IJEEP

INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY

EJ EconJournals

ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2020, 10(2), 113-123.

EJ EconJournals

Electricity Consumption, Public Agricultural Expenditure and Output in Nigeria: A Time Series Dynamic Approach

Uchechukwu E. Okorie[1]*, Evans S. Osabuohien[2], Hassan E. Oaikhenan[3]

[1]Department of Economics and Development Studies and Fellow, Centre for Economic Policy and Development Research, Covenant University Ota, Nigeria, [2]Centre for Economic Policy and Development Research, Covenant University, Ota, Nigeria, [3]University of Benin, Benin, Nigeria. *Email: uchechukwu.okorie@covenantuniversity.edu.ng

Received: 18 July 2019 **Accepted:** 30 November 2019 **DOI:** https://doi.org/10.32479/ijeep.8436

ABSTRACT

This study interrogates the effects of electricity consumption and government agricultural spending on agricultural output (AGOP) in Nigeria using data that spanning through from 1981 to 2017. The unit root test was conducted with Phillip Perron at constant and trend while the dynamic model of autoregressive distributed lags was used in ascertaining the existence of cointegration among the variables in the model. The outcome of the study shows that poor electricity supply has significantly retarded the level of AGOP in Nigeria while public agricultural spending indicates a weak positive lag effect on agricultural sector performance. These outcomes capture the adverse effect of shortage in electric energy supply and poor government allocation on agricultural production of goods and services. We, therefore, advocate for sector-driven energy policies that will foster the growth and development of the agricultural sector through mechanisation of agricultural system.

Keywords: Electricity Supply, Government Expenditure, Agricultural Sector
JEL Classifications: E23, E62, H54, L94

1. INTRODUCTION

The quest for energy and the utilisation of electricity have witnessed significant increase over the last two decades due to its pivotal role in real sector productivity which most importantly includes the agricultural sub sector. This could further be attributed to the increase in industrialisation and human development globally, (Matthew et al., 2018). Economic growth and development are easily attained especially among developing economies through intense utilisation of energy such as electricity in value creation process. Increases in population and urbanisation have also enhance the demand for energy across the globe (Akinyemi et al., 2019).

With the increase in commercialisation of the agricultural sector, the use of electric energy in the processing and preservation of agricultural products have accounted for the high volume of production and marketing of commodities from agriculture (Osabuohien et al., 2019). It is possible to process perishable farm produce such as fruits and vegetables into drinks that can be preserved for a longer period of time without going, which is essential element of value chain development (Oyebola et al., 2019). This through strategy agricultural products could be protected from excessive waste while losses incurred due to product spoilage are minimised for the producers. Adequate supply and consumption of electricity facilitates economic development and growth through improvement in the quantity and quality of agricultural commodities of emerging economies. Not with standing, electricity consumption (ELEC) have resulted into increase in green house emission, pollution of the immediate environment and destruction of the ecosystem on a high dimension (Alege et al., 2017; Rehman et al., 2019; Egbetokun et al., 2019).

Electricity is one of the topmost sources of energy needed for daily consumption particularly in agricultural production such as heat generation and processing of agricultural products. It is one of the three highly ranked basic infrastructure that is lacking in developing countries. Many youths lack access to adequate source of electricity in addition to the high rate of unemployment in emerging economies (Matthew, 2011). Industries and manufacturing companies makes use of electricity on daily production activities. Poor electricity supply have hampered industrial production of physical goods and services. Previous studies (Adeniran et al., 2018, Alege and Osabuohien, 2015; Osabuohien et al., 2018) have observed that in the absence of electricity human strengths and potential in relation to production and creation of value will hardly become a reality. Electricity in its usefulness and application to agriculture facilitates commercialisation of agricultural practice through large scale production, processing and packaging of agricultural output (AGOP). It further encourages the establishment of agro-allied industries that are involved in the agricultural value chain which mostly rely on electric energy to power their machines and equipment. This could be easily achieved when the environment is business friendly. A conducive business environment is one that is characterised by low cost of production especially in the process of generating power. In such case, the role of public infrastructural expenditure which includes the provision of constant electricity supply become very pertinent for production to strive. Public provision of electricity will ensure energy generation at minimum cost and maximum social welfare is achieved unlike situations where individuals are forced to source for their power supply at a higher cost.

This study is driven by the discovering from literature that on the global level, approximately 1.2 billion people have poor access to electricity while 2.8 billion individuals rely on other sources such as charcoal, coal, firewood and solid fuel (Jahan, 2000). The excessive reliance on these other energy sources have also escalated the problem of household air pollution in the cooking process. The United Nations for energy sustenance in recognition of the need for a better environment free from air pollution came up with three goals to be attained by 2030, these are; to reach to the level of world acceptance of cleaner energy, see that there is adequate supply of energy and an increase in the percentage of renewable energy in international composition of energy.

Agriculture, on the other hand, has been the main stay of the Nigerian economy and provides highest proportion of employment particularly among the rural dwellers, (Okezie et al., 2013). The growth rate of public expenditure on the agricultural sector has been very low. However, the agricultural sector have witnessed some structural changes, the mechanisation process is increasing, and the utilisation of energy to power agricultural machines have improved. Owing to inadequate supply of electricity, the agricultural production has been drowsy and laborious.

In regard to the best of the knowledge of the authors studies on the growth of AGOP through higher utilisation of electric energy triggered by public expenditure have not been conducted. Hence, the present study contributes to the existing literature by filing this gap in the literature. Most interestingly this study is able to separate the short-run and long-run effect of public expenditure and energy consumption on AGOP having observed that the short-run and long-run effect of energy consumed varies for a given economy. Thus the authors have utilised the auto-regressive distributed lags (ARDL) approach to co-integration to examine the short-run and long-run effect. The stationarity test of the variables were verified with the use of Phillips Perron (PP) test. The remaining parts of the paper is organised as follows; the second section deals with a detail review of the literature. Section 3 focuses on methodological approach and data while empirical evidences and discussion were handled in section 4. Finally, policy implications in relation to government spending and consumed energy are suggested based on the empirical validations.

2. LITERATURE REVIEW

Economic growth according to the neo-classical school of thought requires the capital and labour mix. Beyond these two factor is the issue of technological progress and human capital development that also determine the rate of growth for an economy. Technological development and application of mechanisation needs quite enormous level of energy generation. Thus, energy could be considered a necessary factor for output growth and consequently economic growth; highly relevant energy resources will improve its influence on technology at large. In other words, quality energy resources can facilitate technological development while less valuable ones can retard efficiency of technological innovation, (Zahir and Murtaza, 2013).

Energy sources also determine the level of production and enhanced economic activities. Zahir and Murtaza (2013) noted that the relevancy of energy is also dependent on other facets of development such as a rise in foreign earning due to the export of energy products, employment generation in energy industries, technological transfer via exploration, production and marketing, rise in workers welfare and remunerations, infrastructural and socio-economic activities in the course of exploiting energy resources.

Nwosa and Akinbobola (2012) considered the link between aggregate energy consumed and Nigerian sectoral output between the periods of 1980 and 2010. The method of data analysis involves a bi-variate vector auto-regressive (VAR) model. The result indicates a two-way causality between aggregate energy consumption and AGOP and a one-way causality running from service sector to aggregated energy consumed. It concluded that the link between consumed energy and output of respective sectors of the economy differs. Hence, energy policies that are targeted to individual sectors rather than a generalised policy was recommended. Energy policies that are conservative in nature was seen to be injurious to productivity in agricultural and service sectors within the economy of Nigeria.

Matthew et al. (2018) studied the multiplier implications of human capital development via the application of electric source of energy in the production process that promotes economic growth in Nigeria. The study employed secondary data from World Development Indicators (WDI) spanning the period 1981-2016. The method of data analysis involves the application of fully modified ordinary least squares (OLS) estimation technique. The evidences from the study indicate that human capital development is not significantly related to economic growth but ELEC proved otherwise. Hence, their study advocated for the development of human capital through public expenditure on education and health facility and also makes adequate provision for both rural and urban electrification so as to achieve high productivity level.

Chinedum and Nnadi (2016) investigated the influence of electric energy supply on the produce of Nigerian manufacturing sector within the period of 1981 and 2013. Their work made use of Johansen maximum likelihood Cointegration and VAR tests. Evidence from the study shows that the presence of a long-run relationship between electricity supply and output from the Nigerian manufacturing sector. Detailed analysis of the paper suggests no significant relationship between electric energy and the manufacturing sector produce. The study recommends that appropriate electricity supply and its stability must be a priority in formulating and implementing social policy. This consequently will culminate to the achievement of the anticipated output from the manufacturing sector.

Zahir and Murtaza (2013) investigated the effect of disaggregate energy consumed on AGOP and growth in the economy of Pakistan. In determining the long-run linkage between the variables they applied ARDL model also known as bound testing procedure in their data estimation while augmented dickey fuller (ADF) unit root test was used for the stationarity of the series. The paper shows that increases in total oil and gas consumption directly and significantly increases AGOP. However, the estimated coefficient of total electricity consumed revealed a negative relationship with AGOP. This implies that electricity consumed adversely and significantly affect AGOP. Increases in other variables such as labour and gross fixed capital formation (GFCF) raises AGOP. This further indicates that increases in agricultural investment such as tractors, harvesters and pesticides could result to an increase in the earnings of the farmers which serves as a motivation for more production.

In the area of government expenditure, Kareem et al. (2015), applied descriptive approach, OLS and correlation procedure to consider the effect of public agricultural spending and output on the economy of Nigeria. Result from the investigation revealed government disbursement in agriculture do not follow a regular trend. It further shows that more than 20% variations in AGOP was traceable to public agricultural spending. AGOP response to government agricultural expenditure was seen to be negative, thus portrays inadequate allocation to the Nigerian agricultural sector from the budget planning and implementation. Agriculture as an integral aspect of the economic land scape in Nigeria has not been given appropriate financial support leading to the retarded performance of the sector.

Okoh (2015) investigated fiscal policy effect on agricultural sector growth in Nigeria for the duration ranging from 1981 to 2013. Using ADF unit root and Johansen Cointegration procedure, he identified a co-integrating relationship fiscal policy instruments and the growth of agricultural sector. Break down of the result shows that customs and excise duties were significantly but inversely related with AGOP. The above results suggest that the imposition of tax on export of agricultural commodities do not enhance output from the sector. It rather results to declining multiplier effect on the sectors growth. Alternatively, the result of value added tax was seen to be positively significant on AGOP. The study of Ozturk (2017) conclude that agricultural value added, cereal yields and forest area significantly decreases food-energy-water poverty nexus, leading to higher economic growth and price levels at the cost of environmental degradation. In general, agricultural sustainability is the prerequisite for reducing food-energy-water poverty.

Chauke et al. (2015) did a comparison study of public agricultural expenditure effect on the growth of the sector for agriculture in two economies-South Africa and Zimbabwe. Agricultural component of gross domestic products (GDP) was used as the dependent variable. The analytical technique involves Cointegration and vector error correction model (VECM). The result revealed a direct relations between public capital expenditure and agricultural sector growth for the two countries within the period considered by the study. The authors recommended that two country's government should give more consideration for capital expenditure while prioritising their spending. This could be explained by the reason that capital outlays relates more with investment spending that has long-time on real sector growth.

Jambo (2017) studied the effect of government spending on agricultural growth in relation to four countries made up of Malawi, South Africa Tanzania and Zambia. The paper utilised various time series model in the estimation of the respective countries outcome. The model utilised agricultural component of GDP as endogenous variable while the exogenous variables were government agricultural research expenditure, infrastructural public spending, and public expenditure on price and subsidy support programes for agricultural inputs, net trade and private sector investment outlay. The evidence from the study shows that agricultural sector growth is uniquely determined by individual countries expenditure in the sector.

Mahjoub (2018) carried out a study on government subsiding agriculture influence on the export of AGOP using nine Common Market for Eastern and Southern Africa countries. The author used fixed effect analytical technique and control for GDP per capita, rural population, inflation rate, real effective exchange rate (EXR) and agricultural land under cultivation. The result indicates a positive significant influence of government agricultural outlay on export of agricultural produce. Further evidence from the investigation shows that the proportion of raw material from agriculture as percent of merchandise export rises by 1.8% due to 1 billion increase in government agricultural spending. The study thus recommends that agricultural subsidies should be increased in addition to financial and input support. These government intervention will assist in the production of higher volume of output that further translate increase export for these countries.

Osabuohien et al. (2018) interrogated the importance of local institutional framework in rice production and processing in Ogun

State, Nigeria. The study employing a key informant interviews discovered that agricultural financing constitutes the most dominant barrier to commercial rice production and processing among the local farmers. In relation to theoretical foundation, this findings conforms to Wagner (1883) law of increasing state activities in and out of the state. There is a consistent discharge of fresh responsibilities and at same time the state makes effort to improve its effectiveness in the execution of already existing duties while broadening its jurisdiction of operational capacity that will gradually lead to increment in public fiscal operations. It is thus essential that the government increase expenditure to efficiently meet up with its statutory obligations required for the development of the state.

However, to the best knowledge and widest search of the authors in literature, most studies (Shahbaz and Feridun 2011; Javid et al., 2013; Kakar and Khilji, 2011; Ahmed et al., 2013) have focused on consumed electricity and growth in the economy, others (Chinedum and Nnadi, 2016) have looked at electricity supply and manufacturing sector. Few works (Nwosa and Akinbobola, 2012) have considered ELEC and sectorial output while Zahir and Murtaza (2013) examined disaggregated energy consumed produce from agriculture and economic growth in Pakistan. Some other studies (Jambo, 2017; Mahjoub, 2018) considered the relationship relations between public expenditure and AGOP and export. There is little or no literature on ELEC, public agricultural expenditure and AGOP in Nigeria. This present study fills this gap using updated data and the ARDL model so as to account for the short-run and long-run effect of ELEC and public agricultural spending on AGOP in Nigeria.

3. DATA SOURCES AND METHOD

This section deals with data and methodology employed to analyse the effects of disaggregate consumed energy and public expenditure on agricultural productivity. In the course of the estimation secondary data from 1981 to 2017 were sourced and estimated with ARDL. Data were gotten from Central Bank of Nigeria (CBN, 2017) Statistical Bulletin, International Labour Organisation-ILO (2017) and World Development Indicators-WDI (World Bank, 2017). The variables in which data were sourced comprises of agricultural productivity (AGPRD) as the endogenous variable while the exogenous ones consists of ELEC, agricultural credit fund (AGCF), agricultural labour force (AGLF), government expenditure on agriculture (GCEA), per capita income (PCI), GFCF and EXR.

The data utilised in this study is a time series; hence, it is important to determine the characteristics of the series through the test for stationarity. The outcome of the test will inform on the appropriate estimation technique.

3.1. Unit Root Test

Here, we applied the Phillip Perron (PP) test to ascertain the whether the series are stationary or not. The variables may not become stationary at level until they are differenced once. In such scenario, the variables are integrated of order one and it is appropriate to verify the existence of Cointegration through Johansen Maximum likelihood and error correction approach. In some cases, the could be a mixture of variable that are integrated of order zero i.e., I(0) and order one i.e., I(1). When this happens it is recommendable to apply the ARDL modelling approach in determining the short-run and long-run relations existing in the model formulated for the study.

3.2. ARDL Modelling Approach

The ARDL technique is utilised on agricultural productivity equation. This enables the authors estimate the long run and short-run coefficient that incorporates the systemic adjustment process from the short-run dynamics to the long-run equilibrium. The dynamic nature of the model increases efficiency of the estimation and controls for biasness that could be associated with the result. It has been observed in literature that the ARDL technique is essential particularly for small sample observations unlike Engle–Granger and Johansen co-integration approach which appears not to yield the best result for small sample studies Narayan and Narayan (2004). In other words, the ARDL produces a more reliable result for small samples in relation to Johansen. Hence, in the application of the ARDL, all the variables do not have to be integrated of the same order. Variables could be integrated of order zero or one and combination of both. It becomes more ideal to apply the ARDL at the mixture of both I(0) and I(1) but not at degree one alone. In the application of this technique, the first process involves the examination of the significance of the long- run coefficient of the lagged level variables with the use of Fisher statistics. Secondly, the estimated parameters of the long-run and short-run relations of the variables are investigated.

3.3. Bound Testing Approach

The bound test is applied in a situation whereby the order of integration in series have been known, Pesaran et al. (2001). The ARDL model is accommodates different order of integration which means series integrated of order zero and 1 are used while Johansen Cointegration is preferred for mostly series that are integrated of order 1. Another strength of the ARDL is that it is suitable for samples that are not large. Assuming a VAR of K ordering, the agricultural productivity model could be expressed as:

$$Z = \beta + \sum_{i=1}^{k} \alpha_t Z_{t-1} + \mu_t \quad (1)$$

The vector Z encapsulates the variables x_t and y_t. Here y_t represent agricultural productivity while x_t is used to capture matrix of exogenous variables consisting of; ELEC, AGCF, AGLF, GCEA, PCI, GFCF and EXR. μ_t and t indicate the error terms and the time horizon.

In order to examine the existence of one co-integrating vector at most between y_t and x_t, the unrestricted VECM (UVECM) is used. The selection of the deterministic trend is derived from case 5 of Pesaran et al. (2001) specification based on unrestricted intercepts and trends. The UVECM equation is shown as;

$$\Delta Z = \beta + \gamma_t + \pi z_{t-1} + \sum_{i=1}^{k} \theta_t \Delta y_{t-i} + \sum_{i=1}^{k} \theta_t \Delta x_{t-i} + \mu_t \quad (2)$$

Δ is the difference operator and the long-run multiplier λ in its matrix form is expressed as;

$$\lambda = \begin{pmatrix} \lambda_{yy} & \lambda_{yx} \\ \lambda_{xy} & \lambda_{xx} \end{pmatrix}$$

The elements at the diagonal are unrestricted, hence the selected series could either be integrated of order zero (if $\lambda_{yy} < 0$, which implies Y is I(0)) or integrated of order1(if $\lambda_{yy} = 0$, which implies Y is I(1)).

3.4. Variable Description

In the data estimation, AGLF and GFCF constitute the variables derived from theoretical framework. ELEC and government disbursement on agriculture are the core variables. PCI is used as the demand side of the equation while AGCF and EXR captured the control variables. The description of the variables and theoretical expectation is expressed in the next section.

i. AGOP

This variable is utilised in examining how the agricultural sector performed and is measured in current market prices.

ii. ELEC

ELEC is one the essential element of production in real subsector. It has been observed that electricity helps to reduce cost of production due to high cost of generating energy though it is expected to exert a negative influence on agricultural production due to low power supply and utilisation in the agricultural sector. ELEC is measured in kilowatts hour per capita.

iii. AGCF

AGOP, ELEC, AGCF, AGLF, GCEA, PCI, GFCF and EXR.

Agricultural credit is used as control variable measure in billions of naira in this study. It is expected that agricultural credit exhibit a positive relationship with AGOP.

iv. AGLF

Labour force is considered an important variable in the AGOP model. Labour is expected to contribute positively to the output of the agricultural sector. In this, we used the total AGLF as a proxy for labour. The total labour in agricultural is measured in millions of people.

v. GCEA

This is a core variable used to measure government spending on the agricultural sector. The theoretical expectation on this variable is that increases in government spending will further increase the volume of output from the agricultural sector. Government agricultural spending is measured in billions of naira.

vi. PCI

This variable represents the demand side of agricultural production. It shows the living standard of the people and is measured in thousands of naira and expected to exhibit a direct relation with output from agriculture.

vii. Capital formation

GFCF is used as a proxy for capital formation and to examine the effect of stock capital or investment in capital stock on agricultural sector output. An increase in capital investment is expected to have a positive impact on AGOP.

viii. EXR

EXR defines the rate in which the Nigeria local currency is being exchanged with the dollar currency at the international market. It also shows the level the naira currency is being demanded for our export commodities. It is measured as a rate and could exert either positive of negative effect on AGOP depending on the depreciation or appreciation effect on the agricultural sector.

3.5. Model Specification

The present study is anchored on Cobb-Douglas's production function of the form;

$$Y=A.f\,(L, K) \tag{3}$$

Where;

Y is total agricultural output

L is total labour force in the agricultural sector

K is the total capital stock

A is total factor productivity.

Here, the Cobb-Douglas model is expanded with the addition of energy as a factor that enhances productivity;

$$A=f\,(ELEC) \tag{4}$$

When A is substituted in equation 1, we have

$$Y=f\,(L, K, ELEC) \tag{5}$$

Hence, the model representing the impact of energy consumed on AGOP is presented as;

$$\begin{aligned}
\Delta\left(AGOP\right)_t = {} & \beta_0 + \sum\nolimits_{i=1}^{p} f_{11}\,\Delta AGOP_{t-1} + \sum\nolimits_{i=1}^{p} f_{12}\,\Delta ELEC_{t-1} + \\
& \sum\nolimits_{i=1}^{p} f_{13}\,\Delta AGCF_{t-1} + \sum\nolimits_{i=1}^{p} f_{14}\,\Delta AGLF_{t-1} + \\
& \sum\nolimits_{i=1}^{p} f_{15}\,\Delta GCEA_{t-1} + \sum\nolimits_{i=1}^{p} f_{16}\,\Delta PCI_{t-1} + \\
& \sum\nolimits_{i=1}^{p} f_{17}\,\Delta GFCF_{t-1} + \sum\nolimits_{i=1}^{p} f_{18}\,\Delta EXR_{t-1} + \\
& \sum\nolimits_{i=1}^{p} \beta_1\,AGOP_{t-1} \sum\nolimits_{i=1}^{p} \beta_2\,ELEC_{t-1} + \\
& \sum\nolimits_{i=1}^{p} \beta_3\,AGCF_{t-1} + \sum\nolimits_{i=1}^{p} \beta_4\,AGLF_{t-1} + \\
& \sum\nolimits_{i=1}^{p} \beta_5\,GCEA_{t-1} + \sum\nolimits_{i=1}^{p} \beta_6\,PCI_{t-1} + \\
& \sum\nolimits_{i=1}^{p} \beta_7\,GFCF_{t-1} + \sum\nolimits_{i=1}^{p} \beta_8\,EXR_{t-1} + \varepsilon_t^{AGO}
\end{aligned} \tag{6}$$

Where;

Δ is the operator signifying first difference and μ_t the error term.

The model is applied to estimate the influence of energy consumption and public spending on AGOP where agricultural commodity output has been captured as the dependent variable. ELEC, AGCF, AGLF, Government outlay on Agriculture, PCI, GFCF and EXR are used as the exogenous variables.

Equation (6) indicates an ARDL of order P. It shows that agricultural produce is influenced by its past values. The Schwarz information criteria is used to choose the minimum lags for the estimation. The lagged value of the first difference endogenous variable and exogenous variables were utilised for the short-term and the first lagged value of endogenous and exogenous variables for the long-run estimation. Thus the ARDL model was used to analyse the short-run and long-run coefficients.

The parameters $f_{11}, f_{12}, f_{13}, f_{14}, f_{15}, f_{16}$, and f_{17} are the long-run coefficients while $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$, and β_7 are the short-run coefficients. The constant term is represented with β_0.

3.6. Wald F-test

In order to distinguish the long run relationship among the variables, the Wald test is further applied on equation (6) as post hoc experiment. In this procedure a restriction is imposed on the long-run coefficients of AGOP, ELEC, AGCF, AGLF, GCEA, PCI, GFCF and EXR as captured in the model estimated.

Therefore, the null hypothesis stating that the long-run coefficient of the exogenous variables are equal to zero is expressed as;

$H_0: f_{11}=f_{12}=f_{13}=f_{14}=f_{15}=f_{16}=f_{17}$

This implies no long-run relationship among the variables.

The alternative hypothesis is presented as;

$H_1: f_{11}=f_{12}=f_{13}=f_{14}=f_{15}=f_{16}=f_{17}$

The calculated F-statistic is compared with the lower and upper bound Pesaran critical values. Null hypothesis is accepted if the F-statistic falls below the lower bound, a state of in conclusion is reached if it fall between the lower and upper bound and a value of the F-statistic higher than the upper bound value suggests the existence of long-run relationship between AGOP and the explanatory variables.

To examine the influence of exogenous variables on AGOP in Nigeria for the short and long duration, equation (6) is estimated with ARDL. The model for the long run coefficient of equation (6) is to evaluate the effect of used electricity and public expenditure on AGOP given as;

$$
\begin{aligned}
AGOP_t = \gamma_0 &+ \sum_{i=1}^{p} \gamma_1 AGOP_{t-1} + \sum_{i=1}^{p} \gamma_2 ELEC_{t-1} + \\
&\sum_{i=1}^{p} \gamma_3 AGCF_{t-1} + \sum_{i=1}^{p} \gamma_4 AGLF_{t-1} + \sum_{i=1}^{p} \gamma_5 GCEA_{t-1} + \\
&\sum_{i=1}^{p} \gamma_6 PCI_{t-1} + \sum_{i=1}^{p} \gamma_7 GFCF_{t-1} + \sum_{i=1}^{p} \gamma_8 AGO_{t-1} + \\
&\varepsilon_t AEX
\end{aligned} \tag{7}
$$

3.7. Error Correction Term

Sequel to the long run estimation, the next stage is to estimate the short-run coefficient in the model alongside the error correction term. The short-run error correction coefficient of the ARDL model will utilised. The error correction term (ECM) measures the discrepancy between the actual values and the estimated values. The error correction term indicates the speed of adjustment from the short-run dynamics to the long-run equilibrium value. The error correction term coefficient is negatively signed, significant and within the magnitude of zero and 1 for it to be reliable. The ECM of the study model that measures the impact of electric energy consumption and public expenditure on AGOP in the framework of time adjustment is as follows;

$$
\begin{aligned}
\Delta(AGO)_t = \phi_0 &+ \sum_{i=1}^{p} \phi_1 \Delta AGO_{t-1} + \sum_{i=1}^{p} \phi_2 \Delta ELEC_{t-1} + \\
&\sum_{i=1}^{p} \phi_3 \Delta AGCF_{t-1} + \sum_{i=1}^{p} \phi_4 \Delta AGLF_{t-1} + \\
&\sum_{i=1}^{p} \phi_5 \Delta GCEA_{t-1} + \sum_{i=1}^{p} \phi_6 \Delta PCI_{t-1} + \\
&\sum_{i=1}^{p} \phi_7 \Delta GFCF_{t-1} + \sum_{i=1}^{p} \phi_8 \Delta EXR_{t-1} + \pi ECM_{t-1} + \mu_t
\end{aligned} \tag{8}
$$

ECM_{t-1} is the lagged error correction term in the model while π is the estimated value of the adjustment speed of ECM. The error correction term measures the speed of equilibrium restoration in the dynamic model. The significance of the ECM is further validation of the presence of co-integrating relation in the model, (Banerjee et al., 1998). The uni-directional influence of the variables is indicated by the negative sign of the error correction term, Faridi and Murtaza (2013).

4. RESULTS AND DISCUSSION

Sequel to the discussion of data and its sources in the previous section, we proceeded for the presentation of the results and discussion on the effect of utilised energy and public spending on AGOP based on the estimated outcome of the study model. In this section, an interpretation of the results is provided from which some recommendations and conclusion can be explored on the basis of empirical outcome in this paper. The study results are presented and discussed accordingly.

4.1. Descriptive Analysis

In Table 1, we presented the descriptive statistics of the paper which comprises of the measures used to explain the summarized properties of the data set employed in the analyses. The table indicates the mean values, standard deviations, skewness, kurtosis and Jarque-Bera results of the variables used in the study.

The study data consists of 37 years of observation on annual basis over the period of 1981-2017. The variables descriptive statistics are presented in Table 1. It is observed that the average AGOP growth is 5.176% with a standard deviation of 0.501. Agricultural credit found indicates the highest growth rate at 13.303 with a standard deviation of 2.170, followed by PCI, government capital spending on agriculture, ELEC, GFCF and agricultural labour at 9.823, 9.211, 4.614, 3.910 and 3.877 respectively. Their respective standard deviation values 2.023, 2.307, 0.278, 0.752 and 0.218 shows the most variability associated with government capital expenditure on agriculture. All the variables with the exception of AGCF and government capital spending on agriculture revealed a negatively skewed series. Kurtosis refers to the weight of the distribution, the height and sharpness of the peak in relation to the rest of the data. Kurtosis of exactly 3 is referred to as mesokurtic, below 3 is platykurtic while above 3 is leptokurtic. Hence, all the variable exhibit a platykurtic distribution except for capital formation. The Jarque-Bera statistic show that all the series are well distributed.

The explanation of the PP test is provided in Table 2. The outcome of the summary statistic shows that two of the series (ELEC and GCEA) were stationary at level while the rest (AGO, AGCF, AGLF, PCI, GFCF and EXR) were differenced once to achieve stationary series at intercept and trend specification. The evidence from the result justifies the application of auto-regressive distributed lag model used in the present study.

4.2. CO-integration (Bound Test) Result

The first stage involves the establishment of a long-run relationship among the variables having identified their order of integration. In order to realise this objective, the study have employed the bound testing procedure to co-integration.

The value of F-statistic derived from the Wald test is as shown in the second column. The lower and upper bound values portrayed in the third and fourth column of Table 3. The outcome of the test shows that the calculated F-statistic (13.81) is found greater than the lower and upper bound Pesaran critical values which suggests the existence of a persistent relations among the series in the estimated model.

The coefficient value of current ELEC (Table 4) revealed no significant effect on agriculture but the evidence from the lagged value of electricity consumed shows a significant retarded impact on output from agriculture. This indicates that poor ELEC retards output by 0.139%. This portrays the low level of electricity infrastructure in support of AGOP coupled incessant power outage which greatly hinder the growth of the sector. Evidence from this study lends credence to the reasoning that without electricity human potentials and strength in relation to production and value creation will be in vain (Adeniran et al., 2018; Alege and Osabuohien, 2015; Osabuohien et al., 2018). In other words, it has been observed that inadequate electric energy supply have retarded the production of physical goods and services more especially in developing African economies like Nigeria.

AGCF showed no significant effect on AGOP at the current and past values. This further suggests the poor accessibility of the peasant farmers to the loan facilities provided by the government. This could be due to poor level of awareness and sometimes there is misappropriation of these funds such that it cannot get the target audience who are mostly the rural farmers.

The coefficient estimate for AGLF at current level revealed no significant impact on AGOP but its cumulative effective indicates a significant positive relationship with AGOP. The detailed analysis of the result revealed that a percentage increase in agricultural labour increases AGOP by 0.368% holding other variables constant. The result thus indicates non-instantaneous on AGOP,

Table 1: Variables descriptive statistics

Statistic	LAGOP	LELEC	LAGCF	LAGLF	LGCEA	LPCI	LGFCF
Mean	5.176388	4.614505	13.30324	3.877309	9.210996	9.823772	3.909957
Standard deviation	0.500528	0.277876	2.170000	0.217882	2.306562	2.022586	0.751608
Skewness	0.194595	−0.121143	0.161186	−0.610296	0.139964	−0.436290	−0.737004
Kurtosis	1.895765	2.382894	1.436822	1.843058	1.622769	1.706731	3.543521
Jarque-Bera	2.056206	0.677596	3.927319	4.360387	3.044982	3.752326	3.805009
Probability	0.357685	0.712626	0.140344	0.113020	0.218168	0.153177	0.149195

Authors' computation with E-views version 10

Table 2: Unit root result

Variables	PP at levels	5% critical values	First difference	5% critical values	Integration order
LAGOP	−2.161999	−3.544284	−6.280892	−3.548490	I (1)
LELEC	−3.731423	−3.540328	-	-	I (0)
LAGCF	−2.124450	−3.540328	−5.832947	−3.544284	I (1)
LAGLF	−2.364178	−3.540328	−7.638966	−3.544284	I (1)
LGCEA	−3.960962	−3.540328	-	-	I (0)
LPCI	−0.110947	−3.540328	−5.117480	−3.544284	I (1)
LGFCF	−2.530269	−3.540328	−5.642040	−3.544284	I (1)
LEXR	−0.913752	−3.540328	−6.815662	−3.544284	I (1)

Authors' computation with E-views version 10. PP: Phillip Perron

Table 3: Bound test result

F-bounds test	Value	Null hypothesis: No levels relationship			
Test statistic		Significance (%)	I (0)	I (1)	Conclusion
F-statistic	13.81146	10	1.99	2.94	Levels relationship exists
K	6	5	2.27	3.28	
		2.5	2.55	3.61	
		1	2.88	3.99	

Authors' computation with E-views version 10. The probabilities of the F-statistics are in parenthesis. Computed F-statistic 13.81146 is significant at 1% level. Critical values at k = 8-1 are derived from Pesaran et al. (1999). Table CI (V), Case V: Unrestricted intercept and trend

Table 4: Long-run ARDL estimates

Dependent variable: LAGOP				
Method: ARDL				
Selected model: ARDL (1, 1, 3, 2, 2, 2, 1)				
Variable	**Coefficient**	**Std. error**	**t-statistic**	**Prob.***
LAGOP(−1)	0.802622	0.077396	10.37033	0.0000***
LELEC	0.086842	0.062659	1.385952	0.1874
LELEC(−1)	−0.138946	0.057555	−2.414126	0.0300**
LAGCF	0.017451	0.014950	1.167347	0.2626
LAGCF(−1)	0.004809	0.019408	0.247762	0.8079
LAGCF(−2)	−0.006895	0.019725	−0.349553	0.7319
LAGCF(−3)	0.026793	0.015874	1.687840	0.1136
LAGLF	−0.054186	0.083767	−0.646869	0.5282
LAGLF(−1)	0.367663	0.060314	6.095783	0.0000***
LAGLF(−2)	−0.129334	0.056459	−2.290736	0.0380**
LGCEA	0.007863	0.009995	0.786662	0.4446
LGCEA(−1)	0.016773	0.009334	1.797043	0.0939*
LGCEA(−2)	0.018401	0.009448	1.947540	0.0718*
LPCI	−0.016087	0.019397	−0.829370	0.4208
LPCI(−1)	0.041015	0.025321	1.619799	0.1276
LPCI(−2)	−0.056152	0.022326	−2.515081	0.0247**
LGFCF	0.012300	0.013567	0.906640	0.3799
LGFCF(−1)	0.025022	0.015750	1.588710	0.1344
C	−0.193374	0.435536	−0.443990	0.6638

Source: Authors' computation with E-views version 10.***,**,*indicate significant at 1, 5, and 10% respectively

Table 5: Short-run coefficients

ARDL error correction regression				
Dependent variable: D (LAGOP)				
Selected model: ARDL (1, 1, 3, 2, 2, 2, 1)				
Variable	**Coefficient**	**Std. error**	**t-statistic**	**Prob.**
D (LELEC)	0.086842	0.034528	2.515114	0.0247**
D (LAGCF)	0.017451	0.009447	1.847325	0.0859*
D (LAGCF(−1))	−0.019898	0.010041	−1.981573	0.0675*
D (LAGCF(−2))	−0.026793	0.010054	−2.664920	0.0185**
D (LAGLF)	−0.054186	0.037781	−1.434234	0.1735
D (LAGLF(−1))	0.129334	0.031888	4.055929	0.0012***
D (LGCEA)	0.007863	0.004989	1.575996	0.1373
D (LGCEA(−1))	−0.018401	0.004979	−3.695450	0.0024***
D (LPCI)	−0.016087	0.012052	−1.334778	0.2033
D (LPCI(−1))	0.056152	0.012599	4.456904	0.0005***
D (LGFCF)	0.012300	0.008134	1.512138	0.1527
Coint Eq(−1)*	−0.197378	0.015332	−12.87391	0.0000***
R-squared	0.870228			
Adjusted R-squared	0.802251			
Durbin-Watson stat	2.329167			

Authors' computation with E-views version 10.***,**,*indicate significant at 1, 5, and 10% respectively

however the effect of the agricultural labour reflects the gestation period involved in agricultural production from the period of labour inputs and the harvest season.

Government expenditure on the agricultural sector have been low and less significant as shown in the coefficient result at the current level. Further evidence from the result shows that the effect of government infrastructural spending on agricultural exerts a positive lag influence on AGOP though not too strong as expected. This also captures the lag period between infrastructural development and its impact on AGOP. A percentage increase in public agricultural capital spending appears to increase output by 0.02%. This shows that infrastructural development in agriculture will improve the productivity of the sector leading to increase in the volume of AGOP. This result further collaborate with Chauke et al. (2015) and Jambo (2017) whose study found a significant impact of government agricultural spending and the sector's growth.

Improved living standard will further result to increase migration from agrarian society towards food import and demand for foreign goods which also affect the level of local food production as time progress. The result of PCI validates this scenario with the evidence of 0.06% decline in AGOP as PCI increased by 1%. This result is found to statistically significant at 5% level.

The coefficient of capital formation is observed to have insignificant impact on AGOP which further illustrates the poor investment and savings into the agricultural sector in order to enhance the output in the sector. Further evidence from the F-statistic (922.14; $P < 0.01$) and Durbin Watson statistic (2.33) shows the model statistical fitness at 1% and absence serial auto correlation in the model.

The short-run coefficient of ELEC (Table 5) appears to be contributing to AGOP such that a percentage rise in electric energy consumption increases AGOP by 0.087 at 5% level of significance. This suggests that though electricity supply appears to support agricultural production in the short-run duration, it is not sustainable in the future due to the uncertainty of power supply and shortage of supply which have lingered over time. The result is applicable to AGCF within the short-run. A percentage change in credit facility to the agricultural sector increases AGOP by 0.02% though significant at 10% significance level. Further analysis of the AGCF in the short-run indicates that the previous year's allocation did not have significantly inhibited AGOP. This could be as a result of the delay and bureaucratic processes involved in the assessment of the facilities that deterred most farmers from benefiting from it and consequently reduces output in the agricultural sector.

The coefficient estimate of AGLF has the same impact on AGOP in the long-run and short-run. This shows that the previous year's labour inputs significantly accounts for the current year output. Agriculture is mainly the preoccupation of the rural dwellers and unemployed youths in the remote areas. Hence, the more these group of people are gainfully employed in the sector the greater the harvest and bumper yield.

It is further observed that government infrastructural spending in the agricultural sector do not have an instantaneous outcome as evidenced in the long-run and short-run results. It could be seen that in the short run output could be distorted due to initial outlay of infrastructural expenditure and reduction in financial support for agricultural inputs such as fertilizer, pesticides and herbicides but will increase output in the long-run.

Improvements in the standard of living appears to support the demand for local AGOP in the short-run but with progress in time there is usually a drift towards food imports and a drastic reduction in the demand for local agricultural produce as observed

Table 6: Diagnostic tests

Test	F-statistic	P	Chi-square (χ^2)/T-statistic	P
Breusch-Godfrey serial correlation LM test	0.801724	0.5185	5.920898	0.1155
Heteroskedasticity test: Breusch-Pagan-Godfrey	0.865886	0.6191	17.38448	0.4968
Jarque-Bera			0.089299	0.9563
Ramsey-reset (log likelihood ratio)	0.710512	0.4145	0.842919	0.4145

Authors' computation with E-views version 10

in the long run result. Evidence from the short-run analysis shows that at 1% significance level, a percent rise in PCI will increase AGOP by 0.056%.

The outcome from GFCF supports the earlier result from the long-run which shows the low level of savings investment in the agricultural sector resulting to retarded effect on the final output of the sector.

4. 3. Error Correction Result

The result of the error correction term (−0.1974) was found to be significant at 1% level, correctly signed and within the magnitude of zero and 1. This shows that it certified the required conditions and implies that the system has 19.74% adjustment speed. In other words 19.74% of the disequilibrium in the system could be corrected per annum in the course of its short-run dynamics to the long-run equilibrium value. It further reaffirms the presence of a co integration among the series in the model, The R-squared result portrayed 87% of the total variations in AGOP explained by the changes in the captured exogenous variables. The adjusted R-squared reported 80.23%. The Durbin Watson statistic (2.33) revealed no instance of serial autocorrelation in the model.

The linear regression method assumes the residuals are normally distributed with zero mean and consistent variance. Consequently, Jack-Bera normality test for the residual series was applied to determine whether the residuals exhibit a normal distribution or otherwise. Breusch-Godfrey LM test was carried out to ascertain if there exists a serial autocorrelation between the model estimates and the error terms. The autoregressive conditional heteroskedasticity (ARCH) was utilised to examine the existence of autocorrelation in the error term variance i.e., the constant variance assumption of the error term. The result of the tests are as presented in Table 6.

5. CONCLUSION AND RECOMMENDATIONS

Empirical findings from the study portrays the level of poor energy generation among developing economies such as Nigeria which also are largely supported by agriculture but lacks the political will for energy sustainability that guarantees continuous increase in AGOP. Constant power supply constitutes one of the major challenges facing the economy which further inhibits industrialisation and mechanisation of the agricultural process. It is therefore observable from the present study that ELEC remains one the greatest challenges of AGOP in Nigeria. However, government infrastructural spending suggests non-instantaneous effect on AGOP. This implies that both the human factor and government capital spending on the agricultural sector requires time to produce the desired outcome. It is therefore important the energy generation be prioritised and vigorously pursued as one of the top most agenda in the provision of public infrastructure. This is to provide adequate motivation and support for the agriculturalist to embark on large-scale production and industrialisation. The provision of electricity will further enhance the quality of local agricultural products through the application of modern equipment for processing and production of agricultural produce from the farm such as agricultural cereals and grains. Consequently these product will be better packaged for proper marketing within and outside the domain of production.

Sequel to the empirical findings from the present study, the following recommendations have been proffered;

First, this study advocates that electricity generation should be given priority attention in public budgeting and spending. This is explained by the reason that electricity is like that the oil that lubricates real sector productivity, it enables for industrialisation and mechanisation of the agricultural process to enhance total AGOP and long-run growth in the economy. This study thus, advocates for more strategic energy policies that are real sector oriented and will provide the necessary platform for investment and increase productivity to strive particularly in the agricultural sector of the economy.

Agricultural credit facilities should be revolutionised to fashion out better ways of reaching the peasant farmer who actually needed the financial support to grow their output. This could be achieved by breaking all bureaucratic bottle necks and barriers that retard the rural farmers from accessing these facilities at the appropriate time. Hence, proper mechanism should be devised to monitor and supervise how these are appropriated and ensure that it get to the rightful audience at the right time.

It is highly imperative to encourage and motivate the young unemployed groups especially in the rural areas to become gainfully employed in agriculture. This will help to provide employment opportunities, reduce the incidence of vices and illegal adventure and consequently increase AGOP as a result of the rise in AGLF.

The government should also intensified effort in provision of agricultural machines and equipment through its capital agricultural outlay. This will assist to provide the necessary support for large scale agricultural production that will yield more income for the farmer and will also make the sector more uncreative and attractive to the young unemployed seeking for a gainful employment.

Welfare policies that will improve the living standard and PCI should be encouraged at all levels of government administrations and most importantly the welfare of the farmers in rural and semi-urban areas should be given adequate consideration as this will also affect the level of their productivity in the long-run.

More capital and savings investments should be channelled into the agricultural sector since it will boost the sectors infrastructural development and create more prospects for the agricultural commodities. Efforts should be geared towards improving varieties, provision of agricultural inputs and modern tools that will facilitate the sectors growth.

6. ACKNOWLEDGEMENTS

We want to this opportunity to deeply thank Covenant University Centre for Research, Innovation and Discoveries for the assistance during the preparation of the paper. This paper draws insights from the first author's thesis supervised by the second and third authors. The comments of the reviewers are also appreciated.

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