Research Article

Impact of Agricultural Output on Economic Growth in Nigeria: Application of Numerical Prediction and Econometric Analysis

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Abstract: The agricultural sector, as a whole, of any nation has been affirmed as one the solution to economic growth challenges. Thus, the agricultural sector can largely impact economic growth, though the process and extent to which it influences economic growth, is a topic that has drawn vast attention from researchers. Hence, this study considers an investigation of the long-run relationship, specifically between agricultural output and economic growth in Nigeria. In order to holistically interpret the relationship between the variables examined, a numerical approach known as the block method is adopted to a mathematical model developed for the variables using the logistic growth model, in order to predict the dataset for years 2020 to 2025. This implies that the study made used of annual data for the period of 1981 to 2025. The econometric analysis was conducted using the ARDL bound test approach to examine the connection between the nation's agricultural output and economic growth. The findings indicate the existence of long-run relationship among variables, likewise short-run relationship. The pairwise granger causality test shows that there is one-way causality moving from agriculture to economic growth. This indicates that agricultural output leads to economic growth, but economic growth does not lead to agricultural output. The results approve the positive link between agricultural output and economic growth, which is helpful to improve the nation's economic outlook. Hence, this study emphasized and suggested the need to support agricultural sector through economic policies and finances.

Keywords: Agricultural Output; Economic growth; Numerical Prediction; Block Method; ARDL Bound Test; Nigeria.

1. Introduction

The economics of nature management takes a range of management perception on the global deteriorating state of the natural environment. Thus, nature management focuses on the economic decision of investing inadequate finances in nature such as agriculture, by many emergent nations, at the expense of investing in other essential sectors such as education or infrastructure. The agricultural segment plays an exceptionally imperative role both in the developing and developed nations, as it is considered as a spine of the nations. Thus, the agricultural sector is the pillar of numerous nations' economies because the segment is vital to the socio-economic improvement.Also, it is a significant component which influencesa nations's advancement [1][2][3][4]. This thereby requires the funtion of agriculture in improving the economic structure of any nation, which cannot be over stressed because of agriculturebeing the source of nourishment for animal and man; and furthmore gives raw materials for the manufacturing segment [5][6][7].

Nigeria as an example of an emergent country is essentially an agrarian nation, as 70% of the populace is obliquely and straightforwardly attached to theagriculture part. For some decades now, the nation's economy strives on this sector with over 60% of its contribution to Gross Domestic Product (GDP) and workforce. However, the proportion of agrarian in 2018 to GDP reduced to about 26% and it utilizes 36.4% of the work power (total employment). Nigeria's aggregate cultivation part is about 76.2 million hectares (77.7% of land areas), and 34 million hectare (37.3% of land areas) region is under developed, indicating that greater part of cultivation zone is inert and unused. Thus, this sector can still be described to be the major significant division of the economy, which owns a ton of possibilities for improvement in the nation's economic outlook as recorded in various studies [3],[8]. Nigeria has many areas of agriculture, such as livestock, forestry, fishing, food and cash crops production, to choose for business. This comprises of produces such as yams, cassava, maize, cocoa, groundnut, oil palm, etc. The nation has emerged as the greatest producer of yam, cassava and cowpea worldwide but still underperforming in food crops for her populace. This makes the nation a net importer with more than 70% of her rural inhabitants living below the poverty line.

Even with the government's ingenuity to encourage private sectors to venture into agriculture, the sector still has low production relative to the nation's populace. Whereas, insufficient finance, inadequate marketing of agricultural product, low literacy rate, among others, have been identified as factors behind low production [9],[10]. Moreover, in spite of the share of agriculture in the GDP gradually declining, the sector still plays an important role in the totality of the nation's socio-economic development. Thus, different measures under the green revolution program which includes introduction of modern inputs and technology (fertilizer, pesticides, high yielding varieties of seeds), cultivation of extra area, extension of irrigation facilities, water management and plant

protection and crop rotation practices have to be considered for productive effect of the agricultural segment [11],[12].

In spite of all these reforms, policies and programmes put in place for the improvement in this sector, there is still little or no change in its contribution to GDP as expected, compared to decades ago. Hence, raised quite a number of questions concerning the impact this sector plays on economic growth in recent time. Such as, why the neglect or decline in the nation's agricultural sector despite its debatable massive productivity potentials? On the basis of this discussion and question, this study is thus motivated to analyze the nation's economic growth performance through the contribution of agricultural output in the nation.

Lot of research studies have focused on observing the influences of macroeconomic factors on economic development and growth in light of the vitality of nations. In various countries, noteworthy research endeavors [9], [10], [13][14][15][16][17][18][19] have examined different variables on economic growth. In a nutshell, these studies concentrated on developing nations by highlighting the vital roles played by agriculture as prime sector for export and revenue. Thus, studies examining agriculture and economic growth are widespread, especially in recent time.

Significant number of research works on agriculture and economic growth have been done both in developed and emerging countries. [7] reconsidered the debate on the function of agrarian on stimulating economic growth in 9 selected developing nation-states. The study inspected the causal connections amid agriculture and GDP growth with the help of directed recurring graphs and a developed algorithm of inductive causation. It was suggested that agriculture could be a driving force of economic growth, but the influence differs across countries. Thus, some nations were found to support the agriculture-led growth hypothesis while other countries signified that vivacious aggregate economy is a requirement for agricultural development.

[12] also investigated whether agriculture production matters for growth in India utilizing a contextual analysis for the period 1961 to 2016. The study utilized the Johansen co-integration and vector error correction (VEC) techniques for analyzing the connection between agricultural production and economic growth. The outcomes exhibited that there is long-run connection among the factors examined, and also indicated that there is unidirectional causality moving from GDP to agriculture output in the long-run, signifying that economic growth leads prompts agriculture output. It was also mentioned that bidirectional causality was found in the short-run, indicating that economic growth leads to agricultural production and vis-à-vis. [2] also led a study on the influence of agriculture on the economic growth in Pakistan. The study revealed that agrarian sector is the most crucial segment and the backbone of the country's economy. The research analyzed time-series data which is collected from different secondary sources. The results indicated that agriculture problems leads to the fluctuations in the nation's economic growth. Similarly, [20] examined the link among economic growth and agrarian yields such, as suger cane, maize, wheat and rice for the duration of 14 years. The study made used of some factors such as agricultural exports and agricultural employment, in order to give conclusive findings for the country (Pakistan). The results revealed that agrarian yields such as wheat and maize outputs significantly upsurges the nation's growth whereas agrarian exports does not. The results confirmed that there is a positive relation between agrarian employment and growth in economic which would reduce internal migration problems in the nation. In conclusion, the study highlighted the necessity to aid sugarcane and rice produces through reasonable charges and economic strategies in the good markets.

In the same manner, [21] carried out a research in Nigeria on agriculture and growth. The work suggested that a possible way of improving economic growth in the state is by boosting the agricultural sector output because causality between the agricultural sector output and economic growth, runs from economic growth to agriculture. The results also found that long-and short-run relationships existed among the factors. The study hereby recommended that the administration should pursue strategies that will stimulate economic growth by boosting the agricultural sector of the nation. Also, the study indicates that increase in agriculture output can be used for feeding the nation's populace as well as promoting exports diversification.

These various studies among other research, established the connection among agriculture, diverse variables, and nations' economic growth. However, this research work is profoundly necessary in order to device long duration of agrarian policies for sustainable growth by evaluating in a specified nation's context (Nigeria) which most studies have not examined. Thus, makes this research work to have a discrete scope in a given situation of predicting and analyzing possible future outcome of agricultural output and the nation's growth. Hence, necessitate the emphasis on this area for further exploration in countries for dynamic policy suggestions.

2. Material And Method

This study involves quantitative analysis of the variables, using numerical and econometric statistical techniques. The methodology will include three phases: model specification, numerical prediction, and data

analysis. These phases are highlighted in the flowchart below with details of each phase given in the subsequent subsections.

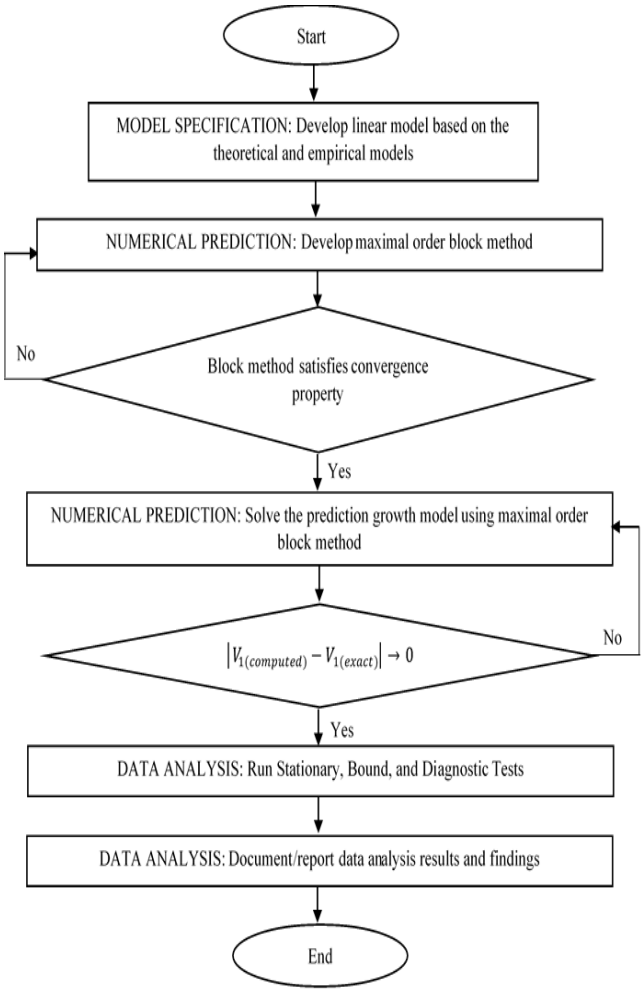

Fig. 1 Flowchart of Research Stages

Model Specification

The model adopted in this study is developed based on the theoretical and empirical models. The generalized growth model by [22], similar with the neoclassical aggregate production function as the theoretical foundation of output equation is presented as follows:

$$GDP_t = A_t f(K_t, L_t) \tag{1}$$

where*GDP* denotes aggregate output, *A* is level of technology, *K* is physical capital with the inclusion of human capital as for the neoclassical aggregate production function, and *L* denotes labour as in Solow's model. Following the Feder's model extension [23] of the production function in an economy presumed to consist of both the export and non-export sectors, each of the sectors have different production functions with the incorporation of *A*, *K*and *L* as factors influencing output. Thus, to achieve the objective of this research work, which is to examine the agricultural output's influence on economic growth, the generalized growth model is modified using agricultural output (*AgrO*) to represent the non-export sector. The obtained linear model is defined as:

$$Y_t = \lambda_0 + \lambda_1 AgrO_t + \mu_t \tag{2}$$

with corresponding ARDL representation given as

$$\Delta Y_t = \lambda_0 + \sum_{i=1}^{n} \lambda_{1i} \Delta Y_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta AgrO_{t-i} + \sigma_2 AgrO_{t-i} + e_t \tag{3}$$

where $Y_t = GDP$, $AgrO_t = Agricultural\ Output$, $\{\lambda_0, \lambda_1, \alpha_2, \sigma_2\}$ are parameters, and e_t represents the error term.

Numerical Prediction

This research analyzes the statistical connection between Nigeria's agriculture output and economic growth. All series of data are based on the annual data, and the sample period of observation is from 1981 to 2025. The required data for the analysis from 1981 to 2018 are collected from the Central Bank of Nigeria (CBN) Statistical Bulletin and World Bank Database, which is more than 30 years in line with the central limit theorem, which states that a conservative definition of a sufficient large sample size can be greater than or equal to 30 [24],[25] . The dataset for 2019 to 2025 which is required for the analysis are predicted using a numerical approach known as the block method. These dataset values are required to forecast the possible outcome of the influence of agrarian productivity on the nation's growth based on past data.

This section will detail the developed block method and also highlight its convergence properties. This is required to ensure the usability of the numerical method to be implemented to solve the prediction growth model. The block method is adopted to a mathematical model developed for the variables using the logistic growth model defined as

$$V' = rV\left(1-\frac{V}{\Gamma}\right), V(t_0) = V_0 \tag{4}$$

with V being substituted for the individual variables to be predicted and $V' = f(V,t)$. Γ denotes the carrying capacity (limiting value) of the variables, r represents the growth rate, $V(t)$ represents the variable value as a function of time t, and the constant V_0 denotes the initialized value at a chosen time t. A two-step block method with order of maximal order with good accuracy is developed using the linear block approach algorithm in [26] to obtain the block method schemes as:

$$\begin{aligned} V_{n+1} - V_n - \frac{h}{240}[101V_n^{(1)} + 128V_{n+1}^{(1)} + 11V_{n+2}^{(1)} \\ + h\left(13V_n^{(2)} - 40V_{n+1}^{(2)} - 3V_{n+2}^{(2)}\right)] = 0 \\ V_{n+2} - V_n - \frac{h}{15}\left[7V_n^{(1)} + 16V_{n+1}^{(1)} + 7V_{n+2}^{(1)} + h\left(V_n^{(2)} - V_{n+2}^{(2)}\right)\right] = 0 \end{aligned} \tag{5}$$

To ensure convergence of the block method schemes in Equation (5), the method should satisfy zero-stability and consistency [27]. For the zero-stability condition, the roots of its first characteristic polynomial $r^2 - r$ satisfies $|r| \le 1$, and in terms of consistency, the order of the method which is 6 satisfies the condition to be greater than or equal to 1. Therefore, since the block method satisfies both conditions of zero-stability and consistency, it is convergent. In order to ensure closely accurate result in the predictions, the method in Equation (5) is adopted to solve the model in Equation (4), such that the iteration is initialized at $t_0 = 2017$, and the schemes combined as simultaneous integrators for the solution of (4). In addition, the condition $|V_{1(computed)} - V_{1(exact)}| \to 0$ is imposed for accuracy, with the value of $V_{1(exact)}$ extracted from the dataset. The resulting predictions were then utilized for the empirical analysis of the data.

3. Result And Discussion

The econometric model is used to analyze the statistical link between GDP as a dependent factor and agricultural output is considered the independent factor. Specifically, the study defines the hypothesis in line with the stated models in order to achieve the objective, which is whether agricultural output would have significant impact on economic growth (GDP) in Nigeria in the long and short-run within the time examined.

4. Stationary Test

To check the variables stationary nature of the time series data, the unit root test is carried out; at level, first difference or second difference that are denoted as I (0), I (1) and I (2) respectively. Thus, if the variables of a model have mixed stationarity results that is revealing a variable at I (0) and others at I (1), then the ARDL estimation method can be conducted. This co-integration analysis developed by [28] is applicable because it

analyses variables irrespective of the stationarity, but variables mainly at I (0) or I (1) are used for the estimation and identification of long-run and short-run adjustments of the independent variable(s) on the dependent variable through the aid of the bound test and error correction model. The Augmented Dickey Fuller (ADF) and Philips-Perron (PP) test are used for conducting the order of integration (stationarity test).

Table I Result of ADF and PP Unit Root Test

Variable	ADF		PP		Result
	Constant	Trend & Constant	Constant	Trend & Constant	
GDP	3.269512 **	2.937720	4.421770 ***	4.191807 ***	I (0)
Agri O	5.217217 ***	5.598288 ***	5.277353 ***	5.652785 ***	I (1)

Notes: ***, **, * indicates dismissal of the invalid speculation of a unit root at the 1%, 5%, and 10% centrality level respectively. No reference mark shows that the arrangement is non-stationary.

According to Table 1, the stationarity test revealed that the two tests adopted are both at level I (0) and first differences I (1) for the variables examined. This implies that the methods of stationarity tests (ADF and PP), leads to the conclusion that the variables (GDP and agricultural sector) examined for the country reflects non-stationary problem, with variables at I (0) and I (1). Hence, the finding supports the proceeding with the ARDL co-integration test that accommodate stationarity of variables at I (0) and I (1) for further analysis.

5. Bound Test

The bound test by [29] establishes the presence of the long-run link amid the factors, and also reflects existence of error correction. Considering the dataset, an Autoregressive distributed lag (ARDL) (1, 3) estimate was chosen for the model with unadjusted R (53.7%) and the adjusted R (47.3%). Therefore, the estimation of 'F' statistics for the ARDL estimate for GDP with the agricultural output is given in Table 2 below.

Table II ARDL Estimate

Selected Model: ARDL (1,3)		
R-Squared	Adjusted	R-Squared
0.537343	0.473085	
F-Statistic	Prob.(F-Statistic)	
8.362279	0.000025	

Source: Authors' computation from EViews 10.

The table 2 induces the appropriate optimal lag length that will leads to a meaningful cointegration result according to Akaike Info Criterion (AIC). Thus, it is evident from Table 3 below that the invalid speculation of no cointegration is rejected and the presence of long-run harmony is affirmed. The concluding part of the cointegration is gotten from [30] basic table for the separate autonomous factors (k = 1), and "n" as the number of observed years (43). With, 5% and 1% criticality dimension for upper and lower limits respectively. It is observed that GDP is co-integrated with agricultural output. This implies that there is long-run connection between GDP and agricultural output.

Table III Result of Bound Test under the Condition of Unrestricted Intercept and No Trend

Calculated F-statistic = 24.83708 (lag lenght, k=1)		
Bounds Level	**I(0) Lower Bandwidth**	**I(1) Upper Bandwidth**
1% Critical Bounds Value	6.84	7.84
5% Critical Bounds Value	4.94	5.73

[31] critical values for: 5% is I (0) =5.235, I (1) = 6.135 and 1% is I (0) = 7.740, I (1) = 8.650. Source: Authors' computation from EViews 10.

Similarly, the error correction model is applicable since there is confirmation of the long run relationship among variables. This application combines the short-run changes with the long-run and demonstrates the speed of alteration from the short run towards the long-run equilibrium. Hence, in accordance to Table 3, the results obtained for the error correction model (ECM) estimation for the model revealed that the independent variable has been proved to be significant and adjusting. This is because the ECT co-efficient (Cointeq (-1) = -0.900052) is not

positive and showing a significant sign at 1%, thus indicating the speed of adjusting in the short-run as shown in Table 4.

Table IV ARDL Error Correction Regression (Unrestricted Intercept; No Trend)

	Coefficient	T-statistic	Prob.
C	2.415622	3.325119	0.0020***
D(Agric)	0.004663	4.630554	0.0000***
CointEq(-1)	-0.900052	-7.145207	0.0000***
F-Statistic	**18.89018**	Prob.(F-Statistic)	0.000000

Notes: ***, **, * indicates the 1%, 5%, and 10% centrality level respectively. Source: Authors' computation from EViews 10

However, for further examination on the variables whether it causes each other, the causality test was examined. The Pairwise Granger causality result exhibited in Table 5 express the causal direction concerning agriculture output and economic growth.

Table V Pairwise Granger Causality Test

	Obs.	F-statistics	Prob.
Agric does not Granger cause GDP	43	3.21811	0.0512
GDP does not Granger cause Agric		0.34041	0.7136

Source: Authors' computation from EViews 10.

The result revealed that the null hypothesis is rejected at 5% (0.0512), which implies that agriculture output only cause economic growth.

6. Diagnostic Tests

The diagnostic tests are conducted to test the proficiency of the model which must be consistent with the standard assumptions of Ordinary Least Square (OLS) such as serial correlation, normality, heteroscedasticity, CUSUM, CUSUMSQ, etc. Serial correlation shows if a model is having autocorrelation problem that must not be significant at any level, while heteroscedasticity shows whether the disturbances are equal or constant variance in the model that must not be significant at any level. CUSUM and CUSUMSQ are applied to examine the stability for the long-run relationship of the model that must be in between the line in order for the test to be significant at 5% level altered. Likewise, Ramsey Reset tests whether there is existence of some significant non-linear relationships on the linear model used in the study that must not be significant at any level [31].

Table VI Diagnostic Tests

Tests	Statistics	Prob.
a. Breusch-Godfrey Serial Correlation LM test:		
F-statistics	0.964953	0.3912
Obs R-squared	2.255950	0.3237
b. Heteroskedasticity test:		
F-statistics	0.643173	0.6683
Obs R-squared	3.444201	0.6318
c. Ramsey Reset test:		
F-statistics	0.165044	0.6870

Source: Authors' computation from EViews 10.

In application to the data, Table 6 shows the Breusch-Godfrey sequential connection LM test demonstrate that F-measurement equivalents to 0.964953 and the prob.F (2, 34) which is 0.3912 is inapt; this shows the assessed model have no autocorrelation issue. The Breusch-Pagan-Godfrey test for heteroscedasticity show that F-statistic = 0.643178 and the Prob.F (5, 36) is 0.6683. Likewise, the Ramsey Reset test show that the F-statistics equals 0.165044 with the probability is 0.6870. Similarly the CUSUM and CUSUMSQ tests for stability are referred to as the Fig. 2 and Fig. 3, respectively.

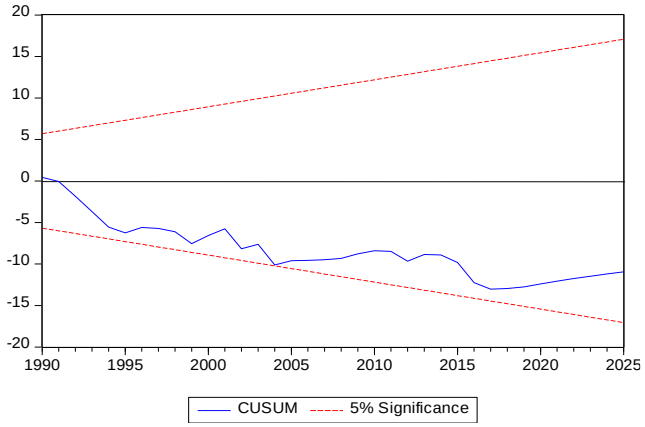

Fig. 2 CUSUM Test for Stability

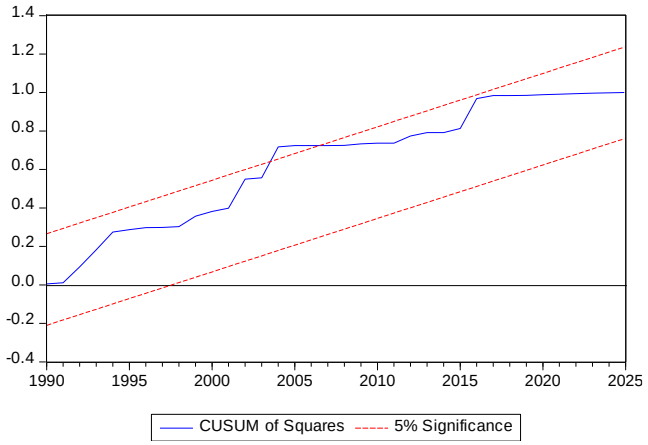

Fig. 3 CUSUMSQ Test for Stability

7. Conclusion

This study has successfully shed insights on the performance of agricultural output to the nation's economic growth during the period of 1981 to 2025. A novel introduction of the adoption of numerical block method in application with the logistic growth model successfully provided the required prediction values to conduct a holistic analysis of the variables within the chosen years. Furthermore, ARDL techniques were used to investigate the relationship between the agricultural output and economic growth. From the analysis conducted, the bound test result indicates that there is long-run equilibrium relationship between the variables in Nigeria. Whereas, the pairwise Granger causality test reveals that unidirectional causality exists between economic growth and agriculture output, running from agriculture output to economic growth. This translates to mean that economic growth does not lead to agriculture output, whereas agriculture output leads to economic growth in the long-run. Thus, highlighting the positive and significant impact of agricultural output on improving the economic outlook performance for the nation. Finally, the study observed that agricultural output really matter for the nation's economic growth. In the future, studies can conduct an examination of the various components encompassing the agricultural sector, separately and also in terms of inter-dependence, in order to identify the exact variable(s) that positively impact the agricultural sector.

From the results obtained in the analysis, it is evident that the agricultural sector has been identified to be significant and vital for the nation's economic growth. Hence, the study hereby recommends that agricultural output should be improved through various means such as setting aside of additional areas for cultivation and extension of irrigation services should be encouraged which will aid the green revaluation. In addition, modernized agricultural equipment such as pesticides and cropping rehearses that has productive results on the sector should be made available for use and also good yielding diversity of seeds should be introduced. Likewise, private sectors should be encouraged by the government through finances and patronizations on agricultural aspects such as the food industries.

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