

Modelling Monetary Policy and Money Market Rates in Nigeria

In Search of Appropriate
Macroprudential Policy Levers

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MODELLING MONETARY POLICY AND MONEY MARKET RATES IN NIGERIA: IN SEARCH OF APPROPRIATE MACROPRUDENTIAL POLICY LEVERS

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Abstract

The global financial crisis of 2007-09 has highlighted the failure of monetary policy to target key macroprudential tools as critical elements in determining the stability of the financial system and impact of monetary transmission to the real economy. We employed a two lag VAR to model the interaction between monetary policy and money market rates in a preliminary analysis in search of appropriate macroprudential levers in Nigeria. Time series data on a number of variables and proxies were obtained from 1998 to 2013. Given that Nigeria is a bank-based financial system, this study modelled the interaction between the policy rates and money market rates to ascertain the efficacy of the credit channel (which affects the lending rate) and money channels (which affects the deposit rate) of monetary policy transmission mechanism in Nigeria. The money market rates used included the 3 months deposit rate ($_3\text{MDR}$), prime lending rate (PLR), maximum lending rate (MLR) and interbank call rate (IBCR). We found that monetary policy has no significant explanatory power for changes in 3 months deposit rate, prime lending rate and maximum lending rate while the policy rate has explanatory power for the interbank call rate. We also found evidence of a bi-directional feedback loop between short-term policy rates and interbank call rates (i.e. they both Granger-cause each other). We also calculated the multiplier effect of monetary policy on money market rates using the Monte Carlo integration analysis. The result shows that a one-unit shock in monetary policy will lead to a 13% change in the deposit rate after the second month while the same shock will result in a 13% increase in lending rate after the 13th month. A practical policy implication of this finding is that when the central bank adjusts the interest rate, banks are unlikely to simultaneously adjust their lending and deposit rates. In other words, sticky-lending and deposit rates may reduce the effects of monetary policy on money market rates.

Key words: Monetary policy, money market rates, macroprudential indicators, VAR, Granger causality, impulse response

1. Introduction

The aftermath of the 2007-09 global financial crises was the unanimous agreement by the international financial agencies such as the IMF and BIS on the failure of monetary policy tool to target macroprudential risks. One of the major lessons from the financial crisis for inflation targeting Central bankers is the fact that finance is a critical determinant of macroeconomic condition; it is a source of shock and an intricate and often unpredictable amplifier of disturbances. As a result, a lot of financial jurisdictions have been establishing all sorts of macro prudential tools that are aimed at limiting the risk of financial system disruptions that have the potential of destabilizing the macroeconomy. Despite recent progress in recent years, the development and implementation of macro prudential policies are still at an embryonic stage particularly in developing economies.

Although, there have been some internationally agreed macroprudential tools such as Debt-to-Income (DTI) ratios, Loan-to-Value (LTV), Reserve Requirements (RR), and Counter-Cyclical Capital Buffer amongst others, however, the interaction between these measures and monetary policy within emerging economies like Nigeria is still unknown. Similarly, it is almost impossible for any reasonable empirical investigation into the interaction between the afore-mentioned macro prudential tools/indicators with monetary policy in Nigeria to be carried out due to the paucity of data. The current research sort to circumvent these limitations by identifying potential macro prudential levers that can be used in reducing the overall level of leverage in the economy or changing the attitudes held by banks about assuming risk. This is expected to crucially impact on the likelihood of asset and credit bubbles forming and inflating, as they did during the periods leading up to the global financial crisis.

Given that the main objective of macroprudential policy is the stabilization of the financial sector with a view to limiting financial system-wide distress, this study focuses on indicators that are helpful in identifying financial fragility within the Nigerian context. Our aim is to select indicators that will help policy makers to lean against the credit/financial cycle. Recent studies that have reconsidered the role of financial intermediaries in monetary economics identified monetary policy as an extremely powerful tool. Effective monetary policy requires a high degree of pass-through of the policy rate changes to money market rates. Theoretically, it is expected that Central Bankers will be able to influence short-term money market rates by controlling the short-term monetary policy rate and thereby longer-term money market rates, the interest rate on government and corporate bonds as well as bank's lending rates. It is these interest rates that matter to economic agents. The bulk of finance for financial institutions, whether banks, stockbrokers or hedge funds, is very much short-term, consequently, central bank's decision on the short-term interest rate is expected to directly affect the marginal price of leverage for almost the entire financial sector which is the major pre-occupation of macro prudential policy.

This study analyses the effectiveness of the Central Bank of Nigeria's monetary policy rate in causing changes in money market rates. We explored whether wholesale money market interest rate expectations are significant in explaining variations in monetary policy rate.

Given the bank-based structure of the Nigeria financial system, this relationship is very important since interest rates, especially, the unsecured money market rates (interbank call rate), determine short-term bank loans and deposit rates which in turn affect financing conditions for households and businesses. Furthermore, the possibility of financial crisis is heightened when due to low interest rates that make short-term funding cheap, increases the total debt raised by financial institutions beyond what may be considered socially optimal. This is frequently the case when policy makers focus exclusively on the conduct of monetary policy without paying adequate attention to the buildup of excessive leverage within the financial system and its potential disruptive effect on the economy.

The focus of this study is quite significant given what financial markets around the world experienced in 2008 at the peak of the crisis. In particular, money markets in most countries contracted substantially leading to severe disruptions in bank's short-term funding. Interest rates in the unsecured segment of the money market increased astronomically reflecting bank's re-assessment of borrower's creditworthiness and their willingness as well as capacity to lend. These developments led to tightening of credit standards for both businesses and households. As a result of these developments, we think it is reasonable to evaluate the efficacy of monetary policy in steering short-term money market rates in both normal and abnormal economic environment. To that aim, we focus on the monthly dynamics of the Monetary Policy Rate (MPR), and the other money market rates namely 3Months Deposit Rate (_3MDR), Maximum Lending Rate (MLR), Prime Lending Rate (PLR) and Inter-Bank Call Rate (IBCR) during the period 1998 to 2013. One of the major policy implications of the findings from this section is a critical evaluation of the proper functioning of the interest rate monetary policy transmission channel and thus the effectiveness of monetary policy in Nigeria. In addition, the finding from this section will help us in the identification of potential money market rate that can be used as a macro-prudential tool.

2. Data and Descriptive Analysis of Money Market Rates in Nigeria

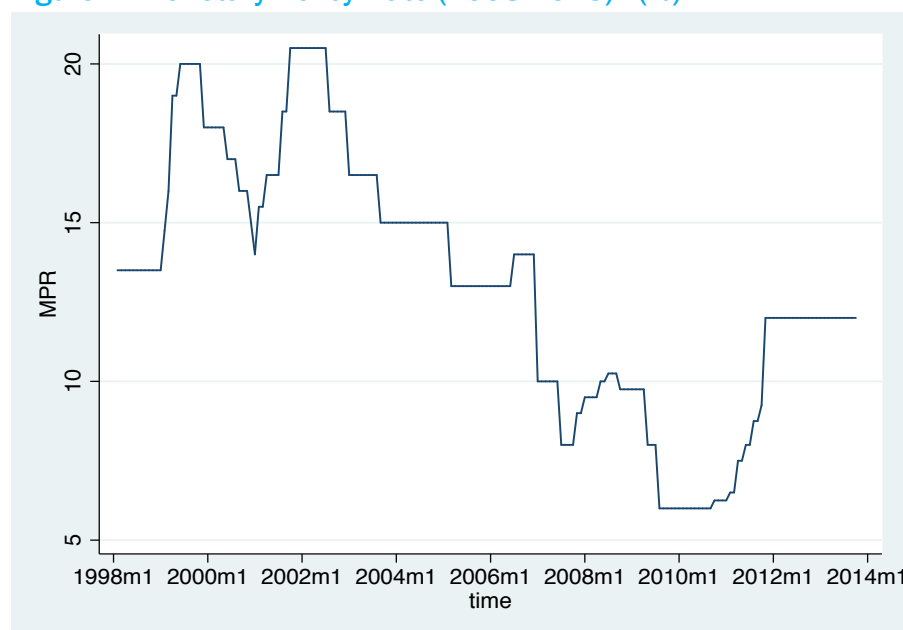
Time series data from 1998 to 2013 on a number of variables and proxies were obtained from the Central Bank of Nigeria (CBN). A description of the key monetary variables currently being monitored in Nigeria and their signaling properties can be found in Appendix 1. These variables include money market rates and macroprudential variables and proxies¹. The rest of this section shows the trend in the variables used in this study and presents the data using graphs/charts.

¹ However, the list of variables is yet to incorporate majority of the core and encouraged set of financial stability indicators (FSIs) proposed by the IMF for regulatory authorities to compile and monitor. The core variables still lacking in Nigeria are the aggregated micro-prudential indicators of the banking sector such as aggregated non-performing loans (NPLs) to total gross loans, NPLs less of provisions to capital, ROE, ROA, interest margin to gross income, non-interest expenses to gross income, liquid-asset ratios, regulatory capital to RWAs, net open position in foreign exchange to capital, etc. Other variables include aggregate household credit, debt service and principal payments to income ratio, real estate prices, etc.

Monetary Policy Rate

The monetary policy rate (MPR) which was previously known as the Minimum Rediscount Rate (MRR) is the nominal anchor for interest rates in the economy, trended downward between 2001 and 2010 (see figure 1), reflecting the proactive drive by the CBN to ameliorate the cost of funds in the economy. The MRR averaged 15% between 1999 and 2005 before the Monetary Policy Rate (MPR) replaced it in December 2006. The MPR is a transactions rate aimed at enhancing transmission of monetary policy actions. At inception, it was fixed at 10.0 per cent with a band of +300 basis points, thus repositioning the CBN as a lender of last resort. The CBN has used MPR proactively to direct the movement of interest rates in the economy. Between 2009 M7 and 2011 M9, the rate hovered between 6% and 8.75%, due to efforts aimed at promoting economic recovery after the global meltdown. The MPR has been at a fixed rate of 12% since 2011 M10, which is reflective of the CBN’s interest rate stabilization policies.

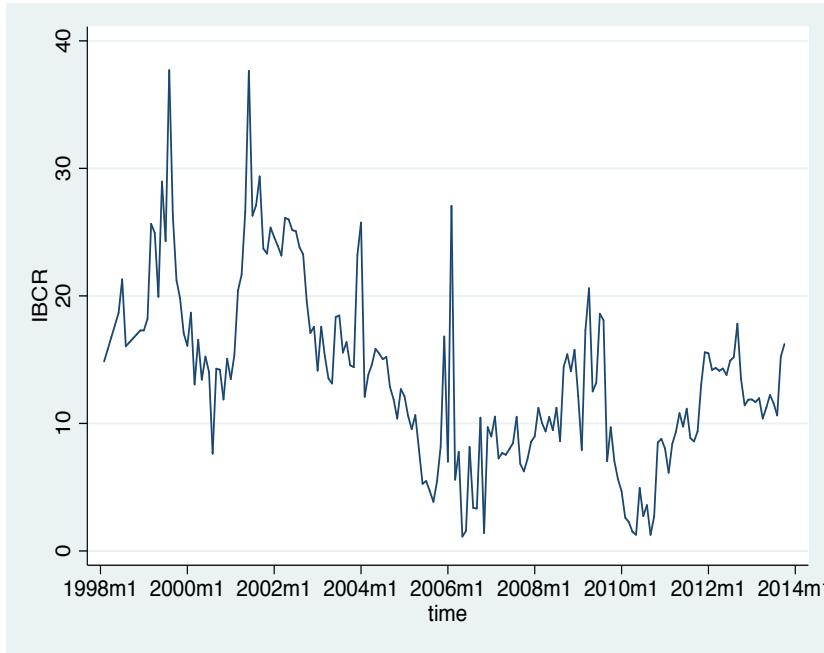
Figure 1: Monetary Policy Rate (1998-2013) - (%)



Interbank Call Rate (IBCR)

The inter-bank call rate, the rate at which banks borrow among themselves, indicated a volatile movement throughout the review period (see figure 2). The irregular trend reflects the liquidity surplus in the system. The rise in 2001 for example, reflected the impact of demand pressure and tight monetary policy stance while the decline witnessed during the following year was as a result of the downward adjustment in MRR and the relative ease of monetary conditions. The banking sector consolidation and implementation of the new monetary policy framework generally moderated volatility in the inter-bank rate in those years (CBN, 2010).

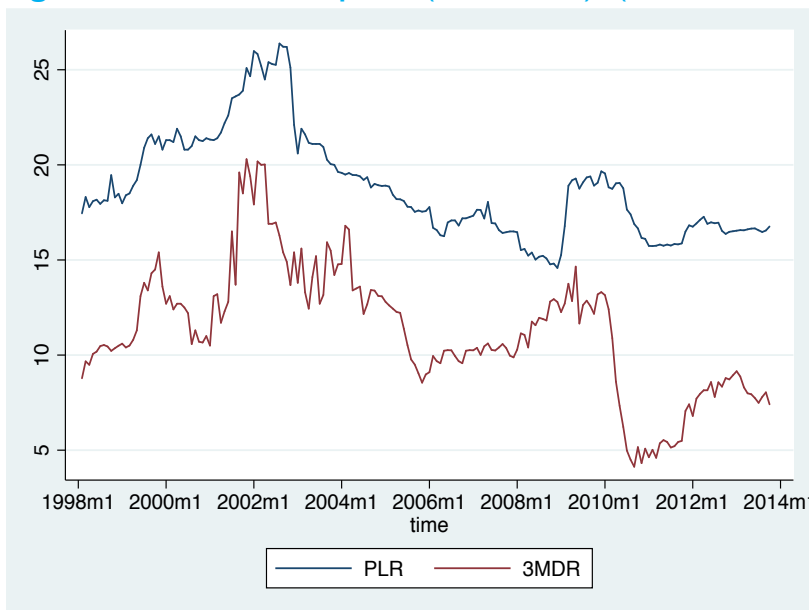
Figure 2: Interbank Call Rate (1998-2013) - (%)



Interest Rate Spread

Narrower spreads (i.e. higher interest rates on deposits and lower lending rates) may signal increasing competition, which may lead to greater risk taking. Though, competition amongst banks is good, it often leads to interest volatility. However, higher real interest rates could be a function of the central bank’s inflation stabilization policies. Figure 3 shows retail credit spread for the Nigerian banking system between 1998 and 2013. In Nigeria, bank spreads are quite substantial. From our data, the average prime-lending rate (PLR) over 189 months from 1998 to 2013 is 18.82%, while the average 3 months deposit rate (3MDR) is 11.25%, giving an average spread of 7.57%.

Figure 3: Interest Rate Spread (PLR-3MDR) - (1998 - 2013)



Now having reviewed the trend of variables used in this study, the next section now focuses on addressing the research question, which is to model the interactions between the monetary policy rate and other money market variables.

3. Modelling Monetary Policy and Money Market Rates

We used the Vector Autoregression (VAR) model in this analysis. Our choice of this estimation method is because of its flexibility in modelling the dynamic behaviour of economic and financial time series and for forecasting. In this study we used the VAR model to perform some structural analysis of the variables. Specifically, we performed Granger-Causality tests; compute the Impulse Response Function (IRF), as well as Forecast Error Variance Decompositions (FEVD). This paper provides a preliminary solution on the practical challenges of the selection and application of Macroprudential Policy Instruments (MPIs) and its interaction with monetary policy in Nigeria.

3.1. Modelling Monetary Policy and Money Market Rates using VAR

We used the VAR² method to analyze the dynamic impact of random disturbances on the system of the variables used for this study. The VAR approach treats all the endogenous variables in the system as a function of the lagged values of all of the endogenous variables in the system. In other words, the VAR model allows the value of a variable to depend on more than just its own lags or combinations of white noise terms thus, making it more pliant than the univariate AR models, Nwafor (2015). The VAR model can be expressed as:

$$y_t = A_1y_{t-1} + \dots + A_p y_{t-p} + Bx_t + \epsilon_t \dots \dots \dots (1)$$

Where y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, A_1, \dots, A_p and B are matrices of coefficients to be estimated, and ϵ_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the dependent variables. In the model we estimated, we assumed that the Monetary Policy Rate (MPR), and the other money market rates namely 3Months Deposit Rate (_3MDR), Maximum Lending Rate (MLR), Prime Lending Rate (PLR) and Inter Bank Call Rate (IBCR) are jointly determined by a VAR. We considered a constant, Oil Price and Nominal Exchange Rates as exogenous variable given that changes in these variables (oil price and exchange rates) are not determined within the country.

Choosing the optimal lag length for a VAR model is critical. This is because the lag length for a VAR is used to determine how long changes in the variables should take to work through the system. The present study used the Information Criteria method to arrive at the optimal lag length. The lag length selection criteria³ suggested lag 2 as the optimal lag length for this

² A VAR can be defined as a systems regression model given that there is more than one dependent variable that can be considered at a time (Nwafor, 2015). In this regards, the VAR model can be seen as a simultaneous equations models.

³ Lag Length selection criteria computes various criteria to select the lag order of an unrestricted VAR. All the criteria are discussed in Lutkepohl (1991, Section 4.3). The two information criteria that are used to determine

estimation. Consequently, the VAR model specified for this study has two lagged values of the endogenous variables and takes this functional form:

$$MPR_t = \alpha_{11}MPR_{t-1} + \alpha_{12}3MDR_{t-1} + \alpha_{13}PLR_{t-1} + \alpha_{14}MLR_{t-1} + \alpha_{15}IBCR_{t-1} + \beta_{11}MPR_{t-2} + \beta_{12}3MDR_{t-2} + \beta_{13}PLR_{t-2} + \beta_{14}MLR_{t-2} + \beta_{15}IBCR_{t-2} + \beta_{16}X_t + C_1 + \epsilon_{1t} \dots\dots\dots(2)$$

$$3MDR_t = \alpha_{11}MPR_{t-1} + \alpha_{12}3MDR_{t-1} + \alpha_{13}PLR_{t-1} + \alpha_{14}MLR_{t-1} + \alpha_{15}IBCR_{t-1} + \beta_{11}MPR_{t-2} + \beta_{12}3MDR_{t-2} + \beta_{13}PLR_{t-2} + \beta_{14}MLR_{t-2} + \beta_{15}IBCR_{t-2} + \beta_{16}X_t + C_1 + \epsilon_{1t} \dots\dots\dots(3)$$

$$PLR_t = \alpha_{11}MPR_{t-1} + \alpha_{12}3MDR_{t-1} + \alpha_{13}PLR_{t-1} + \alpha_{14}MLR_{t-1} + \alpha_{15}IBCR_{t-1} + \beta_{11}MPR_{t-2} + \beta_{12}3MDR_{t-2} + \beta_{13}PLR_{t-2} + \beta_{14}MLR_{t-2} + \beta_{15}IBCR_{t-2} + \beta_{16}X_t + C_1 + \epsilon_{1t} \dots\dots\dots(4)$$

$$MLR_t = \alpha_{11}MPR_{t-1} + \alpha_{12}3MDR_{t-1} + \alpha_{13}PLR_{t-1} + \alpha_{14}MLR_{t-1} + \alpha_{15}IBCR_{t-1} + \beta_{11}MPR_{t-2} + \beta_{12}3MDR_{t-2} + \beta_{13}PLR_{t-2} + \beta_{14}MLR_{t-2} + \beta_{15}IBCR_{t-2} + \beta_{16}X_t + C_1 + \epsilon_{1t} \dots\dots\dots(5)$$

$$IBCR_t = \alpha_{11}MPR_{t-1} + \alpha_{12}3MDR_{t-1} + \alpha_{13}PLR_{t-1} + \alpha_{14}MLR_{t-1} + \alpha_{15}IBCR_{t-1} + \beta_{11}MPR_{t-2} + \beta_{12}3MDR_{t-2} + \beta_{13}PLR_{t-2} + \beta_{14}MLR_{t-2} + \beta_{15}IBCR_{t-2} + \beta_{16}X_t + C_1 + \epsilon_{1t} \dots\dots\dots(6)$$

To check the stability of the VAR model estimated, we plotted the *AR Roots Graph*, which reports the inverse roots of the characteristic *AR polynomial*; see Lutkepohl (1991). The graph (see appendix 2) suggests that the VAR model is stable (stationary) given that all roots have modulus less than one and lie inside the unit circle. The stability of the model is important in ensuring that the Impulse Response standard errors are all valid. Where $\alpha_{ij}, \beta_{ij}, c_i$ are the parameters to be estimated. The components of the vector X_t are known as exogenous variables given that their values are determined outside the VAR system- in other words there are no equations in the VAR with any of the components of X_t , as dependent variables. For the current study we treated oil prices and nominal exchange rates as exogenous variables.

3.2. Estimating the Directionality of Policy Rate and Money Market Rates using VAR Granger Causality/Block Exogeneity Wald Test

Block *F – tests* and Granger causality is used in identifying which of the variables in the estimated VAR model have statistically significant impacts on the future values of each of the variables in the system. Given that the money market plays a unique role in signalling the

the lag length are namely the Akaike Information Criterion (AIC) and Schwarz Criterion (SC) are computed as $AIC = -2\ln(L) + 2k$ and $BIC = \ln(n)k - 2\ln(L)$ respectively. Where: n is the number of data points in the sample, k is the total number of estimated parameters in the VAR model and L is the maximized value of the likelihood function of the model.

stance of monetary policy and in transmitting monetary policy decisions to financial markets, being able to assess the directionality of the policy rate and money market rates particularly the interbank call rate will be an important milestone in understanding the cooperative nature of these variables. The orderly functioning of the money market is crucial for the transmission of the key policy rates to the economy in general. In this section, we are interested in determining whether monetary policy causes changes in money market rates or vice versa.

Runes (1962) cited in Olushina (2012) define causality as a relationship between events, processes or entities in a time series such that the occurrence of one event will invariably lead to the occurrence of the other. This definition seems to suggest that one of the processes has the efficacy to produce or alter the other. In time series analysis, inference about cause-effect relationships hinges on the concept of Granger causality, Granger (1969)⁴. This concept is defined in terms of 'predictability' and exploits the direction of the flow of time to achieve a causal ordering of dependent variables, Eichler (2007). According to Granger (2001), if a signal X_1 Granger-causes a signal X_2 , then it implies that the past values of X_1 contains information that helps predict X_2 beyond the information contained in past values of X_2 alone.

The logic of Granger causality could be described as follows; suppose that we have three terms X_t , Y_t , and W_t , and that we want to forecast X_{t+1} using past values of X_t and W_t . and then we try to forecast X_{t+1} using past terms of X_t , Y_t , and W_t . If the second forecast is found to be more successful, then it implies that the past values of Y appears to contain information that helps in forecasting X_{t+1} that is not in past values of X_t or W_t . Specifically, W_t could be a vector of possible explanatory variables. Therefore, Y_t would Granger cause X_{t+1} if the following two fundamental principles applies: (a) Y_t occurs before X_{t+1} and (b) it contains information that is useful in forecasting X_{t+1} that is not found in a group of other appropriate variables⁵. According to principle b, the causal series must contain unique information about the series being caused that is not available otherwise.

The result from the VAR Granger causality test in table 1 (Model 1 MPR) indicates the absence of directional causality between Monetary Policy Rate (MPR), 3 Months Deposit Rate ($_3$ MDR), Prime Lending Rate (PLR), and Maximum Lending Rate (MLR). This result implies that these money market rates and monetary policy rate are independent. The absence of a significant causal relation between these deposit money bank rates seems to suggest that monetary does not have any effect on them. Therefore, changes in monetary policy stance will have no associated effect on these rates. In addition, the result suggests a bi-directional causality or bi-directional feedback between monetary policy and the interbank call rate, indicating a high correlation between the past and current values of both variables.

⁴ The mathematical formulation of Granger Causality is based on linear regression modelling of stochastic processes.

⁵ Logically, the larger W_t is, the more stringent a criterion Y_t is passing eventually, Y_t might seem to contain unique information about X_{t+1} that is not found in other variables.

Furthermore, the result from model 1 in table 1 reveals that the interbank call rate in this model should be treated as an exogenous variable. This implies that this variable is not determined within the system in the monetary policy model. A practical implication of this finding is that monetary policy seems to be ineffective in steering money market rates. However, the result from the Granger causality test will be compared with those from the Impulse Response Function (IRF) and the Variance Decomposition since the $F - test$ results does not show how long it would take for the effect of monetary policy to work through the system.

Table 1: VAR Granger Causality/Block Exogeneity Wald Test

Model 1: Dependent variable: MPR			
Explanatory Variables	<i>Chi – sq</i>	<i>df</i>	<i>Prob.</i>
<i>_3MDR</i>	3.09	2	0.21
<i>PLR</i>	2.01	2	0.37
<i>MLR</i>	0.03	2	0.98
<i>IBCR</i>	5.43	2	0.07
ALL	12.76	8	0.12

Notes: The dependent variable for this model is *MPR*, which represents the monetary policy rate. *_3MDR* denotes the weighted 3 months deposit rate, *PLR* denotes the prime lending rate, *MLR* denotes the maximum lending rate and *IBCR* represents the interbank call rate. *df* is the degree of freedom and *Chi – sq* is the *Chi square* values and *prob* is the probability values.

The result from the VAR Granger causality test in table 2 (Model 2_3MDR) suggests that maximum lending rate *MLR* and interbank call rate *IBCR* explains variations in 3 months deposit rate. Within the Granger framework, this result indicates that these two variables help in the prediction of the 3 months deposit rate. The result suggests that about 9% of the variations in 3 months deposit rate can be explained by the maximum lending rate while 25% of the variations in 3 month’s deposit rate are caused by changes in the interbank rate. In addition, the Block exogeneity Wald test suggests that all the variables in this model are determined within the system.

Table 2: VAR Granger Causality/Block Exogeneity Wald Test

Model 2: Dependent variable: <i>_3MDR</i>			
Explanatory Variables	<i>Chi – sq</i>	<i>df</i>	<i>Prob.</i>
<i>MPR</i>	3.04	2	0.21
<i>PLR</i>	2.06	2	0.37
<i>MLR</i>	9.65	2	0.00
<i>IBCR</i>	25.05	2	0.00
ALL	38.72	8	0.00

Notes: The dependent variable for this model is *_3MDR*, which represents the 3 months, deposit rate. *MPR* denotes the monetary policy rate, *PLR* denotes the prime lending rate, *MLR*

denotes the maximum lending rate and *IBCR* represents the interbank call rate. *df* is the degree of freedom and *Chi – sq* is the *Chi square* values and *prob* is the probability values.

However, monetary policy and prime lending rate has no causal effects on the deposit rate. This finding is quite disturbing given that effective monetary policy should have an efficient bank pass through channel. This result seems to suggest that there might be other important factors that determine the bank deposit rate. A practical implication of this finding is that deposit money banks do not take changes in the monetary policy rate in setting the deposit rate.

Table 3: VAR Granger Causality/Block Exogeneity Wald Test

Model 3: Dependent variable <i>PLR</i>			
Explanatory Variables	<i>Chi – sq</i>	<i>df</i>	<i>Prob.</i>
<i>MPR</i>	0.41	2	0.81
<i>_3MDR</i>	10.37	2	0.00
<i>MLR</i>	13.43	2	0.00
<i>IBCR</i>	3.15	2	0.21
ALL	31.90	8	0.00

Notes: The dependent variable for this model is *PLR*, which represents the prime-lending rate. *MPR* denotes the monetary policy rate, *_3MDR* denotes the 3 months deposit rate, *MLR* denotes the maximum lending rate and *IBCR* represents the interbank call rate. *df* is the degree of freedom and *Chi – sq* is the *Chi square* values and *prob* is the probability values.

Model 3 in table 3 shows that only the 3 months deposit rate and maximum lending can explain future paths of prime lending rate. Specifically, 10% and 13% of the changes in *PLR* can be explained by changes in the 3 months deposit rate and the maximum lending rate, while monetary policy and the interbank call rate have no past or future predictive powers on the variable.

Table 4: VAR Granger Causality/Block Exogeneity Wald Test

Model 4: Dependent variable <i>MLR</i>			
Explanatory Variables	<i>Chi – sq</i>	<i>df</i>	<i>Prob.</i>
<i>MPR</i>	4.03	2	0.13
<i>_3MDR</i>	0.58	2	0.75
<i>PLR</i>	0.77	2	0.68
<i>IBCR</i>	12.77	2	0.00
ALL	23.35	8	0.00

Notes: The dependent variable for this model is *MLR*, which represents the maximum lending rate. *MPR* denotes the monetary policy rate, *_3MDR* denotes the 3 months deposit rate, *PLR* denotes the Prime lending rate and *IBCR* represents the interbank call rate. *df* is the degree of freedom and *Chi – sq* is the *Chi square* values and *prob* is the probability values.

The result from table 4 (model 4) reveals that only the interbank call rate can explain variations in the maximum lending rate. Quantitatively, approximately 13% of the changes in maximum lending rate can be explained by the changes in the interbank call rate. Monetary policy rate is again insignificant in this model. The Wald $F - test$ in this model suggests that all the variables in this model can be considered as endogenous.

The results from the Granger causality analysis ($F - test$) does not reveal whether changes in the values of these variables have a negative or positive impact on the other variables in the system or how long it would take for the effect of that variable to wear out. We will analyze the sign and persistence of the effect of the target variable on all the other variables via the examination of the VAR's impulse responses and variance decompositions.

Table 5: VAR Granger Causality/Block Exogeneity Wald Test

Model 5: Dependent variable <i>IBCR</i>			
Explanatory Variables	<i>Chi - sq</i>	<i>df</i>	<i>Prob.</i>
<i>MPR</i>	5.46	2	0.07
<i>_3MDR</i>	0.32	2	0.85
<i>PLR</i>	7.34	2	0.03
<i>MLR</i>	0.99	2	0.61
ALL	23.35	8	0.04

Notes: The dependent variable for this model is *IBCR*, which represents the interbank call rate. *MPR* denotes the monetary policy rate, *_3MDR* denotes the 3 months deposit rate, *PLR* denotes the Prime lending rate and *MLR* represents the maximum lending rate. *df* is the degree of freedom and *Chi - sq* is the *Chi square* values and *prob* is the probability values.

3.3. Quantifying Shocks to Monetary Variables Using Impulse Response Function

To quantify the effect of a shock to monetary policy rate and the other money markets rates over time we calculated the impulse response function (IRF). The logic of impulse responses is that a shock to any of these variables not only directly affects that particular variable but is also transmitted to all of the other endogenous variables through the dynamic lag structure of the VAR. Therefore, an Impulse Response Function (IRF) traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. Appendix 2 shows the dynamic response of the target variable to a one-standard deviation shock on itself and the other variables. The horizontal line (X-axis) presents the 12 months following the shock while the vertical axis (Y-axis) measures the monthly impact of the shock on each endogenous variable. Provided the system is stable, the shock should gradually die away.

In this analysis we are interested in the response of the money market rate to a shock in monetary policy as well as the response of monetary policy rate to a shock in money market rates. The impulses were transformed to *Cholesky - dof adjustment* that uses the inverse of the Cholesky factor of the residual covariance matrix to orthogonalize the impulses.

4. Conclusion and Policy Implications

Our study employs a two lag VAR to model the interaction between monetary policy and money market rates in Nigeria as a first step towards searching for appropriate macroprudential levers. Given the paucity of macro prudential data in Nigeria, the study only modelled the interaction between the policy rates and deposit bank rates including the 3 months deposit rate, prime lending rate, maximum lending rate and interbank call rate. The idea is to ascertain the efficacy of the credit channel (affects the deposit rate) and money channels (affects the lending rate) of monetary policy transmission mechanism in Nigeria. The aim of this preliminary analysis is to identify potential macroprudential levers that can be used in reducing the overall level of leverage in the economy or changing the attitudes held by banks about assuming risk. This is expected to crucially impact on the likelihood of asset and credit bubbles forming and inflating, as they did during the periods leading up to the global financial crisis.

We found conflicting results on the credit and money channel monetary policy transmission mechanisms. First the Granger causality tests which is used to measure the precedence and information content of variables seems to suggest that monetary policy has no significant explanatory power for changes in 3 months deposit rate, prime lending rate and maximum lending rate while the policy rate has explanatory power for the interbank call rate. It is possible to state that the interbank call rates Granger-causes the short-term policy rate and the policy rate Granger-causes the interbank call rate i.e. a bi-directional feedback loop.

This is a bizarre result given that a central bank achieves its economic targets by adjusting monetary market interest rates. To further consider the effect of monetary policy on money market rates, the impact multipliers (Cholesky d.f. adjustments impulse responses) were calculated for the estimated VAR model. Two standard error bands were calculated using the Monte Carlo integration approach employed by McCue and Kling (1994) with 500 replications. The result shows that a one-unit shock in monetary policy will lead to a 13% change in the deposit rate after the second month while the same shock will result in a 13% increase in lending rate after the 13th month. A practical policy implication of this finding is that when the central bank adjusts the interest rate, banks are unlikely to simultaneously adjust their lending and deposit rates. In other words, sticky-lending and deposit rates may reduce the effects of monetary policy on money market rates. Our analysis of the Impulse Response Function (see appendix 2) IRF suggests that more than 36% variations in the interbank call rates can be attributed to changes in the policy rate in the first month, this increase to 67% after the second months and gradually dies down after some time. The forecast error variance is also decomposed to determine the proportion of the movements in the monetary policy series and the interbank call rate series that are a consequence of their own shocks rather than shocks to other variables. We found a high level of persistence in the policy series. Specifically, 100 percent of the movement in the policy rate in the first month can be attributed to its own shock. For the interbank call rate we found that in the first month 97% of the changes in this series can be attributed to its own shock while the rest are shocks from other variables.

It is important to mention that in this model we considered exchange rate and oil prices as been determined outside the system. With these findings, we will now consider the interbank call rate as a potential tool that may be used to reduce the buildup of excessive leverage within the system. In other words, we will use it as a potential macro prudential tool, in addition, the interest rate spread or the money market spread will also be used in the estimation. We will interact these variables with monetary policy, and other macroeconomic variables and financial market variables to see how they behave within the system. Before producing detailed policy implications of our findings.

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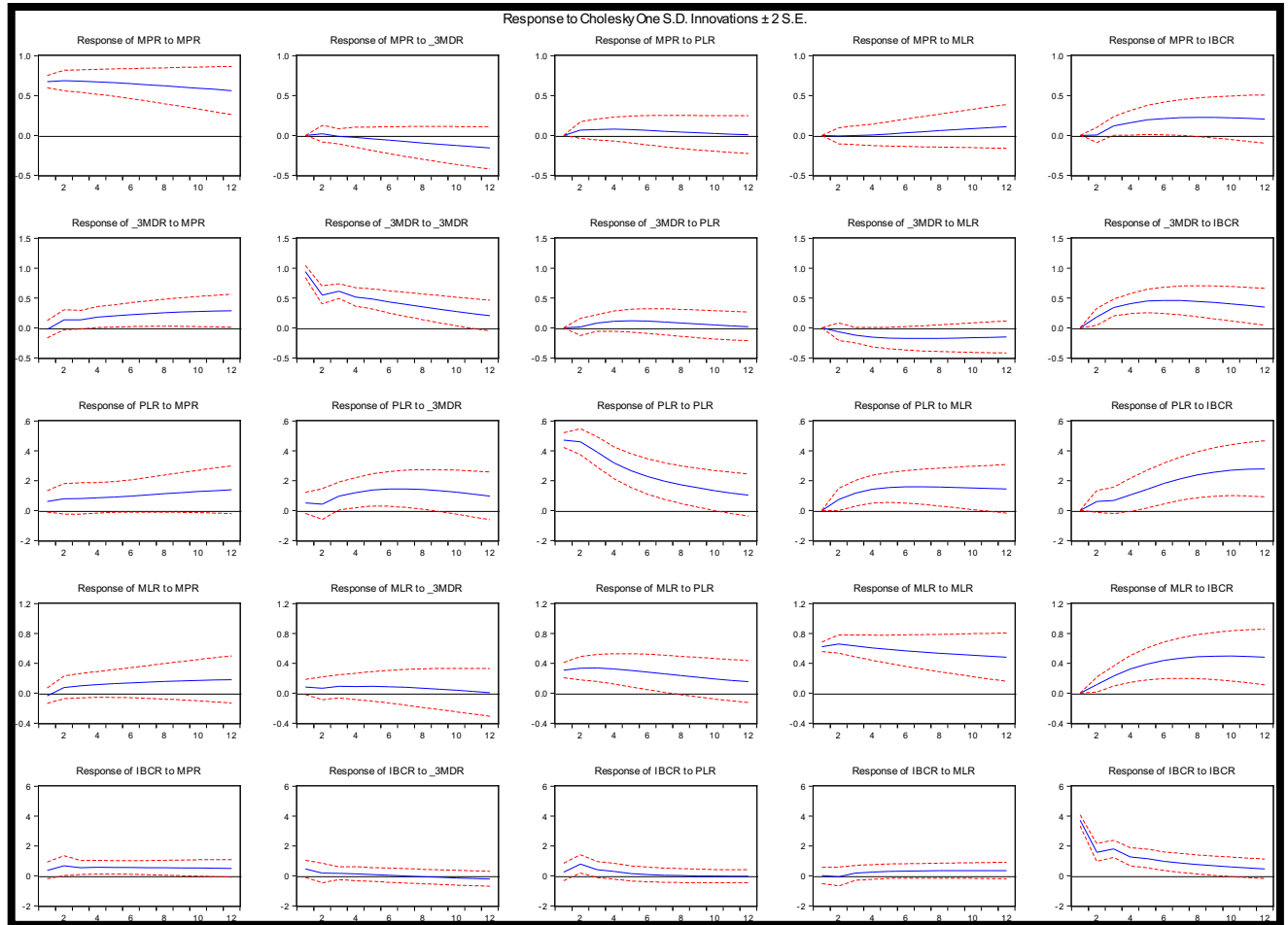
Appendix 1: Key Monetary and Macroprudential Variables Currently Monitored in Nigeria

Variable Name/ Notation	Description and Signaling Properties
M1- Narrow Money	<p>Narrow money is made up of currencies, (that is paper notes and coins in circulation) and demand deposits. It is regarded as liquid component of money supply. Narrow money consists of currency outside banks (COB) plus demand deposits.</p> <p>Narrow Money (M1) = Currency Outside Bank (COB) + Demand Deposits (DD)</p>
M2- Broad Money	<p>Broad money is a broader measure of money supply, in terms of its composition and refers to the total value of money in the economy. Broad money includes narrow money and quasi-money. Quasi money is the summation of savings deposits (SD), time deposits (TD) and foreign currency deposits (FCD) with the deposit money banks.</p> <p>Broad Money (M2) = Narrow Money (M1) + Quasi-Money (QM)</p> $M2 = \{COB + DD\} + \{SD + TD + FCD\}$ $M2 = M1 + QM$ $M2 = COB + DD + SD + TD + FCD$
M2/GDP – Broad money to GDP	<p>A high M2/GDP ratio triggers concern for oversupply of money or excess liquidity in the system, which could in turn trigger inflation risks. Excess liquidity is the amount of liquidity over and above the optimum level of liquidity, determined by the levels of output and prices.</p>
NFA – Net Foreign Assets	<p>Net Foreign Assets (NFA) is the total value of foreign assets held by the monetary authority and deposit money banks, less their foreign liabilities. Net foreign assets (NFA) of the banking system are the net position of the current account balance (CAB) plus the net capital inflow from the rest of the world to the economy. It is the channel through which international transactions impacts are transmitted to the domestic economic conditions.</p> <p>NFA = Foreign Assets – Foreign Liabilities</p>
NDC – Net Domestic Credit	<p>Net Domestic Credit (NDC) is a summation of credit to the private sector and credit to the government. Changes to NDC reflect the expansion in credit to the private sector as well as claims on the Federal Government.</p>
RM – Reserve Money or Base Money	<p>Reserve money (RM), also referred to as high-powered or base money, comprises certain liabilities of the CBN and includes currency with the non-bank public and total bank reserves. The main sources of monetary base are the net foreign assets of the CBN, net claims on government, claims on deposit money banks, and other assets (net) of the CBN. This can be expressed mathematically as:</p> <p>Reserve Money (RM) = reserves of DMBs (R) + currency with the non-bank public (CIC)</p> $RM = R + CIC$
CRR – Cash Reserve Ratio	<p>This is the percentage of deposit liabilities of DMBs that is required to be kept in liquid form with the Central Bank. The CRR is a prudential tool used by central banks to influence the supply of money. A slight change in the CRR may produce significant effect on the money multiplier and also affects the credit-creating ability of the DMBs.</p>
LR- Liquidity Ratio	<p>The liquidity ratio defines the volume of liquid assets in the total deposit liabilities of a given bank and it is a prudential requirement aimed at protecting the bank's customers. Just like the CRR, it is also a prudential tool used by the CBN to influence money supply.</p>
RES – External Reserves	<p>External reserves are assets held by the central bank usually in various reserve currencies, mostly the US dollar, and to a lesser extent the euro, GBP and Japanese yen. They are used by the monetary authority to back its liabilities (e.g. the local currency issued, and the various bank reserves deposited with the central bank by the government or by financial institutions). Higher external reserves signal a greater ability of the monetary authority to back its local currency and hence leads to an appreciation of the local currency. A continuous fall in international reserves (e.g. via a fall in exports or rise in fiscal deficit) may signal domestic currency depreciation and hence a potential future speculative attack (i.e. investors supply more of the local currency by purchasing and keeping more of foreign currency). In Nigeria, which is almost solely dependent on crude oil, external reserve accumulation is exogenously determined by international price of crude oil.</p>
FD- Fiscal Deficit	<p>Rising budget deficit may imply increasing central bank financing of fiscal activities and hence loss of reserve money.</p>
CPS – Credit to Private Sector	<p>Credit to the private sector (CPS) consists of all forms of loans and advances extended by the DMBs to households and businesses as well as other forms of debt instruments incurred. Excessive growth in CPS could signal high leverage in the economy and could lead to higher risk of non-performing loans or defaults.</p>

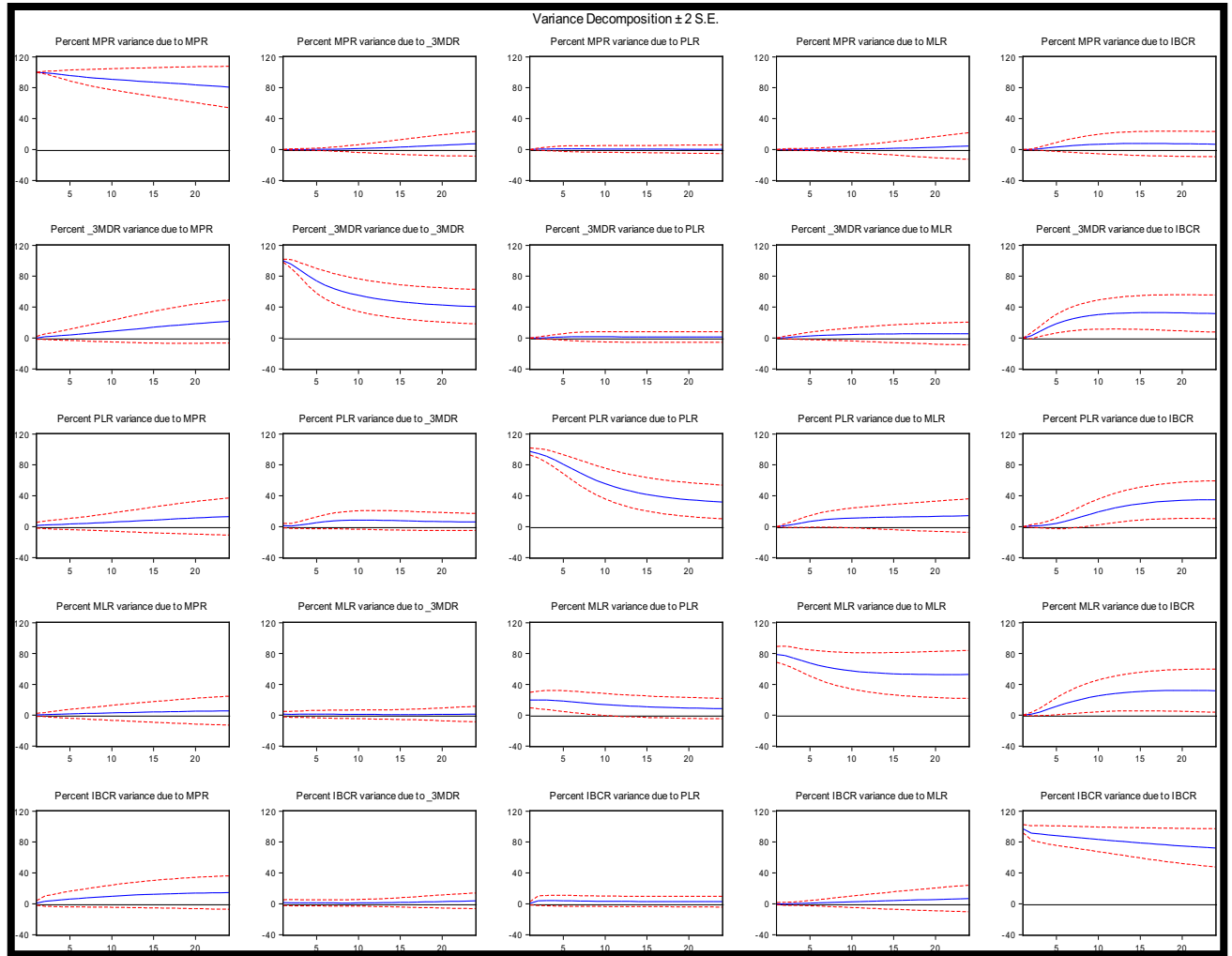
CGDMB – Credit to Government by Deposit Money Banks	Credit to Government consists of all forms of loans or credit granted to the Federal Government and the subnational governments by DMBs. Higher ratio of government credit to total credit relative to private sector credit shows competition for private sector credit and possible crowding out of private investment.
BCRE - Bank Credit to Real Estate and Construction	This variable measures the amount of bank credit that is allocated to the real estate and construction sector. It signals the amount of leverage in that single sector and excessive growth in this indicator could fuel real estate bubbles, particularly where a major economic shock hits households and corporates who take on residential and commercial mortgages respectively, leading to massive defaults and shrinking of bank balance sheets. BCRE is a new variable that is only available from December 2006 in Nigeria.
NER – Nominal Exchange Rate	NER measures the price of the local currency relative to the US dollar. Exchange rate fluctuations have grave consequences for economic activities. For example, exchange rate depreciation makes imports more expensive and would reduce the value of banking sector liabilities denominated in foreign currency. Nigeria's exchange rate is mainly determined by oil prices and the value or income from oil exports.
HCPI – Headline Consumer Price Index	Headline CPI measures the general price level (or purchasing power) of all goods and services in the economy. CPI is a key macroeconomic activity variable, since price stability (or low inflation) promotes efficiency and long-term economic growth. Conversely, high inflation promotes uncertainty, discourages savings and investment.
RGDPGR – Real GDP Growth Rate	This variable indicates how much the domestic economy grows each year, shown as a percentage and adjusted to remove the effects of inflation. Excessive growth rate of the GDP may signal an economic bubble or unsustainable economic growth. On the other hand, too slow GDP growth rate or a reduction in real growth may imply dwindling economic activities or weakening macroeconomic fundamentals.
MPR – Monetary Policy Rate	The Monetary Policy Rate (MPR) is the nominal anchor for monetary policy in Nigeria and influences the level and direction of other interest rates in the domestic market. The MPR signals the monetary policy stance of the CBN to market operators, hence guiding the way the CBN policy rate influences credit availability, as a lender-of-last resort to DMBs.
TBR – Treasury Bill Rate	The treasury bill rate, which is the rate at which bills are discounted at the market is the most competitive and representative rate aside from the deposit rate in the money market. It is quoted in various maturities ranging from 90 days, 180 days and 360 days corresponding to the 3-month, 6-month and 12-month deposit rates. It actually determines the portfolio preferences of the investing public. Excessively high TB rates relative to lending rates can encourage banks to simply invest more in risk-free government bonds and thereby act as disincentives for real sector financing. High TB rates also signal excessive deficit financing of the government.
Interest Rates (deposit and lending rates)	Interest rates are a potent tool for policy makers as it affects the level of domestic and foreign investment as well as the exchange rate. Interest rate, thus, significantly affect the macroeconomy in several aspects. For instance, an increase in interest rate dampens aggregate demand, exacerbates inflationary pressures, and decelerates capital spending, investment, output and employment. In addition, higher domestic interest rate worsens the current account position of the balance of payments in the face of capital inflows, deterioration in domestic exchange rate, and the decline in the demand for locally produced goods, as well as increase in national debt depending on the source of financing fiscal deficits.
Interest Rate Spread (PLR-3MDR)	Interest spreads are a measure of bank competition. Narrower gaps between PLR and 3MDR signals increasing competition, which may lead to greater risk taking.
IBCR – Interbank Call Rate	This is the rate at which banks lend to each other in the money market. It is rate at which the bank rediscounts bills of exchange and other eligible instruments. In unsophisticated or rudimentary markets like those in the emerging economies, the interbank call rate (IBCR) is employed by the central bank in the extension of credit to the borrowers in the economy. The IBCR is also a proxy for the degree of availability of liquidity in the economy.
OP - Oil Prices (Bonny Light Crude Oil)	Crude oil price is a major indicator for Nigerian economy, which runs mainly on a single commodity (crude oil accounts for 75% of total government revenue and 95% of Nigeria's foreign exchange earnings). Falling oil prices will lead to loss of government revenue, exchange rate depreciation or devaluation and increase in government deficit financing, among other economic implications for the private sector.
ASI – All Share Index	The all share index tracks the general market movement of all equities listed on the stock exchange. Stock price indices are a general measure of economic performance and vulnerability to financial crisis. It also helps to track the value of stock assets used as collateral for margin loans.

Source: CBN (2010, 2012, 2013), authors' own explanations.

Appendix 2: Response to Cholesky One S.D Innovations



Appendix 3: Variance Decomposition ± 2 S.E



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