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Exchange Rate Dynamics and Agricultural Sector Performance Nexus: The Nigerian Experience

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ABSTRACT

The main objective of the study is to investigate the impact of exchange rate dynamics on agricultural sector performance in Nigeria. The study employed time series data obtained from the Central Bank of Nigeria statistical bulletin, World Development Indicators and National Bureau of Statistics. Agricultural sector performance was disaggregated into the overall agricultural, crop, livestock and fishery output. Autoregressive Distributive Lag (ARDL) and Generalized Autoregressive Conditional heteroskedasticity (GARCH) estimation techniques were used to establish the long run relationship among the variables, and the responsiveness of overall agricultural output, crop, livestock and fishery production to changes in exchange rate. It was revealed that long run relationship exists among the variables in all the estimated models. The result of the Error Correction Mechanism (ECM) within the framework of the ARDL shows that exchange rate has significant impact on agricultural sector performance. The GARCH results revealed that the responsiveness of aggregate agricultural output, crop, livestock and fishery production to changes in exchange rate is negative and statistically significant. This study concludes that the government must consciously direct policy actions towards the agricultural sector to achieve its full potentials in order to place the Nigerian economy on the path of self-sufficiency in agricultural production. The study recommends that; the government should implement appropriate exchange rate policy that will ensure sufficient crop production for both domestic consumption and exports. The movement in the market determined exchange rate should be strictly monitored by the apex bank, in order to ensure that the deregulation in exchange rate is not counterproductive through distortionary prices on agricultural production. The Nigerian government should revisit sustainable policies that will persuade deposit money banks and agricultural development banks to increase their lending to the livestock and fishery subsectors.

Key Words: *Exchange rate dynamics, Agricultural sector performance, ARDL, GARCH, Nigeria.*

INTRODUCTION

The surest way of achieving national development is through the real sector, especially for a nascent economy (Feldman, Hadjimichael, Lanahan & Kemeny, 2015), and for an economy to be on steady growth path, its trade ties with other industry-oriented countries of the world should be intensified (Van, 2015). Hence, Lily, Kogid, Mulok, Sang and Asid (2014) stressed that the link between strengthening exchange rate and the real sector is the surest route to accelerated economic growth and development. To them, movements in exchange rate either build or reduce the confidence of foreign investors to invest in the real sector of the economy especially agriculture. The aforementioned studies show that the effect of exchange rate movements on the real sector of an economy has continued to occupy the central issue in economic development agenda. The development of agriculture has been seen as very imperative in achieving accelerated high level of growth and development. In Nigeria, prior to independence, agriculture was the dominant economic activity, employing over 60 per cent of the population and providing about 70 per cent of total government revenue. It constituted almost 80 per cent of Nigeria's total exports (Olajide, Akinlabi & Tijani, 2012; Udah & Odey, 2016). It is important to note that the rearing of animals provides agro-allied products for industrial growth and development (Ijaiya & Abdulaheem, 2000; Wasiu, Kehinde & Taiwo, 2021; Ada, Akan, Angioha & Enamhe, 2021). This impressive role has since diminished following the discovery and subsequent exploitation of oil in commercial quantities, especially beginning from 1970. The diminished role of agriculture has been blamed on several factors including movements in exchange rate. Ethan, Carmen and Kenneth (2017) have further made an argument for flexible exchange rate. According to the authors, when the exchange rate is allowed to fluctuate in line with market conditions, there could be a decrease in agricultural exports volume leading to increased earnings (Ingwe, Ada & Adalikwu, 2013).

Today, less than 50 percent of the country's cultivable agricultural land is being cultivated with smallholder and traditional farmers who use crude agricultural tools in cultivating most of this land (Olajide *et al*., 2012). The sector is bedeviled by problems such as organizational and weak policy, limited access to improved technologies in the form of improved seeds and the use of mainly crude farm tools such as hoes and cutlasses. Also, there are infrastructural inadequacies as the sector suffers from poor road network, lack of storage/processing facilities as well as inadequate irrigation facilities and underfunding leading to the problem of high food importation.

Despite the various exchange rate policies and agricultural development program adopted over the years, the agricultural sector seemed not to have performed impressively. Over the years, the share of agriculture in aggregate gross domestic product has remained relatively low. For instance, the share of agriculture in aggregate output declined sharply in the early parts of the 1970s, falling sharply from 48.79 per cent in 1970 to 27.35 per cent in 1975, reaching its lowest

level of 20.17 per cent in 1980, before rising gradually to 39.21 per cent in 1985 (CBN, 2011). The share of agriculture in total gross domestic product declined from 26.03 per cent in 1987 to 27.27 per cent in 1992 but fluctuated between 26.57 per cent and 39.05 per cent from 1993 to 2001 but rose to the height of 48.57 per cent in 2002. The share of agriculture in total gross domestic product again declined from 48.57 per cent in 2002 to 32.0 per cent in 2006 before rising slowly to 37.05 per cent in 2009 and declined to 20.24 per cent in 2014. By 2016, agricultural share of gross domestic product increased to 21.21 percent (CBN, 2016). By 2017, the share of agriculture in total gross domestic product also increased to 28.22 percent (CBN 2017). By 2018, the share of agriculture in total gross domestic product decreased to 26.22 percent (CBN, 2022). By 2019, the share of agriculture increased to 28.25 percent. The low contribution of agricultural sector in the total economic activity arising from instability in exchange rate movements means that there is little income for farmers. This little income to farmers has brought about low per capita income, unemployment and rising level of poverty. This is one of the reasons why Nigeria is still having high levels of unemployment and poverty in the world (Oriavwote & Oyovwi, 2014; Ingwe, Ada & Angiating, 2014). For an improvement in the performances of agriculture, the central challenges are to stimulate agricultural transition from a traditional subsistence-oriented low productivity sector to a modern business activity that is productive, profitable, competitive (Oti, Odigbo & Odey, 2016). Hence, the main objective of this study is to investigate the responsiveness of agricultural output to changes in exchange rate in Nigeria.

REVIEW OF RELATED LITERATURE

Conceptual issues

The exchange rate changes very often, it moves from minute to minute, hour to hour and day to day under floating exchange rate. When there are large swings in the exchange rate over a period of time, the exchange rate is considered volatile. Thus, exchange rate movement is a measure of the degree or frequency by which the price of foreign exchange changes over time. The larger the magnitude of the price change, the more volatile the exchange rate is. If the price increases or falls with very wide margins over a period, it shows that the exchange rate movement is unstable (CBN, 2019). When there is deviation of this rate over a period of time from the benchmark or equilibrium, exchange rate is said to move from the equilibrium (Azeez *et al*., 2012). Exchange rate movement is a situation where the price of a currency relative to another move from one point to another (Shehu & Youtang, 2012). The monetary authorities may however, determine the exchange rate decree or executive flats based on their perceptions of macro-economic condition in the country. In practice, no exchange rate is clean or pure float, that is, a situation where it is left completely to be determined by market forces but rather the prevailing system is the managed float whereby monetary authorities intervene periodically in the foreign exchange market in order to attain some strategic objectives (Mordi, 2006; Oti, Effiong & Odey, 2017).

Theoretical Underpinning

This study is anchored on the elasticity approach to balance of payments. The elasticity approach to balance of payments was developed independently by two economists namely, Marshall (1923) and Lerner (1944), to explain the outcome of policy actions on balance of payments. In specific terms, the theory prescribes the condition under which the devaluation of currency may result to an improvement in the trade balance of a country, particularly countries experiencing balance of payments disequilibrium (Caporale, Gil-Alana & Mudida, 2012). According to Marshall-Lerner condition, devaluation of currency can lead to the balance of payments improvement whenever the sum of price elasticities of supply for exports and demand of imports in absolute terms is greater than one (Jhingan, 2005). This implies that as soon as this condition is achieved in any country, exchange rate devaluation may be beneficial to the devaluating country in terms of significant improvement in the trade balance (Ajakaiye, 1985, Nyong, 2005). From the theoretical exposition, devaluation of currency will cause import prices to rise, thereby making imports to fall and exports to increase. At the same time, exchange rate devaluation stimulates domestic production for exports because of the increase in profitability of exports in domestic monetary terms. Thus, with the fall in imports and an increase in exports, the balance of trade is likely to improve (Nyong, 2005). However, the benefits of devaluation may not be instantaneous due largely to policy lag. Thus, there is agreement among economists that both demand and supply elasticities will be greater in the long run period of time than in the short run time frame. This is so because it will take some period of time for both producers and consumers to adjust fully to the policy actions of the government (Jhingan, 2005). This makes Marshall-Lerner condition to be satisfied in the long period of time than in the short period of time. In this way, devaluation of currency seems to have a worsening effect on the balance of trade position in the short run but improves the trade balance position in the long run. This scenario gives rise to a situation described as the J-curve effect of devaluation (Jhingan, 2005). The elasticity theory to the determination of balance of payments predicts that exchange rate exerts a short run negative influence on balance of trade and a positive influence in the long run.

Empirical Studies

Anigbogu *et al.* (2014) analyzed the real exchange rate movement misalignment and its volatility on agricultural Sector in Nigeria from 1960 to 2010. The study adopts a single regression model and employ the ordinary least squares techniques because of the poor coefficients got from the VECM model. The result of the study suggested that RER misalignment and RER volatility impact negatively on agricultural production value. Odior (2014) investigated the consequences of macroeconomic policy indicators on agricultural performance in Nigeria using annual data from 1970–2012. A one-step dynamic forecast model was employed to analyze the nature of this impact. To check for the unit root, the study uses the individual root of Pesaran and Shin unit root test. The result revealed that real monetary aggregate, technological change introduced overtime and pass level of agricultural sector performance play a crucial role in affecting the agricultural output performance in Nigeria. Oyinbo, Ibrahim and Rekeot (2014) using time series approach, evaluated the relationship between deregulation of exchange rate and the agricultural share of gross domestic product in Nigeria. The study employed the Augmented Dickey-Fuller (ADF) test of unit root,

unrestricted vector auto regression and pair wise granger causality. The result shows the existence of causality between exchange rate and agricultural share of gross domestic production in Nigeria. This means that exchange rate policy has been significant in influencing agricultural share of gross domestic production in Nigeria.

Mousavi and Leelavathi (2013) evaluated the causal relationships among quantity of agricultural export and real exchange rate in India by using time series data from 1980 to 2010. This study conducted unit root test and found that all the macroeconomic variables used are stationary after the first difference but co-integration analysis show that there is no existence of co-integration among variables. The study also carried out Granger-causality test in order to assess whether there is any potential predictability power of one indicator for the other. The result of the study reveals that there is no significant relationship between quantity of agricultural export and real exchange rate. That is to say, the variables do not granger cause each other in either direction. Essien and Dominic (2011) investigated the effects of price and exchange rate fluctuations on Agricultural exports (cocoa) in Nigeria. The ordinary least squares regression was used to estimate export supply function for cocoa. From the result it was observed that exchange rate movement and agricultural credits affect cocoa exports positively. The result also shows that relative prices of cocoa are not significantly related to quantity of export, however, it has a negative sign which is in line with the a priori expectation. Abiodun and Salau (2010) analyzed the response of aggregate agricultural output to exchange rate and price movements of food and export crops in Nigeria using available time series data. Augmented Dickey Fuller (ADF) was used to test for unit root, Co integration and Vector Error Correction Model (VECM) was employed. From the result, it was observed that the entire variables used in the model are integrated of the same order. 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, export prices and real exchange rate jointly explained 57 percent of the variation in the Nigeria aggregate agricultural output in the short run and 87 percent variation in the long run. It was also noted that with respect to short run and long run, Total agricultural output responds positively to increases in exchange rate and negatively to increases in food prices respectively. The significance of food crop prices and exchange rate at 5 percent and 1percent respectively both in the short and long run suggest that changes in these variables will has direct effect on agricultural output.

Awolaja and Okedina (2020) examined the effects of real exchange rate increases (appreciation) and decreases (depreciation) on aggregate and sectoral agricultural output in Nigeria, using the nonlinear auto-regressive distributed lag cointegration framework. The findings indicate the existence of cointegration between real exchange rate and aggregate and sectoral agricultural output. In the long-run, real exchange rate appreciation has significant positive effect on aggregate and sectoral agricultural output, while the effect of real exchange rate depreciation is negative and significant. The long run estimates also indicate that the effects on agricultural output of real exchange rate increases are greater than that of real exchange rate decreases. Findings from this empirical analysis indicate the need for an appropriate exchange rate policy to promote agricultural sector development. Ogunjimi (2020) examined the symmetric and asymmetric effects

of exchange rate dynamics on the performance of the agricultural, industrial and services sector of Nigeria using the ARDL and NARDL frameworks over the period of 1981-2016. The results of the short-run linear ARDL model reveal that exchange rate dynamics stimulates the performance of the agricultural and services sector of Nigeria while those of the nonlinear ARDL depict that exchange rate dynamics (depreciation and appreciation) is positively related to agricultural and services sector output but inversely related to industrial output. The result also showed that exchange rate dynamics has no asymmetric impact on sectoral performance which implies that positive and negative exchange rate movement have the same impacts on sectoral output both in the short-run and long-run. Wasiu Kehinde, Taiwo and Odugbemi (2021) investigated the possible asymmetric effect of real exchange rate dynamics on agricultural performance in Nigeria over the period of 1981 to 2016, due to limited data constraints. The Nonlinear Autoregressive Distributed Lag method was adopted. Based on the bound test for cointegration, a long-run relationship was absent between real exchange rate and agricultural output, having controlled for some other variables. Findings showed that the significant fundamentals were real exchange rate (log-levels), real appreciation and depreciation (after some lags), industrial capacity utilization rate, and government expenditure on agriculture (after some lags) in the short-run. ACGSF loan exerted positive but insignificant influence on agricultural output. In addition, though the effect of real appreciation was larger than that of real depreciation, the study could not find any evidence in support of the asymmetric effect of real exchange rate dynamics on agricultural performance in the Nigerian economy within the period of this study.

The review of empirical studies as presented above shows that studies have existed in Nigeria that investigated the effect of exchange rate on agricultural performance. However, a cursory examination of these studies shows that, none of these studies has made an attempt to examine the impact of exchange rate dynamics on the aggregate agricultural sector performance over the period of 1981 to 2022 incorporating the post-COVID 19 era.

METHODOLOGY

Resign Design

The study examines the effect of exchange dynamics on agricultural performance in Nigeria. To achieve this, the study adopted the ex post facto research design. In particular, the study adopts both the descriptive and analytical methodologies in analyzing the estimation of the relevant relationships. The analytical method that was used in the study is the ARDL and GARCH estimation techniques. The descriptive analysis was done using the mean, median, minimum, maximum and standard deviation.

Model Specification

In order to examine the response of aggregate agricultural output to changes in exchange rate in Nigeria, the study specifies the mathematical form of the model as follows:

$$AGDP = f(EXR, BLA, ALF, TRFAL, CPI) \quad 3.1$$

The functional form of the model is:

$$lnAGDP_t = \beta_0 + \beta_1 lnEXR_t + \beta_2 lnBLA_t + \beta_3 lnALF_t + \beta_4 lnTRFAL_t + \beta_5 CPI_t + \mu_t \quad 3.2$$

Where; $\beta_0$to β_5 are the long run parameters to be estimated; μ_t is the error term; CRP = crop production; EXR = exchange rate; TRFAL = Total rainfall; BLA = deposit money bank loan to agricultural sector; ALF = agricultural labor force; CPI = consumer price index.

The reduced or parsimonious form of Equation 3.2 is stated as follows:

$$Z_t' = \beta + \sum_{i=1}^{n} \Pi_i Z_{t-i}' + \mu_t' \quad 3.3$$

Where $Z_t' = (Z_{1t,}\ Z_{2t}, \dots, Z_{kt})$, $\mu_t' = (\mu_{1t}, \mu_{2t}, \dots, \mu_{3t})$, $\Pi_i = \begin{bmatrix} \beta_{11.i} & \beta_{12.i} \dots & \beta_{1k.i} \\ \beta_{21.i} & \beta_{22.i} \dots & \beta_{2k.i} \\ \vdots & \vdots & \vdots \\ \beta_{k1.i} & \beta_{k2.i} & \beta_{kk.} \end{bmatrix}$

Where$Z_{1t,}$ represents the vector of the dependent variable, Z_{t-i}'represents vector of the independent variables, β represents vector of constant,Π_i represents vector of the parameter, μ_t' represents vector of shocks and in this case, agricultural output (AGDP), exchange rate (EXR), commercial bank loan to agriculture (BLA), agricultural labor force (ALF), total rainfall (TRFAL), consumer price index (CPI).

The short run dynamics (in- distributed lag form) of equation 3.2 can specified as

$$\Delta lnAGDP_t = \beta_0 + \beta_{1i} \sum_{i=1}^{p} \Delta lnAGDP_{t-i} + \beta_{2i} \sum_{i=0}^{q} \Delta lnEXR_{t-i} + \beta_{3i} \sum_{i=0}^{q} \Delta lnBLA_{t-i} + \beta_{4i} \sum_{i=0}^{q} \Delta lnALF_{t-i} + \beta_{5i} \sum_{i=0}^{q} \Delta lnTRFAL_{t-i} + \beta_{6i} \sum_{i=0}^{q} \Delta CPI_{t-i} + \varphi ECM_{t-1} + \mu_t \dots \dots \dots \dots \dots \quad 3.4$$

$\beta_0 \dots \beta_6$ Represents the short run dynamics for the parameters to be estimated and φ is the coefficient of the error correction term.

RESULTS AND DISCUSSION OF FINDINGS

Descriptive statistics and matrix of correlations

The descriptive statistics of the variables is reported in table 4.1a. According to the table, Nigeria witnessed low level of agricultural output (AGDP) within the period of this study. This is evidenced by the statistics of the mean, median and maximum for AGDP of N9346.35billion, N3133.47billion and N43564.77billion, respectively. The response of exchange rate to agricultural performance has been volatile. This is shown by the mean, median and maximum values of exchange rate of 154.22, 100.69 and 536.95 percent, respectively.

The skewness result depicts that all the variables are positively skewed meaning the variables are all long right tail. Kurtosis results show that agricultural output (AGDP), consumer

price index (CPI), exchange rate (EXR) and bank loan to agriculture (BLA) are all leptokurtic in their distribution since they are greater than three (3). The kurtosis estimates for total rainfall (TRFAL) and agricultural labour force (ALF) are less than 3 and hence are platykurtic in nature. The Jarque-Bera test shows that all the variables are normally distributed within the period of analysis, except total rainfall and agricultural labour force. The value of the standard deviation depicts the variation of the variables from their true values over the period under review. Agricultural output deviated by N12299.40billion. Others are consumer price index, exchange rate, bank loan to agriculture, total rainfall and agriculture labour force with deviations of 16.47 and 123.58 percent; N247.15billion, 152.43 millimeters and 14,555,059 persons, respectively.

The correlation matrix represented in table 4.1b shows that a number of the pairwise correlations are high. Given the result, variables that are highly correlated are not included on the same side of an equation to circumvent the issue of multi-collinearity that may affect the reliability of the results

TABLE 4.1A

Descriptive Statistics

	AGDP	***CPI***	***EXR***	***BLA***	***TRFAL***	***ALF***
Mean	*9346.357*	*18.86714*	*154.2231*	*178.2805*	*1686.318*	*44865716*
Median	*3133.470*	*12.71500*	*100.6950*	*48.97500*	*1660.875*	*43578960*
Maximum	*43564.77*	*72.84000*	*536.9500*	*834.1200*	*1995.870*	*82345621*
Minimum	*17.05000*	*5.390000*	*49.75000*	*0.590000*	*1291.380*	*23666612*
Std. Dev.	*12299.40*	*16.47192*	*123.5803*	*247.1567*	*152.4316*	*14555059*
Skewness	*1.375809*	*1.885515*	*1.747674*	*1.319007*	*0.158714*	*0.454351*
Kurtosis	*3.912823*	*5.452960*	*4.994528*	*3.346853*	*2.975343*	*2.501942*
Jarque-Bera	*14.70813*	*35.41595*	*28.34230*	*12.38899*	*0.177396*	*1.879154*
Probability	*0.000640*	*0.000000*	*0.000001*	*0.002041*	*0.915122*	*0.390793*
Observations	*42*	*42*	*42*	*42*	*42*	*42*

Source: Researcher's computation (2023), using E-Views 9.

TABLE 4.1A

Correlation Matrix

	AGDP	***CPI***	***EXCH***	***BLA***	***TRFAL***	***ALF***
AGDP	*1*					
CPI	*-0.265789*	*1*				
EXR	*-0.044038*	*-0.119137*	*1*			
BLA	*0.781883*	*-0.245489*	*-0.029539*	*1*		
TRFAL	*-0.148882*	*0.095492*	*-0.197629*	*-0.193934*	*1*	
ALF	*0.728451*	*-0.294105*	*-0.244718*	*0.798000*	*-0.078651*	*1*

Source: Researcher's computation (2023), using E-Views 9.

Lag length selection

The efficiency and validity of an error correction model depends on the lag structure. The study used VAR lag order selection criteria to determine the lag lengths. The study employed the Akaike Information Criterion (AIC) and Schwarz Criterion (SC) and the result shows three optimal lag length in the model as shown in table 4.2. In order to reduce the possibility of underestimation whilst maximizing the likelihood of recovering the true lag, the study used three maximum lag lengths.

TABLE 4.2
Optimal lag selection criteria for the models

Endogenous variables: AGDP EXR TRFAL BLA ALF CPI

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	*-1924.817*	*NA*	*4.05e+35*	*99.01625*	*99.27219*	*99.10808*
1	*-1687.469*	*389.4942*	*1.36e+31*	*88.69071*	*90.48224**	*89.33350**
2	*-1643.116*	*59.13732**	*1.01e+31**	*88.26236*	*91.58948*	*89.45610*
3	*-1600.467*	*43.74259*	*1.06e+31*	*87.92138**	*92.78410*	*89.66608*

Source: Researcher's computation (2023), using E-Views 9.

Unit root test results

The Augmented Dickey Fuller and the Philip-Perron unit root tests were conducted to examine the stationarity condition of the variables. As indicated in table 4.3, CPI was stationary at level in ADF, and TRFAL was stationary at both ADF and PP. In other words, the variables are integrated of order zero (i.e., I (0)). However, all other variables were stationary after first differencing using both ADF and PP. The aforementioned variables are therefore integrated of order one i.e., they are I (1).

Where some of the variables are I (0) while others are I (1) one suggests the problem of unit root in the equations. It becomes imperative to perform co-integration tests to determine the presence of equilibrium relationship amongst the variables in the equation. The study adopted the ARDL bound testing technique for co-integration, as the variables are integrated of diverse orders (i.e., order zero and order one).

TABLE 4.3
ADF and Philip-Perron unit root test results

Variables	*ADF Level*	*1st Difference*	*Order of integration*	*Level*	*PP 1st Difference*	*Order of integration*
AGDP	*-1.889924*	*-5.720798**	*I(1)*	*-1.495854*	*-5.902021*	*I(1)*
CPI	*-3.046478**	-	*I(0)*	*-2.913058*	*-10.63780**	*I(1)*
EXR	*-1.823438*	*-3.302169**	*I(1)*	*-1.001168*	*-3.793583**	*I(1)*
BLA	*4.091944*	*-6.371627**	*I(1)*	*4.192951*	*-6.600018**	*I(1)*
TRFAL	*-4.197846*	-	*I(0)*	*-4.355172**	-	*I(0)*
ALF	*-0.829953*	*-3.021580**	*I(1)*	*-0.253379*	*-3.216297**	*I(1)*

Source: Researcher's computation (2023), using E-Views 9.
Mackinnon critical values for ADF at 1, 5 and 10% levels are -3.610, -2.938 and -2.607respectively, and for PP are 3.605, 2.936 and 2.606, respectively. ** means significant at 5% level.

Co-integration test results

From the bound testing result reported in Table 4.4, long run relationship exists amongst the variables in the estimated equation, given that the value of the F-statistic (5.12) is greater than the critical values at five per cent level in both the upper (3.79) and the lower (2.62) bounds. Therefore, the null hypothesis of absence of co-integration is rejected, while the study proceeds to estimate the long run coefficient of the equation.

TABLE 4.4
Co-integration test results

			5% critical value		
Equations	***K***	***F-Stat***	***I (0)***	***I (1)***	***Outcome***
AGDP (EXR, TRFAL, BLA, ALF, CPI)	*5*	*5.12*	*2.62*	*3.79*	*Co-integration*

Note: K =number of parameters
Source: Researcher's computation (2023), using E-Views 9.

Granger causality test results

From table 4.5, in the agricultural output equation, a unidirectional causality was found between exchange rate, bank loans to agriculture and agricultural output, while a bidirectional association was observed between total rainfall, agricultural labour force, consumer price index and agricultural output.

TABLE 4.5
Pair wise Granger causality test results

AGDP = f(EXCH, TRFAL, BLA, ALF, CPI)

Null Hypothesis:	***Obs***	***F-Statistic***	***Prob.***
EXR does not Granger Cause AGDP	*41*	*0.74303*	*0.3941*
AGDP does not Granger Cause EXR		*3.69360*	*0.0621*
TRFAL does not Granger Cause AGDP	*41*	*0.30847*	*0.5819*
AGDP does not Granger Cause TRFAL		*0.18037*	*0.6735*
BLA does not Granger Cause AGDP	*41*	*0.75193*	*0.3913*
AGDP does not Granger Cause BLA		*12.8730*	*0.0009*
ALF does not Granger Cause AGDP	*41*	*3.68519*	*0.0624*
AGDP does not Granger Cause ALF		*11.9367*	*0.0014*
CPI does not Granger Cause AGDP	*41*	*4.5E-05*	*0.9947*
AGDP does not Granger Cause CPI		*0.46312*	*0.5003*

Source: Researcher's computation (2023), using E-Views 9.

Presentation and analysis of econometric results

The long run equation of aggregate agricultural output and exchange rate equation is reported in table 4.6a. From the results and in contravention of the theoretical expectation, a positive relationship exists between exchange rate (EXR) and aggregate agricultural output (AGDP) in Nigeria. The value of the coefficient of 43.15 implies that an increase in exchange rate by 1 percent will result to an increase in aggregate agricultural output by 43.15 percent. The p-value indicates that exchange rate is statistically significant. This simply means that agricultural output significantly response to changes in exchange rate in the long run. The relationship between total rainfall (TRFAL) and aggregate agricultural output (AGDP) is positive and statistically significant. A 1 percent rise in total rainfall will lead to 15.22 percent increase in aggregate agricultural output in the long run, ceteris paribus. The p-value shows that the variable is statistically significant. According to the result, an increase in deposit money banks loans to agriculture (BLA) has a positive and significant long run relationship with aggregate agricultural output. The magnitude of the coefficient shows that a 1 percent increase in deposit money banks loans to agriculture in the long run will lead to about 40.07percent rise in aggregate agricultural output. Furthermore, the relationship between agricultural labour force (ALF) and aggregate agricultural output (AGDP) is positive and statistically significant. Hence, a 1 percent rise in agricultural labour force will lead to 0.0007 percent increase in aggregate agricultural output in the long run, ceteris paribus. The p-value shows that the variable is statistically significant. A positive and significant relationship exists between consumer price index (CPI) and aggregate agricultural output (AGDP). A 1 percent rise in consumer price index will lead to about 106.72 percent increase in aggregate agricultural output in the long run, ceteris paribus. The p-value shows that the variable is statistically significant.

The short run dynamics result of aggregate agricultural output and exchange rate equation is as reported in table 4.6b. From the table, there exist a positive and significant relationship between aggregate agricultural output (AGDP) and it one period lag (AGDP (-1)). The coefficient of the one period lag of aggregate agricultural output is 0.74. Hence, a 1 percent increase in one period lag of aggregate agricultural output will lead to a rise in its current period by 0.75 percent. The relationship between exchange rate (EXCH) and aggregate agricultural output (AGDP) is positive at the current period, but became negative after first, second and third period lags with coefficients of 2.06, -3.58, -1.51 and -4.88 respectively. It was statistically significant after the third period lag implying that agricultural output significantly response to changes in exchange rate in the short run. The relationship between total rainfall (TRFAL) and aggregate agricultural output (AGDP) in the short run was negative at current, first and second period lags, but became positive after third period lag, with coefficients of -1.01, -2.50, -0.50 and 2.96 respectively. It was statistically significant after first and third period lags. Hence, a 1 percent rise in total rainfall will lead to 1.01, 2.50 and 0.50 percent decrease and 2.96 percent increase in aggregate agricultural output in the short run, ceteris paribus. According to the result, an increase in deposit money banks loans to agriculture (BLA) has a positive and significant relationship with aggregate agricultural output in the short run at current and one period lag, with coefficients of

8.30 and 11.17 respectively. The relationship became negative after second and third period lags with the value of -9.34 and 9.27, accordingly. The magnitude of the coefficients shows that a 1 percent increase in deposit money banks loans to agriculture in the short run will lead to about 8.30 and 11.17 percent rise, as well as 9.34 and 9.27 percent decrease in aggregate agricultural output respectively. It was statistically significant at current, first, second and third period lags, signifying the relevance of deposit money banks loans to the development of the agricultural sector in Nigeria. However, the relationship between agricultural labour force (ALF) and aggregate agricultural output (AGDP) in the short run is negative but statistically significant at current period. Hence, a 1 percent rise in agricultural labour force will lead to 0.00032, 0.00011 and 0.00031 percent at current, first and third period lags. The p-value shows that the variable is statistically significant at the current period. A positive and significant relationship exists between consumer price index (CPI) and aggregate agricultural output (AGDP) at current and third period lags in the short run with coefficients of 18.29 and 23.78 respectively. It was negative after first and second period lags. Hence, a 1 percent rise in consumer price index will lead to about 18.29 and 23.78 percent increase, but 6.55 and 16.36 percent decrease in aggregate agricultural output in the short run, ceteris paribus. The p-value shows that the variable is statistically significant at the third period lag.

The error correction mechanism (ECM) has the correct sign and size. The ECM coefficient of -0.341966 indicates that, it takes about 34 percent for the short run disequilibrium to adjust to the long run equilibrium within the year. The t-statistic of -3.198 shows that the error correction term is statistically significant at 5 percent level of significance.

R-squared value of 0.974954 and the value of R-squared adjusted of 0.901331 indicates that about 90 percent of variation in the AGDP is explained by one period lag of agricultural output, exchange rate, total rainfall, bank loans to agriculture, agricultural labour force and consumer price index and about 10 percent was unexplained which may be accounted for by other factors not included in the model. The F-statistic of about 14.41 shows that all the variables in the aggregate agricultural output model are together as a group statistically significant which means that the model has a good fit. The Durbin-Watson (D-W) statistic of 2.27 indicates no autocorrelation in the model. Therefore, the results can be used for economic forecast and economic policy.

The stability test using the cumulative sum (CUSUM) test in fig. 1, further shows that the variables included in the equation were stable within the period of the study. This is evidenced by the swing of the trends within the CUSUM bound at the ± five percent significance level. The study, therefore, infers that the equation is stable and consistent to be adopted for economic policies and forecasts.

TABLE 4.6a

Long Run Results
Dependent variable: AGDP

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
EXR	*43.154496*	*9.581504*	*4.503938*	*0.0011*
TRFAL	*15.220105*	*6.555884*	*2.321595*	*0.0427*
BLA	*40.070636*	*7.456382*	*5.374005*	*0.0003*
ALF	*0.000731*	*0.000154*	*4.741841*	*0.0008*
CPI	*106.7203*	*48.139742*	*2.216886*	*0.0510*
C	*-57530.94*	*14261.5035*	*-4.034003*	*0.0024*

TABLE 4.6b

Short Run Results
Dependent variable: D(AGDP)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
D(AGDP(-1))	*0.743424*	*0.226992*	*3.275113*	*0.0084*
D(EXCH)	*2.062791*	*2.339154*	*0.881854*	*0.3986*
D(EXCH(-1))	*-3.585375*	*2.867197*	*-1.250481*	*0.2396*
D(EXCH(-2))	*-1.513952*	*3.056148*	*-0.495379*	*0.6310*
D(EXCH(-3))	*-4.886764*	*2.320035*	*-2.106332*	*0.0614*
D(TRFAL)	*-1.012799*	*1.172679*	*-0.863663*	*0.4080*
D(TRFAL(-1))	*-2.505654*	*1.136104*	*-2.205479*	*0.0520*
D(TRFAL(-2))	*-0.541061*	*0.998318*	*-0.541973*	*0.5997*
D(TRFAL(-3))	*2.967572*	*1.280395*	*2.317700*	*0.0429*
D(BLA)	*8.304432*	*3.419836*	*2.428313*	*0.0356*
D(BLA(-1))	*11.177023*	*4.456488*	*2.508034*	*0.0310*
D(BLA(-2))	*-9.344053*	*4.197128*	*-2.226297*	*0.0502*
D(BLA(-3))	*-9.271209*	*3.935034*	*-2.356068*	*0.0402*
D(ALF)	*-0.000325*	*0.000126*	*-2.572639*	*0.0278*
D(ALF(-1))	*-0.000113*	*0.000272*	*-0.415012*	*0.6869*
D(ALF(-2))	*0.000011*	*0.000251*	*0.044656*	*0.9653*
D(ALF(-3))	*-0.000310*	*0.000211*	*-1.470474*	*0.1722*
D(CPI)	*18.29081*	*13.74259*	*1.330958*	*0.2128*
D(CPI(-1))	*-6.55738*	*10.31414*	*-0.635767*	*0.5392*
D(CPI(-2))	*-16.368327*	*9.539288*	*-1.715886*	*0.1169*
D(CPI(-3))	*23.780167*	*8.068755*	*2.947192*	*0.0146*

ECM(-1)	*-0.341966*	*0.106899*	*-3.198965*	*0.0095*	
R-squared	0.974954				
Adjusted R-squared	0.907331				
F-statistic	14.41746	Durbin-Watson stat	2.276832		2.676832

Source: Researcher's computation (2023), using E-Views 9.

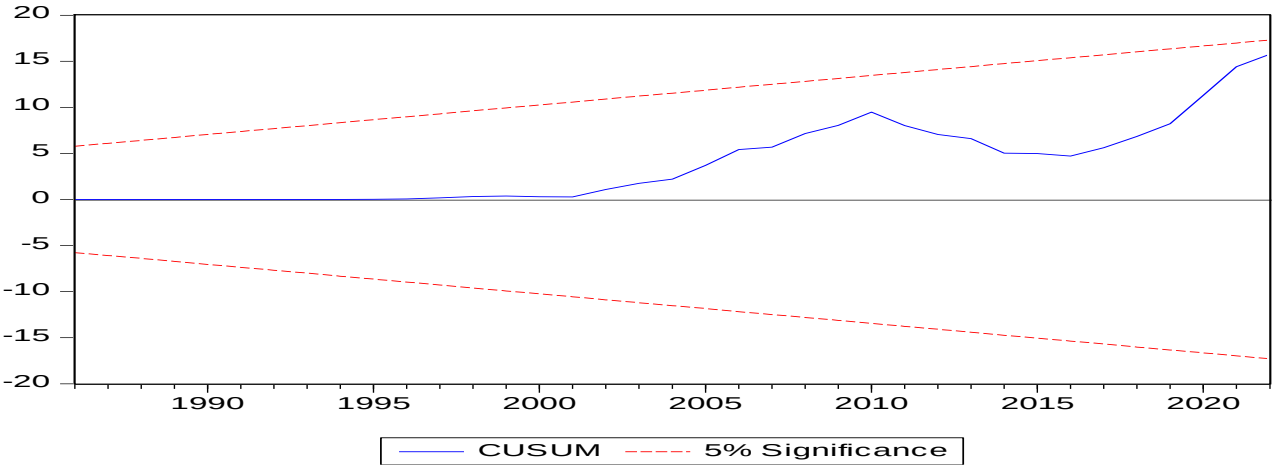

Fig.1: Aggregate Agricultural Output and Exchange Rate Equation CUSUM

4.3 Presentation and Analysis of ARCH and GARCH Results

The autoregressive conditional heteroskedasticity (ARCH) and generalized autoregressive conditional heteroskedasticity (GARCH) results of the aggregate agricultural output and exchange rate equation is presented in table 5. It is made up of the mean and variance components. The constant from the mean equation captures the mean exchange rate coefficient, which is positive and statistically significant. The average exchange rate volatility is 9133.11 percent and its past value significantly predicts the current series by 21.12 percent. The coefficient of the ARCH(RESID (-1) parameter is positive while the parameter for the GARCH(GARCH(-1)) term is negative. They are both statistically significant at 5 percent level. Hence, the time varying volatility in the aggregate agricultural output and exchange rate equation includes a constant of (0.0000000147) plus it past value (0.73) and a component which depends upon past errors (1.05). The result revealed the presence of time varying conditional volatility of exchange rate on aggregate agricultural output in Nigeria. Hence, the results show that aggregate agricultural output response to changes in exchange rate in Nigeria.

TABLE 5

Dependent Variable: AGDP

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	9133.116	3034.993	3.009271	0.0026
EXCH	-21.12835	10.43301	-2.025144	0.0075
Variance Equation				
C	1.47E+08	1.30E+08	1.135045	0.2564
RESID(-1)^2	1.054230	0.450427	2.340512	0.0055
GARCH(-1)	-0.737848	0.235826	-3.128786	0.0018
TRFAL	-57.71460	46727.60	-0.001235	0.9990
BLA	34.82614	157209.4	0.000222	0.9998
ALF	-2.767096	1.432778	-1.931281	0.0534
CPI	-1.288413	1055137.	-1.22E-06	1.0000

Source: Researcher's computation (2023), using E-Views 9.

4.4 Post-Estimation Tests

In order to determine the applicability of the estimated model for policymaking, the post estimation results in table 6, helps in the validation of the ECM results. This model fit well and passes all of the diagnostic tests in terms of the diagnostic checks. The dependent variables' variance is 97 percent and the remaining 3 percent variance is represented by the error terms. It passes the Breusch-Godfrey test for serial correlation since the t-value is statistically significant; the Jarque-Bera test for normality since the p-value is less than 0.05; the heteroscedasticity tests since the probability value of Obs*R-squared (0.3443) is greater than 0.05, hence there is no heteroskedasticity. The CUSUM (cumulative sum of recursive residuals) are used to determine whether the parameters are stable. Pesaran and Pesaran (1997) recommended these tests for gauging parameter stability.

TABLE 6

Residual Diagnostic Tests

	t-value	Prob.
Jarque-Bera normality test	28.34230	0.0001
Heteroskedasticity test	0.89444	0.3443
Correlogram Q-Residual	6.0525	0.999
Breusch-Godfrey LM test	4.85804	0.0881

Source: Researcher's computation (2023), using E-Views 9.

Discussion of findings

In the agricultural output equation, a unidirectional causality was found between exchange rate, bank loans to agriculture and agricultural output, while a bidirectional association was observed between total rainfall, agricultural labour force, consumer price index and agricultural output. This result indicates that increase/decrease in these variables causes increase/decrease in agricultural sector performance. The feedback effect of agricultural sector performance on exchange rate, bank loans to agriculture, agricultural labour force, total rainfall and consumer price index portends that agricultural sector performance enhance the performance of these variables in the Nigerian economy. The bound test result shows that a long run relationship exists among the variables in the estimated equation. Therefore, the null hypothesis of absence of co-integrated is rejected while the alternative hypothesis is retained. This signifies the relevance of these variables in enhancing agricultural sector performance in Nigeria.

The model was estimated using the error correction mechanism (ECM) and the outcome of the aggregate agricultural output equation revealed positive and significant relationship among the variables in both the short run and long run. From the long run and short run results of aggregate agricultural output and exchange rate, a positive/negative and significant relationships were found between real effective exchange rate, total rainfall, deposit money banks loans to agriculture, agricultural labour force, consumer price index and aggregate agricultural output in Nigeria. This study is in tandem with the views of Oriavwote and Oyovwi (2014) and Oyinbo, Abraham and Rekwot (2014) who revealed that real effective exchange rate has significant positive impact on agricultural productivity in Nigeria, and that the deregulation of the exchange rate has had a significant influence on the agricultural output in the country.

The error correction coefficient in the estimated model met the three criteria for its acceptability given that it is negative, fractional and statistically significant. Consequently, the estimated result confirms the presence of long run relationship among the variables in the model. It also shows that the speed of adjustments is moderate in the estimated model. The value of the adjusted R-squared implies that the model has good fit as the independent variables have high explanatory power. The Durbin-Watson Statistic connotes absence of autocorrelation in the estimated equation. The study, therefore, accepts the null hypothesis of no serial correlation in the model. This further implies that the error terms of different periods are not serially correlated. The stability test using the cumulative sum test showed that the variables included in the model were stable within the period of the study.

The results of the volatility in exchange rate and agricultural sector performance in Nigeria, using the autoregressive conditional heteroskedasticity (ARCH) and generalized autoregressive conditional heteroskedasticity (GARCH) revealed a negative but significant relationship between the responsiveness of real effective exchange and the aggregate agricultural output. Hence, it was revealed from the findings that agricultural sector performance response negatively to fluctuation in exchange rate in Nigeria.

Conclusion and Recommendations

This study concludes that the government must consciously direct policy actions towards the agricultural sector to achieve its full potentials in order to place the Nigerian economy on the path of self-sufficiency in aggregate agricultural production. This must be facilitated through appropriate exchange rate policies to contain market power in the Nigerian foreign exchange market. In line with the findings of the study, it is recommended that the government should implement appropriate exchange rate policy that will ensure sufficient crop production for both domestic consumption and exports. For this reason, there is need to stabilize the exchange rate so as to facilitate the crop sub-sector performance in Nigeria. The movement in the market determined exchange rate should be strictly monitored by the apex bank, in order to ensure that the deregulation in exchange rate is not counterproductive through distortionary prices on agricultural production as well as the investment in the sector in line with the Agricultural Transformation Agenda. The positive impact of exchange rate, deposit money banks loans and agricultural labour force on agricultural output suggests that the Nigerian government should revisit sustainable policies that will persuade deposit money banks and agricultural development bank to increase their lending to the sector. Agricultural loans and advances should be granted to farmers to increase agricultural productivity in the country. This will enable farmers exploit the untapped potentials of Nigeria's agricultural sector, reduce inflation, lower the cost of agricultural production, generate surplus for export, increase Nigeria's foreign earnings as well as diversify its revenue base. The negative responses of the aggregate agricultural output to real effective exchange rate as revealed by the ARCH and GARCH models call for urgent policy actions to strictly monitor exchange rate depreciation by the monetary authorities.

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