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Assessment of interest rate channel Effectiveness in the transmission of Monetary Policy in Nigeria

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Abstract

This study attempted to investigate the effectiveness of the interest rate channel in the transmission of monetary policy by employing a structural vector autoregressive (SVAR) model using sign restriction. It used a set of policy and non-policy macroeconomic variables based on monthly data spanning the period 2007 and 2020. The structural impulse response functions provided evidence to support the use of the MPR as a signaling rate for domestic interest rates but was, however, found to be ineffective in stabilizing prices or increasing output. Furthermore, results from the variance decomposition of the non-policy variables found the effect of exchange rate innovations to be more significant in explaining variations in the price level. The study, therefore, concludes that the effectiveness of the policy rate in stabilizing prices is dampened by shocks prevalent from the external sector. Given the importance of international trade, the study recommends aggressive exchange rate management including policies that encourage import-substitution to build reserves and strengthen the value of the domestic currency.

Keywords: *monetary policy, Interest rate channel, Nigeria, structural vector autoregressive (SVAR)*

JEL Classification: E43

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1. Introduction

For most economies, monetary policy continues to help determine the path of growth in real output and prices. This has traditionally been achieved using various policy tools available to the monetary authority to influence relevant macroeconomic variables. [Boivin et al \(2010\)](#) suggest that for a proper assessment of central bank policies, an insight of the mechanism through which monetary policy

innovations impact output and prices is especially indispensable. The literature is replete with studies which reveal that the monetary policy transmission works through various channels to affect different institutions, markets and sectors at different intensities and speeds. These channels include the interest rate channel, the exchange rate channel, the bank credit channel and the assets price channel

(Cecchetti, 1999; Ganev et al., 2002; Kujis, 2002; Elbourne et al., 2003; Juks, 2004; Nwosa and Saibu, 2012; Ishioro, 2013; Ndekwu, 2013; Hassan, 2015).

The most effective channel is, however, not clear and continues to be a subject of debate.¹

In Nigeria, the uncertain nature of the transmission mechanism continues to be a perennial problem for effective monetary policy implementation. The lackluster performance of the economy in recent years, despite the use of different monetary policy tools and strategies adopted by the Central Bank (CB), suggest amongst other factors, an inadequate perception of the most effective conduit through which monetary actions transmit to the real economy. Consequently, various studies on Nigeria have found evidence of one or more channels of monetary policy transmission, although to varying degrees and intensities. For instance, Nwosa and Saibu (2012) find strong evidence to support the interest rate and exchange rate channels as the dominant channels for monetary policy transmission while Ogbulu & Torbira (2012) opine that the bank assets channel plays a significant role in the transmission of monetary policy decisions. Similarly, Bernhard (2013) concludes that only the interest rate, exchange rate and the credit channels are functional. Ekong and Ukoha (2018) also find evidence supporting the money supply, interest rate and exchange rate channels as positive channels of transmission but find no evidence to support the credit channel.

Indeed, for a monetary targeting central bank such as the Central Bank of Nigeria (CBN) which targets the growth of the monetary aggregates, evaluating the efficacy of the interest channel is especially imperative. This is because changes in the short term central bank policy rate are expected to impact output and prices through their effects on macroeconomic variables such as the exchange rate, real cost of capital, bank credit, as well as other monetary aggregates (Mukherjee and Bhattacharya, 2011; Taylor, 1995).

The Monetary Policy Rate (MPR), which replaced the Minimum Rediscount Rate (MRR) in 2006 serves as the anchor rate in Nigeria from which other market interest rates are expected to be derived. Several studies found that over

time, however, market interest rates seem to have become less responsive to changes in the policy rate as witnessed in the volatility in short-term interbank lending rates, particularly, the overnight Call and Open Buy Back rates (see Adekunle, et'al (2018); adofu & Salami (2017); Adeoye & Shobande 2017; and Boivin, Kiley & Mishkin (2010)). Furthermore, there seems to be an asymmetric response by banks to changes in the policy rate. Market lending rates tend to increase with upward revisions of the anchor rate but remain sticky when the policy rate falls (see Ekong & Ukoha (2018); Chileshe & Akanbi (2017); and Butkiewicz & Ozdogan (2013)). We also note with concern that although the policy rate features in banks' determination of their lending rates, other considerations, including the exchange rate, overhead costs, risk factors, and cost of fund, among others, appear to be more prominent and substantive, thereby reducing the relative importance of the policy rate and its corridor. This notwithstanding, low and stable inflation continues to be the primary objective of the CBN, but continued deviations from the expected growth of monetary aggregates, coupled with the expansionary policies of the fiscal authorities continue to diminish the effectiveness of monetary policy to adequately control inflation and boost output. This has consequently called into question, the efficacy of monetary policy implementation in Nigeria, particularly whether the interest rate channel is effective in the Banks's effort to create a stable price environment conducive for real output growth².

The implication of the continuous expansion of informal sector in Nigeria cannot be left out in addressing the efficacy and/or efficiency of the interest rate channel in the monetary policy transmission mechanism, in fact, some studies found that informal economy significantly weakens the effectiveness of the interest rate channel in achieving consistent monetary policy framework with the ultimate goal of attaining stable price level conducive for growth (Idowu et'al 2020; Adekunle et'al 2018; and Adeoye & Shobande (2017)).

Idowu et'al (2020) further found that informality dulls the effectiveness of monetary policy in Nigeria through the interest rate channel by at least 72 percentage points. This, therefore, indicates a high presence of informality which

¹Conclusions on the most effective channel have varied from one economic clime to another and have, to a large extent, been informed by the structure and level of development of the economy being studied. This does not undermine the importance of credit channel in monetary policy transmission mechanism, in fact, some studies found strong evidence to support the credit channel, see Yaaba (2013), Tule et' al (2014) and Idowu et' al (2020).

² The peculiar nature of the Nigeria's economy has posed so many challenges to the effectiveness of interest channel, this however, alluded to the fact that other channels could be incorporated to complement the interest rate channel in ensuring efficacy and effectiveness of monetary policy in Nigeria.

continue to threaten the efficiency of interest rate channel in achieving price stability mandate of the Central Bank of Nigeria (CBN). The size of the informal sector in Nigeria is estimated at about 65 per cent and consists of activities that range from agricultural production to mining and quarrying, small-scale building and construction and machine-shop manufacturing, which are mostly not captured fully and appropriately in the annual GDP records (Ademola, Adegoke, and Adekunle, 2019). The formal financial system provides services to about 35 per cent of the economically active population, while the remaining 65 per cent are excluded from access to formal financial services due to the issue of informality especially in less developed communities (Foluso, 2020). Informal sector is considered to be one of the key economic indicators in Nigeria and unless is reduced to the barest minimum, interest channel would continue to face serious drawback.

In view of the foregoing, this study seeks to first investigate the behavior of domestic interest rates in relation to CB policy rate decisions as well as changes in other macroeconomic aggregates (inflation and output) to ascertain if monetary policy in Nigeria follows the neutrality proposition. In this regard, we will attempt to shed more light on the interest rate pass-through in Nigeria and how quickly this occurs given the implicit assumption that the monetary authority can determine short-term interest rates to influence long term market prices and output. A secondary objective of the study will be to include the influence of the external sector, paying particular attention to variations in the exchange rate, to help explain movements in output and prices. The fact that Nigeria is connected to the global community through trade and investment suggests that the domestic exchange rate would play a significant role in shaping developments in the domestic economy. The findings of the study through innovations in the SVAR methodology would contribute to the body of literature on the subject matter for Nigeria as well as provide the monetary authorities with a clearer picture on the efficacy of the policy rate in monetary policy transmission.

The rest of the paper is organized as follows: following the introduction, section two presents the literature review including theoretical framework and while section three describes the research method. Section four presents the analysis and interpretation of results while section five concludes the paper.

2. Theoretical Framework and Empirical Literature Review

2.1 Theoretical Framework

For central banks espousing price-stability oriented monetary policy, the policy rate remains the primary tool for influencing economic decisions. It is therefore, no surprise that most economists recognize the traditional interest rate channel as the most effective channel for monetary policy transmission (Taylor, 1995, Loayza and Schmidt-Hebber, 2002, Adekunle et al., 2018). Recent developments and evolving economic theory however continue to shine light on the exact mechanism through which the interest rate channel works, prompting a reevaluation of earlier tenets (Butkiewicz and Ozdogan, 2013). As such contemporary views now hold that monetary policy transmission is a combination of one or more channels albeit with different intensities.

The underpinnings of the interest rate channel are derived from the traditional Keynesian IS-LM model developed by Hicks in 1937. Here, the quantum of money in the economy is inversely related to the real interest rate and monetary policy is generally believed to have a significant impact on financing conditions prevalent in the economy. Policy-induced changes in short-term nominal interest rates or the nominal quantum stock, impact real variables such as employment, prices or aggregate output (Ndubisi, 2015). This is irrespective of whether policy decisions are restricted to open market operations (OMO) or discount window activities (Ireland, 2005). For example, through accommodative monetary policy, downward adjustments in the cost of borrowing increase both consumption and investment spending thereby generating employment and boosting output. Mishkin (1996) provides the following schematic to help explain the relationship:

$$M \uparrow \rightarrow ir \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

Where M = Money Supply, ir = Real interest rate, I = Investment Spending and Y = Output.

In addition to the traditional path of the interest channel earlier identified, policy decisions by central banks also affect the economy through the forward exchange rate (Turguttopbas, 2017). Under the stewardship of the monetary authority, the exchange rate serves as an important intermediate policy variable capable of influencing the economy through its impact on the value of the domestic currency, the external sector, capital flows, domestic inflation via the pass-through effect as well as macroeconomic credibility and financial stability. Thus, movements in the exchange rate affect aggregate demand,

particularly, firm and household expenditure where consumption and investment activities are largely import oriented. The effect is further amplified if significant levels of domestic wealth are held in foreign currencies or assets. Consequently, the adoption of higher domestic interest rates to moderate inflationary pressures, relative to interest rates on equivalent foreign-currency assets, has the additional benefit of attracting foreign investors seeking higher returns which can boost aggregate demand. This, however, comes with expensive interest payments if the inflows are not effectively utilized. The monetary authority thus has the ability to indirectly affect the exchange rate through domestic interest rate policies which invariably affects the relative prices of domestic goods and services given the import-dependent nature of the economy. The management of the domestic exchange rate is thus of great importance to the monetary authority and given significant attention by central banks globally.

2.2 Empirical Literature Review

Studies on the effects of monetary policy are extensive and go back decades but empirical studies focusing on the channels of monetary policy transmission only started emerging in the 1990s. Most of these studies focused on industrialized nations³ and emerging and developing economies⁴. Studies on Sub-Saharan Africa are more limited. Authors have nonetheless been in disaccord on the ways the various channels of monetary policy work, even in industrialized nations, where the topic has been subjected to decades of theoretical and empirical research. The process is still more uncertain in developing and low-income countries. Even so, the traditional interest rate channel has been the most relevant in the literature. With reference to the African continent, several authors have investigated the strength of the interest rate channel in propagating monetary policy decisions to the real economy. For example, **Kovanen (2011)** applying an unrestricted VAR model and using a combination of secondary data on short term wholesale rates and the policy rate as well as specific data on retail deposit and lending rates for the 20 largest banks in Ghana, found that while the interbank rate responds to changes in the policy rate with a lag of one month, the response was asymmetric with only about half of the policy rate change reflecting in the interbank rate. He also discovered that in the long run, the speed of adjustment of retail rates to interbank rate changes was slow and

incomplete, ascribing this to the high level of macroeconomic uncertainty and high non-performing loans (NPL) in the banking system. Similarly, **Matemilola et al., (2014)** investigated the pass-through of policy rate decisions by the South African Reserve Bank to bank lending rates as a measure of the effectiveness of monetary policy to control inflation or stabilize the economy. The authors used the monthly money market rate and the South African bank lending rate from January 1978 to December 2012 and adopted both momentum threshold autoregressive and asymmetric error correction models in their analysis. Their results reveal that bank lending rates adjust to a decrease in money market rates suggesting that commercial banks adjust their lending rates downward during periods of monetary expansion but the lending rate appears rigid upward during periods of contraction or tightening, which supports the customer reaction hypothesis. In the examination of the relative importance of the different channels of the monetary policy transmission mechanism in Zambia, **Chileshe and Akanbi (2017)** used different variants of the VAR methodology and employed monthly data of CPI, the all share index, interpolated GDP and the Federal Funds Rate for the period January 1993 to June 2015. Their results indicated that although the interest rate channel was present and working, it was, however, weak and that the exchange rate and credit channels were the effective channels of monetary policy transmission in the economy.

On Nigeria, the subject has received extensive attention. In their study, **Nwosa and Saibu (2012)**, attempted to investigate the channels of monetary policy transmission across the different sectors of the Nigerian economy using the unrestricted VAR model and quarterly data spanning from January 1986 to April 2009. Their model employed five endogenous variables comprising of the interest rate, exchange rate, credit to private sector, asset price and the consumer price index as well as one exogenous variable, sectoral output. Their findings revealed evidence of the simultaneous operation of multiple channels of transmission. The interest rate and exchange rate channels were the most pronounced channels affecting the most important sectors. The agricultural, manufacturing, building and construction sectors were perceived to be affected by the interest rate channel while the exchange rate channel accounted for monetary policy impulses to the mining,

³ Bernanke and Blinder, 1992; Berkelmans, 2005; Bjorland and Havolsen, 2010; D'Amico and Farka, 2011; Phan, 2013; Janssen et al., 2015; and Endut et al., 2017

⁴ Mukherjee and Bhattacharya, 2011; Bhattacharya et al., 2011; Tahir, 2012; Mohanty, 2012

services and wholesale and retail sectors. **Ishioro (2013)** using the Granger causality test also studied the channels of the monetary policy transmission mechanism in Nigeria. The author sought to estimate the relationship between the various channels and selected macroeconomic aggregates. The study used annual time series data from 1970 to 2011 and included GDP per capita, an investment proxy, interest rate, exchange rate and private domestic credit extended by the banking system. The results indicated that the interest rate, exchange rate and credit channels were functional in the economy. Similarly, **Sanya (2014)** found evidence supporting the interest rate channel using an SVAR model which incorporated real GDP, CPI, money supply, short term interest rate and the exchange rate. The results indicated that an increase in the policy rate tends to be accompanied by a reduction in the general price level as well as an increase in the exchange rate but had little impact on the level of production attributing the low pass-through to weakness in the financial sector and low level of financial intermediation by commercial banks.

Specifically, **Kelikume (2014)** used secondary time series data with quarterly frequency from 1996Q1 to 2013Q3 to explore the interest rate channel and assess the extent of stickiness in interest rates. The study applied co-integration and error correction econometric analysis. The analysis used real GDP and real interest rates and the results indicated a long run inverse relationship between the policy rate and output. Similarly, in their study, **Onanuga and Onanuga (2014)** examine the interest rate channel across two periods, the Post-Structural Adjustment Programme Period (1986Q1-1999Q1) and the period of the civilian administration (1999Q2-2012Q4) by using a VAR analytical model. Data used included real aggregate output, the monetary policy rate, consumer price index and narrow money supply (M1). The authors find evidence of the interest channel in both periods but suggest that monetary policy was more effective during the civilian administration. **Adeoye and Shobande (2017)**, used the Vector Error Correction (VEC) technique to determine the effect of the interest rate channel of monetary policy transmission on the real economy. The model employed real GDP, broad money supply, expected inflation, real interest rates, investment and the exchange rate for the period 1985Q1 to 2015Q4. They found evidence showing that money supply, expected inflation, real interest rate and exchange rate are crucial for any meaningful economic growth, suggesting that the manipulation of the policy rate and exchange rate by the monetary authority is essential for

the effectiveness of monetary policy in Nigeria. **Osundina et al., (2018)** using a Bayesian VAR model with Minnesota/Litterman prior criterion examined the dynamic response of the real economy to interest rate shocks. The endogenous variables used include consumption, GDP, physical investment, nominal money supply, the price level and the interest rate while government spending was used as an exogenous variable. The impulse response functions revealed that with the exception of investment, all other variables used were consistent with economic theory while the forecast error variance decomposition provided confirmation of the theoretical relationship between the policy rate, inflation and market interest rates. They submit that the interest rate channel is effective in stabilizing the economy by controlling inflation although this invariably could be inimical to growth due to policy conflicts. **Foluso (2020)** utilized a structural VAR framework and a set of policy and non-policy macroeconomic variables based on monthly data spanning the period 2006 and 2019. The study used six domestic variables; real gross domestic product, inflation rate, the nominal exchange rate, monetary policy rate, prime lending rate, and monetary aggregate. The author found evidence to support the use of the MPR as a policy tool as it is effective in stabilizing price levels, increasing output marginally, and improving the nominal exchange rate conditions. The study, however, revealed the significant effect of the exchange rate which strongly influences domestic economic activity and distorts the efforts of the monetary authority. This paper follows the work of **Foluso (2020)** albeit with modifications in the SVAR specification and choice of variables employed.

3.0 Methodology

Methodology

3.1 The Structural VAR Model

In examining the efficacy of monetary policy transmission, the vector auto-regression (VAR) methodology, pioneered by **Sims (1980)** has been widely used across several countries. The fact that VARs consider the simultaneity between monetary policy instruments and relevant macroeconomic variables made them especially popular. Notwithstanding the recent improvements in the VAR methodology, this study employs the structural vector autoregressive (SVAR) model with sign restriction identification. SVAR models, unlike in the traditional VAR models, provide explicit behavioral interpretations for all the parameters. Furthermore, SVAR is a representation of a set of connected and observable time series variables that

assumes that all variables depend on some fixed proportion of their past values and other variables. SVAR models require additional identifying assumptions for meaningful interpretation. The assumptions must be grounded in economic theory, institutional knowledge or other extraneous constraints imposed. In addition, forecast errors must first be decomposed into mutually uncorrelated structural shocks that have economic interpretation before one can assess the causal effects of these shocks on the model's variables. This study will therefore conduct impulse response tests as well as forecast error variance decompositions to explain the relationship between the variables.

We consider a time series of k dimensions $y_t, t=1, \dots, T$. We assume that y_t can be estimated by a vector autoregression of finite order p . Given the following structural vector autoregressive model:

$$B_0 y_t = B_1 y_{t-1} + \dots + B_p y_{t-p} + u_t \dots \dots \dots (1)$$

Our objective is to learn about the parameters where y_t is an $n \times 1$ vector of endogenous variables in the system, where:

$$y_t =$$

(MPR, rGDP, Money Supply, Inflation, Exchange rate, Treasury Bill rate)

The $n \times 1$ vector of u_t refers to a structural shock or innovation and signifies a mean zero serially uncorrelated error term. The error term is assumed to be unconditionally homoscedastic and for notational convenience, all deterministic regressors have been suppressed. The model can be written more concisely as:

$$B(L)y_t = u_t \dots \dots \dots (2)$$

where $B(L) \equiv B_0 - B_1L - B_2L^2 - \dots - B_pL^p$ is the autoregressive lag order polynomial. The variance-covariance matrix of the structural error term is typically normalized such that:

$$E(u_t u_t') \equiv \Sigma_u = I_K \dots \dots \dots (3)$$

This implies first, that the number of structural shocks and variables are equivalent. Second, since by definition, structural shocks are mutually uncorrelated, it is implied that Σ_u is diagonal. Third, the variance of all structural shocks is normalized to unity without a loss of generality given that the diagonal elements of B_0 remain unrestricted. For the structural model to be estimated, the reduced-form representation must first be derived. This requires y_t being expressed as a function of lagged y_t only. The reduced form

representation is derived by pre-multiplying both sides of the structural VAR representation by B_0^{-1}

$$B_0^{-1} B_0 y_t = B_0^{-1} B_1 y_{t-1} + \dots + B_0^{-1} B_p y_{t-p} + B_0^{-1} u_t \dots \dots \dots (4)$$

Hence, the same model can be represented as:

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t \dots \dots \dots (5)$$

where $A_i = B_0^{-1} B_i, i=1, \dots, p$, and $\varepsilon_t = B_0^{-1} u_t$. Equivalently the model can be written more compactly as:

$$A(L)y_t = \varepsilon_t \dots \dots \dots (6)$$

where $A(L) = I - A_1L - A_2L^2 - \dots - A_pL^p$ denotes the autoregressive lag order polynomial.

In order to generate consistent estimates of the reduced-form parameters $A_i, i=1, \dots, p$, the reduced-form errors ε_t , and their covariance matrix $E(u_t u_t') \equiv \Sigma_\varepsilon$, standard estimation techniques are employed. The reduced-form innovations ε_t are typically a weighted average of the structural shocks u_t and as such studying the response of vector y_t to reduced-form shocks ε_t does not reveal anything about the response of y_t to the structural shocks u_t . If one is interested in learning about the structure of the latter responses that are of significance and they are dependent on $B_i, i=0, \dots, p$. Thus, to reconstruct u_t from $u_t = B_0 \varepsilon_t$ and $B_i, i=1, \dots, p$ from $B_i = B_0 A_i$, we have to recover the elements of B_0^{-1} from consistent estimates of the reduced-form parameters:

By construction, $\varepsilon_t = B_0^{-1} u_t$. Hence, the variance of ε_t is:

$$\begin{aligned} E(\varepsilon_t \varepsilon_t') &= B_0^{-1} E(u_t u_t') B_0^{-1'} \\ \Sigma_\varepsilon &= B_0^{-1} \Sigma_u B_0^{-1'} \\ &= \Sigma_\varepsilon \end{aligned}$$

3.2 Impulse Response Function:

The Structural Impulse Response Functions help reveal the dynamic response of current and future values of each variable to a one-unit change in the current value of one structural shock while assuming that other shocks are equal to zero (Bala and Alhassan, 2018). Furthermore, impulse response analysis attempts to answer the question of what the effect of a shock is on current or future values of the variables in the model (Sebastian, 2019).

Forecast Error Variance Decomposition:

FEVD shows the proportion of movements in the endogenous variables of a VAR model that occurs due to its shocks versus shocks to other variables in the model. It assesses the proportion of the forecast error variance of a given variable that is explained by innovations to each explanatory variable in the model (Adofu and Salami 2017). The results of an SVAR model are usually presented using either or combination of both IRF and FEVD. This study used both the Impulse Response Function and the Forecast Error Variance Decomposition to analyze the statistical significance of the variables.

3.3 Identification of Structural VAR

The traditional identifying assumptions based on either short-run or long-run exclusion restrictions have drawn increasing skepticism in recent years. This has given rise to

the emergence of, and increasing popularity of, an alternative class of structural VAR models where structural shocks are identified by restricting the sign of the responses of selected model variables to structural shocks (Kilian, 2011). The approach of using sign restrictions to identify structural VAR models was pioneered by Faust (1998) and built upon by Canova and De Nicolò (2002), and Uhlig (2005). In sign-identified models, identification requires that each identified shock is associated with a particular sign pattern and unlike the traditional short-run or long-run exclusion restrictions, the sign restrictions can usually be directly derived from economic theory (Kilian, 2011). We impose our restrictions based on a vector of two structural shocks, namely a contractionary monetary policy shock and an exchange rate shock, depicted by a devaluation. Identification involves sign restrictions of the form:

Structural Shock	Int	Rgdp	Inf	M3
I. Contractionary monetary policy shock	+	-	-	*
II. Exchange rate shock	+	-	+	*

An unexpected monetary policy tightening is associated with tightening liquidity, higher interest rates, but lower real output and lower inflation on impact in line with the traditional interest rate channel of monetary policy transmission, whereas an unplanned depreciation/devaluation of the domestic currency by the monetary authority, especially on account of pressure in the foreign exchange market is anticipated to heighten inflationary pressures.

3.4 Data and Source

This study utilizes time a monthly series data from January 2007 to June 2020. The period was chosen to accommodate the introduction of the new monetary policy framework by the CBN where the Monetary Policy Rate (MPR) replaced the erstwhile Minimum Rediscount Rate (MRR) as the nominal anchor for other market rates. Consequently, we use five variables to estimate the model, namely real GDP, inflation, exchange rate, money supply and the MPR. The TBR which represents the best measure of the opportunity cost of holding money or the return of risk-free assets, was used as the proxy for interest rates (Nakorji and Asuzu, 2019). Similarly, the BDC exchange rate was selected in preference to the other official rates at the interbank

segment or the investors and exporters window since the BDC rate is more sensitive to movements in the supply and demand of foreign exchange in the Nigerian foreign exchange market. This was emphasized by Doguwa (2014) in an earlier study. All data was sourced from the statistical database of the CBN.

4. Estimation and Results

4.1 Preliminary tests

The summary statistics are provided in table 1 and are a precursor for further tests for stationarity and stability. Accordingly, to determine the level of stationarity of the data, the study adopted the Augmented Dickey-Fuller (ADF) test based on the Akaike Information Criterion (AIC) which was complemented with the Phillips-Perron (PP) test. Only inflation was stationary at level at 10 percent while all other variables were stationary at first difference (Table 3). As part of the diagnostic tests and to ascertain the reliability of the VAR model, a stability test was also undertaken, the model was perceived to exhibit stability since all the roots were located inside the unit circles (Table 2).

Table 1. Summary Statistics

	Descriptive Statistics					
	EXC	INF	LGDP	M3	MPR	TBILL
Mean	231.83	11.39	6.54	7.22	11.20	9.05
Median	167.16	11.37	6.68	7.25	12.00	9.94
Maximum	494.70	18.72	6.80	7.56	14.00	15.00
Minimum	118.70	4.12	6.02	6.59	6.00	1.04
Std. Dev.	107.08	3.23	0.25	0.25	2.61	3.61
Skewness	0.74	0.08	-0.64	-0.50	-0.77	-0.41
Kurtosis	2.00	2.73	1.74	2.35	2.37	2.29
Jarque-Bera	21.50	0.65	21.99	9.68	18.78	8.06
Probability	0.00	0.72	0.00	0.01	0.00	0.02
Sum	37556.81	1845.82	1059.10	1169.26	1814.75	1466.09
Sum Sq. Dev.	1845874.00	1679.17	10.10	9.78	1098.44	2102.77
Observations	162.00	162.00	162.00	162.00	162.00	162.00

Table 2. Stability Test

Root	Modulus
0.993191	0.993191
0.957102	0.957102
0.923015	0.923015
0.886348 - 0.091477i	0.891056
0.886348 + 0.091477i	0.891056
0.760513 - 0.122217i	0.770270
0.760513 + 0.122217i	0.770270
0.238112	0.238112
0.185111 - 0.105527i	0.213077
0.185111 + 0.105527i	0.213077
-0.152864	0.152864
0.017620	0.017620

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 3. ADF and PP Stationarity Test

Variables	Augmented Dicker Fuller (ADF)		Phillips-Perron (PP)	
	Level	1 st Difference	Level	1 st Difference
Exc	-0.220910 (0.9320)	-9.005958 (0.0000)	-0.105921 (0.9458)	-8.987807 (0.0000)
Inf	-2.747100 (0.0685)	-7.115865 (0.0000)	-2.219088 (0.2004)	-11.81601 (0.0000)
Lgdp	-1.703506 (0.4274)	-2.759708 (0.0667)	-1.938335 (0.3141)	-6.066730 (0.0000)
MPR	-1.103731 (0.7138)	-12.08294 (0.0000)	-1.279975 (0.6383)	-12.16782 (0.0000)
M3	-3.541135 (0.0081)	-10.60727 (0.0000)	-4.008526 (0.0018)	-12.48776 (0.0000)
Tbill	-2.187347 (0.2118)	-8.924339 (0.0000)	-1.935338 (0.3155)	-8.933901 (0.0000)

4.2 Impulse Response Function

The impulse response function provides an understanding of the dynamic responses of real GDP growth and inflation to a structural one-standard-deviation shock in monetary policy, via the policy rate and the exchange rate. Consequently, figure 1 depicts the response of the endogenous variables to a policy rate shock. With respect to inflation, the contractionary shock accounts for a temporary rise in inflation in the first and second months before moderating and declining after seventh month. The initial rise could be attributed to price puzzle effect. Output growth is also positive and stable over the time horizon indicative of the minimal influence of monetary policy in determining output growth and giving credence to the neutrality of money proposition. In terms of the monetary aggregate, an innovation in the policy rate is seen to have little effect on the quantum of money in the system as it rises and remains positive and constant over time. Domestic interest rates proxied by the treasury bill rate are also positive

underscoring the desired impact of a contractionary monetary policy in pushing market interest rates higher to moderate spending. The effect, however, begins to wane over time. In terms of the exchange rate shock depicted in figure 2, the shock has a lasting positive effect on inflation which is sustained, this is attributed to the increment rise in the cost of imported goods and services on account of a devaluation/depreciation due to exchange rate pass-through effect. The shock to policy rate has spillover effect on exchange rate and inflation, in an event of exchange rate depreciation, the CBN is expected to raise policy rate which attracts capital inflow and further moderate exchange rate depreciation and rein-in inflation.

Therefore, policy rate increase attracts foreign direct investment (especially portfolio investment)⁵ which strengthens the value of the Domestic currency, as the currency appreciates due to high demand (though it has implication on net export), inflation is likely to moderate, this happens in a typical advanced economy with less informal sector. However, if CBN allows Naira to continue

⁵ Although, there are arguments as to whether higher interest rate in emerging markets like Nigeria truly generates capital inflow as expected, other constraints

may include uncertainty and lack of confidence in most developing economies. Isah, Joseph, & Dairo (2022)

to depreciate without any response, it has a negative impact of inflation, as such, policy rate plays an important role in moderating exchange rate instability especially in an economy with small informal sector.

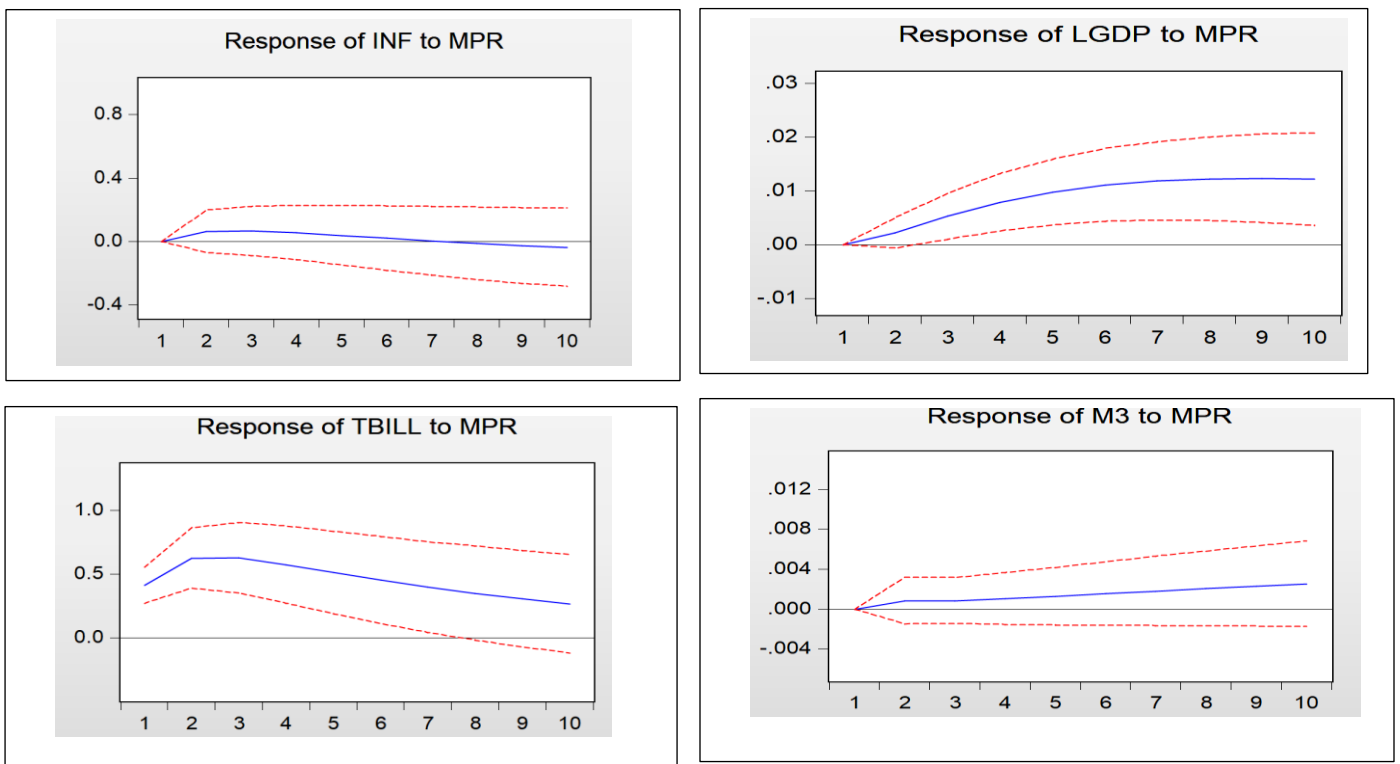
With respect to output, the shock has a negative effect due to the knock-on effect of costlier goods and services and the detrimental effect it has on businesses and households. The shock has a positive effect on money supply as the purchasing power of the naira reduces inducing the monetary authority to increase money supply. Domestic interest rates dip slightly in the first month before picking up and sustaining the trend.

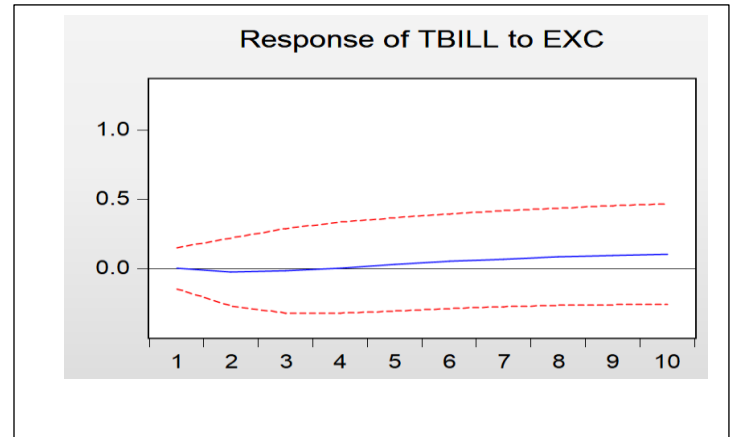
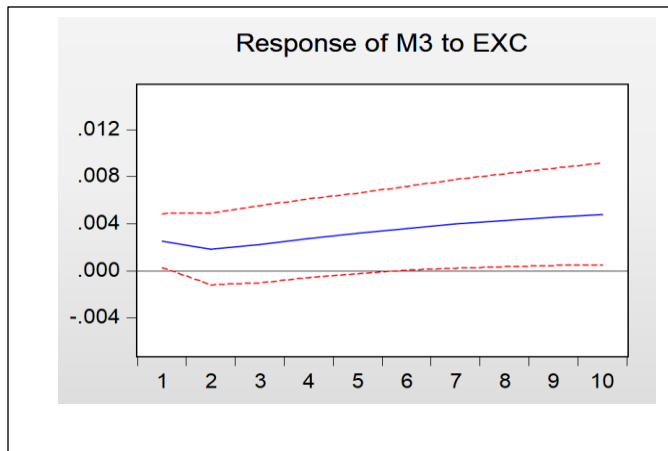
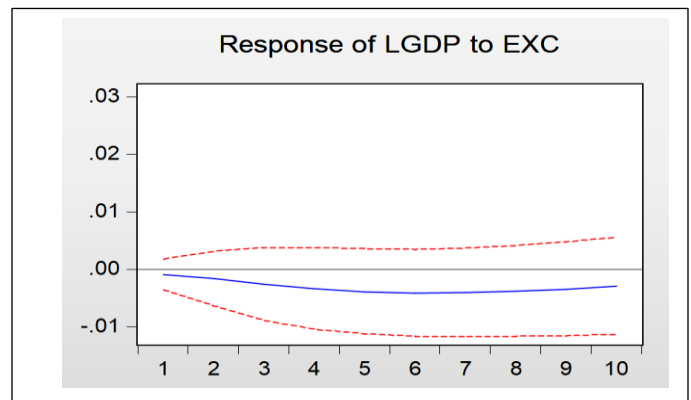
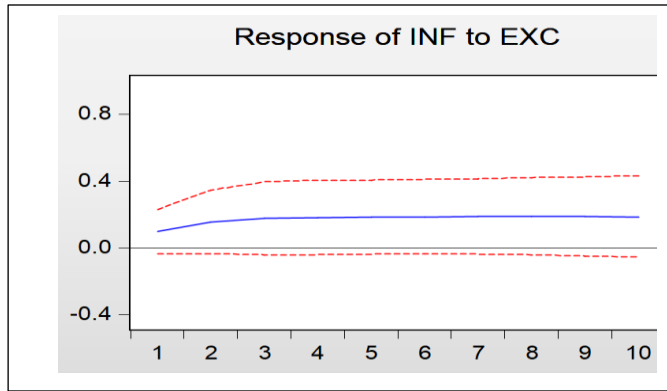
The general rise in prices from exchange rate devaluation or depreciation also accounts for the rise in interest rates as lenders reprice loans. In terms of policy, the monetary policy innovation is influential in moving market interest rates but is less successful in moderating inflation and boosting output. Conversely, the shock from an exchange rate depreciation is more influential in affecting prices and output. In terms of the monetary policy transmission mechanism, this however, the system appears to break down after influencing interest rates with greater influence being exerted by exchange rate movements. This, however, does not underpin the efficacy of interest rate channel in some economies. Although, some exogenous factors such as global interest rate and global inflation sometimes dampen the efficiency of domestic policy rate by the CBN. For example, capital inflow might not necessary be driven by high interest rate in Nigeria, this is due to the fact investors

consider several factors before pooling out their funds from one country to another. Part of the reasons that might affect interest rate channel not to be fully effective in attracting foreign reserves so as to moderate exchange rate and inflation even in an event of hiking policy interest rate, is low confidence by the investors, and this is usually caused by economic and political instability that pose several challenges even in an event of high rate of return on investment in Nigeria. Another key factor that dampens the efficacy of interest rate channel is Domestic inflation that results to negative real interest rate. Investors consider real interest rate (not just nominal) when bringing in their funds to a particular country, regardless of the magnitude of the Domestic interest rate, if the inflation is higher than the interest rate, that means the rate of return is negative as real interest rate is defined as inflation less interest rate.

While exchange rate channel appears to be more prominent in the literature (Yaaba, 2013; Tule et al, 2014; Idowu et al, 2020), because it seems to be more effective in an export driven economy. A productive economy enjoys exchange rate depreciation which leads to positive net export (through increase in export to the rest of the world) and increase in output, income and employment in the economy. A consistent increase in export strengthens the exchange rate of the Domestic economy and if sustained, rein-in inflation. Whichever channel, the structure and peculiarities of an economy defines the best approach to adopt, however, for Nigeria, different studies proposed different approaches for different purposes.

Figure 1. Impulse Response to a monetary policy shock





4.3 Variance Decomposition

Table 4 presents the proportion of variations in endogenous variables that can be explained by shocks from other economic variables. The decomposition values are provided for 10th month into the future. From the results, real GDP accounts for circa 98 per cent of its own variance in the first month, although this declines over the period to 62 per cent in the 10th month. Over the period however, shocks to the policy rate and domestic interest rates account cumulatively for roughly 28 per cent of the variations in output in the 10th month, lending support to some influence of the policy rate in affecting output in the long run. Furthermore, the variance of inflation was caused largely by its innovations and exchange rate with about 95 and 5 per cent respectively in month five and 92 and 6 per cent, respectively, in month 10. The cumulative contribution of the policy rate and domestic interest rate never rose above 1 per cent over the time frame, further indicative of the poor relationship between the policy rate and prices. Again, the

exchange rate effect seems to be a bigger determinant of price movements than the policy rate innovation. In respect of the other shocks; the policy rate seems to be best explained by itself and domestic interest rates, money supply is best explained by itself, real GDP and the exchange rate, domestic rates are best explained by the policy rate and itself while the exchange rate is best explained by itself, inflation and domestic interest rates.

4.4 Post estimation tests

The estimated model was tested for autocorrelation, heteroscedasticity and normality. The results from these tests are presented in the Appendix. The results reveal no evidence of serial correlation or heteroscedasticity. Moreover, the Jarque-Bera test indicates that the data series satisfied the normal distribution requirement. The behavior of the residuals of each of the variables following estimation are also normally distributed.

Table 4. Variance Decomposition

Variance Decomposition of EXC:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	11.24584	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	17.88585	98.43881	0.372447	3.87E-05	0.989795	0.173190	0.025723
3	22.80933	96.79552	0.917081	0.010592	1.383995	0.364202	0.528613
4	26.83882	94.61924	1.488300	0.049282	1.536949	0.422115	1.884116
5	30.36504	91.83072	2.012707	0.100757	1.590168	0.419785	4.045867
6	33.57536	88.56477	2.492076	0.139746	1.615522	0.403485	6.784405
7	36.55824	85.02935	2.937040	0.154041	1.643701	0.392493	9.843370
8	39.35565	81.41701	3.353559	0.147035	1.687922	0.394695	12.99978
9	41.98650	77.87708	3.743041	0.130691	1.753609	0.414315	16.08127
10	44.45801	74.51348	4.104814	0.118196	1.842547	0.454251	18.96671

Variance Decomposition of INF:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.836644	1.405920	98.59408	0.000000	0.000000	0.000000	0.000000
2	1.215434	2.313084	97.15827	0.184268	0.003827	0.265502	0.075045
3	1.486376	2.959824	96.02302	0.480446	0.038688	0.367897	0.130124
4	1.691704	3.447572	95.20363	0.760596	0.068974	0.388734	0.130491
5	1.853504	3.873768	94.58138	0.974263	0.095283	0.365815	0.109491
6	1.984529	4.272867	94.05936	1.109321	0.118829	0.329379	0.110243
7	2.093208	4.654948	93.56502	1.174283	0.140833	0.296285	0.168627
8	2.185394	5.020787	93.04627	1.185943	0.161863	0.274961	0.310178
9	2.265276	5.367991	92.46879	1.162288	0.182151	0.268779	0.549999
10	2.335884	5.693424	91.81404	1.119049	0.201784	0.278049	0.893650

Variance Decomposition of LGDP:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.017136	0.260362	0.890252	98.84939	0.000000	0.000000	0.000000
2	0.030097	0.362074	0.514142	97.40802	0.135158	0.525186	1.055419
3	0.040773	0.582870	0.434395	93.98722	0.557686	1.967900	2.469930
4	0.049331	0.853581	0.411802	89.67263	1.233290	3.915354	3.913340
5	0.056172	1.125095	0.380630	84.94641	2.096822	6.075961	5.375080
6	0.061735	1.362348	0.334175	80.07426	3.083232	8.257648	6.888332
7	0.066400	1.543460	0.289087	75.24526	4.124437	10.32435	8.473405
8	0.070456	1.658778	0.268328	70.60562	5.155849	12.18092	10.13051
9	0.074103	1.709467	0.291873	66.25981	6.124558	13.77122	11.84307
10	0.077468	1.704735	0.372329	62.27084	6.994456	15.07486	13.58279

Variance Decomposition of M3:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.014526	3.063782	0.018019	1.268049	95.65015	0.000000	0.000000
2	0.019448	2.617308	0.275499	1.520614	95.36107	0.192628	0.032886
3	0.023166	2.783729	0.474967	1.926589	94.44359	0.271054	0.100075
4	0.026239	3.250224	0.682337	2.441669	93.04367	0.371635	0.210460
5	0.028934	3.890654	0.870972	3.035314	91.34904	0.505088	0.348936
6	0.031369	4.632069	1.036613	3.676763	89.48623	0.675044	0.493278
7	0.033611	5.431070	1.179541	4.335056	87.54998	0.879227	0.625124
8	0.035701	6.259105	1.302062	4.981790	85.60912	1.114569	0.733360
9	0.037664	7.096387	1.406762	5.593885	83.71136	1.378141	0.813463
10	0.039520	7.928827	1.496125	6.154847	81.88714	1.667387	0.865676

Variance Decomposition of MPR:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.445347	0.103729	0.483820	3.755861	0.007821	95.64877	0.000000
2	0.625681	0.549109	1.913531	4.219507	1.655424	90.94471	0.717723
3	0.760853	0.738281	1.867955	4.191982	2.145521	88.89226	2.164002
4	0.867770	0.901896	1.607059	3.849632	2.449426	87.09916	4.092832
5	0.956977	1.059723	1.343454	3.383890	2.626885	85.25735	6.328698
6	1.034310	1.220403	1.152328	2.932474	2.731751	83.25584	8.707209
7	1.103218	1.384456	1.050578	2.579371	2.789994	81.11360	11.08200
8	1.165698	1.550716	1.033386	2.362296	2.818771	78.89671	13.33812
9	1.222892	1.717729	1.087970	2.285245	2.829927	76.68133	15.39779
10	1.275450	1.884272	1.199677	2.331718	2.831875	74.53427	17.21819

Variance Decomposition of TBILL:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.952835	0.000203	0.146719	0.340537	0.041999	18.70830	80.76224
2	1.561288	0.027055	1.089838	0.171215	0.094812	23.05304	75.56404
3	2.018556	0.023528	1.414703	0.656657	0.114347	23.43442	74.35635
4	2.374769	0.017542	1.382074	1.569240	0.102973	22.77231	74.15587
5	2.660229	0.026809	1.243114	2.680038	0.087689	21.84871	74.11364
6	2.891966	0.054751	1.097204	3.829165	0.075137	20.93550	74.00824
7	3.080439	0.099479	0.976121	4.924439	0.066228	20.12362	73.81012
8	3.233083	0.157975	0.886230	5.919559	0.060395	19.43645	73.53939
9	3.355802	0.227293	0.825238	6.795728	0.056840	18.87141	73.22349
10	3.453580	0.304783	0.788321	7.549732	0.054855	18.41637	72.88594

Variance Decomposition of MPR:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.445347	0.103729	0.483820	3.755861	0.007821	95.64877	0.000000
2	0.625681	0.549109	1.913531	4.219507	1.655424	90.94471	0.717723
3	0.760853	0.738281	1.867955	4.191982	2.145521	88.89226	2.164002
4	0.867770	0.901896	1.607059	3.849632	2.449426	87.09916	4.092832
5	0.956977	1.059723	1.343454	3.383890	2.626885	85.25735	6.328698
6	1.034310	1.220403	1.152328	2.932474	2.731751	83.25584	8.707209
7	1.103218	1.384456	1.050578	2.579371	2.789994	81.11360	11.08200
8	1.165698	1.550716	1.033386	2.362296	2.818771	78.89671	13.33812
9	1.222892	1.717729	1.087970	2.285245	2.829927	76.68133	15.39779
10	1.275450	1.884272	1.199677	2.331718	2.831875	74.53427	17.21819

Variance Decomposition of TBILL:

Period	S.E.	EXC	INF	LGDP	M3	MPR	TBILL
1	0.952835	0.000203	0.146719	0.340537	0.041999	18.70830	80.76224
2	1.561288	0.027055	1.089838	0.171215	0.094812	23.05304	75.56404
3	2.018556	0.023528	1.414703	0.656657	0.114347	23.43442	74.35635
4	2.374769	0.017542	1.382074	1.569240	0.102973	22.77231	74.15587
5	2.660229	0.026809	1.243114	2.680038	0.087689	21.84871	74.11364
6	2.891966	0.054751	1.097204	3.829165	0.075137	20.93550	74.00824
7	3.080439	0.099479	0.976121	4.924439	0.066228	20.12362	73.81012
8	3.233083	0.157975	0.886230	5.919559	0.060395	19.43645	73.53939
9	3.355802	0.227293	0.825238	6.795728	0.056840	18.87141	73.22349
10	3.453580	0.304783	0.788321	7.549732	0.054855	18.41637	72.88594

5.0 Conclusion and Policy Recommendation

The paper investigated the effectiveness of the interest rate channel in the transmission of monetary policy to the real economy using a structural VAR model. The crux of the matter was identifying if innovations in the MPR were sufficient in meeting the overarching mandate of the Bank of ensuring price stability and boosting output growth. The results of the structural impulse response function identify the MPR as an anchor in determining market interest rates but only for a short period, as inflation response to monetary policy shocks was also found to be short lived. Conversely the results point to movements in the exchange rate as a stronger determinant in the explanation of inflationary pressures and output growth. Taking cognizance of the import dependent nature of the country as well as its dependency on oil export for its foreign exchange earnings, it is no surprise to see why the exchange rate plays such a significant role in the domestic economy and somewhat blunts the effectiveness of the monetary policy rate in combating inflationary pressures.

Nevertheless, to get the MPR to serve its purpose as an effective monetary tool for anchoring market interest rates, there would be need for ensuring optimal liquidity in the system as presence of excess liquidity can be a hindrance to the effective transmission of monetary policy and by implication, inability of the Bank to influence inflation expectation using the monetary policy rate⁶ inability of the Bank to influence inflation expectation using the monetary policy rate. With the exchange rate channel identified to be more effective, deployment of monetary tools that would enhance flow of foreign capital into the economy would stabilize the exchange rate and moderate inflationary pressures as well as promote a more conducive for growth. This is, however, contingent on interest cost not being excessive and outweighing the benefits of appreciation of the domestic currency. Thus, exchange rate management remains key in safeguarding the value of the naira. In addition, the monetary policies that support the import substitution industrialization should be promoted as that would help in conserving the country's foreign exchange, stabilize the naira exchange rate and by implication moderate exchange rate - induced inflationary pressure.

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⁶ Our findings supported other studies in recommending the integration of all the key channels (namely; interest rate channel, exchange rate channel and credit channel) to ensure full implementation of monetary policy in Nigeria.

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APPENDIX

VAR Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: No residual autocorrelations up to lag h

Sample: 2007M01 2020M06

Included observations: 160

Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	5.712696	---	5.748624	---	---
2	61.53710	---	62.27967	---	---
3	123.2010	0.0000	125.1219	0.0000	36

*Test is valid only for lags larger than the VAR lag order.

df is degrees of freedom for (approximate) chi-square distribution

VAR Residual Serial Correlation LM Tests

Sample: 2007M01 2020M06

Included observations: 160

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	62.27899	36	0.0042	1.770143	(36, 600.0)	0.0042

2	64.28339	36	0.0026	1.830135	(36, 600.0)	0.0026
3	78.76933	36	0.0000	2.269542	(36, 600.0)	0.0001

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	62.27899	36	0.0042	1.770143	(36, 600.0)	0.0042
2	136.4055	72	0.0000	1.981006	(72, 713.1)	0.0000
3	200.7659	108	0.0000	1.977484	(108, 717.8)	0.0000

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: Residuals are multivariate normal

Sample: 2007M01 2020M06

Included observations: 160

Component	Skewness	Chi-sq	Df	Prob.*
1	-0.128777	0.442227	1	0.5060
2	0.326685	2.845942	1	0.0916
3	0.495715	6.552879	1	0.0105
4	0.247034	1.627359	1	0.2021
5	0.276804	2.043210	1	0.1529
6	-0.700958	13.10247	1	0.0003
Joint		26.61409	6	0.0002

Component	Kurtosis	Chi-sq	Df	Prob.
1	4.406497	13.18822	1	0.0003
2	12.58392	612.3431	1	0.0000
3	4.379818	12.69266	1	0.0004
4	13.95682	800.3463	1	0.0000
5	6.207407	68.58308	1	0.0000
6	12.88420	651.3165	1	0.0000
Joint		2158.470	6	0.0000

VAR Residual Heteroskedasticity Tests (Levels and Squares)

Date: 11/12/20 Time: 09:45

Sample: 2007M01 2020M06

Included observations: 160

Joint test:

Chi-sq	df	Prob.
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Individual components:

Dependent	R-squared	F(24,135)	Prob.	Chi-sq(24)	Prob.
res1*res1	0.353300	3.073009	0.0000	56.52804	0.0002
res2*res2	0.273820	2.121009	0.0038	43.81113	0.0080
res3*res3	0.233421	1.712799	0.0293	37.34742	0.0404
res4*res4	0.188920	1.310200	0.1688	30.22724	0.1773
res5*res5	0.114241	0.725488	0.8183	18.27861	0.7893
res6*res6	0.505610	5.752662	0.0000	80.89763	0.0000
res2*res1	0.283007	2.220267	0.0022	45.28116	0.0054
res3*res1	0.180754	1.241070	0.2187	28.92066	0.2231
res3*res2	0.316937	2.609967	0.0003	50.70995	0.0011
res4*res1	0.199180	1.399050	0.1186	31.86880	0.1303
res4*res2	0.135086	0.878537	0.6301	21.61376	0.6023
res4*res3	0.156121	1.040648	0.4206	24.97936	0.4069
res5*res1	0.089627	0.553787	0.9534	14.34034	0.9386
res5*res2	0.147430	0.972696	0.5058	23.58874	0.4853
res5*res3	0.112904	0.715913	0.8285	18.06459	0.7999
res5*res4	0.120517	0.770801	0.7671	19.28268	0.7368
res6*res1	0.106050	0.667297	0.8755	16.96797	0.8500
res6*res2	0.206498	1.463825	0.0905	33.03961	0.1032
res6*res3	0.319893	2.645754	0.0002	51.18284	0.0010
res6*res4	0.244871	1.824059	0.0171	39.17937	0.0261
res6*res5	0.127406	0.821300	0.7048	20.38503	0.6747

VAR Residuals

