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Effect of Exchange Rate Shock on Key Sectors of the Nigerian Economy

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1. Introduction

Exchange rate is a vital policy tool that is used to direct and redirect the economy. The dynamics of exchange rate is dependent on the monetary authority's stand and policy which is geared towards improving macroeconomic performance. Exchange rate whether fixed or flexible affects macroeconomic fundamentals such as import, export, current account balances, general price level, interest rate, agricultural output, industrial output and many more (Chang & Tan, 2008).

According to Tamunonimim and Ibe (2013), Exchange rate is the ratio at which a nation's currency unit interplays for one unit of internationally traded currency such as the US dollar. Exchange rate policy is one of the most important price policy tools that directly linked to the current account balance of the economy. That is to say, it serves as a nexus between the price systems of countries by allocating real resources between the tradable and non-tradable sectors; and an instrument in the design of the balance of payment programmes of countries. As such, exchange rate shock and its accompanying effects on the real sectors of the economy is controversial and has been a subject of much debate (Ezeanyejí & Onwuteaka, 2016). Considerable number of studies addressed the issue both theoretically and empirically and arrived at various conclusions (Khan, Mohammad & Alamgir 2010; Tamunonimim & Ibe, 2013; Betts & Kehoe, 2005). The traditional view is that exchange rate affects relative domestic prices, causing expenditures to shift between domestic and foreign goods, thereby indirectly affecting other macroeconomic fundamentals.

Examination of Nigerian exchange rate reveals that substantial transformation has begun since post-independence era when the country strictly followed a fixed exchange rate system up to the early 1970s and the structural adjustment programme in 1986, ushered in market-based exchange rate system otherwise referred to as

flexible exchange rate regime. Market-based exchange rate system allows the interplay among market fundamentals to determine the prevailing level of exchange rate. Prior to 1973, Nigeria’s exchange rate system was in consonance with the IMF fixed exchange rate system that allows the exchange rate to be subject to administrative management (Tamunonimim & Ibe, 2013).

In May 2016, the monetary authority reintroduced the flexible exchange rate strategy to take effect June 20th. This was as a result of the worsening state of the economy and the slide to recession. The implementation of this policy led to wider margin between the nominal official exchange rate and the parallel market rate. This policy in exchange rate management means that the naira is to be devalued by a rate to be determined by the market forces, which is the demand and supply for foreign exchange.

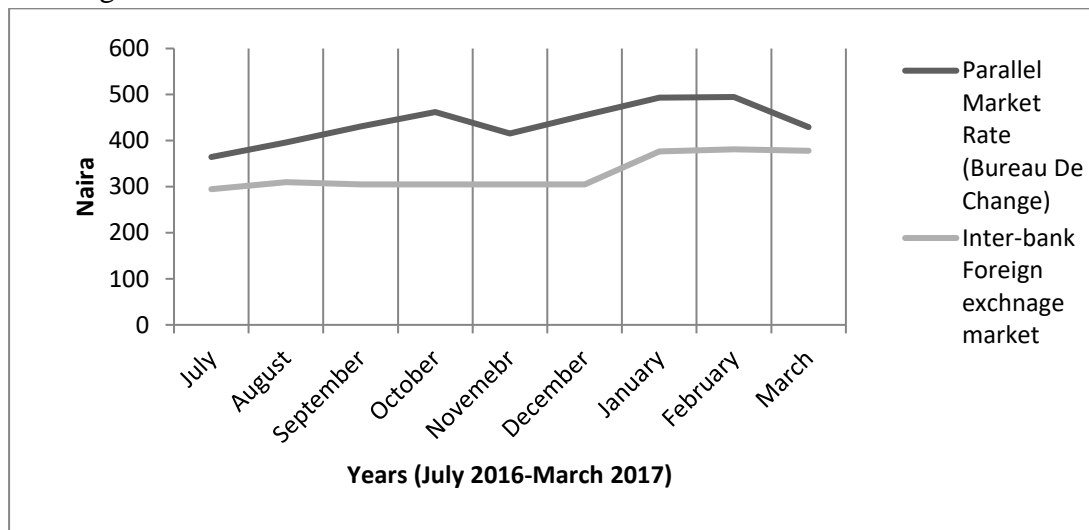


Figure 1: Nigeria Exchange Rate Profile

Sources: Data Obtained from CBN official website April, 2017

Fig 1 shows the average monthly interbank exchange rate and the average monthly parallel market exchange rate in Nigeria for the periods July, 2016 till March, 2017, a period of 8 months after its implementation. This figure helps to show the aftermath effect of implementing the new exchange rate policy by the monetary authority. Figure 1 shows that there is a wide gap between the interbank lending rate and the parallel market rate with the widest gap experienced in October and December of the same year.

The exchange rate system is market-based and also allows it to be subject to administrative management. This system is inflationary in nature and can result in contradictory policies geared towards growth and hence variances in sectoral

performance. In this regard, the policy creates wider margin between the inter bank official exchange rate and the parallel market; this can trigger an increase in inflation on imported raw materials needed in the industrial and agricultural sector as most of Nigeria’s capital goods are imported. To this effect, the industrial and agricultural sector is greatly affected.

This study places emphases on the agricultural and industrial sector because they are the main drivers of growth in a developing country like Nigeria. Theoretically, the Rostow’s stages of growth emphasises that a precondition for take-off is a revolution in the agricultural sector while one of the conditions for take off into rapid growth is a substantial increase in at least one the manufacturing sectors which is a sub-set of the industrial sector (Nafziger, 2012). This shows the importance placed on the industrial and agricultural sector theoretically one of the major determinants of the growth in the economy. At present, the government has placed emphasis on programmes which will aid diversification of the Nigerian economy away from oil to agriculture and massive industrial production; such as the Economic Recovery and Growth Plan (ERGP) in which two of her five key execution priorities are to achieve agriculture and drive industrialisation. Exchange rate shocks can hamper the goals of such programmes; this study therefore seeks to examine the possible consequences of such shock on the industrial and agricultural sector. A further conviction of examining the industrial and agricultural sector can be illustrated in figure 2.

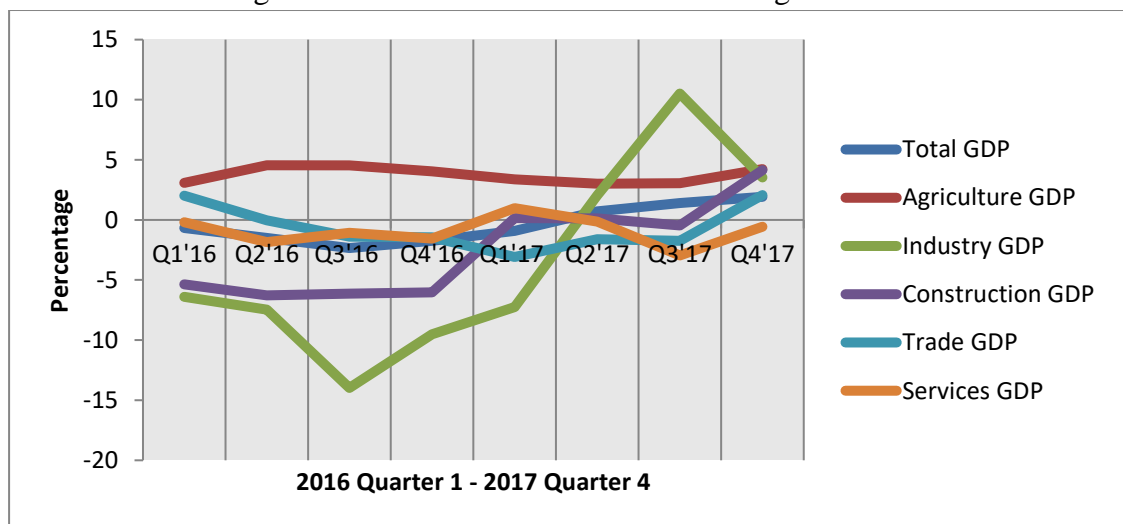


Figure 2: Quarterly Total GDP Growth rate and Sectoral Contribution to Growth

Sources: Data Obtained from CBN 2017 Fourth Quarter Statistical Bulletin

Examining the performance of the agricultural and industrial sector between 2016 and 2017 as presented in figure 2, it can be observed that the economy remained in recession with negative growth rate until the second quarter 2017 and at this second

quarter, the industrial and agricultural sector experienced 2.04% and 3.01% growth rate respectively; this was able to plunged the economy out of recession in the third quarter with a massive growth rate of 3.06% in agriculture and 10.51% in industrial sector while other sectors remained negative. It can thus be concluded that it is the agricultural and industrial sector that moved the economy out of recession towards recovery. It is thus important to examine how exchange rate shock can affect this two sectors of the economy.

It is evident from the foregoing that the recent 2017 economic recession has revealed that Nigerian economy is excessively exposed to external shocks. Although various factors have been adduced to Nigeria's poor sectoral economic performance, the major problem has been the economy's continued excessive reliance on the fortunes of the ever unstable oil market for foreign exchange thereby causing frequent fluctuations in the country's exchange rate. The renewed emphasis on the production of alternatives to fossil-fuel energy, such as solar, wind and bio-energy in the advanced economies, would reduce oil demand and further weaken Nigerian foreign earnings. Thus, in the absence of concerted efforts to shore-up and widen the revenue base, there will be reduction in crude oil revenue, excess crude oil receipts savings and foreign exchange earnings in the coming years (Nwankwo, 2015). This will spell doom for the real sectors in the country that rely on foreign exchange for the purchase of most of their inputs. This raises the question of the relative effect of exchange rate shock on Nigeria's real sectors with emphasis on the industrial and the agricultural sector? This study therefore focuses on conducting a comparative analysis of the effect of exchange rate shock on the industrial and agricultural sector.

This study is motivated to provide an empirical answer to the pressing issue in this study. Previous research have examined exchange rate dynamism either on current account balances, exchange rate impact on economic growth (Akpan, 2012; Lartey, 2007), exchange rate impact on the manufacturing sector (Umeh & Ameh, 2010), exchange rate impact on capital inflows (Rashid and Fazal, 2010), exchange rate impact on foreign direct investment (Alaba, 2003) and exchange rate impact on general price level (Udoh & Egwaikhide, 2008; Odusola & Akinlo, 2001). Few researchers have underscored a comparative analysis of the effect of exchange rate shock on the industrial and agricultural sector. The study covers periods broken down into two; the Regulated regime (1961-1986) and Guided Deregulated regime (1987-2016). The remaining part of this work is divided into four sections, literature review; methodology and model specification; empirical results and findings; conclusion and policy implication.

2. Literature Review

Review of Concepts

Regulation of Exchange Rate

Regulation of exchange rate is the pegging of a country's currency to a basket of other currencies by the country's monetary policy. The regulation of the exchange rate is practiced under a fixed exchange rate regime. Hence, regulated exchange rate can be used interchangeably with fixed exchange rate or pegged exchange rate as used in Obi, Oniore and Nnadi (2016). In Nigeria, the regulation of exchange rate was mostly practiced between 1960 till 1985.

Guided Deregulation of Exchange Rate

In guided deregulation of exchange rate, the exchange rate is allowed to fluctuate from day to day and the monetary authority at the same time will influence the rate by buying and selling currencies on interval basis. Thus, guided deregulation is practiced in managed floating exchange rate regime and can also be used interchangeably with managed floating exchange rate system Obi, Oniore and Nnadi (2016).

Exchange Rate Policy in 2016-The Managed Float Exchange Rate System

Nigeria since the third quarter of 2014 and prior to 2016 has been experiencing the effect of three significant and simultaneous global shocks. These include the over 70% drop in the price of crude oil, which contributes the largest share of our Foreign Exchange Reserves; Global growth slowdown and geopolitical tensions along critical trading routes in the world; Normalization of Monetary Policy by the United States Federal Reserve (Emefiele, 2016). In view of these headwinds, the CBN witnessed a significant decline in our Foreign Exchange Reserves from about US\$42.8 billion in January 2014 to about US\$26.7 billion as of 10th June 2016. To avoid this depletion in 2015 the CBN pegged the Naira-Dollar Exchange Rate at about N197/US\$1 over the last 16 months, and then provide the available but highly limited foreign exchange to certain needs.

To augment this in 2016, the monetary authority introduced the following measures as the new system of exchange rate policies in Nigeria. They are the market operates as a single market structure through the inter-bank/autonomous window; CBN would participate in the Market through periodic interventions to either buy or sell foreign exchange as the need arises; introduction of FX Primary Dealers (FXPD) to deal directly with the Bank for large trade sizes on a two-way quotes basis; no predetermined spread on foreign exchange spot transactions executed through the

CBN intervention with Primary Dealers; the Forty-One (41) items classified as “Not Valid for Foreign Exchange” as detailed in a previous CBN Circular shall remain inadmissible in the Nigerian foreign exchange market (Emefiele, 2016). The result of this policy led to exchange rate been traded as at February 2017 in the inter-bank lending rate at 381.17 Naira to a dollar and in the parallel market at 494.7 naira to a dollar thereby creating over 30% gap in between the system.

Theoretical Construct

The elasticity and the Marshall-Lerner condition Approach provides a theoretical link in which exchange rate impacts on the economy. Given the nominal exchange rate N and the ratio of the price indices P for two countries, Nigeria the home country and United States the foreign country; assuming that P_{NG} and P_{US} are the price level in Nigeria and United States respectively. The real exchange rate is then defined as:

$$EX = N \frac{P_{US}}{P_{NG}} \quad (1)$$

The real exchange rate (EX) from equation (1) is the price of American goods relative to that of Nigerian goods. If the real exchange rate increases, it implies that American goods become more expensive relative to Nigeria goods. Hence, real exchange rate can increase if the nominal exchange rate (N) increases; the price level in Nigeria decreases or the price level in United State increases (Marrewijk, 2005). It then implies that we expect an increase in the real exchange rate to cause a substitution away from American goods towards Nigerian goods in both countries. The elasticity approach, therefore lays emphasis on the nexus between real exchange rate and the flow of goods and services. This flow of goods and services is measured by the current account balance (Rogoff & Reinhart, 2002). From Equation (1), it shows that imports and exports are functions of the real exchange rate. We can therefore analyse that depreciation of Nigeria exchange rate which is increase in N will lead to increase in real exchange rate and this will cause American goods to become expensive which will not only reduces the Nigerian demand for imports M but also increases the demand for European exports X. A summary can then be placed on the effects of exchange rate depreciation on both current account balance (CA) which measures net exports. Hence:

$$\text{Depreciation} \Rightarrow EX \uparrow \Rightarrow X \uparrow, M \downarrow, \Rightarrow \text{current account} \uparrow$$

This can further be summarized as:

$$CA(EX) = X(EX) - EX.M(EX) \quad (2)$$

Equation (2) shows the current account balance and it shows that imports must be pre-multiplied by real exchange rate since imports is measured in American goods and its price, with the real exchange rate (EX). Net export increases improves the current

account and a decrease causes deterioration. Equation (2) explains the Marshall (1923) and Learner (1944) approach that analyzed the conditions in which an increase in real exchange rate leads to an improvement of the current account. To explain this, Marshall (1923) and Learner (1944) pointed out that flexible exchange rate regime that allows for depreciation results into increase in current account balance and then economic growth and the Marshall Lerner condition determines whether or not the equilibrium real exchange rate is stable, or not.

In summary, the elasticity approach advocates that exchange rate depreciation would promote trade balance (this transmits to improvement in the industrial sector to stimulate export), alleviate balance of payment difficulties and then expand output (Obi, Oniore & Nnadi, 2016). This is because the devaluation of a currency divert citizen's importation of goods towards local purchases as imported goods become expensive and locally produced goods become cheaper; this will promote export industries.

The Absorption approach follows the elasticity framework approach but explicitly include income effects which enable the analysis of some simple policy such in solving adjustment problems. The absorption approach remedies the shortcoming of the elasticities approach in a simple Keynesian framework (Rogoff, 2002). The term absorption, which we will denoted by ABSRP, refers to the total spending level in an economy and is equal to the sum of consumption spending C, investment spending I, and government spending G. Let Y denote income. Recall the simple income equation which is given as:

$$Y = \underbrace{C + I + G}_{\langle \text{Absorption} \rangle} + (X - M) \qquad Y - \text{ABSRP} = X - M \qquad (3)$$

From the second part of the equation, it can therefore be seen that if income exceeds absorption, there is current account surplus and if absorption is more than income, then there is current account deficit. The absorption approach thus emphasizes that the excess of domestic demand over domestic production will have to be met by imports. To maintain current account equilibrium, a combination of absorption *ABSRP* and the real exchange rate *EX* is needed. The current account balance depends negatively on the level of absorption because an increase in domestic spending leads to an increased demand for import goods. It depends positively on the real exchange rate *EX*, provided the Marshall – Lerner condition is fulfilled. That is;

$$CA = CA(\overset{-}{\text{ABSRP}}, \overset{+}{\text{EX}}) \qquad (4)$$

Equation (4) shows that increase in the level of absorption for a given real exchange rate will lead to additional import demand and therefore a current account deficit. To restore external equilibrium the relative price of American goods, *EX* (Exchange rate) will have to increase, such as to increase the demand in America for Nigerian exports and reduce the demand in Nigeria for American imports and eliminate the European current account deficit.

The elasticities and the absorption approach have little to say about capital flows but majorly dwelled on the current account. Hence, the monetary approach goes beyond trade flows but also incorporates the role of the financial assets in exchange rate determination. According to the monetary approach, balance of payments disequilibrium is a monetary disequilibrium; that is it is disequilibrium between the amount of money supplied and the amount of money people wish to hold. Simply stated; if the domestic demand for money is higher than what is supplied by the central bank, the excess demand for money will be satisfied by an inflow of money from abroad and vice versa if the demand for money is lower than what is supplied by the central bank (Marrewijk, 2005).

In summary, the monetarist opines that exchange rate devaluation does not influence real output in the long run because given that the assumption of the Purchasing Power Parity (PPP) holds, increase in price in the long run will cause exchange rate devaluation to become ineffective on output and initially improved balance of payment.

Empirical Review

The study conducted by Ojede (2015) examined whether the agricultural or services sector of United State is affected more by exchange rate shock for a period of 1992 January to 2009 December. The study concludes that the exchange rate has greater impact and is more persistent on the services sector than the agricultural sector. Ojede (2015) study placed emphases on the two sectors because of the relative importance of services to the US economy. However, in the Nigeria context, our study focuses attention on the agricultural and industrial sector.

Waziri, Nor, Mukhtar and Mukhtar (2017) conducted a study how exchange rate affects the export of agricultural raw materials and economic growth in Nigeria within the periods 1981 till 2013 employing the Autoregressive Distributed Lag Model (ARDL). Their findings suggest that agricultural raw materials export does not impact positively on economic growth but only exchange rate does. Their results however

does not yield long run equilibrium among the variables understudied; it shows a disequilibrium that would diverge in the long run.

Akinlo and Lawal (2015) investigated the effect of exchange rate on industrial production in Nigeria economy employing the vector error correction mechanism. Amongst its findings is that exchange rate and industrial production has a long run relationship while the depreciation of exchange rate does not impact on the extent of industrial production. The study further draws that money supply shocks explains a large variation in industrial production. The implication of this is that money supply shocks is a possible determinant of industrial production fluctuations both in the long run and the short run. The two conclusions drawn from this study can however be contradictory. Increasing money supply implies expansionary monetary policy which the study recommends also exchange rate depreciation is favourable in the long run; but given that there is capital mobility, expansionary monetary policy in the face of exchange rate depreciation is ineffective following the trinity Mundell-Fleming model.

Gutu, Strachinaru and Ilie (2015) examined how macroeconomic variables impacts on industrial performance in Romania and the study concludes that the global financial crisis in USA led greatly affected industrial production through exchange rate shocks. Hence, financial crisis transmits its effect into the industrial sector through the exchange rate. The study also concludes that disequilibrium in industrial production occurs due to exchange rate shocks and in return, instability in the capital-assets relation of industrial firms transmits to exchange rate crisis. The conclusion from this study simply puts is that there is a feedback effect of shocks from both exchange rate and productions in the industrial sector.

The study conducted by Tarawalie (2010); De Vita and Kyaw (2011); Benhima (2012) all examined the relationship between real exchange rate fluctuation and output growth. in their conclusions and findings, they all opined that undervaluing or depreciating the exchange rate improves output performance while over valuation of the currency negatively affects growth. This is because the depreciation makes the local goods internationally cheap thereby improving exports and balance of payments equilibrium.

The study conducted by Benhima (2012) showed that in developing countries and emerging markets, the announcement of the introduction of fixed exchange rate and de facto stability in exchange rate normally have positive effects on growth. He opined that given that a currency is pegged to the US dollars only, it may hinder its

economic development; this is because as the higher the degree of dollarization, the more likely it will exhibit a negative effect on growth. It is worthy to note that De Vita and Kyaw (2011) argue that the choice of exchange rate regime does not have direct effects on the long term growth in developing countries. That is, in the long run, market-based or fixed exchange rate dynamism does not have significant impact on growth.

However, Glüzmann, Levy-Yeyati and Sturzenegger (2012) hold different views on the effects of exchange rate undervaluation on the different components of GDP. Their result shows that undervalued currency in developing countries do not affect the export sectors, but promote greater domestic saving, investment and employment. This serves as a guide to examining various exchange rate regimes which this study seeks to examine.

Owoundi (2015) seeks to examine the effects of currency misalignments on growth in Sub-Saharan Africa. Currency misalignments and economic growth was assessed using Bayesian estimation techniques. The study concluded that undervaluation of exchange rate has insignificant effect on output and even a change in the regime has no significant impact on economic growth.

The empirical review suggests that none of the studies have examined the effect which exchange rate shock has on both the agricultural and industrial sector with respect to Nigeria. This study therefore seeks to contribute to this strand of literature.

3. Methodology and Model Specification

This study employs the Structural Vector Autoregressive (SVAR) model in achieving its objective. A SVAR model isolate purely exogenous shocks and get the responses of the endogenous variable(s) after the economy is hit by these shocks Sims (1980). With SVAR, important questions are answered; such questions are like what is the effect of exchange rate shocks on the various sectors of the economy? In order to measure the effect of such shock, one must identify purely exogenous variable(s), purely independent movement or shocks of the variable in interest and see how the economy reacts to it, SVAR model helps to provide answers to these questions. It is however important that the SVAR be identified.

SVAR methodology has be found to be simple because it does not require a formal specification of the underlying theoretical model, useful for investigation of historical data dynamics, allows feedback and dynamic interrelationship across all the variables in the system, avoids the need for structural modelling by modelling every endogenous

variable in the system as a function of the lagged values of all the endogenous variables in the system and is a natural approach to analyse the dynamics of sectoral output (Sim, 1980, Akinmulegun, 2012 and Salisu , 2015). According to Gottschalk (2001), a drawback of the SVAR methodology is that due to the low dimension of typical SVAR models the assumption that the underlying shocks are orthogonal is likely to be fairly restrictive.

Impulse Response Function (IRF) and the Forecast Error Variance Decomposition (FEVD) is done to establish real sector's responsiveness to innovations in exchange rate policy. The IRF shows the response of each variable in the system to shocks from the system variables while FEVD tells us the proportion of the forecast error variance in a variable that is explained by innovations to itself and other variables (Johnston & Dinardo, 1996; Greene, 2002). The SVAR is suitable for the study because it accounts for structural breaks that may arise due to different macroeconomics and financial reforms implemented and regime switch in Nigeria (Olayungbo & Ajuwon, 2015). This VAR framework also takes account of possible endogeneity and time lags in the interrelationships among the variables of a system (Hahn, 2007).

The Structural VAR Model

We model our SVAR by employing a nine variable to represent an open economy that include foreign block variables which is similar to that of Ojede (2015) that modelled the US economy in determining whether exchange rate shock affects the agricultural sector or services sector the more. The variables employed by Ojede (2015) were industrial production, consumer price index, money supply aggregate, the U.S. federal funds rate, oil price, exchange rate, value of services exports and the real value of agricultural exports. Our model adapts the above variables with little modifications by using inflation instead of consumer price index, introducing government capital expenditure and value of services exports with external reserve to capture part of the foreign block (Vinayagathan, 2013). The variables thus employed are Share of Agriculture to GDP (AGDP), Industrial Contribution to GDP (INDGDP), Nominal Exchange rate (NER), Inflation rate (INF), Interest rate (INTR), Broad Money supply (MS), oil price (OP), Government capital expenditure (GOVCAP) and external reserve (RES).

This study is built on the premise of the work of Vinayagathan (2013) in identifying the endogenous and exogenous variables. The variables that makes up the foreign block are oil price (OP) and the external reserve (RES); thus these variables are included to control for exogenous change in the global economic stance forming an exogenous vector $\{X_t: OP, RES\}$. The domestic block comprise of endogenous

variables which is a vector (Y_t : AGDP, INDGDP, NER, INF, INTR, GOVCAP, MS). The domestic block comprises of two blocks in the system; the non policy block and the policy variable block which are { AGDP, INDGDP, INF} and {NER, MS, INTR, GOVCAP} respectively.

The VAR method is a linear equation with n variables, each variable is explained by its own lags, along with current and past values of the other $n-1$ variables, so the structural form of the VAR model with n variables in turn has the form:

$$A_0 R_t = A(L)R_t + U_t \quad (3.1)$$

Where R_t is an $(m \times 1)$ matrix vector of endogenous variables, A_0 is an identity matrix of $(m \times m)$ with 1 on its diagonal. The A_0 It contains the structural parameters that capture the contemporaneous relations among the endogenous variables. Furthermore U_t is the vector with the structural shocks, while $A(L)$ is the lag operator. The structural equation (3.1) cannot be estimated directly because of the correlation between the variables and the error terms. Therefore the structural equations is transformed into reduced form equations which can actually be gotten by pre-multiplying equation (3.1) by A_0^{-1} , to obtain a reduced-form equation which is given as

$$R_t = A_0^{-1} \cdot A(L)R_{t-1} + A_0^{-1} \cdot \mu_t \quad (3.2)$$

Equation (3.2) can then be written as:

$$R_t = S(L)R_{t-1} + \varepsilon_t \quad (3.3)$$

Where $S(L)_t = A_0^{-1}A(L)$, $\varepsilon_t = A_0^{-1}\mu_t$,

In estimating equation (3.3), we first select the best lags according to the Alkaike Information Criterion (AIC), we also test to ensure that there is stability in the system and there is no unit root among the variables; this thus guarantees a moving average Wold-chain representation.

Also, $R_t = (AGDP_t, INDGDP_t, INF_t, INTR_t, MS_t, OP_t, NER_t, RES_t, GOVCAP_t)$ is the vector of endogenous variables and the vector $\varepsilon_t = (\varepsilon_t^{AGDP}, \varepsilon_t^{INDGDP}, \varepsilon_t^{INF}, \varepsilon_t^{INTR}, \varepsilon_t^{MS}, \varepsilon_t^{OP}, \varepsilon_t^{NER}, \varepsilon_t^{RES}, \varepsilon_t^{GOVCAP})$ contains the reduced-form residuals which are white noise.

Identification of the Exchange Rate Shocks

The reduced-form residuals from equation (3.3) possess little economic relevance because they are linear combinations of structural shocks. In particular, following Blanchard and Perotti (2002) and Perotti (2004), the reduced-form residual of NER_t , of our equation of interest ε_t^{NER} is seen to possess linear combinations of three types of

shocks which are the automatic responses, system responses and random shocks, taken as the truly uncorrelated structural exchange rate shocks.

In a VAR system that is made up of n -variables, there are $\frac{n(n+1)}{2}$ restrictions that are required for the system to be identified. Normalizing the diagonal element to one places n -restrictions on the VAR system. The difference between $\frac{n(n+1)}{2}$ and n

implies that there are still $\frac{n(n-1)}{2}$ other identification restrictions needed. Sims (1980)

proposed the recursive identification strategy in which the matrix of contemporaneous effects of structural shocks on the variables is assumed to be lower triangular and this yields the exactly needed other identification restrictions. However, the Sims strategy was criticized because re-ordering the variables yields different parameter estimates and hence results into a different shock magnitude. Cooley and Leroy (1985) and Bernanke (1986) proposed the non-recursive structural relations among contemporaneous variables in the system. These structural identifications, combined with the use of Bayesian priors, have become the cornerstone in many recent macroeconomic studies. Here, the non-recursive assumptions are employed to identify the exchange rate shocks. The matrix representing the identifying restrictions is presented in equation (3.4) below

$$\begin{bmatrix} \varepsilon_t^{AGDP} \\ \varepsilon_t^{INDGDP} \\ \varepsilon_t^{INF} \\ \varepsilon_t^{INTR} \\ \varepsilon_t^{MS} \\ \varepsilon_t^{OP} \\ \varepsilon_t^{NER} \\ \varepsilon_t^{RES} \\ \varepsilon_t^{GOVCAP} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & \beta_{23} & \beta_{24} & 0 & 0 & \beta_{27} & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & \beta_{34} & \beta_{35} & \beta_{36} & \beta_{37} & 0 & 0 \\ 0 & 0 & \beta_{43} & 1 & \beta_{45} & \beta_{46} & 0 & 0 & 0 \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ \beta_{71} & \beta_{72} & 0 & 0 & 0 & \beta_{76} & 1 & 0 & 0 \\ \beta_{81} & \beta_{82} & 0 & 0 & 0 & \beta_{86} & \beta_{87} & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{AGDP} \\ \mu_t^{INDGDP} \\ \mu_t^{INF} \\ \mu_t^{INTR} \\ \mu_t^{MS} \\ \mu_t^{OP} \\ \mu_t^{NER} \\ \mu_t^{RES} \\ \mu_t^{GOVCAP} \end{bmatrix} \quad (3.4)$$

Assuming we are to employ the recursive identification strategy, we should have 36 zero restrictions above the leading diagonal for an exact identification. However, following the non-recursive over identified strategy, 48 zero restrictions is employed. It must be noted that certain exclusion restrictions on the structural parameters have become standard for studies of both closed and open economy macroeconomics literature.

Row 1, 2, 3 and 9 from equation (3.4) represent the block of variables in the goods market which are share of agriculture to GDP, Industrial contribution to GDP, price level and government capital expenditure. The four variables represent an open economy I-S type (Ojede, 2015). Following Ojede (2015) with little modification, since there is a lag period or gestation within the agricultural industry, we assume that farmers are unable to respond contemporaneously to changes in macroeconomic variables, hence financial variables don't affect their decision.

For the industrial sector in row 2, we assume that the industrialist contemporaneously respond to changes in inflation rate (β_{23}) and interest rate (β_{24}) as interest rate changes will like cause changes immediately in capital required for production. Also, given that the typical developing country like Nigeria is import dependent in terms of raw materials, the industrial sector is assumed to contemporaneously respond to exchange rate changes (β_{27}). We assume that they will not respond contemporaneously to changes in money balances as they already have an optimal cash balance for production.

For price level in row 3, we assume that inflation rate contemporaneously respond to changes in the I-S variables and foreign block variables but not foreign reserve and government capital expenditure. For Foreign reserve, there is no direct link between changes in foreign reserve and changes in inflation rate. Also, capital expenditure has a lag of time before tranches of fund is been disbursed and also, in terms of deficit financing for capital projects as typical of Nigeria, bulk of the funds is borrowed externally and as such, capital expenditure is not expected to contemporaneously cause a change in inflation rate. In a typical economy like Nigeria, oil price is allowed to contemporaneously affect inflation rate (β_{36}) as most of the cause of inflation is due to international market fluctuations due to Nigeria's heavy reliance on crude oil.

For row 9, following Fernandez and Hernandez (2006), no macroeconomic variable is allowed to contemporaneously cause a change in government capital expenditure.

Row 4 and 5 of the identification matrix in equation (3.4) is the LM framework. Row 4 is the supply of money and thus, monetary authority observes the current money supply balances, the level of inflation rate and the oil price before setting the monetary policy rate. Hence, following Kim and Roubini (2000) and Rahman and Serletis (2009), Inflation rate (INF) (β_{43}) money supply (MS) (β_{45}) and the oil price (OP) (β_{46}) are allowed to contemporaneously enter the equation for interest rate (INTR). Oil price is included in interest rate equation because fluctuations in oil prices are usually driven by the overall changes in the global supply and demand for energy and are unlikely to signal a general change in inflation brought about by the domestic monetary policy. Thus, price of oil in the model allows us to isolate the impact that the monetary policy shocks alone can have on prices and other variables in the system. Row 5 is the demand for real money balances and as such, Share of agricultural output (β_{51}), share of industrial output (β_{52}), the level of inflation rate (β_{53}) and interest rate (β_{54}) is allowed to contemporaneously determine the level of money demand.

Row 6, 7 and 8 represents the foreign block characterized with oil price, exchange rate and foreign reserve. For 6, none of the macroeconomic variables contemporaneously causes a change in oil price as oil price is globally dependent on world demand and supply and also the quota system spelt out by the cartel-OPEC. For row 7 which is exchange rate, we modify Ojede (2015), given that Nigeria operates a flexible exchange rate system, agricultural production (β_{71}), share of industrial output to GDP (β_{72}) and oil price (β_{76}) contemporaneously cause a change in exchange rate. For row 8, given that the government budget is drawn and so a projected share of foreign earnings is allotted to nationals and sub-nationals using the sharing formula; hence, share of agricultural GDP, share of industrial output to GDP, oil price and exchange rate is allowed to contemporaneously cause a change in foreign reserve.

Before estimating the SVAR model, we carried out necessary tests both unit root and Co-integration tests to justify the applicability of SVAR. First, we proceed by determining the underlying properties of the process that generates our time series. That is, to test whether each variable is stationary or non-stationary. This investigation is necessary to ensure stability in subsequent econometric modelling. To test for unit roots, we employed the Augmented Dickey Fuller (ADF) tests to test for the null hypothesis of non stationarity.

4. Empirical Results and Findings

Descriptive Statistics

$$R_t = (AGDP_t, INDGDP_t, INF_t, INTR_t, MS_t, OP_t, NER_t, RES_t, GOVCAP_t)$$

These descriptive statistics provide a historical background for the behaviour of our data. The variables examined here are Agricultural sector contribution to Real GDP (AGDP), Industrial sector contribution to Real GDP (INDGDP), inflation rate (INF), Interest rate (INTR), Money supply (MS), Oil price (OP), Nominal Exchange rate (NER), External Reserve (RES) and Government Capital Expenditure (GOVCAP). The descriptive statistics are presented in table 1.

Table 1: Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque-Bera	Probability	Obs
AGDP	4.6 trillion	3.25 trillion	16.6 trillion	1.3 billion	5.1 trillion	9.231962	0.009892	56
GOVCAP	0.24 trillion	12.6 billion	1.15 trillion	63766000	0.346 billion	15.49581	0.000432	56
INDGDP	5.98 trillion	6.85 trillion	13.8 trillion	0.17 billion	4.92 trillion	5.175802	0.075178	56
INF	15.89571	11.69000	72.73000	-5.6	15.28331	57.65085	0.000000	56
INTR	13.77538	15.57837	29.80000	6.000000	6.418798	3.048401	0.217795	56
MS	2.68 trillion	42.1 billion	21.6 trillion	0.29 billion	5.46 trillion	68.90249	0.000000	56
NER	49.57482	5.964146	258.9375	0.546358	68.48989	11.28879	0.003537	56
OP	28.48196	18.53000	109.4500	1.210000	29.49734	24.10388	0.000006	56
RES	10.7 billion	3.7 billion	58.5 trillion	71021699	15.3 billion	25.96248	0.000002	56

Source: Author's Computation using Data extracted from CBN 2011 and 2016 Statistical Bulletin

From table 1, there seems to be evidence of significant variations as shown by the huge difference between the minimum and maximum values for the variables under consideration. High standard deviation depicts a high degree of volatility in the variables during the period under investigation. The descriptive result reveals that inflation rate was highly volatile as the maximum rate was 72.73% while the minimum was (5.6%), this variability is considerably high. However, the exchange rate peak was 258.94 naira to a dollar and this was reported in 2016. The result of the descriptive statistics further shows that oil price peak was 109.45 dollars per barrel while the minimum was 1.21 dollars per barrel. All the distributions are positively skewed with the exception of industrial contribution to GDP that is negatively skewed during the study period. Kurtosis less than three are called platykurtic (fat or short-tailed) and NER and PLR variables qualified for this. On the other hand, variable whose kurtosis value is greater than three are called leptokurtic (slim or long tailed).

Unit Root Test

The study deployed Augmented Dickey-Fuller (ADF) test to examine the stationarity of the time series and test the null hypothesis of unit root. It is expected that the series do not contain unit root in order to find relationship among the variables in the long run. The test is carried out at level, and first difference using 5% Mackinnon Critical value. The variables of Agricultural sector contribution to Real GDP (AGDP), Industrial sector contribution to Real GDP (INDGDP), inflation rate (INF), Interest rate (INTR), Money supply (MS), Oil price (OP), Nominal Exchange rate (NER), External Reserve (RES) and Government Capital Expenditure (GOVCAP) were tested. The levels of statistics of the tests are reported in table 2.

Table 2 Augmented Dickey-Fuller (ADF) Unit Root Test Result

Variable	Method	At Level			At First Difference			Order
		ADF statistics	5% critical value	Prob	ADF statistics	5% critical value	Prob	
log(AGDP)	ADF	-1.137965	-2.915522	0.6945	-7.300361**	-2.916566	0.0000	I (1)
log(GOVCAP)	ADF	-1.369149	-2.915522	0.5907	-7.561156**	-2.916566	0.0000	I (1)
LOG(INDGDP)	ADF	-1.596309	-2.915522	0.4777	-7.435860**	-2.916566	0.0000	I (1)
INF	ADF	-3.469641	-2.915522*	0.0126	-	-	-	I (0)
INTR	ADF	-1.425545	-2.916566	0.5631	-11.70125**	-2.916566	0.0000	I (1)
LOG(MS)	ADF	-0.198132	-2.916566	0.9321	-3.959334**	-2.916566	0.0032	I (1)
NER	ADF	2.521261	-2.915522	1.0000	-4.062490**	-2.916566	0.0024	I (1)
OP	ADF	-1.504817	-2.915522	0.5238	-6.489462**	-2.916566	0.0000	I (1)
LOG(RES)	ADF	-1.230089	-2.917650	0.6549	-6.313094**	-2.917650	0.0000	I (1)

* Implies significant at 5% meaning that the variable is stationary at that order

** Implies significant at 1% meaning that the variable is stationary at that order

Source: Author's Computation using Data extracted from CBN 2011 and 2016 Statistical Bulletin

From table 2, the ADF reported inflation rate (INF) to be stationary at levels as their ADF statistics were significant at 5% while it was tested at levels and others are stationary at first difference. This finding implies that the series contains no unit root at the level and at first difference; hence, their seasonal variation has been corrected for, making them fit for regression.

Bounds Co-Integration Test

From table 2, one of the variables is stationary at level and others are stationary at first difference, there is a practical difficulty that has to be addressed when we conduct F-test. Exact critical values for the F-test are not available for an arbitrarily mix of I(0) and I(1) variables. However, Pesaran, Shin and Smith (2001) prescribes a technique to investigate the appropriate order in which the variables are co-integrated. Peseran et al. (2001) supplied bound for the critical value for the asymptotic distribution of the F-statistic. If the computed F-statistic falls below the lower bound we would conclude

that the variables are I(0), so no co integration is possible, by definition. If the F-statistics exceeds the upper bound, we conclude that we have co-integration. Finally if the test statistic falls between the bounds, the test is inconclusive. The Peseran results for the equation or model is presented in table 3.

Table 3: Bounds Wald statistic Result

LOS	Equation	
	I(0)	I(1)
10%	1.92	2.89
5%	2.17	3.21
2.5%	2.43	3.51
1%	2.73	3.9
F-Stat	1.438802	
D.F	7	

Source: Author's Computation using Data extracted from CBN 2011 and 2016 Statistical Bulletin

Table 3 shows that for the equation estimated, computed F-statistic falls below the 5% lower bound we would conclude that the variables are I(0) as in $1.4388 < 2.17$.

Exchange Rate Shock Impact on Agricultural Sector in the Regulated and Guided Deregulated Regime

In order to examine this objective, a structural Vector Autoregressive (SVAR) model as specified in the previous section was estimated and then the SVAR Forecast Error Decomposition (FEVDs) and the Impulse-Response Function were estimated on the various exchange rate regimes for the agricultural sector. This enabled us to see the response of agricultural sector performance to shocks in two different exchange rate regimes, the regulated and the guided deregulated regime. By definition, Impulse response Function is the dynamic responses of variables to their structural variation, while the variance decomposition shows the proportion of forecast error variance for each variable that is attributable to its own structural shocks or innovation and to innovation in the other endogenous variables.

Table 4: SVAR Forecast Error Decomposition (FEVDs) of Agricultural Output in Nigeria

Variable Shocks	Regulated Regime (1961-1986)			Guided Deregulated Regime (1987-2016)		
	Forecast Horizon			Forecast Horizon		
	Next 1 Period	After 5 Periods	After 10 Periods	Next 1 Period	After 5 Periods	After 10 Periods
Agricultural contribution to GDP Shock	100.00%	85.01%	36.53%	100.00%	36.40%	32.14%
Government Capital Expenditure shock	0.00%	3.13%	6.87%	0.00%	4.60%	3.93%
Inflation Rate Shock	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
Interest rate Shock	0.00%	0.19%	0.29%	0.00%	0.29%	0.31%
Money supply Shock	0.00%	6.75%	48.37%	0.00%	0.01%	0.01%
Exchange rate shock	0.00%	3.21%	3.53%	0.00%	46.21%	49.93%
Oil price shocks	0.00%	0.05%	0.04%	0.00%	0.01%	0.02%
External Reserve shocks	0.00%	1.65%	4.37%	0.00%	12.47%	13.05%
Total Accumulated shocks	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Author's Computation using Data extracted from CBN 2011 and 2016 Statistical Bulletin

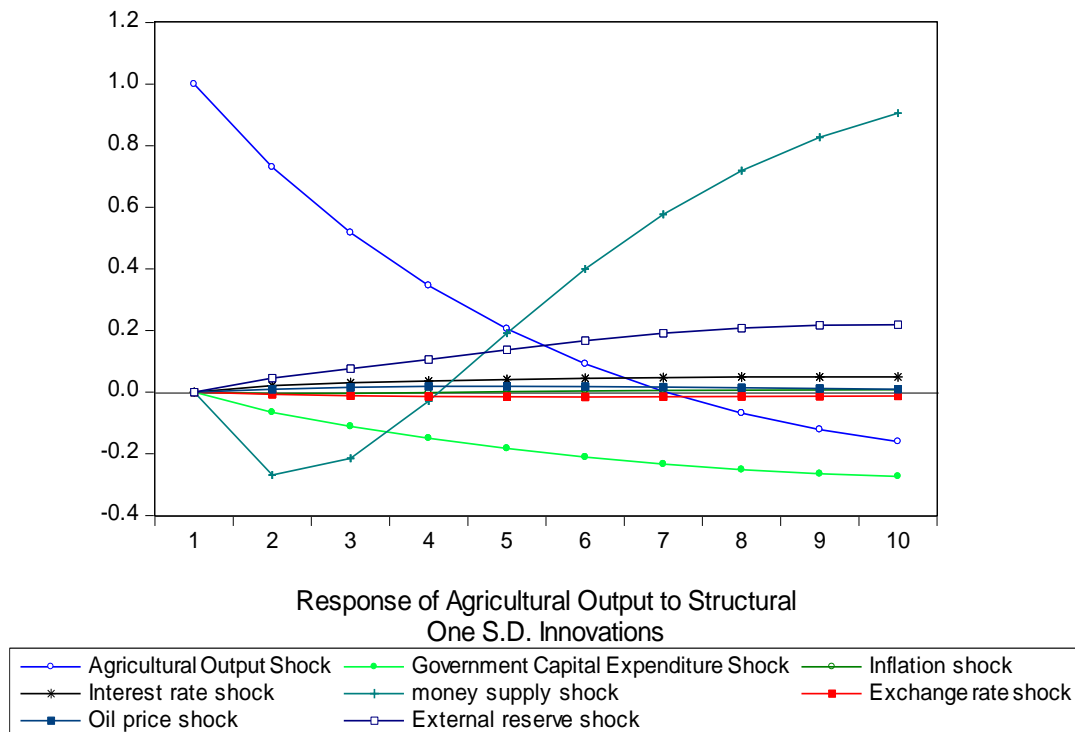


Figure 3: Response of Agricultural Output to Shocks in the Regulated Regime (1961-1986)

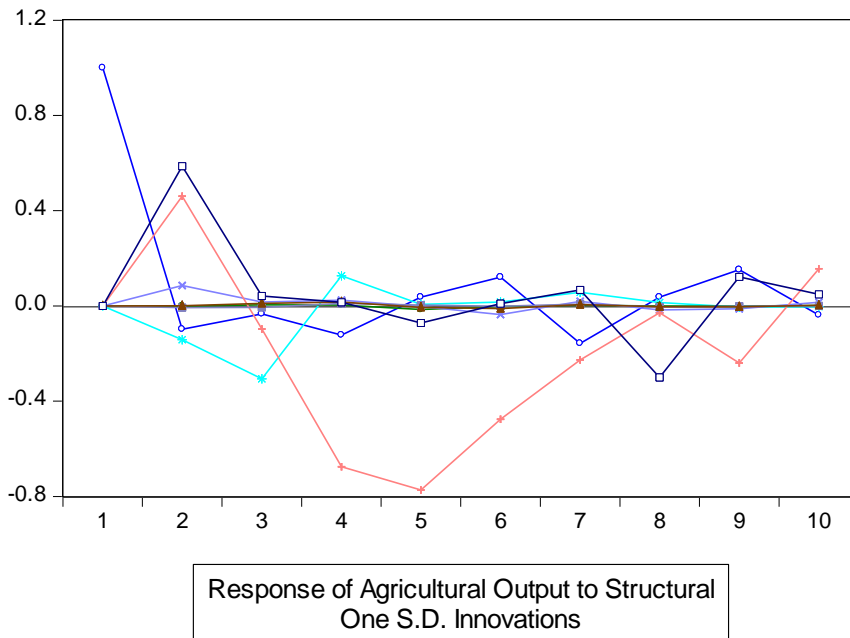


Figure 4: Response of Agricultural Output to Shocks in the Guided Deregulated regime (1987-2016)

Figure 4: Response of Agricultural Output to Shocks in the Guided Deregulated regime (1987-2016)

Figure 3 depicts the accumulated responses of agricultural output to generalized one S.D. innovation as described by Lescaroux and Mignon (2008) in the regulated regime of which all of the variables are up to ten periods. As Figure 3 portrays, in the regulated regime, agricultural output did not significantly responded to exchange rate shocks from period 1 to the tenth period.

Figure 4 depicts the accumulated responses of agricultural output to generalized one S.D. innovation as described by Lescaroux and Mignon (2008) in the guided deregulated regime of which all of the variables are up to ten periods. As Figure 4 portrays, in the guided deregulated regime, agricultural output negatively and significantly responds to exchange rate shocks from period 1 to the eight period and this is felt greatly in the 5th period.

Table 5 revealed that 63.57% of shocks in agricultural output were explained by exchange rate in the first period during the regulated regime and this rose greatly to 98.32% in the fifth period but endured a gradual decrease after the 10th period only accounting for 98.16% of shocks in agricultural real output. This obviously shows that

exchange rate accounted for the greatest shocks experienced on agricultural output in the regulated regime.

Table 4 also revealed that only 0.00% of shocks in agricultural output were explained by exchange rate in the first period during the guided deregulated regime and this rose greatly to 46.21% in the fifth period but endured a gradual increase after the 10th period only accounting for 49.93% of shocks in agricultural real output. This obviously shows that exchange rate accounts for the greatest shocks experienced on agricultural output in the guided regulated regime than the deregulated regime.

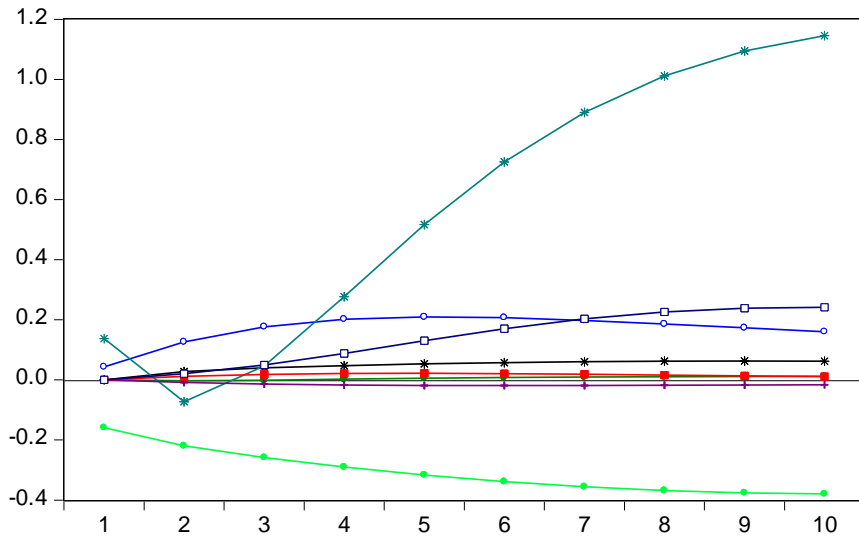
Exchange Rate Shock Impact on Industrial Sector in the Regulated and Guided Deregulated Regime

In order to examine this, a structural Vector Autoregressive (SVAR) model as specified in the previous section was estimated and then the SVAR Forecast Error Decomposition (FEVDs) and the Impulse-Response Function were estimated on the various exchange rate regimes for the Industrial sector.

Table 5: SVAR Forecast Error Decomposition (FEVDs) of Industrial Output in Nigeria

Variable Shocks	Regulated Regime (1961-1986)			Guided Deregulated Regime (1987-2016)		
	Forecast Horizon			Forecast Horizon		
	Next 1 Period	After 5 Periods	After 10 Periods	Next 1 Period	After 5 Periods	After 10 Periods
Agricultural contribution to GDP Shock	95.95%	69.44%	23.38%	92.30%	37.37%	33.52%
Government Capital Expenditure shock	2.22%	11.45%	11.11%	0.04%	0.99%	1.71%
Inflation Rate Shock	0.00%	0.00%	0.01%	0.37%	4.50%	3.94%
Interest rate Shock	0.00%	0.26%	0.29%	0.00%	0.01%	0.01%
Money supply Shock	1.66%	13.07%	58.83%	0.01%	0.31%	0.33%
Exchange rate shock	0.17%	5.69%	6.42%	7.29%	56.80%	60.46%
Oil price shocks	0.00%	0.05%	0.03%	0.00%	0.01%	0.01%
External Reserve shocks	0.00%	0.03%	0.03%	0.00%	0.01%	0.02%
Total Accumulated shocks	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Author's Computation using Data extracted from CBN 2011 and 2016 Statistical Bulletin



Response of Industrial Output to Structural One S.D. Innovations

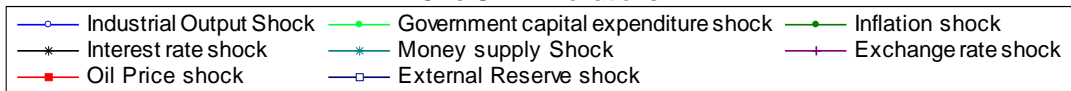
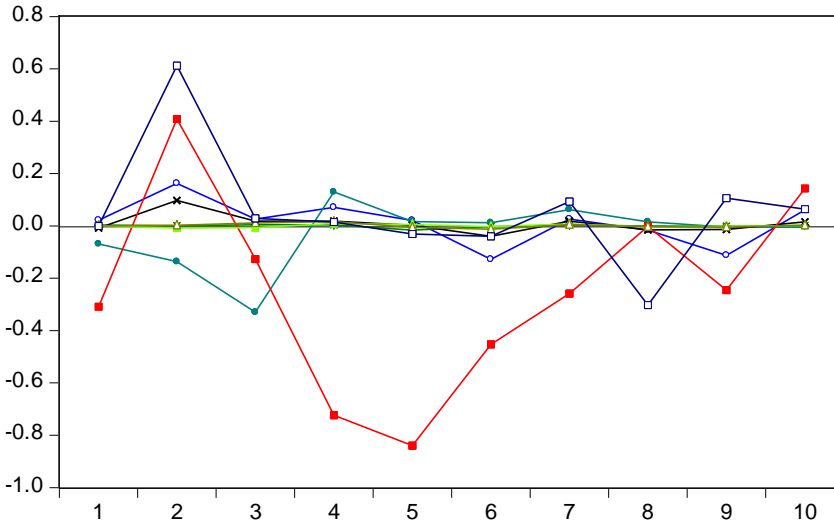


Figure 5: Response of Industrial Output to Shocks in the Regulated Regime (1961-1986)



Response of Industrial Output to Structural One S.D. Innovations

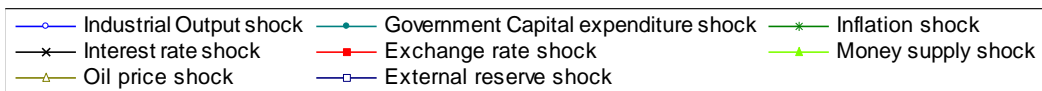


Figure 6: Response of Industrial Output to Shocks in the Guided Deregulated regime (1987-2016)

Figure 5 depicts the accumulated responses of Industrial output to generalized one S.D. innovation in the regulated regime of which all of the variables are up to ten periods. As Figure 5 portrays, in the regulated regime, Industrial did not significantly responded to exchange rate shocks from period 1 to the tenth period.

Figure 6 depicts the accumulated responses of Industrial output to generalized one S.D. innovation in the guided deregulated regime of which all of the variables are up to ten periods. As Figure 6 portrays, in the guided deregulated regime, Industrial output positively and significantly responded to exchange rate shocks for only period 2 and negatively responded in the 3rd period until the eighth period and this is felt greatly in the 5th period.

Table 5 reveals that 0.17% of shocks in Industrial output were explained by exchange rate in the first period during the regulated regime and this rose to 5.69% in the fifth period but endured a gradual increase after the 10th period only accounting for 6.42% of shocks in Industrial real output. Table 5 also revealed that only 7.29% of shocks in Industrial output were explained by exchange rate in the first period during the guided deregulated regime and this rose greatly to 56.80% in the fifth period but endured a gradual increase after the 10th period only accounting for 60.46% of shocks in Industrial real output. This obviously shows that exchange rate accounted for the greatest shocks experienced on Industrial output in the guided regulated regime than the deregulated regime.

5. Conclusion and Policy Implication

This study conducts a comparative analysis of the effect of exchange rate shock on the industrial and agricultural sector during the regulated regime and the guided deregulated regime in Nigeria. The study employs a structural VAR to estimate the shock with the aid of SVAR Forecast Error Decomposition (FEVDs) and the Impulse-Response Function. It can be concluded from the study that in the regulated regime, agricultural output and industrial sector output fairly responded to exchange rate shocks from period 1 to the tenth period and this was felt greatly in on industrial sector than the agricultural sector. The policy implication therefore is that any shock in a regulated exchange rate system greatly affects the industrial sector than the agricultural sector in the long run. This implication is strongly connected to the Nigerian economy as most of her industrial raw materials and machineries are imported without concessions on exchange rate.

However, in the guided deregulated regime, exchange rate shock in the long run negatively affects the agricultural sector in the long run and also affects the industrial

sector in the short run. This result supports the nature of the agricultural sector that is based on primary product. This implies that prolonged exchange rate shocks stimulates exportation of agricultural products and hence, increases foreign exchange earnings from sales of agricultural product.

Another conclusion drawn from the study is that most of shocks in the agricultural and industrial sector are primarily caused by exchange rate shocks when it is deregulated as 60.46% of it in industrial is caused by exchange rate and 49.93% of it in the agricultural sector and this supports the reason why the agricultural and industrial sector negatively responds to shocks from exchange rate in a deregulated regime.

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