Prices and Output Response to Monetary Policy Variation in Nigeria

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Successful policy implementation often requires an accurate assessment of the magnitude at which the effect of monetary policy change propagates to other sectors of the economy. For this reason, a thorough understanding of the mechanism through which monetary policy affects targeted economic variables is necessary. This study used innovation accounting in a SVAR model to establish that monetary authorities in Nigeria employed a hybrid of operating procedures and also pursued price stability and growth objectives. Employing Impulse Response Functions (IRFs) and Variance Decompositions (VDs) to examine the dynamic responses of the variables to various shocks within the SVAR system on monthly data from 2000:Q1 to 2012:Q4, bank interest rate and reserve money were identified as the two operating targets of the Central Bank of Nigeria (CBN). The study established that reserve money was a more effective measure of monetary policy than bank rate and also that bank lending was the monetary policy transmission channel in Nigeria. We therefore recommended that CBN should focus primarily on price level stability rather than combine it with output growth since achieving the former has the tendency of fostering growth in output.

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Statement of the Problem

Money plays a pivotal role in the dynamics of activities in any economy. Thus, to preserve this important role of money, the Nigerian government reposed the task of designing an appropriate monetary policy (MP) to maintain a stable price level, among other important functions, with the Central Bank of Nigeria (CBN) as contained in the CBN Act of 2007. However, the impact of policies designed by the Central Bank on the economy as a whole, especially the channels through which they affect prices and output among other macroeconomic variables, have remained a key issue in macroeconomic theory and policy.

Some of the challenges confronting the central bank generally include knowing the appropriate MP instrument to choose for a particular policy action and the subsequent response from the economy. Also, the central bank's choice of instruments for attaining its desired objectives at any particular time has been influenced by many factors. These include the structure...
of the economy, the state of development of the money and capital markets and the institutional and legal frameworks within which the financial system operates.

In Nigeria, the main instrument of MP was the exchange rate, fixed as per between the Nigerian naira and the British pound between 1959 and 1967. Due to apprehension that devaluing the naira would raise the prices of imports without any appreciable impact on exports, given the large resources gulped by the civil war, the CBN became obsessed choosing rather to maintain the existing exchange rate and ultimately peg the currency to the US dollar. However, following the international financial crises of the early 1970s when it affected the US dollar, this rate was abandoned for the status quo. In 1973, when it was again pegged to the US dollar. Ultimately in 1978, the naira was pegged to a basket of 12 currencies of Nigeria’s major trading partners.

With the dominance of Nigeria’s foreign currency revenue by proceeds from crude oil export to as much as 57.6 percent in 1970 and 96 percent in 1980, the conduct of MP shifted to Monetary Targeting (MT), controlling the monetary aggregates (Nnanna, 2008). This involved the use of market (indirect) and non-market (direct) instruments. The CBN imposed quantitative interest rate in an effort to promote rapid and sustainable economic growth. However, the interest was too high and therefore determined minimum reduction rate. In addition to regulating deposit and lending rates, it also placed sectoral lending directives on banks deposits.

Notably, the poor performance of Nigeria’s real sector and the prevailing structure of the economy has remained major challenges in the formulation and implementation of an appropriate MP by the CBN. Thus, while the monetary authority grew the economy’s broad money (M2) at an average of 36.5 percent and 18.8 percent between 1975 and 1979 as well as 1980 and 1984 respectively, the corresponding growth in the economy’s output (GDP) for this same period stood at 17.5 percent and 7.5 percent. Furthermore, the use of various monetary instruments by the CBN to achieve its targeted inflationary rate of five percent in 1992, 25 percent in 1993, and 17.5 percent in 1995 escalated to 44.59 percent, 57.52 percent, and 72.81 percent respectively. Policy related questions arising from these are: How are MP shocks propagated through the economy? What is the appropriate monetary instrument for achieving the CBN’s objective? Which of the monetary transmission channels of MFIs in existence in Nigeria? Addressing these and other related issues constitute the main thrust of this study.

Concept of Monetary Policy in Nigeria

Monetary policy, a major economic stabilisation tool, can be described as a deliberate effort by the monetary authority to introduce with the level of economic activities, to control the monetary supply and credit conditions, for the purpose of achieving economic objectives. Meanwhile, since 1992, designed by the CBN, over the years, the conduct of MP in Nigeria has evolved from a system of dual targeting to a system of single targeting.

Under the colonial government, the conduct in Nigeria was largely dictated by the prevailing economic conditions in Britain. Thus, the instrument of MP at that time was the exchange rate. Between the Nigerian pound and the British pound. This was very convenient, as pegging the exchange rate provided a more effective mechanism for the maintenance of balance of payments stability, and controls over inflation in the Nigerian economy.

Between this period and 1982, the MP objective became that of accommodating the pace of rapid and sustainable economic growth and development, maintaining domestic price stability and a healthy balance of payments position. Also, during this period and until the adoption of the SAP in 1986, the conduct of MP in Nigeria relied mainly on direct control
measures, involving the imposition of aggregate credit ceilings and selective sectoral control, interest rate controls, cash reserve requirements, exchange rate control and call for special deposits. The use of market-based instruments such as open market operations was not feasible because of the underdeveloped structure of the financial market, characterised by limited menu of money market instruments, fixed and inflexible interest rates, and restricted participation in the market. Beginning from September 1973, selective removal of all credit ceilings for some banks was carried out by the monetary authority. Series of amendment to the Central Bank’s Act was also carried out to reduce the influence exerted by the Ministry of Finance on the conduct of MP. With the amendment granting more autonomy and discretion to the CBN in the conduct of MP, the focus of MP shifted significantly from growth and development objectives to price stability. Under the operational framework of market (indirect) instruments; only the operating variables, the monetary base or its components are targeted while the market is left to determine the interest rates and credit allocation.

**Literature Review**

Various transmission mechanisms through which the MP can affect economic activity have long been established by theory and evidence hence, we provide a brief highlight of some of these channels. In the light of the complexity shrouding this subject, tagging the monetary transmission mechanism as ‘black box’ seems accurate since there are not one but many channels through which MP simultaneously operates. Observably, depending on the state of payments system and the money (especially financial) markets, the relative strength of the various channels vary from country to country. Thus, beginning with the transmission of Open Market Operations (OMOs) to money market interest rates; the process passes through the reserves market or more broadly to market interest rate through the supply and demand for money. Some of the major channels identified in the literature include the interest rate, the exchange rate and the credit channels. A brief review is provided below.

**i) The Interest Rate Channel**

The interest rate channel, originated by Hicks (1937), provides the foundation for the traditional Keynesian IS-LM model. According to this theory, all agents in the economy hold only two types of assets, namely money and bonds as a superficial collection of all other financial assets. A monetary expansion through an open market purchase of bonds, the theorists claim, will lead to an excess supply of money thus making economic agents hold more money and fewer bonds. Therefore for equilibrium to exist in the assets market, short term interest rate should fall to make economic agents accept extra money holdings. This fall in interest rate will lead to an increase in investment spending (due to decrease in the capital cost of financing investment) which will ultimately cause an increase in aggregate demand and output.

**ii) The Exchange Rate Channel**

This channel examines the relationship between net private capital inflows and monetary policy and how an alteration of the interest rate alters the attractiveness of a country’s currency. This channel posits that an increase in the domestic currency’s attractiveness will cause foreign investors to shift part of their investment to financial assets denominated in this currency. The currency, therefore, appreciates and lowers the competitiveness of the domestic industry which ultimately results in a decline in net exports (Kuttner and Mosser, 2002).

The exchange rate channel also involves interest rate effects (Mishkin, 1995). On the demand side, an expansionary monetary policy lowers domestic interest rate. The fall in interest rate causes deposit in the domestic currency and credit in foreign currency to become less attractive thus bringing about a real
depreciation of the domestic currency. This in turn leads to high net export and a strong aggregate demand (Obstfeld and Rogoff, 1995). On the supply side, the real depreciation that results from monetary expansion raises the domestic prices of imported goods thus raising inflation directly. In addition, the high price of imported inputs contracts aggregate supply, reduces output and increases inflation. Thus, an expansionary monetary policy that results into a fall in domestic interest rate, will cause an outflow of capital according to this channel. The outflow of capital puts pressure on the exchange rate and this leads to a depreciation of the domestic currency. Depreciation makes the foreign price of exports relatively cheap (expanding exports) and the domestic price of imports expensive (reducing imports) hence, leading to an increase in net exports. The increase in net exports leads to an increase in aggregate demand and output.

The Credit Channel

The literature describes two versions mainly the bank lending and balance sheet channels. Unlike the interest rate channel, it shows an indirect impact of MP on the real economy. Its emphasis is on how imperfect information and other “frictions” in the credit market work as an important channel of MP. Due to information asymmetry in the credit market and enforcement cost, Bernanke and Gertler (1995) argue that, principal-agent problems arise in the financial market and create an external finance premium. They therefore postulate that: variations in monetary policy stance alter the external finance premium facing borrowers and that small firms which rely more on bank credit and have limited access to external funds than large ones could be expected to be more affected by an increase in interest rate. They submit that the credit channel is not really an independent alternative to the traditional interest rate mechanism but rather an amplifying mechanism. The strength of this effect however depends on the health of the banking system and the degree to which it can react to policy changes.

The Bank lending channel postulates that banks play an important role in an economy by issuing liabilities (bank deposits) that contributes to the broad monetary aggregates and by holding assets (bank loans) which scarcely has any substitute. The proponents of this channel therefore emphasise that for many banks; deposit represent the principal source of funds for lending and that for many firms, bank loans represents the principal source of funds for investment. Thus, variation in monetary policy stance affects the external finance premium through the shifts in the supply of intermediated credits especially the quantity of loans supplied by the banking institutions to the credit markets.

The Balance Sheet Channel though operates via the net worth of business firms (Bernanke and Blinder, 1988) rest on the notion of asymmetric information in credit markets and emphasises the role of collateral in reducing moral hazards. Business firms with low net worth clearly signal to the lenders that there is less collateral for their loans, and so lenders are weary that losses from adverse selection may be high. Therefore, a low net worth raises the adverse selection problem thus leading to decreased lending to finance investment spending. Additionally, low net worth of business firms increases the moral hazard problem because it means that owners have a low equity stake in their firms, giving them more incentive to engage in risky investment projects. Since undertaking more risky investment projects makes it more likely that lenders will not be paid back, a decrease in business firms’ net worth leads to a decrease in lending and hence in investment spending (Mishkin, 1995).

Methodology

The SVAR framework/methodology based on Sims (1986) was employed to explain the dynamic effect of monetary policy shocks on output and price level in the Nigerian economy. The methodology is utilized in recent empirical studies (Morsink and Bayoumi, 2001;
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Suppose Nigeria's monetary transmission process is described by a dynamic system whose structural equation written in a compact form is denoted as

\[ A x_t = C(L)x_{t-1} + Dz_t \]  

where \( A \) is an invertible \((n \times n)\) matrix of variable coefficients describing contemporaneous relations among the variables. The elements of the square matrix, \( A \), are the structural parameters on the contemporaneous endogenous variables and \( C(L) \) is a \( k \)th degree matrix polynomial in the lag operator \( L \).

\( D \) is a matrix whose non-zero off–diagonal elements allow for direct effects of some shocks on more than one endogenous variable in the system. The vector \( Z \) above is assumed to consist of unobservable variables, interpreted as disturbances to the structural equations while and are vectors with length equal to the number of structural equations in the model.

The key features of the structural form of the model are that there may be simultaneous links between the elements of vector, defined by the matrix of coefficients. Thus, to transform the structural VAR specification model in equation (1) into a reduced-form/standard VAR representation model, we pre-multiply it by as follows:

\[ x_t = A^{-1}C(L)x_{t-1} + A^{-1}Dz_t - - - (2) \]

which in standard matrix form is written as follows, with \( x_t \) defined exclusively in terms of a vector of predetermined variables:

\[ x_t = \sum^k \Psi_i x_{t-i} + e_t - - - (3) \]

Where: \( \Psi_i = A^{-1}C \) and \( e_t = A^{-1}Dz_t \) is an \((n \times 1)\) vector of error terms assumed to have zero means, constant variances and to be serially uncorrelated with all the right hand side variables as well as their own lagged values though they may be contemporaneously correlated across equations. The variance-covariance matrix of the regression residuals in equation (3) is defined as \( E(c_t, c_t) \). Given the estimates of the reduced form VAR in equation (3), the structural economic shocks are separated from the estimated reduced form residuals by imposing restrictions on the parameters of matrices \( A \) and \( D \) as presented in equation (4):

\[ A e_t = D z_t - - - (4) \]

which derives from equation (3).

In estimating the reduced-form VAR model depicted by equation (3), the issue of whether the variables in the system need to be stationary still remains. As a result of the non-stationarity of most of economic time series data, empirical research on the VAR model has been conducted using the first differences of the series and a unit root process of the structural innovations, whereas, differencing the data prior to estimation have the tendency of obscuring the long run equilibrium relationship that may exist among the non-stationary data under consideration.

The identification of the relevant structural parameters, given the estimation of the reduced form, is the most traditional problem in econometrics and requires the imposition of some restrictions on the elements of \( A \) and \( D \). A structural model is then identified by (i) assuming orthogonality of the structural disturbances, \( e_t \); (ii) imposing that macroeconomic variables do not simultaneously react to monetary disturbances with contemporaneous reaction.
variables, while the simultaneous feedback in the reverse direction is allowed for, and (iii) imposing restrictions on the monetary block of the model reflecting the operational procedures implemented by the monetary policy maker (Favero, 2001).

The orthogonality assumption of the structural innovations, \( E(\xi, \eta) = 1 \), and the constant variance-covariance matrix of the reduced-form equation residuals, \( E(\epsilon_i, \epsilon_i') = 1 \) impose identifying restrictions on \( A \) and \( D \) as presented in equation (5):

\[
A \sum A' = DD' - - - (5)
\]

Data, Data Sources and Measurement of Variables

The study employs monthly time series data from 2000:1 to 2012:12 sourced from the CBN official website www.cenbank.gov.ng. While the GDP series were interpolated using quadratic-match average. The period above reflects the true post-democracy performance of the study's macroeconomic variables of interest. These variables, with the exception of bank rate, are seasonally adjusted and expressed in natural logarithms.

Bank rate (BR) is proxy for the minimum rediscount rate (now monetary policy rate-MPR), the rate at which the central bank discount bills for commercial banks and discount houses in its function as the lender of last resort. The variable enters the SVAR as an instrument target of MP. Reserve money (RM) is also employed as an instrument target of monetary policy in the SVAR. Components of RM are identified as total cash reserves held by the central bank, vault cash in commercial banks and currency held by the non-bank public. The variable CPS captures commercial bank loans and advances to the private sector and it enters the SVAR as an intermediate target of MP. Similarly, exchange rate (EXR) enters the SVAR as an intermediate target of MP. Nominal effective exchange rates of the Nigerian naira (₦) vis-à-vis the United States dollar (USD) are used as a proxy. Aggregate money supply is measured by the sum of currency in circulation, demand deposits plus savings and time deposits (M2). This variable also enters the SVAR as an intermediate target of MP. Consumer prices (CPI) are measured by the all items national composite consumer price index. The variable enters the SVAR as a MP goal. A measure of output (GDP) enters the SVAR as a MP goal as well.

Subjecting the variables to stationarity test reveals that they are mostly I(1). Nonetheless, we proceed with analysis of the SVAR in levels consistent with standard practice in the literature. Sims, Stock and Watson (1990) argue that transforming a model to stationary form when variables are I(1) is unnecessary because the statistics of interest have distributions not affected by non-stationarity. In addition, the residuals are stationary even with I(1) variables, because of the inclusion of lagged levels of the variables in the SVAR (Becklelmans, 2005). Other studies that have followed this approach include Sims (1992), Bernanke and Mihov (1995), Ramaswamy and Stock (1998), Brischetto and Voss (1999), Kim and Roubini (2000), Dungey and Pagan (2000), Piffanelli (2001) and Ngalyawa (2009).

Empirical Findings and Analysis

Testing for stationarity

Choosing the most appropriate unit root test is empirically difficult. Thus, to resolve this problem, Enders (2004) opines that a safe choice is to use both types of unit root tests—the Augmented Dickey–Fuller (ADF), (1981) and the Phillips–Perron (PP) (1988) if they reinforce each other, then we have confidence in the results. Using both tests, the unit root tests were performed at level and at first difference for both with the intercept, and with the intercept and trend term. The optimum lag was selected by using the Schwartz Information Criterion (SIC) (as suggested by Pesaran and Shin, 1997) (Appendix A1). A summary of the ADF
unit root test result is presented in Table 1. Aside from LNRM, which is stationary at levels under intercept and trend for both the ADF and PP tests, the two tests' results show that all the variables are non-stationary at levels rather at first difference.

In Figure 1 below, where we show the response of the CBN to shocks in the policy goals, we present the impulse responses of the bank rate and reserve money to structural one standard deviation innovations in prices and output over a three-year horizon. Impulse responses of output and consumer prices to own shocks are also presented in the same figure.

### Table 1 ADF and PP Unit Root Tests Results for Stationarity of the Variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF (using SIC)</th>
<th>PP (with Newey-West using Bartlett kernel)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Levels</td>
<td>First Diff.</td>
</tr>
<tr>
<td></td>
<td>Intercept</td>
<td>Int./Trend</td>
</tr>
<tr>
<td>LNRGDP</td>
<td>-7.04776</td>
<td>-0.527264</td>
</tr>
<tr>
<td>LNM2</td>
<td>-1.149601</td>
<td>-2.385687</td>
</tr>
<tr>
<td>LNRM</td>
<td>-1.327249</td>
<td>-4.428452</td>
</tr>
<tr>
<td>BR</td>
<td>-0.717168</td>
<td>-3.703887</td>
</tr>
<tr>
<td>LNCPI</td>
<td>-1.298858</td>
<td>-2.954715</td>
</tr>
<tr>
<td>LNEXR</td>
<td>-1.809553</td>
<td>-2.240738</td>
</tr>
<tr>
<td>LNCPS</td>
<td>-0.683204</td>
<td>-0.917394</td>
</tr>
</tbody>
</table>

Notes: (i) The automatic lag selection box which sets the maximum number of lag at 12 is chosen while *indicates at 5%.
(ii) Critical values at:
Level (with intercept) at 1% and 5% for ADF statistic are -3.473961 and -3.438515 while for PP are -3.47067 and -2.87915.
Level (with intercept and trend) at 1% and 5% for ADF statistic are -4.01718 and -3.43999 while for PP are -4.01534 and -3.43762.
First difference (with intercept) at 1% and 5% for ADF statistic are -3.471987 and -2.87972 while for PP are -3.47093 and -2.87926.
First difference (with intercept and trend) at 1% and 5% for ADF are -4.01718 and -3.438515 while for PP -4.0157 and -3.4378.

### Generic Model

Using four-variable generic model, we commence the investigation of the monetary transmission process with the vector of endogenous variables as presented in equation (6):

\[ x_t = [GDP_t, CPI_t, BR_t, RM_t] \]  \( \text{---(6)} \)

The equation separating structural economic shocks from the estimated reduced form residuals for the generic model is presented as:

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
\alpha_{11} & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & \alpha_{41} & 0
\end{bmatrix}
\begin{bmatrix}
\epsilon_t^{GDP} \\
\epsilon_t^{CPI} \\
\epsilon_t^{BR} \\
\epsilon_t^{RM}
\end{bmatrix}
= \begin{bmatrix}
d_{11} & 0 & 0 & 0 \\
0 & d_{22} & 0 & 0 \\
0 & 0 & d_{33} & 0 \\
0 & 0 & 0 & d_{44}
\end{bmatrix}
\begin{bmatrix}
z_t^{GDP} \\
z_t^{CPI} \\
z_t^{BR} \\
z_t^{RM}
\end{bmatrix}
\]  \( \text{---(7)} \)
Figure 1: Impulse Responses of Bank Rate and Reserve Money: The Generic Model

The above figure shows output shock corresponding to an unanticipated 0.18 per cent variation in output and a supply shock equivalent to an unexpected 0.11 per cent rise in consumer prices in the first quarter triggers significant responses by the central bank. The implication of this is that the CBN is concerned with inflation and economic growth in accordance with its objectives as contained in the CBN Act of 2007. The bank responds to output shock by loosening monetary policy through a decrease in the bank rate to boost the growth of output. In response to price shock, MP is tightened by raising the bank rate to arrest the increase in the consumer prices. The central bank’s response with regard to reserve money shows their determination to address any observed macroeconomic imbalance.

Following the sudden decrease in output, reserve money declines by -0.11 per cent while the unexpected rise in consumer prices triggers an increase in reserve money by 0.87 per cent.

The Impulse Responses of Output and Consumer Prices: The Generic Model

In attempting to analyse how MP goals are affected by shocks to the operating targets; we plot the impulse responses of output and consumer prices to structural one standard deviation shocks in the bank rate and reserve money. Figure 2 reveals that a MP shock corresponding to an unanticipated increase in the bank rate of about 2.02 per cent leads to output declining to
a permanent position on the baseline throughout the first four quarters. The response of price level to the monetary tightening of bank rate was found to be exactly similar to that of output maintaining a baseline position throughout the first eight quarters of the year.

Figure 2 also shows that an expansionary monetary shock equivalent to a 0.11 per cent sudden increase in reserve money in the first quarter causes a decrease in output from the baseline position in the first quarter to -0.02 per cent in the second and third quarters. However, there was a 0.03 per cent increase in output in the fourth quarter, which returned to the baseline from the fifth quarter and remained even till the ninth quarter.

Figure 2: The Impulse Responses of Output and Consumer Prices: The Generic Model
Consumer prices response to a 0.105 per cent unexpected increase in reserve money by the monetary authority is a -0.06 per cent decrease in prices which only oscillates back to baseline and changed into a 0.03 per cent rise in price in the fourth quarter. However, from the fifth quarter to the twelfth, it stabilises on the baseline. Overall, shocks to one of the MP operating targets, reserve money, attract significant output and consumer price responses. This suggests that monetary factor via reserve money remains a primary determinant of price level and output in Nigeria even though bank rate does not seem to have much impact. In essence, we can infer that reserve money remains the most effective policy instruments at the disposal of the monetary authority.

The magnitude of output seem to be more responsive to reserve money variation than bank rate connoting that the former impacts more on our target variables than the latter. The observed response of consumer prices to reserve money can therefore be interpreted to mean that the principal objective of MP in the country is price stability.

In addition, the table also shows shocks to the consumer prices and output account for less than one percent of the bank rate fluctuations throughout the quarters of the years. The lower section of the table shows that shocks to consumer prices account for an average of about 19 per cent of the reserve money fluctuations throughout the quarters. Shocks to output, on the other hand, only accounted for about 6 per cent of reserve money fluctuations in the eighth quarter of the second year. This indicates that price level and output are responsive to reserve money.

**Channels of Monetary Transmission**
The analysis further attempts to establish the specific channel of monetary transmission that exist in Nigeria.

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE</th>
<th>QUARTER</th>
<th>D(RGDP)</th>
<th>D(CPI)</th>
<th>D(BR)</th>
<th>D(RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>99.702</td>
<td>0.248</td>
<td>0.002</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>93.372</td>
<td>1.004</td>
<td>0.086</td>
<td>5.537</td>
</tr>
<tr>
<td>Consumer Prices</td>
<td>1</td>
<td>0.252</td>
<td>99.748</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.358</td>
<td>99.439</td>
<td>0.008</td>
<td>0.196</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.345</td>
<td>84.265</td>
<td>0.018</td>
<td>15.372</td>
</tr>
<tr>
<td>Bank Rate</td>
<td>1</td>
<td>0.068</td>
<td>0.007</td>
<td>99.925</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.068</td>
<td>0.008</td>
<td>99.923</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.093</td>
<td>0.879</td>
<td>97.075</td>
<td>1.954</td>
</tr>
<tr>
<td>Reserve Money</td>
<td>1</td>
<td>0.212</td>
<td>18.989</td>
<td>1.034</td>
<td>79.765</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.363</td>
<td>20.076</td>
<td>1.027</td>
<td>78.534</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>6.341</td>
<td>19.175</td>
<td>1.029</td>
<td>73.454</td>
</tr>
</tbody>
</table>

Table 2 presents variance decompositions for each variable in the model over a two-year forecast horizon. The variance decomposition shows the relative importance of each structural innovation in explaining fluctuations of the variables in the generic model. Given the two policy goals, fluctuations in the bank rate and reserve money witnessed a mixed response from the target variables. Consumer prices as well as some
Bank Lending Model
For the purpose of establishing this channel, we include the loans of commercial banks to the private sector in equation (6) to transform the generic model to a bank lending model and the corresponding vector of endogenous variables becomes:
\[ x_t = [GDP_t, CPI_t, CPS_t, BR_t, RM_t] \] -------(8)

Following the identification scheme in system of equations (6) and (7), the model is identified as:

\[
\begin{pmatrix}
1 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 \\
a_{31} & a_{31} & 1 & a_{34} & a_{35} \\
0 & 0 & 1 & 0 \\
0 & 0 & a_{53} & a_{54} & 0
\end{pmatrix}
\begin{pmatrix}
\xi^{\text{CR}}_t \\
\xi^{\text{CP}}_t \\
\xi^{\text{CS}}_t \\
\xi^{\text{CRM}}_t \\
\xi^{\text{RM}}_t
\end{pmatrix}
= \begin{pmatrix}
d_{11} & 0 & 0 & 0 & 0 \\
0 & d_{22} & 0 & 0 \\
0 & 0 & d_{33} & 0 \\
0 & 0 & 0 & d_{44} \\
0 & 0 & 0 & 0 & d_{55}
\end{pmatrix}
\begin{pmatrix}
\xi^{\text{CR}}_t \\
\xi^{\text{CP}}_t \\
\xi^{\text{CS}}_t \\
\xi^{\text{CRM}}_t \\
\xi^{\text{RM}}_t
\end{pmatrix} \] -------(9)

Appendix B1 shows that a shock equivalent to an unanticipated marginal increase in the bank rate of about 0.001 per cent and a 0.04 per cent increase in the reserve money causes credit to the private sector to decline from 0.89 per cent in the first quarter to negative 0.23 per cent below baseline after the second quarter and remains significant even till the third quarter. The response of output to the shock in commercial bank lending shows a negative 0.12 per cent reduction in output for the second quarter and negative 0.08 per cent for the third quarter. Output response further shows some slight fluctuations, in tandem with bank lending variations, between the fifth and sixth quarters before returning to baseline in the seventh quarter.

Further, the figure also shows the response of consumer prices at a time corresponding to the period of variation in commercial bank lending. Following a shock in bank lending, consumer prices fell to -0.15 per cent and -0.10 per cent in the second and third quarters respectively, increasing slightly when bank lending returned to baseline before normalizing from the seventh quarter.

Exchange Rate Model
By including nominal effective exchange rate into the generic model for estimation, equation (6) transforms to exchange rate model and the corresponding vector of endogenous variables becomes:
\[ x_t = [GDP_t, CPI_t, EXR_t, BR_t, RM_t] \] -------(10)

Following the identification scheme in system of equations (6) and (7), the model is identified as:

\[
\begin{pmatrix}
1 & 0 & 0 & 0 & 0 \\
a_{11} & 1 & 0 & 0 & 0 \\
a_{31} & a_{31} & 1 & a_{34} & a_{35} \\
0 & 0 & 1 & 0 \\
0 & 0 & a_{53} & a_{54} & 0
\end{pmatrix}
\begin{pmatrix}
\xi^{\text{CR}}_t \\
\xi^{\text{CP}}_t \\
\xi^{\text{CS}}_t \\
\xi^{\text{CRM}}_t \\
\xi^{\text{RM}}_t
\end{pmatrix}
= \begin{pmatrix}
d_{11} & 0 & 0 & 0 & 0 \\
0 & d_{22} & 0 & 0 \\
0 & 0 & d_{33} & 0 \\
0 & 0 & 0 & d_{44} \\
0 & 0 & 0 & 0 & d_{55}
\end{pmatrix}
\begin{pmatrix}
\xi^{\text{CR}}_t \\
\xi^{\text{CP}}_t \\
\xi^{\text{CS}}_t \\
\xi^{\text{CRM}}_t \\
\xi^{\text{RM}}_t
\end{pmatrix} \] -------(11)

Appendix B2 presents impulse responses of exchange rate to own, bank rate and reserve money shocks and responses of output and consumer prices to innovations in exchange rate, bank lending rate and reserve money. As shown in the figure, a monetary tightening corresponding to an unexpected 2.02 per cent increase in the bank rate leads to no change in the exchange rate causing it to remain on the baseline throughout the first to the twelfth quarter. In line with theoretical expectations, the exchange rate does not respond to shock in the reserve money equivalent to a 1.05 per cent sudden increase hence also remaining on the baseline throughout the twelve quarters. In the same light, an exchange rate shock equivalent to a depreciation of the domestic currency by 0.55 per cent was found to attract no response in the output in the domestic economy as well as the consumer price level. Consumer prices as well as output response remain stable on the baseline beginning from the first to the twelfth quarter. The implication of this result is that variations in exchange rate, precipitated by shock in the reserve money or bank rate, does not in any way
affect the output and price levels in the domestic economy of Nigeria.

THE COMPOSITE MODEL
Preliminary inferences from the preceding section suggest that bank lending, exchange rate and interest rate channels contain important additional information for the country's monetary transmission process. A composite model of monetary transmission in Nigeria is therefore drawn from the resulting vector of endogenous variables.

\[ x_t = \{GDP_t, CPI_t, CPS_t, EXR_t, M2_t, BR_t, RM_t \} \]

identified according to system of equations (6) and (7).

Impulse Response for the Composite Model
For the composite model, the impulse responses over a three year period are presented in Appendix B3. The figure illustrates that bank lending channel (credit to the private sector) alone is the important channel of monetary transmission in Nigeria, even though appearing somewhat weak. Among the three intermediate policy targets, only bank lending channel responds marginally to reserve money shocks, while the interest rate and exchange rate channels show no significant response. The exchange rate and interest rate channels do not respond to a decrease in reserve money shock from 0.07 per cent in the first quarter to 0.03 per cent in the second quarter causes output to fall from the baseline position in the first quarter to -0.02 per cent in the second quarter. A further increase in the shock to 0.02 per cent in the fourth quarter expectedly elicits a marginal response in output to 0.01 per cent in the same quarter. However, consumer prices respond to shocks from bank lending with a decrease of -0.02 per cent in the second quarter from baseline position in the first quarter.

Variance Decomposition: Composite Model
To examine the interactions among all the variables over the impulse response horizon, the results of the forecast error variance decomposition are presented in this section. The essence is to determine the proportion of fluctuations in a given variable caused by the different shocks to all the variables in the model. Table 5.3 reports the variance decomposition of the first 12 period horizons into the future.

Interestingly, variations in output are hardly affected by other variables in the first quarter. The table also shows that the contributions of other variables are insignificant throughout the other periods. In essence, beside own contributions, output fluctuations can be attributed to marginal variations in the consumer prices from the second quarter through to the twelfth quarter, maintaining a seemingly constant trend.

Table 3 also shows that the forecast-error variance explained by own innovations in consumer prices in the first quarter amounts to 97.34 per cent.
while the remaining 2.66 per cent is explained by variations in the level of output. Over time, however, the variation in consumer prices explained by own shock diminished. Aside from own variation accounting for 91.59 per cent of the shock in the fourth quarter, the contribution of shock to output variation also increased to 3.61 per cent, while credit to the private sector joined to contribute 3.55 per cent in the second quarter. Though own variations retain a high percentage of the explanations for variations in consumer prices, the contributions of output and bank lending to explaining the variations in price level increased over time and stabilised at an average of 3.6 per cent from the fourth quarter to the twelfth. Variations to other variables in the model do not account for any significant percentage in the variations to consumer prices. Also, just like the addition of broad and reserve money, the collective contribution of the three channels was observed to be less than one per cent implying that they do not account for variation in price level in the economy.

From the variance decomposition of bank lending (credit to the private sector), it is observed that more than half of the variations to bank lending in the first quarter is attributed to own shock while consumer prices and output variations account for the remaining 36.7 per cent and 7.6 per cent respectively. The explanatory power of bank lending to own shock diminished to 50.83 per cent and 50.68 per cent in the fourth and eighth quarters while that of consumer prices increased to 39.44 per cent and 39.53 per cent and that of output to 8.02 per cent and 8.03 per cent in the fourth and twelfth quarters respectively.

The variance decomposition of exchange rate reveals that a significant percentage of the observed variance is accounted for by own variation which amounted to 97.5 per cent in the first quarter while bank lending accounted for 2.02 per cent of the remaining

---

**Table 3: Variance Decomposition of the Composite Model**

<table>
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<tr>
<th>Dependent Var.</th>
<th>Quarter</th>
<th>(D(GDP))</th>
<th>(D(CPI))</th>
<th>(D(CPS))</th>
<th>(D(EXR))</th>
<th>(D(BR))</th>
<th>(D(M2))</th>
<th>(D(RM))</th>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>1.282</td>
<td>0.68</td>
<td>0.005</td>
<td>0.002</td>
<td>0.092</td>
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<td></td>
<td>8</td>
<td>97.722</td>
<td>1.327</td>
<td>0.704</td>
<td>0.005</td>
<td>0.002</td>
<td>0.095</td>
<td>0.144</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>97.718</td>
<td>1.33</td>
<td>0.705</td>
<td>0.005</td>
<td>0.002</td>
<td>0.095</td>
<td>0.144</td>
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<td>Consumer Price Index</td>
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<td>97.338</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td></td>
<td>4</td>
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<td>91.597</td>
<td>3.555</td>
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<td>0.01</td>
<td>0.481</td>
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<td>3.634</td>
<td>91.415</td>
<td>3.668</td>
<td>0.028</td>
<td>0.011</td>
<td>0.496</td>
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<td>12</td>
<td>3.636</td>
<td>91.406</td>
<td>3.673</td>
<td>0.028</td>
<td>0.011</td>
<td>0.497</td>
<td>0.749</td>
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<td>Private Sector Credit</td>
<td>1</td>
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<td>36.708</td>
<td>55.693</td>
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<td>0</td>
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<td>8.037</td>
<td>39.53</td>
<td>50.687</td>
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<td>0.015</td>
<td>0.676</td>
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<td>39.534</td>
<td>50.679</td>
<td>0.038</td>
<td>0.015</td>
<td>0.676</td>
<td>1.02</td>
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<tr>
<td>Nom. Eff. Exch. Rate</td>
<td>1</td>
<td>0.142</td>
<td>0.314</td>
<td>2.015</td>
<td>97.53</td>
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<td>0</td>
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<td>4</td>
<td>0.142</td>
<td>0.314</td>
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<td>0.17</td>
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<td>97.713</td>
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<td>0.171</td>
<td>0.871</td>
<td>1.234</td>
<td>97.71</td>
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<td>0.004</td>
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<tr>
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<td>0.007</td>
<td>0.171</td>
<td>0.871</td>
<td>1.234</td>
<td>97.71</td>
<td>0.003</td>
<td>0.004</td>
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<tr>
<td>Broad Money (M2)</td>
<td>1</td>
<td>6.66</td>
<td>38.76</td>
<td>27.07</td>
<td>0.121</td>
<td>2.964</td>
<td>24.426</td>
<td>0</td>
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<td></td>
<td>4</td>
<td>7.238</td>
<td>41.098</td>
<td>27.198</td>
<td>0.136</td>
<td>2.47</td>
<td>20.889</td>
<td>0.971</td>
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variation. The table also shows that all the other variables did not account for variation in the exchange rate. This pattern was maintained by all the variables in the model throughout the twelve quarters under observation.

Similar to the observed pattern of exchange rate decomposition, bank rate variance decomposition also shows that a significant percentage of the observed variance is only accounted for by own variation. This amounted to 97.78% in the first quarter while exchange rate accounted for 1.23% of the remaining variation. Unlike the exchange rate decomposition, here, while broad and reserve money did not account for variation in bank rate, credit to the private sector accounted for less than one per cent of the variation. The observed trend in the percentage of variation in bank rate accounted for by own and exchange rate was also shown in the table to remain the same all through the twelve quarters. The other variables in the model were found, consistently, to have accounted for an insignificant percentage of the variation in bank rate.

Consumer prices and credit to the private sector accounted for a greater percentage of the shock in the variance decomposition of broad money. In the first quarter, while variations to consumer prices and credit to the private sector accounted for 38.76% and 27.07% respectively, own shock of broad money only accounted for 24.43% per cent. However, while credit to the private sector maintained the magnitude of its contribution throughout the quarters, the percentage of consumer prices explanation to broad money variation increased to 41 per cent throughout the remaining quarters. In all of these, own explanation to variation in broad money declined to approximately 21 per cent in the rest of the quarters just as output maintained its share of seven per cent throughout the quarters.

Variance decomposition of reserve money reveals that all the variables in the model exhibited a uniform trend throughout the quarters following quarter one. The table also shows that consumer prices provide more explanation (37%) to variation in reserve money than own shock (26%) and broad money (13.8%). Bank lending and output provide further explanation for variation in reserve money. All the variables in the model were found to retain the percentage of their explanatory power throughout the remaining quarters.

Contemporaneous Model Analysis

The SVAR estimation in Appendix C shows the results of the contemporaneous model generated from using economic theory-based restrictions. The log-likelihood ratio test statistic for null hypothesis of over-identifying restrictions does not reject the restrictions implying that they are statistically valid.

The coefficient in the consumer prices (CPI) specification with output (GDP) shows that it has positive impact in the short run. This implies that any change in the price level will impact output along the same direction. Also in line with theory, the credit to the private sector equation shows a positive sign to GDP and CPI. Again, the result also suggest that a positive variation in the amount of credit to the private
Prices and Output Response to Monetary Policy Variation in Nigeria

sector will cause output as well as price level to increase. A plausible explanation for the increase in price level could be that the resultant increase in aggregate demand outstrips that of output.

In the exchange rate (EXR) equation, the coefficient is both positive on output (GDP) and the amount of credit to the private sector (CPS) while it is negative on CPI specification. The impact of this on GDP and CPS could be interpreted to mean that an appreciation of the exchange rate will lead to increase in domestic production and the amount of credit to the private sector and result in a fall in price level.

The coefficients of bank rate specification have heterogeneous signs with output, price level and exchange rate showing negative correlation while CPS has a positive sign. Expectedly, increase in the rate of interest will dampen investment as cost of production will increase, thus impacting negatively on CPI and leaving its ripple effect on exchange rate.

In the broad money equation, the coefficients have different signs with output, price level and credit to the private sector having a positive sign while exchange and bank rates have a negative sign. The expected response of output, price level and private sector credit to increase in broad money supply is a corresponding increase while the response of exchange and bank rates were also expected to fall with an increase in broad money supply.

Positive signs were noticed in the reserve money coefficients for all the variables. Notably, this sign was expected only for exchange and bank rates but not for output, consumer prices, private sector credit and broad money supply. The positive sign of interest and exchange rates suggests that an increase in the monetary authority’s reserve money will cause bank and exchange rates to increase. However, the expected signs for output, consumer prices, private sector credit and broad money supply are negative. In essence, we expect variation in reserve money to negatively impact output, consumer prices, bank lending and broad money.

Summary, Conclusions and Recommendations

Given the huge tasks the CBN saddled with by the Federal Government among which are ensuring price stability and output growth, there is need to ascertain how the various MP instruments at the disposal of the CBN could be deployed to achieve these objectives. This study therefore investigated the mechanism through which variation in MP impacts macroeconomics variables such as output and price level in the Nigerian economy. Using SVAR model, we established that the CBN employed a hybrid of MP instruments to achieve its desired goal of price stability and output growth in the economy. It was also established that, of the two instruments, namely reserve money and bank rate, the former seemed to be a more effective policy instrument deployed by the CBN. Another important finding was that both price level and output responded to MP variation though output seemed to respond more to shocks emanating from reserve money. Finally, among the perceived channels of monetary transmission mechanism, exchange rate was found to be the existing channel of MP in Nigeria. Emerging from these is the recommendation that the CBN should focus more on the use of reserve money and policy instruments rather than a hybrid since this has been shown to be more effective. From the observation that both target variables were pursued by the CBN, we recommend also that the monetary authority should focus primarily on price level stability since this has the tendency of fostering growth in output.

References


Ibadan Journal of the Social Sciences


Prices and Output Response to Monetary Policy Variation in Nigeria


Biographical Note
Samuel O. Orekoya (Ph.D.) is a Lecturer in the Department of Economics, University of Ibadan. His research interests include Monetary, Development, Energy and Health.
VAR Lag Order Selection Criteria
Endogenous variables: LNRGDP LNCPI LNM2 BR LNCPS LNEXR LNRM
Exogenous variables: C
Sample: 2000M03 2012M12

Included observations: 152

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<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
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* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix A2:

Inverse Roots of AR Characteristic Polynomial

![Graph of inverse roots of AR characteristic polynomial]
Appendix B1: Impulse Response for the Bank Lending Model