

# The Effectiveness of Monetary Policy in Nigeria: An Empirical Investigation

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## Abstract

The paper has attempted to assess the effectiveness of monetary policy in Nigeria between 1986 and 2012, against concerns over the inelasticity of real sector variables to monetary policy shocks. We have applied a vector autoregressive (VAR) methodology to answer two questions: what is the role of monetary policy on the growth of output, inflation and the nominal exchange rate in Nigeria? Secondly, is there a price puzzle attributable to monetary policy in Nigeria? Subject to the restrictions imposed by our data sample and the six variables specified, the study found that monetary policy was effective in the period of study; it explained movement in output, inflation and the exchange rate. Specifically, we found no output or price puzzle associated with monetary policy in Nigeria but that an exchange rate puzzle is established, suggesting that domestic monetary policy might only be partly responsible for variation in the exchange rate in the country.

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**Key Words:** Monetary policy, Policy effects, monetary policy transmission mechanism, monetary policy tools.

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## I. Introduction

Monetary policy is one of the strategies for achieving domestic macroeconomic stability. The foundation is primarily the monetarists' belief in the relationship between money supply and inflation embodied in the classical equation of exchange. Though monetary policy is generally considered to be neutral with respect to output in the long run [Patinkin 1987 pp. 639–44], "almost all economists accept that the long-run effects of money falls entirely on, or almost entirely, on prices" [Walsh, 2010 pp 9]. The short run impact of monetary policy equally generates debates that range from disagreements on appropriate monetary policy transmission mechanisms to the traditional question of central banks' ability to achieve desired changes in money supply through its instruments. Still, the phrases

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"monetary policy objectives" and "effectiveness" have been described as moving targets (Rasche and Williams, 2005). Sometimes, they have been described as central bank actions to influence monetary aggregates, which is consistent with the "old view" of money supply determination that has its foundation traceable to the works of Friedman and Schwartz (1963). Yet, direct inflation targeting is equally emphasised as a major monetary policy focus particularly since the experience of New Zealand in 1990 and subsequently, Canada in 1991, England in 1992 and a growing number of countries. The various dimensions of monetary policy focus obviously create a climate for analysis of monetary policy effectiveness on different platforms. For instance, there is need for clarity on monetary policy target(s) and instruments as well as the most appropriate monetary policy transmission mechanism. Second, there is need for identification of an appropriate monetary policy implementation framework.

In Nigeria for instance, the objective of monetary policy is cast as the "attainment of price stability, maintenance of external payments equilibrium as well as promoting employment and output growth and sustainable economic development", achieved through the growth rate of money supply consistent with the required growth rate of the gross domestic product<sup>3</sup>. This has compelled the central bank of Nigeria (CBN), since its inception in 1958, to focus on the target growth rate of money supply, first through the credit guidelines before 1985 and then through market directed policies since the structural adjustment programme in 1986 to date. The adoption of open market operation (OMO) as a major instrument of monetary policy in 1993 has however, shifted emphasis to the target of short-term interest rates for liquidity management. Expectedly, achieving target range in short-term interest rate is expected to impact long-term rates similarly, in view of the role of long-term interest rates on long-term saving and investment decisions and in the propagation of macroeconomic policies [Orr et al, 1995]. The question then is that in view of the fluctuations in inflation and output observed other the years, what portion of it can be ascribed to monetary policy given that the transmission of monetary policy shocks is akin to a black box<sup>4</sup>.

While this paper is not strictly intended to reinvestigate separate monetary transmission mechanisms for Nigeria given that a comprehensive documentation exists<sup>5</sup>, it however focuses on identifying some facts about the possible response of macroeconomic variables to changes in monetary policy. Thus, effective monetary policy is assessed on the basis of attainment of some predetermined policy objectives. Accordingly, we define monetary policy effectiveness as the

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<sup>3</sup> This is extracted from the CBN's 'Understanding monetary policy series', No 1, 2011

<sup>4</sup> See Bernanke 1995.

<sup>5</sup> CBN (2010)



ability to influence movement in inflation, the foreign exchange rate and output through instruments of monetary policy. Thus, the larger the impact of the policy stance on these variables, the more effective policy would be adjudged. Furthermore, the longer the impact of changes in monetary variables on target variables, the still greater the effectiveness of monetary policy. To carry out the task, we have organized the paper into five sub-sections. Section two provides a review of some relevant empirical literature. The third section overviews monetary policy implementation in Nigeria. Section four discusses the analytical framework which extends to analysis of the empirical results obtained from a reduced form Vector Autoregressive Regressive (VAR) estimates<sup>6</sup>. Section five concludes the paper and also makes some recommendations for policy.

## II. Empirical literature

Studies examining the effects of monetary policy are vast in the literature, and have produced mixed outcomes with respect to the role of monetary policy in macroeconomic outcomes. Among the various studies, differences exist mainly in the choice of analytical methodologies as well as variables for analysis-with a stronger division between price and quantity variables. Opinion is also varied in the potency of monetary policy on prices, output and employment. For instance, Coricelli et al. (2006) found that the rise in prices following a contractionary monetary policy is a 'puzzle'. However, Barth and Ramey (2001) explained the prize puzzle as a signal of the prevalence of a cost channel of monetary policy, where restrictive monetary policy raises the cost of production that ultimately impacts inflation. Cover (1992) and Morgan (1993), applied a 2-stage ordinary least square (OLS) and found output in the United States to be more sensitive to contractionary monetary policy than expansionary largely because output decline faster with a monetary contraction than the increase associated with expansionary monetary policy. This result is consistent with empirical estimates of the monetary policy transmission in the Czech Republic by Borys and Hovárth, (2007), where prices and output are found to fall following a monetary policy tightening action, thus, denouncing the price puzzle in the Czech Republic. The study however concluded that there existed persistent appreciation of domestic currency after a contractionary monetary policy.

Bhattacharyya and Sensarma (2008) investigated the effect of monetary policy signals and the impact of changes in monetary policy instruments on four segments of the Indian financial market (money market, foreign exchange

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<sup>6</sup> Reduced -form VARS analyses the impact of monetary policy on inflation and output without looking deep into the structural relations represented by the various monetary policy transmission channels (Mishkin2007) pp584

market stock market and government securities market) covering the sample period 1996:1-2006:12. Adopting a Structural Vector Auto Regression (SVAR) model, the conclusions indicated that bank rate and reverse repo rates were the dominant policy instrument of the Reserve Bank of India during the pre-LAF and post-LAF regime, respectively. It was however observed that these two signalling instruments were more effective on the money, bond and foreign exchange market with only a negligible impact observed on the stock markets.

Dickinson and Liu (2007) empirically examined the real effects of monetary policy in China during the 1984-1997 restructuring period. Adopting a VAR approach and employing variables such as output, prices, total deposits, and policy variables (rates on central bank loans and total credit); they concluded that the impact of monetary policy decisions on the real economy had been influenced by institutional and structural changes that occurred within the real and financial sectors of the economy. Furthermore, they found evidence of the importance of the interest rate and lending channels of monetary policy, albeit interest rate channels impacted greater significance on output and non- state owned institutions. Their research did not reveal significant relationship between monetary policy tools and the banking system which was proxied by aggregate deposits.

Studies on monetary policy effectiveness in Nigeria are replete in the literature, an account of which is documented in (Nenbee and Madume (2011)). Popular studies include, but not limited to; Saxegaard (2006); Aliyu (2012); Nenbee and Madume (2011); Chimobi and Uche (2010); Bogunjoko (1997). Saxegaard (2006) undertook a comparative analysis on the effects of monetary policy shocks in Nigeria, Uganda and CEMAC economies under regimes in which banks held excess reserves and regimes in which they did not hold excess reserves. He concluded that monetary policy innovations were weaker at impacting on output and inflation outcomes in Nigeria during the period of excess reserve. However, Aliyu (2012) employed monthly data to examine the effects of monetary policy shocks on the Nigerian stock market during the global financial crisis. Using the GARCH and E-GARCH methodologies, the author found evidence that unanticipated shocks to the policy rate and broad money supply were destabilising on the stock market returns.

Nenbee and Madume (2011) investigate the effects of monetary policy on price stability using the cointegration and error correction techniques. Their analysis, covering a period 1970-2009 found evidence that "47 per cent of total variations in the model were attributed to changes in money supply, minimum rediscount rate and treasury bills". They also concluded that inflation was not always a monetary phenomenon. As cited in Nenbee and Madume (2011), Bogunjoko



(1997) used an error correction model to examine the effectiveness of monetary policy as a stabilization tool in the Nigerian economy. He concluded that domestic credit was the most appropriate monetary target.

In their analysis, Chimobi and Uche (2010) explored the empirical relationship between money, inflation and output in Nigeria. Employing the co-integration and granger-causality test techniques, their findings indicated that money supply had a significant causal effect on both output and inflation. They however found that there was no co-integrating relationship between money, output and inflation in Nigeria.

It is obvious from the above that empirical literature does not seem to converge on the quantitative effects or outcomes of monetary policy analysis. It has often been argued in the empirical literature that the reliance on ex-post and revised data, even though more precise, when conducting an empirical examination of monetary policy effects on the economy could produce misleading estimates. The reason is that the monetary policy making and decision process rely most times on available data/information at the time of policy or decision making, (Croushore and Evans, 2006). This is particularly so for gross domestic product (GDP) data. To resolve some of these technical issues, researchers have adopted forward looking variables such as futures, forward rates or prices with a link to the policy rate as well as estimates of output gap to resolve the prize puzzle and ex-post data scenario, (Brissimis and Magginas, 2006); (Bory and Hovárth, 2007); (Giordani 2004). The inclusion of a variable with a forward looking element presupposes that the prize puzzle scenario is brought about by a misspecification problem which can be addressed by the forward variable. In addition, most market participants often assume that changes in monetary policy are often a result of changes in the economic conditions. In other words, there is the assumption that monetary policy is at best reactionary and formalises such a relationship between monetary policy and economy with a feedback rule. In practical terms, it is sometimes recognised that significant variations in monetary policy can also be adduced to a monetary policy shock. In spite of these quantitative and methodological differences, there however seems to be a consensus on the qualitative effects of monetary policy.

### **III. Review of Monetary Policy Implementation in Nigeria**

The objectives of monetary policy in Nigeria have largely remained the attainment of internal and external balance using a broad spectrum of policy instruments. The choice of instruments and/or policy implementation approach has been guided largely by the prevailing economic conditions and expectations about the futures course of those conditions.

From inception in 1959, the CBN has adopted two broad monetary policy frameworks following changes in the domestic and global macroeconomic environment. These are; exchange rate targeting (1959-1973) and monetary targeting since 1974. Within these frameworks, there have been overlaps in the phases of monetary policy. The first phase (pre-1986) relied heavily on direct controls and monetary instruments such as credit rationings and credit ceilings, while post-1986 considered as the era of indirect control was consistent with the philosophy of the Structural Adjustment Programme (SAP) that relied mainly on market mechanisms for the attainment of policy objectives. The post-1986 monetary policy era also witnessed a switch in the conduct of monetary policy from a one-year horizon to a medium term perspective, starting from 2002. Ever since then, monetary policy has been conducted with a medium term focus, "aimed at freeing monetary policy from the problem of time inconsistency and minimising overreaction due to temporary shocks", (CBN 2011). By December 2006, following the completion of the bank consolidation exercise, a new monetary policy implementation framework was introduced, which saw the monetary policy rate (MPR) replacing the minimum rediscount rate (MRR) as the bank's signalling rate; a standing facility window and discount window operations. Consequently, open market operation remains the main liquidity management instrument.

### **III.1 Monetary Policy since 1986**

The adoption of Structural Adjustment Programme in 1986 was aimed to promote a more liberalized environment for achieving macroeconomic objectives. Therefore, monetary policy was required to play a significant role in the new economic management process. Though SAP did not change the objectives of monetary policy, it however changed the monetary policy implementation approach, with more emphasis on the power of the markets for policy effectiveness. By 1993, open market operations (OMO) became officially an instrument of monetary policy; complemented by the minimum rediscount rate (MRR), reserve requirements and discount window operations as well as Liquidity Ratios (LRs). Between 1986 and 1996, the CBN shifted between fixing of interest rates and partial deregulation of rates until October 1996 when total deregulation of interest rates was restored, (CBN 2010). Some other measures included the abolition of credit allocation, adjustment of cash reserve ratio to cover all deposit liabilities, interest rate deregulation, and introduction of prudential guidelines.



### **III.2 The Medium-Term Monetary Policy Framework**

Prior to 2002, monetary policy was designed and implemented within the fiscal year of government. This meant that monetary policy objectives with a long-term focus sometimes could not be achieved within the government fiscal year. Empirical evidences have also shown that even though monetary policy could achieve its objectives, it did so with a substantial lag. Thus, a medium-term approach to monetary policy commenced in 2002 in order to minimise the time inconsistency problems associated with monetary policy implementation and to enable the Bank to periodically adjust its targets in line with market conditions. The medium term strategy has been in force ever since.

### **III.3 The New Monetary Implementation Framework**

Within the context of the medium-term strategy to monetary policy, the Central Bank of Nigeria, in 2006, changed its policy implementation framework, replacing the minimum discount rate (MRR) with the monetary policy rate (MPR) and a standing facilities window with upper and lower corridor for the standing lending and deposit facility. The corridor can be asymmetric or symmetric. For instance, at inception, the interest rate corridor was symmetric at  $\pm 3$  per cent around the policy rate for the standing lending and deposit facilities, respectively. It is currently at  $\pm 2$  per cent around the MPR and that has remained at 12 per cent since July 2011. One of the main aims of the new framework was to control the supply settlement balances of banks and motivate the inter-bank market to target zero balances at the CBN. The operating principle of the standing facilities is to impart on short-term overnight money market rates, encourage inter-bank trading, reduce interest rate volatility, as well as entrench the lender of last resort role of the central bank. Other complementary measures have included reserve requirements (cash reserve requirement and liquidity ratio), discount window/expanded discount window operations, adjustments on public sector deposits of deposit money banks and more recently, foreign exchange swaps. Within the new framework, reserve money acts as the operating target for monetary policy and broad money is the intermediate target.

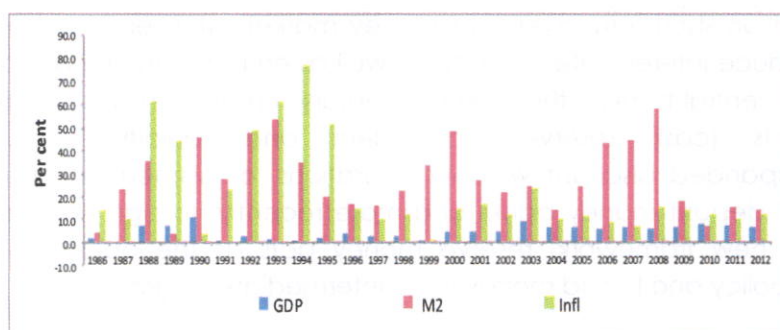
### **III.4 Trends in Macroeconomic Indicators**

The oil glut of the late 1970s and early 1980s resulted in a decline in the economic fortunes of the country with worsening unemployment, high consumer goods imports and inflation. The period between 1980 and 1985 also showed a negative performance in terms of growth and inflation; the growth rate of GDP was negative on average, while the rate of inflation grew from 6.9 per cent in 1982 to 22.6 per cent in 1984. Even the Structural Adjustment Program (SAP) in 1986 could not effectively redress the distortions as the problems of high inflation and

balance of payments persisted. Indeed, monetary aggregates and GDP exhibited an inverse relationship for most part of the sample period, with the exception of some few years: 1998, 2001 and 2008-2012. Money Supply (M2) growth was 4.2 per cent at end-December 1986 and rose significantly by 57.8 per cent by 1993 when indirect instruments was introduced. Interest rates also skyrocketed following the lifting of the partial control on the interest rates, just as the rapid and volatile growth in inflation at 61.2 and 76.8 per cent in 1993 and 1994 shrunk real growth of GDP. The pressure on the external account as a result of the unstable oil price and fiscal policies of the Federal government intensified, as both current and capital accounts were weak, recording substantial deficits. Growth in credit to private sector has remained positive, but below growth in output. In some cases, especially the period between 1986-1990 and 1997-2007, an inverse relationship existed between these two variables.

Prior to the banking sector consolidation program of 2004, commercial banks were weak in carrying out their intermediation functions. It became obvious that the central bank would not achieve its objectives of monetary policy with fragile banks relying heavily on government deposits for survival. Thus, in July 2004, a higher minimum capital base was prescribed for deposit money banks, (DMBs) as part of a 13-point reform agenda. Other key element of the exercise included stringent rules on corporate governance.

**Figure 1: Growth Rate of Real GDP, Money Supply and Inflation**



The 2007/2008 global financial and economic crisis strained the gains of the bank consolidation exercise, compelling the CBN to adopt some liquidity support measures, capital support and asset restructuring program. By 2008, money supply growth had peaked to 57.8 per cent, while growth in consumer prices stood at 15.1 per cent from 6.6 per cent in 2007. Real growth rate of GDP stood at 5.8 per cent from 6.5 per cent in 2007. Furthermore, the excess liquidity generated by the quantitative easing measures induced a less accommodative



monetary in October 2010, leading to an upward review of the MPR to 6.25 per cent and an asymmetric corridor of +200 above the MPR and -300 below the MPR. Consequently, money market rates- inter-bank call rate and open buy back rate subsequently rose from 2.7 per cent to 8.5 per cent and from 1.9 per cent to 7.5 per cent, respectively. However, prime and maximum lending rates declined to 16.2 and 21.9 per cent, respectively. Money supply growth and net domestic credit also declined to 6.7 and 9.8 per cent in response to the monetary policy action. Inflation also declined to 11.8 per cent. This suggests that monetary policy did achieve the intended market response. However, the growth rate of GDP in 2010 surpassed the growth target in many of the years (Table 1).

What seems clear from inspection is that the outcome of GDP reflects developments in the prime and maximum lending rates, which ab-initio did not respond positively to the upward review of the policy rate, possibly suggesting of a weak link between changes in monetary policy and output. The 2007- 2008 global financial and economic crisis perhaps lends credence to this. The inverse relationship between GDP growth and credit to the private sector, during the 2007-2008 periods, replicating the developments in the 1986-1990 periods constitutes a puzzle, running counter to conventional wisdom, where credit growth is expected to promote economic growth. It however further supports the possible disconnect between monetary policy and the real economy.

**Table 1: Growth performance of some selected macroeconomic indicators (%)**

Year	Reserve Money		Money supply (M2)		Private sector credit		GDP		Inflation	
	Target	Outcome	Target	Outcome	Target	Outcome	Target	Outcome	Target	Outcome
1980	n/a	n/a	n/a <sup>1/</sup>	48.6	30	32.8	n/a	5.5	n/a	16.1
1990	n/a	n/a	n/a	40.4	12.5	19.7	n/a	5.2	n/a	3.6
1995	n/a	n/a	10.1	10.3	21.9	49.4	4	2.2	15	51.6
1996	n/a	n/a	16.8	25.7	29.5	23.3	5	3.4	30	14.3
1997	n/a	n/a	15	16.8	45.4	39.3	5.5	3.8	15	10.2
2004	12.8	5.2	16	14	22	26.6	5	9.5	10	10
2005	6.5	10.2	15	16.2	22	29.3	7	6.5	10	11.6
2006	7.5	20.5	27	30.6	30	28.2	7	5.6	9	8.5
2007	3.3	22.6	24.1	44.2	30	90.8	10	6.5	9	6.6
2008	20.8	29.6	45	57.8	54.7	59.4	7.5	5.8	9	15.1
2009	3.6	7.7	20.8	17.1	45	26	5	6.7	9	12
2010	36	11.7	29.3	6.9	31.5	-3.8	6.1	7.9	11.2	11.8
2011	12.8	50.9	13.8	15.4	29.9	44.3	7.2	7.7	10.1	10.3
2012	8.2	26.8	24.5	13.7	47.5	7.8	7.3	6.6	11.2	12

Source: Central Bank of Nigeria

#### IV. A Note on Theory.

The development of the quantity theory of money since the writings of David Hume (1771-1777), makes monetary policy attractive as an output stabilization mechanism. It simply states that under certain restrictions<sup>7</sup>, the product of money in an economy and its rate of circulation (MV) among economic agents would identically be equal to the total value of money transaction (PT); i.e.  $MV=PT$ ; where M, V, P and T stand, respectively, for the stock of money, velocity of money circulation, the price level and the volume of transactions. With the stock of money exogenously fixed at any given time and the equilibrium values of V and T also fairly constant in the short run, the price level would be the only variable that can change to ensure equilibrium between money demand and the given supply of money. Implicit in this formulation is the opportunity given to central banks to influence the price level of goods and services through monetary policy instruments that include open market operation-sale and purchase of bills or discount window operations, and reserve requirements. Essentially, price stability is expected to boost economic stability. Stabilization of the economy, however, presupposes monetary control which leads to fluctuations in the short-run nominal interest rates; lowering them when economic growth is weak or inflation or expected inflation is below some desired rate and raising them when the economy is growing strongly or when inflation or expectations of inflation are high (Taylor 1993). Typically, setting the short-term interest rate at a level consistent with economic fundamentals is expected to generally attain both the most efficient level of output and an inflation rate consistent with long-run inflation objectives (Dotsey (2013 pp1)). Most central banks subscribe to the Taylor principle<sup>8</sup> despite the non-negativity constrain on short-term interest rates that can undermine monetary policy effectiveness as observed in many countries during the 2007-2008 global financial and economic crises.

The relationship between interest rates, output and prices is discernible from a typical Keynesian statement of monetary transmission mechanism:

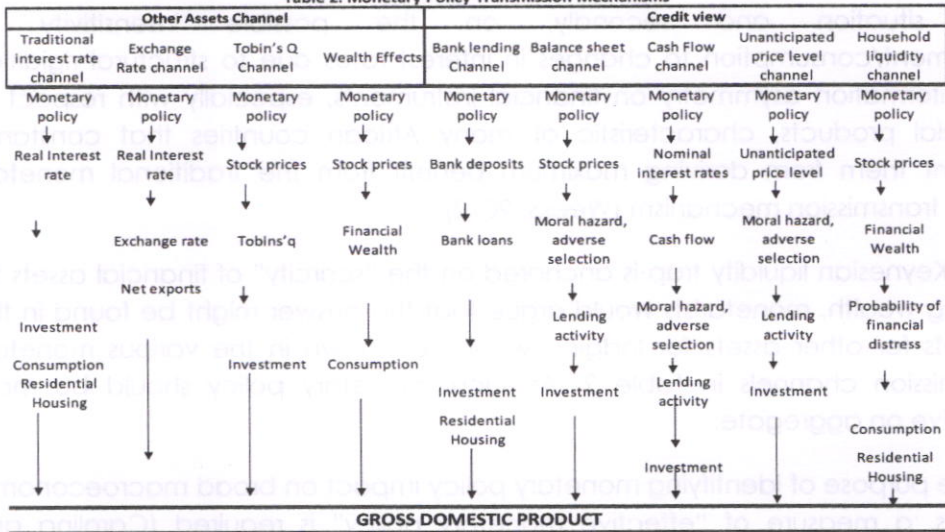
$$\downarrow M \rightarrow \uparrow r \rightarrow \downarrow AD \rightarrow \downarrow Y$$

<sup>7</sup>Classical economists believe, via the say's law that attainment of equilibrium output is guaranteed provided that wages and prices are flexible at both directions.

<sup>8</sup>The Taylor principle stipulates every inflation increase must be met by a rise in the policy interest rate which is larger than the increase in inflation (to be more precise, the rise in the policy interest rate must be equal to 1.5 times the increase in inflation)



Table 2: Monetary Policy Transmission Mechanisms



Source : Extracted from Mishkin (2007)

Where  $M$ ,  $r$ ,  $AD$  and,  $Y$  respectively stand for money supply, interest rate, aggregate demand and output. A contraction in money supply is expected to constrain investment and consumption spending and ultimately output as interest rates rise. Intuitively, the expectation hypothesis according to which the long term interest rates represent an average projection of the short-term rate would also mean that changes in the short-term rates following a monetary policy action should cause a corresponding change in the long-term rates and vice versa. The significance of long-term interest rate to monetary policy effectiveness is plausible even when the economy is in a liquidity trap (Dotsey 2013). Thus, the systematic movement of interest rates is generally assumed in the analysis of monetary policy. However, the relationship can be broken if long-term rates are more sensitive to non-policy influences as shown in a study by one of us<sup>9</sup>. It is obvious that effectiveness of monetary policy via the interest rate channel depends on its many links that can possibly be broken. First is the link between changes in money supply and interest rate, and next is the link between the change in interest rate and investment and/ or consumption. In a typical IS-LM framework, the sensitivity of investment and /or consumption spending to a change in interest rate is important for achieving desired change in output following a monetary policy shock. Thus, the aggregate demand channel of monetary policy transmission rests first, on the interest rate stickiness encapsulated in the Keynesian liquidity

<sup>9</sup>Preliminary results in Kure (2014) indicate that long-term interest in Nigeria is sensitive to foreign capital inflows and stock of global savings. Consequently, domestic monetary policy is only partially responsible for movement in long-term interest rates in Nigeria, which partly explains the weakness of the interest rate channel of monetary policy transmission.

trap situation and secondly, on the possible insensitivity of investment/consumption to changes in interest rates due to structural rigidities, e.g. information asymmetry on financial instruments, especially with respect to financial products, characteristic of many African countries that constantly prevent them from deriving maximum benefit from the traditional monetary policy transmission mechanism (Weeks, 2012).

If the Keynesian liquidity trap is anchored on the "scarcity" of financial assets for lodging wealth, monetarists would argue that the answer might be found in the markets for other assets for lodging wealth as shown in the various monetary transmission channels in Table 2. As such, monetary policy should be more effective on aggregate.

For the purpose of identifying monetary policy impact on broad macroeconomic targets, a measure of "effective monetary policy" is required (Carolina and Chalk, 2008). It is necessary also that while doing that, all information sets that might characterize the central bank's policy reaction function are taken into consideration. Bernanke (2002) observes two potential problems with the sparse information sets typically used in conventional VAR empirical models for assessment of monetary policy effectiveness. First, they do not reflect information that central banks and the private sector might have information, and the second problem is that "impulse responses can be observed only for the included variables, which generally constitute only a small subset of the variables that the researcher and policymaker care about". It is on the basis of this that the author suggests a factor augmented vector autoregressive (FAVAR) model for analysis of response of economic variables to changes in monetary policy given that it also enables experiment with larger data set in a VAR while restrictions are based on economic theory.

In the search for how far monetary policy can affect output and inflation, other familiar questions regarding central bank's ability to attain control over the growth rate of monetary aggregates are also pertinent. This is apt in view of the arguments in Palley (1993) and many others on the possible endogeneity of money supply. Impliedly, the starting point for analysis of monetary policy effectiveness in Nigeria is an investigation into the extent to which the CBN controls the growth rate of monetary aggregates over time with its instruments. The process is then scales up to analysis of the effectiveness of instrumental variables. However, while efficiency in monetary management may not necessarily be a precondition for effectiveness, our premise is that the CBN is efficient in liquidity management, particularly since 2006 following the change in



monetary policy implementation framework<sup>10</sup>. Under the new framework, growth in monetary aggregates is targeted for price stability with a peripheral consideration for the exchange rate stability. The standing facilities window is meant to guide movement of the short-term interbank rate. Thus a change in the short-term inter-bank rate through open market operation is expected to influence the output growth, inflation and the exchange rate.

This objective of the paper is achieved in the context of a vector autoregressive (VAR) procedure, following its appeal in monetary policy analysis since the technique was introduced by Sims (1980). VARs "are a suitable model class for describing the data generation process (DGP) of a small or moderate set of time series variables where all variables are treated as being a priori endogenous" Lütkepohl and Kratzig, (2004 pp 86). They are well-suited to help macroeconometricians "describe and summarise macroeconomic data, make macroeconomic forecasts, quantify what they do or do not know about the true structure of the macroeconomy, and make policy advice" (Stock and Watson, 2001 pp1). Though "we would like, in principle, to include all of the variables in our analysis in one large unconstrained VAR and report the implied system of dynamic response functions, the strategy is not feasible because of the large number of variables which we wish to analyse" (Burnside et al, 2002). Apparently it makes sense to think that, in analysis of the relative effectiveness of monetary policy in Nigeria, considerable attention is given to the variables that provide information about the evolution of output, inflation and the exchange rate.

#### IV.1 The Model

If we assume that the joint dynamics of the policy and non-policy variables in Nigeria can be represented by the following order  $p$  (VAR ( $p$ )) of the following form:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} \dots + A_p Y_{t-p} + B_1 Z_{t-1} + \dots + B_p Z_{p-1} + v_t \quad (2)$$

Where  $Y$  and  $Z$  are respectively, a vector of all non-policy variables and policy variables.  $A$  and  $B$  are matrices of coefficients associated with the variables.  $v$  is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and also uncorrelated with all of the right-hand side variables.

The assumption in equation 2 is that the matrix  $A_0$  can contain  $n$  parameters and each  $A_i$  ( $i = 1 \dots p$ ) contains  $n + pn^2$  coefficients that need to be estimated, which

<sup>10</sup> The new Framework includes a monetary policy rate (MPR) in place of the minimum rediscount rate (MRR), standing facilities window, reserve requirements and discount window operations

obviously makes the model overparametrized, (Enders 2005). Hence the appropriate lag structure becomes an integral part of VAR model. Lütkepohl (1993) for instance, indicates that selecting a higher order lag length than the true lag length causes an increase in the mean square forecast errors of the VAR and that under fitting the lag length often generates auto correlated errors. Braun and Mitnik (1993) show that impulse response functions and variance decompositions are inconsistently derived from the estimated VAR when the lag length differs from the true lag length. In addition, all variables would need to be stationary while a test for long-run co integration provides guidance on the choice between restricted and unrestricted VAR.

The base line model comprises five non-policy variables and one policy variable. The non-policy variables are output (Ly), defined as the gross domestic product, rate of inflation (INF), measured as the year on year change in the consumer price index, the exchange rate (EXR), defined as the units of local currency exchanged with one US dollar, credit to the private sector (CP), defined as the total credit of commercial banks to the core private sector and money supply (MS) defined broadly. The policy variable is represented by the short-term inter-bank call money rate (IBR) being the target variable for liquidity management. Money supply is assumed to be exogenously determined by the central bank but could also be determined by the demand for it. Though the chosen variables are unlikely to capture all the information set used by the CBN for the purpose of monetary policy, they nonetheless constitute a fair representation of the information set that can indicate the stance of monetary policy. For instance, following a change in the monetary policy rate (MPR), signalling the Bank's desired change in interest rates in the money market, the resulting change in the short-term (inter-bank) rate, following an open market operation, is expected to provide guidance on the movement in the rates on both short-and long-term financial assets, which might include the foreign exchange rate, and hopefully output and inflation. It is important in this case that the movement in short-term rates also impact long-term rates for monetary policy effectiveness. Also, credit to the private sector is impacted upon to the extent that changes in short-term interest rates affect the lending rate, which is the most probable channel of monetary policy transmission Nigeria; lending rates are highly sensitive to changes in the monetary policy rate but mostly sticky in the downward direction.

The model's specification allows joint determination of the variables-output, inflation, exchange rate, credit to the core private sector, short-term interbank rate and money supply. The inter-bank rate is the most exogenous variable in the model, specified to affect all other variables but is in itself determined by other factors not specified, including the monetary policy rate and the state of liquidity in banking system.



### IV.1.1 Data and Empirical Results

Data for the analysis is obtained from statistical bulletin of the CBN and cover the period 1986Q1 to 2012Q4. The period is chosen because it cuts across well-defined policy regimes that can potentially alter the impact of monetary policy on output and prices. These include the structural adjustment program and the bank consolidation exercise. There was also the change in monetary policy implementation framework within this period. Our expectation therefore is that these policy and program shifts should have implications on the stability of the money demand and the transmission of monetary policy. Accordingly, the model was estimated with appropriate dummy variables, taking the values 1 from the beginning of the regime or policy change and zero in any other year. All variables, except the interbank rate are in log form since doing so was considered to be advantageous as the changes in the log series display much more stable variances than the changes in the original series (Lütkepohl and Kratzig, 2004). We report results from ganger causality tests, impulse response and forecast variance decomposition based on suggestion in Stock and Watson (2001). E-Views (version 8) was used for all the estimations.

**Table 3: Summary Statistics**

Summary of variables in the model						
	EXR	IBR	INFL	LY	M2	CP
Mean	4.82	14.43	22.14	28.72	27.40	31.11
Median	4.80	13.50	13.67	23.84	24.11	26.61
Maximum	5.93	26.00	76.76	114.83	57.78	90.76
Minimum	4.25	4.68	0.22	-3.34	3.54	-3.68
Std. Dev.	0.32	5.30	20.12	24.53	14.99	21.67
Skewness	1.32	0.58	1.38	1.62	0.37	1.42
Kurtosis	6.60	2.98	3.61	6.48	2.14	4.80
Jarque-Bera	89.44	6.04	36.18	101.44	5.80	50.71
Probability	0.00	0.05	0.00	0.00	0.06	0.00
Sum	520.81	1558.88	2390.60	3102.20	2959.00	3359.64
Sum Sq. Dev.	10.79	3007.65	43324.62	64397.13	24047.37	50249.73
Observations	108	108	108	108	108	108

### IV.1.2 Unit root and VAR Co-integration Tests

First, as a preliminary check, we examined the time series properties of the variables using the Augmented Dickey-fuller (ADF) test. Test results suggest that all the variables in the model are non-stationary at level but at first difference with time trends. However, test for long-run co-integration revealed no long-run co-integration among the chosen variables. Consequently, an unrestricted VAR was estimated at first difference consistent with suggestion in (Hill et al, 2008 pp. 347).

**Table 4: Unit root test**

<b>Unit root Test</b>			
<b>Variable</b>	<b>t-Statistic</b>	<b>Prob.*</b>	<b>Order of Int</b>
IBR	-8.483	0.00	I(1)
INF	-6.268	0.00	I(1)
M2	-10.199	0.00	I(1)
GDP	-6.285	0.00	I(1)
CPS	-8.748	0.00	I(1)
ER	-6.185	0.00	I(1)

The consideration of policy/ regime changes in analysis of monetary policy effectiveness was considered necessary since an LR test for structural breaks validates the inclusion of the specified dummy variables in the model. Indeed, recognition of economic policy shifts rather than policy regime shifts CBN (2010) potentially improves the robustness of our estimates and further provides more credible information on the monetary policy transmission mechanisms in Nigeria.

**Table 5: Johansen co integration Test**

<b>Johansen Test for co-integration</b>				
<b>Hypothesized</b>		<b>Trace</b>	<b>0.05</b>	
<b>No. of CE(s)</b>	<b>Eigenvalue</b>	<b>Statistic</b>	<b>Critical Value</b>	<b>Prob.**</b>
r=0	0.28	89.32	95.75	0.13
rs 1	0.22	56.40	69.82	0.36
rs 2	0.10	30.68	47.86	0.68
rs 3	0.09	19.39	29.80	0.47
rs 4	0.07	10.14	15.49	0.27
rs 5	0.03	2.99	3.84	0.08
Trace test indicates no cointegration at the 0.05 level				
<b>Hypothesized</b>		<b>Max-Eigen</b>	<b>0.05</b>	
<b>No. of CE(s)</b>	<b>Eigenvalue</b>	<b>Statistic</b>	<b>Critical Value</b>	<b>Prob.**</b>
r=0	0.28	32.93	40.08	0.25
rs 1	0.22	25.72	33.88	0.34
rs 2	0.10	11.29	27.58	0.96
rs 3	0.09	9.26	21.13	0.81
rs 4	0.07	7.14	14.26	0.47
rs 5	0.03	2.99	3.84	0.08

Max-eigenvalue test indicates no cointegration at the 0.05 level

The base line model was initially estimated without any prior identification such that the ordering of the variables was arbitrary. Nevertheless, it provided the climate for checking the appropriateness of the VAR, including the identification of the appropriate lag length of the VAR estimates.

### IV.1.3 Lag Structure and Granger/Block Exogeneity test

An optimal lag length of five was used for the estimates based on suggestions from three information criteria-LR, FPE and AIC. For the granger causality test,



inflation, money supply and the inter-bank rate granger cause output as well as all the variables in the model.

**Table 6: VAR Lag Selection**

VAR Lag Order Selection Criteria (1986-2012)						
Endogenous variables: LY INF EXR CP M2 IBR						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2011.502	NA	1.35E+10	40.35005	40.50636	40.41331
1	-1674.317	627.1649	32620573	34.32634	35.42051*	34.76917*
5	-1479.745	188.2392*	13445766*	33.31489*	38.16051	35.276
6	-1472.015	9.739327	26013198	33.8803	39.66378	36.22098
7	-1457.822	16.17985	46174606	34.31644	41.03778	37.03669
8	-1416.95	41.68911	50854078	34.21901	41.87821	37.31883

Similarly, causality runs from output, money supply and the policy target rate to inflation, and also from the variables as a group. The exchange rate and credit to the private appear to be exogenous in the model as they are not granger-caused by any variable individually or collectively. However, inflation, exchange rate and credit to the private sector cause movement in domestic money stock and all the variables in the model as a block as well, suggesting that money supply could be endogenously determined.

**Table 7: VAR Granger Causality tes**

VAR Granger Causality/Block Exogeneity Wald Tests						
Dependent variables in the regression						
Regressor	LY	INF	EXR	CP	M2	IBR
LY	0.00	0.00	0.97	0.97	0.97	0.57
INF	0.00	0.00	1.00	0.97	0.04	0.83
EXR	0.44	0.00	0.00	0.98	0.02	1.00
CP	0.28	0.83	0.33	0.00	0.01	0.82
M2	0.08	0.00	0.90	0.77	0.00	1.00
IBR	0.02	0.03	0.30	0.83	1.00	0.00
All	0.00	0.00	0.86	1.00	0.01	0.99

P Values Reported

#### IV.1.4 Model's Stability Test and other Diagnostics

The model's stability condition is satisfied as all roots were found to have modulus less than one and lie inside the unit circle. Similarly, portmanteau tests show no residual autocorrelation up to lag 7. Finally, the test for joint significance of the variables (test results available on request) indicates all variables are jointly significant in the model. The model however failed normality test but could still

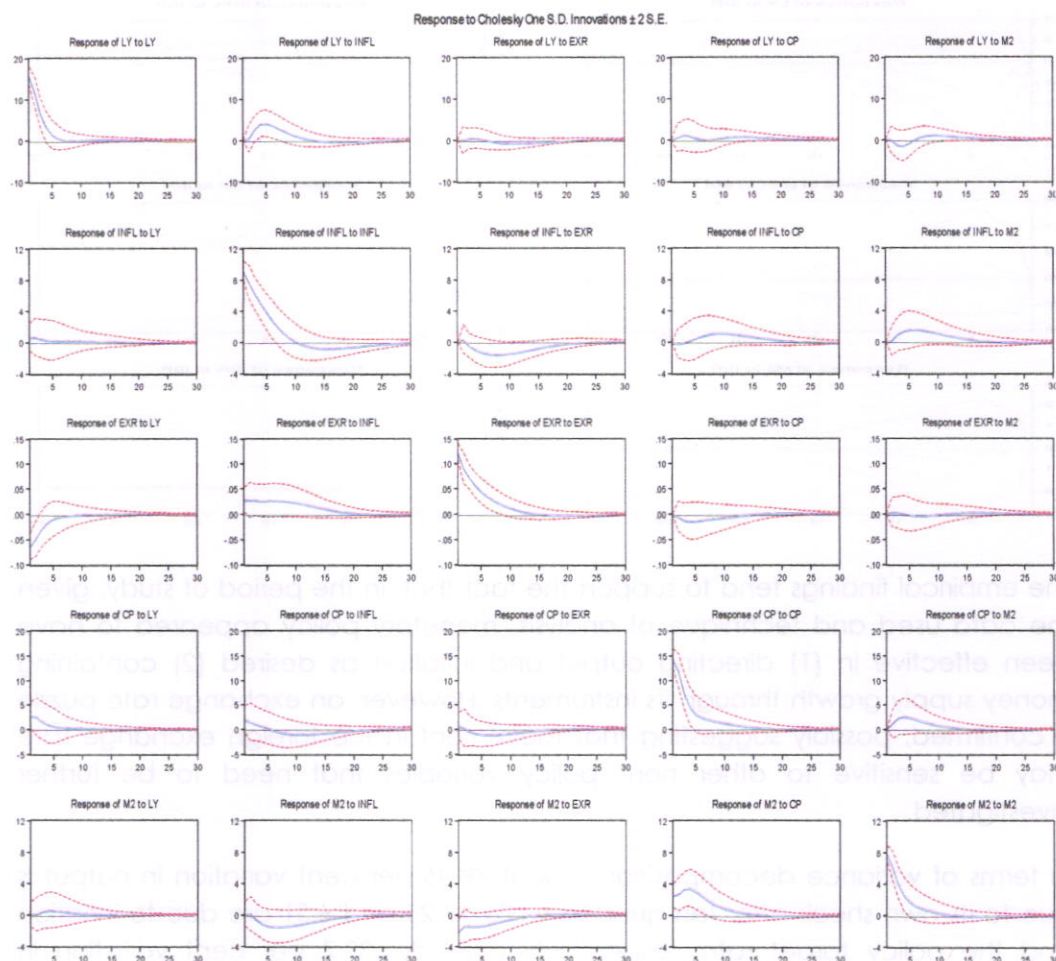
enable credible analysis of the impulse response functions and the variance decomposition on the strength of all other diagnostics.

#### **IV.1.5 Impulse Response and Variance Decomposition of the Non-Policy Variables**

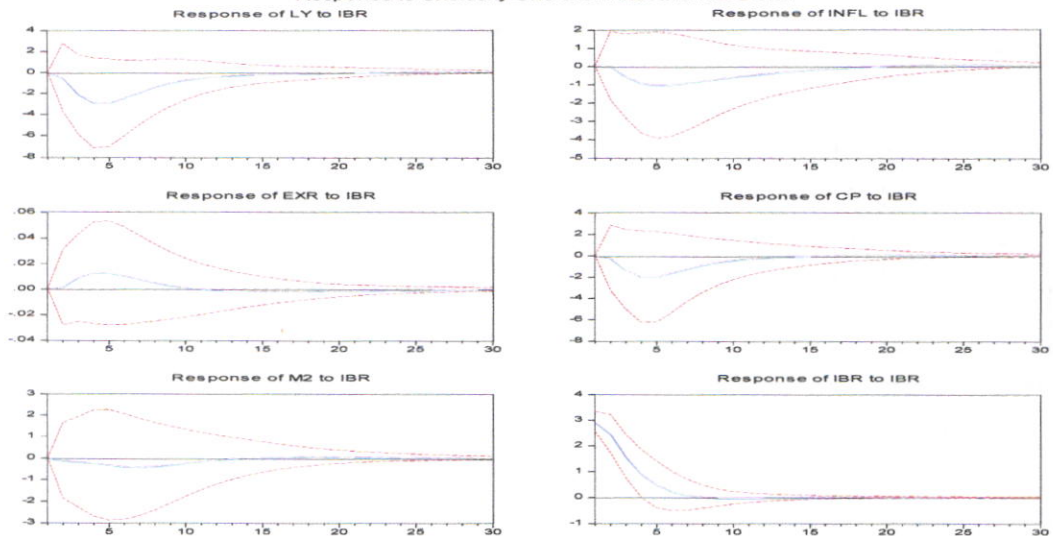
The ordering of variables for the impulse responses is such that the policy target rate is considered the most exogenous. There are two scenarios: the first considers money supply as the policy variable and the second considers the inter-bank rate. The first part of the results (Figure 2) assumes that the non-policy variables respond to their own shocks and contemporaneously to other variables even without the direct influence of monetary policy shock. For instance, output responds positively to its own shock and to inflation as well. The positive response of output to a shock to inflation possibly reflects the positive impact of inflation on firms' profitability and investments. Nevertheless, the response of output to exchange rate is flat in the first one year but fell afterwards, reflecting possible impact of imports on domestic economic growth. The positive response of output to credit to the core private sector is consistent with economic theory and the negative response of output to money supply is explained by the likely insensitivity of output to interest rates changes, considering that lending rates are mostly sticky downward following a monetary policy shock.

Inflation responds positively to output shock as predicted by Keynesian aggregate demand theory and to its own shock as well. However, the appreciation of the nominal exchange rate following a shock to domestic inflation could be indicating the positive impact of inflation on foreign investment and non-oil exports. Furthermore, the increase in inflation following a shock to private sector credit and money supply is as predicted by economic theory; it shows the absence of a price puzzle in Nigeria following changes in monetary variables. The nominal exchange rate appreciates within a year as a result of a positive shock to output, possibly reflecting increased export potential that comes with increased domestic production. It responds positively to its own shock, appreciates with increased claims on the core private sector but stays flat with respect to money supply shock. Both money supply and claims on the core private sector respond positively to an output shock. The response of credit to inflation is initially positive till the fifth period. Exchange rate depreciation causes credit to the private sector to fall but that money supply shock causes a depreciation of the exchange rate. That money supply declines with a shock to inflation suggests the confidence in authorities to fight inflation with changes in money supply. However, the negative response of money supply to an exchange rate appreciation is counter intuitive.



**Figure 2.0: Impulse Response Function**

When the monetary policy variable is the inter-bank rate (Figure 2.1), the fall in output and inflation following a shock to it reinforces the evidence on output or price puzzle in Nigeria. However, an exchange rate puzzle is identified following a shock to the policy target rate, which should cause an appreciation of the rate as domestic interest rates rise. Economic theory postulates that an increase in domestic interest makes capital inflow profitable, leading to an appreciation of the domestic exchange rate. The fall in money supply following a positive shock to the policy target rate is consistent with economic theory and suggests that targeting short-term interest rate for liquidity management is credible. The decline in domestic credit following a shock to the policy rate confirms the strength of the credit channel of monetary policy transmission in Nigeria. The policy rate is positively related to its own shocks.

**Table 2.1: Impulse Response Functions**Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

The empirical findings tend to support the fact that, in the period of study, given the data used and technique of analysis, monetary policy appeared to have been effective in (1) directing output and inflation as desired (2) containing money supply growth through its instruments. However, an exchange rate puzzle is confirmed, possibly suggesting that movement in the foreign exchange rate may be sensitive to other non-policy variables that need to be further investigated.

In terms of variance decomposition, about 79.06 per cent variation in output is due to its own shock after ten quarters while 12.23 and 6.51 are due to inflation and the policy target rate, respectively. Similarly, 82.7 per cent variation in inflation is due to its own shock ten periods part while 5.58, 4.96, and 2.11 per cent are respectively due to changes in the money supply, the exchange and policy target rate. Equally, over 69.0 per cent variation in the exchange rate is due to its own shock while 14.28, 12.16 and 1.10 per cent are due to changes in output, inflation and the policy rate.





## V. Conclusion and Policy Implications

The paper has attempted to assess monetary policy effectiveness in Nigeria using a vector autoregressive model for the period 1986Q1 and 2012Q4. The model was estimated with some variables to account for some policy/ regime shifts. Given the broad objectives of monetary policy in Nigeria, the focus of the study was to assess its effectiveness relative to measures of domestic inflation, output, the exchange rate credit to the private sector, in which case policy was deemed effective when a unit change in a policy instrument caused desired change on one or all of the target variables. To achieve the objective, a six variable vector autoregressive model comprise five domestic non-policies and one policy variable was specified and estimated. The empirical estimates confirm that a change in monetary policy does impact output and inflation, and there was no output or price puzzle in Nigeria attributable to monetary policy. However, an exchange rate puzzle was established following changes in monetary policy, especially when short-term interest is the policy variable. Secondly, private sector credit and domestic price inflation are sensitive to changes in the short-term inter-bank rate, suggesting that liquidity management through the target of short-term inter-bank rate is credible and could be sustained. The impact of private sector credit on output growth is slow but remains positive, suggesting there could be other factors that undermine policy effectiveness through the credit channel.

Empirical result suggests that the conduct of domestic monetary policy is relevant for promotion of economic growth in Nigeria. Accordingly, monetary authorities can sustain its efforts at liquidity management in order to influence prices and output. Furthermore, the presence of an exchange rate puzzle following changes in monetary policy signifies the presence of non- policy influences on the exchange rate, which goes to suggest that an appropriate monetary policy strategy is required, that which significantly moderate the high cost of liquidity management in the country.



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