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Evaluating the Responses of Monetary Policy Variables to Shocks in Capital Inflows in Nigeria

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Abstract: Monetary economists and researchers in financial related fields have been closely monitoring the responses of monetary authorities to fluctuations in capital inflows. This study investigated the responses of monetary policy variables to shocks in capital inflows in Nigeria. The study covered the period from 2007M1 to 2021M9 using the Vector Autoregressive (VAR) approach. Through the VAR, the impulse response function and the variance decomposition were obtained. The VAR method was considered as it assisted in capturing the feedback arising from one variable to the other. The results of the impulse response function reveal that the broad money supply (M2) responded positively to shocks in capital inflows (proxy by NFA) in all the quarters, while the cash reserve requirements (CRR) responded positively to shocks in capital inflows only in the first quarter. Finding equally reveals that the monetary policy rate (MPR) exhibited a positive response due to shocks in capital inflows, while the response of exchange rate to shocks in capital inflows was positive in all the quarters. In another respect, capital inflows were found to respond positively to shocks in the MPR in the first quarter, negative up to the second quarter and thereafter it responded positively in all the other quarters. The results of the variance decomposition lend further credence to the response of the monetary policy variables to shocks in capital inflows. The study concluded that while monetary policy variables reacted expectedly to shocks in capital inflows within the study period, a reverse causality existed between capital inflows and monetary policy variables. The implication of the finding is that even though monetary policy variables could be effective in reducing the monetary impact of capital inflows, their implementation may end up producing unintended results.

Keywords: monetary policy, capital inflows, VAR, impulse response function.

Introduction

In order to make up for deficits in revenue, it has become necessary for capital to flow into the country. Additionally, capital inflows help a nation generate more capital to enhance economic development and foster innovation. A country that lacks sufficient capital may struggle to meet the necessary domestic investments needed for economic growth. This is more so for a country like Nigeria whose revenue generation is mainly tied to the vagaries of oil price that is exogenously determined by developments in the global economy. Several episodes of fall in international price of oil has forced the country to embark on deficit budgeting since budget implementation is benchmarked on projected oil revenue. Of recent however, Diaspora remittances have come to represent another veritable source of capital inflow to the country, contributing billions of Dollars annually to the country's gross domestic product (GDP). Other sources of capital inflows for the country include, among others; foreign direct investment (FDI) inflows and foreign portfolio investment (FPI) inflows. Notwithstanding the role of capital inflows in revenue generation for a country, they could destabilize the macroeconomic environment if not regulated. As noted by Blanchard et al. (2015), countries that open their economy are prone to policy challenges arising from global shocks to capital flows. Among the negative implications of unregulated capital inflows include rising monetary aggregates and thus, rising domestic prices as well as exchange rate appreciation.

As a way to insulate the domestic economy from the negative macroeconomic implications of capital inflows, monetary authorities apply different strategies. One of the measures includes foreign exchange intervention by the central bank (Fanelli & Straub, 2021). The Central Bank of Nigeria (CBN) which is responsible for monetary policy management uses different tools to drain off excess liquidity arising from huge capital inflows. The primary focus of the CBN's policies in recent times has been on targeting inflation. Therefore, as rising capital inflows have the tendency to raise the general price level, the CBN is constantly overhauling the monetary policy tools to ensure the economy is not overheated. Such tools include the cash reserve requirement (CRR), monetary policy rate (MPR) and the open market operation (OMO). According to Jume (2021), other measures include the withdrawal of public sector deposits from the deposit money banks (DMBs), in addition to some exchange rate flexibility options. While the CRR is raised to reduce liquidity in the banking system in periods of rising capital inflows, MPR which is the benchmark rate that influences other domestic rates is equally raised during such situation. With respect to the OMO, the monetary authorities sell bonds during periods of rising capital inflows in order to reduce liquidity in the system. Karahan and Bayır (2022) found that policy interventions aimed at contraction have been effective in reducing capital inflows. Specifically, they noted that contractionary monetary policy can negatively impact FDI inflows in developing countries. Monetary policy implementation can as well lead the attraction of capital inflows as have been observed by some studies such as Villamizar-Villegas et al. (2022).

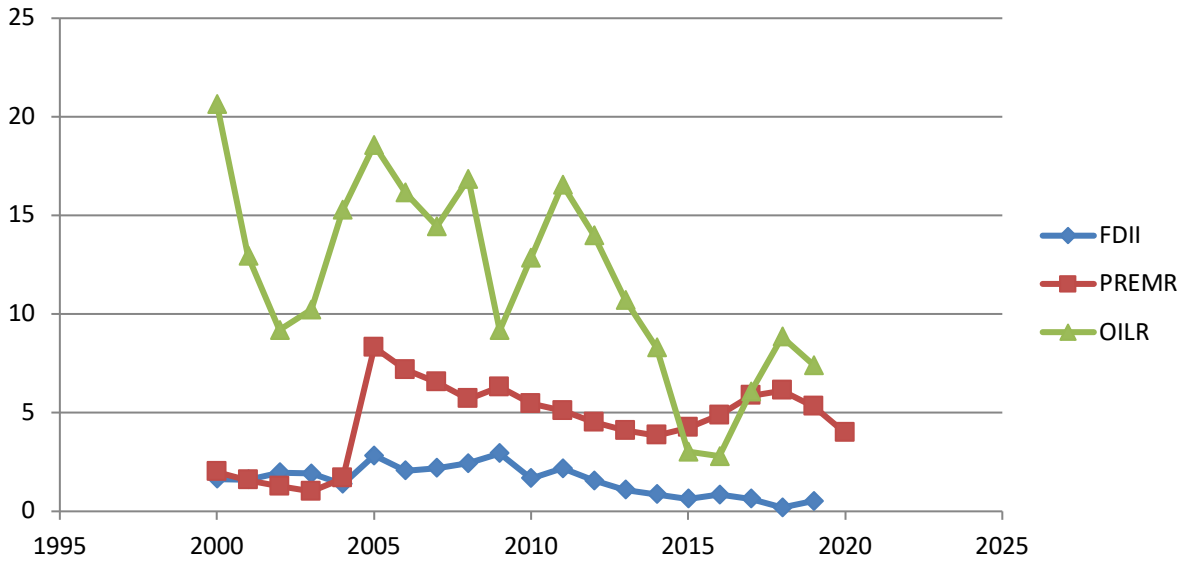
The rest of the study is structured as follows: section one focuses the introduction, research problem, scope of the study, trends in some key variables, objectives of the study, research questions and research hypotheses. Section two discusses the empirical literature; section three handles model specification, data sources and justification, section four handles results and discussion, section five handles conclusion, recommendation and suggestion for further studies

Trends in Some Key Variables

Figure 1 above shows the trend in some sources of capital inflows in Nigeria over the period from 2000 to 2020. Evidence shows that the contribution of rent from the oil sector to the GDP is higher than the contribution of other sources of inflows. A major feature of inflows from the oil sector is that it experiences fluctuations arising from developments in the global economy. For instance, in 2002, the trend in oil rent was very low, but it gradually improved beginning from 2003 until it rose to a peak in 2005. Also, in 2008, 2011 and 2018, oil rent got to a peak but approached a trough in 2009 and 2016, respectively. Following the significant impact of oil rent on the GDP, remittances also played a crucial role, reaching peak levels in both 2005 and 2018. In contrast, foreign direct investment remained relatively stagnant throughout the sample period. It is important to recognise that global events and trends have a significant impact on capital inflows in Nigeria. For instance, around 2009 when there was a global financial meltdown, evidence shows that all the sources of inflows were very low. Also, in 2019 and thereafter, these sources also saw declining trend owing to the impact of the COVID-19 pandemic.

Figure 1

Trend in the Sources of Capital Inflows in Nigeria



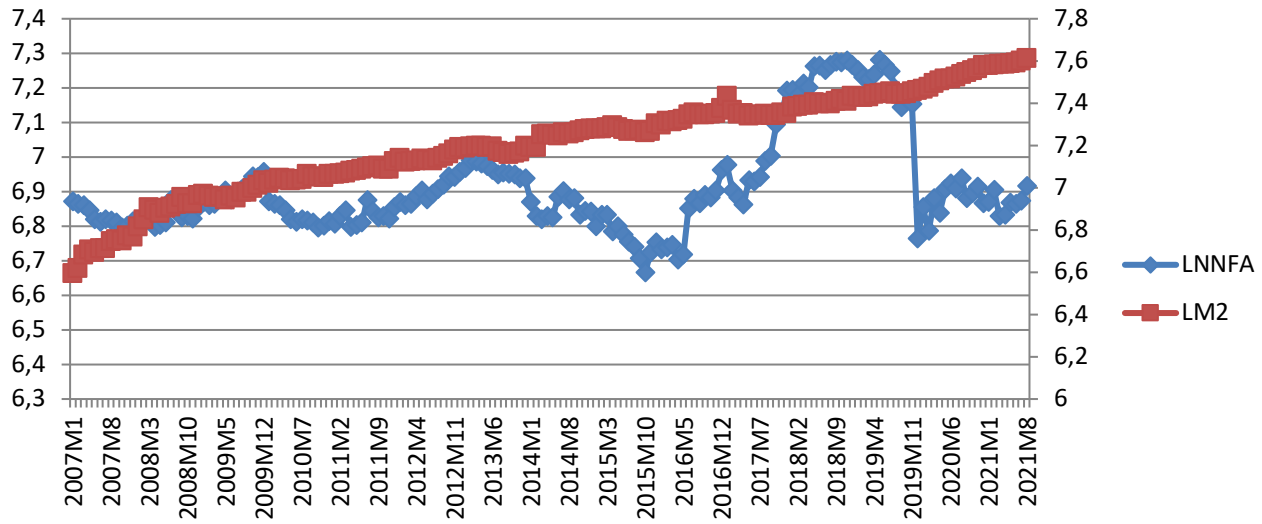
Note. FDII = foreign direct investment inflows, OILR = oil rent and PREMR = Personal remittances received. All the variables are measured as a percentage of GDP.

Source: https://data.worldbank.org/country/nigeria

It has been noted that rising capital inflows lead to rising growth of monetary aggregates and this phenomenon could result in rising prices. The trend of the net foreign assets and the M2 in figure 2 above indicates that, while money supply maintained a straight trajectory over the sample period, the NFA fluctuated. Money supply is exogenously determined by the monetary authority and as such, it can be influenced to move to a particular direction depending on the objective being pursued. However, capital inflows can be shaped by a combination of global and local factors. Even at these, evidence in figure 2 above indicates that when the trend of the NFA was low, money supply trended low, however, as the NFA began to trend high, money supply equally trended up. This shows that during period of rising capital inflows, money supply also rises.

Figure 2

Trend of Net Foreign Assets and Money Supply



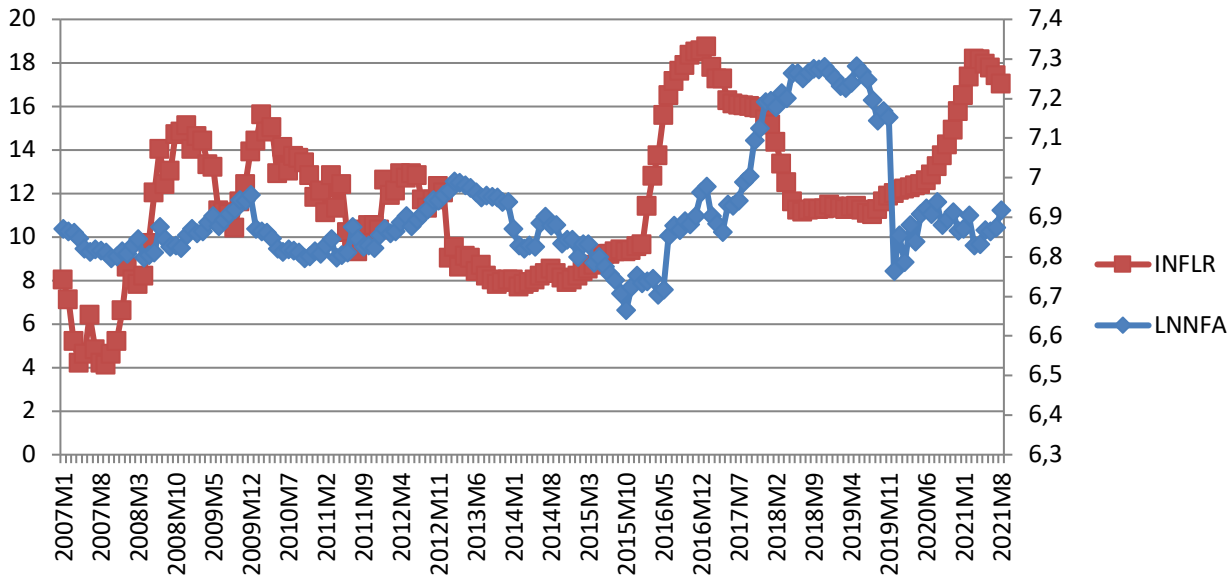
Note. LNFA = log of net foreign assets (a proxy for capital inflows), M2 = broad money supply (a proxy for money supply).

Source: https://www.cbn.gov.ng/rates/mnycredit.asp

The link between inflation rate and capital inflows is that rising capital inflows causes inflation to rise as money supply rises. This relationship is established in figure 3 as there is almost a co-movement of both the NFA and inflation rate within the sample period. It is noticed that when the NFA rose, inflation rate also rose with it and when the former declined, the later declined with it. A typical example is the event in 2015 when capital inflows began to build up, inflation rate moved in tandem with it, however as the NFA got to a peak in 2018, inflation rate declined owing possibly to the intervention by the monetary authorities. The trend in these two variables therefore confirms the postulation that rising capital inflows have the potency to cause inflation in the recipient country.

Figure 3

Trend of Inflation Rate and Net Foreign Assets



Note. INFLR = inflation rate.

Source: https://www.cbn.gov.ng/rates/mnycredit.asp

Research Problem

Any country faced with volatile capital inflows should be ready to defend the domestic economy from such situation. These could be in the form of domestic currency appreciation which is inimical to the achievement of balance of payments equilibrium, rising inflation and the tendency for abrupt capital reversal. For a country like Nigeria whose main monetary policy objective is to achieve price stability, implementing policies to insulate the domestic economy from the destabilizing effect of capital inflows is necessary. However, the dynamic nature of the link between monetary policy variables and capital inflows should be an issue that requires attention. As an illustration, an increase in foreign investment causes an influx of capital, resulting in an uptick in the money supply and higher prices. Consequently, domestic interest rates decrease, contributing to the appreciation of the domestic currency. On the other hand, rising domestic interest could as well raise capital inflows. If the monetary authorities raise the MPR to reduce the negative impact of capital inflows, such measures may lead to an upward pressure on other domestic rates. As a consequence, more capital inflows are attracted to the economy as international investors seek to take advantage of the rising domestic interest rate to channel more investment into the economy. The fall out of this is to encourage more capital inflows into the economy, thereby thwarting the objectives of the monetary authorities. In addition to this, for the implementation of the monetary policies to be effective, it is expected to influence capital inflows in a particular direction. This suggests that monetary policy authorities expect capital inflows to behave appropriately when the tools of monetary policy are deployed to regulate the economy. Related studies in this area either focused on monetary variables and their role in determining capital inflows (Alstadheim & Blandhol,

2018; Lipovina-Božović & Ivanović, 2018; Nwokoye & Oniore, 2017) or on the influence of capital inflows on domestic interest rate (Arimurti & Morley, 2020). In another vein, the focus of some studies is on examining the degree of sterilization of capital inflows (Jume, 2021; Nzeh et al., 2020). Equally, the impact of the implementation of monetary policy on capital inflows has been examined (Karahan & Bayır, 2022; Nguyen, 2023; Nwosa & Babawale, 2023). Thus, there is a literature gap on how monetary policy variables react to capital inflows and the possible feedback from capital inflows. If there is no comprehensive study designed to investigate this phenomenon and other issues arising from the implementation of policies to regulate capital inflows, effective monetary policy management could be hindered. Therefore, filling this existing literature gap is the aim of this study.

Research Focus

Given the above scenario, the major focus of the study was to investigate the response of the monetary policy variables to shocks in capital inflows in Nigeria. In order to accomplish this, the research utilized monthly data from 2007M1 to 2021M9 and conducted analyses using the impulse response and variance decomposition frameworks. The foreign interest rate data was sourced from the Federal Reserve Bank of St Louis, while all other variables were obtained from the Central Bank of Nigeria Statistical Bulletin. The study found that some variables lacked monthly data and as such were left out. However, their non-inclusion did not affect the achievement of the study's objectives.

Research Aim and Questions

Arising from problems stated, the broad objective of the study was to investigate the link between monetary policy variables and capital inflow in Nigeria. However, the study's specific objectives were:

1) To examine the response of monetary policy variables to shocks in capital inflows in Nigeria.
2) To examine if capital inflows also react to the implementation of monetary policy variables in Nigeria.

On grounds of the stated objectives, the study was guided by the following research questions:

1) How do the monetary policy variables respond capital inflows in Nigeria?
2) Do capital inflows also react to the implementation of monetary policy variables in Nigeria?

Research Hypotheses

Consequently, the following hypotheses guided the study:

1) Monetary policy variables do not respond to capital inflows in Nigeria.
2) Capital inflows do not respond to the implementation of monetary policy variables in Nigeria.

Literature Review

In literatures, the response of monetary authorities to shocks arising from capital inflows has occupied the attention of researchers in recent times. While some focused on finding the degree of sterilization, others investigated the impact of domestic policy actions on capital inflows. The use of monetary policy variables to regulate capital inflows could have led to unintended results that may

have further aggravated the macroeconomic environment. Thus, this present study adds to existing literature by evaluating the reaction of monetary policy variables to shocks arising from capital inflows and by also ascertaining the behaviour of capital inflows to the implementation of the monetary policies.

In Korea, Kim (2014) employed the structural vector autoregression (SVAR) to show that capital inflows into the bond market rise on account of contractionary monetary policy. Also using SVAR, Olani (2016) observed that policies on monetary and exchange rate influence portfolio inflows into emerging economies than foreign direct investment inflows. In Nigeria, Nwokoye and Oniore (2017) used the autoregressive distributed lag (ARDL) to reveal that money supply, interest rate spread and nominal exchange rate are major determinants of foreign capital inflows. However, Jume (2021), Nzeh et al. (2020), and Okpanachi (2013) focused on finding the degree of sterilization in Nigeria. Their findings showed a high degree of sterilization, thus indicating that the sterilization effort was successful in regulating capital inflows. The different degrees of sterilisation presented by each study were as a result of the different periods in which the studies were carried out. In another vein, Nzeh et al. (2021) investigated the impact of sterilization policy on domestic interest rate and found that sterilization policy mounted an upward pressure on interest rate only in the short run. In another study that employed the SVAR, Alstadheim and Blandhol (2018) revealed that domestic monetary policy influences capital flows in Norway. In Montenegro, Lipovina-Božović and Ivanović (2018) observed that domestic factors did not significantly influence capital flows.

Using an augmented Taylor rule model, Arimurti and Morley (2020) found that nominal interest rates are determined by both capital inflows and outflows. However, in a study comprising 83 countries, Frost et al. (2020) found that exchange rate policies retard capital inflows. In Pakistan, Khushik et al. (2021) found that the degrees of sterilization are relatively smaller than the degrees of capital mobility implying that it is difficult for Pakistan to sterilize the impact of foreign capital inflows on domestic money base. In a study in India, Rishad et al. (2022) revealed that the central bank of India was able to sterilize 93 percent of its interventions, while the degree of capital mobility was 72 percent during the period of study. Research conducted by Karahan and Bayır (2022) in emerging economies revealed that the adoption of expansionary monetary policies before and during the COVID-19 pandemic led to an increase in foreign direct investment (FDI) inflows in developing countries. Conversely, findings from a study in Southeast Asia by Nguyen (2023) showed that expansionary monetary policies had a negative impact on FDI inflows, whereas contractionary monetary policies were found to stimulate such inflows. Similarly, Nwosa and Babawale (2023) emphasized the significant influence of monetary policy in attracting capital inflows in Nigeria. In another paper for Nigeria, Ibrahim et al. (2023) revealed that volatility of remittances was determined by the exchange rate, both in the short run and the long-run. In New Zealand, Mansur (2023) revealed that a contractionary monetary policy shock impeded the volatility in capital flow.

From the papers reviewed so far, it is evident that the focus of past studies was either to examine the factors that determine capital inflows or to identify the effectiveness of the policy (through the examination of the degree of sterilisation) used in regulating capital inflows. To the best of the knowledge of the researchers, the response of monetary policy variables to shocks in capital

inflows and the possible feedback arising from the use of these variables to regulate capital inflows have not received empirical attention.

Research Methodology

The study followed a sequence of approaches that guided the achievement of the objectives of the paper. First, a test of unit root was conducted in order to ascertain the order of integration of the series. In doing this, the study used both the augmented Dickey Fuller (ADF) and the Phillip Perron tests. The results of the unit root tests showing that the series are integrated of order one, ie I (1) indicated that the Johansen co-integration test is more appropriate. Since the Johansen co-integration test indicated that the series are not cointegrated, the study estimated an unrestricted VAR. From the unrestricted VAR, the study estimated the impulse response function, the variance decomposition.

The VAR Model

The VAR model was used in the study to capture the dynamic relationship among the monetary policy tools and capital inflows. The VAR model is suitable for the study because it allows all the variables of the model to be treated as endogenous, such that whatever effect the variables have on one another can be addressed. As observed by Lu (2012), the VAR model takes into cognizance, the joint effects of different variables, by overlooking the issue of multi collinearity problems inherent in cross-sectional data. In this study, a seven-variable VAR model consisting of monetary policy variables, capital inflow variable and an exogenous variable was estimated. The monetary policy variables employed are monetary policy rate (MPR), cash reserve requirement (CRR) and money supply that serves as an intermediate target. The proxy for capital inflows is the net foreign assets (NFA), while the exogenous variable is the US federal fund rate which is an indicator for foreign interest rate. Inflation rate and exchange rate are included as explanatory variables given the link; they have with capital inflows. To ensure that the VAR model is used appropriately, the study carried out lag order selection tests in order to ascertain the optimal lag length. The choice of optimal lag length was further verified by conducting a lag exclusion test. Since the VAR stability is paramount in ensuring the reliability of the VAR results, the inverse roots of the autoregressive characteristic polynomial were used to determine the stability of the VAR.

The VAR model can be expressed as follows:

$$x_t = \alpha + \sum_{i-1}^{k} A x_{t-1} + \mu_t, \tag{1}$$

where

x_t = *(7x1)* vector of endogenous variables, α = *(7x1)* vector of intercept terms, A_t = fixed coefficient matrix, μ_t = 7-dimensional white noise, k = lag order.

Following equation 1 and with respect to the variables of interest in the study, the structural unrestricted VAR model that guided the study is specified in a matrix form as follows:

$$\begin{bmatrix} LNFA_t \\ CRR_t \\ EXCHR_t \\ MPR_t \\ M2_t \\ INFLR_t \\ FORINT_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \\ \alpha_7 \end{bmatrix} + \begin{bmatrix} A_{1,1} & A_{1,2} & A_{1,3} & A_{1,4} & A_{1,5} & A_{1,6} & A_{1,7} \\ A_{2,1} & A_{2,2} & A_{2,3} & A_{2,4} & A_{2,5} & A_{2,6} & A_{2,7} \\ A_{3,1} & A_{3,2} & A_{3,3} & A_{3,4} & A_{3,5} & A_{3,6} & 3,7 \\ A_{4,1} & A_{4,2} & A_{4,3} & A_{4,4} & A_{4,5} & A_{4,6} & A_{4,7} \\ A_{5,1} & A_{5,2} & A_{5,3} & A_{5,4} & A_{5,5} & A_{5,6} & A_{5,7} \\ A_{6,1} & A_{6,2} & A_{6,3} & A_{6,4} & A_{6,5} & A_{6,6} & A_{6,7} \\ A_{7,1} & A_{7,2} & A_{7,3} & A_{7,4} & A_{7,5} & A_{7,6} & A_{7,7} \end{bmatrix} \begin{bmatrix} LNFA_{t-1} \\ CRR_{t-1} \\ EXCHR_{t-1} \\ MPR_{t-1} \\ M2_{t-1} \\ INFLR_{t-1} \\ FORINT_{t-1} \end{bmatrix} + \begin{bmatrix} \mu^{LNFA_t} \\ \mu^{CRR_t} \\ \mu^{EXCHR_t} \\ \mu^{MPR_t} \\ \mu^{M2_t} \\ \mu^{INFLR_t} \\ \mu^{FORINT_t} \end{bmatrix}. \quad (2)$$

where

$LNFA_t$ = log net foreign assets (a proxy for capital inflows), CRR_t = cash reserve requirement, $EXCHR_t$ = exchange rate (measured in nominal term), MPR_t = monetary policy rate, $M2_t$ = broad money supply (proxy for money supply), $INFLR_t$ = inflation rate, $FORINT_t$ = foreign interest rate, a and A represent the fixed intercept terms and the regression coefficients, respectively while μ_t represents the error term.

Data and Sources/Justification

In this study, monthly data was utilised and the dataset covered a period from 2007M1 to 2021M9. All the data were obtained from the Central Bank of Nigeria Statistical Bulletin with the exception of foreign interest rate which was sourced from the Federal Bank of St Louis. The US federal funds rate was used as proxy for foreign interest rate following Kim and Roubini (2000). Net foreign assets (NFA) and money supply (M2) were measured in naira, while exchange rate was measured in nominal form and it is expressed as the rate of naira to the US Dollars. Monetary policy rate (MPR), cash reserve requirement (CRR), inflation rate and foreign interest rate were all in percentage.

Net foreign assets, as defined by the CBN in 2015, represent the central bank's total claims on non-residents minus its liabilities to non-residents. This figure is calculated by adding up the current and capital account balances, which closely corresponds to the change in international reserves. The justification for including in the study is because it serves as aggregate capital inflows and hence eliminates the need for the decomposition of the sources of capital inflows. The M2 is the broad money supply (M2) which is used in the study as a proxy for money supply and it is defined as currencies and coins in circulation in the hands of the non-banking public and the demand deposit with commercial banks plus time and savings deposit. The first impact of capital inflows is to increase money supply and the attention of the monetary authorities is to reduce it in periods of rising capital inflows. Monetary policy rate (MPR) is the benchmark official rate which influences other interest rates. The monetary authorities usually raise it in order to drain off the increased liquidity arising from increased capital inflows. The cash reserve requirement is the portion of cash which the monetary authorities demand to be kept in its vaults from the deposit money banks. In periods of rising capital inflows, it is usually raised to curtail banks' abilities to extend credit. Exchange rate is the rate at which a country's currency exchanges for another country's currency. Rising capital inflows leads to domestic currency appreciation and policies are often put in place to check this tendency such as

officially devaluing the domestic currency. Inflation is the persistent and general rise in the prices of goods and services. During the period of rising capital inflows, the rate of inflation is usually high owing to the increased money supply. The monetary authorities usually react through influencing some monetary policy variables to lower it. Foreign interest rate is the interest rate that is exogenous to the domestic economy and it is thought to influence other rates internationally. Usually, the U.S Federal Funds rate is used and that is the rate the study adopted. The justification for including it is to account for the exogenous shock that could influence the implementation of monetary policy. For instance, if foreign interest rate is high, such could push both domestic and foreign investors to invest in foreign assets. Thus, even if the monetary authorities increased domestic interest rate to regulate the economy during rising capital episode, such may not necessarily lead to additional inflows into the domestic economy.

Results

In order to avoid the problem of obtaining spurious results, the study employed both the augmented Dickey Fuller (ADF) and Philip-Peron (PP) to check the order of integration of the series. In Table 1, results indicate that only foreign interest rate achieved stationary (no unit root) at level under both ADF and PP. That is, foreign interest rate is integrated of order zero I (0) under both ADF and PP, while other series exhibited unit root.

Table 1

Results of Unit Root Tests at Level

Variables	ADF t-stat.	PP t-stat.	ADF Critical value at 5%	PP Critical value at 5%	Order of integration
LNNFA	-2.03	-2.05	-2.87	-2.87	Not stationary
CRR	-0.38	-0.85	-2.87	-2.87	-
EXCHR	1.10	1.06	-2.87	-2.87	-
MPR	-1.22	-1.43	-2.87	-2.87	-
M2	-2.18	-2.18	-2.87	-2.87	-
INFLR	-2.64	-2.18	-2.87	-2.87	-
FORINT	-3.43*	-3.23*	-2.87	-2.87	Stationarity

Note. Figures with asterisks (*) indicate the rejection of the null hypothesis of no stationarity at the 5% level.

Since almost all the series have unit root at level, the study went further to test for stationary of the series at first difference. In Table 2, the results indicate that after first differencing, all the series achieved stationarity. That is, after first differencing of the series, they became integrated of order one I (1). Thus, there is no remaining unit root in the series.

Table 2

Results of Stationarity at First Difference

Variables	ADF t-stat.	PP t-stat.	ADF Critical value at 5%	PP Critical value at 5%	Order of integration
ΔLNNFA	-14.84*	-14.77*	-2.87	0.00	I(1)
ΔCRR	-9.42*	-13.35*	-2.87	-2.87	I(1)
ΔEXCHR	-11.34*	-11.27*	-2.87	-2.87	I(1)
ΔMPR	-12.64*	-12.77*	-2.87	-2.87	I(1)
ΔM2	-4.09*	-3.66*	-2.87	-2.87	I(1)
ΔINFLR	-7.20*	-12.11*	-2.87	-2.87	I(1)
ΔFORINT	-6.84*	-6.73*	-2.87	-2.87	I(1)

Note. Figures with asterisks (*) indicate the rejection of the null hypothesis of no stationarity at the 5% level.

Having established the order of integration of the series, the study went ahead to test for the cointegrating relationship among the variables. This is achieved using the Johansen cointegration test. However, in order to obtain optimal results, there is need to carry out a test of optimal lag length in the VAR framework used for the estimation. In the unrestricted VAR model, lag 8 was chosen and from this, the optimal lag was selected. As shown in Table 3, the lag length test results indicated that both SIC and HQ selected lag 1, however, AIC selected lag 2.

Table 3

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4576.14	NA	1.14	59.13	59.27	59.19
1	-3060.70	2874.4	6.89	40.21	41.31*	40.66*
2	-2999.43	110.67	5.90*	40.05*	42.11	40.89
3	-2967.84	54.21	7.46	40.28	43.30	41.51
4	-2937.98	48.55	9.72	40.52	44.51	42.14
5	-2913.26	37.95	1.37	40.84	45.79	42.85
6	-2847.37	95.22	1.15	40.62	46.53	43.02
7	-2797.15	68.03	1.21	40.60	47.48	43.39
8	-2742.44	69.18*	1.22	40.53	48.36	43.71

Note. * indicates lag order selected by the criterion, LR = sequential modified LR test statistic (each test at 5% level), FPE = Final prediction error, AIC= Akaike information criterion, SC = Schwarz information criterion and HQ = Hannan-Quinn information criterion.

In order to settle for a suitable optimal lag length, the study conducted a VAR lag exclusion Wald test. The test is conducted under the condition that the p-value of the joint model variables is statistically significant at the 5% level. As shown in Table 4, the Wald test result indicates that the joint

p-value of the joint model variables is statistically significant at the 5% level. By implication, lag 1 as suggested by both the SIC and the HQ is chosen.

Table 4

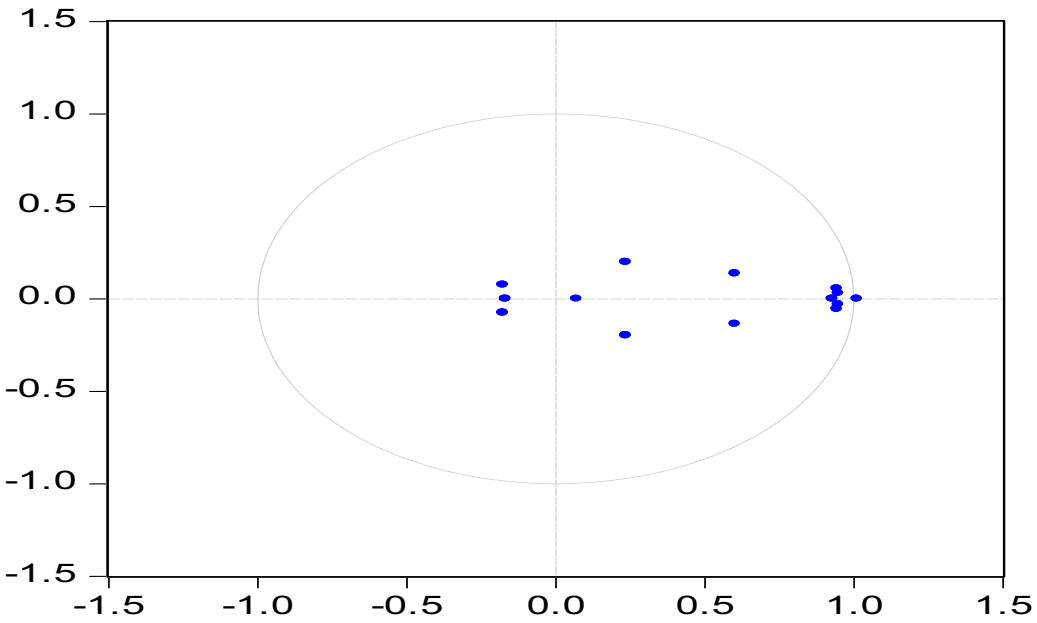
VAR Lag Exclusion Wald Tests

	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR	Joint
Lag 1	102.3 [0.00]	128.9 [0.00]	166.7 [0.00]	138.7 [0.00]	188.7 [0.00]	219.9 [0.00]	419.3 [0.00]	1360.6 [0.00]
Lag 2	8.18 [0.31]	11.8 [0.10]	3.24 [0.86]	7.15 [0.41]	14.05 [0.05]	32.13 [3.83]	53.43 [3.04]	136.6 [3.27]
Df	7	7	7	7	7	7	7	49

In order to ensure that the VAR model is stable which is essential for an optimal result; the study conducted a stability test using the inverse roots of the autoregressive characteristic polynomial. Under this test, the VAR model is stable if the roots of the autoregressive equation lie inside the unit circle. As indicated in figure 4, the roots of the equation are found inside the unit circle, indicating that the autoregressive (AR) process is stationary. Thus, the VAR stability is guaranteed.

Figure 4

Inverse Roots of the Autoregressive Characteristic Polynomial



After completing initial tests to confirm the stability of the VAR model, the study moved on to conduct a cointegration test among the series. In retrospect, the study employed the Johansen cointegration test in this regard. Results are evaluated by the outcome of both the Trace and Max-Eigenvalue. Tables 5 and 6 show that both the Trace and Max- Eigenvalue tests have p-values that are greater than 0.05%. This confirms that at the 5% level of significance, the series are not cointegrated. Thus, by implication the study can only investigate the short-run relationship among

the variables by estimating an unrestricted VAR model to obtain the impulse response function and the variance decomposition.

Table 5

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05Critical Value	Prob.**
None	0.17	109.14	125.6	0.32
At most 1	0.16	77.43	95.75	0.45
At most 2	0.11	48.53	69.81	0.69
At most 3	0.08	29.58	47.85	0.73
At most 4	0.06	16.003	29.79	0.71
At most 5	0.03	6.03	15.49	0.69
At most 6	0.009	1.63	3.84	0.20

Note. Trace test indicates no cointegration at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level.

Table 6

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.17	31.70	46.23	0.67
At most 1	0.16	28.89	40.07	0.49
At most 2	0.10	18.95	33.87	0.82
At most 3	0.07	13.58	27.58	0.85
At most 4	0.05	9.96	21.13	0.74
At most 5	0.02	4.40	14.26	0.81
At most 6	0.009	1.63	3.84	0.20

Note. Max-eigenvalue test indicates no cointegration at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level.

Discussion

This paper examined whether monetary policy variables in Nigeria responded appropriately to capital inflows and tests the potential for capital inflows to react inversely to monetary policy variables. The paper was constrained by the absence of monthly data on key indicators of capital inflows such as FDI inflows, remittances, external debt, and FPI inflows in Nigeria. As a result, NFA is utilised as a proxy for capital inflows, a method commonly used in various studies. Previous research has focused on either the drivers of capital inflows or the efficacy of policies aimed at managing them. However, there has been limited empirical investigation into how monetary authorities actually

respond to capital inflows through adjustments in monetary policy variables, and the potential for capital inflows to respond to these policy changes. The researchers argue that the lack of empirical research in this area could result in one-sided policy decisions with unintended consequences. This study aims to generate interest in future research on policies to regulate capital inflows.

For the first stated hypothesis, the results of the impulse response in appendix 1 show that the M2 responded positively to shocks in the NFA in all the quarters and this is in line with apriori expectation. Rising capital inflows lead to growth in monetary aggregate and this is the major reasons for intervention by the monetary authorities. The study also found inflation rate to respond positively to shocks in the NFA in the first quarter, but thereafter, the response became negative. It is the contention of the study that the positive response of inflation in first quarter is due to the increase in liquidity occasioned by capital inflows. However, the policy response adopted to curtail the inflationary impact of the capital inflows was responsible for the negative response after the first quarter. Maintaining price stability is the major target of the Central Bank of Nigeria, so from time to time the Bank intervenes to regulate the liquidity arising from capital inflows. In another vein, it was found that the CRR only responded positively to shocks in the NFA in the first quarter which indicates the behaviour of this variable when a policy measure is adopted to reduce the monetary impact of capital inflows. The CBN usually raise the CRR in periods of increased liquidity in order to discourage such liquidity build-up from causing inflation. Thus, the positive response of this variable is in line with apriori expectation. However, the subsequent negative response may be owing to the relaxation of the policy after the capital inflow episode. This is because policies aimed at regulating capital inflows are designed to work in the short-run. The MPR also exhibited a positive response due to shocks in NFA. The positive response of the MPR to shocks in the NFA is in line with the outcome of the interventions of the monetary authorities as the variable is normally raised during period of rising capital inflows to drain off liquidity arising from such. In another vein, the response of exchange rate to shocks in the NFA was positive in all the quarters, confirming the view that capital inflows lead to appreciating exchange rate. These results find corroboration in the findings of previous studies in Nigeria such as Nzeh et al. (2020) and Jume (2021). The attention of these past studies was to examine the degree of sterilization of capital inflows which informs whether the policy is effective in regulating capital inflows. The expectation is that a high degree of sterilization is an indication of the effectiveness of the policy in regulating capital inflows. The study by Nzeh et al. (2020) revealed that about 74% of capital was sterilized within the period, while Jume (2021) indicated that about 95% was sterilised. This present study thus corroborates the outcome of the past studies as evidence have shown that the monetary policy variables behaved appropriately when there is a shock to capital inflows.

The second hypothesis showed varying responses when it came to the relationship between the NFA and the MPR. The study found that the NFA reacted positively to the MPR in the first quarter, negatively in the second quarter, and then positively in all subsequent quarters. The negative reaction of the NFA to MPR shocks in the second and third quarters may be attributed to the increase in domestic money supply resulting from capital inflows, leading to a decrease in interest rates. However, as results indicate, the NFA responded positively to shocks in the MPR after the third

quarter. This outcome confirms the point raised earlier that by increasing the MPR as a way to reduce the negative impact of capital inflows, such measure may eventually lead to an upward pressure on other domestic interest rates which results in attracting more capital inflows. This result finds support in the work of Nzeh et al. (2021) which found that in the long-run, the implementation of sterilization policy in Nigeria led to an increase in domestic interest rate. Thus, rising domestic interest rate implies that more capital will be attracted as investors channel more investment into the domestic economy to benefit from the rising interest rate.

In Appendix 2 below, the results of the variance decomposition show that other than shocks to itself which was 95.6% in the first period, shocks to the NFA explained about 4.4% of shocks to the M2 which rose to 7.5% in the second quarter and thereafter fluctuated until it declined to 3.9%. Apart from shocks to itself which was 98.8% in the first quarter, shocks arising from the NFA explained about 0.64% of shocks to the CRR in the first quarter which rose to 1.68% in the second quarter and thereafter fluctuated. Findings equally indicated that shocks to the MPR arising from shocks to the NFA rose continuously from the first quarter to the last quarter, while shocks to the exchange rate on account of shocks to the NFA fluctuated in all the quarters.

Conclusions and Implications

Assessing the impact of regulatory policies on capital inflows on the effectiveness of monetary policy tools is crucial and requires careful consideration. Unexpected consequences of these regulations could potentially exacerbate the issues they were meant to resolve. This present study used monthly series to examine the responses of monetary policy variables to shocks in capital inflows in Nigeria. The findings of the study were as follows:

- The impulse response function and the variance decomposition results confirmed that monetary policy variables actually responded to shocks in capital inflows within the study period.
- The study found that while money supply responded positively to shocks in capital inflows, the response of both the cash reserve requirement and the MPR was positive within the study period.
- Results indicated that capital inflows responded positively to the MPR in the first quarter, negatively up to the second quarter and thereafter it responded positively in all the other quarters.

The implication of these findings is that monetary authorities adjust these policy tools upwardly in periods of rising capital inflows to curtail the impact of the rising money supply on the economy. It is interesting to note that capital inflows responded positively to shocks in MPR after the third quarter. This development has implication for monetary policy setting in Nigeria. The result suggests that increasing the MPR to mitigate the effects of capital inflows can inadvertently raise domestic interest rates, potentially attracting even more inflows. This could create a cycle where the CBN needs to repeatedly hike the MPR, leading to ongoing interventions with negative consequences for the economy. The study therefore recommends that a balance should be struck among the monetary policy measures used in reducing the monetary impact of rising capital inflows in order to avoid unintended consequences. Those monetary policy measures which do not overheat the macroeconomic environment when used to regulate capital inflows should be given adequate attention.

Suggestions for Future Research

The study recommends that future research should focus on evaluating the costs associated with using different monetary policy measures to control capital inflows. This is important because each measure is expected to have its own impact on the economy. For example, if the cash reserve requirement is increased to regulate capital inflows, it could decrease liquidity in the banking system and affect the role of deposit money banks. Similarly, raising the benchmark interest rate could attract more portfolio investments, potentially worsening the situation and hindering domestic investment.

Future studies should also consider the role of fiscal policy in regulating capital inflows. It has been observed in Nigeria and other developing countries that monetary and fiscal authorities sometimes have conflicting objectives. While monetary authorities may aim to reduce money supply to control capital inflows, fiscal authorities may pursue expansionary policies that could undermine these efforts.

The study also suggests that future research should examine the impact of foreign exchange speculation on capital inflows regulation. Currency speculation, particularly in Nigeria where the domestic currency (naira) is highly volatile, has been identified as a barrier to effective monetary policy implementation. Hoarding foreign currencies such as the US dollar in anticipation of appreciation has been cited as one of the factors hindering the effectiveness of monetary policy in the country.

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Conflict of Interest

None.

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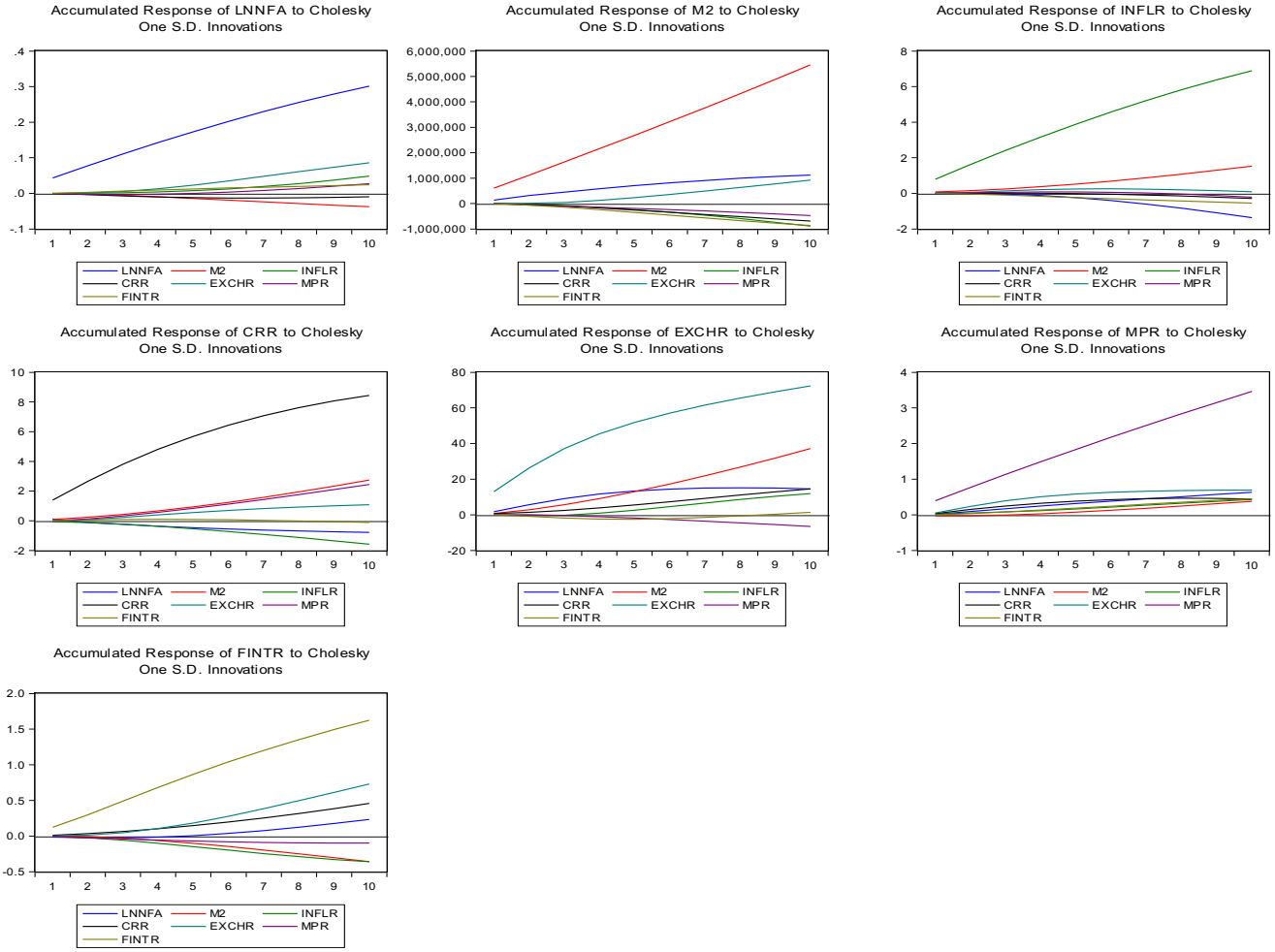
Appendix 1

Impulse Response Results



Appendix2:Variance Decomposition Results

Variance Decomposition of LNNFA

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	0.04	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.05	98.77	0.10	0.005	0.45	0.05	0.28	0.32
3	0.06	97.90	0.33	0.04	0.64	0.37	0.21	0.49
4	0.07	96.48	0.59	0.13	0.63	1.37	0.18	0.58
5	0.08	94.62	0.83	0.31	0.58	2.79	0.23	0.61
6	0.08	92.54	1.03	0.60	0.51	4.31	0.37	0.61
7	0.09	90.39	1.19	1.04	0.45	5.72	0.58	0.60
8	0.09	88.26	1.31	1.65	0.41	6.91	0.85	0.59
9	0.10	86.14	1.39	2.43	0.38	7.87	1.17	0.58
10	0.10	84.03	1.44	3.37	0.38	8.62	1.53	0.59

Variance Decomposition of M2

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	620831.2	4.40	95.59	0.00	0.00	0.00	0.00	0.00
2	828858.3	7.57	91.12	0.11	0.12	0.008	0.49	0.55
3	996249.5	6.99	90.34	0.33	0.55	0.13	0.56	1.06
4	1144341.	6.65	89.17	0.62	0.84	0.56	0.57	1.55
5	1281438.	6.18	88.08	0.98	1.08	1.16	0.57	1.92
6	1410432.	5.71	87.14	1.35	1.26	1.75	0.58	2.18
7	1532840.	5.23	86.40	1.74	1.40	2.26	0.60	2.34
8	1649860.	4.77	85.84	2.13	1.49	2.68	0.63	2.42
9	1762575.	4.35	85.41	2.53	1.55	3.01	0.67	2.44
10	18719.	3.95	85.06	2.94	1.59	3.28	0.73	2.41

Variance Decomposition of INFLR

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	0.80	0.13	1.02	98.85	0.00	0.00	0.00	0.00
2	1.15	0.08	0.85	98.58	0.006	0.29	0.07	0.11
3	1.40	0.16	1.07	97.85	0.005	0.55	0.10	0.24
4	1.60	0.40	1.43	97.11	0.007	0.59	0.08	0.37
5	1.77	0.83	1.87	96.23	0.02	0.52	0.07	0.45
6	1.91	1.44	2.37	95.09	0.05	0.45	0.07	0.52
7	2.04	2.22	2.93	93.71	0.08	0.40	0.09	0.55
8	2.15	3.13	3.52	92.07	0.14	0.38	0.16	0.57
9	2.25	4.14	4.16	90.22	0.20	0.41	0.27	0.59

10	2.35	5.22	4.82	88.12	0.28	0.44	0.43	0.60

Variance Decomposition of CRR

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	1.39	0.63	0.36	0.16	98.83	0.00	0.00	0.00
2	1.91	1.68	0.83	0.22	96.65	0.14	0.39	0.06
3	2.26	1.57	1.29	0.38	95.06	0.52	1.08	0.07
4	2.51	1.51	1.91	0.63	93.21	0.89	1.78	0.06
5	2.69	1.44	2.66	0.92	91.22	1.13	2.55	0.05
6	2.84	1.39	3.56	1.24	89.10	1.27	3.36	0.05
7	2.96	1.35	4.58	1.58	86.84	1.34	4.23	0.06
8	3.05	1.30	5.72	1.95	84.45	1.37	5.10	0.07
9	3.14	1.26	6.96	2.34	81.97	1.38	5.97	0.09
10	3.22	1.21	8.28	2.76	79.42	1.36	6.82	0.12

Variance Decomposition of EXCHR

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	13.14	1.74	0.40	0.007	0.25	97.58	0.00	0.00
2	19.26	4.88	1.26	0.08	0.27	93.27	0.00	0.22
3	22.59	5.87	2.51	0.06	0.40	90.75	0.04	0.33
4	24.51	6.08	4.11	0.25	0.65	88.44	0.11	0.33
5	25.83	5.93	5.99	0.65	1.01	85.90	0.18	0.30
6	26.87	5.64	8.06	1.15	1.40	83.15	0.27	0.30
7	27.79	5.31	10.26	1.62	1.78	80.31	0.35	0.33
8	28.63	5.007	12.54	2.00	2.10	77.49	0.44	0.40
9	29.44	4.73	14.85	2.26	2.35	74.75	0.53	0.49
10	30.23	4.51	17.19	2.40	2.53	72.12	0.62	0.59

Variance Decomposition of MPR

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	0.40	0.17	0.63	0.31	0.76	1.64	96.46	0.00
2	0.59	1.72	0.29	0.42	4.21	10.29	82.67	0.36
3	0.73	2.29	0.29	0.41	4.46	11.62	80.28	0.62
4	0.83	2.64	0.41	0.51	4.30	10.85	80.41	0.85
5	0.91	2.79	0.58	0.68	3.99	9.67	81.18	1.07
6	0.98	2.85	0.78	0.87	3.63	8.58	81.99	1.26
7	1.04	2.89	0.99	1.04	3.28	7.68	82.69	1.40
8	1.10	2.92	1.20	1.19	2.96	6.94	83.25	1.50

9	1.15	2.95	1.41	1.31	2.71	6.35	83.68	1.56
10	1.19	2.99	1.61	1.40	2.52	5.87	83.99	1.59

Variance Decomposition of FINTR

Period	S.E.	LNNFA	M2	INFLR	CRR	EXCHR	MPR	FINTR
1	0.12	1.36	0.08	0.13	0.74	0.02	0.51	97.15
2	0.21	0.57	0.29	0.92	1.36	0.32	0.62	95.90
3	0.29	0.31	0.71	1.73	1.78	1.41	0.63	93.38
4	0.36	0.27	1.24	2.49	2.24	3.38	0.60	89.73
5	0.42	0.44	1.79	3.11	2.74	5.93	0.56	85.40
6	0.47	0.78	2.32	3.53	3.30	8.65	0.50	80.88
7	0.52	1.24	2.82	3.76	3.91	11.25	0.44	76.55
8	0.56	1.75	3.26	3.83	4.57	13.58	0.39	72.58
9	0.60	2.29	3.66	3.76	5.27	15.59	0.34	69.06
10	0.63	2.82	4.01	3.61	6.00	17.27	0.31	65.95