies, investment and GDP growth show a decline for a short period after the shock, with the impacts becoming insignificant eventually. A rise in policy rate seems to have no significant effect on real consumption growth in emerging economies, as rise in consumption of food mitigates the decline in consumption of non-food in emerging economies following a monetary tightening. Moreover, as suggested in the long-existing literature on monetary policy transmission, low level of financial development and integration, and institutional development cause small real impact of monetary policy shocks in emerging economies compared to advanced economies.

The present study contributes to the empirical literature on effectiveness of monetary policy to stabilise food inflation in three major ways. First, the limited existing literature mainly stress on the relationship of monetary policy and commodity prices where food constitutes one item in the set of commodities. We exclusively highlight the role of monetary policy for food inflation via the consumption demand channel, and its implication for core

and headline inflation in a reduced form general equilibrium framework.

Second, the existing literature mainly focus on US, representing a large advanced economy. The present study provides insight on this issue from a comprehensive set of advanced and emerging economies, compares the findings for the two sets of economies and thereby fills the void in the literature for emerging economies.

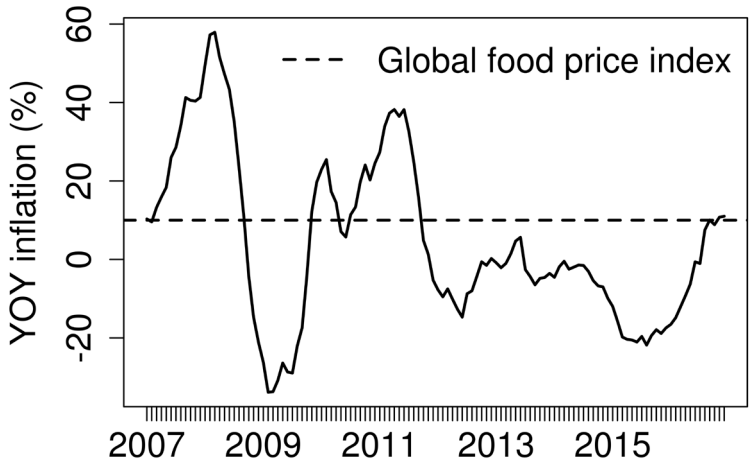
Third, this study has implication for monetary policy designing for many emerging economies subject to inflationary pressure coming from food sector. Overall, our analysis suggest that in the backdrop of an inflationary pressure stemming from food sector, an one-time monetary tightening to stabilise it may turn out to be destabilising the food as well as overall inflation in the economy. To have a negative effect on food prices, a sustained monetary contraction is required so that the negative real income effect can outweigh the positive relative price effect on food consumption. However, in that process, the activities in non-food sector will have disproportionately higher negative effect given the Engel's Law. Hence, including food inflation in the indicator for inflation target may have unbalanced negative growth effect of monetary policy across food and non-food sector, with core sector bearing the greater burden.

The rest of the paper is organised as follows. Section 2 discusses a few stylised facts relating cross-country food consumption pattern, level of per capita income, food inflation and monetary policy. Section 3 reviews the related theoretical and empirical literature on effectiveness of monetary policy to stabilise food inflation. Section 4 outlines the data and the estimation method applied in the analysis, and finally discusses the findings. Section 5 analyses the alternative modelling strategy to test the robustness of our results. Finally, Section 6 concludes the paper.

2 Food inflation and monetary policy: Stylised facts

In the decade of 2006 to 2016, the global food price index grew at an average year-on-year monthly rate of 4.5% with a very high volatility of 21.36%. During this period, there are three occasions when the global food inflation exceeded the 10% mark (see Figure 1). These three phases span the periods respectively from January, 2007 to September, 2008; November, 2009 to April, 2010, and July, 2010 to September, 2011, with the first phase record-

Figure 1 Global food inflation



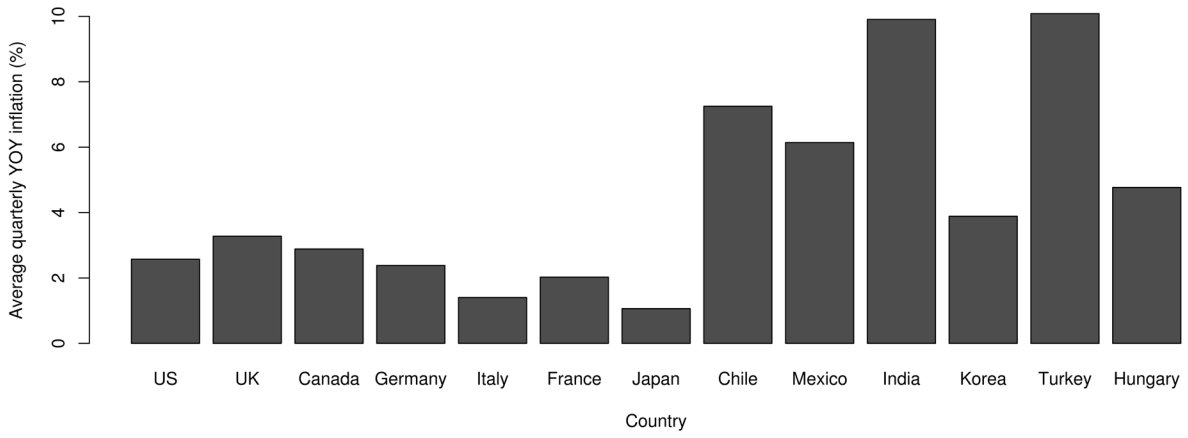
Source: FAO & Author's estimates

ing the highest rate of inflation at 33%. The world food prices grew at an average rate of 10% during the last four months of 2016. The periods of severe deflation in the world food prices are also observed.

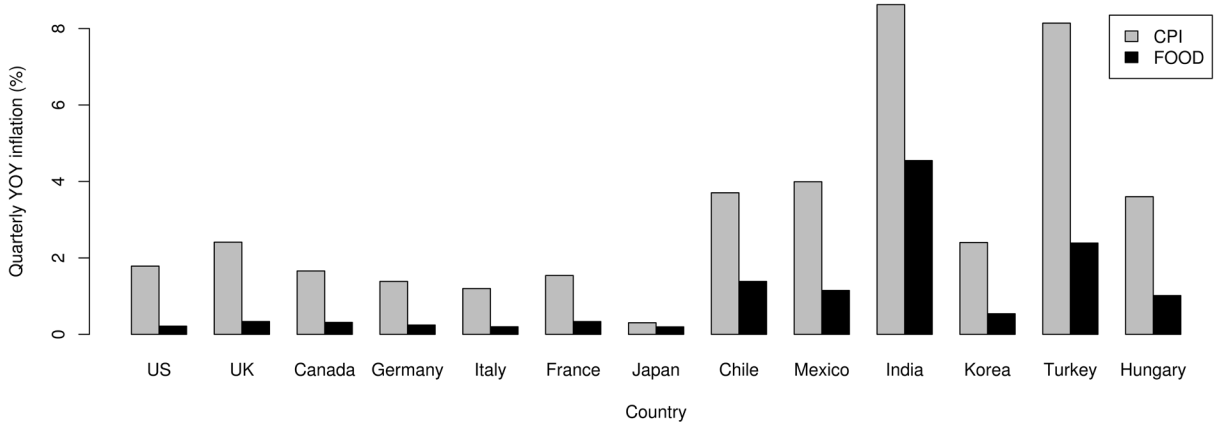
During the same period, average inflation rate in domestic food prices seems to vary substantially across individual countries in the world. The emerging economies record higher average food inflation compared to their advanced economies counterparts. The average food inflation in emerging economies in the last decade exceeds 6% except for South Korea and Hungary, while it lies in the range of 2-4% in the advanced countries (see the upper panel of Figure 2). The emerging economies also record higher average headline inflation compared to that in the advanced countries (see the lower panel of Figure 2). We also observe that countries with high food inflation are also the ones with high headline inflation, indicating a positive correlation among headline and food inflation. The low income countries and the countries with large share of expenditure devoted to food tend to record high average food inflation (Figure 3).

How do central banks respond to inflationary situation in food sector? A well-known dilemma central banks often face is the choice between headline inflation including food components, and core inflation as the target inflation indicator. Such dilemma is even more profound for emerging economies where food constitutes a substantial share of the consumption basket. In practice, central banks in general are found to have preference for headline inflation including food component as the target indicator. We observe that all the countries in our sample, except Japan, have chosen some variation

Figure 2 Average food and headline inflation across countries



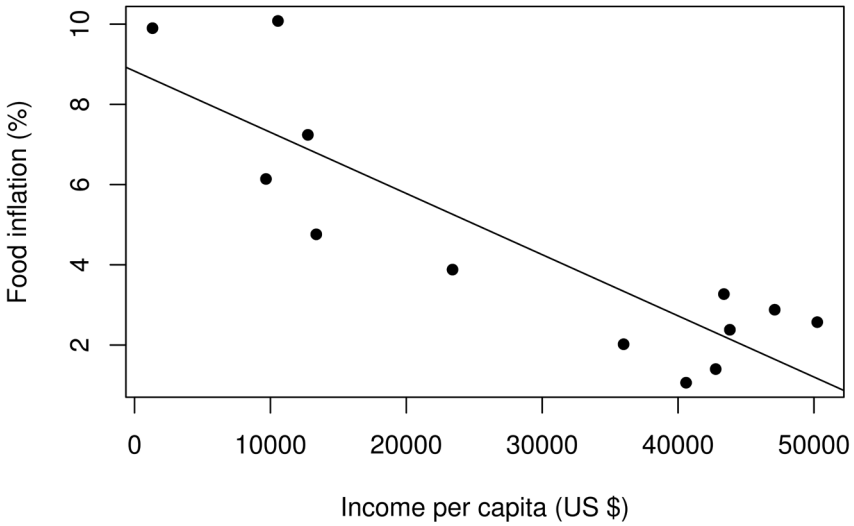
(a) Average domestic food inflation



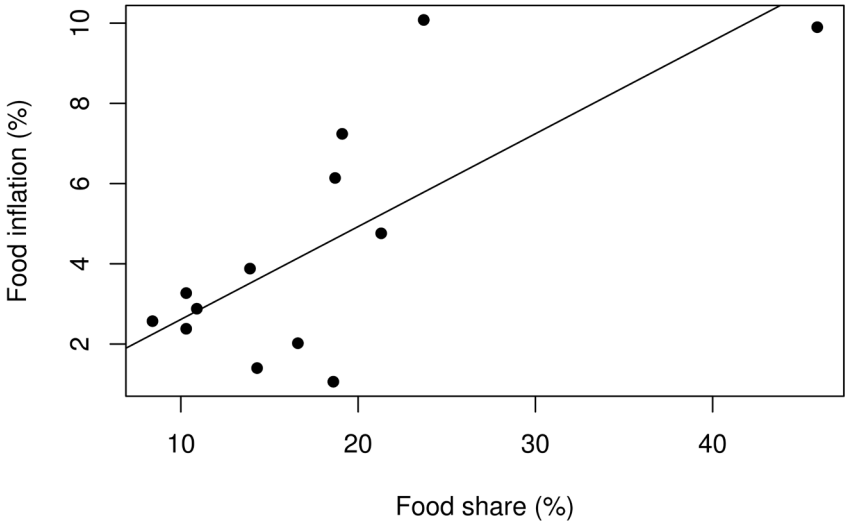
(b) Average headline vs. food inflation

Source: Official websites of countries in the sample, Federal Reserve Bank of St. Louis (FRED) & Author's estimates

Figure 3 Food inflation versus stages of development



(a) Food inflation versus per capita income



(b) Food inflation versus share of food in consumption basket

Source: Official websites of countries in the sample, Federal Reserve Bank of St. Louis (FRED), IMF & Author's estimates

Table 1 Central Banks and indicators for inflation target

Country	Adoption Year	Indicator for inflation target
Canada	1991	Headline CPI
UK	1992	Retail price index excluding mortgage interest payments, replaced by Headline CPI from 2003 onwards
EU countries	1998	Harmonised index of consumer prices (HICP)
Germany		
Italy		
France		
Japan	2013	Core CPI
Chile	2000	Headline CPI
Mexico	2001	Headline CPI
South Korea	1998	Headline CPI
Turkey	2006	Headline CPI
Hungary	2001	Headline CPI
India	2015	Headline CPI

Source: Central Banks' websites of the countries in the sample

of the overall CPI including the food component as the underlying indicator for inflation target (Table 1). This implies that central banks around the globe indeed take into account the inflationary situation in food sector while making decision about the monetary policy for the economy.

However, the empirical pattern of central banks' response to food inflation shows substantial variations across countries (Table 2). There are four distinct patterns of response observed in a cross-correlation analysis among the food inflation and policy rate, where correlation of policy rate at period t with food inflation at $t \pm k, \quad k = 0, 1, 2, 3, 4$ are evaluated. We find that, for most of the advanced and emerging economies, food is a coincident indicator, showing high correlation with policy rate at lag -1, the coincident period 0, and lead +1.[1] EU countries, such as Germany, Italy, France, and emerging economies such as, Chile, Mexico, Turkey and India fall in this group. Policy rate seems to respond positively to food inflation dynamics almost immediately in these economies, except India. Interestingly, in response to dynamics of food inflation, policy rate is found to respond negatively in India. Food

[1] In empirical macroeconomics literature, a variable is defined as a coincident indicator to a target indicator when the latter has high correlation with the former at lags ± 1 around 0 lag. A variable is a leading indicator to the target indicator when higher correlation are observed at lags beyond -2 compared to the coincidence period.

Table 2 Response of policy rate to food inflation

Country	Q(-4)	Q(-3)	Q(-2)	Q(-1)	Q(0)	Q(+1)	Q(+2)	Q(+3)	Q(+4)
US	0.026	0.081	0.160	0.271	0.416	0.540	0.613	0.648	0.617
UK	-0.019	0.039	0.120	0.252	0.424	0.544	0.643	0.705	0.674
Canada	-0.109	-0.200	-0.259	-0.254	-0.154	-0.025	0.119	0.284	0.424
Germany	0.096	0.249	0.385	0.505	0.589	0.561	0.492	0.368	0.157
Italy	0.153	0.268	0.415	0.593	0.731	0.773	0.767	0.721	0.605
France	0.071	0.178	0.326	0.485	0.608	0.658	0.639	0.560	0.420
Japan	-0.124	-0.141	-0.157	-0.113	-0.053	0.062	0.128	0.178	0.147
Chile	-0.209	0.066	0.356	0.555	0.682	0.742	0.635	0.417	0.172
Mexico	0.002	0.125	0.220	0.336	0.482	0.600	0.624	0.541	0.381
S. Korea	0.095	0.096	0.058	0.052	0.067	0.103	0.195	0.258	0.213
Turkey	0.305	0.361	0.437	0.483	0.512	0.466	0.357	0.258	0.143
Hungary	0.753	0.786	0.776	0.765	0.759	0.644	0.527	0.417	0.300
India	-0.165	-0.347	-0.470	-0.491	-0.480	-0.404	-0.310	-0.191	0.035

Source: Official websites of countries in the sample, Federal Reserve Bank of St. Louis (FRED), IMF & Author's estimates

inflation is a leading indicator for policy rate in Hungary. At lags -2 and -3, food inflation show highest correlation with policy rate in Hungary. The third category includes countries where it is the food inflation that follows policy rate at a lag. US and UK belong to this category where food inflation at leads 2 and 3 show highest correlation with policy rate. Canada, Japan and South Korea constitute the fourth category where significant correlation among policy rate and food inflation can not be found at any lag or lead or at the coincidence period.

3 Review of related literature

In this section, we discuss a few selected literature on the role of monetary policy for stabilising food inflation. The strand of theoretical literature, based on Dynamic General Equilibrium Models mainly focus on optimal monetary policy. The issue addressed here is whether the central bank should target core or headline inflation when the economy consists of two distinct sectors, namely food and non-food sectors. The conclusion crucially depends on the structural properties of the economy. Targeting core inflation, after taking into account the pass-through of food inflation to non-food inflation, is found to be optimal under the assumption of complete financial market (Aoki,

2001).[2]

On the other hand, stabilising headline CPI inflation is welfare superior when financial market is incomplete so that farmers do not have access to financial services for saving or borrowing (Anand and Prasad, 2010; Anand et al., 2015). Targeting headline CPI inflation is also advocated when food constitutes a large share of the consumption basket, be it a non-traded good (Soto, 2003; Pourroy et al., 2016) or an imported one (Catao and Chang, 2015).

While the theoretical insights vary in terms of appropriate indicator for inflation targeting, the literature in general suggests a stabilising role of monetary policy for food inflation under optimal monetary policy. On the contrary, there exists hardly any empirical consensus on effectiveness of monetary policy to stabilise food inflation. Very recently, a limited strand of empirical literature attempt to shed light in this arena. Next, a discussion on the related empirical literature follows.

Frankel (2008); Akram (2009); Scrimgeour (2014) find stabilising role of monetary policy for real commodity prices, including agricultural commodities. The evidence in these studies are mainly based on the data from US, a large advanced country. The channels highlighted in these studies, through which a rise (decline) in real interest rate reduces (increases) real agricultural commodity prices are the following: higher (lower) interest rate (i) increases (decreases) storing cost and hence encourages suppliers to deplete (accumulate) stocks, thereby enhancing (reducing) the supply; (ii) encourages speculators to re-arrange portfolio by shifting from (to) commodity contracts to (from) treasury bill. Scrimgeour (2014) also mentions the role of aggregate demand channel.

Frankel (2008) uses US data for the period 1950-2005, and finds that a rise in the real interest rate lowers aggregate real commodity price indices as well as 23 individual commodity prices, including agricultural commodities. He further compared the evidence with some selected emerging economies and other advanced countries. Using aggregate commodity price index data, he also finds similar evidence for other advanced economies, namely UK, Canada, Switzerland, Australia and New Zealand, and for emerging economies, such as Brazil and Chile. However, Mexico showed a positive impact of monetary contraction on commodity prices.

Akram (2009) estimates a structural VAR model using data on oil and food

[2]For practical purposes, Gregorio (2012) also suggests that when shocks to food inflation is transitory, targeting core inflation adjusting for the pass-through effect of food to non-food inflation is sufficient.

prices in US dollar, US real interest rate and exchange rate for the period of 1990 Q1 to 2007 Q4. He finds that a positive shock to real interest rate causes a decline in real prices of both oil and food. In a more recent study, Scrimgeour (2014) finds similar insights using high frequency data in an event-study framework.

However, Hammoudeh et al. (2015) observe initial price puzzle following a monetary contraction in all classes of commodities in US, with a persistent rise in food prices. This paper estimates a structural VAR model using US quarterly data for the period 1957 Q1 to 2008 Q3. A monetary tightening is found to increase all commodity prices initially, owing to various possible causes such as aggregation bias, greater expected inflation and speculation, high production costs, and overshooting. As the contractionary impact on the real economic activities sets in, the positive impact eventually subsides and reverses sign for prices of all commodities except for food. Following a monetary tightening, food prices persistently rise after an initial decline.

4 Effect of unexpected change in monetary policy on food inflation: A cross-country analysis

To assess the role of monetary policy on food inflation, we estimate a reduced form Panel Vector Auto-Regression (PVAR) model for a set of selected advanced and emerging economies. In order to capture the effect of monetary policy on food inflation via consumption demand channel, the set of endogenous variables are chosen following Hammoudeh et al. (2015). The set of endogenous variables included in the PVAR analysis are real GDP capturing total real income, real consumption and investment expenditure representing consumption and investment demand, policy rate representing the monetary policy stance of the central bank, sectoral and aggregate prices, and exchange rate.

We estimate the VAR structure in a panel framework as a system of equations using the Generalised Method of Moments (GMM) technique following Holtz-Eakin et al. (1988); Abrigo and Love (2016). While the VAR structure allows us to capture the endogeneity of macroeconomic variables, the panel framework allows us to control for the unobserved cross-country heterogeneity. It also helps to increase efficiency by reducing the potential bias caused by the small degrees of freedom in country-level VAR models (Jawadi et al.,

2016). The following sections discuss the data and the estimation strategy used in the analysis in detail.

4.1 The Data

The dataset is a quarterly panel consisting of macroeconomic indicators for thirteen advanced and emerging economies, for the period 2006 Q1 to 2016 Q2. The sample of countries consists of seven advanced economies and six emerging economies. We select countries is based on the classification of countries given in World Economic and Financial Surveys, World Economic Outlook, published by the International Monetary Fund (IMF). The sample of countries consists of US, UK, Canada, Japan, Italy, France and Germany from the set of developed economies, while, India, Korea, Chile, Mexico, Turkey and Hungary represent emerging economies.

In our analysis, real GDP proxies for total income whereas nominal Household Consumption Expenditure and Gross Fixed Capital Formation data, after deflated by the GDP deflator, captures real consumption and investment expenditures. The national accounts data for each of the country are sourced from the International Financial Statistics (IFS) published by the IMF.

The components of the Consumer Price Index (CPI), namely, food, non-food and non-oil, and the aggregate price level are used to gauge the food, core and headline inflation in our analysis. The data for the overall consumer price index (CPI) along with its major components such as food, energy and core for the countries in our sample are sourced from the respective country's official websites and the economic database given in the website of Federal Reserve Bank of St. Louis (FRED). The detailed description of prices data for the countries in the sample are given in Table A.1 in Appendix A. The monthly price indices are converted into quarterly indices using the average price level for the three months spanning that particular quarter.[3]

The national currency vis-à-vis SDR proxies for the exchange rate for each country in the panel, capturing the source of external shock for the respective

[3]The developed countries officially publish seasonally adjusted national accounts variables. We conduct seasonal adjustment of price data of both developed and emerging economies and the national accounts variables of emerging economies using X12Arima programme of the US Census Bureau. To include in the panel VAR estimation, the choice between any original series and its seasonally adjusted component is made, based on various post adjustment diagnostic tests.

economy. The exchange rate data measured as national currency per SDR, is sourced from International Financial Statistics (IFS) of the IMF for all countries except for the European countries, namely, Italy, Germany and France. The exchange rate data for these countries, available in daily frequencies are sourced from IMF,[4] and converted to quarterly series for the final analysis.

An unexpected change in the monetary policy stance of the central bank is captured by shocks to policy rate. The repo rate and the federal funds rate are the key policy rates for India and US respectively. Similarly, each countrys central bank define their policy rates to influence their monetary policy objectives. The data for policy rates are sourced from the official Central Bank websites of the respective countries and International Financial Statistics (IFS) of the IMF. The European countries (Italy, Germany and France) follow the same policy rate defined by the European Central Bank as European Central Bank interest rate. The details of the policy rates used by the countries in the sample are given in Table A.2 in Appendix A.

While using the Fisher-type test for unit root which tests the null hypothesis that all panels contain unit root, against the alternative hypothesis that at least one panel is stationary, we find that real GDP, consumption, investment, food, core and overall CPI are I(1), while the policy rate is found to be stationary (see Tables B.1 and B.2 in Appendix B).

The four error-correction based panel cointegration tests developed by Westerlund (2007) indicate that the variables are not co-integrated as we can not reject the null hypothesis of no cointegration (see Table B.3 in Appendix B).[5]

4.2 Estimation

Since the macroeconomic variables chosen for the analysis are non-stationary and are not cointegrated as suggested by the panel unit root and cointegration tests, we estimate a VAR model in first difference in a panel framework. To be more specific, the VAR structure includes first difference of the variable in log, except for policy rate which is found to be stationary. This implies that the variables included in the VAR model are GDP, consumption and

[4] https://www.imf.org/external/np/fin/data/param_rms_mth.aspx.

[5] Given the size of the data set and that the STATA programme does not allow to perform the test with more than six variables at a time, we test for cointegration of each of the price indices (food, core and headline) along with rest of the variables, namely, real GDP, real consumption, real investment, policy rate and exchange rate at a time. Finally, we test for cointegration among the three price indices.

investment growth, all three in real terms, food, core and headline inflation, policy rate, and exchange rate.

As in Hammoudeh et al. (2015), GDP, consumption and investment are allowed to react to the monetary policy shock with a lag. However, unlike this study, we assume that sectoral and headline inflation also react to monetary surprises with a lag. We assume that monetary policy responds to all domestic sources of shocks contemporaneously. Exchange rate, which is ordered in the last, is subject to all domestic shocks including the monetary surprises contemporaneously in addition to external shocks.[6]

We estimate the following PVAR model to assess the impact of monetary surprises on food inflation:

$$Y_{it} = A_0 + A(L)Y_{it} + v_i + \epsilon_{it}; \quad i = 1, ..., N; \quad T = 1, ..., T_i \tag{1}$$

where Y_{it} is the vector of endogenous variables as follows:

$$\begin{bmatrix} \Delta \log \text{Real GDP}_t \\ \Delta \log \text{Real consumption}_t \\ \Delta \log \text{Real investment}_t \\ \Delta \log \text{CPI Food}_t \\ \Delta \log \text{CPI Core}_t \\ \Delta \log \text{CPI}_t \\ \text{Policy rate}_t \\ \Delta \log \text{Exchange rate}_t \end{bmatrix}. \tag{2}$$

In equation (1), A_0 is a vector of constants, $A(L)$ is a matrix polynomial in lag operator, v_i represents country-specific fixed effects. The idiosyncratic errors ϵ_{it} are assumed to follow white noise properties such that $E[\epsilon_{it}] = 0$; $E[\epsilon'_{it}\epsilon_{it}] = \Sigma$; $E[\epsilon'_{it}\epsilon_{is}] = 0$ for all $t > s$.

The model is estimated by system-GMM method using the lags of the endogenous variables as instruments (Holtz-Eakin et al., 1988), after transforming the variables in the system using the Helmert procedure to remove the country-specific fixed effects (Areliano and Bover, 1995). The Helmert procedure is a forward mean-differencing method where the average of all available future observations is subtracted from the variable to be transformed.

We estimate PVAR model for the set of selected advanced and emerging economies to gauge the effect of monetary policy shock on food inflation.

[6] In our robustness analysis we preserve the ordering of variables as in Hammoudeh et al. (2015).

Since economic, financial and institutional structures differ substantially across advanced and emerging economies, the behaviour of food inflation in response to monetary policy shock may differ across these two sets of economies. Hence, we estimate the model for advanced and emerging economies separately as well.

The optimal lag order selection criteria (Moment and Model Selection Criteria or MMSC) for both panel VAR specification and moment condition for GMM models, analogous to standard AIC, BIC and HQIC Andrews and Lu (2001) suggest a first order PVAR model for the overall sample as well as for the sub-samples of advanced and emerging economies (see Table B.4 in Appendix B). All eigen values of the PVAR models estimated for full and sub-samples lie within the unit circle, thus satisfying the stability condition of the models (see Figure 7 in Appendix B).

Impulse response analysis captures the dynamic impacts of a monetary surprise on food inflation and other key macroeconomic indicators. The Forecast Error Variance Decomposition (FEVD) analysis allows us to identify the sources of variations in food inflation and other macroeconomic indicators over a horizon of eight quarters.

4.3 Results

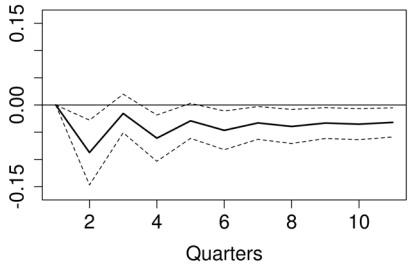
This section discusses the impacts of an unanticipated change in the policy rate on food inflation for the set of advanced and emerging economies in our sample. We also analyse the pattern of monetary policy transmission to food inflation in advanced and emerging economies separately.

4.3.1 Transmission of monetary policy shocks to food inflation in advanced and emerging economies

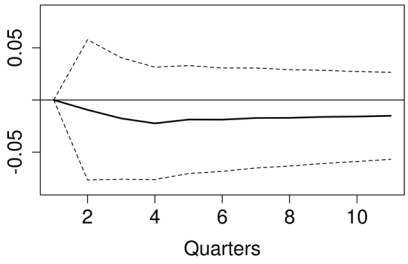
Figure 4 depicts the results of impulse response analysis for food inflation, along with responses of core and headline inflation and other key macroeconomic indicators.

We find that an unanticipated monetary tightening has a positive effect on food inflation. An one standard deviation unanticipated positive interest rate shock causes policy rate to rise by 0.67% initially, with the effect subsiding in the subsequent quarters. Following the rise in policy rate, quarter-on-quarter food inflation rises by 0.10% after three quarters of the shock. The

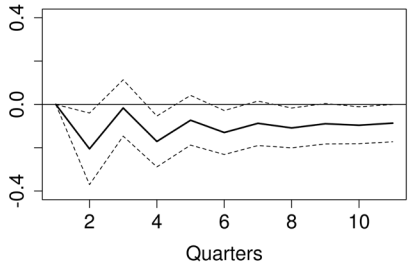
Figure 4 Effects of an unanticipated change in monetary policy on food inflation and other macroeconomic indicators



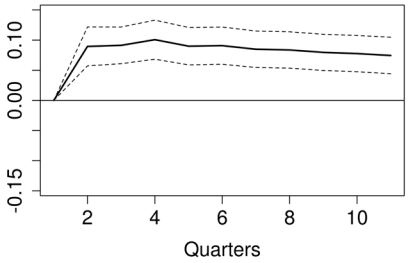
(a) Response of real GDP growth to policy rate



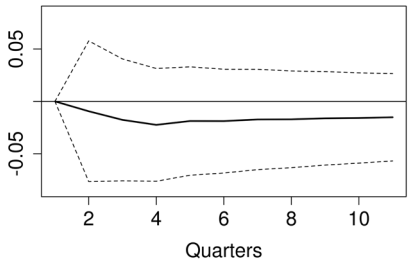
(b) Response of real consumption growth to policy rate



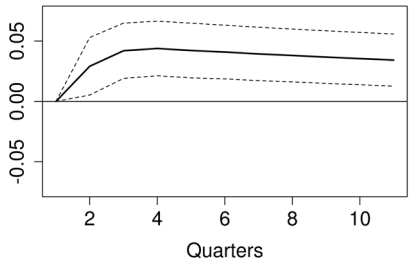
(c) Response of real investment growth to policy rate



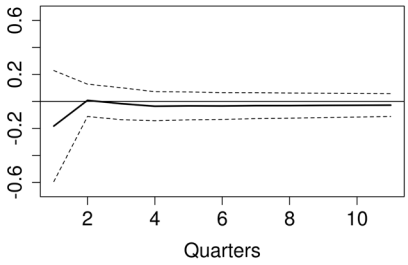
(d) Response of food inflation to policy rate



(e) Response of core inflation to policy rate



(f) Response of headline inflation to policy rate



(g) Response of exchange rate change to policy rate

Source: Author's Estimates

impact on food inflation declines afterwards, but remains significant for the subsequent periods. An increase in the policy rate tends to raise the cost of capital, and hence, cost of production in relatively capital intensive non-food sector. Given the level of demand faced by firms in this sector initially unchanged, higher interest rate requires them to raise the price level initially. Extensive empirical evidence on such phenomenon have been documented in long-existing literature on 'production cost channel of monetary policy transmission' (Barth and Ramey, 2001; Chowdhury et al., 2006; Gaotti and Secchi, 2006; Henzel et al., 2009).[7] Durable goods, which can be bought against loan also become expensive following an interest rate hike. As a result, households substitute consumption of non-food items by food. The substitution effect is stronger when food has a high share in the consumption basket. The overall positive effect on food inflation becomes even more stronger in economies where a large share of population consumes food at far below the satiation point. While, consumption of non-food declines, consumption of food increases, leaving an overall negative effect on real consumption growth, although the effect is not significant.

Rise in policy rate, on the other hand, enhances cost of investment, inducing a statistically significant lowering impact on real investment growth. One standard deviation increase in the policy rate tends to reduce real investment growth by 0.21% in the next quarter, although the effect is transitory. As a result, the real GDP growth declines and the effect is significant. An increase in the policy rate by one standard deviation causes real GDP growth to decline by 0.09% in the next quarter, the effect subsides but remains significant in the subsequent periods. The decline in real GDP growth, in turn, causes real consumption and investment growths to decline in the subsequent periods. The decline in aggregate demand growth causes positive effect of food inflation to subside eventually.

The decline in consumption of non-food items is reflected in the decline in core inflation. The overall effect of an unanticipated monetary tightening on headline inflation is positive, indicating evidence of the well-known *price puzzle* effect highlighted in the empirical literature of monetary policy transmission. Apart from the cost channel of monetary policy transmission already discussed, the role of commodity prices, and omission of forward looking variables in the VAR models are some of the widely-argued explanations behind such puzzle (Sims, 1992; Rusnak et al., 2013; Brissimis and Magginas, 2006;

[7]The cost channel of monetary policy transmission refers to the scenario when producers initially raise prices of their products following a monetary tightening that enhances the cost of capital.

Castelnuovo and Surico, 2010).[8] Sims (1992) and the subsequent literature suggest that when commodity sector is the source of inflationary pressure in the economy, a one-time contractionary interest rate innovation may not be sufficient to mitigate the commodity price shock on headline inflation. The role of commodity inflation, thus, can explain the initial short term rise in headline inflation following a rise in the policy rate. In the similar line, our results also highlight the role of food inflation in shaping the pattern of monetary policy transmission across countries in the world.

A monetary tightening increases the price of domestic currency, vis-à -vis other countries' currencies, causing appreciation of the domestic currency, although the effect is not statistically significant.

The Forecast Error Variance Decomposition (FEVD) analysis in Table C.1 and Table C.2 in Appendix C suggest that after four quarters of a shock, out of the total variation in food inflation, real income growth captured by real GDP growth explains 9% of the variation followed by change in exchange rate (2.36%), real consumption demand growth (1.52%), and finally monetary policy shock (1.52%) in addition to contribution of demand growth. While core inflation is found to explain 1.37% of variation in food inflation, the role of aggregate inflation is found to be negligible (0.5%).

Apart from the ideosyncratic shock to core inflation, food inflation and real consumption growth are the factors explaining a significant part of the variation in core inflation after four quarters of the shock. While food inflation explains 5.9% of the variation in core inflation, 1.37% of it is explained by the variation in real consumption growth. After 4 quarters of a shock, 26.11% variations in headline inflation is explained by the food component, followed by core inflation variation (9.17%) and exchange rate movements (1.10%). The variation in policy rate explains 1.52% of the variation in aggregate CPI inflation after 8 quarters.

Interestingly, the FEVD results suggest that after four quarters of a shock to

[8] According to the new Keynesian theory of monetary policy transmission, expectations about the future state of the economy affect the decision making process of economic agents in the current period. In an environment of staggered price setting, producers revise their prices downwards today if they anticipate a contraction of economic activities tomorrow following a credible monetary tightening. Hence agents' perception about the future state of the economy plays an important role in monetary policy transmission to prices. Inflation expectation, leading indicator of economic activity reflecting the future state of the economy, and money market forward rate capturing the monetary policy expectations are some of the indicators to summarise agents' perception on the future course of the economy. Empirical literature highlight the role of these forward-looking variables in explaining the price puzzle in the monetary policy transmission literature.

the policy rate, 12.54% variation in it is explained by variations in headline inflation, followed by real GDP growth (5.43%) and food inflation (3.74)%. These results indicate that, in general, during the period of analysis, the monetary policy stance of the central banks are directed towards stabilising economic performance and headline inflation, with separate focus to food inflation as well.

4.3.2 Transmission of monetary policy shocks to food inflation in advanced economies

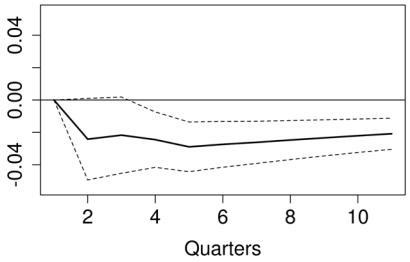
Figure 5 depicts the results of impulse response analysis for food inflation, along with responses of core and headline inflation and other key macroeconomic indicators for the sample of advanced countries.

After an initial decline, food inflation responds positively following an unanticipated monetary tightening in advanced economies. Due to a one standard deviation unanticipated positive monetary policy shock, policy rate immediately increases by 0.29% in the, while the impact decreases in the following quarters. Food inflation gradually increases by 0.07% after four quarters of the shock. Unlike the overall sample, the response of the core inflation shows price puzzle preceded by an initial decline. The price-puzzle effect is also observed for the headline inflation as well.

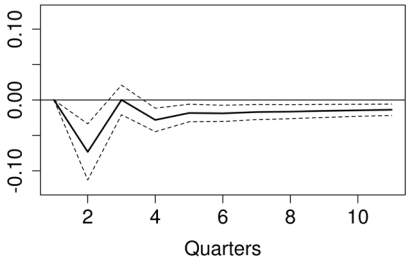
We find significant real effects of monetary policy shock in advanced economies. The positive shock to policy rate is found to reduce real GDP growth by 0.03% after four quarters of the shock. The effect remains significant for quite a few subsequent quarters. The real consumption growth reduces by 0.07% immediately. The magnitude of the impact declines afterwards, but, remains significant for the subsequent quarters. Following the rise in the policy rate, the real investment growth immediately declines by 0.04%, and further declines by 0.11% after three quarters of the shock. The impact subsides in the following quarters, but remains significant during the horizon.

One striking observation here is that the transmission effects in the real side of the economy are mostly of persistent nature in the advanced economy compared to the transitory nature found in the overall sample. Also, significant transmission effect on real consumption growth is found for the advanced economies, while the response of real consumption growth to monetary policy shock is not statistically significant for the overall sample. However, despite the significant decline in real consumption growth sourced from decline in consumption of non-food following the monetary tightening, core inflation

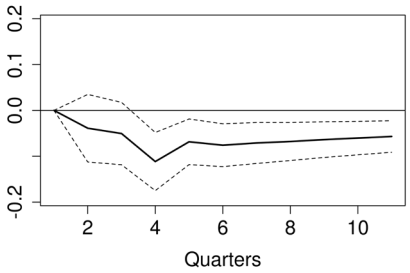
Figure 5 Effects of an unanticipated change in monetary policy on food inflation and other macroeconomic indicators in advanced economies



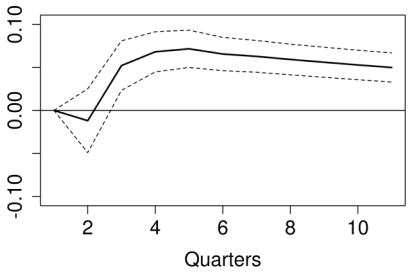
(a) Response of real GDP growth to policy rate



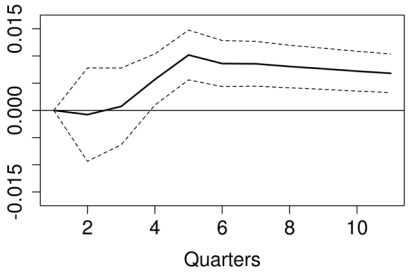
(b) Response of real consumption growth to policy rate



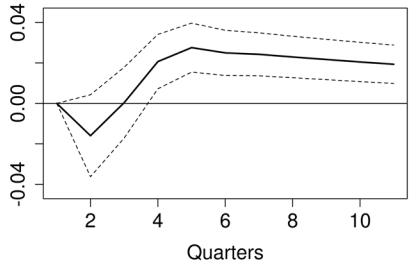
(c) Response of real investment growth to policy rate



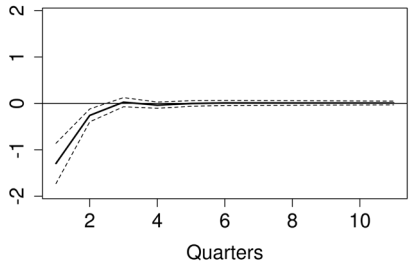
(d) Response of food inflation to policy rate



(e) Response of core inflation to policy rate



(f) Response of headline inflation to policy rate



(g) Response of exchange rate change to policy rate

Source: Author's estimates

in advanced economies show price-puzzle effect. This result reflects the existence of cost channel of monetary policy transmission which possibly became even more prevalent during the post Global Financial crisis period spanning most of the sample period of our analysis. Finally, significant appreciation effect of exchange rate in advanced economies is found following monetary tightening.

Tables C.3 and C.4 in Appendix C report FEVD results of the analysis for advanced economies. As in the overall sample, variation in food inflation in advanced economies, after four quarters of a shock is found to be driven by variations in income growth (7%), change in exchange rate (3.58%), real consumption growth (2.99%). However, unlike the overall sample, in advanced economies, variations in real investment growth (2.06%) and headline inflation (1.19%) also contribute to the variations in food inflation after four quarters of a shock. Core inflation does not seem to play much role here. After eight quarters, the role of monetary policy becomes significant as the variation in it explains 2.48% of the variation in food inflation.

Unlike the overall sample, after four quarters of a shock, variations in core inflation is driven by variations in overall inflation (7.94%), food inflation (3.39%), real consumption demand growth (1.8%), real investment growth (1.7%), and aggregate demand growth (1.13%). In advanced economies, core inflation, followed by food inflation are found to be the major drivers of variation in aggregate inflation. After four quarters of a shock, 27.61% of the variation in headline inflation is explained by core inflation, while food inflation explains 15.30% of the variation. Additionally, variations in real aggregate and consumption demand growth, and exchange rate changes contribute to 3.45%, 1.01% and 2.16% respectively of the variation in headline inflation after four quarters of a shock.

Interestingly, the FEVD result for policy rate shows that unlike the overall sample, in advanced economies, central banks' policy stances are primarily driven by growth consideration as variation in real GDP growth explains 40.96% of the variation in policy rate after four quarters of a shock. This result is mainly driven by the fact that the period of analysis spans the period of post Global Financial Crisis when reviving economic performance emerged as the major challenge for the advanced economies. The variation in headline inflation explains 4.06% of the variation in policy rate, while food inflation does not seem to play a role in policy rate determination in advanced economies.

4.3.3 Transmission of monetary policy shocks to food inflation in emerging economies

Figure 6 depicts the results of impulse response analysis for food inflation, along with responses of core and headline inflation and other key macroeconomic indicators for the sample of emerging economies.

The pattern of impulse responses in emerging economies closely resemble that of the overall sample. This implies that the results for the overall sample are mainly driven by the pattern of responses in emerging economies.

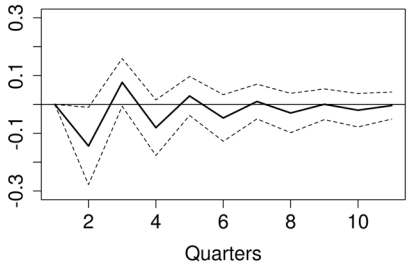
An unexpected monetary tightening that increases policy rate by 0.90% causes food inflation to increase by 0.13% immediately. The impact subsides afterwards but remains significant for the subsequent periods. The positive response of food inflation to a monetary tightening is rapid in emerging economies compared to that in advanced countries. This corroborates with the fact that emerging economies assign a higher share of expenditure to food, and hence substitutes non-food items with food at a higher rate following a rise in the policy rate. As a result, these economies experience a higher rise in food inflation compared to the advanced countries.

Since consumption of non-food, including durables decline and that of food items increases, the overall effect of a monetary tightening on real consumption growth is not statistically significant. This causes the effect on core inflation to be insignificant as well. The effect on headline inflation is mainly driven by the impact on the inflation in food components. A one standard deviation rise in the policy rate is associated with a 0.04% rise in the headline inflation in the next quarter. The effects decline in magnitude in the subsequent quarters, but remains statistically significant.

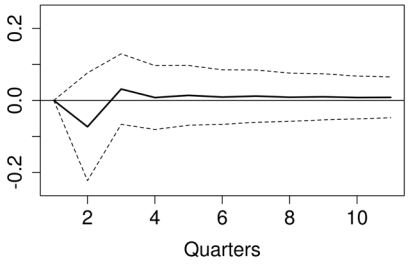
In emerging economies, an unanticipated monetary tightening is found to have marginal and transitory real effects. While we do not find any significant effect on real investment growth, real GDP growth declines by 0.14% in the next quarter following a one standard deviation rise in the policy rate. However, the effects become insignificant in the subsequent quarters. Our findings of low degree of monetary transmission stand with the existing literature highlighting the lack of monetary transmission to the real side in emerging economies due to underdeveloped financial system, low level of financial integration and weak institutional structure including the central banking system (Moreno, 2008; Mishra et al., 2012; Mishra and Montiel, 2013; Mishra et al., 2014; Bhattacharya et al., 2011; Hove et al., 2017).

We do not find any significant impact of monetary policy shock on exchange

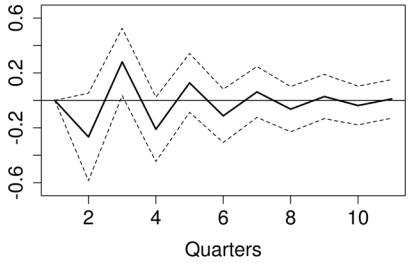
Figure 6 Effects of an unanticipated change in monetary policy on food inflation and other macroeconomic indicators in emerging economies



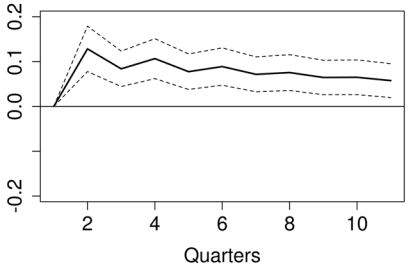
(a) Response of real GDP growth to policy rate



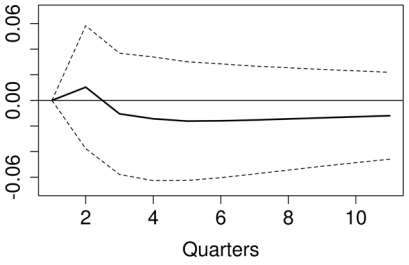
(b) Response of real consumption growth to policy rate



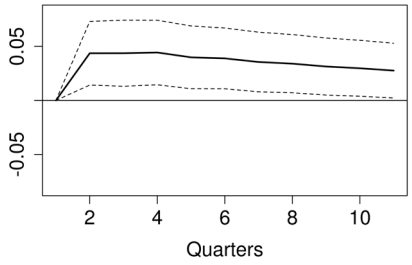
(c) Response of real investment growth to policy rate



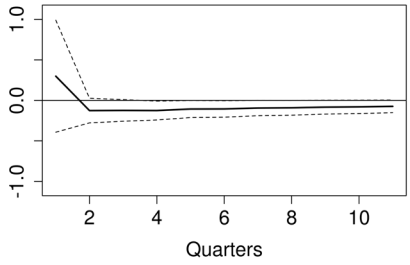
(d) Response of food inflation to policy rate



(e) Response of core inflation to policy rate



(f) Response of headline inflation to policy rate



(g) Response of exchange rate change to policy rate

Source: Author's Estimates

rate in emerging economies as central banks in these countries frequently intervene in the foreign exchange markets to contain the volatility of exchange rate movements.

Tables C.5 and C.6 in Appendix C report FEVD results of the analysis for emerging economies. In emerging economies, aggregate demand growth and overall inflation explain a significant part of the variations in food inflation. After four quarters of a shock, variation in real GDP growth explains 14.21% of the variation in food inflation followed by variations in headline inflation (10.25%), core inflation (3.35%), real consumption demand growth (1.38%), real investment demand growth (1.34%), exchange rate changes (1.47%) and policy rate (1.05%).

Like in the overall sample, variations in the core inflation is found to be mainly driven by the core-sector specific shock, while variations in food inflation, and real consumption demand growth explain 6.56%, and 1.16% of the variations in it respectively after four quarters of a shock to food inflation. Variation in exchange rate changes is found to explain 1.44% of the variation in core inflation after four quarters of a shock. Unlike the advanced economies, aggregate demand growth does not seem to play much role here.

As opposed to the advanced counterparts, variation in aggregate inflation is driven by variation in food inflation (29.18%) followed by the variation in core inflation (7.48%) after four quarters of a shock. This indicates that the FEVD result for aggregate inflation has been driven by the pattern of relationship found in emerging economies. Apart from that, variations in real investment demand growth and aggregate demand growth explain 1.17% and 1.13% of the variations in headline inflation after four quarters of a shock.

In a stark contrast to advanced countries where growth scenario is found to be the major determinant of monetary policy, in emerging economies, it is primarily driven by overall inflationary situation and dynamics of food inflation. After four quarters of a shock, variation in headline inflation contributes 22.39% of the variation in policy rate, while food inflation's share in it amounts to 6.79%.

4.3.4 Discussion of results

Comparing the dynamic macroeconomic impacts of an unanticipated monetary policy shock in advanced countries visà-vis emerging economies, we find significant and long-lasting negative real effects in advanced economies, while transitory negative effects on real GDP growth is found in emerging

economies. The effects on real consumption and investment growth in emerging economies are not statistically significant. The results are in line with the long-standing literature on monetary policy transmission indicating lack of transmission effects in emerging economies due to underdeveloped financial and institutional set up in these countries.

An unexpected monetary tightening increases relative price of non-food including consumer durables vis-'a-vis food. The substitution of non-food by food drives up food prices in both advanced and emerging economies, while the magnitude of the rise is higher in the later. Emerging economies with a higher share of food in consumption basket and substantial fraction of population consuming food far below the satiation level, substitute non-food items with food at a higher rate following a rise in the policy rate compared to advanced countries. As a result, the emerging economies experience a higher rise in food inflation compared to the advanced economies.

Rise in consumption of food along with decline in non-food have an overall negative effect on real consumption growth in both set of countries, but the effect is found to be significant in advanced economies only. The decline in consumption of non-food is reflected in a decline in core inflation in emerging economies, however the impact is not statistically significant. Despite a decline in real consumption growth, core-inflation shows the famous *price-puzzle* in advanced economies. This can be explained in the light of *cost channel of monetary policy transmission*. This finding is in line with Chowdhury et al. (2006) suggesting the cost channel to outweigh the aggregate demand channel of monetary transition in G-7 countries. Monetary tightening shows a positive impact on headline inflation in both advanced and emerging economies, owing to the rise in food inflation. This result stands in line with Sims (1992) and the descendant literature highlighting the role of commodity prices behind the *price puzzle*.

The FEVD analysis suggests that the drivers of inflation and monetary policy vary across advanced and emerging economies substantially. Variation in food inflation is found to be driven by variations in demand growth and overall inflation in both advanced and emerging economies. While demand side factors play relatively prominent role in advanced economies, it is aggregate and non-food price specific shocks play major role in variation of food inflation in emerging economies. The demand side factors also drive fluctuations in core inflation in advanced economies, while core-sector specific shocks are the main drivers of variation in core inflation in emerging economies. Variations in core inflation followed by food inflation drive a significant part of the variation in headline inflation in advanced economies. In

emerging economies, it is the variations in food inflation followed by core inflation mainly drive the variation in overall inflation.

The FEVD results of the policy rate reveal an interesting picture about the policy priority in the two sets of economies. In the post Global Financial Crisis period, a significant part of the variation in policy rate is driven by the variation in real GDP growth, indicating stabilisation of the economic performance as the main policy focus of the monetary authorities in the advanced economies. Apart from the growth consideration, overall inflation is another determinant of monetary policy in these countries. In a stark contrast, in emerging economies, stabilisation of headline inflation, with additional focus on stabilising food inflation is the major goal of exercising monetary policy.

5 Robustness analysis

To check the robustness of our results, we re-estimate the model following the orderings of the variables as in Hammoudeh et al. (2015). According to this ordering, food inflation followed by core and finally headline inflation receive all the macroeconomic and policy shocks as these three variables are ordered in the last. The main findings of the analysis are preserved under this alternative ordering, indicating the robustness of the relationship between food inflation and monetary policy. The effect of a monetary policy change on core and headline inflation and other macroeconomic indicators also resemble that of our baseline model.

As in our main analysis, here also we find that a monetary surprise causes food inflation to increase in both emerging and advanced economies, as well as in the overall sample (Figure 8 in Appendix C). Like in our main model, core inflation in advanced economies show price puzzle due to a monetary tightening, while the effect is negative for emerging economies, although not statistically significant. The overall effect on headline inflation of an increase in policy rate is found to be positive as in our baseline analysis.

As in our main analysis, under this alternative ordering, we find significant real effects of monetary policy change in advanced economies, with no significant real effect for emerging economies and the overall sample (Figure 9 in Appendix C).

6 Conclusion

This paper investigates the effect of monetary policy changes on food inflation in a set of advanced and emerging economies and also compare the findings across these two sets of countries. We find that an unexpected monetary tightening has a positive and significant effect on food inflation in both advanced and emerging economies. Our findings suggest that in the backdrop of inflationary pressure stemming from food sector, a monetary tightening may turn out to be destabilising the food as well as overall inflation in the economy. With the limited strand of existing literature on monetary policy and food inflation focusing only on US, an advanced economy, our findings fill the void in the literature pertaining to emerging economies.

In our analysis, the cost channel of monetary policy transmission in capital intensive non-food sector and relative strength of substitution and real income effect under consumption demand channel on food consumption drive our results. However, in order to identify and gauge the mechanism of the two channels on relative price dynamics and consequently on food inflation, a Dynamic General Equilibrium Model (DGM) with cost channel of monetary policy transmission following Tillmann (2008), augmented with food and non-food sectors will be useful.

Finally, a monetary policy tightening can reduce food inflation by enhancing supply through lowering of storage cost (Frankel, 2008). Incorporating this feature in a two-sector DGM model would further enrich our understanding of food inflation's response to monetary policy.

A Appendix A

The Table A.1 describes the sources, base years and classification details of CPI and its components for each country in the sample. The food and energy components of CPI include different items which vary across countries. The core price indices are calculated by subtracting food and fuel indices from overall consumer price index for the countries where official sources do not provide the measure of core price index. The share of food and energy in total CPI is used to derive the weighted average of food and energy prices while deriving the expression for core indices.

Country	Data source	Base year	Classification details
US	Bureau of Labour Statistics	1982-84	Food does not include non-alcoholic beverages.
UK	Office for National Statistics	2015	
Canada	Statistics Canada	2002	Food includes non-alcoholic beverages. Energy includes electricity, natural gas, fuel oil and other fuels, gasoline and fuel, parts and accessories for recreational vehicles.
Germany	Federal Statistical Office	2010	Food doesn't include non-alcoholic beverages. Energy includes household energy and fuels. Household energy includes electricity, gas and other fuels.
France	National Institute of Statistics and Economic Studies	2015	Food includes non-alcoholic beverages.

Italy	National Institute of Statistics (ISTAT)	2015	Food does not include non-alcoholic beverages.
Japan	Statistics Bureau	2015	Food does not include non-alcoholic beverages.
Turkey	Turkish Statistical Institute	2003	Only food commodities
Hungary	Hungarian Central Statistical Office	1990	Food includes non-alcoholic beverages
India	Labour Bureau	2001	Only food commodities
Korea	Statistics Korea	2015	Only food commodities
Mexico	National Institute for Statistics, Geography and Information Technology for overall CPI and CPI core; FRED for CPI food	2010	

Chile	National Institute of Statistics	2013	The period 2006 to 2013 includes non-alcoholic beverages in food component. From 2014 onwards, food and non-alcoholic beverages are given as separate categories. Hence we include both these series in food component from 2014 onwards to have a consistent food price series for the periods pre 2014 and 2014 onwards. Similarly, during 2006 to 2013, housing, water, electricity and other fuels are clubbed in one category, whereas, from 2014 onwards, these are given as segregated series. Hence, we choose all these categories under fuel from 2014 onwards to obtain a consistent fuel price component across the two time periods.

Table A.1: Description of price data

Table A.2 Description of policy rate

Country	Policy rate	Data source
US	Federal Funds rate	International Financial Statistics (IFS), IMF
UK	Bank rate	International Financial Statistics (IFS), IMF
Canada	Overnight rate	International Financial Statistics (IFS), IMF
Germany	Refinancing rate	European Central Bank
Italy	Refinancing rate	European Central Bank
France	Refinancing rate	European Central Bank
Japan	Uncollateralised overnight call rate	Bank of Japan
Chile	Monetary Policy Rate (MPR)	International Financial Statistics (IFS), IMF
Mexico	Overnight interest rate	International Financial Statistics (IFS), IMF
India	Repo rate	Reserve Bank of India
Korea	Base rate	International Financial Statistics (IFS), IMF
Turkey	Overnight rate	International Financial Statistics (IFS), IMF
Hungary	Three-month MNB deposit rate	Magyar Nemzeti Bank (MNB), Central Bank of Hungary

B Appendix B

Table B.1 Results of unit root test in level

	Inverse chi-squared		Inverse normal		Inverse logit		Modified inv. chi-squared	
Variable	P	p-value	Z	p-value	L*	p-value	P_m	p-value
Log real GDP	9.9341	0.9981	3.1592	0.9992	3.5367	0.9996	-2.2279	0.9871
Log real GDP deflator	41.9953	0.0246	0.0855	0.5341	0.1667	0.5660	2.2181	0.0133
Log real consumption	7.6414	0.9998	2.9692	0.9985	3.1284	0.9985	-2.5459	0.9945
Log real investment	25.3759	0.4978	2.8788	0.9980	3.0529	0.9984	-0.0865	0.5345
Log food price index	45.4289	0.0106	-0.6227	0.2667	-0.9379	0.1758	2.6943	0.0035
Log core price index	30.9761	0.2292	1.1994	0.8848	0.6256	0.7332	0.6901	0.2451
Log CPI index	17.8527	0.8811	1.3523	0.9119	1.3514	0.9095	-1.1298	0.8707
Log exchange rate	32.0539	0.1913	-0.6458	0.2592	-0.6913	0.2459	0.8395	0.2006
Policy rate	89.3720	0.0000	-6.7131	0.0000	-7.0933	0.0000	9.4356	0.0000

Source: Author's estimates

Table B.2 Results of unit root test in first difference

	Inverse chi-squared		Inverse normal		Inverse logit		Modified inv. chi-squared	
Variable	P	p-value	Z	p-value	L*	p-value	P_m	p-value
Δ Log real GDP	64.5743	0.0000	-4.4439	0.0000	-4.5507	0.0000	5.3493	0.0000
Δ Log GDP deflator	73.6011	0.0000	-5.0604	0.0000	-5.3601	0.0000	6.6011	0.0000
Δ Log nominal consumption - Δ Log GDP deflator	80.9285	0.0000	-5.9408	0.0000	-6.0801	0.0000	7.6172	0.0000
Δ Log nominal investment - Δ Log GDP deflator	70.2654	0.0000	-4.2683	0.0000	-4.7597	0.0000	6.1385	0.0000
Δ Log food price index	63.3495	0.0000	-4.4135	0.0000	-4.4702	0.0000	5.1794	0.0000
Δ Log core price index	86.0285	0.0000	-5.5783	0.0000	-6.2726	0.0000	8.3245	0.0000
Δ Log CPI	48.9083	0.0042	-3.1664	0.0008	-3.1326	0.0013	3.1768	0.0007
Δ Log exchange rate	130.9579	0.0000	-8.2202	0.0000	-9.9486	0.0000	14.5550	0.0000

Source: Author's estimates

Table B.3 Results of panel cointegration analysis

	Food price index and rest of the variables			Core price index and rest of the variables			Headline price index and rest of the variables			Food, core and headline price indices		
Statistic	Value	Z-value	p-value	Value	Z-value	p-value	Value	Z-value	p-value	Value	Z-value	p-value
Gt	-3.087	-1.601	0.055	-2.907	-0.948	0.172	-3.306	-2.398	0.008	-1.256	2.093	0.982
Ga	-11.800	1.334	0.909	-10.284	1.971	0.976	-13.255	0.723	0.765	-4.982	1.431	0.924
Pt	-6.915	1.208	0.886	-5.567	2.454	0.993	-5.494	2.522	0.994	-6.111	-0.897	0.185
Pa	-13.468	-0.895	0.185	-7.305	1.667	0.952	-13.538	-0.924	0.178	-4.139	0.074	0.529

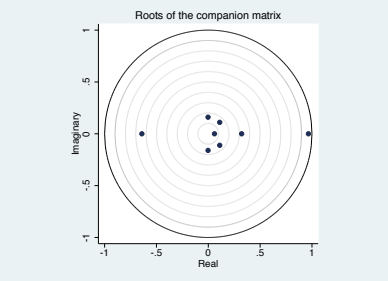
Source: Author's estimates

Table B.4 Results of lag order selection test

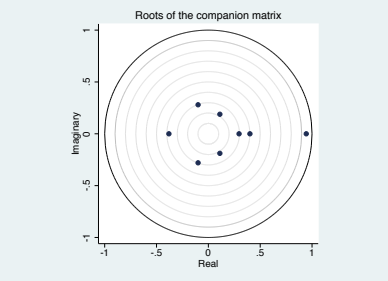
	Full sample		Advanced countries		Emerging economies	
Statistic	Lag 1	Lag 2	Lag 1	Lag 2	Lag 1	Lag 2
MBIC	-579.0363	-282.8577	-542.4421	-268.8622	-526.6735	-254.4926
MAIC	-59.46849	-23.07384	-108.0577	-51.66999	-99.46863	-40.89014
MQIC	-264.6692	-125.6742	-283.4736	-139.3779	-272.2083	-127.26

Source: Author's estimates

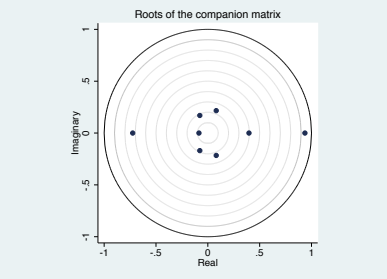
Figure 7 Stability of estimated PVAR models



(a) Stability condition for full sample analysis



(b) Stability condition for sample of advanced economies



(c) Stability condition for sample of emerging economies

Source: Author's estimates

C Appendix C

Table C.1 FEVD Analysis: All countries

Response variable	Forecast horizon	Impulse variable							
		Real GDP growth	Real consumption growth	Real investment growth	Food inflation	Core inflation	Headline inflation	Policy rate	Exchange rate change
Real GDP growth	1	1	0	0	0	0	0	0	0
	2	.8809264	.0482224	.0269229	.0051551	.0231275	.0010293	.0012142	.0134023
	4	.8482499	.0738803	.0297946	.0094834	.0227004	.0013189	.001609	.0129633
	8	.8428518	.0774072	.0300513	.0101727	.0227646	.0014912	.0023366	.0129246
Real consumption growth	1	.3369099	.6630902	0	0	0	0	0	0
	2	.3119874	.6086584	.0185358	.0026994	.0229796	.0001429	.0000172	.0349794
	4	.3105312	.6077467	.019186	.0031282	.0241477	.0001475	.0001736	.0349394
	8	.310485	.6075047	.0191847	.0031423	.0241425	.0001877	.0004227	.0349306
Real investment growth	1	.6373369	.0085782	.3540849	0	0	0	0	0
	2	.6566895	.0502607	.2701605	.0001653	.0085349	.0013559	.0006938	.0121394
	4	.6519552	.0748811	.2411931	.0063486	.0112879	.0015439	.0010206	.0235853
	8	.6515986	.0784673	.2361302	.0071281	.0116783	.0016776	.0015732	.0231386
Food inflation	1	.0468886	.0010521	.0023425	.9497168	0	0	0	0
	2	.0766245	.0057305	.0042311	.8673574	.0132834	.003188	.0048429	.0247423
	4	.0908902	.0152333	.0079803	.828291	.0137194	.0050799	.0152206	.0235853
	8	.0922077	.0162952	.0080338	.8063394	.0134701	.0086866	.0318284	.0231386

Table C.2 FEVD Analysis: All countries continued

Response variable	Forecast horizon	Impulse variable							
		Real GDP growth	Real consumption growth	Real investment growth	Food inflation	Core inflation	Headline inflation	Policy rate	Exchange rate change
Core inflation	1	.0011575	.0027284	.0022181	.0610669	.9328291	0	0	0
	2	.0020318	.0118843	.0029304	.0599253	.9065723	.0080112	0.000003	.0086417
	4	.0022065	.0136644	.003842	.0590506	.9032149	.0094485	0.000005	.0085681
	8	.0022149	.0136677	.0038411	.0590591	.9031112	.009506	.0000319	.0085682
Headline inflation	1	.0010346	.0018594	.0003848	.2356624	.0989764	.6620824	0	0
	2	.0017267	.0017862	.0028966	.2620522	.0928847	.6271254	.0012089	.0103192
	4	.0020838	.0021544	.0040343	.2610642	.0917912	.6218677	.0063837	.0106206
	8	.0027326	.0022013	.0040002	.258441	.0906643	.6161458	.0152681	.0105468
Policy rate	1	.0227117	.0006678	.0028013	.0202507	.0003905	.0263361	.9268419	0
	2	.0521384	.002744	.0013013	.0248452	.0009477	.0896955	.8261699	.002158
	4	.0543614	.0038454	.0010595	.0374032	.0012683	.1253847	.7728659	.0038114
	8	.0548263	.0038364	.0009558	.0443843	.0019719	.1444696	.7454166	.0041391
Rate of exchange rate change	1	.0077235	.015304	.0191397	.0000572	.0011853	.0000618	.0015784	.9549501
	2	.0081123	.0247066	.024073	.0145874	.0019788	.0011159	.0015293	.9238967
	4	.0084012	.0247854	.0241133	.0159634	.0020428	.0011723	.0015969	.9219246
	8	.0084661	.024809	.0241144	.0159743	.0020437	.0012117	.0017896	.9215912

Table C.3 FEVD Analysis: Advanced countries

Response variable	Forecast horizon	Impulse variable							
		Real GDP growth	Real consumption growth	Real investment growth	Food inflation	Core inflation	Headline inflation	Policy rate	Exchange rate change
Real GDP growth	1	1	0	0	0	0	0	0	0
	2	.9638597	.0033463	.0009435	.0144928	.0134795	.001244	.0007059	.0019283
	4	.9519106	.0034872	.0009541	.019469	.0163258	.0040078	.0019415	.001904
	8	.9483439	.0034749	.0009544	.0193686	.0162312	.0041019	.0052857	.0022393
Real consumption growth	1	.2927512	.7072488	0	0	0	0	0	0
	2	.2610379	.6538648	.0075313	.01594	.0105342	.0143206	.0055964	.0311748
	4	.2604337	.6495188	.0080161	.0159983	.0113585	.0145229	.0062859	.0338658
	8	.2606995	.6479288	.0079974	.0159686	.0113578	.0145957	.0075464	.0339058
Real investment growth	1	.2280451	.1241907	.6477641	0	0	0	0	0
	2	.333091	.1555042	.4421284	.00081	.0158574	.0520853	.0002329	.000291
	4	.3424303	.1649699	.4198118	.0024205	.0154643	.0495489	.0024096	.0029448
	8	.3424721	.1642139	.4174997	.0024425	.0155313	.0493613	.0053145	.0031648
Food inflation	1	.0095881	.0030876	.0255114	.9618129	0	0	0	0
	2	.041931	.0306494	.0211709	.8628637	.0011669	.0064032	.0001618	.0356532
	4	.0700528	.0299465	.0206579	.8187306	.0048438	.0119499	.0080148	.0358037
	8	.0919264	.0287957	.0197484	.7812126	.0048727	.0129021	.0248339	.0357082

Table C.4 FEVD Analysis: Advanced countries continued

Response variable	Forecast horizon	Impulse variable							
		Real GDP growth	Real consumption growth	Real investment growth	Food inflation	Core inflation	Headline inflation	Policy rate	Exchange rate change
Core inflation	1	.006406	.0002062	.0015041	.0067042	.9851796	0	0	0
	2	.0107416	.0130017	.0172837	.0278736	.8547219	.0749465	5.74e-06	.0014252
	4	.0113535	.0180598	.017571	.0339435	.8343332	.0794326	.0003106	.0052001
	8	.015278	.0180887	.0174519	.0337087	.827906	.079035	.0032259	.0053058
Headline inflation	1	.0066543	.0027242	.001806	.0787	.3325019	.5776136	0	0
	2	.0253334	.0095002	.0059248	.1517662	.2860184	.5078661	.0006291	.0129617
	4	.0345166	.0101414	.0070895	.1530292	.2761386	.495819	.0016157	.02165
	8	.0435102	.0100769	.0069888	.1505232	.2716673	.4880669	.0074006	.0217661
Policy rate	1	.1730207	.0037154	.0004616	.0012299	.0315685	.089297	.7007069	0
	2	.2940956	.0017139	.0013735	.0010612	.0135525	.0627158	.6093848	.0161027
	4	.4096169	.0014825	.0013806	.001525	.0072963	.0405524	.5113771	.0267693
	8	.4640149	.0016911	.0012983	.0033802	.005706	.034736	.4581502	.0310234
Rate of exchange rate change	1	.0096215	.0445406	.0116107	.0000188	.002031	.0164905	.1157811	.7999059
	2	.0189993	.0787133	.0203571	.0006835	.0365234	.0162291	.1051219	.7233724
	4	.0187971	.0782143	.0215963	.0055156	.0363177	.0192731	.1039955	.7162905
	8	.0188205	.0782102	.0216096	.0055216	.036348	.0193461	.1039853	.7161587

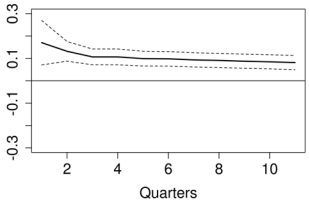
Table C.5 FEVD Analysis: Emerging economies

Response variable	Forecast horizon	Impulse variable							
		Real GDP growth	Real consumption growth	Real investment growth	Food inflation	Core inflation	Headline inflation	Policy rate	Exchange rate change
Real GDP growth	1	1	0	0	0	0	0	0	0
	2	.7741413	.0154528	.0383424	.0199573	.0707529	.0673047	.0012307	.0128177
	4	.6959379	.0341006	.0541551	.0358701	.0825343	.081849	.0014689	.0140841
	8	.6798071	.037953	.055821	.0398098	.0852763	.0858501	.0015229	.0139596
Real consumption growth	1	.3825361	.6174638	0	0	0	0	0	0
	2	.3133656	.5005368	.0283961	.0009178	.0572233	.034615	.0004652	.0644802
	4	.3091103	.4974025	.0366426	.0013978	.0563961	.0005474	.0639713	
	8	.3091752	.4971053	.0366429	.0014386	.034532 .0564241	.0346887	.0005893	.063936
Real investment growth	1	.6897758	.0089743	.3012498	0	0	0	0	0
	2	.6491642	.0193865	.1982658	.0071088	.0452737	.073253	.0004798	.0070682
	4	.6013995	.03609	.1717815	.0276474	.067434	.0852219	.0009582	.0094674
	8	.5918311	.0400251	.1640164	.0324509	.0717644	.0891406	.0010474	.0097242
Food inflation	1	.1029224	.0037959	.0003551	.8929265	0	0	0	0
	2	.1137377	.0043919	.0037704	.725733	.0290013	.1022151	.0054479	.0157027
	4	.1421109	.0137688	.0134758	.6693223	.0335316	.1025375	.0105345	.0147186
	8	.1489119	.0155842	.0150316	.6474695	.0362966	.1047967	.0173127	.0145967

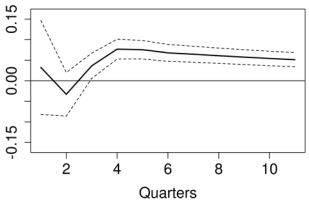
Table C.6 FEVD Analysis: Emerging economies continued

Response variable	Forecast horizon	Impulse variable							
		Real GDP growth	Real consumption growth	Real investment growth	Food inflation	Core inflation	Headline inflation	Policy rate	Exchange rate change
Core inflation	1	.0052672	.0022432	.0017748	.0738862	.9168287	0	0	0
	2	0047327	.0101411	.0042199	.0664142	.8987641	.0010445	.0000366	.0146468
	4	.0046737	.0115629	.0059507	.0656322	.8945668	.0030855	.0001426	.0143856
	8	.0046685	.0115502	.0059463	.0656067	.8937894	.0036039	.0004651	.01437
Headline inflation	1	.0113142	.0008475	.0003497	.3110083	.0805208	.5959595	0	0
	2	.0103633	.0051692	.0152472	.2962734	.0736304	.5906442	.0016856	.0069866
	4	.0113342	.0057577	.0171161	.2917871	.0747942	.5872017	.005035	.0069738
	8	.0114564	.0057963	.0170293	.2898468	.0747247	.5844371	.0097529	.0069563
Policy rate	1	1.09e-06	.0028909	.0020032	.0550127	.000127	.0159246	.9240406	0
	2	.003775	.0053722	.0012005	.0579176	.0000935	.1567873	.7744952	.0003588
	4	.0029539	.0076986	.0035143	.0679298	.0087649	.2238799	.6838209	.0014379
	8	.0024207	.0076441	.0040979	.0710575	.0174241	.2586234	.6367919	.0019404
Rate of exchange rate change	1	.0144503	.0149491	.0220096	.0000325	.0015138	.0059379	.0030754	.9380314
	2	.0141797	.0233399	.0373546	.0299642	.0017723	.0183463	.003349	.871694
	4	.0152326	.0234559	.0384563	.0309004	.002502	.0219905	.0042933	.863169
	8	.0153396	.0234665	.0384198	.0310091	.0026128	.022547	.0055332	.861072

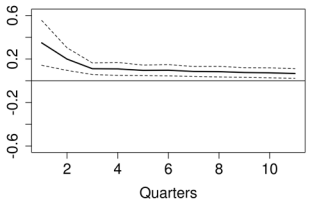
Figure 8 Effects of an unanticipated change in monetary policy on sectoral and aggregate inflation from alternative model



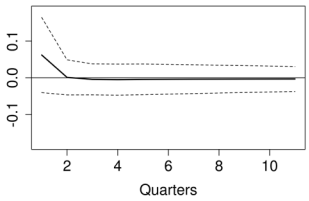
(a) Response of food inflation to policy rate for all



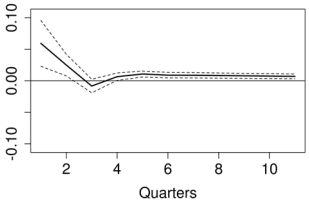
(b) Response of food inflation to policy rate in advanced countries



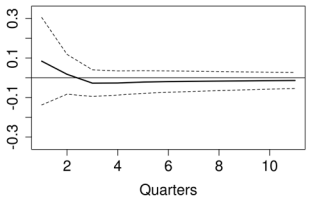
(c) Response of food inflation to policy rate in emerging economies



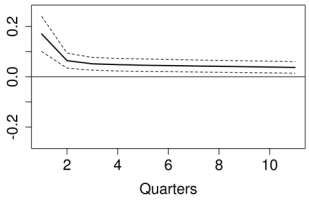
(d) Response of core inflation to policy rate for all



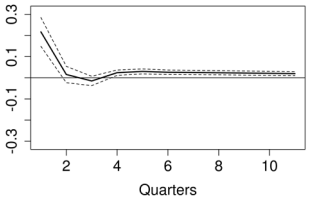
(e) Response of core inflation to policy rate in advanced countries



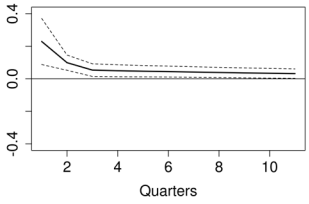
(f) Response of core inflation to policy rate in emerging economies



(g) Response of headline inflation to policy rate for all



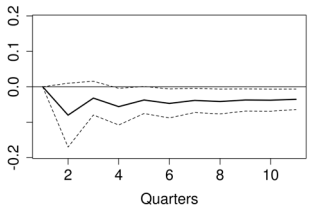
(h) Response of headline inflation to policy rate in advanced countries



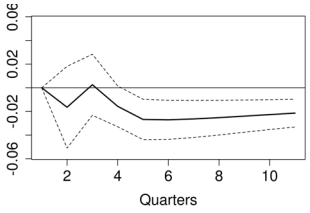
(i) Response of headline inflation to policy rate in emerging economies

Source: Author's Estimates

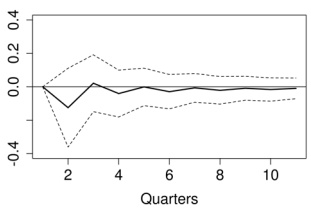
Figure 9 Effects of an unanticipated change in monetary policy on macroeconomic indicators from alternative model



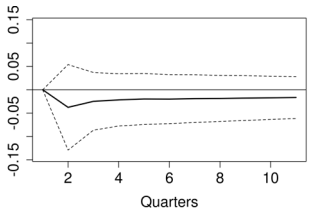
(a) Response of real GDP growth to policy rate for all



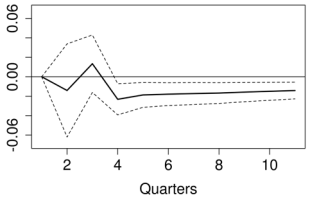
(b) Response of real GDP growth to policy rate in advanced countries



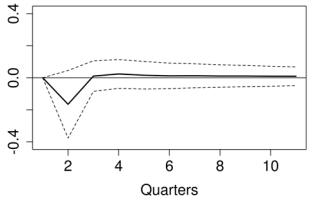
(c) Response of real GDP growth to policy rate in emerging economies



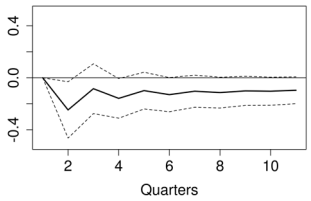
(d) Response of real consumption growth to policy rate for all



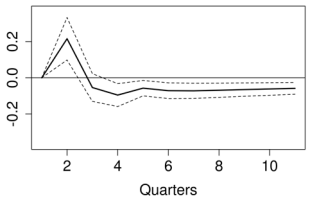
(e) Response of real consumption growth to policy rate in advanced countries



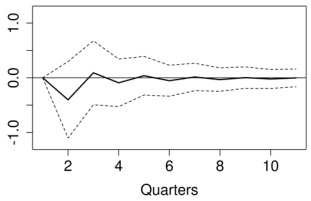
(f) Response of real consumption growth to policy rate in emerging economies



(g) Response of real investment growth to policy rate for all



(h) Response of real investment growth to policy rate in advanced countries



(i) Response of real investment growth to policy rate in emerging economies

Source: Author's Estimates

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