The Exchange Rate and Fundamental Shocks: A Panel SVAR Analysis for Developing Countries

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Abstract

This study investigates the Exchange Rate (ER) response to fundamental economic factors such as money supply, output, interest, and inflation shocks. The dynamic responses of exchange rate, output, money supply, expected inflation, and nominal interest rate in response to macroeconomic disturbances and their relative effects are analyzed using the impulse response function. The study also attempts to explore the contribution of the macroeconomic policy shocks to the forecast error variance of real ER and other macroeconomic variables of the study. Both impulse responses and FEVD are computed by imposing identification restriction after the estimation of reduced form VAR model. For this purpose, the SVAR model is employed by using the panel data over the period 1991 to 2020 for 84 developing countries. The impulse response function and variance decomposition are estimated based on the structural decomposition. The study's findings indicate that fundamental macroeconomic variables play a significant role in determining the behavior of exchange rates in the case of developing countries.

Keywords: Exchange Rate, Money Supply, Inflation, Interest Rate

Introduction

The exchange rate is one of the essential prices in an economy, which can widely affect the country's net trade balance, balance of payments, debt situation, return on the asset, and overall economic performance. After the WW-II, many countries pegged their currencies to the US dollar, which was fully convertible into gold. During the 1960s, the US faced a shortage of gold along with an increase in domestic and foreign liabilities. The system started to collapse when the US suspended the dollar-gold convertibility in 1971, and the managed floating exchange rate came into existence. Afterward, introducing a floating exchange rate results in extreme exchange rate volatility, sometimes disconnecting its link to the changes in fundamental macroeconomic variables. This anomaly has led to the researchers' higher interest in investigating the exchange rate determinants and their response towards different shocks, which can be considered one of the most critical problems in international macroeconomics. Considering the exchange rate's importance, this paper analyzes the exchange rate response to the macroeconomic variable shocks in developing countries.

Commonly, countries manage their exchange rates for the promotion of free trade. One of the essential examples is the European Monetary Union, in which the euro' is the common currency for all the member countries as their medium of exchange. Most developing countries have adopted managed exchange rate regimes depending upon their countries' economic situations. Extreme exchange rate variation is one of the main reasons behind all these efforts. The exchange rate instability creates uncertainty in foreign transactions of machinery. This uncertainty obstructs the import of physical capital and is held responsible for technological development impediments. It

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decisively determines the exports, crucial in augmenting total factor productivity [Edwards (1997)]. A shock is an unexpected or unanticipated event that affects the internal as well as external sectors of the economy. Shocks, either internal like policy shocks, demand side and supply side shocks, or external shocks like oil price shock, food inflation, recession, and any unexpected events, will affect the performance of an economy. Developing countries are more vulnerable to these shocks due to a lack of shock absorbent capacity.

Moreover, Economic shocks also result in unpredictable changes in the aggregate demand and aggregate supply sides of the economy, which causes disequilibrium. The disequilibrium further causes fluctuations in macroeconomic variables like investment, inflation, interest rate, exchange rate, employment level, and trade balance, ultimately affecting the exchange rate. However, the duration and intensity of these shocks and their impacts on the exchange rate may differ when we move from one variable to another. Thus, this study attempts to measure the response of the exchange rate toward macroeconomic shocks such as output shocks, interest rate shocks, inflation shocks, and money supply shocks in developing countries.

Macroeconomic Variables Shocks and the Exchange Rate: Empirical Evidence

Numerous research studies have investigated the factors influencing exchange rates and their response to various economic shocks. For instance, Grilli and Roubini (1995) examined how exchange rates respond to a contractionary monetary policy shock in South African nations. Their findings revealed a pattern where the exchange rate initially exhibited a gradual depreciation, followed by an appreciation and another gradual depreciation. Overall, these results validate the relevance of the overshooting hypothesis when applied to African countries. Meanwhile, in a separate study, Lee and Chin (1998) explored the relationship between monetary policy, the current account, and actual exchange rate variables in seven developed countries. The study supports the existence of the J-curve and high volatility in the existing version of the US and many other industrialized nations due to the monetary policy shock.

Edward (2001) examines the dynamic relationship between exchange rate regimes, capital flows, and currency crises in the context of emerging economies. The study focuses on the solution to policy controversies that arose during the Brazilian, East Asian, Mexican, and Russian crises based on the lessons learned during the 1990s. The author argues that the policy of limited capital inflows in the case of Chile is valid. Still, its effectiveness is exaggerated, which implies that if other countries adopt the same procedures, it can yield different outcomes. Kim (2001) uses the VAR model to examine the effects of monetary policy shocks on the trade balance, terms of trade, and real exchange rate for three small open European countries, including France, Italy, and the UK. The study's findings reveal that the impulse response of trade balance when subjected to one standard deviation shock to the expansionary monetary policy indicates that trade balance volume increases initially. It returns to its original level in one year.

Moreover, the unit value of the trade balance decreases, and this response remains slightly different in the case of all countries. However, the reaction of the total nominal trade balance is quite different across countries depending on the volume and the value effects of the trade balance in these countries. The study's findings also support the theoretical predictions of the traditional Mundell–Flemming model. However, the expenditures switching effect dominates the income absorption effect. Finally, the study finds little support in favor of the J-curve effect in the case of France, Italy, and the UK.

Federici and Santoro (2001) analyze the fundamental exchange rate dynamics for Italy and G6 countries using the micro founded general equilibrium model based on the work of Obstfeld and

Rogoff (1995). The study employs the complete information maximum likelihood estimation procedure to measure the structural parameters capturing the exchange rate response towards monetary shocks. The study reveals that monetary policy shocks play a crucial role in determining the actual exchange rate behavior in Italy and G6 countries. Moreover, the empirical model appears stable as the estimated structural parameter values are statistically plausible. Jang and Ogaki (2004) also examine the exchange rate behavior subjected to the US monetary shocks by employing the SVECM. The study also imposes short- and long-run restrictions on the SVECM to check the robustness of the results. The study based on the seven variable models of Eichenbaum and Evans (1995) imposes the restrictions that contractionary monetary policy shock doesn't affect the US and Japan output levels, foreign interest rates, and actual exchange rates. The findings of the study show that initially, a contractionary monetary policy shock results in the appreciation of the US dollar, and this effect persists for five years, which is indicative of the overshooting hypothesis of the exchange rate. The study also shows that the federal interest rate and output increase initially but start diminishing after six months. Moreover, prices decreased persistently after the monetary shock in the US. The imposition of the long-run restriction in the analysis resolves the price puzzle in VECM.

Berument (2008) examines the importance of monetary policy shocks for Turkey by employing the VAR model and introducing specific conditions to identify and isolate monetary policy shocks. These conditions included three main premises: firstly, foreign variables were considered exogenous to domestic variables; secondly, the exchange rate exhibited contemporaneous responses to both domestic and foreign variables; and lastly, monetary policy contemporaneously reacted to interest rates, exchange rates, and economic variables while showing no immediate response to changes in price levels or gross domestic product. The study's findings indicate that when a contractionary monetary policy shock occurred, the nominal interest rate was expected to increase, and the domestic currency appreciated in the short term, aligning with theoretical expectations. Ahmed (2009) examines the behavior of the real exchange rate for Pakistan from 1972 to 2007. The author also tests the existence of the Dutch disease phenomena along with measuring the degree of ER overvaluation in Pakistan. The study's findings reveal that capital flows, terms of trade, and government spending on non-tradable goods lead to the appreciation of ER, while the degree of openness results in ER depreciation. Furthermore, the study shows an overvaluation of Pakistani currency to 22.9 percent in 2007 from 0.75 percent in 2001.

Kim (2011) investigates the transmission mechanism of structural shocks and the sources of macroeconomic fluctuation in the Korean economy. This study employed the quarterly data for two sub-periods ranging from January 1987 to April 1996 and from January 1999 to April 2008. The author imposes several restrictions, such as the output differential is only affected by the supply shocks, and the actual demand and supply shocks also change the exchange rate value in the long run. At the same time, the nominal shocks do not significantly affect the output differential and the exchange rate. The study reveals that the supply shock (technology) increases the output differential in both periods. At the same time, the supply shocks positively impacted the exchange rate only in the second sub-period of the study. The demand side shocks proved less critical in explaining the trade balance and exchange rate fluctuations than the supply shocks, which significantly contribute to the macroeconomic volatility in the Korean economy. The study of Ncube and Ndou (2013) examines the impact of the exchange rate and monetary policy shocks on the trade balance of South Africa by employing the VAR model over the time 1983: I to 2010: II. The result shows that the effect of the exchange rate shocks on the trade balance is quantitatively higher than the influence of the monetary policy shock. This paper gives essential policy implications:

1. The exchange rate shock leads to a reduction in net exports, which adversely affects the trade balance in South Africa.
2. The lower share of the net exports in the GDP is temporary.
3. The long-run growth rate remains unaffected by the exchange rate shock, and the exchange rate can be used to change the composition of the demand for domestic and imported goods in the South African economy.

Ivrendi and Yildirim (2013) conducted a study investigating the impacts of domestic monetary policy and external shocks on macroeconomic variables in six rapidly developing emerging economies: China, India, Brazil, South Africa, Turkey, and Russia. They employed a recursive structural VAR model and a block exogeneity procedure to identify monetary policy and external shocks. The study covered the period from 1995 to 2012, focusing on critical variables such as money supply, Treasury bill rates, exports, imports, consumer price index, producer price index, and real effective exchange rates. Additionally, it considered advanced economies' industrial production index, consumer price index, world interest rates, and oil prices as exogenous factors. The study's findings were generally consistent with theoretical expectations for India, South Africa, Russia, and China. A contractionary monetary policy shock was associated with domestic currency appreciation and reduced output in these countries. However, this pattern did not hold for Brazil and Turkey.

Moreover, the study diverged from Lee and Chin's (1998) research conclusions, demonstrating that the inverse J-curve phenomenon existed in five of the six emerging economies under consideration. This difference in findings was attributed to varying factors, including disparities in financial market development and integration, the accountability and prioritization of central banks, as well as price and wage rigidities. Furthermore, the study revealed that external shocks, such as those related to world output, did not significantly drive macroeconomic fluctuations in these growing emerging economies.

By using the multiple indicator approach (MIA), Chandan and Rajat (2017) measure the effect of monetary policy shocks on the exchange rate in the context of India. The authors construct a monetary policy index by using the principal component analysis method. The study tests the co-movements among variables using the Johanson cointegration approach, and the robustness of the results is also checked by estimating the Forecast Error Variance Decomposition (FEVD) over one year. Results indicate that there exist two cointegrating vectors in the model. Moreover, the impulse response results reveal that a contractionary monetary policy, such as an increase in the interest rate, leads to decreased output followed by an initial rise in the price level and then a decline in the prices in the long run, which confirms the price puzzle in the case of India. The exchange rate shows an immediate rise after the contractionary monetary policy shock, it slowly achieves stability. The findings obtained by applying the FEVD illustrate that the monetary policy rate brings four percent fluctuations in the output and eight percent movements in the prices, and it appreciated the Indian exchange rate by eleven percent.

Similarly, the money supply shows 18 percent fluctuations in one year. In another study, Kim and Lim (2018) empirically examine the exchange rate response towards monetary policy shocks in the case of Australia, Canada, Sweden, and the UK. The study employs the VAR model in which some restrictions are imposed on the impulse responses to identify monetary policy shocks. The findings of the study reveal that the exchange rate appreciates as a result of contractionary monetary policy shock, and the exchange rate overshooting is delayed by a short span of six months. Moreover, the exchange rate deviation from the uncovered interest rate parity is relatively tiny in the long run but significant in the short run in some countries. The study suggests that analyzing the inflation-targeting period for small open economies in which monetary policy remains relatively consistent over time is essential. Mao et al. (2021) investigates the quality response of Chinese agriculture exports towards real exchange rate shocks. This study employs a panel structural VAR model, utilizing comprehensive monthly data on China's agricultural exports, to explore the intricate dynamics and variations in how product quality responds to real exchange rate (RER) shocks. The results indicate that, on average, RER appreciation tends to enhance the quality of China's agricultural exports compared to situations where exports are discouraged. However, this effect is primarily observed in the short term. The average quality response peaks in the month immediately following the RER shock, and the cumulative response stabilizes constantly within three months.

Recently, Yousaf and Mukhtar (2022) analyzed the Exchange Rate Disconnect Puzzle for Developing Countries using the flexible price monetary model and the sticky price monetary model of the exchange rate. The study employs static and panel data estimation techniques to test the validity of the puzzle. The findings reveal that the flexible price monetary model performs better than the sticky price monetary model in explaining the exchange rate movements in low, middle, and upper-middle-income countries.

The above discussion shows that a number of researchers have examined the impact of different macroeconomic shocks on the exchange rate and trade balance, which provides diverse results depending on the model specification, period, estimation technique, and the choice of variables. These studies mainly focus on the estimation of separate effects of the fiscal and monetary policies on the exchange rate and trade balance. However, we need help finding a single study that examines the impact of macroeconomic shocks such as output shocks, inflation shocks, money supply shocks, interest rate shocks, and exchange rate shocks in the context of developing countries. Therefore, this study attempts to fill the gap in the existing literature by analyzing the behavior of macroeconomic shocks in developing countries.

Theoretical Framework

Estimation Technique and Methodology

The Structural Vector Auto Regression (SVAR) Approach

The VAR model was initially presented by Sim (1980). The inability of the existing structure models to capture the dynamic characteristics of an economy led to the emergence of VAR model. In this regard, the impulse response function and the variance decomposition analysis are considered as the hallmark of the VAR approach. However, the criticism of Bernanke (1986), Blanchard and Watson (1986) and Sim (1986) that the identification restrictions impose by the VAR model are not linked with the economic theory results in the development of the Structural VAR (SVAR) approach. SVAR uses economic theory to formulate a system of structural equations rather than just relying on the reduce form VAR equations. The model imposes specific structure restrictions to estimate the parameters with accurate precision. Later on, Shapario and Watson (1988) and Balanchard and Quah (1989) develop a long run structural VAR model which applies the long run restrictions on the reduced form equations to identify the economic structure under consideration. This approach is not only consistent with the theoretical restrictions used to measure parameters of the model but also exhibits the short run properties.

Moreover, SVAR is a widely used approach to examine the dynamic interactions among the variables through the impulse response function in which a onetime shock given to one variable not only affect that variable only but also transmits to other variables to predict the current and future values of an endogenous variables and the variance decomposition analysis which measures the impact of different shocks on a variable at different time periods.

Our empirical work relies on the SVAR approach. A five variables system is develop for the estimation which consists of nominal exchange rate (s_t), gross domestic product (y_t), money supply (m_t), expected inflation (π_t) and nominal interest rate (i_t).

Basic Model of SVAR

The first step in the construction of SVAR model is as follow

$$X_t = A(L)X_{t-1} + U_t \tag{1}$$

X_t is the 5×1 vector of endogenous variable such that $X_t' = (Y_t, m_t, \pi_t, i_t, s_t)$ is 5×5 matrix of lag polynomials and U_t is a 5×1 vector of reduce form innovation such as $U_t' = (u^y{}_t, u^m{}_t, u^\pi{}_t, u^i{}_t, u^s{}_t)$. The following relationship between reduced form and structural shocks in the form of AB-model is suggested by Amisano and Giannini (1997) which is as

$$AU_t = BV_T \tag{2}$$

In order to obtain the structural VAR from the reduce form VAR, we will multiply both sides of equation (15) by A

$$AX_t = AA(L)X_{t-1} + AU_t \tag{3}$$

Consequently, substituting equation (2) in equation (3) we will get

$$AX_t = AA(L)X_{t-1} + BV_t \tag{4}$$

Equation (4) can be written in the following matrix form as

$$\begin{bmatrix} 1 & -\theta_{12} & -\theta_{13} & -\theta_{14} & -\theta_{15} \\ -\theta_{21} & 1 & -\theta_{23} & -\theta_{24} & -\theta_{25} \\ -\theta_{31} & -\theta_{32} & 1 & -\theta_{34} & -\theta_{35} \\ -\theta_{41} & -\theta_{42} & -\theta_{43} & 1 & -\theta_{45} \\ -\theta_{51} & -\theta_{52} & -\theta_{53} & -\theta_{54} & 1 \end{bmatrix} \begin{bmatrix} Y_t \\ m_t \\ \pi_t \\ i_t \\ s_t \end{bmatrix} \equiv \begin{bmatrix} \omega_{11} & \omega_{12} & \omega_{13} & \omega_{14} & \omega_{15} \\ \omega_{21} & \omega_{22} & \omega_{23} & \omega_{24} & \omega_{25} \\ \omega_{31} & \omega_{32} & \omega_{33} & \omega_{34} & \omega_{35} \\ \omega_{41} & \omega_{42} & \omega_{43} & \omega_{44} & \omega_{45} \\ \omega_{51} & \omega_{52} & \omega_{53} & \omega_{54} & \omega_{55} \end{bmatrix}$$

$$\begin{bmatrix} Y_{t-1} \\ m_{t-1} \\ \pi_{t-1} \\ i_{t-1} \\ s_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^Y \\ u_t^m \\ u_t^\pi \\ u_t^i \\ u_t^s \end{bmatrix}$$

After solving equation (4), we get the following form

$$X_t = A^{-1}A(L)X_{t-1} + A^{-1}BV_t \tag{5}$$

$$\begin{bmatrix} Y_t \\ m_t \\ \pi_t \\ i_t \\ s_t \end{bmatrix} = \begin{bmatrix} 1 & -\theta_{12} & -\theta_{13} & -\theta_{14} & -\theta_{15} \\ -\theta_{21} & 1 & -\theta_{23} & -\theta_{24} & -\theta_{25} \\ -\theta_{31} & -\theta_{32} & 1 & -\theta_{34} & -\theta_{35} \\ -\theta_{41} & -\theta_{42} & -\theta_{43} & 1 & -\theta_{45} \\ -\theta_{51} & -\theta_{52} & -\theta_{53} & -\theta_{54} & 1 \end{bmatrix}^{-1} \begin{bmatrix} \omega_{11} & \omega_{12} & \omega_{13} & \omega_{14} & \omega_{15} \\ \omega_{21} & \omega_{22} & \omega_{23} & \omega_{24} & \omega_{25} \\ \omega_{31} & \omega_{32} & \omega_{33} & \omega_{34} & \omega_{35} \\ \omega_{41} & \omega_{42} & \omega_{43} & \omega_{44} & \omega_{45} \\ \omega_{51} & \omega_{52} & \omega_{53} & \omega_{54} & \omega_{55} \end{bmatrix}$$

$$\begin{bmatrix} Y_{t-1} \\ m_{t-1} \\ \pi_{t-1} \\ i_{t-1} \\ s_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & -\theta & -\theta & -\theta & -\theta \\ -\theta & 1 & -\theta & -\theta & -\theta \\ -\theta & -\theta & 1 & -\theta & -\theta \\ -\theta & -\theta & -\theta & 1 & -\theta \\ -\theta & -\theta & -\theta & -\theta & 1 \end{bmatrix}^{-1} \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^Y \\ u_t^m \\ u_t^\pi \\ u_t^i \\ u_t^s \end{bmatrix}$$

Equation (5) can also be written as

$$X_t = M(L)X_{t-1} + \varepsilon_t \tag{6}$$

Where $M = A^{-1}A(L)\ \varepsilon_t = A^{-1}BV_t$

$$\begin{bmatrix} \varepsilon_t^Y \\ \varepsilon_t^m \\ \varepsilon_t^\pi \\ \varepsilon_t^i \\ \varepsilon_t^s \end{bmatrix} = \begin{bmatrix} 1 & -\theta & -\theta & -\theta & -\theta \\ -\theta & 1 & -\theta & -\theta & -\theta \\ -\theta & -\theta & 1 & -\theta & -\theta \\ -\theta & -\theta & -\theta & 1 & -\theta \\ -\theta & -\theta & -\theta & -\theta & 1 \end{bmatrix}^{-1} \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^Y \\ u_t^m \\ u_t^\pi \\ u_t^i \\ u_t^s \end{bmatrix}$$

Equation (6) is the autoregressive representation of the model where every variable is expressed as a function of its own lagged values and other values of the system. Moreover, it also explains that reduce form equations are linear combination of structural equations. The moving average representation of structural model expresses endogenous variable in X_t as a function of present and past reduced form innovations. Equation (6) can be written as moving average representation as follow

$$X_t = [1 - M(L)L]^{-1}\varepsilon_t \tag{7}$$

Where $C(L)$ is the structure autoregressive lag polynomial. The estimation of SVAR requires that the model should be exactly or over identified. The necessary condition for the model to be exactly identified is that there should be equal number of parameters in the structural and reduced form models. In next step, we will impose restrictions on the contemporaneous relationship among variables based on economic theory.

Identification Restrictions for SVAR

The identification given in equation (2) is as follow

$$AU_t = BV_T$$

There is no direct method to measure the value of A and B in the basic SVAR model. Therefore, the first step is to estimate the reduce form VAR. In next step, we identify the system and the fundamental objective of identification is to transform the correlated equations of the reduced form model into uncorrelated and theoretically meaningful structural shocks. The straightforward rule of identification is in case of m variables, m^2 independent restrictions on the parameters of structural model are required for the system to be exactly identified. Out of total m^2 restrictions $(m^2+m)/2$ are generated due to inbuilt diagonal structure of variance-covariance matrix while the remaining $(m^2-m)/2$ restrictions can be placed either on contemporaneous or the long run properties of the system.

As we know, the limitations placed on the concurrent characteristics of a system are commonly referred to as short-term restrictions, a concept introduced by Sims in 1980. In the literature, various short-term identification schemes have been devised, and they can be categorized into two groups: triangular restrictions and non-triangular restrictions. These restrictions find application in both economic and theoretical contexts. Triangular restrictions, also known as a recursive system, involve constraining the matrix in equation (2) to a specific dimension and the matrix "theta" (Θ) to a lower triangular matrix with a unit diagonal. The recursive approach necessitates establishing a causal order for variables within a given model. In a model with "n" variables, there can be multiple feasible orderings. Triangular restrictions are implemented on the matrices in equation (2) in the following manner:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ -\theta_{31} & -\theta_{32} & 1 & 0 & -\theta_{35} \\ 0 & -\theta_{42} & -\theta_{43} & 1 & -\theta_{45} \\ -\theta_{51} & -\theta_{52} & -\theta_{53} & -\theta_{54} & 1 \end{bmatrix}^{-1} \begin{bmatrix} \varepsilon^{y}{}_{t} \\ \varepsilon^{m}{}_{t} \\ \varepsilon^{e(\pi)}{}_{t} \\ \varepsilon^{i}{}_{t} \\ \varepsilon^{s}{}_{t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{y} \\ u_t^{m} \\ u_t^{e(\pi)} \\ u_t^{i} \\ u_t^{s} \end{bmatrix}$$

The above-mentioned restrictions are based on the following ordering of the variables in the model;

$Y \ m \ \pi \ i \ s$

In the above ordering nominal economic activity (Y) comes first implying that it affects the rest of the variables. It is well established fact that with improvement in economic activity all the macroeconomic variables of the economy get affected. Placing money supply (m) next to nominal economic activity implies that changes in money supply affect the values of all variables except real economic activity contemporaneously. It is well known that with variations in money supply, price level, nominal interest rate and nominal exchange rate will definitely alter. Expected inflation $(e\inf)$ is assumed to be affected from the innovations in nominal economic activity and money supply along with its own innovations. This assumption is defended on the ground that variations in price level are determined by structural as well as real factors of the economy. In the ordering next comes nominal interest rate (i),it is assumed that nominal interest rate is influenced by nominal economic activity, money supply, and expected inflation. Finally comes to real exchange rate (s) in the ordering and it is assumed that all the other variables significantly affect the exchange rate. We knew that developments in economic activity and monetary sector of the economy lead to bring variations in real exchange rate. Hence, we placed real exchange rate at the end of the ordering.

Data and Sources

The study will use the Panel data which consist of 84 developing countries and covers the period from 1991 to 2020. All the required data is sourced from the World Development Indicators (WDI), The World Bank and the International Financial Statistics (IFS), the IMF. The nominal exchange rate (s_t) is taken as dependent variable which is domestic currency of the developing countries per US dollar.

The Response of the Exchange Rate to Different Shocks by Using the SVAR Approach

Panel Unit Root Test

The first step to estimate panel SVAR is to test the stationarity property of the series. We apply the panel unit root test which assumes common unit root process to check the stationarity property of the series under consideration. The findings of the Panel unit root test are reported in table 1. Results indicate that all variables are stationary at level except output (LY). However, LY becomes stationary at its first difference.

Table 1 Panel Unit Root Test (Common Unit Root Process-Levin, Lin & Chu)

Variables	Level	First Difference	Result	Order of Integration
LY	-0.537 (0.286)	-27.67 (0.000)	Stationary at first difference	$I(1)$
LM	-17.832 (0.000)	_	Stationary at Level	$I(0)$
$LEINF$	-25.236 (0.000)	_	Stationary at Level	$I(0)$
IR	-7.654 (0.000)	_	Stationary at Level	$I(0)$
$LOER$	-21.569 (0.000)	_	Stationary at Level	$I(0)$

Lag Length Selection Criteria

Lag length selection is a crucial condition for the estimation of SVAR. In literature, there are various criteria for the selection of the appropriate lag length such as Akaike Information Criterion, Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion. However, this study reports the SIC which is the most widely used criteria. Results are reported in table 2. Results indicate that according to the SIC the appropriate lag length is one.

Table 2 Lag Length Criterion

Lag	SIC
0	14.959
1	-3.435*
2	-3.399
3	-3.228
4	-3.074

Impulse Response Function Based on the SVAR Model

The impulse response is based on an identification scheme generally derived from VAR. When a shock is given to a variable, then this response not only captures the effect of the shock on that affected variable only however measures the intensity of the shock to all other variables. In other words, an impulse response function traces the effect of onetime shock and predicts an endogenous variable's current and future values. On the horizontal axis, the annual period is taken, whereas on the vertical axis, the minimum and maximum lengths of the responses are placed. The answers are plotted for twenty years. In this study, we will consider different shocks such as output shock, money supply shock, expected inflation shock, nominal interest rate shock, and exchange rate shock, and we will analyze their impulse responses in the context of developing countries.

Response of the Macroeconomic Variables to the Output Shock

Figure 1 shows the response of output, money supply, expected inflation, nominal interest rate, and the exchange rate toward onetime output shock. In other words, a temporary positive surprise is given to the output level to see its effect on its own and other macroeconomic variables.

Panel 1 of Figure 1 shows that the effect of output shock on the output is maximum in the first year of the shock, then gradually declining during the 2nd and 3rd years. Finally, the effect of the shock on the output lasts only till the 4th year of the sample period. It implies that output shock has only a short-term impact on the production.

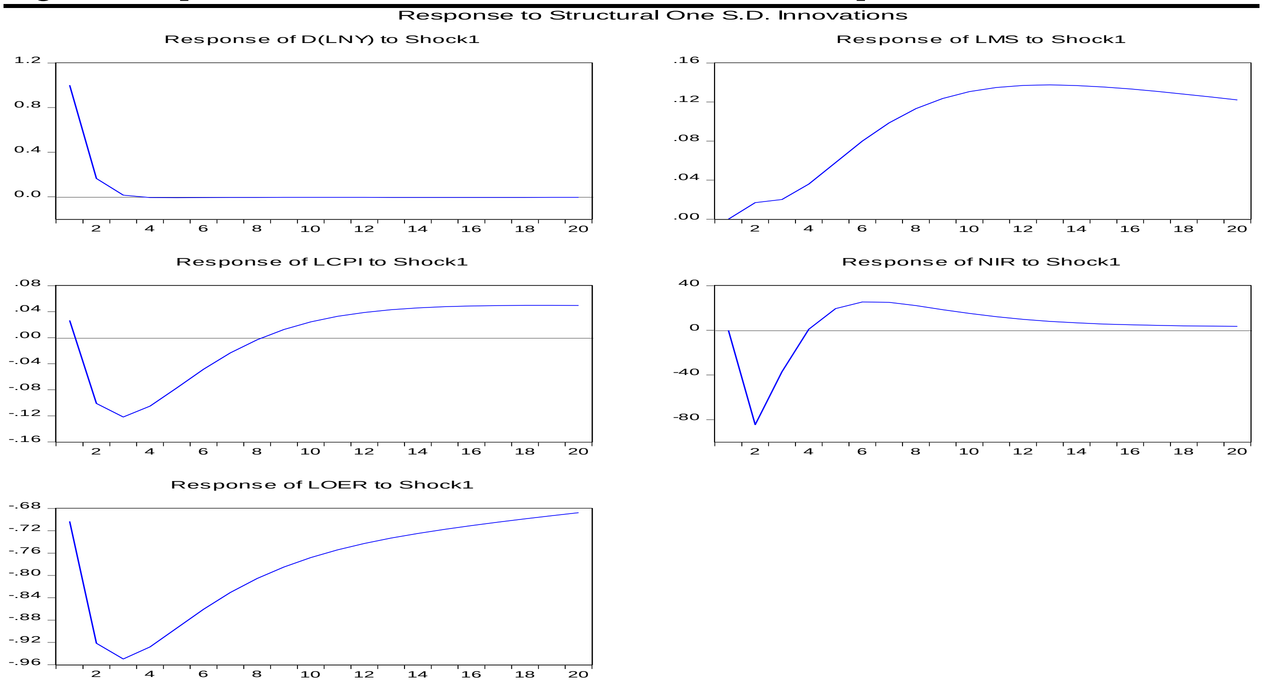
The response of the money supply to output shock shows that initially, the collection is not affected by the output shock during the first year, then it begins to rise gradually in the 2nd year. It remains constant during the first half of the 3rd year, and then it starts increasing and reaches its peak value in the 13th year. After that, the money supply continues diminishing until the sample period's end.

The response of expected inflation to the output shock is given in panel 3 of Fig. 1. Initially, expected inflation decreases after the output shock. Still, it remains in the positive zone in the first few months. After that, it entered the opposing area and continued to decline till the 3rd year. The expected inflation starts to rise in the 4th year, enter the positive zone in the 9th year, and remain positive till the end of the sample period.

The output shock initially decreases the nominal interest rate as it remains in the negative zone till the first half of the 2nd year. After that, it starts increasing and enters the positive area in the 4th year and continues to grow until it becomes constant in the 6th and 7th years, and then it starts declining till the end of the sample period (see panel 4 of Fig. 1).

In panel 5 of Fig. 1, when an output shock is given, the initial response is a decrease in the exchange rate, and it reaches the minimum level in the 3rd year. After that, it shows some recovery but remains in the negative zone till the end of the sample period.

Figure 1 Response of the Macroeconomic Variables to the Output Shock



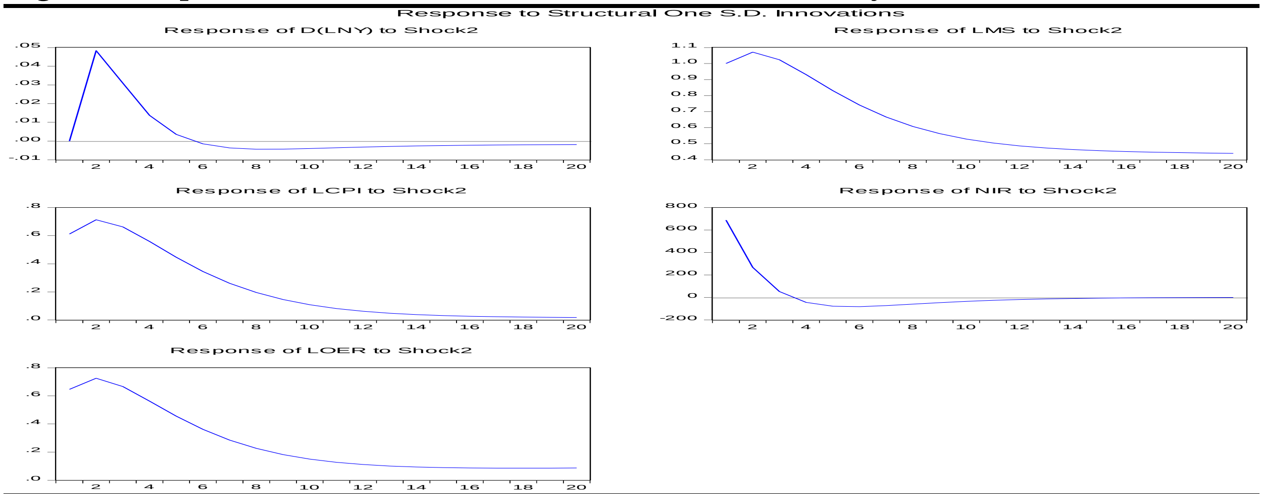
Response of the Macroeconomic Variables to Monetary Shock

The response of the output, money supply, expected inflation, nominal interest rate and nominal exchange rate to money supply shock is given in figure 2. Panel 1 of figure 2 indicates that output is significantly affected by the monetary shock for the first year and attains its peak towardtheendofthe2ndyear.However, after that output starts declining and gradually loses all the gain by the end of 6th year and remains in the negative zone till the end of the sample period. It implies that monetary shock stabilizes the output at a new low level after the monetary shock in developing countries. Generally, monetary shocks do not bring immediate adjustments in the spending and investment behavior of the economic agents. It shows that the immediate response of the output in our case during the first two years may not reflect the effect of monetary policy changes rather it may cause by the changes in the preceding period output (Chuku, 2009). This finding is consistent with the result of Ghosh (1999) for Ukraine and Chuku (2009) for Nigeria which find that the expansionary monetary policy has transitory and quick effects in context of developing countries like Ukraine and Nigeria.

Initially, Money supply shows a positive trend to the monetary shock during the first year. However, it couldn't maintain it and continues to decrease till the end of the 20th year which implies money supply is adversely affected by its own shock. Panel 3 of figure 2 shows the response of the expected inflation to monetary shock which is quite similar to that of the money supply. Initially, expected inflation increases till the first half of the 2nd year and then continues to decrease till the end of the sample period.

Nominal interest rate continues to decrease after the monetary shock and it loses all of its gain till the end of 3rd year. After that nominal interest rate enters in the negative zone and once again the effect of monetary shock completely vanishes in the 19th year. Finally, response of the nominal exchange rate to monetary shock is given in panel 5 of figure 2. Nominal exchange rate increases till the first half of the 2nd year and then continues to decrease till the end of the sample period.

Figure 2 Response of the Macroeconomic Variables to Monetary Shock



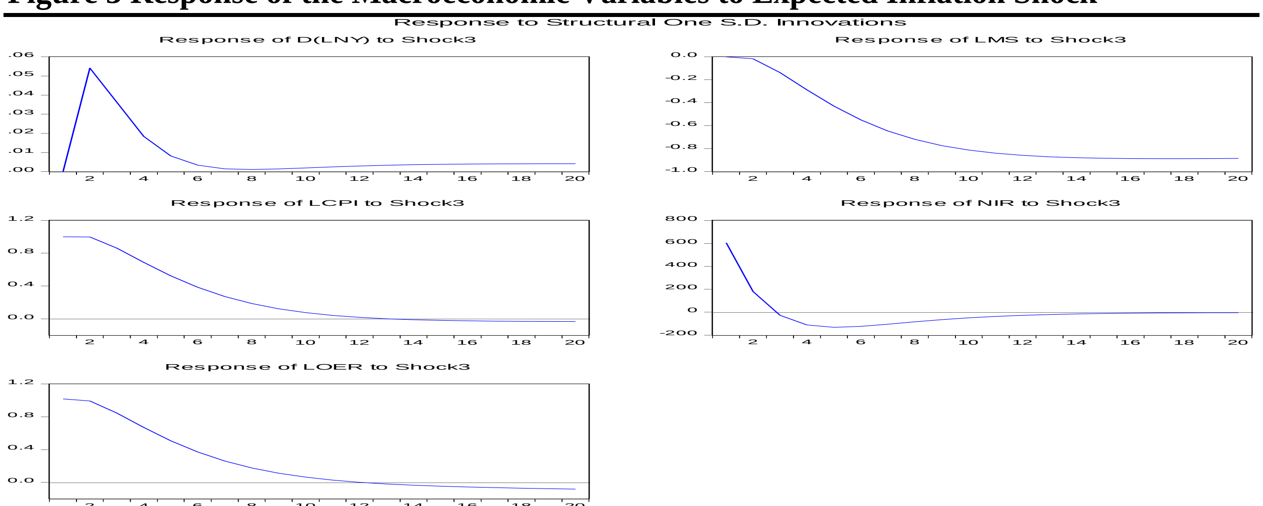
Response of the Macroeconomic Variables to Expected Inflation Shock

The response of different macroeconomic variables to expected inflation shock is shown in figure 3. Panel 1 of figure 3 indicate that after the expected inflation shock initially output starts increasing till the first half of the 2nd year and then it continues to decrease till the end of the 8th year. After that it shows a slower recovery till the end of the 20th year.

The response of the money supply to expected inflation shock is given in Panel 2 of figure 3. It is clear from the graph that money supply does not alter in the first year after the expected inflation shock and then gradually started to decline. The analysis shows that money supply adversely affected by the expected inflation shock as it remains in the negative zone throughout the sample period of the study.

Expected inflation shows some inertia in first one and a half year after its own shock as its value remains constant. After that expected inflation continues to decrease till the 12th year and then it reaches to the minimum point and enters in the negative zone. Afterwards, it remains in the negative zone till the end of the period.

Figure 3 Response of the Macroeconomic Variables to Expected Inflation Shock



When expected inflation shock is given, the nominal interest rate continuously decreases and it enters in the negative zone after the 3rd and a half year. Subsequently, it shows some improvement but it continues to remain in the negative zone. In other words, expected inflation shock adversely affects the nominal interest rate in developing countries (see panel 4 of figure 3). The response of the exchange rate to the inflation shock is quite similar to that of the expected inflation. After shock exchange rate continues to decreases and it reaches to the minimum level in the 12th year. After that exchange rate enters in the negative zone and continuously decreases till the end of the sample period.

Response of the Macroeconomic Variables to Nominal Interest Rate Shock

Now we will analyze the response of the macroeconomic variables to nominal interest rate shock. In other words, a temporary positive shock is given to the nominal interest rate to measure the impulse response of the output, money supply, expected inflation, nominal interest rate and the nominal exchange rate.

Panel 1 of figure 4 shows that due to nominal interest rate shock, output initially decreases sharply in first 3 years and then it becomes constant from 4th year to 10th year. Afterwards, output level shows some improvement but it remains in the negative zone till the end of the sample period. It implies that nominal interest rate shock has an adverse effect on the output/economic activity. The main reason of the output fall after the nominal interest rate shock is that higher interest rate raises the cost of borrowing which adversely affect the private investment. Hence, output decreases multiple times as a result of fall in private investment. This effect is term as a negative multiplier effect. In other words, nominal interest rate shock deteriorates economic activity in the developing countries and these countries fail to regain their initial output level.

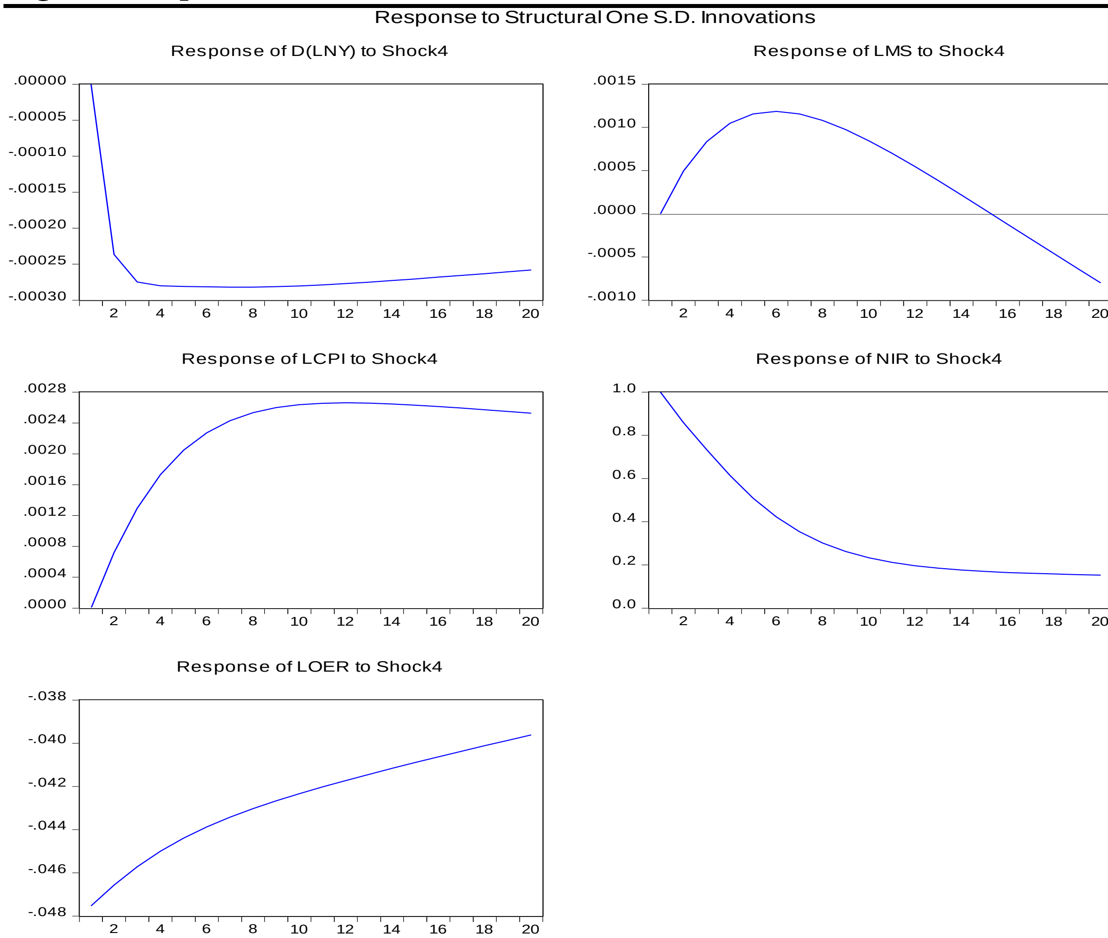
In response to the nominal interest rate shock, money supply gradually increases in first six years and then it starts to decline continuously till 15th year. Afterwards, it enters in the negative zone and remains there till the rest of the time period. It implies that the increase in money supply after the shock was quite temporary and the shock adversely affects the money supply in the developing countries.

The effect of the nominal interest rate shock on the expected inflation is captured in panel 3 of figure 4. The graphical analysis indicates that the expected inflation continuously increases till the 10th year then it becomes constant from 11th to 13th year. Subsequently, expected inflation shows a slight decrease but becomes stable till the end of the sample period in the developing countries. This analysis highlights that inflation is structural rather than a monetary phenomenon in developing countries. Moreover, increasing food prices, removal of subsidy on electricity, gas and petroleum items, weak economic conditions, instability in domestic currency/ dollar exchange rate are the main drivers of higher expected inflation in context of developing countries.

Panel 4 of figure 4 captures the response of the interest rate to its own shock. Throughout the sample period of the study, the interest rate continuously decreases. However, it remains in the positive zone till the end of the period.

The response of the exchange rate to the nominal interest rate shock is represented in panel 5 of figure 4. Opposite to the interest rate response, the exchange rate continuously increases in response to the nominal interest rate shock. Theoretically monetary policy shock such as an increase in the interest rate leads to the high cost of production. Consequently, low level of investment along with reduction in output level creates a recessionary pressure in the economy which also reduces the price level and leads to the increase in real exchange rate. So, the response of exchange rate to monetary tightening shows the prevalence of depreciation of domestic currency in context of developing countries.

Figure 4 Response of the Macroeconomic Variables to Nominal Interest Rate Shock



Response of the Macroeconomic Variables to Nominal Exchange Rate

The response of the macroeconomic variables of the study to the nominal exchange rate shock is presented in figure 5. When a temporary positive shock is given to the nominal exchange rate (depreciation) then the output starts to rise and attain its peak towards the end of 2nd year. Afterwards output begins to decrease and reaches to the minimum level at the end of 8th year and then continuously remains at its minimum level till the end of the sample period.

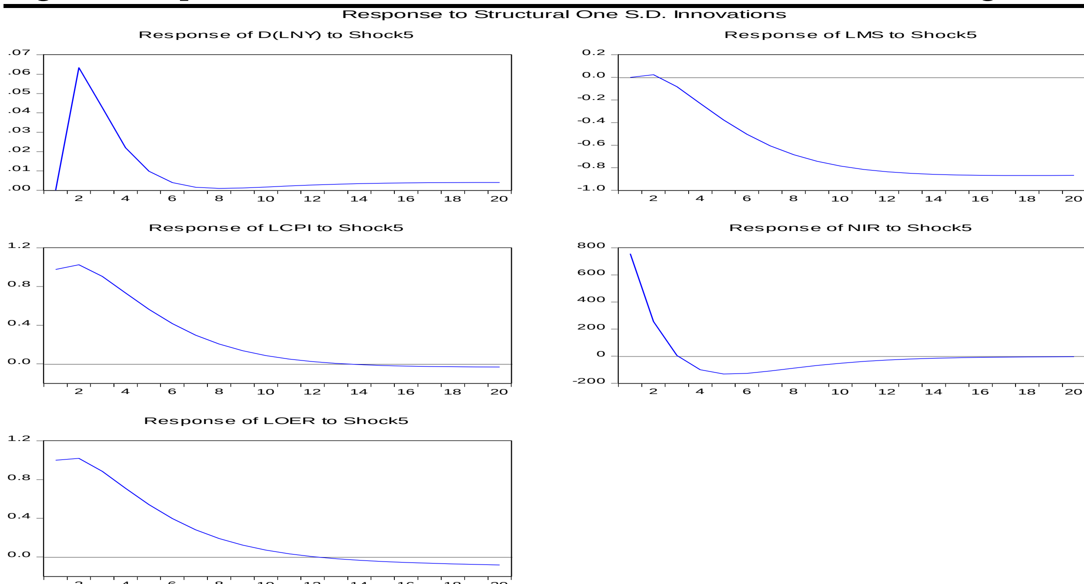
Panel 2 of figure 5 shows that money supply is not affected by the nominal exchange rate shock for the first year then it slightly increases in second period. However, after that money supply enters in the negative zone and starts to decrease continuously and it becomes constant in the 15th year and shows the same behavior till the end of the sample period.

When a shock is given to the nominal exchange rate, initial response of the expected inflation is positive in the first 2 years but then expected inflation declines gradually and loses all the gain by the end of 13th year. Moreover, it enters in the negative zone in 14th year and continue remain in the negative zone till the end of the 20th year (see panel 3 of figure 5). Contrary to our findings, the exchange rate depreciation makes local commodities more competitive globally which results in overall higher demand for tradable commodities (Chuku, 2009). This increase in demand should put upward pressure on the expectations regarding inflation. In context of developing countries, this abnormal behavior can be explained by the weak production capacity and obsolete technology available for tradable goods.

A positive nominal exchange rate shock will have a negative effect on the nominal interest rate as initially nominal interest rate decreases but still it remains in the positive zone till the end of 4th year. It enters in the negative zone in the 5th year and touches the minimum level in the 6th year and then gradually it starts rising but still remains in the negative zone.

Finally, the response of nominal exchange rate shock to its own shock is somehow similar to that of expected inflation behavior (see panel 5 of figure 5). As initially nominal exchange rate shows positive response till the first half of the 2nd year and then it starts decreasing but it still remains in the positive zone till the end of 12th year. Subsequently, it enters in the negative zone in 13th year and continues to remain in the negative zone till the end of the sample period.

Figure 5 Response of the Macroeconomic Variables to Nominal Exchange Rate



Forecast Error Variance Decomposition (FEVD) Analysis

Sims (1980) introduced the Forecast Error Variance Decomposition (FEVD) analysis, which offers valuable insights for enhancing our understanding of the relationships among variables within a VAR model. Specifically, FEVD serves to reveal how much of the forecast error variance of each variable can be attributed to exogenous shocks originating from the other variables.

In our study, we conducted FEVD estimation for five key variables: output, money supply, expected inflation, nominal interest rate, and nominal exchange rate, over a 20-year time horizon. The results provide information regarding the proportion of forecast error variance for each variable that can be explained by a specific shock. Notably, the sum of these proportions for each variable should consistently total to one (or 100 percent) at any forecast horizon, ensuring a comprehensive understanding of the interplay among these variables.

Variance Decomposition of Output to Various Shocks

Table 3 reports the FEVD of output. Results 3 indicate that 100 percent variations in output are due to its own shock while the other macroeconomic variables are not bringing any variation in the output at the first period.

Table 3 Variance Decomposition of Output to Various Shocks

Period	S.E.	Output Shock	Money Supply Shock	Expected Inflation Shock	Nominal interest rate Shock	Exchange rate Shock
1	1.000000	100.0000	0.000000	0.000000	0.000000	0.000000
2	1.017865	99.10449	0.225277	0.282584	5.39E-06	0.387648
3	1.019986	98.71504	0.316163	0.407363	1.26E-05	0.561419
4	1.020505	98.61942	0.333910	0.439542	2.01E-05	0.607105
5	1.020624	98.60283	0.335050	0.445868	2.77E-05	0.616228
6	1.020661	98.60016	0.335244	0.446894	3.53E-05	0.617667
7	1.020686	98.59849	0.336525	0.447078	4.29E-05	0.617867
8	1.020711	98.59653	0.338322	0.447173	5.06E-05	0.617925
9	1.020735	98.59449	0.340089	0.447340	5.82E-05	0.618024
10	1.020759	98.59241	0.341597	0.447673	6.57E-05	0.618258
11	1.020783	98.59019	0.342814	0.448232	7.31E-05	0.618696
12	1.020810	98.58774	0.343779	0.449035	8.05E-05	0.619366
13	1.020838	98.58504	0.344552	0.450063	8.78E-05	0.620260
14	1.020867	98.58209	0.345184	0.451281	9.49E-05	0.621346
15	1.020897	98.57895	0.345715	0.452644	0.000102	0.622584
16	1.020928	98.57567	0.346174	0.454111	0.000109	0.623933
17	1.020959	98.57230	0.346582	0.455649	0.000116	0.625358
18	1.020991	98.56887	0.346953	0.457228	0.000122	0.626831
19	1.021022	98.56542	0.347296	0.458829	0.000129	0.628329
20	1.021054	98.56197	0.347619	0.460436	0.000135	0.629838

Moreover, over the next 19 years output shocks still remains the major contributor (98%) in explaining the forecasted variations in output followed by the exchange rate and expected inflation shocks which bring less than one percent variations in the output over the forecast time horizon.

Variance Decomposition of Money Supply to Various Shocks

The FEVD of money supply to various shocks is reported in table 4. Results indicate that during the first period, significant variations in money supply are explained by its own shock which is 100 percent. Overtime, the contribution of the money supply shock decreases (30%) while the expected inflation shock becomes important over time in bringing variation in the money supply (35%). Similarly, the importance of the exchange rate shock in explaining the

major proportion of forecasted variance of money supply (33%) also increases till the end of the period. A small proportion of total forecasted variations in money supply are also explained by the output shock which is only 0.82 percent. The variance decomposition of money supply analysis indicates that nominal interest rate shock is not a significant contributor in elucidating money supply variations.

Table 4 Variance Decomposition of Money Supply to Various Shocks

Period	S.E.	Output Shock	Money Supply Shock	Expected Inflation Shock	Nominal interest rate Shock	Exchange rate Shock
1	1.000000	0.000000	100.0000	0.000000	0.000000	0.000000
2	1.465720	0.013266	99.94655	0.014255	1.15E-05	0.025920
3	1.795016	0.021405	99.14919	0.600567	2.93E-05	0.228809
4	2.055663	0.046857	96.10160	2.414446	4.83E-05	1.437048
5	2.290660	0.101749	90.55627	5.464848	6.44E-05	3.877070
6	2.521965	0.184293	83.34044	9.272021	7.52E-05	7.203174
7	2.756843	0.282165	75.58894	13.25629	8.05E-05	10.87253
8	2.994902	0.381814	68.16714	17.00332	8.13E-05	14.44765
9	3.233047	0.473871	61.52531	20.31371	7.88E-05	17.68703
10	3.468023	0.553765	55.79963	23.14081	7.44E-05	20.50573
11	3.697355	0.620307	50.95429	25.51694	6.90E-05	22.90839
12	3.919494	0.674157	46.88248	27.50406	6.34E-05	24.93924
13	4.133656	0.716768	43.46112	29.16821	5.78E-05	26.65384
14	4.339606	0.749801	40.57526	30.56896	5.27E-05	28.10592
15	4.537459	0.774843	38.12643	31.75627	4.82E-05	29.34241
16	4.727538	0.793291	36.03368	32.77059	4.45E-05	30.40240
17	4.910275	0.806331	34.23181	33.64417	4.16E-05	31.31765
18	5.086144	0.814942	32.66871	34.40256	3.96E-05	32.11374
19	5.255626	0.819928	31.30286	35.06602	3.85E-05	32.81116
20	5.419183	0.821944	30.10105	35.65064	3.84E-05	33.42632

Variance Decomposition of Expected Inflation to Various Shocks

The forecast variance decomposition of expected inflation shows that at the start of the period most of the variations emanate from its own shock which is almost 43 percent followed by the exchange rate shock (41%). However, this proportion changes overtime as the exchange rate explains the major part of the forecasted variations (40%) in the expected inflation as compared to its own shock which contributes 38 percent towards the end of the forecasted time period. Similarly, the role of money supply shock also become quite significant overtime as it elucidates 21 percent forecast error variance of the expected inflation variable. Nevertheless, both the output shock and especially nominal interest rate shocks are not significant in describing variations in the expected inflation (see table 5).

Table 5 Variance Decomposition of Expected Inflation to Various Shocks

Period	S.E.	Output Shock	Money Supply Shock	Expected Inflation Shock	Nominal interest rate Shock	Exchange rate Shock
1	1.525977	0.030220	16.07820	42.94415	0.000000	40.94743
2	2.212141	0.223063	18.03868	40.79385	1.06E-05	40.94440
3	2.628290	0.372825	19.13747	39.63552	3.17E-05	40.85415
4	2.870971	0.446574	19.82444	38.96716	6.29E-05	40.76177
5	3.006458	0.472988	20.27952	38.56672	0.000104	40.68067
6	3.078971	0.475711	20.58939	38.32209	0.000154	40.61266
7	3.116208	0.470021	20.80216	38.17067	0.000211	40.55693
8	3.134564	0.464626	20.94772	38.07551	0.000274	40.51187
9	3.143268	0.463669	21.04605	38.01430	0.000340	40.47564
10	3.147281	0.468447	21.11114	37.97359	0.000410	40.44641
11	3.149151	0.478722	21.15293	37.94530	0.000480	40.42256
12	3.150128	0.493583	21.17849	37.92461	0.000552	40.40276
13	3.150792	0.511954	21.19284	37.90864	0.000622	40.38595
14	3.151390	0.532840	21.19950	37.89565	0.000693	40.37132
15	3.152014	0.555420	21.20095	37.88459	0.000762	40.35828
16	3.152689	0.579059	21.19888	37.87483	0.000831	40.34640
17	3.153410	0.603289	21.19448	37.86594	0.000898	40.33539
18	3.154166	0.627773	21.18855	37.85769	0.000964	40.32502
19	3.154944	0.652277	21.18165	37.84989	0.001029	40.31515
20	3.155734	0.676640	21.17415	37.84243	0.001093	40.30568

Variance Decomposition of Nominal Interest to Various Shocks

The major contributor to nominal interest rate variations throughout the forecasted period is the nominal exchange rate shock as it explains around 41 percent variation in first year and 40 percent in the 20th year (see table 6). Results indicate that among all other macroeconomic variables money supply shock is more prominent in explaining 33 percent fluctuations in the nominal interest rate followed by the expected inflation rate shock which brings 26 percent variations in the nominal interest rate. Interestingly, nominal interest rate own shock does not significantly contribute to nominal interest rate variance.

Table 6 Variance Decomposition of Nominal interest rate to Various Shocks

Period	S.E.	Output Shock	Money Supply Shock	Expected Inflation Shock	Nominal interest rate Shock	Exchange rate Shock
1	1188.465	0.000000	33.56635	25.91076	7.08E-05	40.52282
2	1260.712	0.450657	34.36947	25.06805	0.000109	40.11171
3	1262.679	0.535791	34.43745	25.03836	0.000143	39.98826
4	1272.343	0.527739	34.03452	25.42653	0.000164	40.01105
5	1288.410	0.537245	33.55411	25.84478	0.000175	40.06369
6	1303.404	0.562648	33.17602	26.15415	0.000182	40.10699
7	1314.441	0.589378	32.92276	26.35171	0.000186	40.13597
8	1321.608	0.610918	32.76562	26.46922	0.000189	40.15405
9	1325.925	0.626362	32.67183	26.53653	0.000192	40.16508
10	1328.404	0.636851	32.61683	26.57432	0.000194	40.17180

11	1329.785	0.643838	32.58466	26.59539	0.000196	40.17592
12	1330.542	0.648509	32.56569	26.60716	0.000198	40.17845
13	1330.955	0.651697	32.55429	26.61380	0.000200	40.18001
14	1331.183	0.653946	32.54726	26.61763	0.000202	40.18096
15	1331.311	0.655598	32.54278	26.61989	0.000204	40.18153
16	1331.387	0.656867	32.53983	26.62126	0.000205	40.18185
17	1331.434	0.657887	32.53780	26.62211	0.000206	40.18200
18	1331.465	0.658741	32.53635	26.62266	0.000208	40.18204
19	1331.487	0.659483	32.53528	26.62302	0.000209	40.18201
20	1331.504	0.660148	32.53444	26.62326	0.000211	40.18194

Variance Decomposition of Nominal Exchange Rate to Various Shocks

The variance decomposition for the nominal exchange rate in table 7 indicate that initially nominal exchange rate variations arise from the expected inflation shock (35%) in the first year. Subsequently, the nominal exchange rate shock becomes the major source of bringing variation (29%) in the nominal exchange rate from 2nd year to 4th year. Afterwards, output shock plays a major role as it explains 55 percent of total variation in the nominal exchange rate in the 20th year. The money supply shock and the nominal interest rate also play significant role in describing the variations in the nominal exchange rate.

Table 7 Variance Decomposition of Nominal Exchange Rate to Various Shocks

Period	S.E.	Output Shock	Money Supply Shock	Expected Inflation Shock	Nominal interest rate Shock	Exchange rate Shock
1	1.717964	16.76068	14.15861	35.12194	0.076553	33.88222
2	2.520873	21.15000	14.86204	31.83589	0.069681	32.08240
3	3.032904	24.41650	15.09214	29.75647	0.070863	30.66402
4	3.366063	27.42425	15.04703	28.12093	0.075403	29.33238
5	3.590250	30.31237	14.83819	26.71542	0.081569	28.05246
6	3.749356	33.06326	14.53626	25.47060	0.088487	26.84138
7	3.870086	35.63991	14.18694	24.35940	0.095643	25.71810
8	3.968193	38.02029	13.81914	23.36603	0.102728	24.69182
9	4.052753	40.20101	13.45039	22.47693	0.109569	23.76210
10	4.128916	42.19189	13.09075	21.67896	0.116076	22.92231
11	4.199594	44.00955	12.74560	20.95971	0.122214	22.16293
12	4.266447	45.67269	12.41747	20.30801	0.127978	21.47386
13	4.330438	47.19936	12.10726	19.71427	0.133381	20.84573
14	4.392146	48.60575	11.81494	19.17052	0.138442	20.27035
15	4.451936	49.90578	11.53999	18.67016	0.143186	19.74088
16	4.510047	51.11124	11.28161	18.20787	0.147635	19.25165
17	4.566649	52.23208	11.03887	17.77924	0.151812	18.79800
18	4.621867	53.27666	10.81082	17.38070	0.155739	18.37608
19	4.675800	54.25210	10.59650	17.00924	0.159435	17.98272
20	4.728530	55.16449	10.39498	16.66238	0.162917	17.61524

Conclusion and Policy Recommendations

The results of the impulse response function show that output shock only temporarily affects the output in developing countries. Whereas the response of money supply to output shock indicates that it initially increases at an increasing rate and then slightly diminishes till the end of the period. Expected inflation first shows a decreasing trend to the positive output shock; then, it gradually rises till the end of the period. Similarly, the output shock initially decreases the nominal interest rate as it remains in the negative zone. Then, after showing some improvement, it again starts declining till the end of the sample period. When an output shock is given, initially, the exchange rate appreciates and then shows some depreciation, but it remains in the negative zone.

Results indicate that output is significantly affected by the monetary shock for the first year. After that, the output starts declining, gradually loses all the gain, and remains in the negative zone until the end of the sample period. Moreover, the money supply is adversely affected by its shock. The response of the expected inflation to monetary shock is quite similar to that of the money supply. Initially, expected inflation increases and then decreases till the end of the sample period. The nominal interest rate continues to decrease after the monetary shock, and it enters the negative zone, and the effect of the monetary shock completely vanishes in the 19th year. Finally, in response to the nominal exchange rate to monetary shock, the exchange rate initially depreciates, showing appreciation.

The response of different macroeconomic variables to expected inflation shock indicates that initially, output starts increasing, then it continues to decrease. After that, it shows a slower recovery till the end of the 20th year. The response of the money supply to the expected inflation shock shows that it is adversely affected by the expected inflation shock as it remains in the negative zone throughout the sample period. Expected inflation shows some inertia in the first one and a half years after its shock as its value remains constant, and then expected inflation continues to decrease till the end. The nominal interest rate continuously decreases when an expected inflation shock is given. Subsequently, it shows some improvement, but it remains in the negative zone in the context of developing countries. In response to the inflation shock, the exchange rate appreciates till the end of the period.

When a temporary positive shock is given to the nominal interest rate, output decreases sharply and becomes constant. Afterward, the output level shows some improvement, but it remains in the negative zone till the end of the period. The increase in money supply after the nominal interest rate shock is quite temporary and the shock adversely affects the money supply in developing countries. The effect of the nominal interest rate shock on the expected inflation indicates that the expected inflation continuously increases at the beginning and then becomes constant. Subsequently, expected inflation shows a slight decrease but becomes stable till the end of the sample period in the developing countries. Moreover, the response of the nominal interest rate to its shock, nominal interest rate continuously decreases. However, it remains in the positive zone till the end of the period. The response of the exchange rate to a positive nominal interest rate shock shows the prevalence of depreciation of the domestic currency in the context of developing countries.

When a temporary positive shock is given to the nominal exchange rate, output rises. Then, output decreases and remains at its minimum level until the end of the sample period. Money supply is adversely affected by the exchange rate shock as it slightly increases and then continuously decreases. Moreover, when a shock is given to the nominal exchange rate, the expected inflation's initial response to the shock is positive, but expected inflation declines gradually and loses all the gain. It enters the negative zone and remains in the negative zone until the end of the 20th year. A positive nominal exchange rate shock will have a negative effect on the nominal interest rate as, initially, the nominal interest rate decreases. Then, it enters the negative zone and touches the minimum level in the 6th year. After it gradually starts rising but remains in the negative zone.

Finally, the response of nominal exchange rate shock to its shock is similar to expected inflation behavior. Initially, the nominal exchange rate shows a positive response, and then it starts decreasing, but it remains in the positive zone. Subsequently, it enters the negative zone and remains in the negative zone until the end of the sample period.

From the variance decomposition analysis, we conclude that output shocks remain the major contributor in explaining the forecasted variations in output, followed by the exchange rate and expected inflation shocks. The analysis of the variance decomposition of the money supply to various shocks indicates that, initially, significant variations in money supply are explained by its shock. Later, the importance of expected inflation shock and the exchange rate shock increases over time, bringing variation in the money supply. Similarly, the forecast variance decomposition of expected inflation shows that at the start of the period, most of the variations in expected inflation come from its shock. However, the role of the exchange rate becomes quite significant over time as it explains the major proportion of variations in the expected inflation compared to its shock. Similarly, money supply shock also emerges as an essential factor in explaining the forecast error variance of the expected inflation variable.

The nominal exchange rate shock is the major contributor to nominal interest rate variations throughout the forecasted period, followed by the money supply shock and the expected inflation shock. Interestingly, nominal interest rate shock does not significantly contribute to nominal interest rate variance. Moreover, the variance decomposition for the nominal exchange rate indicates that initially, nominal exchange rate variations arise from the expected inflation shock followed by the nominal exchange rate shock, output shock, money supply shock, and nominal interest.

The study suggests that monetary shocks such as money supply shock, expected inflation shock, and interest rate shock play an essential role in inducing variations in the exchange rate. Therefore, for attaining a stable exchange rate, monetary management is pivotal so that developing countries can secure their economies from fluctuating exchange rates.

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