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Determinants of Agribusiness Output in Nigeria: An Empirical Analysis

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Abstract

This study applied ARDL model in estimating the determinants of agribusiness output in Nigeria. The underlying data spanning from 1981-2018 were sourced from statistical bulletin of Central Bank of Nigeria as well as World Bank Database. The ARDL approach was appropriate for the study because results arising from the Augmented Dickey-Fuller (ADF) unit root test showed that the variables under consideration were of mix integration, that is, at level and first difference. The determinants of agribusiness output selected for this study were categorized into climatic and non-climatic factors. The climatic factors were annual rainfall and temperature, while the non-climatic factors were farm size, exchange rate, inflation rate, monetary policy rate, capital and labour employed in agribusiness. On the other hand, agribusiness output was measured by total value agricultural sector contribution to annual GDP in Nigeria. Results from the ARDL bounds test indicated that there was long-run relationship between agribusiness output and its observed determinants. The long-run estimates revealed that agribusiness output was majorly determined by temperature level, exchange rate, capital and labour employed. On the other hand, the short-run estimates indicated that all the explanatory variables, that is, both climatic and non-climatic factors were significant determinants of agribusiness output in Nigeria. Based on these findings, various policies were advanced to maintain sustainable level of agribusiness output in Nigeria.

Key words: Agribusiness, agriculture, climate change, macroeconomic variables, ARDL.

JEL classification: O47, O40, O53, Q10, Q14.

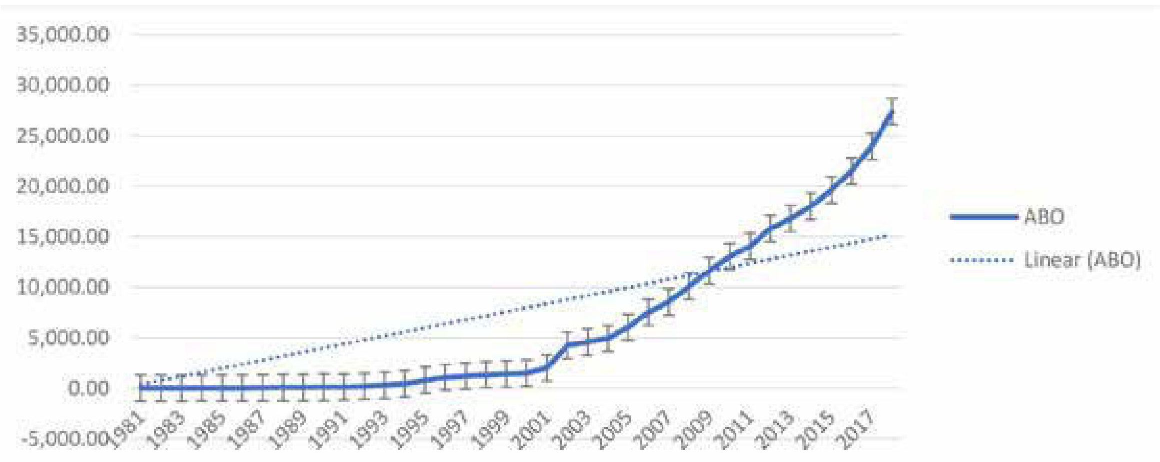
Paper classification: Research paper

Introduction

Agribusiness refers to the business of farming and farm-related commercial activities towards enhancing agricultural productivity and overall economic growth. In other words, it is the combination of agriculture and investment activities towards stimulating economic growth and development of a country. The term agribusiness was popularized in 1957 by John Davis and Ray Goldberg. Hence, it is traced to the economic framework of Davis & Goldberg (1957) that began with farmers acquisition of seeds and livestock and ends up with products fit for human consumption. In recent times, agribusiness has been recognized as the driving force of the global economy (Phiri, 2018; Hanumanthappa, 2016). The significance of agribusiness is seen from the fact that it meets a nation's demand for food; it is a prominent source of foreign exchange earnings; growth of agribusiness raises income of farmers, thus aid alleviation of poverty; by promoting agribusiness, influx of rural population to urban area is checked, thus help to curb overcrowding; through agribusiness, essential raw materials for industrial production are made available. In fact, according to Nwachukwu & Shisanya (2017), revitalizing agribusiness is key to delivering the expected 10 per cent yearly economic growth rate within the scope of "Vision 2030." In recognition of the all-important benefits from agribusiness, UNCTAD (2015) affirmed that the level of agribusiness output explains the resource gap separating less developed nations from the developed nations.

Notwithstanding the importance of agribusiness to economic life of a country, Nigeria has failed to thrive in agribusiness amidst rich agricultural resource endowment evident in highly diversified arable land and agroecological condition. Prior to political independence in Nigeria, the country's economy was primarily anchored on agribusiness, which implies that agribusiness was the backbone of the economy. However, following the oil boom of the mid-1970s, Nigeria resorted to crude oil production as a primary source of foreign earning while neglecting agribusiness (Uremadu & Onyele, 2016). Unfortunately, ever since Nigeria switched to crude oil as a major source of revenue, there have been serious fluctuations in crude oil price on one hand and agribusiness has been growing at a very slow pace on the other hand. For instance, agribusiness output has been below expectation as farming systems have been predominantly carried out in small scale and at a subsistence level. Also, diverse agricultural policies initiated by the Nigerian government have failed to fulfil its objectives of enhancing agribusiness, either because they were often misguided, or because their impacts were overshadowed by macroeconomic policies influencing inflation, exchange rates, interest rate as well as inefficient supply of capital (Ehui & Tsigas, 2009). As a result, agribusiness has been moving at a slow pace in Nigeria (See, Figure 1 for trend in agribusiness output in Nigeria).

Figure 1: Agribusiness output in Nigeria



Another fundamental problem facing agribusiness activities across the globe is the issue of climate change. The Nigerian meteorological agency has affirmed an appreciable fluctuation in the country's weather pattern in recent years (Enete, 2017). Most regions of the country, especially, the northern region have been experiencing low rainfall when compared to the southern region. Records show that while rainfall in the northern part has been on the decline, temperature has increased from about 1.4 to 1.9 degree Celsius on average and scientist have stated that it could increase from 2 to 5 degree Celsius in the future (Nwajiuba, 2013). The repercussions associated with such persistent increase in temperature are decrease in agribusiness output and surge in evaporation rate which results in depleting soil moisture, thereby drying up the surface water and reduction of available ground water (Ufiobor, 2017). Also, with an unbearable temperature level, labourers easily get tired and they become less productive compared to a period of mild temperature (Enete, 2017).

Some non-climatic constraints to agribusiness productivity borders on insufficient supply of inputs (such as, labour and capital) as well as macroeconomic swings and inefficiencies in supply and distribution of these inputs. For instance, given the frequent fluctuations of the Naira-Dollar exchange rate, acquisition of modern farm inputs from technologically advanced countries have limited productivity of the farmers (Omekwe, Bosco & Obayori, 2018; Anyanwu, 2013). At this age, Nigerian farmers still depend on crude implements which adversely affect agribusiness output (Ogundele & Okoruwa, 2014). Also, supply of funds for agribusiness has been paltry as farmers lack access to bank credit due to double-digit interest rate charged on borrowings by Nigerian banks. Similarly, government have failed to bridge the finance gap inherent in agribusiness due to inconsistencies in fiscal policy (Uremadu & Onyele, 2019). Based on this premise, it becomes compelling to investigate determinants of agribusiness output so as to advance necessary policy recommendations, to ensure there is continued improvements in enhancing agribusiness as this will spur income, employment opportunities, and ensure food security as well as increase foreign exchange in Nigeria in the years ahead.

Ufiobor (2017) discussed the strengths, weaknesses, opportunities and threats (SWOT) of agribusiness in Nigeria as summarized in Table 1:

Table 1: SWOT analysis of Agribusiness in Nigeria

	Strengths		**Weaknesses**
a.	Large expanse of land for cultivation	a.	Overreliance on the oil sector
b.	Large local markets and access to foreign market	b.	Crude equipment
c.	Low labour cost	c.	Inconsistent agricultural policies
d.	Large labour force	d.	Economic instability
e.	Financial support from international financial organizations e.g. World bank, FAO, etc.	e.	Large number of unskilled labour
			Poor marketing
	Opportunities		**Threats**
a.	Free trade (large domestic and international market)	a.	Climate change
b.	Large income from crude oil	b.	Unsustainable agricultural practices
c.	Good telecommunication system	c.	Pest and disease
d.	Large numbers of trained manpower in agriculture	d.	Religious and ethnic conflicts
e.	Plenty of raw material e.g. fertilizer	e.	Unstable policies
	Improved and developed planting material		Unstable government

Source: Adapted from Ufiobor (2017)

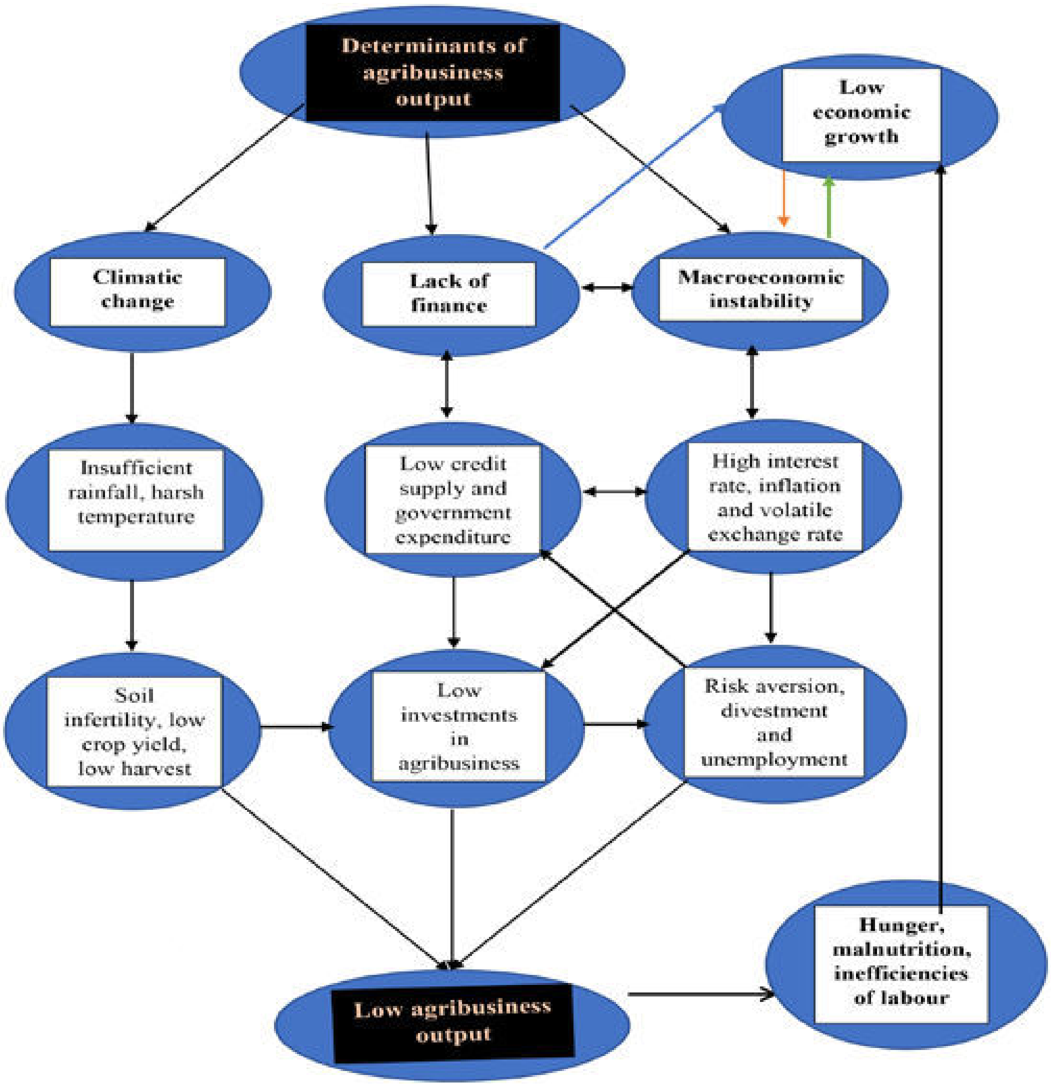
The objective of this study is to estimate determinants of agribusiness output in Nigeria. A special focus is put on the role of climatic factors (rainfall and temperature) and non-climatic factors (farm size, exchange rate, inflation, monetary policy rate, capital and labour) as determinants of agribusiness output in Nigeria.

Literature Review

Conceptual Framework

An attempt to conceptualize agribusiness is to understand factors that could cause fluctuations in growth of agribusiness. The Boserupian school of thought postulated that the major stimulus to agribusiness is growth in population (Boserup, 1965). This implies that increase in population triggers efforts towards agribusiness activities. Over time, Boserupian school of thought has been reframed as a more generalized theory and had continued to gain prominence in relation to population and agribusiness productivity (Coppola, Ianuario, Chinnici, Di Vita, Pappalardo & D'Amico, 2018). Chart 1 shows the vicious circle of climate change, lack of capital and low agribusiness output:

Chart 1: Conceptual Framework



Source: Developed by Authors

In support of the Boserupian school of thought, is the Malthusian theory which averred that population growth increases exponentially while food production increases arithmetically, implying the possibility of population outgrowing available resources. With this undesirable trend in the face of changing climate and macroeconomic fluctuations, the world is likely to experience high magnitude of Malthusian catastrophe. It then implies that analysis of determinants of agribusiness output is crucial.

Also, stability of macroeconomic environment has been an important condition that promotes agribusiness productivity. For instance, uncertainties about future economic outlook due to volatile domestic prices, exchange rate and interest rate could raise doubts about sustainability of public finance or possibility of future economic recession, which could cause significant decline in agribusiness investments. Fischer (1993) defined macroeconomic stability as being characterized by single digit and predictable inflation, sustainable fiscal policy, and increase in capital accumulation and domestic productivity. Hence, macroeconomic policy and agribusiness productivity have been the central attention of the policy makers across the world.

Theoretical Framework

This study is rooted in the Cobb-Douglas production function and endogenous growth model. The Cobb-Douglas production function is generally used to show the relationship of output and two inputs (labour and capital). The Cobb-Douglas production function is modelled in equation 2.1 as follows:

P(L, K) = ... (2.1)

Where: P = productivity, L = labour, K = capital input, B = total factor productivity (efficiency coefficient) α and β are the output elasticity of labor and capital, respectively.

On the other hand, the endogenous growth theory avers that government interventions are needed to achieve long-run growth in output (Lucas, 1988). Government make policies to manage macroeconomic factors such as interest rate, exchange rate, inflation rate amongst others to influence growth in output. Also, it has been reported that agribusiness is strongly influenced by climatic factors, especially rainfall and temperature (Enete, 2017). Hence, considering components of the endogenous growth model and climate change, the Cobb-Douglas was reframed as follows in equation 2.2:

P(L, K, M, C) = ... (2.2)

Where, M = macroeconomic variables; and C = climatic factors

In this production function, the sum of exponent ($\alpha + \beta$) measures returns to scale. Output elasticity measures the response of agribusiness output to a change in the supply of labour and capital; and macroeconomic factors or climate change, *ceteris paribus.*

Empirical Review

Most recently, Seven & Pumen (2020) presented cross-country evidence showing that agricultural credit positively affects agricultural productivity. Particularly, it was found that increasing agricultural credits generated about 4-5 percent increase in agricultural productivity. This suggested that the nature of the relationship between agricultural finance and agricultural output varied along the development path.

Similarly, Gero & Egbendewe (2020) studied the macroeconomic effects of agricultural productivity in Benin Republic. They applied a dynamic computable general equilibrium (CGE) model. The results suggested that public policies that promoted growth in food crop productivity might become more effective in enhancing greater economic performance.

Again, Emenuga (2019) investigated the effect of credit supply to the Nigerian agricultural sector over a period of 37 years (1981-2017). The results of the Johansen cointegration test showed a long-run relationship between bank credit and agricultural sector development in Nigeria. The study also indicated that commercial banks' credit and Agricultural credit guarantee scheme were positively related to Agricultural sector development while interest rate showed a negative relationship with agricultural development in Nigeria.

Also, Omekwe, Bosco & Obayori (2018) examined the determinants of agricultural output in Nigeria from 1985-2016. The study utilized the econometric cointegration test and error correction mechanism (ECM) approach for the analysis of data. The Johansen cointegration test results showed that the variables were cointegrated which fit the model for the ECM. The findings from the study showed that agricultural funding; agricultural credits as well as climate change were key drivers of agricultural output in Nigeria.

Again, this time in Uganda, Epule, Ford, Lwasa, Nabaasa & Buyinza (2018) analyzed the determinants of crop yields. The study considered climatic and non-climatic variables affecting crop yields using a systematic approach which involved a multiple linear regression. The findings revealed that non-climatic determinants of crop yields such as dynamics in forest area, wood fuel and usage of tractors were significant determinants of crop production than climatic fundamentals like temperature, CO_2 emissions as well as precipitation.

A similar study by Nwachukwu & Shisanya (2017) investigated the determinants of agricultural production in Kenya from 1970-2012. Secondary data used for the study were sourced from publication of Food and Agriculture Organization (FAOSTAT), United Nations Development Programme (UNDP) and the World Bank. The data analysis was accomplished with the aid of log quadratic equation. The log quadratic equation indicated that agricultural production was mainly influenced by labour, availability of arable land and precipitation.

Similarly, Muraya & Ruigi (2017) identified the determinants of agricultural productivity in Kenya from 1980 to 2013. The study considered inflation, real exchange rate, labour force, government expenditure and climate/rainfall as the factors determining agricultural productivity. The study applied Cobb-Douglas production function and ordinary least squares estimation technique for the data analysis. From the results, increase in government expenditure, annual rainfall and labour force caused an increase in agricultural productivity. On the other hand, increase in inflation rate and exchange rate caused a decrease in agricultural productivity. The long-run estimates highlighted an inverse impact of exchange rate and inflation on agricultural productivity, while labour force, rainfall, and government expenditure had positive impact on agricultural productivity.

Again, Enete (2017) analyzed impact of climatic factors on agricultural productivity in Enugu state, Nigeria using primary data collated from Enugu State Agricultural Development Programme (ENADP). Also, data on rainfall for a period of thirty years (1981–2010) were sourced from Nigerian Meteorological Agency. The data were analyzed with the aid of descriptive statistic and correlation technique. The study revealed there was significant change in seasonal rainfall. Again, the study indicated that the traditional crops except cassava and pepper experienced a significant decrease as rainfall continued to diminish.

In another study, this time in Pakistan, Kakar, Kiani & Baig (2016) examined the determinants of productivity in the agricultural sector of Pakistan using annual data 1990 - 2017. The ARDL technique was applied for the estimation. It was revealed based on the results that higher area under cultivation, application of fertilizer, credit to farmers, and yearly average rainfall had affected agricultural productivity positively, while labour engaged in agriculture and use of pesticides exerted positive and statistically insignificant influence on agricultural output in the long-term.

Also, Maniriho & Bizoza (2016) estimated the Cobb-Douglas production function with focus on factors determining crop production in Musanze, Rwanda. The study utilized a structured questionnaire to collate data via a survey of 107 farmers which were randomly selected. Both descriptive statistic and the ordinary least squares approach were applied for the data analysis. The results showed that crop production was positively related with increased labour supply, fertilizer application, availability of seeds and pesticides. The test of significance showed that labour supply, fertilizer application and seeds were highly significant factors that contributed to crop production.

Similarly, Raza & Siddiqui (2014) analyzed the key determining factors of agricultural output in Pakistan. The variables considered for the study were yearly agricultural output, application of fertilizer, improved availability of seeds, labour employed, improved technology, water availability. Data for the variables were annual dataset spanning from 1972 to 2012 which were obtained from Agriculture Statistics of Pakistan and Pakistani Economic Survey. Johansen cointegration approach was applied for the data analysis. Results showed the use of improved technology was a significant determinant of agricultural output. The study also showed that improved seeds, water supply, labour supply were positively related to agricultural output.

With focus on Imo State, Nigeria, Anyanwu (2013) investigated the key determinants of agricultural output. Data collated from eighty (80) small scale farmers who were randomly selected from two (2) agricultural zones in Imo State, Nigeria. Results obtained from the regression analysis showed that farm size, capital, labour, supply of planting materials, market accessibility, education level and farming experience were statistically significant in explaining the trends in aggregate agricultural productivity in Imo State, Nigeria.

Using autoregressive distributed lag (ARDL) model, Ahmad & Heng (2012) identified determinants of agriculture productivity growth in Pakistan for the period 1965-2009. Fertilizer application, human capital development was the most prominent determinants of agricultural productivity. Credit to agriculture sector as well as area under crop cultivation were insignificant in both the short-run and long-run.

Methodology

Research Design and Sources of Data

The paper used *ex post facto* research design. The data were annual time series spanning from 1981 to 2018. The data were sourced from the Central Bank of Nigeria Statistical Bulletin and World Bank Database. The test hypotheses were at 5% level of significance which denotes rejection of the null hypothesis and acceptance of the alternative hypothesis if $p<0.05$, otherwise accept the null hypothesis if $p>0.05$.

Model Specification

This study followed the model of Muraya & Ruigu (2017) to ascertain the relationship between agribusiness output and its determinants. The multivariate regression model is as specified below in equation 3.1:

$$LnY_t = \beta_0 + \beta_1(\ln L_t) + \beta_2(\ln R_t) + \beta_3(\ln E_t) + \beta_4(\ln G_t) + \beta_5(\ln I_t) + \mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.1)$$

Y_t = agricultural productivity

L_t = labour force

R_t = rainfall

E_t = real exchange rate

G_t = government expenditure

I_t = inflation rate

μ_t = error term.

The model of Muraya & Ruigu (2017), was modified to include annual rainfall and temperature, farm size, monetary policy rate and capital. The need for including additional variables to the model is to capture the effect of climatic factors and economic factors on agribusiness output as discussed in other literature (Kakar, Kiani & Baig, 2016). Hence, the model used for this study was specified below as follows:

$$ABO_t = \beta_0 + \beta_1\ln(RNF_t) + \beta_2\ln(TRP_t) + \beta_3\ln(FMZ_t) + \beta_4\ln(EXR_t) + \beta_5\ln(IFR_t) + \beta_6\ln(MPR_t) + \beta_7\ln(CAP_t) + \beta_8\ln(LAB_t)\ \mu_t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Where,

ABO = Agribusiness output

RNF = Average annual rainfall

TPR = Average annual temperature

FMZ = Farm size

EXR = Exchange rate

IFR = Inflation rate

MPR = Monetary policy rate

CAP = Capital for agribusiness

LAB = Labour force employed in agriculture

ln = Natural log

β_0 = Constant

β_1 - β_8 = Coefficient estimates of the explanatory variables

μ_0 = Error term

Description and measurement of model variables

The variables were briefly described to show how they fit into the regression model. Consequently, the dependent variable and the independent variables were described as follows:

Agribusiness output (ABO): The dependent variable, agrobusiness output entails the total value of yearly output of the Nigerian agricultural sector. Hence, annual contribution of agricultural sector to overall GDP was used to measure agribusiness output.

The independent variables were also described as follows:

To measure climate change, annual **rainfall (RNF)** and **temperature (TPR)** of Nigeria was used. This is because departure from normal rainfall and temperature, individually or collectively, could alter agribusiness output (Nwachukwu & Shisanya, 2017; Enete, 2017). From theory, *ceteris paribus,* a positive relationship is expected between rainfall and agribusiness output, while a negative relationship is expected between temperature and agribusiness output.

To measure effect of inputs, **farm size (FMZ), capital (CAP) and labour (LAB)** were employed in agribusiness (Muraya & Ruigi, 2017; Kakar, Kiani & Baig, 2016; Anyanwu, 2013). Farm size was measured by total hectares of arable land engaged in agribusiness. Capital was measured by the sum of government funds and bank credit allocated to agricultural sector while labour entails the number of people engaged in agribusiness in Nigeria. Hence, it is expected that availability of arable land, capital and labour would cause agribusiness to thrive.

Again, macroeconomic factors such as, **inflation (IFR), exchange rate (EXR) and monetary policy rate (MPR)** were considered among the determinants of agribusiness output in Nigeria. Empirical study by Muraya & Ruigi (2017) showed that volatile exchange rate could affect importation of necessary agribusiness inputs from technological advanced countries. Similarly, unstable inflation rate could influence domestic consumption as low agribusiness output accompanies low supply of agricultural products due to instability in food prices. Other hand, when MPR increases, banks pay more interest rate to obtain funds from the Central Bank, hence lending rate to farmers and other borrowers would increase, thus resulting to low agribusiness output.

Technique of Data Analysis

The study applied autoregressive distributed lag (ARDL) bounds test approach for the study. In ARDL analysis, long-run and short-run coefficients are estimated simultaneously where the series of data under consideration are of mixed level of stationarity; for instance, group of data that are stationary after first differencing 1(1), or at level i.e. 1(0). ARDL model is used when the variables are of mixed integration at order one, 1(1) and at level, 1(0), but not at second differencing, 1(2) (Pesaran, Shin & Smith, 2001). The ARDL bounds test specification of equation 3.3 was expressed as follows:

$$\Delta\ln(\mathrm{Y})_t = \delta_o + \sum_{i=1}^{p} \delta_1\Delta\ln(Y)_{t-i} + \sum_{i=0}^{p} \delta_2\ln(A)_{t-i} + \sum_{i=0}^{p} \delta_3\ln(B)_{t-i} + \sum_{i=0}^{p} \delta_4\ln(C)_{t-i} + \,..\, + \sum_{i=0}^{p} \delta_t\ln(Z)_{t-i} + \Delta\ln(Y)_{t-1} + \beta_2\ln(A)_{t-1} + \beta_3\ln(B)_{t-1} + \,..\, + \beta_t\ln(\mathrm{Z})_{t-1} + \mu_t \quad \ldots\ldots\ldots(3.3)$$

After cointegration is established, the estimation of the long-run relationship would follow, thus:

$$\Delta\ln(Y)_t = \delta_0 + \beta_1 \ln(Y)_{t-1} + \beta_2 \ln(A)_{t-1} + \beta_3 \ln(B)_{t-1} + \beta_4 \ln(C)_{t-1} + \,..\, + \beta_t \ln(Z)_{t-1} + \mu_t \quad \ldots\ldots\ldots\ (3.4)$$

The short-run relationship is estimated using an error correction mechanism as shown below:

$$\Delta\ln(Y)_t = \delta_o + \sum_{i=1}^{p} \delta_1 \Delta\ln(Y)_{t-i} + \sum_{i=0}^{p} \delta_2 \Delta\ln(A)_{t-i} + \sum_{i=0}^{p} \delta_3 \Delta\ln(C)_{t-i} + \ldots + \sum_{i=0}^{p} \delta_t \Delta\ln(Z)_{t-i} + \theta\, ecm_{t-i} + \mu_t \quad \text{......}(3.5)$$

Where,

δ_0 = Constant

δ_1 - δ_t = short-run elasticities

β_1 - β_t = long-run elasticities

θ = Speed of adjustment

ecm_{t-i} = Error correction term

Δ = First difference operator

p = Lag length

Prior to ARDL estimation, the time series data was tested for stationarity. The test for stationarity of data was done with the aid of Augmented Dickey Fuller (ADF) test (Dickey & Fuller, 1979). This is very important as most macroeconomic time series contains unit root and regression analysis involving non-stationary data always produce spurious regression output. The general model for ADF unit root test is as represented below:

$$\Delta y_t = \beta_0 + \beta_1 t + \beta\lambda y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \mu_t \quad \text{......}(3.6)$$

Where,

y_{t-1} = Lagged value of at first difference

Δy_{t-j} = A change in lagged value

δ = Measure of lag length

Δy_t = First difference of

μ_t = Error term

Results and Discussions

Descriptive statistic

The descriptive statistic displayed the basic features of the variables as shown in Table 2. As revealed by descriptive analysis, the series were consistent as their respective mean and median values were within their maximum and minimum values. Also, the null hypothesis of normal distribution of the data was accepted since the p-values of the Jarque-Bera test were greater than the 0.05 critical value. Also, the measure of skewness for all the data were within the range of "-1 and 1" which implies that the data were moderately skewed. Similarly, the Kurtosis values were less than three (3) or approximately 3 which is the acceptable limit for normally distributed dataset.

Table 2: Descriptive Statistic

	ln(ABO)	ln(RNF)	ln(TPR)	ln(FMZ)	ln(EXR)	ln(IFR)	ln(MPR)	ln(CAP)	ln(LAB)
Mean	7.041424	6.692874	3.526502	15.40635	3.428916	2.681565	2.510641	3.652980	3.817237
Median	7.318811	6.721185	3.529297	15.42457	4.630058	2.556452	2.564949	3.931433	3.862760
Maximum	10.21725	6.864952	3.558201	16.38636	5.725903	4.288265	3.258097	6.483765	4.062510
Minimum	2.836150	6.378766	3.499533	14.46382	-0.430783	1.682688	1.791759	-0.040822	3.600595
Std. Dev.	2.493322	0.123258	0.013293	0.427266	1.962568	0.659420	0.324111	2.155070	0.124049
Skewness	-0.335751	-0.893063	-0.040057	0.149015	-0.724086	0.854379	-0.404325	-0.259765	-0.240186
Kurtosis	1.623649	3.166056	2.912601	3.133511	2.264777	3.103685	3.348710	1.739204	2.187354
Jarque-Bera	3.615605	4.960806	0.021671	0.164414	4.066541	4.518018	1.195582	2.866754	1.410991
Probability	0.164014	0.083709	0.989223	0.921081	0.130907	0.104454	0.550025	0.238502	0.493864
Observations	37	37	37	37	37	37	37	37	37

Source: Author's computations using EViews 10.0

Test for stationarity of data

The results of the ADF test was presented in Table 3.

Table 3: Stationarity test results

	ADF @ level		ADF @ first difference		
Variables	**t-Statistic**	**Prob.**	**t-Statistic**	**Prob.**	**Order of integration**
ln(ABO)	-0.043660	0.9940	-3.622603	0.0436	I(1)
ln(RNF)	-4.948089	0.0015	--	--	I(0)
ln(TPR)	-5.808808	0.0001	--	--	I(0)
ln(FMZ)	-3.568910	0.0474	--	--	I(0)
ln(EXR)	-1.549591	0.7934	-6.169127	0.0001	I(1)
ln(IFR)	-4.809472	0.0023	--	--	I(0)
ln(MPR)	-3.037697	0.1361	-7.433496	0.0000	I(1)
ln(CAP)	-2.361370	0.3926	-6.301516	0.0000	I(1)
ln(LAB)	-1.851494	0.6572	-5.415253	0.0005	I(1)

Source: Author's computations using EViews 10.0

The ADF based stationarity test results for unit root was reported in Table 3. It is worthy to note that the logged values of RNF, TPR, FMZ and IFR were stationary at level, that is, I(0). On the other hand, the logged values of ABO, EXR, MPR and LAB were stationary after being differenced once, that is, I(1). As the variables of the model were of mixed integration, that is, either I(0) or I(1), the most appropriate estimation approach is the ARDL.

Long-run estimation of the ARDL model

The long-run estimation began with the bounds testing for possible cointegration among the variables under review after which the long-run coefficient estimates of the ARDL model was presented. The outcome of the ARDL bounds test was presented in Table 4.

Table 4: Bounds test results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	6.577644	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Source: Author's computations using EViews 10.0

The computed F-statistic value (6.577) is greater than the upper bound value (3.21) at 5% level of significance. Hence, the null hypothesis of no cointegration is rejected at 95% of confidence interval. This implies that agribusiness output and its identified determinants are bound by a long-run relationship.

Once cointegration is established, long-run coefficient estimates were obtained for the model. Table 5 contains the long-run coefficients of ARDL (2, 2, 2, 2, 2, 2, 0, 2, 2) model with optimal lag length suggested by the Akaike Information Criteria (AIC).

Table 5: Long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.44270	9.577441	2.030052	0.0672
ln(ABO(-1))	-0.347234	0.089734	-3.869597	0.0026
ln(RNF(-1))	0.256470	0.292700	0.876223	0.3996
ln(TPR(-1))	-5.797707	2.627159	-2.206836	0.0495
ln(FMZ(-1))	0.028675	0.050257	0.570574	0.5798
ln(EXR(-1))	0.138230	0.041608	3.322225	0.0068
ln(IFR(-1))	-0.053576	0.043373	-1.235241	0.2425
ln(MPR)**	0.018161	0.056063	0.323933	0.7521
ln(CAP(-1))	0.263618	0.091905	2.868380	0.0153
ln(LAB(-1))	0.304586	0.101029	3.014837	0.0097

Source: Author's computations using EViews 10.0

Of the eight (8) determinants of agribusiness output considered in this study, TPR, EXR, CAP and LAB emerged the most significant factors influencing agribusiness output in the long-run, but exchange rate and labour employed in agribusiness had the highest impact since their significance level were at 1% as against the 5% level of significance obtained for TPR and CAP. The estimated coefficients of TPR, EXR, CAP and LAB mirrored the predictions of economic theory regarding the negative effects of high temperature on agribusiness output and the positive effects of exchange rate, capital and labour employed in agribusiness. *Ceteris paribus*, the coefficient of TPR revealed that a 10% increase in average annual temperature (TPR) in Nigeria led to 57.97% decrease in agribusiness output (ABO). Also, the coefficient of exchange rate (EXR) showed that 10% increase in Naira-Dollar exchange rate accelerated ABO by approximately 1.38%. Again, the estimated coefficient of agricultural capital (CAP) indicated that ABO increased by about 2.63% due to a 10% increase in CAP. Similarly, the estimated coefficient of LAB showed that a 10% increase in labour employed in agribusiness caused ABO to accelerate by approximately 3.04% in the long-run. The one period lag of ABO showed that previous year's agribusiness output caused significant effect on current year's ABO. On the other hand, RNF, FMZ, IFR and MPR were not significant determinants of agribusiness output in the long-run, though inflation rate (IFR) caused a diminishing effect on agribusiness output in Nigeria.

A plausible reason for the positive and significant effect of exchange rate could be due to the fact that increased exchange rate of Naira-Dollar made imports (including agricultural imports) to be expensive, hence consumers relied on domestic products which led to increase in agribusiness output. Also, the positive and significant effect of agribusiness capital and labour is as expected that increased capital supply (in terms of finance) and supply of labour is required to run investment activities in agribusiness as such investments are usually capital intensive as predicted by the production function where capital and labour are considered prominent in the production process. On the other hand, the negative and significant coefficient of average annual temperature is indicative of the fact that excessive weather temperature could hinder productivity of agribusiness sector as myriad of crops might not thrive under such harsh weather condition.

Short-run ARDL estimation and error correction mechanism (ECM)

The short-run and error correction representation of the selected ARDL model was displayed in Table 6. The letter 'd' before the variables indicates first difference of the variable. Table 6 revealed that the short-run coefficient of annual rainfall (RNF) was positive and significant, but became positive with one lag which indicated that 10% increase in RNF spurred ABO in the short-run within one year. The negative short-run coefficient of temperature (TPR) is consistent with its long run coefficient, thus implying that increase in TPR was associated with diminishing ABO.

Table 6: Error Correction Model Equations (ECM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dln(RNF)	-0.530673	0.076128	-6.970834	0.0000
Dln(RNF(-1))	0.138230	0.041608	3.322225	0.0068
DLOG(TPR)	-1.313752	0.678040	-1.937573	0.0788
Dln(TPR(-1))	-3.567189	0.528390	-6.751053	0.0000
Dln(FMZ)	0.030924	0.018364	1.683941	0.1203
Dln(FMZ(-1))	0.173676	0.020064	8.656161	0.0000
Dln(EXR)	0.058011	0.031872	1.820121	0.0960
Dln(EXR(-1))	-0.383592	0.039117	-9.806253	0.0000
DlnG(IFR)	0.032780	0.013108	2.500799	0.0295
Dln(IFR(-1))	-0.025225	0.010486	-2.405651	0.0349
Dln(CAP)	0.304782	0.036230	8.412314	0.0000
DlnCAP(-1))	0.294206	0.035265	8.342701	0.0000
Dln(LAB)	0.244668	0.042213	5.796062	0.0000
DlnLAB(-1))	0.112847	0.048394	2.331857	0.0264
ECM(-1)*	-0.347234	0.034339	-10.11200	0.0000
R-squared	0.967950			
Adjusted R-squared	0.946021			

F-statistic	3569.189			
Prob(F-statistic)	0.000000			
Durbin-Watson stat	1.580748			

Source: Author's computations using EViews 10.0

However, after a period lag, the effect of TPR became more significant as 10% increase in TPR caused ABO to diminish by 35.67% at 1% level of significance. Also, the coefficient of farm size (FMF) revealed that increase in arable land spurred ABO, but became significant at 1% level after one period lag when 10% increase in FMZ caused ABO to accelerate by 1.73% increase in ABO. The positive coefficient of short-run FMF was in consonance with its long-run estimated coefficient which proved that increase in farm size stimulates agribusiness output in Nigeria to a large extent. Again, in the early stage, exchange rate (EXR) had positive and insignificant effect on ABO, but it turned negative and significant after one period lag as 10% increase in EXR caused 3.83% decrease in ABO at 1% level of significance. Similarly, inflation rate (IFR) had a positive and insignificant effect on ABO, but became significant after one-year lag as an increase in IFR caused a diminishing effect on ABO by a tune of 2.52%. On the other hand, short-run coefficient of capital (CAP) and labour (LAB) revealed that 10% increase in capital and labour supply to agribusiness spurred ABO by 3.04% and 2.44% respectively in the short-run in consonance with the long-run estimates. It then implies that accelerations in agribusiness output is associated with capital and labour supply to agribusiness.

As expected, the coefficient of the ECM(-1) is negative and significant. It then implies that the ARDL model is stable. It also reveals that 34.72% of the disequilibrium from the previous year is corrected within one year. However, the coefficient (-0.347234 or 34.72%) of the ECM shows a relatively slow speed of adjustment and reaffirms the existence of long-run relationship among the model variables. The value of the coefficient of determination, that is, adjusted R-Squared is 0.946021 which indicates that about 94.60% of the variation of agribusiness output in Nigeria was explained by the explanatory variables. The F-statistic is also statistically significant at 1% level of significance which verified that the model was well specified.

Diagnostic tests

The study confirmed the stability of the ARDL model by conducting the residual based diagnostic test listed in Table 7. These tests are subject to the following hypotheses at 5% level of significance:

1. **Serial Correlation Test**

   Hypothesis:

   H_0: Absence of autocorrelation

   H_1: Presence of autocorrelation

2. **Heteroskedasticity Test**

   Hypothesis:

   H_o: Absence of heteroscedasticity

   H_1: Presence of heteroscedasticity

3. **Jarque-Bera test for Normality**

   Hypothesis:

H_0: Normally distributed error term.

H_1: Non-normally distributed.

Results from the diagnostic tests were summarized in Table 7 :

Table 7: Diagnostic tests

Tests	t-Statistic	Prob.
Breusch-Godfrey Serial Correlation LM Test	0.272294	0.7677
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.754662	0.7219
Jarque-Bera test for Normality	1.781627	0.4103

Source: Author's computations using EViews 10.0

Based on the diagnostic tests, it was concluded that the residuals of the ARDL model was free from severe autocorrelation, heteroskedasticity and abnormality in the residuals.

Figure 2: CUSUM test

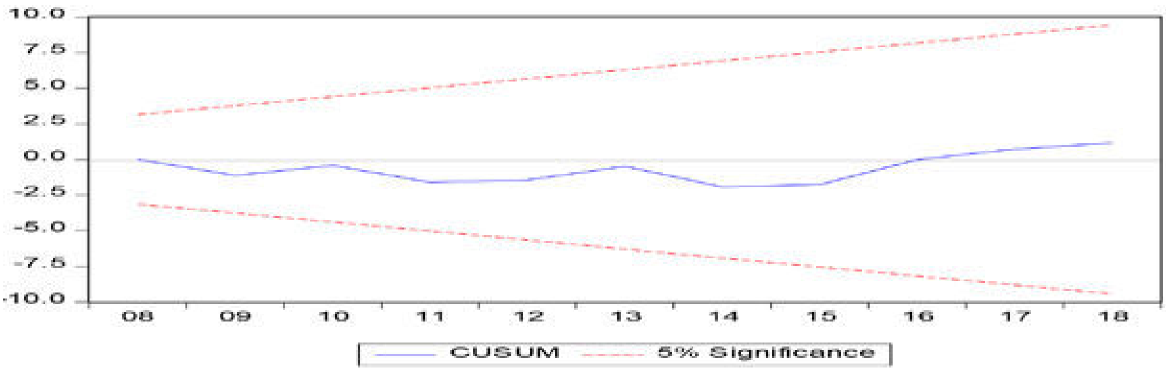
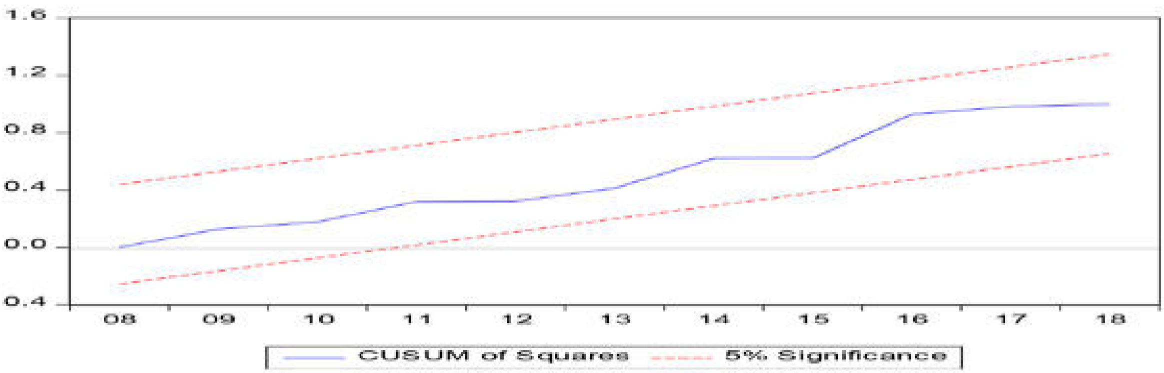


Figure 3: CUSUM of Squares



The cumulative sum (CUSUM) of recursive residuals and cumulative sum of squares of recursive residuals (CUSUMSQ) test (see, Figures 2 and 3) was used to confirm the stability of the ARDL (2, 2, 2, 2, 2, 2, 0, 2, 2) model. Figure-1 reveals the plot of (CUSUM) while plot of (CUSUMSQ) is given in Figure-2. Figure-1 indicates that the CUSUM remains within the 5% critical bounds. Similarly, Figure-2 reveals that the CUSUM of Squares was within 5% critical bounds. Hence, both graphs verified that the ARDL model was well specified and stable; and the coefficients of the model are reliable.

Conclusions and Recommendations

Having analyzed the determinants of agribusiness output in Nigeria with the aid of ARDL model, it was discovered that the major factors responsible for the observed level of agribusiness output in the long-run were temperature, exchange rate, capital and labour. On the other hand, agribusiness output in the short-run was mainly determined by rainfall, temperature, farm size, exchange rate, inflation rate, capital and labour. Hence, it was concluded that determinants of agribusiness output were more influential in the short-run. It is, therefore, recommended that:

1. To effectively manage the incidence of climate change in agribusiness, farmers should embark on implementation of more irrigation practices as well as integrated farming system. For instance, integration of crop-livestock can accelerate agribusiness productivity as livestock can use parts of plant and crop by-products while the crops can utilize livestock waste as manure.
2. One of the problems associated with acquisition of sufficient land for agribusiness activities is the issue of feudalism. Hence, policy makers should introduce land reforms that would bridge the wide income gap between land owners (landlords) and land users (farmers) to increase the area under cultivation for agribusiness activities in Nigeria.
3. Monetary and fiscal authorities should implement effective macroeconomic policies that would ensure maintenance of moderate monetary policy rate as well as single digit inflation and stable exchange rate through proper economic diversification to increase varieties of export commodities which will in turn strengthen the domestic macroeconomic environment.
4. To ensure sufficient capital flow to agribusiness, government should increase agricultural expenditure through the annual budget allocations. Also, government should ensure adequate credit should be extended to farmers through commercial banks, microfinance banks, etc.
5. To ensure optimal productivity of labour, government should ensure proper education of farmers through extension services. If the farmers are properly trained and educated, they can make use of the available technology, hence labour efficiency is ensured leading to increase in agribusiness output.

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