THE IMPACT OF EXCHANGE RATE ON AGRICULTURAL OUTPUT IN NIGERIA: A STRUCTURAL VECTOR AUTOREGRESSION APPROACH

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ABSTRACT

Agricultural sector has elucidated at the very beginning of the study is considered one of the many ways through which a nation's economy could grow. As much as it associated with production of food for the teeming masses, provision of employment for the largest percentage of the nation's population, provision of raw material for many agro-allied industries, a major avenue for foreign exchange earnings to the nation as well as being a major components of the nation's gross domestic product, the importance of the sector cannot be over-emphasised. The study therefore examines the impact of exchange rate reforms of agricultural output in Nigeria. The study made use of unit roots test and structural vector autoregression in analyzing the data. Of the four variables of acreage (ACRE), agricultural labour (AGLAB), lending rate (LR) and exchange rate (EXR), both acreage and lending rates were positively related to agricultural output, while agricultural labour and exchange rate were positively related to it. The study therefore recommend a general macroeconomic policy that will envelope a stable exchange rate policy, that will act as impetus for proper planning by farmers and guards against the dire consequence of exchange rates fluctuation. The said policy should make lending rates to be investment friendly, as high lending rate that negatively affect agricultural output will also negatively affect all other potential investments in the country.

Keywords: Agricultural Output, Agricultural Trade, Exchange Rate and Structural Autoregression

JEL Codes: C10, E10, E60

1.0. Introduction

That agriculture is an important component of any given economy is to say the obvious. Even the most advanced countries of the world would never neglect agricultural sector probably for the purpose of boosting science and technology. According to Lewis theory of development, (Todaro and Smith, 1979), the importance of agricultural sector to national development in a developing economy with surplus labour in the traditional agricultural sector existing side by side with high-productivity modern urban industrial sector has long

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been noticed. Growth in agriculture is essential to provide food for the teeming masses, provision of raw materials for industrial production, provision of savings and tax revenue to support development of the rest of the economy, to earn more foreign exchange (or save foreign exchange when primary products are imported), a source of employment for a greater percentage of a nation's populace and provide a growing market for domestic manufactures (Meier, 1998).

Notwithstanding the strength of the oil sector on the Nigerian economy, Nigeria is an agrarian economy (Ogen, 2003). This is because in terms of comparative advantage in production, the country excels in agricultural productivity than in science, technology and other allied sectors (Abiola, 2017). According to FAOSTAT (1970), Nigeria is the largest producer of cocoa, palm oil and cotton. The second largest producer of coffee and one of the largest producer of rubber in Africa. In terms of food production, a very good agricultural climate has aided the country in the production of various food crops ranging from yams as obtained mostly from the North Central part of the country as well as the eastern part. The country is also reputed to be the largest producer of cassava, found mostly in the southern and the eastern part of the country. While grains mainly maize, millet, sorghum, beans and rice are abound in the Northern part of the country. These crops do not in any way diminish the giant stride made in vegetables production especially tomatoes. All these are glaring evidences that even if the country cannot produce for export, it should be at least comfortable in food self-sufficiency, but the reverse is the case.

According to FAOSTAT 2016, Nigeria's import of crops and livestock in 1970 was approximately $125million, while export was $438 million dollars. During this periods, a combination of a strong Naira against US dollars and British pounds and a very active agricultural sector made the export to be greater than import. By 1980, the trend had reversed with import of $2.1 billion and export of $445million. This also is not unconnected with both exchange rate depreciation as well as the neglect of the agricultural sector in favour of the money spinning oil sector. By 2016, the situation had worsened with the import of $2.998 billion and export of a meagre $648million. In between that periods of 1970 till date, a lot of agricultural programmes and policies had been put in place with the intention strengthening and revamping the sector. The National Accelerated Food Production Programme (NAFFP) of 1972, the Agricultural Development Programmes (ADPs) of 1974, the Operation Feed the Nation (OFN) of 1976, the River Basin Development Authorities (RBDAs) of 1976, the Green Revolution (GR) of 1980, the Directorate of Food, Road and Rural Infrastructure (DFFRI) of 1986, the National Agricultural land Development Authority (NALDA) of 1992, the National Fadama Development Project (NFDP) of the 1990s, the National Economic Empowerment and Development Strategy (NEEDS) of 1999, the National Special Programme on Food Security (NSPFS) of 2002, the Roots and Tuber Expansion Programme (RTEP) of 2003, the 7-Point Agenda (2007), the Bank of Agriculture (BOA) of 2010, the Agricultural

Transformation Agenda (ATA) of 2011 and a host of other agricultural programmes are pointers of the successive governments' efforts in bettering the lots of agriculture.

Despite all these programmes and coupled with many macoreconomic policies that aimed at enhancing agriculture sector performance, Nigeria is still a huge net importer of agricultural commodities especially the importation of rice, wheat and sugar (Abiola, 2017). One variable that was found central to the growth of agriculture is the price. The price which is greatly influenced by exchange rate. The importance of exchange rate according to Oyejide 1986 is in the effect of the rates on both the input prices and the output prices. While the exchange rates and prices are important to inputs like fertilizers and machinery, the exchange rate and prices are very fundamental to farm gate prices, which are major incentives for farmers' productivity. The questions that arose among many others are why is Nigeria still importing agricultural products despite the availability of human and natural resources that can help in the production of same, why is the country not self-sufficient in food production even if the sector does not develop to exportation level, what macroeconomic policies aid or hinder agricultural development in the country, what is the impact of exchange rate on agricultural productivity. This and many other questions form the basis of this research study. The study therefore assesses the impact of exchange rates on agricultural output in Nigeria.

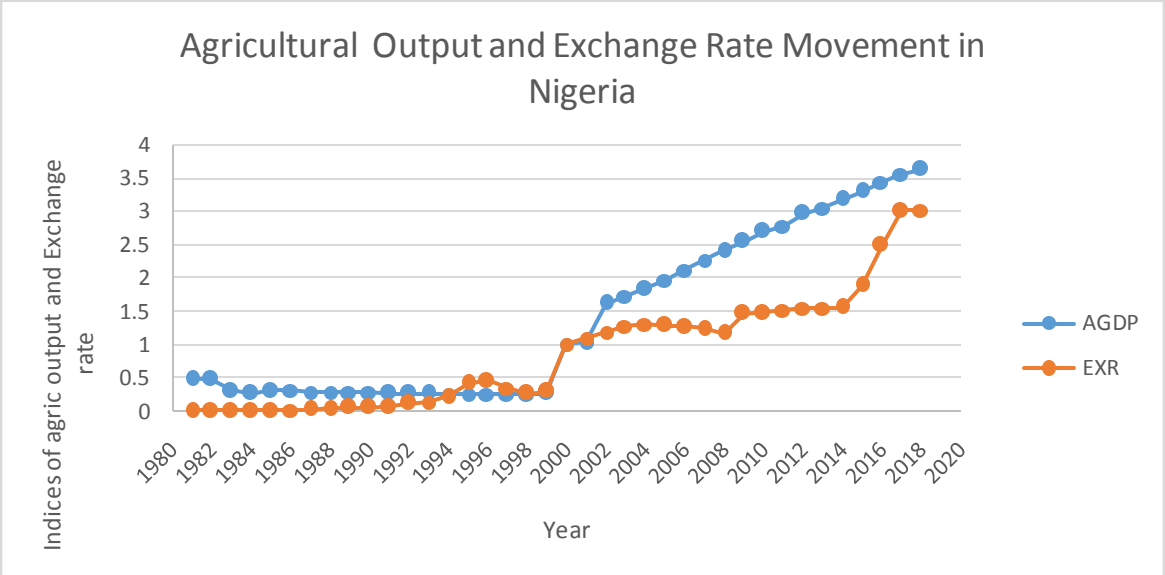
2.0. Background to the Study

Theoretically, exchange rate is the price one currency in terms of another. Nominally in the Nigerian context, it is the amount of Naira that will be given out in exchange for one unit of another country's currency. According to Obadan (2006), exchange rate is a key macroeconomic variables in the general macroeconomic equations of any country. Two concepts are normally distinguished in exchange rates discuss; the nominal exchange rates and the real exchange rates. While the former is a price, the latter is relative, as it reflects the floating nature of most exchange rate regimes in the world. According to Kipici and Kesriyeli (1997), the basic difference between the two, is that real exchange rates take into consideration inflation differentials among countries. In Nigeria, exchange rate has been a major factor in economic discuss due to its impact on many other economic variables like interest rates, prices, investment as well as employment. The country had undergone series of exchange rates regimes that oscillate between fixed and floating exchange rate. The way and manner in which the nominal exchange rates has affected the agricultural gross domestic production is presented in Table 2.1.below:

Periods	Agricultural GDP N'billion	Exchange rates N:$
1981-1985	2446.80	0.74
1986-1990	3168.75	5.14
1991-1995	3765.27	30.17
1996-2000	4491.82	89.85
2001-2005	7922.40	125.04
2006-2010	11641.11	134.44
2011-2018	15,646.65	210.63

Source: Central Bank of Nigeria Statistical Bulletin 2018

The naira 1981 and 1985 was found to be stronger than the US dollars. The reason for that was because of the inflow of foreign exchange from crude oil, which was discovered in commercial quantity then. With more money from the exportation of the crude oil as against less the country paid in terms of importation, the impact of that was appreciation of naira against dollars. By 1986, when the country like most African countries adopted the Structural Adjustment Programme, conditionalities that include liberalization of the country's trade as well devaluation of the country's currency, naira depreciated against dollars. Since then, till date, it has been a free fall of the currency against major currencies of the world. Between 2011 and 2018, the exchange rates between naira and dollars had fallen to as low as N306 to $1 dollar. While the exchange rate was on the low side, the agricultural gross domestic product was observed to be rising steadily from 1985 till date. Between 1981 and 1985, it was N2446.80billion, which rose to N3,168.75 billion between 1986 to 1990. The increase in the agricultural gross domestic product however is to other factors like increase participation of labour force in the sector, as well as increase in the use of more acreage than the influence of exchange rate. The collocation of both the exchange rate and agricultural output proxy by agricultural gross domestic product is presented in Figure 2.1.



3.0. Literature Review

The impact of exchange rate in a given economy has been the subject of many economic literature. It has been examined on many economic variables that have direct bearing on the overall economic growth and development. In Obayelu and Salau (2010), the study tries to examine the response of agriculture to changes in relative prices and exchange rates. The study estimated the response of aggregate agricultural output to exchange rate and price movements of food and export crops in Nigeria using available time series data that span about 37 years from the Central Bank of Nigeria (CBN) Annual Reports. This study through the Augmented Dickey Fuller (ADF) and unit root test found that the variables used in the model are integrated of the same order. Using maximum likelihood estimation results also shows that the entire variables cointegrated. The results of the Vector Error Correction Model (VECM) for the estimation of short run adjustment of the variables toward their long run relationship showed a linear deterministic trend in the data and that food and export prices as well as the real exchange rate jointly explained 57% of the variation in the Nigeria aggregate agricultural output in the short run and 87% variation in the long run. Total agricultural output responds positively to increases in exchange rate and negatively to increases in food prices both in the short and long run. The significance of food crop prices and exchange rate at 5% and 1% respectively both in the short and long run suggest that changes in these variables are passed immediately to agricultural output.

Oputu, Opue and Bankong (2012) examines and evaluates in comparative terms, the effect of exchange rate devaluation on selected agricultural export commodities as well as o

n the total agricultural export commodities in the Pre-SAP (1972-1985) and the SAP era (1986-2010) in Nigeria. Based on the data collected from Central Bank of Nigeria and

Federal Office of Statistics, the Ordinary Least Squares (OLS) technique was employed to analyze the effect of exchange rate devaluation on agricultural export commodities. The overall results confirmed that in most cases, the lagged values of exchange rate devaluation had a significant and positive relationship with agricultural export commodities but of a higher magnitude in the total agricultural export commodities than in the individual products, whereas the current values were not statistically significant at 5% level. The results also showed that exchange rate devaluation in the SAP and Pre-SAP eras had no significant effect on agricultural export commodities except in the case of natural rubber export. This was attributed to the low level of agricultural output in Nigeria.

Closely related to the studies above is Oyakhilomen, Abraham and Rekwot (2014) that examines the causal relationship between exchange rate deregulation and the agricultural share of gross domestic product in Nigeria from an econometric perspective using time series data spanning a period of 26 years (1986 – 2011). Data on exchange rate and gross domestic product were analysed using Augmented Dickey Fuller unit root test, unrestricted Vector auto regression, pair wise granger causality and vector error correction model. The results showed the existence of unidirectional causality from exchange rate to agricultural share of gross domestic production and also, exchange rate deregulation had negative influence on agricultural share of gross domestic production in Nigeria. This implies that market driven exchange rate policy has been having undesirable influence on the trend in agricultural share of gross domestic production in Nigeria.

Muftaudeen and Abdullahi (2014) empirically investigates the impact of macroeconomic policies on agricultural output, but specifically on crop production in Nigeria. The Multivariate Vector Error Correction approach has been applied to examine both short run and long run relationship between the series over the period of 1978-2011. The study finds a cointegrating relationship among agricultural output, government expenditure, agricultural credit, inflation, interest and exchange rates. The findings show that in the long run, agricultural output is responsive to changes in government spending, agricultural credit, inflation rate, interest rate and exchange rate. The results of impulse response functions suggest that one standard deviation innovation on government expenditure and interest rate reduces the agricultural output thus threatening food security in the short, medium and long term. While results of the variance decomposition indicate that, a significant variation in Nigeria's agricultural food output is due to changes in exchange rate and government expenditure movements. This implies the imperative of the role played by both fiscal and monetary policy in an effort to ensure food security. The study recommended that to achieve a sustainable food security, an expansionary fiscal policy that is not inflationary should be rigorously pursued along with a realistic exchange rate that takes account of the prevailing internal macroeconomic environment rather than the dynamics of international undertones.

Fluctuations in exchange rates in Nigeria was the focal point of Gatawa and Mahmud (2017).The paper analyses short and long-run impacts of exchange rate fluctuations on agricultural exports volume in Nigeria. The data are made up of secondary sources obtained from Central Bank of Nigeria Statistical Bulletin, National Bureau of Statistics and International Financial Statistics of the International Monetary Fund (IMF) websites spanning over 34 years (1981-2014). A combination of Autoregressive Distributed Lag (ARDL) and Generalised Auotregressive Conditional Heteroscedasticity (GARCH) were employed as methods of analysis. The short-run results revealed that official exchange rate and agricultural loans have significant positive impact on agricultural export volumes which has the effect of expanding the dependent variable while, relative prices of agricultural exports has significant negative impact on agricultural exports volume which also has the effect of contracting the dependent variable. The long-run results revealed similar findings with the exception of official exchange rate which has statistically significant negative impact on agricultural exports volume. i.e. contrary to normal expectations. The paper recommends the relevance of stabilizing exchange rate from the present downward trend and providing farm equipment and input on credit basis by the government and private sector institutions rather than loanable fund that can be redirected to other activities other than agriculture.

Oye, Lawal, Eneogu & IseOlorunkanmi (2018) concentrated more on the devaluation aspect of exchange rates rather than the overall movement of the rates. The purpose of the study was to examine the effect of exchange rate devaluation on agricultural output in Nigeria. The paper used the available time series data of 30 years (1986-2016) from the Central Bank of Nigeria (CBN) Statistical Bulletin and the National Bureau of Statistics. The real effective exchange rate was used as the proxy for currency devaluation and Consumer Price Index (CPI) was used as a proxy for inflation. Other variables were Agricultural Gross Domestic Product (AGDP), Price of Export (PEXP), and Real Agricultural Exports (RAEXP). The research through the Augmented Dickey Fuller (ADF) and Philip Perron's unit root tests find that the variables used in the model are integrated in the same order. Using the Johansen's cointegration test results show that the variables are cointegrated. The results of the Vector Error Correction Model (VECM) indicates that a percent increase in the Real Effective Exchange Rate (REER), a proxy for devaluation will lead to a decrease in gross agricultural output. This implies that total agricultural output responds negatively to exchange rate devaluation. The result of the causality test by Toda and Yamamoto reveals that a unidirectional causality exists between real effective exchange rate and price of exports. This shows that a significant relationship exists between exchange rate devaluation and gross exports earnings. It reveals that the past values of the price of exports can be used to predict the current values of agricultural output.

Adekunle and Ndukwe (2018) investigates the possible asymmetric effect of real exchange rate dynamics on agricultural output performance in Nigeria over the period of 1981 to 2016 by collecting data from secondary sources. The study employed a combination of

stationary and non-stationary variables as was found out through the ADF unit root test. Based on the Bounds test for cointegration, a long-run relationship was absent between real exchange rate and agricultural output, irrespective of specifications. Generally, the result of model estimation showed that the significant drivers of agricultural output are real exchange rate (log-levels), real appreciation and depreciation (after some lags), industrial capacity utilization rate, and government expenditure on agriculture (after some lags). ACGSF loan exerted positive and insignificant influence on agricultural output. The study concluded among others that fiscal and monetary authorities in Nigeria should work in unison at ensuring that the full potentials of the agricultural sector are harnessed for the growth and development of the country.

4.0. Theoretical Framework

How exchange rate movement translates into output is a function of the type of movement. Two types of exchange rate movement are discernible in economic literature. According to Choudhary and Chaudry (2007), under a fixed exchange rate system, official movement in the value of a country's currency relative to others are called devaluations and revaluations. Whereas under a flexible exchange rate system, market force-generated changes in the value of the country's currency are known as depreciations and appreciations. For ease of analysis, this study uses the two terms interchangeably.

According to the conventional textbook model, depreciation of the domestic currency makes the export relatively cheaper for foreigners and makes import relatively more expensive for domestic consumers. This helps increase the country's export and switches demand towards domestically produced goods and therefore shifts the aggregate demand curve to the right (Dornbusch, 1988). Schematically, transmission mechanism is presented thus:

Depreciation → Weaker Domestic Currency → Export Cheaper → Import Expensive

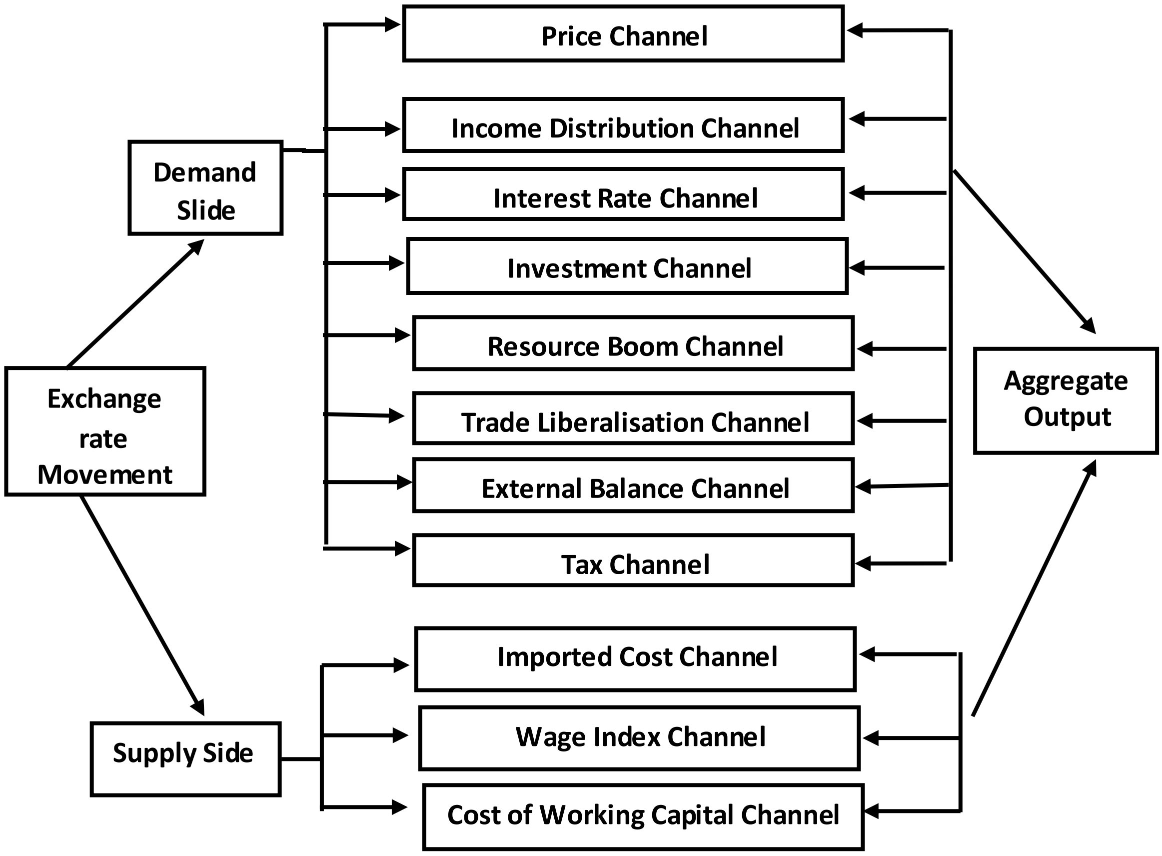
→ Export ⇧ Domestically produced goods ⇧

However this textbook model is not uniformly supported by prior theoretical research or actual historical experience. As a matter of fact, the theoretical views on the impact of exchange rate movements has not enjoyed consensus among economics scholar. The dominant view up to 1970 was that devaluation would improve trade balance, alleviate balance of payments difficulties and accordingly expand output and employment. The mechanism behind these positive effects is that devaluation switches demand from imports to domestically produced goods by increasing the relative prices of imports, and makes export industries more competitive in international markets by stimulating domestic production of tradable goods and inducing domestic industries to use more

domestic inputs. The economic policies directed towards affecting external balance and output by changing the composition of expenditures are called expenditure-switching policies. One of the most frequently used policy instruments for expenditure-switching policies has been exchange rate devaluation.

However, the consensus on this issue (i.e. the devaluation leads to output expansion) was broken at the end of the 1970s. An alternative line of approach has emerged since, which has raised the possibility that devaluation could be contractionary, especially in developing countries. This approach is sometimes referred to as structuralist because it usually tends to consider the economic problems of LDCs as "structural."Contrary to the traditional approach, this view argues that devaluation is highly likely to have a contractionary effect on output and employment, especially for LDCs. The channels through which devaluation might cause a reduction in national output can be divided into two categories: demand side channels and supply side channels. As these names suggest, channels in the first category are considered to be effective primarily on aggregate demand, while those included in the second category are effective rather on aggregate supply. The pictorial summary of the transmission of exchange rate to output is presented in Fig 3.1.

Fig 3.1: Stylized Representation of the Transmission Mechanism of Exchange Rate to Output



There are numerous models that are closely related to this study in the literature. They include Gylfason and Risager (1983), Bautista and Valdes (1993), Goldberg and Knetter (1997), Marchand (2012) and a host of other related studies. This study however adopted Gylfason and Risager (1983). The model starts by describing the production function of a typical economy as:

$$q = q(e,n)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

q in equation 1 is the gross domestic output, and it is defined as a function of labour and other domestic inputs (e) and foreign inputs (n). In terms of proportional rate of change, the production function exhibits decreasing or constant returns to scale as the sum of Θ_e and Θ_n (the shares of domestic and foreign inputs respectively in gross domestic output) is less than or equal to 1. Linearly, equation 1 is expressed as:

$$q = \theta_e \hat{e} + \theta_n \hat{e} \text{ where } \theta \equiv \theta_e + \theta_n \leq 1 \quad \ldots\ldots 2$$

The model assumes that the price of imported input, P^n , E = exchange rate and the price of domestic factor W are both exogenously determined and the elasticity of substitution between the two factors is given by

$$\sigma = \frac{(n - \hat{e})}{(E - W)} \quad \ldots\ldots 3$$

Given equations 2 and 3, it follows that:

$$n = (\frac{1}{\theta})q - (\frac{\theta_e \sigma}{n})(E - W) \quad \ldots\ldots 4$$

Equation 4 is the derived demand for the foreign factor as a function of output and relative factor prices. Given the output function above, the cost function expressed in domestic currency is given as:

$$C = eW + n(1+t)EP^n \quad \ldots\ldots 5$$

Where eW is total amount spent on domestic inputs, t is the rate of tariff, $n(1+t)EP^n$ is the total amount spent foreign input. Expressing equation 1 in terms of real GNP we have:

$$y = q - \left(\frac{E}{P}\right)n - \left(\frac{E}{P}\right)r * D^* \quad \ldots\ldots 6$$

Where the real GNP is defined as the difference between gross domestic output and the amount of real factor inputs and foreign interest payment. If equation 6 is corrected to proportional rates of change, it yields:

$$y = \left[\frac{(1+\mu)}{(1-\theta_n)}\right]q - \left[\frac{\theta_n(1+\mu)}{(1-\theta_n)}\right](E - P + n) - \mu(E - P) \quad \ldots\ldots 7$$

Where μ is the ratio of foreign interest payments to GNP. From equation 7, the price equation can be defined as:

$$P = \left(\frac{\theta_e}{\theta}\right)W + \left(\frac{\theta_e}{\theta}\right)E + \left(\frac{1-\theta_e}{\theta}\right)q \quad \ldots\ldots 8$$

Where the price equation is implied by the non-increasing returns to scale production technology assumed in equation 2. This is derived in the usual way by first deriving the input demand function $e = e(q, \frac{W}{P})$ and $n = n(q, \frac{E}{P})$ from the maximisation of equation 1

subject to equation 5. This is substituted into the production function in 1 and we then solve for P.

The resulting equation 8 corresponds to an upward sloping aggregate supply schedule under decreasing returns to scale; with constant returns to scale, the supply schedule becomes horizontal. Combining equation 4, 6 and 7 we have:

$$y = \left[\frac{\theta+\mu}{\sigma}\right]q + \left\{\frac{[\theta_n(1+\mu)\theta_e(1-\sigma)}{(1-\theta_n)\theta} + \frac{\mu\theta_e}{\theta}\right\}(E-W) \quad \text{.....9}$$

Equation 8 shows the effect of devaluation on real income. Specifically, it shows that devaluation can lower real income obtained from any given level of domestic input and factor prices if the elasticity of substitution between domestic and foreign input is less than or equal to 1 and if net interest payment to the rest of the world are positive ($\mu>0$).

By combining 7 and 8, we can write the supply equation as:

$$P = b_1 y + b_2 E + b_3 W \quad \text{where } b_1, b_2, b_3 \succ 0 \text{.....10}$$

and where

$$b_1 = \frac{(1-\theta)}{(\theta+\mu)}$$

$$b_2 = \frac{\left[\theta_n + (1+\theta)(\theta_e\sigma - \theta\Lambda)\right]}{\theta}$$

$$b_3 = \frac{\left[(\theta_e - (1-\theta)(\theta_e\sigma - \theta\Lambda)\right]}{\theta}$$

and

$$\Lambda = \frac{\theta_e\sigma}{\theta+\mu} - \frac{\left[(1-\theta)\theta_e(\theta_n+\mu)\right]}{\left[(\theta+\mu)(1-\theta_n)\theta\right]}$$

On the basis of this theoretical framework, the model specified for this study and derivable from equation 1 above is;

$$AGDP = f(EXR, AGLAB, ACRE, LR) \text{.....11}$$

Where

AGDP	=	Agricultural Gross Domestic Product
EXR	=	Nominal Exchange Rates
AGLAB	=	Agricultural Labour
ACRE	=	Acreage
LR	=	Lending Rate

The methodology adopted for this study is Structural Vector Autoregression (SVAR). This becomes pertinent because of the apparent usage of most econometric techniques in virtually all the literature reviewed which seemed not to take into consideration the importance of SVAR, as a VAR that factored in theory in its analysis.

A thorough scrutiny of the variables above indicates that the Cholesky ordering of the variables and taking into consideration economic theory shows that agricultural gross domestic product is highly likely to be first affected by the availability of land (ACRE), this follows by the availability of labour (AGLAB), next by lending rate (LR) and finally by exchange rate. Hence equation 11 is re-arranged as follows:

$$AGDP = f(ACRE, AGLAB, LR, EXR) \quad \text{.....12}$$

Following from equation 12 above, the Structural VAR equations of the above specified model will have $n(\frac{n+1}{2}) = 5(\frac{5+1}{2}) = 15$ on the model, and hence, 5^2-15=10 more restrictions are required to identify the structural matrix B.

$$\overline{Y} = \begin{bmatrix} b_{11}AGDP & +b_{12}ACRE & +b_{13}AGLAB & +b_{14}LR & +b_{15}EXR \\ b_{21}AGDP & +b_{22}ACRE & +b_{23}AGLAB & +b_{24}LR & +b_{25}EXR \\ b_{31}AGDP & +b_{32}ACRE & +b_{33}AGLAB & +b_{34}LR & +b_{35}EXR \\ b_{41}AGDP & +b_{42}ACRE & +b_{43}AGLAB & +b_{44}LR & +b_{45}EXR \\ b_{51}AGDP & +b_{52}ACRE & +b_{53}AGLAB & +b_{54}LR & +b_{55}EXR \end{bmatrix}$$

This matrix can be represented as follows

$$\begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \end{bmatrix} \begin{bmatrix} AGDP \\ ACRE \\ AGLAB \\ LR \\ EXR \end{bmatrix} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \end{bmatrix}$$

In order to extract the recursive restriction matrix, the following restrictions were made to retrieve the structural shocks.

1. In the agricultural production function, agricultural gross domestic product (AGDP) is affected by all the variables as specified in equation 12.
2. ACRE is affected by AGLAB and AGDP
3. AGLAB is affected by AGDP and ACRE.

4. Lending rate (LR) is affected by agricultural gross domestic product (AGDP) and exchange rate (EXR).
5. Nominal exchange rates (EXR) are affected by only lending rate. This means that AGDP, AGLAB and ACRE are not determinants of EXT.

Given the assumptions above, the following can be deduced. In the case of ACRE that is affected by AGLAB and AGDP, $b_{24}=b_{25}=0$. Similarly for agricultural labour (AGLAB), $b_{34}=b_{35}=0$. For lending rate that is affected by AGDP and EXR, $b_{42}=b_{43}=0$. While for exchange rate (EXR), $b_{51}=b_{52}=b_{53}=b_{54}=0$. The product recursive matrix as a result of the restrictions is presented thus:

$$B_0 = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 \\ 0 & b_{42} & b_{43} & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix}$$

When the above recursive matrix is expressed in linear form, we have:

AGDP = @e1 = C(1)*@u1
ACRE = @e2 = C(2)*@e1 + C(3)*@u2
AGLAB = @e3 = C(4)*@e1 + C(5)*@e2 + C(6)*@u3
LR = @e4 = C(7)*@e1 + C(8)*@e2 + C(9)*@e3 + C(10)*@u4
EXR = @e5 = C(11)*@e1 + C(12)*@e2 + C(13)*@e3 + C(14)*@e4 + C(15)*@u5

5.0. Presentation and Discussion of Results

Table 5.1. presents the statistical properties of the series used for the models. The table provides information about the mean, the median, standard deviation, the maximum value, the minimum value, the skewness as well as the Jarque-Bera of each variable. The table shows the logarithm of the observed value of each variable. The mean values of the logarithm of agricultural gross domestic product (AGDP), acreage (ACRE), agricultural labour (AGLAB), exchange rate (EXR) and lending rate (LR). AGDP and AGLAB have the largest means among all the variables. With 4.82 and 4.89 respectively, the implication of the large means is that they are both variables with bogus data from the direct observation. Exchange rate with the mean of 1.03 is the variable with lowest observable data. A close at the data of mean and median shows that the values of the two statistics are approximately equal to one another. The implication of which is the existence of normal

distribution in the data set. This feature is one of the common assumptions underlying many statistical tests.

Table 5.1: Summary Statistics of the Series.

	ACRE	AGDP	AGLAB	EXR	LR
Mean	3.79	4.82	4.89	1.03	1.48
Median	3.68	4.84	4.90	1.02	1.99
Maximum	4.24	4.87	5.00	1.38	2.49
Minimum	3.36	4.67	4.77	0.67	-0.21
Std. Dev.	0.30	0.05	0.07	0.18	0.85
Skewness	0.18	-1.51	-0.17	0.09	-0.76
Kurtosis	1.49	4.29	1.80	2.47	2.27
Jarque-Bera	15.17	68.57	9.95	1.97	18.12
Probability	0.00	0.00	0.01	0.37	0.00
Sum	575.52	732.40	743.40	157.08	225.68
Sum Sq. Dev.	13.50	0.43	0.73	4.66	109.05
Observations	152	152	152	152	152

Source: Author's Computation from E-Views 9

The summary statistics Table 5.1. also provides information on other explanatory variables such as the logs of acreage (ACRE), exchange rates (EXR) and lending rate (LR). Further statistical tests that affirmed the symmetric nature or otherwise of the data set were the skewness, the standard deviation and the Kurtosis. The skewness for a normal distribution is between zero and one. Of the 5 variables in Table 5.1., the skewness of all of them with the exception of AGDP is between zero and one. This was a further confirmation of the normality of the data set.

5.2. Correlation

Table 5.2 displays correlations between logarithm of agricultural gross domestic products (AGDP) and its components. The significance of the correlations is show first hand, the degree and the direction of relationships among the variables. This was done to avoid inconsistency in the regression analysis by establishing the substitutability of the variables. As a result, they provide a useful guide in the specification of the models. The simple correlations suggest that there was a positive correlation between logarithm of AGDP and the logarithms of the components of AGDP. In most of the cases, the correlation appears to be strong, as the coefficients of the correlations in most cases are more than 60%.

Table 5.2. Correlations

	ACRE	AGDP	AGLAB	EXR	LR
ACRE	1	0.76	0.97	-0.39	0.90
AGDP	0.76	1	0.85	0.01	0.93
AGLAB	0.97	0.85	1	-0.33	0.96
EXR	-0.39	0.01	-0.33	1	-0.14
LR	0.90	0.93	0.96	-0.14	1

Source: Author's computation from E-Views 9.

5.3. Stationarity Property of the Series

The data employed for this analysis is time series data. They were obtained from the records of the Central Bank of Nigeria (CBN) and Food and Agricultural Organisation (FAO). Being time series data, they are always prone to serial or auto-correlation problem. This problem if not taken care always produce what Yule (1926) called spurious or non-sense results. To avoid the serial correlation problem, the study tested for stationarity or otherwise of the variables included in the model. Testing for the stationarity or otherwise of a series involves testing for the unit root. This was done by employing the Augmented Dickey Fuller approach.

Table 5.3. Augmented Dickey Fuller Unit Root Test

Critical Statistics: 1% =-4.0200, 5% = -3.4339, 10% = -3.1443

Variables	Level	1st Difference	2nd Difference	Order of Integration
AGDP	-2.0061	-13.4347*		I(1)
ACRE	-2.3030	-13.3153*		I(1)
AGLAB	-0.9555	-6.8442*		I(1)
LR	-1.4187	-13.1446*		I(1)
EXR	-2.9510	-12.1549*		I(1)

Source: Author's Computation *Significant @1%, ** Significant@5%, ***Significant@10%

Table 5.3. is the result of the unit root test conducted on all the variables included in the model. The Augmented Dickey Fuller (trend and intercept) approach was adopted. From the results, none of the variables have unit root. This implies that all variables that make up the model were non stationary. They were however made stationary after first differencing. Since the stationary properties of the series had been determined, we proceeded to estimate the Vector Autoregression by first examining the lag length needed for the estimation. The results which are presented in Table 5.4.

Table 5.4: Lag Length Selection Criteria

VAR Lag Order Selection Criteria						
Endogenous variables: AGDP ACRE AGLAB LR EXR						
Exogenous variables: C						
Sample: 1981Q1 2018Q4						
Included observations: 148						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	896.5729	NA	4.03e-12	-12.04828	-11.94703	-12.00714
1	1985.740	2090.023	2.29e-18*	-26.42892*	-25.82137*	-26.18207*
2	1992.135	11.83895	2.95e-18	-26.17749	-25.06366	-25.72495
3	2002.699	18.84542	3.59e-18	-25.98242	-24.36231	-25.32417
4	2025.457	39.05642*	3.72e-18	-25.95212	-23.82572	-25.08817
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Source: Author's Computation

The initial lag length selected for the VAR estimates was 4. A further probe using lag length selection criteria produced the above result. This shows that of the five selection criteria of LR, FPE, AIC, SC and HQ, all the criteria with the exception of LR test suggest a lag length of 2. On the basis of that a Structural Vector Autoregression was estimated and the result presented as follows:

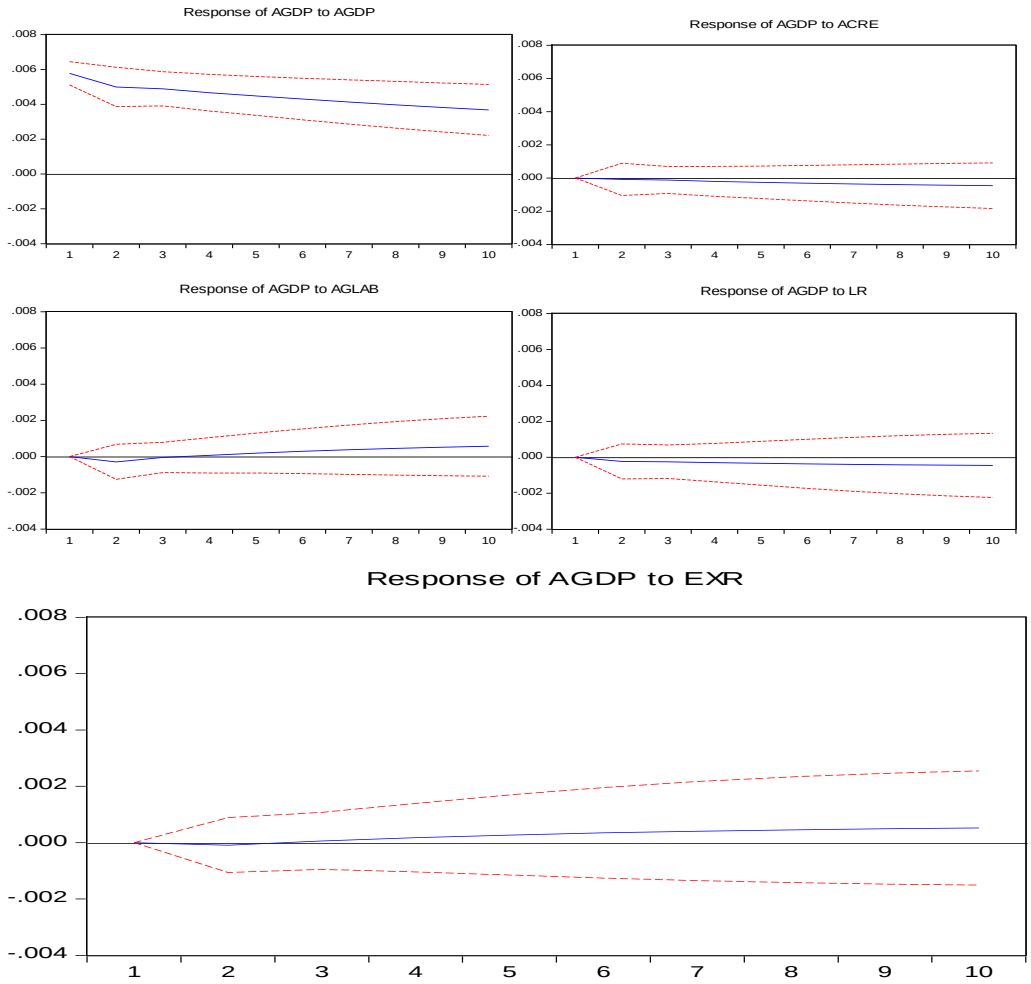
Table 5.5: SVAR Estimates of Agricultural Gross Domestic Product

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.005777	0.000334	17.32051	0.0000
C(2)	- 1.063189	0.256551	-4.144157	0.0000
C(3)	0.018151	0.001048	17.32051	0.0000
C(4)	-0.160217	0.050362	-3.181270	0.0015
C(5)	0.039594	0.015183	2.607822	0.0091
C(6)	0.003375	0.000195	17.32051	0.0000
C(7)	2.645731	0.987584	2.678995	0.0074
C(8)	0.108961	0.294623	0.369834	0.7115
C(9)	4.185600	1.549686	2.700934	0.0069
C(10)	0.064059	0.003698	17.32051	0.0000
C(11)	-1.337107	0.978461	-1.366542	0.1718
C(12)	0.707073	0.285289	2.478446	0.0132
C(13)	-3.485729	1.535946	-2.269434	0.0232
C(14)	0.312669	0.079027	3.956490	0.0001
C(15)	0.062001	0.003580	17.32051	0.0000

Source: Author's computation

Table 5.5 displays the estimates of SVAR model for the agricultural gross domestic product equation. It is the results of the model specified and estimated with the sole intention of examining the impact of exchange rate on agricultural output in Nigeria. Fifteen coefficients give an insightful depiction of the kind of cross relationships that exist among the variables that make up the model. Of major importance to this analysis are the coefficients of C(2), C(3), C(4) and C(5). These are the coefficients of acreage (ACRE), agricultural labour (AGLAB), lending rate (LR) and exchange rate (EXR). Two of the independent variables (AGLAB) and (EXR) were found to be positive related to agricultural output proxy by agricultural gross domestic product, while the other two (ACRE) and (LR) were negatively related. All the variables were found to be statistically significant at 5%. The major implication of this is that the higher the nominal exchange rate, the higher the output of the agricultural sector. The layman implication of this is that the more the nation's currency depreciates against the US dollars, there is incentives for farmers to produce more especially export commodities to take advantage of more naira coming to their pockets after exchange rate conversion to naira. The impulse response of the SVAR is presented in Figure 5.1.

Figure 5.1.



The first figure of Figure 5.1 shows the response of AGDP to its own shock. A one standard deviation shock to AGDP led to a fall in AGDP from period one to period ten, albeit positive movement.. The second figure shows the response of AGDP to the shock from acreage (ACRE). With an impulse from ACRE, AGDP was unresponsive between period one to period three, before a marginal negative response was observed from period four to period ten. The trend was similar to that between AGDP and lending rate (LR). In the case of the major variable of exchange rate, AGDP was unresponsive between period one to four, before a marginal positive response was observed between period five to ten.

Table 5.6: Variance Decomposition of AGDP

Variance Decomposition of AGDP:						
Period	S.E.	AGDP	ACRE	AGLAB	LR	EXR
1	0.01	100.00	0.00	0.00	0.00	0.00
2	0.01	99.74	0.01	0.14	0.09	0.01
3	0.01	99.72	0.02	0.11	0.14	0.01
4	0.01	99.62	0.06	0.09	0.20	0.04
5	0.01	99.45	0.10	0.10	0.25	0.09
6	0.01	99.22	0.15	0.15	0.31	0.16
7	0.01	98.94	0.22	0.22	0.37	0.25
8	0.01	98.62	0.28	0.32	0.44	0.34
9	0.01	98.27	0.36	0.43	0.50	0.43
10	0.01	97.91	0.43	0.56	0.56	0.53

Source: Author's Computation

Table 5.6 shows the results of variance decomposition of the first ten periods' horizon into the future. The results show that in the first period, variations in AGDP were wholly explained by own shocks. This implies that variations in AGDP were hardly affected by other variables in the first period. The results also show that beside own contribution, variations in AGDP can only be attributed marginally to variations to acreage, agricultural labour, lending rate and exchange rates. Lending rates were the most significant variable that affected variations in AGDP followed by exchange rates. They accounted for 0.2% and 0.04% in period 4 and by period 10, it rose to 0.56% and 0.53% respectively.

6.0 Summary, Conclusion and Recommendation

Agricultural sector has elucidated at the very beginning of the study is considered one of the many ways through which a nation's economy could grow. As much as it associated with production of food for the teeming masses, provision of employment for the largest percentage of the nation's population, provision of raw material for many agro-allied industries, a major avenue for foreign exchange earnings to the nation as well as being a major components of the nation's gross domestic product, the importance of the sector cannot be over-emphasised. A major talk on agricultural sector therefore means a strong emphasis on the agricultural output, by extension agricultural supply. Of many policies that successive government put in place in boosting agricultural sector, the exchange rate policy has been seen as very pivotal to agricultural supply. This is because of the impact of the policy on the prices of both agricultural inputs and outputs, two major

determinants of agricultural supply. It was on the basis of this background that the study tried to examine the impact of exchange rate on agricultural output in Nigeria. The study concludes among other things that exchange rate is positively and significantly related to agricultural output. Same goes with agricultural labour. While acreage and lending rate were found to be negatively related to it.

The study therefore recommend a general macroeconomic policy that will envelope a stable exchange rate policy, that will act as impetus for proper planning by farmers and guards against the dire consequence of exchange rates fluctuation. The said policy should make lending rates to be investment friendly, as high lending rate that negatively affect agricultural output will also negatively affect all other potential investments in the country.

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