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Effects of Monetary Policy on the Real Economy of Nigeria: A Disaggregated Analysis

BY

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CENTRAL BANK OF NIGERIA

CENTRAL BANK OF NIGERIA

A 'FESTSCHRIFT' IN HONOUR OF MR. B.S. ADEBUSUYI (DEPUTY DIRECTOR AND HEAD OF REAL SECTOR DIVISION)

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Foreword

One cardinal objective of macroeconomic policy is to catalyze the growth centers to enable provision of goods and services which improve economic welfare of citizenry. The real sector of the economy creates the opportunities to produce physical output, generate employment that yields income for investment and consumption, which reinforce growth of aggregate demand. In recent times, monetary policy has emerged as a veritable tool for stimulating economies, yet the transmission process from policy pronouncements to the real sector outcomes remains a 'black box' that requires continual appraisal and review. The Central Bank of Nigeria has been very active in studying the transmission mechanism of monetary policy in Nigeria. The outcomes of these studies have helped in sharpening the instruments of policy and modelling the operating frameworks. These studies have also been invaluable in designing special intervention schemes where open market credit pricing has not provided enough stimuli for priority sectors. This study is yet another step in unravelling the functional connection between monetary policy and the real sector of the Nigerian economy. It explicitly assesses the impact of monetary policy on the real economy. The paper is a current treatise of the topic with the scope spanning 1993 to 2013. The analysis is deep and the data disaggregated into subsectors so that impact of policy could be traced to the agricultural, manufacturing, and other sectors

More importantly, this study is special not just because of the content and rigorous analysis but because of the fact that it is published in honour of one of our finest professional economic researchers, in our contribution to knowledge in addressing the numerous bottlenecks that inhibit the growth of the real economy in Nigeria. This celebration of Pastor Stephen Olabanji Adebusuyi is in recognition of his contribution to the Central Bank of Nigeria in the Research Department, where he devoted 35 years of service to supporting the evolution of policies to grow agriculture, industry and oil and gas sectors. His efforts also are appreciated in developing the data base in the Economic and Social Indicators Office. 'Pastor' (fondly called) represented the Bank in several capacities and managed the editorial board of the various publications of the Research Department. He retired from service in May 2014 after reaching the enviable level of Deputy Director and Head of the Real Sector Division.

I recommend this study to a vast spectrum of stakeholders. The academia would find it a valuable addition to literature while, policymakers would have a handy companion in watching the ever changing coefficients of association between monetary policy and the real sector. Younger students of monetary policy would be equipped with another perspective to evaluating the impact of monetary policy on the economy.

The study is published under the responsibility of the Director of Research, Mr. Charles O. N. Mordi and the Head of Real Sector Division, Dr. B. A. G Amoo. As a policy focused study, it reflects the views of the authors and does not necessarily reflect the official position of the Central Bank of Nigeria.

Charles N.O Mordi,
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November 15, 2014

Acknowledgements

The study was a conscious reminiscence of an effective leader who was priviledged to oversee the real sector of the Research Department, Pastor B.S Adebusuyi. Retiring on May 17, 2014, he spent the whole of his career in the Research Department and indeed, the Bank serving in the Real Sector Division. His leadership style was flexible and tough to put into action, but pays off in performance.

It was undertaken by the Real Sector with the authors and coordinators of the study comprising Drs B. A. G. Amoo and Mattew Eboreime; Messrs Mbuto O. Mbuto, Nkenchor N. Igue and Yusuf Adamu. Other divisional colleagues who provided important contributions and deserve special gratitude are: Mr Lawrence I. Odey, Dr. Patterson Ekeocha, Williams Kanya, N.I. Akpan, Olugbenga M. Adebayo, Mrs Margaret J. Hilili, Halima Nagado, Dr. Shettima T. Zimboh, Balarabe Hamma, Ibrahim A. Uba, Derek O. Ibeagha, Izuchukwu I. Okafor, Maximillan C. Belonwu and Emeka R. Ochu. Their input led to the success of the study. The secretariat assistance and logistics support from Messrs O.O Ikotun and Undie N. Ashibe are hereby acknowledged.

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The immense contribution and support of the Director of Research as well as his encouragement and guidance are well appreciated. The Management of the Bank also provided the conducive atmosphere to undertake and complete this study.

Our special gratitude goes the Deputy Governor (Economic Policy), Dr (Mrs) Sarah O. Alade OON for supporting the sustenance of research activities in the Directorate.

EFFECTS OF MONETARY POLICY ON THE REAL ECONOMY OF NIGERIA : A DISAGGREGATED ANALYSIS*

Abstract

This study investigated the effect of monetary policy on different components of real output, by employing the structural vector autoregressive (SVAR) framework. It used a suite of policy and non-policy macroeconomic variables based on quarterly data spanning the period 1993Q1 and 2012Q4. A six variable SVAR for aggregate output (baseline model) and a seven variable SVAR for the disaggregated output components were estimated. Inter alia, we find from the results of the impulse response functions that sectoral output responded heterogeneously following contractionary monetary policy shocks, with some immediately responding negatively (services and wholesale/retail sectors), while others displayed lagged negative responses (manufacturing, building and construction, and agriculture). These findings are consistent with economic theory, as output in each sector is expected to decline following monetary tightening. The results of the forecast error variance decomposition show that the most important monetary policy variables that explain the variation in sectoral output are interbank call rate and money supply. Innovations from the monetary policy rate and exchange rate do not significantly explain the variations in output. The study therefore recommends that the monetary authority should provide some measure of support for specific sectors adversely affected by unanticipated monetary policy shocks.

Key words: Nigerian economy, monetary policy, Structural VAR
JEL Classification: C32, E23, E52, E58

Written by Real Sector Division Team : Dr. Bandele A. G. Amoo, Lawrence I. Odey, Williams Kanya, Dr. Mattew Eboreime, Dr. Patterson Ekeocha, Nkereuwem I. Akpan, Olugbenga M. Adebayo, Mbuto O. Mbuto, Nkenchor N. Igue, Mrs Margaret J. Hilili, Halima Nagado (Mrs), Dr. Shettima T. Zimboh, Balarabe Hamma, Yusuf Adamu, Ibrahim A. Uba, Derek O. Ibeagha, Izuchukwu I. Okafor, Maximillan C. Belonwu and Emeka R. Ochu, Edited by Charles N. O. Mordi.

1.0 Introduction

The real economy is strategic and vital for growing the entire nation. It confers many benefits to the nation as it has been adjudged to have the strongest pull on a nation's economic growth and employment generation (Anyanwu 2010). In many economies, the performance of the real Sector is the gauge for assessing the effectiveness of macroeconomic policies. Government policies can only be deemed successful if they impact positively on the production and distribution of goods and services. A vibrant and productive real economy creates more linkages in the economy and promotes internal and external balance.

Monetary policy is one of the macroeconomic management tools used to influence outcomes in the real economy to its desired direction. The basic goals of monetary policy are the promotion of stable prices, sustainable output and employment. In macroeconomic theory, monetary policy is expected to affect the real economy through movements in interest rates which would alter the cost of capital and investment in the productive sector. According to Mishkin (1996 and 2007) monetary policy influences the economy through a variety of channels — interest rates, credit and/or bank lending, asset prices via exchange rates, equity and housing prices. Investigations into the effect of monetary policy on the economy has continued to generate active research interest because the channels through which shocks are transmitted changes with developments in both global and the domestic

economy.

In recent times, increasing attention has focused on the sectoral effects of monetary policy given that sectors respond differently to monetary policy shocks. This has implications for macroeconomic management as monetary authorities have to weigh the consequences of their actions on various sectors of the economy. For instance, the tightening of monetary policy might be considered benign from the general perspective, yet it can be viewed as excessive for certain sectors of the economy. If that is true, then monetary policy should have strong distributional effects to the economy. According to Alam and Waheed (2006), understanding the sectors that are affected adversely by monetary tightening for example, provide valuable policy information for the monetary authority. Such information helps to uncover the underlying nature of transmission mechanism of monetary policy actions.

Understanding the responses of the disaggregated components of the real economy is important for a number of reasons. A disaggregation is imperative given that different sectors have different capital intensities that generate different responses in sectoral output from monetary policy. These differences in responses are largely disguised at an aggregate level – thus making the disaggregated approach more informative than aggregate method for the purpose of analyzing the transmission mechanism of monetary policy (Dedola and Lippi, 2005). Furthermore, knowledge of the size, timing, and persistence of monetary policy shocks on economic

activities provides the monetary authority with vital information required to fine-tune policy initiatives towards stabilizing the macroeconomy, and the real sector in particular.

There are quite a number of studies from Nigeria that have investigated the impact of monetary policy on the real economy (Omotor, 2007; Mordi, 2008; Chuku, 2009; CBN, 2010; Onyeiwu, 2012; Ndekwu, 2012; Fasanya et al, 2013), which has largely focused on how aggregate output and prices, as well as other variables respond to unanticipated monetary impulses. However, literature is scant on the effects of unanticipated changes in monetary policy on the sectoral components of aggregate output. The only study we are aware of that has attempted such an investigation is Nwosa and Saibu (2012). The authors used unrestricted vector auto regression (VAR) model or recursive VAR to carry out their investigation, which may be inappropriate. According to Enders (2002), recursive VAR assumes that errors are orthogonal and forces restrictions on the residual covariance matrix, making the structural estimates of the impulse response functions and forecast error variance decomposition highly sensitive to the ordering of the variables.

Given the importance of a disaggregated study and the yawning methodological gap in the literature, the broad objective of this paper is to examine the effects of monetary policy shocks on sectoral gross value added of five sectors of the real economy, namely: agriculture, building and construction, manufacturing, services, and wholesale and retail. The specific objectives include to:

I. Examine the effect of monetary policy shocks on sectoral output components;
ii. Determine the size, timing and persistence of monetary policy shocks in a sectoral framework; and
iii. Provide some insight on the key channel(s) of monetary impulse transmission to different sectors of the economy.

This study will extend the frontiers of knowledge in respect of the Nigeria's experience, as it is the first to reflect the market orientation period of monetary policy based on a quarterly data from 1993Q1 to 2012Q4. Also, the current study is the first of its kind to apply the SVAR approach to examine monetary policy effects on the disaggregated components of the real sector in Nigeria.

Following this introduction, section 2 discusses monetary policy and the real sector in Nigeria, while section 3 reviews the literature. Section 4 presents the methodology and section 5 gave the estimation results, findings and policy discussion. Section 6 summarizes, concludes and provides policy implications.

2.0 Monetary Policy and Real Sector in Nigeria

2.1 Monetary Policy in Nigeria

Over the years, the main objectives of monetary policy remained achieving internal and external balances, and the promotion of non- inflationary growth in output. Specifically, monetary policy measures are designed to ensure stable inflation rate, stimulate growth in the productive sectors and reduce pressure on the balance of payments in order to maintain a stable exchange and positive interest rates. The techniques and instruments to achieve these objectives varied over the years. There have been two distinct phases in the conduct of monetary policy, namely direct era (pre-SAP) and indirect era (post-SAP). The era of direct monetary policy involved the use of monetary controls, whereas the indirect era depends on price mechanism.

Monetary policy in Nigeria has evolved over time. During the early years of independence (1961-64), which coincided with the second development plan, monetary policy actions were focused on the establishment of a strong financial base and the promotion of domestic financial infrastructure, such as the money and capital market institutions. This period witnessed intensive credit allocation to the "preferred" sectors of the economy (direct control). The policy actions were informed by the extant monetary system, in response to the priority needs of Nigeria.

The CBN act was amended in 1962 in order to strengthen the Bank for effective monetary policy implementation. The major monetary policy action adopted was to enable the government borrow as cheaply as possible, for the purpose of financing the Second National Development Plan.

In the 1970s, Nigeria experienced high inflation owing to the civil war and the wage increase by the Adebo and Udoji Commission in 1971 and 1974, respectively. As a response to the observed inflationary trend, the CBN adopted a policy of direct control aimed at encouraging the DMBs to channel substantial amount of their credit to the productive sectors of the economy. The Bank also issued stabilization securities to reduce the liquidity in the banking system. The year 1992 marked the end of the direct control regime. It also introduced additional policy measures that included the special deposit that was intended to sterilize excess liquidity.

The direct control regime was abandoned as a natural reaction to the liberalisation of the financial sector. The framework for monetary policy changed in line with the liberalisation policy. It relied on intermediate targets to influence the ultimate objective of policy. Besides several other policy instruments, the minimum rediscount rate (MRR) was the anchor rate for monetary policy. Generally, both the direct and indirect policy regimes have the same objectives, of channeling funds from surplus to deficit sectors, , with the aim of extending the frontiers of growth and development.

Under the Period of Indirect monetary policy regime (1993-Date) the CBN adopted a liberalized monetary policy framework through the use of market driven instruments such as the Open Market Operations (OMO), introduced in 1993. The outcomes of the policy measures indicated that monetary aggregates increased significantly. A cursory look at monetary aggregates as at end 1993 broad money (M2) on the average rose by 28.0 per cent above its average target of 14.9 per cent. Total bank credit to the private sector also rose, on average by 32.7 per cent over its target level of 29.8 per cent, while inflation rate surged to 42.8 per cent far surpassing its target of 14.5 per cent. Consequently, monetary policy was pursued to curb excess liquidity in the system, stem the tide of high and rising inflation rate and improve the balance of payment position.

During the period 1998-2002, the CBN adopted some policy measures in response to the challenge of controlling excess liquidity in the economy. The measures included: intervention at the weekly OMO and foreign exchange market to moderate the effects of expansionary fiscal policies, upward review of the minimum rediscount rate (MRR) and cash reserve requirements as well as the commencement of the medium term monetary policy framework. The outcomes showed that the growth of domestic liquidity measured by the broad money supply (M2) increased by an average of 30.4 per cent over the targeted average level of 13.5 per cent. The growth in bank credit to the private sector grew by an average of 25.0 per cent, which was below the target level of 26.7 per cent, while the inflation rate declined significantly to 12.8 per cent. Between 2003 and 2007,

monetary policy measures were specifically designed to promote stable macroeconomic environment through the achievement of single digit inflation, sustained stability in the exchange rate, financial sector soundness and a non-inflationary GDP growth. The Bank introduced the Monetary Policy Rate (MPR) to replace the Minimum Rediscount Rate (MRR), in 2006, as a new Monetary Policy Implementation framework. The new framework was designed to achieve stable aggregate prices, including the exchange rate of the domestic currency through stability in short- term interest rates. The interbank rate was expected to converge around the MPR which had become the Operating Target. The MPR serves as an indicative rate for transactions in the money market. Other policy measures undertaken included the use of deposit and lending facilities, amongst others. The liquidity management efforts of the CBN yielded the expected results as single-digit inflation rate of 8.6 per cent in 2006 and 6.6 per cent in 2007, respectively, were achieved (CBN, 2008).

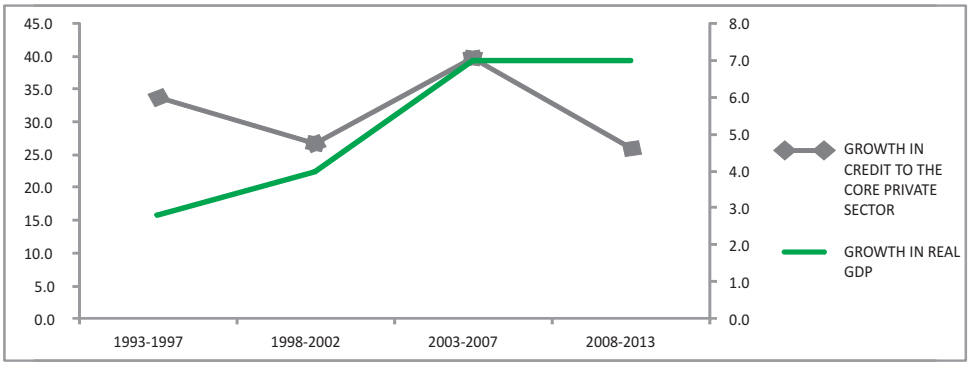
Monetary policy outcomes improved with the new monetary framework. The success of monetary policy was further enhanced by the prudent fiscal operations of the Government During the period 2008 and 2012, the conduct of monetary policy was largely influenced by the global financial crisis which started in the United States and later spread to other regions, including emerging markets. The crisis created liquidity crunch in the banking system due to large capital outflows which exerted pressures on the foreign exchange market as well as induced large volume of non-performing loans in the banking

sector and a crash in stock market prices. The situation further led to the fall in crude oil prices that caused external reserves to decline. Government revenues also fell drastically and required huge fiscal injections. In response, the CBN adopted monetary easing for the economy to rebound to address the problem of liquidity shortages in the banking system from September 2008 to September 2010. The policy measures taken during the period among other things included: suspension of OMO, reduction of monetary policy rate (MPR) from 10.25 per cent to 6.0 per cent, progressive reduction of Net Open Position (NOP) limit of deposit money banks from 20.00 per cent to 10.00 per cent, 5.00 per cent and 1.00 per cent, and injection of N620 billion as tier2 capital into 8 troubled banks. With the return of normalcy to the economy, the Bank has since reverted from monetary to tight monetary policy stance. Active OMO for the purpose of liquidity management

The overall performance of monetary policy during the period showed that M2 grew moderately by an average of 22.7 per cent, which was below the target of 26.7 per cent, while credit to the private sector grew by 26.6 per cent compared with the target level of 40.4 per cent. The Inflation level moderated at 12.6 per cent.

Overall, the growth in GDP for the period 1993-1997 averaged 2.8 per cent. It rose gradually to an average of 4.0 per cent in the period 1998-2002. Available data showed that the growth in credit and GDP peaked during the period 2003-2007 with growth in credit to the core private sector rising to 39.9 per cent

Figure 1: Growth in Credit to the Core Private Sector and Growth in Real GDP



Source: CBN Statistical Bulletin and CBN Annual Report 2012

Table 1: Growth in Credit to the Core Private Sector and Growth in Real GDP

	GROWTH IN REAL GDP	GROWTH IN CREDIT TO THE CORE PRIVATE SECTOR
1993-1997	2.8	33.8
1998-2002	4.0	26.7
2003-2007	7.0	39.9
2008-2013	7.0	26.1

Source: NBS 2013

(table 1). This was attributed to the increased ability of banks to lend following the banking sector consolidation exercise of 2005/2006 which improved the capital base of banks. The growth trend in credit to the core private sector was however reversed during the period 2008-2013. This was largely attributed to the effect of the global financial crisis in 2008/2009.

2.2 Developments in Nigeria's Real Sector

The real sector is one of the four distinct and interrelated sectors of the economy. Others are financial, fiscal and external sectors. The sector consists of agriculture, industry, mining,

building and construction, and services. The real sector is one of the main drivers of the economy and propels economic growth and development. It directly deals with the production of goods and services using available resources, including capital and labour. A productive real sector, especially agriculture and manufacturing builds linkages in the economy more than any other sector, thus reducing the economic pressures on the external sector. Also, growth in the real sector leads to increase in employment and income generation. Therefore, the success of any macroeconomic policy can thus, be assessed based on its positive impact on the level of economic activities, especially the production of goods and services, which promotes the general welfare of the citizens.

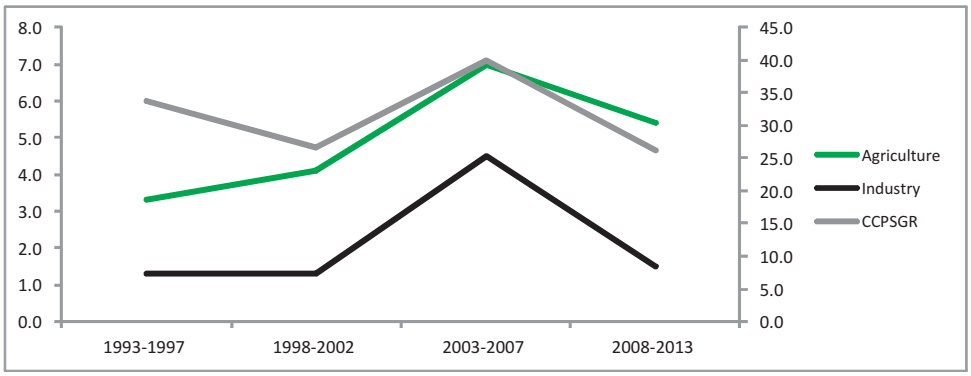
Essentially, developments in Nigeria's real sector have been mixed over the years. Available data shows that the agricultural sub-sector grew on average by 3.3, 4.1 and 7.0 per cent for the periods 1993-1997, 1998-2002 and 2003-2007, respectively. It however decelerated to 5.4 per cent for the period 2008-2013 and this may be attributed to the devastating effect of the flood which occured in 2012/2013. The wholesale and retail trade, industry, and services all showed mixed trends over the period under review. The building and construction sub-sector, however, showed a continuous growth trend of 3.7, 6.0, 11.4, and 12.8 per cent in the period 1993-1997, 1998-2002, 2003-2007 and 2008-2013, respectively.

Table 2: Sectoral growth rates of GDP at 1990 Constant Basic Prices (per cent)

Sector	1993-1997	1998-2002	2003-2007	2008-2013
Agriculture	3.3	4.1	7.0	5.4
Industry	1.3	1.3	4.5	1.5
Building & Construction	3.7	6.0	11.4	12.8
Wholesale & Retail Trade	1.1	3.2	11.9	11.2
Services	3.1	7.9	7.3	12.1

Source: National Bureau of Statistics 2013

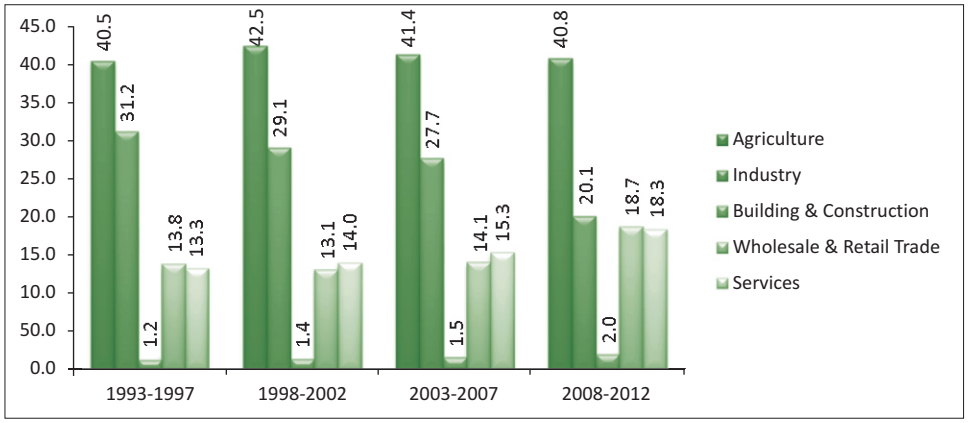
Figure 2: Growth in Agricultural and Industrial Sectors visa vis Growth in Credit to the Core Private Sector



Source: National Bureau of Statistics 2013

Further analysis shows that the performance of the agricultural and industrial sub-sectors both reflect the movement in credit to the core private sector. Growth in credit to the core private sector during the period 1998-2002 and 2003-2007, reflected in the rising growth in both the agricultural and industrial sector that grew from 4.1 and 1.3 per cent to 7.0 and 4.5 per cent, respectively. The growth in credit to the core sectors was attributed to the consolidation of banks during the period.

Figure 3: Sectoral Contribution to GDP Growth



Source: NBS 2012

Table 3: Sectoral Contribution to GDP Growth

	1993-1997	1998-2002	2003-2007	2008-2012
Agriculture	40.5	42.5	41.4	40.8
Industry	31.2	29.1	27.7	20.1
Building & Construction	1.2	1.4	1.5	2.0
Wholesale & Retail Trade	13.8	13.1	14.1	18.7
Services	13.3	14.0	15.3	18.3
TOTAL VALUE ADDED	100.0	100.0	100.0	100.0

Source: National Bureau of Statistics 2013

Despite continued government effort to promote industrialization in Nigeria through channeling credit to targeted prospective entrepreneurs in the form of SME loans and credit, the contribution of the agricultural sector has continued to dominate other sectors. The sector alone accounted for over 40.0 per cent growth in GDP throughout the period under review. The share of the industrial sector which was

31.2 per cent in the period 1993-1997 continued to decelerate and accounted for only 20.1 per cent of the GDP for the period 2008-2012. The low performance of the industrial sector has been attributed to the poor state of infrastructure, particularly, power in the country. The building and construction sub sector has however, shown an upward growth in its share of GDP rising from 1.2 per cent in the period 1993-1997 to1.5 per cent in the period 2003-2007, and 2.0 per cent in 2008-2012. The progress has been attributed to successes of the various housing policies of government targeted at bridging the wide gap in housing needs.

The share of wholesale and retail trade and the services sub-sectors to the GDP grew from 13.1 and 14.0 per cent in the period 1998-2002 to 14.1 and 15.3 per cent in 2003-2007 and 18.7 and 18.3 per cent in 2008-2012, respectively. The performance of the services sector is dominated by the performance of the telecommunications sub-sector which grew steadily over the years. The hotels and restaurant also has shown significant contribution to the performance of the services sub-sector over the years.

3. Review of Literature

There have been extensive studies from the extant literature on the effects of monetary policy shocks on the real economy both in developed and developing economies. These studies have been able to create the understanding that monetary policy and other shocks do have different impact on the economy and its component parts (Raddatz and Rigobon, 2003; Llaudes, 2007; Jansen, Kishan and Vacaflores, 2010; Alam and Waheed, 2011; Nampewo etal, 2013; Nwosa and Saibu, 2012). The findings showed that some sectors are more interest sensitive when compared to others.

The study on the effects of monetary policy shocks on the disaggregated components of the GDP in the US was first carried out by Bernanke and Gertler (1995). They employed a VAR model and established the differential impact of monetary policy on the components of final expenditures. Thereafter, studies such as Ganley and Salmon (1997) found that following a monetary policy tightening, there were substantial variation in the size and timing of changes in sectoral output. The sector that experienced the largest and fastest decline in output was construction, while the response from the manufacturing industries was lower, which reflected credit market imperfections in the monetary policy transmission process.

Raddats and Rigbon (2003) employed SVAR to analyse the effects of monetary policy in the US and found disparities in the response to monetary policy among the productive sectors in

USA. Consequently, the authors asserts that due to the heterogeneity of sectoral responses, a monetary policy rule aimed at stabilizing aggregate output and price will have an asymmetric effect across sectors. Thus, high interest rate sensitive sectors will be subjected to larger cyclical fluctuations than those with low interest rate sensitivity.

Llaudes (2007) studied the effects and transmission mechanism of unexpected monetary shocks in an open economy setting within the context of a VAR framework for 15 OECD countries. The study considered an economy with two sectors namely, tradable and non-tradable and employed a recursive identification scheme based on the cholesky decomposition and the structural VAR (SVAR) methodology. The author found evidence that both the tradable and non-tradable sectors were sensitive to the effects of monetary policy. Contractionary monetary policy shock that raises the level of the interest rate causes an appreciation of the exchange rate, while tradable and non-tradable output decrease in all countries in the sample.

However, the reduction in tradable output is more pronounced than the reduction in non-tradable output. This was because the manufacturing sector (which engage in the production of tradeables), are more interest rate sensitive than non-tradables (service) production, such that for a given increase in interest rates, tradable output was more negatively affected. In addition, a monetary contraction that precipitated appreciation of the exchange rate results in a loss of price

competitiveness of the domestic tradable goods in both international markets and in relation to the non-tradables sector. The results showed that the behavior of the two sectors varied within the economy, as the tradable sector showed a higher degree of responsiveness to policy shocks more than the non-tradable.

Crawford (2007) investigated the impact of monetary policy shocks on sectoral output in the Australian economy. The study used an open economy SVAR to examine the effects of monetary policy shocks on nine sectors. The impulse response functions showed that monetary policy shocks have uneven impact across the different sectors. Result of the impulse response function indicate that following unanticipated monetary shocks, agriculture, forestry and fishing sectors experienced the largest and most rapid decline in output. The forecast error variance decomposition revealed that monetary policy shocks contribute the least to mining output when compared to others. Furthermore, the study portrays that after three years, agriculture, forestry and fishing sector displayed the greatest shock persistence, while the construction sector was least. The size and timing of contractions in output confirmed that certain sectors were more sensitive to changes in the policy stance of the monetary authority. The construction and manufacturing sectors were more responsive, in terms of the sizeable and quick decline in output, when compared to mining, services and utilities that reacted more slowly.

In the same vein, Lawson and Rees (2008) employed SVAR to

examine the effect of unanticipated changes in monetary policy on expenditure and production components of GDP in the Australian economy during the period 1983 – 2007. Their findings were in consonance with the extant literature indicating heterogeneous response of the components of GDP to monetary policy impulses. Specifically, they found that dwelling investment, as well as machinery and equipment investment were the most interest sensitive expenditure components of GDP, while construction and retail trade sectors were the most interest sensitive production components of GDP. Jansen, Kishan and Vacaflores (2010) examined the impact of monetary policy on net sales of publicly traded firms in various sectors of the US economy by estimating regression models with firm-level fixed effects for each sector. They found evidence that monetary policy has a heterogeneous impact on firms in different industries, with the strongest effect on firms in wholesale and retail.

Alam and Waheed (2006) used a VAR framework to investigate the monetary transmission mechanism in Pakistan at the sectoral level in the period 1973 – 2003. Their results confirmed the existence of sector-specific variation to the real effects of monetary policy changes. Particularly, they found that manufacturing, construction, finance, insurance, real estate and business services sectors respond more negatively to changes in interest rate when compared to aggregate output. In contrast however, agriculture, forestry and fishing, mining and quarrying, electricity, gas and water were relatively insensitive to interest rate changes. The short term interest rate was used as

a measure of monetary policy stance, while the unrestricted VAR was employed in their analysis with three variables for the aggregate economy as well as for each sector: the level of output, the level of prices (represented by the consumer price index), and a monetary policy indicator.

Nampewo et al (2013) investigated the sectoral effects of monetary policy in Uganda over the period 1999 to 2011 via the interest rate, bank credit and the exchange rate channels by employing pairwise granger causality test and recursive VAR. They analyzed sectors adjudged to be the key drivers of Uganda's GDP growth namely; agriculture, manufacturing and service sectors. They found evidence that a positive shock in exchange rates result in increase in output of agriculture and service sectors, while the output in the manufacturing sector declined. They found evidence that the exchange rate channel is the most effective monetary policy transmission channel to all the three sectors studied, while the interest rates and bank credit channels remain relatively weak, especially within the manufacturing sector.

As mentioned earlier, the only available study for Nigeria was carried out by Nwosa and Saibu (2012). They investigated the transmission channels of monetary policy impulses on sectoral output growth in Nigeria. They employed the unrestricted VAR and the Granger causality on quarterly data that spanned the period 1986 – 2009. They found interest rate and exchange rate as the most effective monetary tools to influence sectoral output growth in Nigeria. The interest rate channel was most

effective in transmitting monetary policy to agricultural and manufacturing sectors, while the exchange rate channel was most effective for transmitting monetary policy to building and construction, mining, service and wholesale/retail sectors.

In view of the major weakness in methodology in the study by Nwosa and Saibu (2012), this study intended to develop an understanding of sectoral responses in an SVAR framework and uncover the insight into Nigeria's transmission mechanism, as well as provide the basis to objectively evaluate the effectiveness of monetary policy. It relied on the structural estimates of the impulse response functions and forecast error variance decompositions to ascertain the sensitivity of the different sectors of the real economy to monetary policy impulses. Besides, the policy variable used and the period of investigation does not confer reliability and credibility of the findings of the study because it does not entirely cover the period of implementing indirect monetary policy regime or truly reflect its market orientation. Therefore, this present study would address these shortcomings as already enunciated.

4.0 Methodology

4.1 Data

This study utilized quarterly data spanning the period 1993Q1 to 2012Q4 which coincides with the indirect monetary policy regime in Nigeria. All data were sourced from the CBN Statistical database.

The variables for the study consist of policy and non-policy variables. The monetary policy variables comprises money supply (M2), nominal exchange rate (NER), interbank call rate (IBR) and monetary policy rate (MPR) while the non-policy variables are consumer price index (CPI) and real gross domestic product, RGDP (Y_t), and five sectoral GDP components. The five classifications of real output or real GDP in Nigeria according to the National Bureau of Statistics (NBS, 2013) are agriculture (AGR), building and construction (BUID), manufacturing (MAN), services (SER) and wholesale and retail (WAR). The industrial sector was substituted with the manufacturing sector (MAN) because activities in the mining sector may not be very responsive to monetary policy, especially the oil and gas sub-sector.

Real GDP is the measure of economic activity used in this work. The essence is to determine how the policy rate would influence the growth of output or economic activities. Some studies like Crawford (2007) and Borys and Horvath (2007) advocate for the use of output gap instead of the real GDP because the monetary authorities tend to react to output gap rather than

trend in the growth of output. However, the use of output gap has been criticized because of the difficulty in measuring the output gap with precision[1]. Also, it has no unique numerical link to inflationary pressure. Moreover, Nigeria is a developing economy yet to fully exploit its resources and operates below its potential output level. Therefore, using output gap in place of the GDP may not adequately capture the effect of monetary policy on aggregate output and its components.

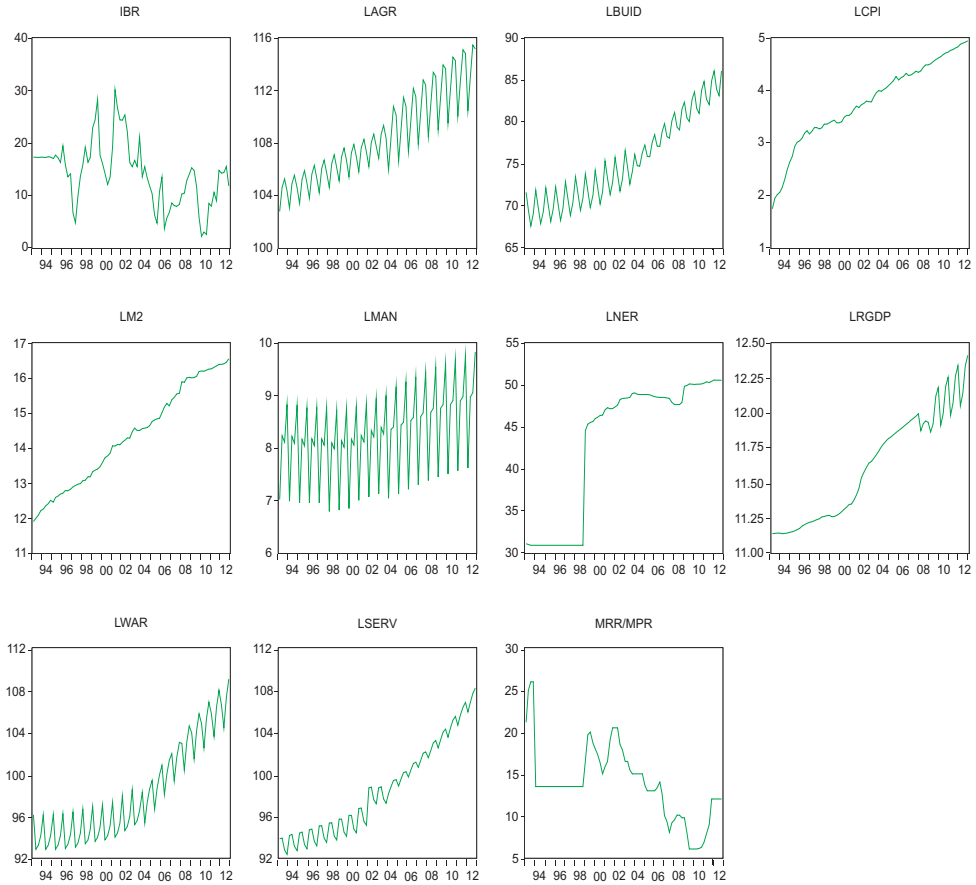
The other non-policy variable included in the model is the CPI. The level form of the CPI variable was employed as an indicator of the general price level. The exchange rate is included in the model to capture the interplay between monetary policy and the foreign exchange segment of the financial market. The nominal exchange rate of the local currency to US dollar was used. Thus, an increase in its numerical value engenders currency depreciation and vice-versa. The other monetary policy variables are the interbank call rate and the broad money supply, which are commonly used by central banks as stabilization tools. The monetary policy rate (MPR) is the official rate of the Central Bank of Nigeria and serves as the anchor rate, as well as the operating range or band of overnight interest rates in the money market. The source of shock propagation in the model is assumed to be the MPR and affects the economy through different channels.

The study is estimated using a six variable SVAR for the aggregate output (Y_{it}). A separate SVAR is estimated for each

[1]George, E. et al. (1999)

sector of the economy aside from the aggregate real output. This is to account for the effect of monetary policy shocks on each sector. In estimating the SVARs, all variables enter the respective models in log-levels, except the policy variables (*MPR* and *IBR*) which enter in their respective percentage terms. A graphical examination of real GDP and its components revealed the presence of cyclicality and seasonality in the variables (figure 4).

Figure 4: Policy and Non-Policy Variables



Estimating the variables without eliminating these observed features would affect the parameter estimates of the impulse response functions. to correct this, the census X-13 approach was employed to seasonally adjust the GDP and its sectoral components.

In examining the properties of the data, the result of the unit root tests indicates that the variables are non-stationary prior to their differencing, which kept them significant at the 5.0 per cent levels (Appendix 1). Since the point of interest lies in the dynamic interrelationships among the macroeconomic variables, the SVARs were estimated in levels to avoid losing economic information embedded in the variables, as it is common in monetary literature. Furthermore, by carrying out level form estimation, we have implicitly assumed that there is cointegration among the economic variables.

A major requirement for the estimation of a VAR model is the choice of an appropriate lag length. The FPE, SC and HQ criteria selected an optimal lag length of order 1, which was employed in the study (Appendix 3). As part of the diagnostic tests, a stability test was undertaken to ascertain the reliability of the VAR model using the autoregressive (AR) root stability test. The estimated VARs proved to be stable since all roots indicated a modulus of less than one and lie inside the unit circles (Appendix 2).

4.2 Analytical Framework

The SVAR methodology was employed to estimate and analyze the effect of monetary policy on various sectors of the Nigerian

economy. Although there are recent improvements in the VAR methodology, the use of SVAR in the analysis of monetary policy effects have produced relatively better and robust results. In addition, the SVAR is theoretically suitable and offers the benefit of identifying monetary policy as well as other shocks.

We begin by assuming that the economy is represented by the following structural form:

$$Ax_t = \alpha_0 + C(L)x_{t-i} + B\varepsilon_t \qquad (1)$$

Where x_t is a vector of endogenous macroeconomic variables, x_{t-i} is a vector of the lagged values of endogenous variables, ε_t is a vector of random error of disturbance terms for every variable that captures exogenous factors in the model, $C(L)$ is a matrix polynomial in the lag operator L of length p, A is a matrix of $n \times n$ dimension, n is the number of variables, and B is a column vector of dimension $n \times 1$, which contains the contemporaneous response of the variables to the innovations or disturbances.

There are three steps involved when estimating an SVAR. The first step is to estimate the VAR in its reduced form because the coefficients in the matrices of (1) are unknown, the variables have temporary effects on each other and the model in its current form cannot be identified. To transform (1) into reduced form, we multiply both sides of equation (1) by the inverse of matrix A translating it into a standard VAR representation of:

$$x_t = A^{-1}\alpha_0 + A^{-1}C(L)x_{t-i} + A^{-1}B\varepsilon_t \qquad (2)$$

Further transformation of equation (2) gives:

$$x_t = \gamma_0 + D(L)x_{t-i} + e_t \qquad (3)$$

Where $\gamma_0 = A^{-1}\alpha_0$, $D(L) = A^{-1}C(L)$ and $e_t = A^{-1}B\varepsilon_t$ The focal issue here is to recover the underlying structural disturbances from the estimated VAR. Hence, we can estimate the random stochastic residual $A^{-1}B\varepsilon_t$ from the residual e_t of the estimated unrestricted VAR:

$$A^{-1}B\varepsilon_t = e_t \qquad (4)$$

Reformulating (4), we have $A^{-1}B\varepsilon_t\varepsilon_t'B'A'^{-1} = e_te_t'$ and since $e_te_t' = I$ we have:

$$A^{-1}BB'A'^{-1} = e_te_t' \qquad (5)$$

In the second step, we identify the structural model from an estimated VAR. As such, it is necessary to impose restrictions on the structural model. Here, we utilized the non-recursive method of imposing restrictions in SVARs for the aggregate and sectoral output components using economic theory as the basic foundation. If there are n variables, equation (3) requires the imposition of $n(n+1)/2$ restrictions on the $2n^2$ unknown elements in A and B. Therefore, additional $n(3n-1)/2$ restrictions are required to be imposed.

$$Ae_t = B\varepsilon_t \qquad (6)$$

From equation (6), it shows that the disturbances or innovations in the reduced form e_t, are complicated mixtures of the underlying structural shocks, which are not easily interpretable except it is directly linked to the structural shocks. The e_t is the source of variation in the VAR analysis.

The third step of the SVAR analysis is to use innovation accounting to access the pass-through from the monetary policy variables to aggregate output and sectoral output. It uses the forecast error e_t from the estimated reduced form VAR

to obtain the impulse response functions (IRF) and forecast error variance decomposition (FEVD), to examine the sectoral effects of monetary policy. The IRF show the response of each variable in the system to shocks from the system variables. A unit shock is applied to the error term of each variable from each equation separately and the effects upon the VAR system are traced over time. The FEVD tells us the proportion of movements in a sequence due to its own shocks versus shocks to the other variables. In other words, it shows the proportion of the forecast error variance in a variable that is explained by innovations to itself and other variables. Therefore, FEVD provides information about the relative importance of each random innovation in affecting the variables in the VAR (Enders, 2010).

4.3 Identification Scheme

In analyzing the effects of monetary policy on the real sector, two sets of estimations were used: one for the aggregate output model and the other for the sectoral disaggregates. Therefore, two sets of identification schemes for the respective SVARs were implemented. The structural shocks in the aggregate output were identified using the non-recursive identification method by placing restriction on the variables in the system as shown in equation 7. In applying restrictions to each equation, premium was placed on the choice of key economic variables predicated on economic theory and other empirical works.

The first two rows in the matrix block represents real GDP and CPI, which capture succinctly the goods market equilibrium of the

domestic economy. The first row contains the restrictions for real GDP. Structural innovations from real GDP, interbank call rate and money supply contemporaneously affect real GDP, while the other macroeconomic variables affect it with a lag. This is premised on the ground that the interest rate and money supply variables are important output determinants following the IS-LM framework. In the second row, the CPI is contemporaneously affected by structural innovations from real output and itself.

$$AX_t = \begin{bmatrix} 1 & 0 & 0 & b_{14} & b_{15} & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & b_{34} & 0 & 0 \\ b_{41} & 0 & 0 & 1 & b_{45} & 0 \\ b_{51} & 0 & 0 & b_{54} & 1 & 0 \\ 0 & 0 & 0 & b_{64} & 0 & 1 \end{bmatrix} \begin{bmatrix} Y_t \\ CPI \\ MPR \\ IBR \\ M2 \\ NER \end{bmatrix} \qquad (7)$$

Taylor (1993), analyzed the effect of monetary policy on the real sector and employed the use of a single short term interest rate (such as the federal funds rate or call money rate) for empirical analysis. The interest rate employed is usually a short-term private market rate, which represents the policy reaction function of central banks. However, in this study, both MPR and IBR were used as interest rate variables. The MPR represents the official monetary policy stance of the CBN and is the source of propagation of shocks when examining the effect of monetary policy on the real sector of the Nigeria economy. Besides, given the lumpiness of the MPR over time and its inability to directly reflect market conditions, the IBR is included to augment the official rate. The MPR equation assumes that there is contemporaneous interaction between MPR and IBR. In other words, the MPR is unaffected by innovations from other

variables except from interbank call rate and itself.

The next two rows relate to money supply and money demand, representing the money market equilibrium. The IBR, which is the money supply equation, is affected contemporaneously by real output, money supply, and its own innovation. The inclusion of these variables in the IBR equation tells us that the policy maker is reacting indirectly through the interest rate channel. This is consistent with economic postulates which dictate that the interest rate equilibrium results from the interaction of money supply and money demand functions. The fifth row shows the money demand equation, which is affected by innovations from real output, interbank call rate and structural shocks from itself. This is in line with the commonly stated money demand equation in macroeconomics.

The last row is the exchange rate which represents the uncovered interest rate parity. Exchange rate is affected contemporaneously by shocks from IBR and itself. Although several studies place numerous restrictions on exchange rate equation (Lawson and Rees, 2008, Vinayagathasan 2013 and Claudes 2007), this study, assumes that interest rate is a key determinant of nominal exchange rate. As such, movements in the rate of interest will generate shocks that will ultimately change portfolio flows and cause currency appreciation or depreciation.

In order to capture the real effect of sectoral output, the study followed the work of Lawson and Rees (2008) and Arnold and

Vrugt (2002). Two output variables were included in the sectoral SVARs, which are the sector's output (Y_{it}) and the net aggregate output (Y_t-Y_{it}) that excludes that particular sector from the aggregate when estimating the individual sectoral SVAR (equation 8).

$$AX_t = \begin{bmatrix} 1 & 0 & 0 & b_{14} & b_{15} & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & b_{34} & 0 & 0 & 0 \\ b_{41} & 0 & 0 & 1 & b_{45} & 0 & 0 \\ b_{51} & 0 & 0 & b_{54} & 1 & 0 & 0 \\ 0 & 0 & 0 & b_{64} & 0 & 1 & 0 \\ b_{71} & b_{72} & 0 & b_{74} & b_{75} & b_{76} & 1 \end{bmatrix} \begin{bmatrix} Y_t - Y_{it} \\ CPI \\ MPR \\ IBR \\ M2 \\ NER \\ Y_{it} \end{bmatrix} \quad (8)$$

Finally, in the sectoral output equation, the gross value added from each sector is considered as the most endogenous variable and responds contemporaneously to all the other variables in the model, except the monetary policy rate. It is noted that regardless of the type of non-recursive structure imposed on the contemporaneous matrix, the test for over-identifying restriction did not yield the expected result. This may be due to underlying data series.

5.0 Discussion of Results and Findings

This section is divided into three sub-categories for a clearer understanding, namely: aggregate effects of monetary policy, sectoral effects, and size, timing and persistence dimensions.

5.1 The Aggregate Effects of Monetary Policy

The structural impulse responses and variance decomposition of the aggregate model are considered below.

5.1.1 Structural Impulse Response Functions

The impulse response function is a means of tracing the dynamic responses of endogenous variables within the structural VAR framework to monetary policy shocks. The responses of macroeconomic variables (RGDP, CPI and NER) to unexpected shocks provide a useful barometer for gauging the effectiveness of monetary policy in the domestic economy and this is shown in Figure 5.

Aggregate output declined within the first quarter following a structural one standard deviation innovation to the monetary policy rate. The negative response of Real Gross Domestic Product (RGDP) to contractionary monetary policy continues for the first 8 quarters before returning to its long-run trend, and expands afterwards. This is consistent with economic theory as monetary policy may impact on output in the short-run, though neutral in the long-run (Blanchard, 2009). An increase in interest rate leads to corresponding increase in nominal long term

interest rate, and an appreciation in nominal exchange rate. Given price rigidities, these changes translate to an increase in real interest rate and real exchange rate. In turn, these variations results in short term decline in real net exports, real consumption, real investment and real aggregate demand and consequently, a drop in real aggregate output (Taylor, 1993).

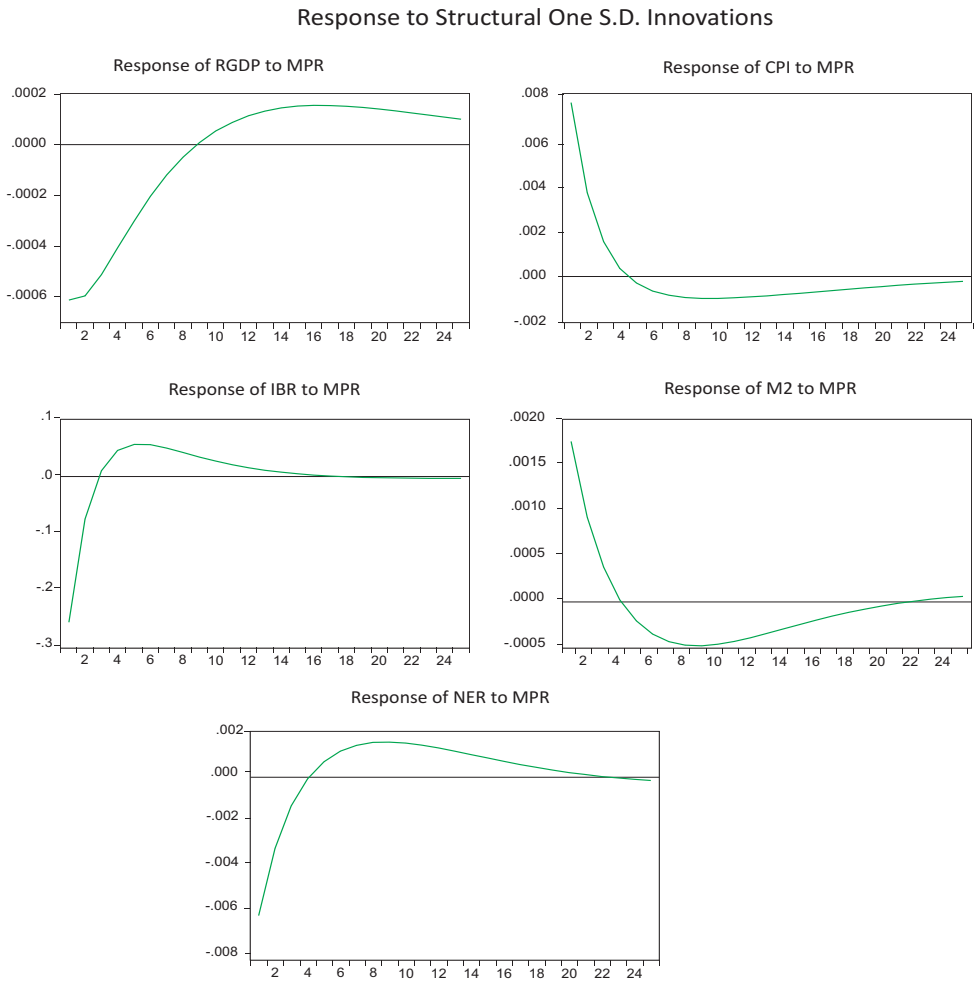
The point of greatest decline in output is attained in quarter 1. The impulse response of real GDP to MPR shock in this study corroborates that obtained by Chuku (2009) for Nigeria where aggregate output declined immediately after monetary shock and returned to equilibrium after about 4 quarters.

Monetary tightening puts downward pressure on prices as theoretically expected. However, the range of greatest decline commences from quarter 5 and continues throughout the forecast horizon. The drop in aggregate output is a definite factor in the downward price spiral. However, the key driving force for the extended fall in CPI may be gleaned from the relatively sustained negative sectoral output response of services and wholesale/retail.

In line with apriori expectation, monetary aggregates responded inversely to a structural one standard deviation shock in the policy rate because declining aggregate expenditure resulting from a higher interest rate translates to a constriction in money demand and money supply. Thus, M2 decelerated following monetary tightening as Figure 5 shows

and declined persistently for 18 quarters attaining its highest negative effect in quarter 9.

Figure 5. Impulse responses to a contractionary monetary policy (Agregate Model)



Theoretically, monetary tightening engenders an appreciation in the nominal exchange rate. The response of exchange rate

to MPR is shown in Figure 5. Monetary contraction leads to an immediate appreciation in the exchange rate. This is in line with economic theory. An increase in interest rate is expected to raise portfolio induced inflows, increase demand for local currency and leads ultimately to currency appreciation. The maximum impact of monetary policy on NER is felt immediately, that is within the first quarter, returning to its long run trend after four quarters.

The responses of key macroeconomic variables to contractionary monetary policy discussed above provide a good indication that the baseline model is adequate and can be employed as a spring-board for deriving the sectoral model and embarking on sectoral output response analysis.

5.1.2 Variance Decomposition

Forecast Error Variance Decomposition (FEVD) explains the variation in an endogenous variable that is accounted for by its own structural shocks as well as those from other endogenous variables in the system.

Table 4: Variance Decomposition of Real Output

		Shocks					
Quarter	**S.E.**	Y_t	***CPI***	***MPR***	***IBR***	***M2***	***NER***
1	0.26	41.42	0.13	0.0005	2.78	55.62	0.04
4	0.61	44.08	0.07	0.0003	1.89	53.94	0.03
8	0.87	44.93	0.04	0.0002	1.7	53.32	0.02
12	1	45.11	0.03	0.0001	1.74	53.1	0.02
24	1.11	44.64	0.03	0.0001	2.31	53	0.02

Note: S. E. means standard errors

Table 5 Variance Decomposition of CPI

		Shocks					
Quarter	**S.E.**	Y_t	***CPI***	***MPR***	***IBR***	***M2***	***NER***
1	1.57	37.38	0.84	0.002	57.84	3.91	0.02
4	2.85	44.26	0.69	0.0009	53.28	1.76	0.009
8	3.32	44.96	0.66	0.0007	52.78	1.59	0.007
12	3.43	44.83	0.65	0.0007	52.83	1.68	0.007
24	3.46	44.99	0.65	0.0007	52.59	1.76	0.007

Note: S. E. means standard errors

The variance decomposition of real GDP and CPI are displayed in Tables 4 and 5. It is readily seen that about 44% of the variation in real GDP is explained by its own innovation while money supply (M2) account for around 54%. Structural shocks from nominal exchange rate explain less than 0.05% of the change in aggregate output. The proportion of the variation in real GDP attributable to MPR is much smaller peaking at a maximum of 0.0005% in the quarter 1. Thus, we infer that the money supply is the key avenue of transmitting monetary policy to the aggregate economy.

5.2 Sectoral Effects of Monetary Policy

5.2.1 Contemporaneous Structural Coefficients

In order to explain the contemporaneous structural coefficients which measure the endogenous response of various components of sectoral output, we focused attention only on the policy block variables (IBR, M2 and NER) rather than the non-policy variables (output and price) as shown in Appendices 4 to 8.

All the policy variables turned up with the expected theoretical

signs in the agriculture equation, but only the coefficients of IBR and M2 were statistically significant. The negative sign of IBR coefficient indicates that an increase in the interest rate will reduce agricultural output while the positive sign of M2 coefficient shows that an increase in the supply of money will raise agricultural production. In the manufacturing, and building and construction sectors, IBR and M2 still remain the only statistically significant coefficients implying that declining output in these sectors will be associated with contractionary monetary policy.

Two policy variables were found to significantly affect the services sector output but only M2 had a positive effect. The positive coefficient shows that expansionary monetary policy which involves an increase in money supply will raise the gross value added for services. With regard to the wholesale and retail sector, the three variables that comprise the monetary policy block were all significant and possess the expected sign. In this context, an increase in the interest rate, a fall in money supply and an appreciation in the exchange rate will result to a decline in wholesale and retail output and vice versa.

5.2.2. Impulse Responses and Variance Decompositions

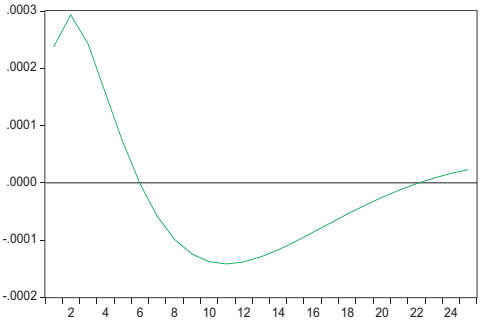
Sectoral output responded heterogeneously following a contractionary monetary policy shock, with some immediately responding positively in the first few quarters before declining, while others moved in the reverse direction (Figure 6). In most of

the forecast horizon, the sectoral output responded negatively to unanticipated monetary policy shock in harmony with economic theory. There were instances when the sectoral output responded positively in the forecast horizon, which is not consistent with theoretical expectation. This may be attributed to endogenous reactions of the macroeconomic variables in the system.

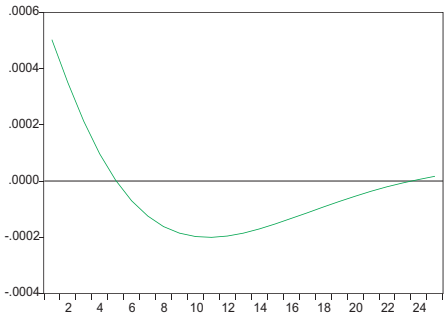
The impulse response showed the absolute effects of endogenous variables to shocks from other variables, but do not tell or explain the relative importance of various shocks to a particular endogenous variable, at particular points in the forecast horizon. The FEVD helps us to uncover the share of variation in each of the endogenous variables that can be attributed to shocks to other variables. Table 6 shows that the monetary policy rate does not significantly explain the variation in sectoral output but the other monetary policy variables, like interbank call rate and money supply, do significantly contribute to the variation in the sub-sectors. It connotes that the monetary policy rate does not directly impact on the sub-sectors, but through other channels. Besides, activities in the other sectors as represented in the net aggregate output do significantly explain the variation in sectoral output in the forecast horizon.

Figure 6 Impulse responses of the sub-sectors to contractionary monetary policy rate

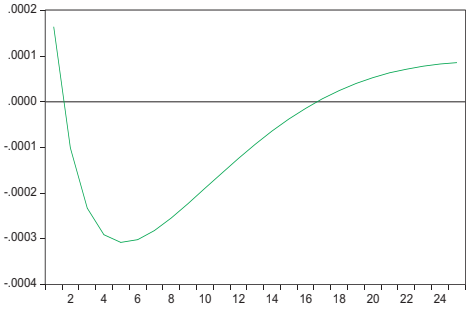
Response to Structural One S.D. Innovations
Response of Agric to MPR



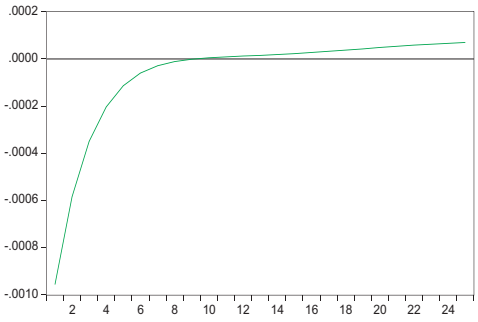
Response to Structural One S.D. Innovations
Response of Building and Construction to MPR



Response to Structural One S.D. Innovations
Response of Manufacturing to MPR



Response to Structural One S.D. Innovations
Response of Services to MPR



Response to Structural One S.D. Innovations
Response of Wholesale and Retail to MPR

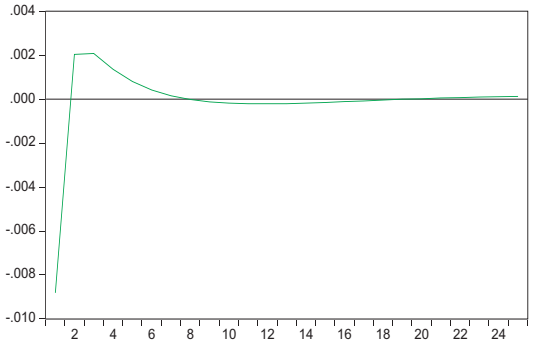


Table 6: Variance Decomposition of the Sectors

		Shocks						
Quarter	**S.E.**	Y_t-Y_{it}	***CPI***	***MPR***	***IBR***	***M2***	***NER***	Y_{it}
Agriculture								
1	0.34	43.18	0.13	0.002	2.71	48.91	0.071	4.99
4	0.72	39.89	0.1	0.001	4.78	52.18	0.05	3.01
8	0.96	36.53	0.07	0.001	7.13	54.08	0.04	2.14
12	1.08	35.42	0.06	0.001	8.19	54.54	0.04	1.74
24	1.16	35.41	0.06	0.001	8.79	54.13	0.03	1.57
Building and Construction								
1	0.4	7.07	0.66	0.0002	65.38	26.47	0.03	0.39
4	0.81	3.53	0.58	0.0001	62.29	33.19	0.02	0.4
8	1.06	3.04	0.49	9.22E-05	55.42	40.67	0.01	0.37
12	1.19	8.24	0.41	7.84E-05	46.84	44.18	0.01	0.31
24	1.39	23.95	0.33	6.99E-05	35.71	39.76	0.01	0.25
Manufacturing								
1	0.22	0.01	1.73	0.001	50.14	32.93	0.04	15.15
4	0.41	27.92	0.83	0.001	22.18	42.02	0.04	7.01
8	0.59	49.27	0.39	0.0003	10.56	36.36	0.03	3.39
12	0.69	54.93	0.31	0.0002	8.06	33.81	0.03	2.86
24	0.74	55.75	0.28	0.0002	7.65	33.26	0.04	3.02
Services								
1	0.65	37.34	2.49	4.18E-05	56.23	2.59	0.02	1.34
4	0.93	29.83	2.82	9.72E-05	59.89	5.95	0.01	1.49
8	0.99	28.88	2.76	0.0001	56.91	9.97	0.01	1.45
12	1.06	35.08	2.42	9.49E-05	50.36	10.85	0.01	1.27
24	1.23	44.03	2.15	8.82E-05	43.82	8.86	0.01	1.13
Wholesale and Retail								
1	0.35	24.92	0.14	0.0004	14.21	60.68	0.05	0.001
4	0.74	22.11	0.12	0.0003	16.63	61.09	0.04	0.004
8	1.02	22.63	0.09	0.0002	16.4	60.84	0.03	0.003
12	1.15	23.9	0.08	0.0002	15.63	60.36	0.02	0.003
24	1.24	26.04	0.07	0.0002	14.59	59.27	0.02	0.003

Note: S. E. means standard errors

5.2.2.1 Agriculture

The agricultural output responded negatively to a structural one standard deviation innovation in MPR as theoretically expected after a lag of 4 quarters. Thereafter, the sub-sector persistently responded negatively for 17 quarters between quarters 5 and 22, and returned to long run trend in the 23rd quarter. The maximum decline in output occurred between the 10th and 12th quarters. The lag in sectoral response of agricultural output to a restrictive monetary policy may be explained, in part, by the fact that Nigerian agriculture is dominated by small scale farmers who depend largely on crude farming methods. In addition, the lack of capital intensity in this sub-sector results in lag response. Furthermore, the long gestation period associated with crop and livestock production may aggravate planning delays and affect decisions on change in operational scale.

The FEVD of agriculture showed that the variables which significantly explain output variability in the sector are money supply and productive activities in other sectors of the economy, as they contributed on the average above 50 and 35 per cent, respectively in the forecast horizon. This implies that monetary policy affects the agricultural sector through the money demand (credit) and money supply channels. This finding is at variance with the sectoral study of Nwosa and Saibu (2012) involving unrestricted VAR where interest rate as a monetary policy instrument had the greatest influence on the agricultural sector.

5.2.2.2 Building and Construction

A structural one standard deviation innovation to the monetary policy rate produces a decline in the activities of building and construction from quarter 6. The full effect of reduced sectoral output is felt between quarter 10 and 12. The decline in value added of building and construction is quite persistent, lasting for 18 quarters and thereafter output returns to the long run trend in quarter 19. The building and construction segment has a significant component of government involvement and this would have partly contributed to the initial lagged response. One implication of this trend is that output stabilization from the angle of monetary policy may not be strong. Furthermore, building and construction can be classified into residential and non-residential components. The residential segment of building and construction is likely to be more responsive to monetary tightening, as an increase in interest rate will reduce mortgage loans. However, the non-residential component is significantly dominated by multinational companies and the public sector, and these may engender a weak response to monetary contraction. If the later dominates the building and construction sector, then the overall response of the sectoral gross value added will be weak. The demand for non-residential component is likely to be interest inelastic.

The FEVD for the building and construction sector showed a different pattern (Table 6). The interbank call rate (IBR), is the dominant source of variation, accounting for over 63 per cent in the first 4 quarters with an average of 47 per cent throughout the

forecast horizon. Next in magnitude is money supply, which explains 37 per cent of the variation. Thus, interest rate and the credit channel are the primary means of transmitting monetary policy to the building and construction sector.

5.2.2.3 Manufacturing

The manufacturing sector responded quickly to a one standard structural deviation increase in MPR within the first quarter. Thereafter, the sector's output declined sharply in quarter 2, reaching its lowest fall at quarter 5. The range of output decline extended over 15 quarters. The one period (1 quarter) lagged response of manufacturing sector to contractionary monetary policy is in tandem with normal productive activities, as instantaneous adjustments may be impractical given that time is needed to plan a scale down in operations. The eventual drop in output after quarter 1 is consistent with economic theory as an increase in interest rate raises the cost of capital to firms, which in turn constrains investment, leading to output decline. Furthermore, the Nigerian manufacturing sector is dominated by the production of non-durable goods, which are mainly consumables. Consequently, monetary contraction will constrain spending in the sector. Given that access to credit by Nigerian manufacturers is difficult, any monetary policy shock would further aggravate the problem of accessing funds. The bulk of manufactured goods in Nigeria are from relatively large firms (medium and large scale). Thus, we expect these firms to be more interest rate sensitive vis-à-vis smaller firms. This finding differs from the sectoral study in Uganda (Nampeno et al, 2013),

where the manufacturing sector responded positively and weakly to a positive innovation in the interest rate.

The FEVD for the manufacturing sector shows that IBR accounts for the bulk of the variations in the sector's output in quarter 1 (50%), but explained only 8% in the 24th quarter. However, M2 predicts 33%, 42% and 33% in quarters 1, 4, and 24 respectively, which makes money supply (the credit channel) the primary means of transmitting monetary policy impulses to manufacturing sector.

5.2.2.4 Services

A contractionary monetary policy results in the immediate decline of output in services sector in the 1st quarter by 0.00096, before returning to equilibrium in quarter 10. The response of services is consistent with economic theory, as output in the sector is expected to decline following tightening of monetary policy. From the 10th quarter onwards, services sector responds positively and persistently up to the end of the forecast horizon. The plausible explanation for the positive response after 2 years may be due to induced effects from other economic sectors like manufacturing, building, and wholesale and retail trade. The other major reason is that the sector is dominated by large firms and face inelastic demand for its output. Besides, the sector's positive response after quarter 10 may be traceable to the endogenous reaction to other macroeconomic variables in the model that is not a direct consequence of contraction in monetary policy.

The results of the FEVD show that monetary policy variables do significantly explain the variation in the services sector, except the monetary policy rate and exchange rate. Shocks in the interbank call rate account on the average for more than 50.0 per cent of the variability in services throughout the forecast horizon. This connotes the relative importance interest rate plays in the sector. The relative contribution of money supply to the variability of the sector was significant only after one year and was not more than 11.0 per cent. The contribution of other sector ranged between 28-56 per cent in the forecast horizon. This also corroborates the findings from the impulse response that the sector is affected by induced effects from other sectors.

5.2.2.5 Wholesale and retail trading

The sector responds negatively and immediately to a contractionary shock from monetary policy by 0.0088 in the 1st quarter before responding positively in the 2nd quarter and peaking at the 3rd quarter by 0.00205 and 0.00209, respectively. The negative response in the first quarter is consistent with theory, as the sector's output is expected to react negatively to unanticipated shock from monetary policy. The sector responded positively to a contractionary monetary policy in quarters 2-7, before returning back to the steady state sometime in quarter 7 and was persistently negative in quarters 8-19, although the magnitude of impact was very small.

The positive response of wholesale and retail sector output in quarters 2-7 appear surprising and not consistent with theory, but not unexpected given that the sector is propelled by

personal consumption rather than industrial demand. The items that constitute personal consumption are mainly not produced locally. An increase in the policy rate would induce higher increases in other market rates, which in turn increases the cost of capital for manufacturers. This stifles production leading to a fall in manufacturing output. The fall in manufacturing output for both durable and non-durable consumption goods would lead to a switch to personal consumption items with inelastic demand, which are not locally produced. As such, it would boost activities of economic agents engaged in on-selling in the wholesale and retail trade. In addition, it is possible that the wholesale and retail trading is largely affected by induced effects from other sectors like manufacturing and services.

The result of the FEVD shows that the variables that explain relatively the variation in the sector's output are money supply, interbank call rate and output from other sectors accounting on the average 60.0, 15.0 and 25.0 per cent respectively, of the variability in wholesale and retail trade. This finding corroborates that of the impulse response which suggests that the sector is largely affected by money supply via bank credit, interest rate and induced effects from activities in other sector like manufacturing, services, etc.

5.2.3. Size, Timing and Persistence of Sectoral Output Responses to Monetary Policy Shocks[2]

In this section, we present the sensitivity of the sectors to unanticipated shocks in monetary policy rate. The analysis is

[2]This section draws heavily from the analysis carried out by Crawford (2007)

undertaken by examining the size, timing and persistence of the response of the sectors to monetary policy shock, as well as ranking the sectors in terms of their sensitivity to shocks from the monetary policy rate. These characteristics are presented in Tables 7 and 8, which were extracted from the impulse responses of the sub-sectors (Figure 6). The sign and size of the biggest deviation of output from trend in absolute terms, the quarter it occurred and a measure of persistence is presented in Table 7. This measure of persistence looks at the number of quarters for which the longest negative output response occurs. The last column in the table measures the average output change between quarters 1-12, which is consistent with theory that monetary policy is expected to have full impact on output within 3 years. The point estimate deviations in output that occur at certain times after the shock is presented in Table 8. The sectors are then ranked according to those that experienced the most negative impact to the most positive change in output for each period. This implies that sectors that drop in their ranking from one period to the next are most likely to experience only a short output change in response to a monetary policy shock.

Table 7 Responses by the sectors to a contractionary monetary policy shock

Sector	*Relative output effect*	*Size of Min or Max effect (St. Deviation of structural error)*	*Timing of Min or Max effect (quarter)*	*Length of longest decline in output (quarters)*	*Average output change (1-12 quarters)*
Agriculture	(-)	0.000293	2	17	0.000025
Building & Construction	(-)	0.000504	1	18	2.45E-06
Manufacturing	(-)	-0.000309	5	15	-0.00019
Services	(+)	-0.000956	1	9	-0.00019
Wholesale and Retail	(-)	-0.008815	1	12	-0.00022

Note: (+)/(-) indicates a relative positive/negative effect. Size of Min or Max effect refers to the maximum or minimum deviation over the 24 quarter horizon after the shock measured in standard deviations of the structural error. Timing of Min or Max effect is the quarter in which the largest absolute deviation occurred.

Table 8: Persistence of sectoral output responses to a contractionary monetary policy shock

Rank	After 6 months		After 1 year		After 2 years		After 3 years	
	Sector	Output change	Sector	Output change	Sector	Output change	Sector	Output change
1	Services	-0.00059	Man	-0.00029	Man	-0.00026	WaR	-0.00021
2	Man	-0.0001	Services	-0.0002	Build	-0.00016	Build	-0.0002
3	Agric	0.000293	Build	9.68E-05	Agric	-9.85E-05	Agric	-0.00014
4	Build	0.00035	Agric	0.000157	Services	-1.07E-05	Man	-0.00012
5	WaR	0.002051	WaR	0.001369	WaR	-9.90E-06	Services	1.24E-05

Note: This table shows the point estimate deviation from trend at particular points in time after the contractionary monetary policy shock. Sectors are ranked from the most negative response to the most positive response to the monetary policy shock. Output changes are measured in standard deviations of the structural error.

An examination of Table 7 shows that all sectors experienced a decline in output sometime following a contractionary monetary policy. This finding is consistent with economic theory that monetary policy tightening impacts on output. Going by the size of the deviation away from trend, the most sensitive sector to unanticipated shock in monetary policy is wholesale and retail trade, which experienced a much larger deviation (-0.0088) when compared to others. This is followed by services (-0.000956) and manufacturing (-0.000309) sectors. The sectors that showed positive response by this characterization were building & construction (0.000504) and agriculture (0.000293).

The fourth column presents the length of time required for the sectors to peak in response to a monetary policy shock. In other words, it shows the monetary policy lag experienced by the sectors following a shock. The result showed that the largest deviation of sectoral output away from trend takes place within

one year of policy shock, except for manufacturing. It implies that the components of GDP responds to unanticipated monetary policy shock mainly within a year. It also means that sectors like building & construction, services and wholesale & retail trade respond with a quarter lag, while agriculture responds with 2 quarter lag and it takes about 5 quarter lag for unanticipated monetary policy shock to have its peak effect on manufacturing output before reverting to equilibrium.

The fifth column provides a measure of persistence of the sectoral output effects following a monetary policy shock. The sectors that show more persistent declines in output are building & construction, agriculture and manufacturing in 18, 17 and 15 quarters, respectively. The last column in Table 7 provides a measure of both persistence and magnitude of the responses of output in 3 years. Ranking the average change in output with respect to the most sensitive, wholesale and retail trade appears first and followed by services, manufacturing, agriculture and building & construction in that order.

6.0 Conclusion and Policy Recommendation

The study examined the effects of monetary policy on the real sector of the Nigerian economy. Specifically, the paper investigated the effects of monetary policy on sectoral output using quarterly data spanning the period 1993Q1 and 2012Q4. In other words, how does output from the sectors respond to unanticipated monetary policy shocks? The paper employed the structural vector autoregressive (SVAR) framework and used a suite of policy and non-policy macroeconomic variables. We estimated a six variable SVAR for aggregate output (baseline model) and a seven variable SVAR for the disaggregated output components.

The Impulse response functions showed that sectoral output responded heterogeneously following contractionary monetary policy shocks, with some immediately responding negatively (services and wholesale/retail sectors), while others displayed lagged negative responses (manufacturing responded after 1 quarter, building and construction 4 quarters, and agriculture 5 quarters). In all, the sectors responded negatively to unanticipated monetary policy shock in most of the forecast horizon. The findings are consistent with economic theory, as output in each sector is expected to decline following monetary tightening.

The size, timing and persistence of contractions in sectoral output confirmed the sensitivity of some sectors to monetary policy shocks. The most sensitive sector to unanticipated shock

in monetary policy is wholesale and retail trade. This was followed by services and manufacturing sectors. The sectors that showed positive response by this characterization were building & construction and agriculture. The size and timing of the maximum effects of services, and wholesale and retail sectors has important implication as they constitute significant drivers of induced effects in other sectors that showed initial lagged responses, like agriculture, building and construction. Besides, the sectors that showed more persistent decline in output are building & construction, agriculture and manufacturing which demonstrate that restrictive monetary policy has longer lasting effects on these sectors as compared to services, wholesale and retail sectors where monetary effects are relatively short-lived.

The results of the contemporaneous structural coefficients show that interbank interest rate has a negative and statistically significant impact on disaggregated output in all the sectors, while money supply, in general, exhibits a statistically significant positive effect on the sectoral output components. The variance decomposition corroborates the above findings as the most important monetary policy variables that explain the variation in sectoral output are interbank call rate and money supply. Innovations from the monetary policy rate and exchange rate do not significantly explain the variations in output.

A number of implications are evident from the findings of the study. First, the outcome of the variance decomposition implies

that the principal means of monetary policy transmission to the sectors is through the credit and interest rate channels. Second, given that monetary tightening will contract output in all the non-oil sectors considered in this study, it has implications for the diversification and economic transformation of Nigeria's oil dominated economy. Third, fairly long lags in the responses of agricultural and building/construction sectors implies that output stabilization from the angle of monetary policy may not be strong. Fourth, the quick responses to monetary policy shocks from manufacturing, services, and wholesale and retail sectors portrays a significant latitude for stabilizing output through these sectors.

The primary objective of the Central Bank of Nigeria as enshrined in the 2007 Act is to maintain stable prices that would promote economic growth. However, if price stability is achieved via monetary tightening, output and jobs in interest rate-sensitive sectors will plunge. Thus, in general, we recommend that the monetary authority should provide some measure of support for specific sectors adversely affected by unanticipated monetary policy shocks. Specifically, the following recommendations are considered apt:

1. The findings of this study justify the creation of more special credit schemes by the Central Bank of Nigeria where appropriate. Therefore, the following existing initiatives should be reviewed to identify weaknesses, strengthen and substantially enlarge;
    - Restructuring/Refinancing to the Manufacturing

Sector/SME

- Small and Medium Scale Enterprises Credit Guarantee Scheme (SMECGS)
- Commercial Agricultural Credit Scheme (CACS)
- Nigeria Incentive- Based Risk Sharing for Agricultural Lending (NIRSAL)

2. The fourth pillar of "the Alpha Initiative of the CBN" should be pursued to its logical conclusion as it has a direct bearing to unlock the potential of the financial sector to intervene and support real activities in the economy.
3. In view of the statistical significance of interest rate and money supply variables, we suggest that the monetary authority should seek out ways to reduce interest rate and increase money supply (credit) to sectors such as agriculture and manufacturing which deposit money banks often time find it difficult to extend credit to.
4. The CBN should leverage on its role as economic adviser to the federal government to influence, not only monetary and exchange rate policies, but all other supply-side policies that would promote real sector development in Nigeria.

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Appendices

Appendix 1: Unit Root Tests

	Augmented Dicker Fuller (ADF)					Philip Perron (PP)				
	Level	Prob.	1st Diff	Prob.	Order of Integration	Level	Prob.	1st Diff	Prob.	Order of Integration
RGDP	-1.902	0.643	-3.910	0.0162	I(1)	-4.401	0.0038	-12.273	0.0001	I(1)
AGR	-1.5333	0.9121	-3.8111	0.021	I(1)	-6.929	0.0001			I(0)
BAC	4.259	1.000	-2.967	0.14		-4.891	0.0008			I(0)
MAN	-0.958	0.943	-273.579	0.0001	I(1)	-14.315	0.001			I(0)
SERV	2.856	1.000	-3.335	0.06	I(1)	0.0396	0.996	-11.859	0.0001	I(1)
WAR	0.144	0.997	-2.562	0.298		-4.774	0.0012	-15.720	0.0001	I(1)
MPR	-1.633	0.0963	-7.735	0.0001	I(1)	-1.229	0.199	-7.735	0.0001	I(1)
CPI	0.895	0.99	-3.029	0.013	I(1)	2.597	1.0	-7.203	0.0001	I(1)
IBR	-1.1877	0.2131	-8.731	0.0001	I(1)	-1.128	0.234	-8.810	0.0001	I(1)
NER	-1.545	0.805	-7.956	0.000	I(1)	-1.693	0.745	-7.956	0.0001	I(1)
M2	0.432	0.99	-9.533	0.0000	I(1)	0.647	0.999	-9.540	0.0000	I(1)

Notes: ADF 1 and PP 1 represent= Unit root tests with constant, while ADF 2 and PP 2 = Unit root tests with constant and trend. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. With constant and trend: McKinnon (1991) critical values are -4.0496(1%), -3.4540 (5%) and -3.1527 (10%).

Appendix 2: Stability Test

Root	Modulus
0.993243	0.993243
0.890115	0.890115
0.879394 - 0.067488i	0.881979
0.879394 + 0.067488i	0.881979
0.864185	0.864185
0.531785	0.531785

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

Appendix 3: VAR Lag Order Selection Criteria Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-349.944	NA	0.000692	9.751891	9.940148	9.826914
1	183.6487	964.8526	8.34e-10*	-3.880786	-2.562988*	-3.355621*
2	218.5767	57.41589*	8.76E-10	-3.851416	-1.404076	-2.876109
3	249.5453	45.81661	1.06E-09	-3.713571	-0.136689	-2.288122
4	282.4677	43.29515	1.27E-09	-3.629252	1.077172	-1.753661
5	319.8615	43.02849	1.45E-09	-3.667438	2.168527	-1.341705
6	367.9651	47.44463	1.37E-09	-3.999043	2.966464	-1.223168
7	414.5399	38.28066	1.57E-09	-4.288764*	3.806285	-1.062747

Notes: The acronyms LR, FPE, AIC and HQ connote sequential modified LR test statistic (each test at 5% level), Final prediction error, Akaike information criterion, Schwarz information criterion and Hannan-Quinn information criterion, respectively. The asterisk * indicates lag order s elected by the criterion.

Appendix 4: Structural Parameter Estimates for Agriculture

Dependent Variables							
Variables	**NGDP**	**CPI**	**MPR**	**IBR**	**M2**	**NER**	**Sectoral Output**
RGDP	1	0.00	0.00	-7.96	4.42	0.00	0.00
				(0.64)	(0.34)		
CPI	6.05	1.00	0.00	0.00	0.00	0.00	0.00
	(0.49)						
MPR	0	0.00	1.00	29.81	0.00	0.00	0.00
				(2.37)			
IBR	-112.86	0.00	0.00	1.00	-65.96	0.00	0.00
	(7.71)				(5.64)		
M2	-12.34	0.00	0.00	-24.75	1.00	0.00	0.00
	(0.99)			(1.98)			
NER	0.00	0.00	0.00	-4.39	0.00	1.00	0.00
				(0.37)			
Sectoral Output	-1.12***	-0.0006	0.00	-5.32***	1.34***	-0.03	1.00
	(0.16)	(0.11)		(0.44)	(0.15)	(0.11)	

Note: Standard errors from the MLE estimates are reported in parenthesis
*** refers to 1% level of significance

Appendix 5: Structural Parameter Estimates for Building

Dependent Variables							
Variables	**NGDP**	**CPI**	**MPR**	**IBR**	**M2**	**NER**	**Sectoral Output**
RGDP	1.00	0.00	0.00	-8.26	5.58	0.00	0.00
				(0.67)	(0.44)		
CPI	4.93	1.00	0.00	0.00	0.00	0.00	0.00
	(0.40)						
MPR	0.00	0.00	1.00	22.13	0.00	0.00	0.00
				(1.76)			
IBR	-140.78	0.00	0.00	1.00	-100.34	0.00	0.00
	(9.73)				(8.45)		
M2	-18.28	0.00	0.00	-29.04	1.00	0.00	0.00
	(1.46)			(2.35)			
NER	0.00	0.00	0.00	-2.49	0.00	1.00	0.00
				(0.23)			
Sectoral Output	4.48***	0.73***	0.00	-5.84***	4.64***	-0.12	1.00
	(0.32)	(0.11)		(0.49)	(0.38)	(0.11)	

Note: Standard errors from the MLE estimates are reported in parenthesis
*** refers to 1% level of significance

Appendix 6: Structural Parameter Estimates for Manufacturing

Dependent Variables							
Variables	**NGDP**	**CPI**	**MPR**	**IBR**	**M2**	**NER**	**Sectoral Output**
RGDP	1.00	0.00	0.00	-3.81	2.36	0.00	0.00
				(0.31)	(0.19)		
CPI	3.72	1.00	0.00	0.00	0.00	0.00	0.00
	(0.31)						
MPR	0.00	0.00	1.00	21.21	0.00	0.00	0.00
				(1.69)			
IBR	-100.87	0.00	0.00	1.00	-53.89	0.00	0.00
	(5.98)				(5.04)		
M2	-7.68	0.00	0.00	-14.44	1.00	0.00	0.00
	(0.62)			(1.18)			
NER	0.00	0.00	0.00	-2.04	0.00	1.00	0.00
				(0.19)			
Sectoral Output	-1.418***	-0.09	0.00	-4.81***	1.48***	-0.16	1.00
	(0.19)	(0.11)		(0.41)	(0.15)	(0.11)	

Note: Standard errors from the MLE estimates are reported in parenthesis
*** refers to 1% level of significance

Appendix 7: Structural Parameter Estimates for Services

Dependent Variables							
Variables	**NGDP**	**CPI**	**MPR**	**IBR**	**M2**	**NER**	**Sectoral Output**
RGDP	1.00	0.00	0.00	-2.74	1.98	0.00	0.00
				(0.24)	(0.17)		
CPI	2.28	1.00	0.00	0.00	0.00	0.00	0.00
	(0.21)						
MPR	0.00	0.00	1.00	15.71	0.00	0.00	0.00
				(1.26)			
IBR	-73.26	0.00	0.00	1.00	--35.59	0.00	0.00
	(4.20)				(3.62)		
M2	-7.09	0.00	0.00	-11.43	1.00	0.00	0.00
	(0.58)			(0.97)			
NER	0.00	0.00	0.00	-1.49	0.00	1.00	0.00
				(0.16)			
Sectoral Output	4.47***	1.07***	0.00	0.80***	1.34***	-0.15	1.00
	(0.33)	(0.11)		(0.14)	(0.17)	(0.11)	

Note: Standard errors from the MLE estimates are reported in parenthesis
*** refers to 1% level of significance

Appendix 8: Structural Parameter Estimates for Wholesale and Retail

Dependent Variables							
Variables	**NGDP**	**CPI**	**MPR**	**IBR**	**M2**	**NER**	**Sectoral Output**
RGDP	1.00	0.00	0.00	-6.39 (0.52)	4.53 (0.35)	0.00	0.00
CPI	5.02 (0.41)	1.00	0.00	0.00	0.00	0.00	0.00
MPR	0.00	0.00	1.00	23.22 (1.85)	0.00	0.00	0.00
IBR	-108.32 (7.23)	0.00	0.00	1.00	-73.11 (6.22)	0.00	0.00
M2	-14.92 (1.19)	0.00	0.00	-24.68 (1.99)	1.00	0.00	0.00
NER	0.00	0.00	0.00	-4.28 (0.36)	0.00	1.00	0.00
Sectoral Output	-.73*** (0.14)	0.47*** (0.11)	0.00	-5.49*** (0.46)	1.25*** (0.13)	-0.25** (0.11)	1.00

Note: Standard errors from the MLE estimates are reported in parenthesis *** refers to 1% level of significance ** refers to 1% level of significance