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A Structural VAR Analysis of the Differential Effects of Monetary Policy Shocks on Some Nigerian Sectoral Outputs

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Abstract
For some time now, monetary policy announcements have been mired with controversies, questioning the effectiveness or otherwise of the demand side management policy in Nigeria. Again, the transmission mechanisms of these policies and its effects on the economy have remained unclear to the public. It is against this backdrop that this study investigated the effects of monetary policy shocks on sectoral components of the Nigerian economy using the Structural Vector Autoregressive (SVAR) model from 1961 - 2019. The Impulse Response Function (IRFs) was performed within the framework of SVAR to analyze the effects of the unanticipated monetary policy shocks on various sectors. The broad money supply, credit to the private sector, exchange rate and liquidity ratios have positive effects on the aggregate output and some selected sectoral components while interest rate and consumer price index have negative effects. The IRFs showed that the effects of monetary policy goes beyond the current year of 3 to 6 years before stabilizing while sectoral components have similar responses to the various monetary policy shocks. The results clearly show that the liquidity ratio is the most effective instrument for the control of aggregate output and not interest rate while broad money supply seems to be the most effective monetary policy instrument for the control of various sectors of the economy. The study therefore recommended among others adequate management of money supply, credit control; interest rate and foreign exchange market liberalization for improving sectoral output in Nigeria.

Keywords: Monetary policy shock,Nigeria, sectoral components, SVAR, transmission mechanisms.

JEL Codes: E47, C32

1. Introduction

Monetary policy is the plan of action undertaken by the monetary authorities, especially the central banks, to regulate and control the demand for and supply of money to the public and the flow of credit to achieve the macroeconomic goals. These changes or shock could be an expansionary monetary policy, which results in a decrease in the policy rate and pushes the real interest rate down, increasing investment spending and aggregate demand, which also causes output to increase. In economics, a shock is an unexpected or unpredictable event that affects an economy, either positively or negatively. Technically,

it refers to an unpredictable change in exogenous factors - that is, factors unexplained by economics theories - which may influence endogenous economic variables. A monetary policy shock occurs when a central bank departs, without warning, from its pattern of interest rate or money supply control. These shocks, in turn, have an effect on the output of the key sectors of the economy (agricultural sector, industrial sector, and service sector and so on). The effect of these shocks on these sectors of the economy turns out to affect the aggregate output either positively or negatively with the intention of the monetary authority being a positive one. Also, these shocks are transmitted into the real economy such as output via the monetary policy transmission mechanisms. The transmission mechanism of monetary policy is the process whereby the action of the central bank in terms of manipulation of money supply and interest rate are transmitted to the economy through several channels.

Real sector growth remains one of the key macroeconomic goals of every economy. However, growing the real sector has been one of the major challenges of contemporary economic management. In recent times, there seems to be an increasing consensus among monetary economists and policy-makers alike that monetary policy does have real effects, at least in the short run on the economy. One aspect that has received considerable attention of late is the differential effect of monetary policy shocks on the output of various sectors of the economy. Recent studies on the subject make it quite clear that different sectors of the economy respond differently to monetary policy shocks. This observation has profound implications for demand management as the Central Bank will have to weigh the varying consequences of its actions on different sectors of the economy. For instance, the tightening of monetary policy might be considered mild from the aggregate perspective, yet it can be viewed as excessive for certain sectors. If this is true, then monetary policy should have a strong distributional effect on the real sectors of the economy

In Nigeria, the idea of managing or trying to manage the macro economy via effective monetary policy is not new. For some time now, the emphasis has been on monetary policy as a major stabilization weapon, with the monetary authority as a consequence, major monetary aggregates such as money supply, interest rate and nominal exchange rate in Nigeria have been on the rise and have somewhat impacted on various sectors of the economy as shown in the figure 1.1

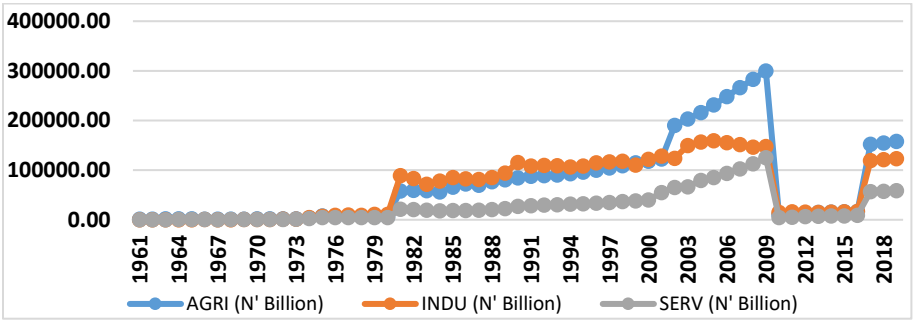


Figure 1.1: KEY SECTORAL OUTPUT COMPONENTS OF THE NIGERIA ECONOMY, 1961-2019

Source: WDI(2020)

Improving the economic welfare of the citizenry through the provision of affordable goods and services remains one of the key objectives of macroeconomic policy. The real sector of the economy creates opportunities to produce physical output, generate employment that yields income for investment and consumption, which reinforce the growth of aggregate demand. Monetary policy, in recent times, has emerged as a veritable tool for stimulating economic activities. By manipulating the monetary policy instruments, Central Banks affect the rate of growth of money supply, the level of interest rate, security prices, credit availability and liquidity creation from the hands of commercial banks. In Nigeria, the effectiveness of monetary policy remains ambiguous based on how the outputs of the various sectors are affected by the decisions of the monetary authorities. There are plethora of studies on monetary policy effective and the economy, using different empirical approaches as shown in the empirical evidence. However, the bulk of these empirical attempts have not come to a conclusion on how monetary policy shocks affect the real economy and the various productive sectors. Thus, it becomes imperative to examine the effect of monetary policy shocks on some key sectoral output (agricultural, industrial and services sectors) of the real economy as opposed to the aggregate output component. The discussions of the paper are guided by the following questions. What are the effects of monetary policy shocks on sectoral outputs of the Nigerian economy? What are the challenges of monetary policy effectiveness on sectoral output of the economy? What are the strategic policy options for overcoming these challenges? The overarching objective of this paper is to examine the effects of monetary policy shocks on some sectoral components in the Nigerian economy.

2 Empirical Evidence

Many empirical studies have been conducted on the effects of monetary policy on the economy. While some of them examined the effects of monetary policy on economic growth and other macroeconomic variables, others have examined the effects of monetary policy shocks on the real economy both in developed and developing economies.Although there are numerous empirical effects in this direction, only those works which are closely

related to the present study were reviewed. Sahinoz and Cosar (2009) based their study on a VAR model to analyze the response of Turkish industrial production to a monetary policy shock. The results show that the industry responds largely to a monetary policy shock through the exchange rate. A restrictive monetary policy discourages growth in various sectors of the economy. Based on the proposition that the stability of the relationship between money and economic growth will show the effectiveness of monetary policy following the conventional Hicksian IS-LM analysis, Nouri and Samimi (2011) studied the relationship between money supply and economic growth in Iran, adopting Ordinary Least Squares (OLS) technique, using data obtained from the Central Bank of Iran during 1974 to 2008. The empirical analysis was based on Levine and Renelt growth model and they found that there is a positive and significant relationship between money supply and economic growth in Iran.

Spulbar, Nitoi, and Stanciu (2012) used the Bayesian VAR framework to provide an analysis of the transmission mechanism of monetary policy in the Romanian economy to identify the major shock in Romania for the period between 2001 and 2010. The variables considered in the analysis include the exchange rate, inflation, the real estate prices, the monetary aggregate M2 and the interest rate. It was found that the exchange rate remains an important mechanism that significantly influences the variables of the real economy. Saibu and Nwosa (2012) examined the effects of monetary policy on sectoral output growth in Nigeria over the period 1986:1 to 2008:4. The study utilized an Autoregressive Distributed lag (ARDL) model and the findings showed that the manufacturing sector is not sensitive to any of the monetary policy variables. In sharp contrast with the manufacturing sector, the agricultural sector is responsive to changes in an interest rate only while service and wholesale/retail economic activities are responsive to the exchange rate. Furthermore, the interest rate and exchange rate are the major determinants of mining output growth while the building/construction sector is more responsive to changes in the exchange rate and bank credit. In general, the exchange rate is the most important and influential monetary policy measure in Nigeria. The study concludes that monetary policy will be more effective if the inherent differences in these sectors are a factor in the design of policies in Nigeria.

On the effects of monetary policy shocks on the disaggregated components of the GDP in Nigeria, empirical evidence is almost non-existent. The only know studies are those of Nwosa and Saibu (2012) and CBN (2014). Nwosa and Saibu (2012) examined the monetary transmission mechanism in Nigeria: a sectoral output analysis from the period 1986 to 2009 employing variables such interest rate, domestic credit, assets index, consumer price index and sectoral output. The vector-regressive method of analysis was utilized and the result showed that the interest rate channel was most effective in transmitting monetary policy. Also, the study concluded that interest rate and exchange rate policies were the most effective monetary policy measures in stimulating sectoral output growth in Nigeria.

Uchechukwu and Uwemedimoh (2013) analyzed sectoral contributions to the gross domestic product by agriculture, industry and services sectors of the economy using a Vector Autoregressive (VAR) approach. Granger causality was used to find the linkages

among the variables under consideration. The result showed bilateral causality between GDP and sectoral contribution to GDP by Industry. Thereafter the unrestricted VAR parameter estimate was obtained for GDP and sectoral contribution to GDP by Industry. In conclusion, it is recommended that the Nigerian government should come up with a strategic master plan to diversify the economy using the Agriculture and services sectors since the Nigerian economy from our analysis is grossly dependent on sectoral contributions of Industry to GDP. CBN (2014) 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).

Singh Sunny and Rao (2014) analyzed the effect of monetary policy shock on the aggregate as well as on the sectoral output of the Indian economy using reduced-form vector autoregressive (VAR) model. The study revealed that the effect of a monetary policy shock at the sectoral level is heterogeneous. Sectors such as mining and quarrying, manufacturing, construction and trade, hotel, transport and communications seem to decline more sharply than aggregate output in response to a monetary tightening. We also augment the basic VAR by including three channels- credit channel, exchange rate channel and asset price channel of the monetary policy, and analyze the sector-specific importance of each of the channel. The channels through which monetary policy is transmitted to the real economy are found to be different for every sector. In most cases, multiple channels are responsible for the changes taken together and sectoral output to the monetary policy shock. These results indicate the need for a sector-specific monetary policy in India.

Anwar (2015) examined the state-wise differential effect of credit on agriculture, industries and the services sector of the Indian economy using a panel regression approach and data sets panelled over 15 of the largest states for a period ranging between 2001 and 2010. The Least Square Dummy Variable (LSDV) estimation approach is employed to capture the state-wise effect of credit on sectoral output. The results of the study reveal that credit has a statistically significant and positive effect on the output of the agriculture, industry and services sector of the economy. The results further reveal that in the agricultural sector, irrigation intensity has a significant and positive effect on output. Concerning the industrial sector, the number of workers and working capital is found to have a significant and positive impact on output.

Eko, Ehigocho and Okoiarikpo (2017) investigated the impact of monetary policy shocks on industrial output in Nigeria using a restricted VAR (VECM) model and Granger causality test for the period 1970 to 2015. Results show that the contribution of the manufacturing subsector to GDP responded positively to shocks in monetary policy,

commercial bank credit to the industrial sector and exchange rates, while the contribution of the solid minerals subsector to GDP responded positively to shocks in commercial bank credit to the industrial sector and exchange rate after the first year. On the other hand, the causality test result indicated a unidirectional causality running from monetary policy rate and exchange rate to the contribution of the manufacturing sector to GDP on the one hand, and commercial bank credit to the industrial sector and exchange rate to the contribution of solid mineral sector to GDP on the other. Charaf-Eddine and Abdellatif (2017) investigated the sectoral effects of monetary policy: evidence from Morocco using the vector-autoregressive model and impulse response function from 1998Q1 – 2014Q4 focusing on eight sectors of the economy (agriculture, fishing, industry extraction, manufacturing, construction and public works, commerce, hotels and restaurants, financial and insurance activities). The results of their analysis indicate that at the aggregate level a monetary policy tightening leads to a decrease in the overall GDP and price level. At the disaggregated level, monetary policy has disparate effects on the performance of the different sectors. Abhjshek (2018) analyzed the heterogeneous effects of monetary policy shocks on sectoral output. Utilizing a vector-autoregressive model, sector-specific responses to monetary policy shocks are observed based on quarterly data for the period 1996-97: Q1 to 2014-15: Q2. Sectors such as Agriculture, Forestry and Fishing, electricity, gas, water supply and community, social and personal services are found to be largely immune to monetary policy shocks, while sectors such as manufacturing, mining, and finance, insurance, real estate, ownership of dwellings, legal and business services and trade, transport and communication show heterogeneous responses to policy shocks.

Although a plethora of similar studies exist in the literature, this study is distinct from previous attempts in several ways. First, it took a more comprehensive measure of real output from the sectoral point of view. Unlike earlier studies which examined either aggregate or one sector of the economy and used only one or two measures of monetary policy, this study analyzed monetary policy shocks on three key sectors of the economy (agricultural, industrial and services sectors). Apart from this sectoral disaggregation, it also used more measures of monetary policy as independent variables (broad money supply, credits to the private sector, interest rate, liquidity ratio, and exchange rate). In Nigeria, most of the existing studies identified all the channels but concentrated only on the credit channel. The neglect of the other channels without any empirical justification raises doubt about the policy inferences from their studies as there could be more than one channel of influence as suggested by theories and evidence from studies on other economies (King, 1994). Secondly, unlike the previous studies carried out in Nigeria, this study utilized the Structural vector autoregressive (SVAR) model framework that represents the standard practice in assessing the dynamic responses of monetary policy shocks, while allowing for the imposition of sufficient restrictions that help identify the structural components of the error terms.

Theoretical Framework, Model Specification and Data

One way of understanding how monetary policy affects the economy is through the various channels of the monetary transmission mechanism. These transmission mechanisms include interest rate, real effective exchange rate effects, assets prices effects and credit channels (Mishkin, 1995). From the aggregate demand side, monetary policy was transmitted either directly through three channels; the exchange rate, the interest rate and wealth channel or indirectly through the bank credit which was transmitted through two channels: the bank-lending channel and the balance sheet channel. From the supply side, monetary policy impulse affected real variables via changes in inventory cost (Baksh and Craigwell, 1997). While acknowledging the supply side channel, this study adopted aggregate demand side channels. For two reasons; first, in the Keynesian framework, the aggregate supply was relatively fixed due to stickiness of price at least in the short run. Second, the Nigerian economy is structurally weak and not well developed to allow the necessary adjustment to take place if the inventory cost approach is to be relevant. The economic intuition behind the aggregate demand channels of policy influence on real variables is usually described by the traditional Keynesian (IS-LM) framework. The framework focused on the equilibrium position between the demand for and the supply of money to determine the rate of interest, which influenced investment spending and consequently output level (Dornbusch et al, 2002). It dichotomized the economy into the real and money sector.

Over the last few years, there have been remarkable changes in the way financial markets operate. Also, the conduct of monetary policy has changed in spectacular ways, with an increased focus on achieving price stability. Additionally, research in monetary economics has stimulated new thinking on how monetary policy can affect the economy, leading to further evolution in our understanding of the monetary transmission mechanism. All of these developments suggest that there is a strong possibility that there have been changes in the monetary transmission mechanism.

3 *Model Specification*

Drawing from the theoretical framework and in line with previous studies, especially in Nigeria such as Nwosa and Saibu (2012) and CBN (2014), we postulate a simple aggregate output function of the form:

$Y_t = X\beta + \mu_t$ *3.1*

*W*here Y_t is the aggregate output (GDP) at time *t*; *X* is the vector of explanatory variables comprising of interest rate (INT), broad money supply (BMS), the exchange rate (EXR), the domestic price level in the form of a consumer price index (CPI), domestic credits in the form of credits to the private sector (CPS), and liquidity ratio (LQR); β is the vector of coefficients and $\mu_t$is the error term at time *t*. Expanding Equation 3.1 and expressing the variables in their logarithmic form, we obtain the baseline model as follows:

$$LGDP_t = \beta_0 + \beta_1 LBMS_t + \beta_2 LCPS_t + \beta_3 LINT_t + \beta_4 LEXR_t + \beta_5 LCPI_t + \beta_6 LLQR_t + \mu_t$$

3.2

$\beta_1>0$; $\beta_2>0$; $\beta_3<0$; $\beta_4>0$; $\beta_5<0$; $\beta_6>0$

Where: L is the natural logarithm. The variables as expressed in their logarithmic form to standardize them and then interpret the estimates as elasticities. Equation 3.2 asserts that aggregate output (LGDP) depends on broad money supply (LBMS), credit to the private sector (LCPS), interest rate (LINT), the exchange rate (LEXR), consumer price index (LCPI), and liquidity ratio (LLQR). However, our major objective is to examine the effects of monetary policy on sectoral components with emphasis on the three major sectors of the Nigerian economy namely; the agriculture sector (LAGRIC), industry sector (LINDU), and the service sector (LSERV). Thus, the Structural Vector Autoregressive (SVAR) model framework is applied to account for the endogenous relationships between the independent variables used here and allows for simultaneous examination of the link between gross domestic product (LGDP) agriculture sector (AGRIC), industry sector (LINDU), service sector (LSERV), and the various monetary policy variables (LBMS, LCPS, LINT, LEXR, LCPI, and LLQR).

The class of the SVAR model applied here is based on the AB model adopted from Amisano and Giannini (1997). The AB model requires the imposition of sufficient restrictions to identify the structural components of the error terms. We start with the following reduced-form VAR model:

$$Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + \mu_t \qquad 3.3$$

Where $Y_t$is a 7×1 vector of variables at time t and comprises of all variables ($LGDP_i$= LGDP, LAGRI, LINDU, LSERV, and LBMS, LCPS, LINT, LEXR, LCPI, LLQR) with the variables appearing in their stationary forms. The A_i's are fixed ($K\times K$) coefficient matrices, p is the order of the VAR model, and μ_t is a 7×1 vector of VAR observed residuals with zero mean and covariance matrix $E(\mu_t \mu_t') = \Sigma\mu$. The innovations of the reduced form model, u_t, can be expressed as a linear combination of the structural shocks, ε_t, as in Breitung et al. (2004):

$$\mu_t = A^{-1}B\varepsilon_t \qquad 3.4$$

Where B is a structural form parameter matrix. Thus, substituting Equation 3.4 into Equation 3.3 and following some minor manipulations, we get the structural representation of Equation 3.3 as follows:

$$AY_t = A_1^* Y_{t-1} + \ldots + A_p^* Y_{t-p} + B\varepsilon_t \qquad 3.5$$

Here, A^*_j is a 7×7 coefficient matrix, where $A_j = A^{-1}A^*_j$ ($j = 1, 2, \ldots, p$); ε_t is a 7×1 vector of unobserved structural shocks, with $\varepsilon_t \sim (0, I_K)$. Note that the structural innovation is orthonormal, meaning that the structural covariance matrix, $\Sigma_\varepsilon = E(\varepsilon_t\varepsilon_t')$, is the identity matrix, I_K. This model is known as the AB model and is estimated in the form:

$$A\mu_t = B\varepsilon_t \qquad 3.6$$

The orthonormal innovations, ε_t, ensure the identifying restriction on A and B:

$$A\Sigma A' = BB' \qquad 3.7$$

Both sides of this expression are symmetric which means that $K(K+1)/2$ restrictions need to be imposed on $2K^2$ unknown elements in A and B so that, at least, $2K^2 - K(K+1)/2$ additional identifying restrictions are needed to identify A and B. With seven endogenous variables in each case, that is, $LGDP_i$, LBMS, LCPS, LINT, LEXR, LCPI, and LLQR (where $LGDP_i$=

LGDP, LAGRI, LINDU, LSERV), the errors of the reduced form VAR are: $\mu_t = \mu_t^{LGDPi} + \mu_t^{LBMS} + \mu_t^{LCPS} + \mu_t^{LINT} + \mu_t^{LEXR} + \mu_t^{LCPI} + \mu_t^{LLQR}$, and the structural disturbances are ε_t^{LGDPi}, ε_t^{LBMS}, ε_t^{LCPS}, ε_t^{LINT}, ε_t^{LEXR}, ε_t^{LCPI}, and ε_t^{LLQR}. This model has a total of 98 unknown elements, with a maximum of 28 parameters to be identified in this system so that, at least, 70 additional identifiable restrictions are required to identify matrices *A* and *B*. The simple zero exclusion restrictions are used to identify the full model. To this end, the elements of the matrices that are estimated are assigned λ_{rc}. All the other values in *A* and *B* matrices are held fixed at specific values. It should be noted that since the model is over-identified, a formal Likelihood Ratio (*LR*) test is carried out to test whether the identification is valid, and the *LR* statistic is computed as follows:

$$LR = T(tr(P)\text{-}Log(P)\text{-}K) \qquad 3.8$$

Where $P = A^{-1}B^{-T}B^{-1}A\Sigma$. The null hypothesis underlying the *LR* test is that the identification is valid. The test statistic is asymptotically distributed with a *Chi-square* distribution, $\chi^2(q\text{-}K)$, where *q* is the number of identifying restrictions. Therefore, the system takes the following form:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \lambda_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \lambda_{31} & \lambda_{32} & 1 & 0 & 0 & 0 & 0 \\ \lambda_{41} & \lambda_{42} & \lambda_{43} & 1 & 0 & 0 & 0 \\ \lambda_{51} & \lambda_{52} & \lambda_{53} & \lambda_{54} & 1 & 0 & 0 \\ \lambda_{61} & \lambda_{62} & \lambda_{63} & \lambda_{64} & \lambda_{65} & 1 & 0 \\ \lambda_{71} & \lambda_{72} & \lambda_{73} & \lambda_{74} & \lambda_{75} & \lambda_{76} & 1 \end{bmatrix} \begin{bmatrix} \mu^{LGDP_i} \\ \mu^{LBMS} \\ \mu^{LCPS} \\ \mu^{LINT} \\ \mu^{LEXR} \\ \mu^{LCPI} \\ \mu^{LLQR} \end{bmatrix} = \begin{bmatrix} \lambda_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \lambda_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \lambda_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \lambda_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \lambda_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \lambda_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \lambda_{77} \end{bmatrix} \begin{bmatrix} \varepsilon^{LGDP_i} \\ \varepsilon^{LBMS} \\ \varepsilon^{LCPS} \\ \varepsilon^{LINT} \\ \varepsilon^{LEXR} \\ \varepsilon^{LCPI} \\ \varepsilon^{LLQR} \end{bmatrix} \qquad 3.9$$

After the estimation of the above structural parameters, the structural impulse response functions (IRFs) analyses were performed within the framework of the SVAR framework to analyze the effect of unanticipated monetary policy shocks on the various sectors ($LGDP_i$= LGDP, LAGRI, LINDU, LSERV) of the Nigerian economy. The IRFs are essential tools in empirical causal and policy effectiveness analyses. It is used to evaluate the effectiveness of a policy, especially monetary policy. Impulse response analysis provides extremely useful information which is used to characterize the dynamics of a model by illustrating the evolution over time of the effects of shock on variables and, more importantly, on the persistence of the effects of the shock over a long period. An IRF traces out the response of a variable of interest to an exogenous shock. This means that the ultimate effect of a shock can vary depending on the state of the system at the time of the impact of the shock, and on the sign and magnitude of the shock. One of the objectives of this study is to determine how long (timing and persistence) it will take for the effect of monetary policy shocks on real aggregate and sectoral outputs to neutralize.

The model of this paper represented in Equations 3.2 (single equation form) and extended to 3.9 (structural equation (SVAR) form) is considered robust enough to address the research objectives due to the inclusion of the most relevant monetary policy variables that cut across the core and control variables. Besides, the theoretical foundation of the model follows from the Keynesian prescriptions for analyzing the transmission channels of monetary policy to real sectoral outputs. In the Keynesian approach, a discretionary change in monetary policy affects the real economy through the two sides of market forces – the demand and supply sides. This study follows the supply-side approach to the analyses of the influence of monetary policy on aggregate output (LGDP) and some key sectoral outputs like the agricultural, industrial and service sectoral outputs (LAGRI, LINDU and LSERV) of the economy. The core variables of the study include broad money supply (LBMS), credit to the private sector (LCPS), interest rate (LINT), liquidity ratio (LLQR), alongside the consumer price index (LCPI) as the domestic monetary policy instruments, and the exchange rate (LEXR) as the foreign monetary policy instrument. This study utilized the Structural Vector Autoregressive (SVAR) model framework. This method represents the standard practice in assessing the dynamic responses of monetary policy shocks while allowing for the imposition of sufficient restrictions that help identify the structural components of the error terms. Four SVAR systems on various sectors of the economy, that is, the aggregate output sector (represented by LGDP) and the three other strategic sectors (represented by LAGRI, LINDU and LSERV) were estimated. Each system consists of seven endogenous variables, that is, four output sector variables (LGDP, LAGRI, LINDU and LSERV), and the monetary policy variables (LBMS, LCPS, LINT, LEXR, LCPI, and LLQR). The functional form of the model follows the logarithm transformation of all variables which is believed to provide a good fit for the time-series data, as well as reduce the various elements of heteroskedasticity and allows for easy interpretation of results.

3.2.1 Definition of Variables

Real Aggregate and Sectoral Outputs (LGDP, LAGRI, LINDU, and LSERV): The real aggregate output, also known as the realgross domestic product, is defined as the total monetary value of all the final goods and services produced within an economy during a given period usually one year. The 'real' in aggregate output implies that the elements of inflation have been taken care of. In other words, real aggregate output is based on constant prices not at the current prices. The real aggregate output is commonly used to proxy economic growth in economic research. Specifically, the real aggregate output is made up of the contribution of the various activity sectors of the economy such as the agricultural sector, industrial sector, service sector, among other sectors. It is the objective of this study to evaluate the effect of monetary policy on aggregate output (LGDP) and these key sectors (LAGRI, LINDU, LSERV). The agricultural sector (LAGRI) is an important contributing sector to the aggregate output of the economy, and it covers all activities relating to crop farming, animal rearing, etc. The industrial sector (LINDU) involves all activities ranging from the processing of raw materials to finished goods, as

well as all activities of the manufacturing sector of the economy. The service sector (LSERV) covers all activities relating to the production of intangible commodities like education, banking, etc. All of these variables are originally captured in monetary terms and the unit of measurement is in billions of naira, and logged in the model of analyses.

Broad Money Supply (LBMS): The broad money supply (M2) includes narrow money plus savings and time deposits, as well as foreign-dominated deposits. The definition of narrow money (M1) includes currency in circulation with non-bank public and demand deposits or current accounts in the banks. The broad money supply measures the total volume of money supply in the economy. Thus, excess money supply (or liquidity) may arise in the economy when the amount of broad money is over and above the level of total output in the economy. The broad money supply is an important instrument of monetary policy and the need to regulate money supply is based on the knowledge that there is a stable relationship between the quantity of money supply and economic activities of the real sector. This variable is originally captured in monetary units (billions of naira) and logged as it enters the empirical model of this study.

Credit to Private Sector (LCPS): This is the aggregate amount of credits available to persons or businesses in the private sector from the various financial institutions. It is the total amount of funds that the financial institutions provide to the private sector for productive activities. Note that the private sector's credits depend on the ability to repay and the total amount of credits available in the financial institutions. Credits to the private sector are also regarded as an agreement between financial institutions and the private business owners where financial institutions trust the private business owners to repay funds plus interest for either a loan, credit card, or line of credit at a later date. This variable is originally captured in the actual monetary figure and logged as it enters the empirical model of the study.

Interest Rate (LINT): This is also known as the lending rate. It is the rate at which the commercial banks or other lenders charge the borrowers when a certain amount of fund borrowed. This is the cost of credits to the economy.

Exchange Rate (LEXR): Exchange rate is the rate at which one currency will be exchanged for another. It is regarded as the value of one currency expressed in terms of another currency. The official exchange rate of Naira per Dollar is usually the common measure for the exchange rate in Nigeria. Given that the Dollar is the reserve currency, most countries trade with it in the international market. The strength of monetary policy depends on the dynamics of the country's currency, which in turn, depends on several factors, among which are the state of the economy in terms of its competitiveness and volume of its exports, the level of domestic production, and the quantum of the foreign reserve. The exchange rate is measured as the ratio of the domestic currency to a unit of other countries or reserved currency. The variable is logged to reduce any heteroske - dasticity tendency.

Consumer Price Index (LCPI): Consumer price index measures changes in the price level of a weighted average market basket of consumer goods and services purchased by households in the economy. It is a statistical estimate constructed using the prices of a

sample of representative items whose prices are collected periodically. We use the consumer price index using 2009 as the base year (i.e. 2009=100) and the variable is logged as it enters the empirical model of the study.

Liquidity Ratio (LLQR): Liquidity ratio refers to a bank regulation that sets the minimum amount of money each bank must keep in liquid form (cash) to be able to meet up with customers' cash request on-demand. It expresses the ability of a bank to repay short-term creditors out of its total cash and also measures how quickly assets can be converted into cash to pay the bank's short-term obligations. It is measured by dividing the total cash by short-term borrowings/deposits. This variable is also logged as it enters the empirical model of this study.

3.2.2 Estimation Techniques and Procedures

Before the estimation of the SVAR model, the Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) unit root procedures were employed to determine the stationarity properties of the relevant time series as well as identify the order of integration of those time series. It is widely known that meaningful economic policy can barely be generated from any model estimation involving non-stationary time series. Given that statistic underpinning of modern time series analyses requires data to be covariance stationary, and that most economic time series display significant trends has led to the use of first difference stationary time series before estimating economic models. As pointed out by Engle and Granger (1987), even though economic series may wander over time, economic theory often provides a rationale for why certain variables should obey equilibrium constraints. In other words, there may exist some linear combinations of variables that, over time, converge to equilibrium. If the individual non-stationary economic series becomes stationary after differencing but their linear combination is level-stationary, then the series is said to be cointegrated. However, the test for cointegration proposed by Engle and Granger (EG) does not reveal the existence of more than one cointegrating vectors, and more importantly, their test relies on a super convergence result and usually applies the OLS to obtain the estimates of the cointegrating vector. These OLS estimates, in practice, will differ with the arbitrary normalization implicit in the selection of the left-hand-side variables for the regression equation; and besides, different arbitrary normalization may, in practice, alter the EG test results (Nwaobi, 2001).In contrast, Johansen (1988), and Johansen and Juselius (1990) provide an alternative procedure for examining the question of cointegration in a multivariate setting. The Johansen approach yields maximum likelihood estimators of the unconstrained cointegrating vector, as well as allow one to explicitly test for the number of cointegrating vectors. This approach does not rely on an arbitrary normalization, and test of certain restrictions suggested by economic theory such as the signs and magnitude of the estimated parameters may also be conducted (Hafer& Jansen, 1991; Nwaobi, 2001). In the light of the foregoing, this study employed the Johansen co integration test for determining the existence of a long-run relationship between the dependent and independent variables, as well as generates the normalized cointegrating coefficients of the Johansen procedure. The Johansen cointegration test is based on

estimating the following vector autoregressive (VAR) model:

$$Z_t = A_1 Z_{t-1} + - - - - + A_p Z_{t-p} + \beta Y_t + \mu_t \quad 3.10$$

Where: Z_t is a k-vector of non-stationary variables; Y_t is a d-vector of deterministic variables, and μ_t is a vector of innovations.

3.2.3 DATA SOURCES

Variables	Description	Source(s)
Aggregate output, RGDP Money supply, MS/GDP	Endogenous Exogenous variable	WDI, 2020, AfDB, 2019 CBN Bulletin, 2020
Credit to private sector, CPS	Exogenous	CBN, 2020
Interest rate, INT	Exogenous	CBN,2020, WDI, 2020
Exchange rate, EXR	Exogenous	AfDB(2020), CBN, 2020
Consumer Price Index, CPI	Exogenous	CBN, 2020
Liquidity ratio, LQR	Exogenous	CBN, 2020, WDI, 2020

4 Results, Analysis and Discussion of Findings

4.1 *Summary of Descriptive Statistics.*

This test aims to characterize the relevant data by examining how they spread around their mean and the existence of outliers for possible data smoothing actions. Thus, the relevant test-statistics used for the analyses of descriptive statistics include the mean, standard deviation, skewness, kurtosis, and the Jaque-Bera statistic. We present the summary of descriptive statistics for the variables in Table 4.1. The results show that the average annual value of GDP, AGRI, INDU, SERV, BMS, CPS, CPI, EXR, INT, and LQR is ₦254164.8 billion, ₦74162.28 billion, ₦65295.97 billion, ₦26930.10 billion, ₦121000000 billion, ₦1104076 billion, 81.15 (2009 = 100), ₦63.40/$, 13.98%, and 49.58% respectively from 1961 to 2019. When compared to their corresponding standard deviation, it was obvious that a very wide variation exists between the successive values of all variables except the INT and LQR whose standard deviations are far less than their mean values. Turning to the values indicated by the skewness statistics, it can be said that only GDP, INDU, and INT are symmetric series since their skewness statistics fall within -1 and +1, while those of AGRI, SERV, BMS, CPS, CPI, EXR, and LQR are greater than +1, indicating a positive/right skew relative to normal distribution. The values of the kurtosis statistics for all variables are larger than 1, meaning that the variables have leptokurtic distribution, indicating that the distributions are quite peaked. The Jaque-Bera (JB) statistics and their corresponding p-values show that the null hypothesis of normality cannot be rejected for only GDP and INT at the 5% level, meaning that they are normally distributed series. However, following the JB statistics and their p-values for the rest of the variables, the null hypothesis of normality is rejected, meaning that they are not normally distributed series (see Table 4.1). It should be noted that the log transformation of variables proposed in the

previous chapter is expected to overcome any challenge of data characteristics explained in this section.

Table 4.1: SUMMARY OF DESCRIPTIVE STATISTICS

	GDP	AGRI	INDU	SERV	BMS	CPS	CPI	EXR	INT	LQR
Mean	254164.8	74162.28	65295.97	26930.10	1.21E+08	1104076	81.15162	63.40466	13.98107	49.58249
Median	265379.1	59009.56	81596.46	19005.73	68662.50	35436.60	5.700000	8.040000	14.00000	45.60618
Maximum	716949.7	299996.9	159161.4	125479.8	2.38E+09	10206087	335.0000	362.7550	29.80000	94.50000
Minimum	2501.200	1338.000	172.4000	346.7000	292.8320	117.1260	0.148508	0.550000	6.000000	25.52000
Std. Dev.	215499.3	82424.22	57565.57	31197.24	5.16E+08	1989311	114.6638	90.33172	6.434175	14.75360
Skewness	0.355576	1.143608	0.115431	1.442305	4.090773	2.604722	1.175301	1.488054	0.323670	1.127986
Kurtosis	1.994720	3.429475	1.386002	4.407427	17.74375	10.79406	2.829881	4.622410	2.039599	4.371760
JB Stat.	3.727635	13.31385	6.534953	25.32531	698.9434	216.0524	13.65426	28.24486	3.297654	17.13736
Prob.	0.155079	0.001285	0.038102	0.000003	0.000000	0.000000	0.001084	0.000001	0.192275	0.000190
Obs.	**59**	**59**	**59**	**59**	**59**	**59**	**59**	**59**	**59**	**59**

Source: Researchers' Computation using Eviews 10

4.2 *Unit Root Test (Stationarity Test)*

This test aims to determine whether the variables are stationarity or not, alongside identify their orders of integration (i.e. whether they are I(0), or I(1), or a combination of both). Table 4.2 presents the results of the ADF and PP unit root tests for all variables. The results show that all the chosen variables entering the various models (i.e. LGDP, LAGRI, LINDU, and LSERV models) are of the same order of integration (i.e. I(1)). This conclusion is reached based on the comparison between the estimated values of the ADF and PP statistics, and their corresponding critical values at the 5% level. Thus, we reject the null hypothesis of the unit root when the estimated values of the ADF and PP statistics are less than their critical values at the 5% level. In summary, we conclude that, in all the estimable models of the study, the order of integration of variables are the same which is I(1). This is an indication that all the models feature I(1) variables including the dependent variables. This finding implies that the conventional Johansen-Juselius (JJ) cointegration approach will generate consistent estimates of long-run coefficients since the necessary condition for cointegration among non-stationary variables within the JJ framework is the same order of integration. This validates the proposed JJ approach for the cointegration test.

Table 4.2: ADF UNIT ROOT TEST RESULTS

Variable	ADF Statistic		I(d)	PP Statistic		I(d)
	Level	1st diff.		Level	1st diff.	
LGDP	-1.650638	-6.941266**	I(1)	-1.704043	-6.915901**	I(1)
LAGRI	-1.555927	-7.413816**	I(1)	-1.562103	-7.414197**	I(1)
LINDU	-1.988753	-7.237507**	I(1)	-1.988753	-7.237469**	I(1)
LSERV	-1.695272	-7.420483**	I(1)	-1.693236	-7.419344**	I(1)
LBMS	1.064638	-7.952660**	I(1)	-1.825121	-7.992343**	I(1)
LCPS	-1.457377	-5.807246**	I(1)	-1.457377	-5.828297**	I(1)
LCPI	-0.759767	-4.320780**	I(1)	-0.497054	-4.320780**	I(1)
LEXR	0.454494	-5.983587**	I(1)	0.227141	-5.991689**	I(1)
LINT	-1.061536	-10.35773**	I(1)	-1.245451	-10.31234**	I(1)
LLQR	-2.382111	-6.127518**	I(1)	-2.419465	-7.884961**	I(1)

NB: ** implies significant at 1% and 5% levels.

Source: Researchers' Computation using EVIEWS 10

4.3 *Cointegration Tests*

Following the tests of unit root, we present the results of the Johansen cointegration tests for the four models of this study in Table 4.3. In the first model which deals with the impact of monetary policy on aggregate output (with LGDP as DV), the variables are ordered as follows: LGDP, LBMS, LCPS, LINT, LEXR, LCPI, LLQR, with the assumption of linear deterministic trend and lag interval between 1 and 5 based on automatic selection of the Akaike Information Criterion (AIC). Other models which relate the agricultural sector (LAGRI), the industrial sector (LINDU) and the service sector (LSERV) to monetary policy have their variables ordered as follows: LAGRI/LINDU/LSERV, LBMS, LCPS, LEXR, LCPI, LINT, LLQR, with the assumption of linear deterministic trend and lag interval between 1 and 5 chosen automatically by the AIC. These results are based on trace statistic and are reported in Table 4.3 as follows:

Table 4.3: JOHANSEN COINTEGRATION TEST RESULTS

Hypothesized No. of CE	**DV: LGDP Trace Statistic (Prob.)**	**DV: LAGRI Trace Statistic (Prob.)**	**DV: LINDU Trace Statistic (Prob.)**	**DV: LSERV Trace Statistic (Prob.)**
None	505.3923* (0.0001)	514.2652* (0.0001)	523.1112* (0.0001)	452.0839* (0.0001)
At most 1	299.0053* (0.0000)	296.3152* (0.0000)	333.2837* (0.0000)	298.3307* (0.0000)
At most 2	165.8800* (0.0000)	163.2568* (0.0000)	184.6412* (0.0000)	179.5874* (0.0000)
At most 3	107.4859* (0.0000)	90.43373* (0.0000)	116.5025* (0.0000)	88.78200* (0.0000)
At most 4	61.72551* (0.0000)	51.51854* (0.0000)	55.22796* (0.0000)	55.67646* (0.0000)
At most 5	28.83788* (0.0003)	19.29565* (0.0127)	25.04630* (0.0014)	24.56843* (0.0017)
At most 6	2.824071 (0.0929)	0.898743 (0.3431)	0.091019 (0.7629)	0.149279 (0.6992)

* denotes rejection of the null hypothesis of no cointegration at the 1% and 5% levels.

Trace Statistic indicates 6 cointegratingEqn(s) at the 5% level for each equation.
NB: DV means Dependent Variable
Source: Researchers' Computation using EVIEWS 10

As shown in Table 4.3, the null hypothesis of no cointegration among the relevant variables is rejected as the trace statistic indicates 6 cointegrating equations in all the models. This is because, in each model, the values of the trace statistics alongside their corresponding probability values could not reject the null hypothesis that at most 6 cointegrating equations exist. Thus, we reject the null hypothesis of no cointegration and conclude that there exists a long-run relationship among the variables in each model. This implies that, in each model, consistent and meaningful estimates of long-run coefficients can be generated even in the face of individually non-stationary variables as the deviation from equilibrium is expected to be a temporal phenomenon since equilibrium must be re-established in the long run. Therefore, it becomes safe to report the normalized cointegrating coefficients of the Johansen procedure as follows; customary to the Johansen cointegration procedure, the normalized cointegrating coefficients are reported as the long-run model of cointegrated variables concerning the variable of interests (core dependent variables, which, in our case include LGDP, LAGRI, LINDU, and LSERV). Table 4.4 presents the normalized cointegrating coefficients of the Johansen procedure for all the models. These coefficients are generated by multiplying both sides of the equation of the normalized segment of the Johansen output by -1. The robustness of these estimates is usually determined by observing the value of the log-likelihood (LogL) that measures the goodness of fit of a statistical model to a sample of data for given values of the unknown parameters. In the case of this study, the LogL for all the models is positive and reasonably high, meaning that the long-run coefficients are based on a good fit.

Table 4.4: NORMALIZED LONGRUN COINTEGRATING COEFFICIENTS OF THE JOHANSEN PROCEDURE

Regressors (IV)	DV: LGDP	DV: LAGRI	DV: LINDU	DV: LSERV
LBMS	2.114**	0.138	0.359*	0.641*
	(15.83)	(1.238)	(2.383)	(2.491)
LCPS	1.415**	3.122**	3.200**	2.633**
	(14.69)	(37.53)	(28.11)	(13.15)
LINT	-4.649**	-4.032**	-2.803**	-4.766**
	(-13.33)	(-15.90)	(-8.079)	(-9.001)
LEXR	1.328**	1.363**	0.966**	1.103**
	(12.22)	(16.70)	(8.550)	(6.569)
LCPI	-5.639**	-4.954**	-4.969**	-5.191**
	(-25.71)	(-28.75)	(-19.37)	(-14.16)
LLQR	0.047	1.808**	2.715**	1.627**
	(0.256)	(12.15)	(12.41)	(4.902)
LogL	**315.3**	**309.6**	**300.4**	**281.1**

** (*) denote significance at the 1% (5%) levels. All figures in Parentheses are the t-Statistics.

NB: DV means Dependent Variable, while IV means Independent Variable.
Source: Researchers' Computation using EVIEWS 10

From the second column of Table 4.4 which shows the impact of monetary policy on aggregate output (LGDP) in Nigeria, all the estimated coefficients are individually statistically significant at 1% level of significance except the coefficient of liquidity ratio (LLQR) which is not statistically significant. Following the a priori expectation, all the estimated coefficients are rightly signed. More elaborately, this result shows that broad money supply (LBMS) has a significant positive impact on aggregate output (LGDP) in the long run. In terms of magnitude, a percentage increase in LBMS is, by this result, expected to bring about a 2.11% rise in the aggregate output (LGDP) in Nigeria over the long run. This is in line with the theoretical expectation that the stock of money in circulation has a long-run positive multiplier effect on the overall output of the economy. Also, the result shows that credit to the private sector (LCPS) has a significant positive impact on aggregate output (LGDP) in Nigeria in the long run. Thus, a percentage increase in LCPS is expected to significantly translate to about a 1.42% increase in the aggregate output (LGDP) in Nigeria. This supports the theory that credit availability and accessibility especially for the private sector is a boost to the economy. Interest rate (LINT) has a significant negative long-run impact on overall output (LGDP) in Nigeria to the tune of a 4.65% decline in aggregate output for a percentage increase in the lending interest rate. This is in line with the theoretical expectations that a high-interest rate discourages investment, and through the multiplier effect, contracts the overall economy.

Other significant explanatory variables include the exchange rate (LEXR), and the consumer price index (LCPI). According to our result, the individual role of these aforementioned variables in the output of the economy of Nigeria has been confirmed to be of significant positive and negative measures respectively. Accordingly, a percentage increase in the exchange rate (depreciation) is expected to bring about a 1.33% increase in the aggregate output of the economy. This is possible through the export-led growth effect of exchange depreciation on the economy. Also, a percentage increase in the level of consumer prices (LCPI) is expected to translate to about a 5.64% decline in aggregate output. This is in line with expectations because the aggregate output is measured in real terms, which creates a negative linkage between real output and prices. These results have important policy implications.

From the third to the fifth column of Table 4.4, the impact of monetary policy variables on the three strategic sectors (LAGRI, LINDU, and LSERV) are reported. The aim of this is to compare the impact of monetary policy across the three strategic sectors. There seems to be a uniform effect of monetary policy on these three strategic sectors in terms of magnitude and direction. For instance, the broad money supply (LBMS) has a positive impact on each of the three sectors, but the impact is only significant on the industrial sector (LINDU) and service sector (LSERV). In terms of magnitude, the impact of broad money supply (LBMS) is more pronounced on the service sector (LSERV) with about 0.64% per unit increase in LBMS, followed by the industrial sector (LINDU) with about 0.36% per

unit increase in LBMS. The magnitude of the impact of LBMS on the agricultural sector (LAGRI) is relatively small and statistically insignificant. This implies that when monetary policy is targeted to adjust the stock of money in circulation, it should be expected that only the industrial and service sectors would be significantly affected.

Credit advancement to the private sector (LCPS) has a significant positive impact on all three sectors of the economy. In terms of magnitude, the impact on each sector appears to be uninformed as a percentage increase in the size of credit to the private sector is expected to result in a 3.12% increase in the output of the agricultural sector, 3.20% increase in the output of industrial sector, and 2.64% increase in the output of service sector. With this, it is safe to posit that the impact of credit to the private sector (LCPS) is the same across the various sectors under study. Interest rate appears to have a uniform impact on the sectoral outputs in terms of direction. Expectedly, the impact is negative and significant across the sectors, but more pronounced on the service and agricultural sectors. It is expected that a percentage increase in interest rate is translated to about 4.03%, 2.80% and 4.77% decline in agricultural, industrial and service sectors respectively. The sizes of these parameters should guide the apex bank in formulating interest rate policies that are meant to affect the sectoral output of the economy.

There seems to be no radical difference in the impact of the exchange rate (LEXR) on the relevant sectoral outputs in terms of magnitude and directions. First, the impact of the exchange rate is positive (as expected) and significant across the relevant sectors. Second, the magnitude of the impact of the exchange rate is about 1.36% on the agricultural sector, 0.97% on the industrial sector, and 1.10% on the service sector. The implication of this is that a percentage increase in the exchange rate is expected to result in about 1.36% increase in agricultural sector output, 0.97% increase in the output of the industrial sector, and about 1.10% increase in the output of the service sector in Nigeria over the long run. Similarly, the impact of a consumer price index (LCPI) appears to be the same across the relevant sectoral outputs of the economy in terms of magnitude and direction. The level of consumer prices (LCPI) has a significant negative impact on each sectoral output such that a percentage increase in the level of consumer prices (LCPI) is expected to bring about 4.95%, 4.97%, and 5.19% decline in the outputs of the agricultural, industrial, and service sectors respectively. Thus, for any policy adjustment on the consumer price level, the policymakers should expect similar responses from these sectors of the economy.

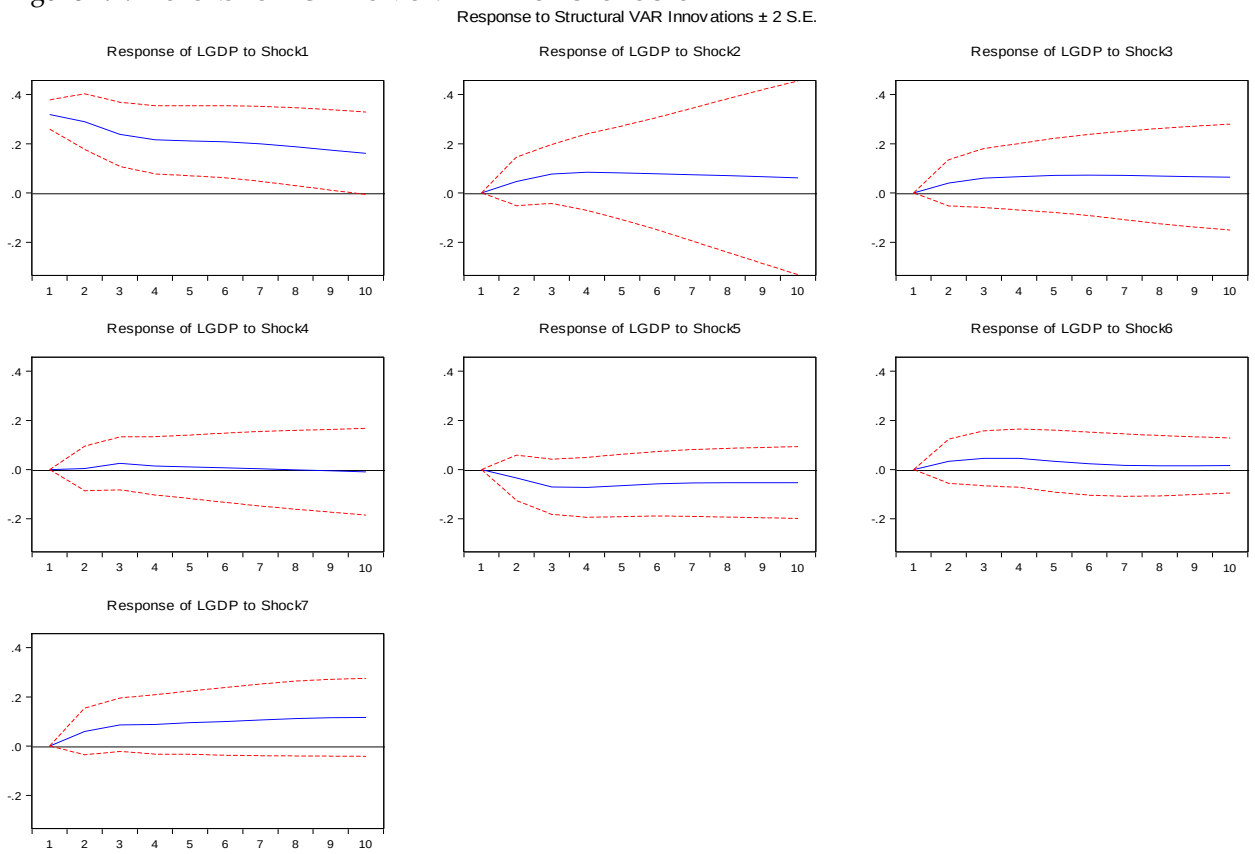
Interestingly, liquidity ratio (LLQR) which has no significant impact on the aggregate output (LGDP) has a significantly positive impact on each of the sectoral outputs of the economy. The divergence influence of liquidity ratio between the aggregate output and sectoral outputs in terms of its significance is suggestive of the prevalence of the problem of aggregate bias should this analysis be limited to aggregate output. It then follows that sectoral analysis of the impact of monetary policy is more policy significant than just the aggregate analysis. According to the results, the liquidity ratio has a relatively more pronounced impact on the industrial sector than on the agricultural and service sectors. For instance, a percentage increase in liquidity ratio is expected to bring about a 1.81%,

2.72%, and 1.63% increase in the outputs of agricultural, industrial, and service sectors of the economy.

4.1.3 *Results of the Structural Vector Autoregressive (SVAR) Model Analyses*

It is generally believed that unanticipated monetary shocks that arise from either the domestic component of monetary policy (money supply, credit to the private sector, liquidity ratio, and interest rate) or the foreign component (exchange rate) can lead to disturbances in the real sector of the economy (both aggregate and sectoral outputs). The effect of these unanticipated shocks on the aggregate and sectoral outputs can be ascertained from the SVAR impulse response functions. If the response is such that the short-run values converge to the long-run values, then it can be deduced that stability can be achieved in the future. Here, we are interested in understanding the impact of these shocks, and the length of time it will take for them to neutralize. This information will enable the policymakers to predict the consequences of unanticipated shocks so that they are well prepared to react to these shocks in future. The structural impulse responses of aggregate output (LGDP) to one standard deviation shock in one of the innovations of all the endogenous variables are presented in Figure 4.1. It is evident from Figure 4.1 that any unanticipated increase in the broad money supply (LBMS) will slightly increase the deviation between the short-run equilibrium values of the aggregate output (LGDP) and its long-run equilibrium values in the short-term horizon (between the 1st and 3rd year). However, the aggregate output (LGDP) when disturbed by a shock in broad money supply (LBMS) could be stabilized after 3 years. In the same vein, any unanticipated increase in credit to the private sector (LCPS) will have a similar, but smaller, effect on aggregate output. Also, any unanticipated increase in interest rate (LINT) will have no significant effect on aggregate output in the first year, but will slightly increase aggregate output within the 2nd and 4th period, after which the effect neutralizes. Any unanticipated increase in the exchange rate will reduce the deviation between the short-run and long-run values of the aggregate output in the first two and a half years, after which the effect neutralizes. The aggregate output will respond positively to the increase in consumer price index (LCPI) from the 1st to 3rd year before declining up till the 7th year, after which the effect neutralizes. Any unanticipated increase in liquidity ratio (LLQR) will increase the deviation between the short-run and long-run values of aggregate output from period one to period three, after which the effect neutralizes.

Figure 4.1: RESPONSE OF LGDP TO MONETARY POLICY SHOCKS



The impulse responses of the sectoral outputs (LAGRI, LINDU, and LSERV) to one standard deviation shock in one of the innovations of all the endogenous variables are reported in the Appendix of this study, while the results are discussed herein. Any unanticipated increase in the broad money supply (LBMS) will increase all the sectoral output. However, the effect of the disturbance arising from a shock in broad money supply on agricultural, industrial and service sectors will neutralize after 4 years, 6 years and 3 years respectively. Also, any unanticipated increase in credit to the private sector (LCPS) will have to increase the outputs of agricultural and service sectors, but will no effect on industrial sector output between period one and two. However, when credit to the private sector is disturbed, the effect on the three sectors will neutralize after 4 years. Any unanticipated increase in interest rate (LINT) will reduce the outputs of the three sectors in the first two periods, after which the effect neutralizes. Regarding the effect of the exchange rate (LEXR), an unanticipated increase in the exchange rate will bring about an increase in the outputs of the three sectors from period 1 to 6, then decline afterwards till period 9, and neutralizes thereafter. As for the effect of a consumer price index (LCPI), an unanticipated increase in consumer prices will not affect the output of the agricultural

sector in period 1, then will increase from period 2 to 3 before neutralizing in the rest of the periods. Also, the disturbance in consumer prices will not affect industrial output in the entire period, while the effect on service sector output seems similar to that of the industrial sector, but will increase in period 3 and neutralizes afterwards. With regards to the impulse response functions of the various sectors, we have noticed that any unanticipated increase in liquidity ratio (LLQR) will increase the three sectors' outputs from period 1 to 3, then decline till period 8 before the effect neutralizes in the remaining parts of the periods.

4.1.3 *SVAR Forecast Error Variance Decomposition (FEVD) Analyses*

It is expected that equilibrium will prevail in the overall economy and all concerned sectors in the long run following the results of the cointegration tests. Thus, after the estimation of the SVAR model, we decompose the forecast error variance based on the structural factorization method to identify the most effective instrument for each targeted variable. We use the SVAR model (with five lags) to decompose the innovations of the endogenous variables into portions that can be attributable to its innovations and innovations in the other variables. The results of the forecast error variance decomposition of the endogenous variables, at various years, generated by the seven-variable, SVAR model are shown in the Appendix of this study.

The predominant source of variations in the forecast errors of the aggregate output (LGDP) is its shocks. The innovations of liquidity ratio (LLQR), broad money supply (LBMS) and credit to the private sector (LCPS) are other important sources of the forecast error variance of the aggregate output. The source of the least forecast error variance of the aggregate output is innovations of interest rate (LINT). The most effective monetary policy instrument for the control of aggregate output appears to be the liquidity ratio. In explaining the forecast error variance of the sectoral outputs (LAGRI, LINDU, and LSERV), we have observed that the innovations of broad money supply (LBMS) are next to their (LAGRI, LINDU, and LSERV) own shocks. The other important variable for the forecast error variance of the agricultural sector (LAGRI) and service sector (LSERV) seems to be the liquidity ratio (LLQR), while the next important variable for the forecast error variance of the industrial sector (LINDU) is the exchange rate (LEXR). The source of least forecast error variance of the agricultural sector (LAGRI) and service sector (LSERV) is the innovations of the interest rate (LINT), while the least source of forecast error variance of the industrial sector (LINDU) is the innovations in the consumer price index (LCPI). The most effective monetary policy instrument for the control of sectoral outputs seems to be the broad money supply.

4.2 Discussion of Findings

The general empirical model of the study was built into a structural vector autoregressive (SVAR) model because it allows for the identification of some sets of independent disturbances utilizing restrictions provided by economic theory rather than the theoretic restrictions used in the reduced-form VAR. However, before estimating the SVAR model,

some relevant preliminary tests like the unit root and cointegration tests were conducted to understand the dynamics of the univariate and multivariate time-series used in the study. Upon the confirmation of six stable long-run relationships among the real aggregate output, real sectoral outputs and the various monetary policy variables, the study relies on the normalized cointegrating coefficients of the Johansen procedure to analyze the long-run effects of the various monetary policy instruments on the aggregate and sectoral outputs of the economy. Structural impulse response functions and forecast error variance decomposition were estimated within the framework of the SVAR model. It is important to note that the discussion of the findings in this section is based on the three objectives of this study. First, the study found that the monetary policy instruments have similar or uniform effects on both the aggregate output and sectoral outputs in terms of magnitude and directions. For instance, the broad money supply, credit to the private sector, exchange rate, and liquidity ratio have a positive effect on the aggregate output and sectoral outputs, while the interest rate and consumer prices have negative effects. While this finding complies with the theoretical expectations, it equally supports the findings by some other researchers like Nwosa and Saibu (2012); Ishioro (2013); Ngozi and Eugene (2015); and Eko, Ehigocho and Okoiarikpo (2017). This finding implies that the aforementioned monetary policy variables are functional in transmitting monetary policy in Nigeria concerning the real sector.

The structural impulse response functions show that the effect of monetary policy aggregate and sectoral outputs goes beyond the current period into the future up to 3 to 6 years before neutralizing or stabilizing. Also, the aggregate and sectoral outputs have similar or the same pattern of responses to the various monetary policy shocks. This implies that the monetary policy instruments as examined in this study are effective in stabilizing the effect of unanticipated monetary policy shocks on aggregate and sectoral outputs of the economy. Evidence from the forecast error variance decomposition suggests that the most effective instrument for the control of aggregate output appears to be the liquidity ratio, while the least effective instrument seems to be the interest rate. Surprisingly, the previous studies failed to account for the role of liquidity ratio in managing the real sector of the economy. The finding that interest rate is the least effective monetary policy instrument is contrary to the finding reported by Nwosa and Saibu (2012); Ishioro (2013); and Ngozi and Eugene (2015). For the control of the various sectoral outputs in Nigeria, the broad money supply seems to be the most effective monetary policy instrument. This finding is consistent with the finding reported by Eko, Ehigocho and Okoiarikpo (2017). The robustness of the results was confirmed by the necessary checks and stability results (See appendix).

4.3 Implication of Findings

The policy implications of the empirical results follow: (a) The monetary policy instruments have similar or uniform effects on the aggregate output and sectoral components in terms of magnitude and directions. For instance, the broad money supply, credit to the private sector, exchange rate, and liquidity ratio have a

positive effect on the aggregate output and sectoral outputs, while the interest rate and consumer prices have negative effects. (b)The structural impulse response functions show that the effects of monetary policy aggregate and sectoral outputs goes beyond the current period into the future up to 3 to 6 years before neutralizing or stabilizing. Also, the aggregate and sectoral outputs have similar or the same pattern of responses to the various monetary policy shocks. (c) Evidence from the forecast error variance decomposition suggests that the most effective instrument for the control of aggregate output appears to be the liquidity ratio, while the least effective instrument seems to be the interest rate. Contrarily, broad money supply seems to be the most effective monetary policy instrument for the control of the various sectoral components in Nigeria.

5 Conclusion, Recommendations and Agenda for Future Research

5.1 *Conclusion*

The main aim of this study is to determine the effect of monetary policy on sectoral outputs of the Nigerian economy with a particular focus on three key sectors – agricultural, industrial and service sectors. In carrying out the broad objective of this study, greater emphasis was placed on the timing and persistence of the effects of monetary policy on sectoral outputs, alongside a comparison of the responses of the various sectoral outputs on monetary policy variables in Nigeria over 59 years from 1961 to 2019. The cointegration analyses confirmed the existence of six stable long-run relationships among aggregate output, sectoral outputs and various monetary policy variables. The empirical evidence from the normalized cointegrating coefficients shows that, on average, the monetary policy variables had significant and uniform effects on the aggregate and sectoral outputs in terms of magnitude and direction. However, the impact of the broad money supply is more pronounced on the service sector than it has on the industrial sector (LINDU) with the least impact on the agricultural sector. Interestingly, the liquidity ratio, which has no significant impact on the aggregate output, has a significantly positive impact on each of the sectoral outputs of the economy.

The empirical evidence on the structural impulse response functions suggests that the effect of monetary policy goes beyond the current period up to 3 to 6 years before it neutralizes. Also, we observed that the effects of monetary policy shocks are transmitted to the real economy (aggregate sectoral outputs). Any unanticipated shock in monetary policy instruments (broad money supply, credit to the private sector, interest rate, exchange rate, consumer prices, and liquidity ratio) would neutralize or stabilize the aggregate and sectoral outputs after 3 to 6 years. This implies that policymakers may wish to devote their attention to both aggregate and sectoral output components of the economy concerning monetary policy shocks. Also, the empirical evidence from the forecast error variance decomposition suggests that the most effective instrument for the control of aggregate output appears to be the liquidity ratio, while the least effective instrument

seems to be the interest rate. On the contrary, the broad money supply seems to be the most effective monetary policy instrument for the control of the various sectoral outputs in Nigeria. In passing, it should be noted that the various sectoral outputs have generally a similar pattern of responses to the various monetary policy variables.

5.2*Policy Recommendations*

From the empirical evidence, the paper recommends as follows: (a) Government and policymakers should devote more attention to the management of money supply, the market for credit to the private sector, cost of borrowing (interest rate), foreign exchange market, level of consumer prices, and specifications of liquidity ratio in the long run. Policies should be designed in such a way that the various economic agents that represent the real sector are encouraged to form expectations about the flow of money supply, interest rate, and credit to the private sector, and liquidity ratio. There is a need to avoid too much intervention in the management of money supply, the market for credit to the private sector, cost of borrowing (interest rate), foreign exchange market, level of consumer prices, and specifications of liquidity ratio so that the speed of adjustment of these markets could be raised. Also, the design of policies for liquidity ratio should be such that it encourages the agricultural and service sectors, while exchange rate policies should be designed to encourage the industrial sector activities. (b) Any unanticipated shock in the broad money supply could be used to stabilize or optimize the various sectoral components, and any unanticipated shock liquidity ratio should be used to stabilize or optimize the aggregate output. Also, the policymakers should see the broad money supply as the most effective instrument of managing the various sectoral components, while the liquidity ratio should be regarded as the most effective instrument of managing the aggregate output.

Thus, this study fills this empirical gap by using annual data spanning from 1961 to 2019. Also, most studies around the topic have relied on the conventional reduced-form VAR which has several limitations including the absence of exogenous variables and lack of identifying restrictions where analyses are done with an appeal to the position of economic theory. To overcome these limitations of the reduced-form VAR, the study employed the SVAR approach which is an advancement over the standard VAR since the identification of some sets of independent disturbances are guaranteed through restrictions provided by economic theory, rather than the theoretic restrictions used in the conventional reduced-form VAR. Since the results of this study are revealing as they shed more lights on the effects of monetary policy on sectoral output growth in Nigeria, the study is not without limitations. The paper suggests the inclusion of structural breaks in the analyses at both univariate and multivariate level of time-series. This is necessary because structural break, which is usually the outcome of the various policy reforms and regime shifts, has important implications on the outcomes of time-series related studies. We also suggest that further studies in this area should include fiscal variables such as fiscal balance to examine the combined effect of both monetary and fiscal policies on

sectoral outputs. Extending the study in these areas would enrich the policy implications and the robustness of the study findings.

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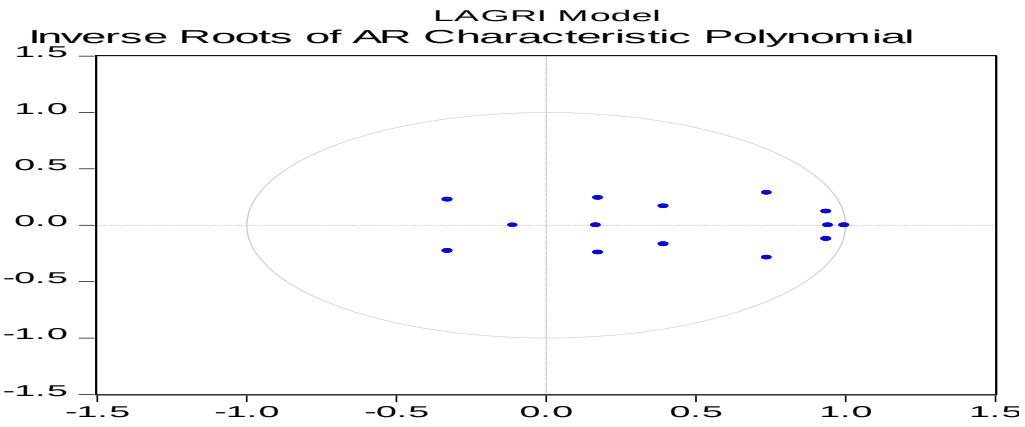

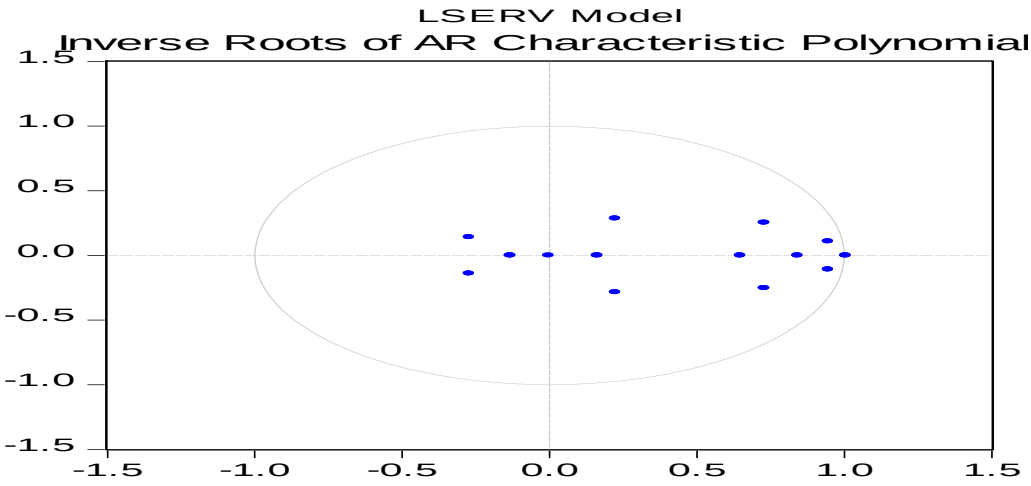
LSERV Model
Inverse Roots of AR Characteristic Polynomial
1.5
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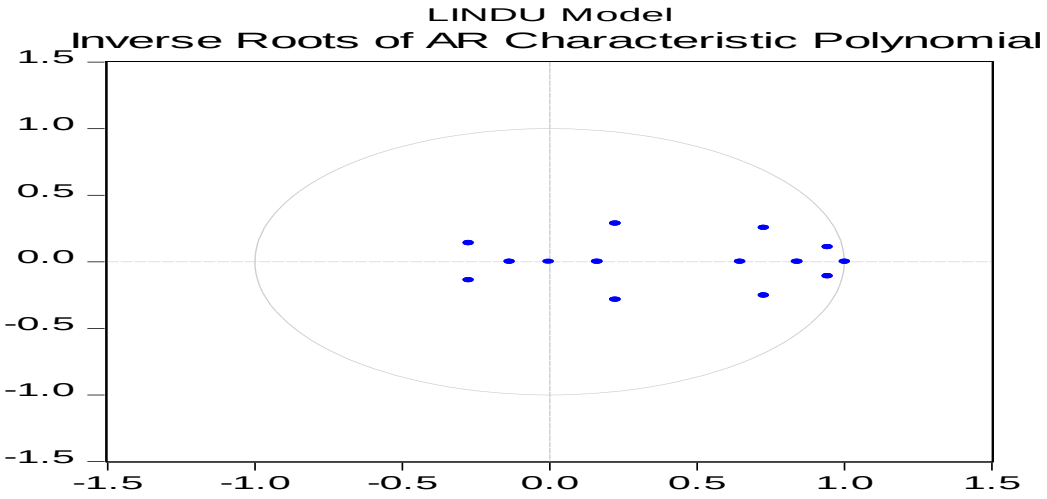
0.0
-0.5
-1.0
-1.5
-1.5 -1.0 -0.5 0.0 0.5 1.0 1.5


LINDU Model
Inverse Roots of AR Characteristic Polynomial
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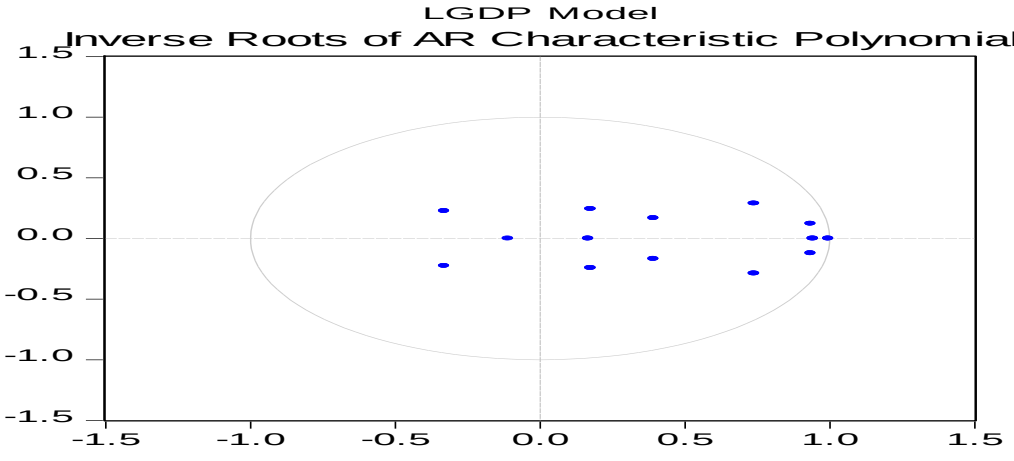
LGDP Model
Inverse Roots of AR Characteristic Polynomial
1.5
1.0
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-1.0
-1.5
-1.5 -1.0 -0.5 0.0 0.5 1.0 1.5

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