# Relationship between Electricity Consumption and Economic Growth in Nigeria

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**Abstract**

This study examined the relationship between electricity consumption and economic growth in Nigeria covering the sample period of 1986 to 2021 using Autoregressive Distributed Lag (ARDL) model and Causality Test. The ARDL results indicated that in the short run electricity consumption is negatively related to economic growth at the 5% level of significance, while electricity generation is positively related to economic growth in the short run at the 5% level of significance. In the long run electricity consumption is positively related to economic growth at the 5% level of significance. The causality test result showed that there is a unidirectional causation from electricity consumption to economic growth in Nigeria during the period covered by the study. The study recommends sustained efforts by both the government and private entities to improve generation, efficient transmission and distribution of electricity to the key productive sectors such as manufacturing, and small and medium enterprises in order to have sustained growth in output in the long run that would lead to economic growth in Nigeria.

**Keywords:** Electricity Consumption, Economic Growth, ARDL Model.

## Introduction

Energy consumption is the force that propels most economic activities and it has externalities of linkages with other sectors of the economy. As fundamental requisite resource for an economy, the importance of electricity cuts across every facet of economic activities of production, consumption and services. Consequently, there is a direct relationship between energy consumption and the growth rate of an economic output. Accessing quality and reliable electricity supply for economic activities is critical and regarded as the main conduits of economic growth and development in any economy (Adewuyi & Emmanuel 2018). Economic growth is often considered as the incremental changes in the total output of an economy measured in terms of the gross domestic product (GDP; World Bank, 1992; Aigbokhan, 1995; Maijama'a & Mohammed, 2003; Ullah & Rauf, 2013). Arguably, the activities that generate the incremental changes in the total output in an economy are essentially energy driven.

Economic growth in Nigeria has been a subject of great concern to both development economists and government policy makers for several decades. The trajectory of growth has been bedevilled by inadequate supply and rising cost of electricity with negative consequences for the living standard of the average person living in Nigeria. The current energy crisis in Nigeria has become an obstacle to the growth and development of socio-economic activities which has resulted to an untold hardship and challenges to the people as well as retarding the growth of industrial production. Currently, electricity supply in Nigeria does not meet national demand. While the estimated daily electricity generation as at December 2009 was about 3,700MW, the peak load forecast for the same period was 5,103MW, a gap of 1403MW. This is based on the existing connections to the grid which does not take into account the suppressed demand due to changes that had occurred over the time.

The projected electricity demand has been translated into demand for grid electricity and peak demand on the basis of assumptions made for transmission and distribution losses, auxiliary consumption, load factor and declining non-grid generation (Energy Information Administration, 2012). The demand is projected to rise from 5,746 MW in 2005 to 297,900MW in 2030 which translates to construction of 11,686MW every year to meet this demand (Sambo, 2008). While the government owned monopoly company (Power Holding Company of Nigeria) has been unbundled for effective service delivery. And in its stead, three hydro and seven thermal generating stations, a radial transmission grid (330KV and 132KV), and eleven distribution companies (33KV and below) that undertake the cabling, sales, billing, collection and customer care functions within their area of geographical monopoly have been set up (Adegbemi, Adegbemi, Olalekan & Babatunde, 2013). The epileptic states of electricity level in Nigeria have led to scarcity of petrol and kerosene as the citizens have resulted to use of generators and kerosene powered equipment to provide energy for use at homes (International Energy Agency, 2012). According to Bamikole (2012), industrial capacity utilization has plummeted from 78.7% in 1977 to 30.1% in 1987 before resurgence to 53.3% in 2007 and 53% in 2010. Capacity utilization in Nigeria average 54.5% from 2009 until 2020, reaching an all-time high of 60.5% in the first quarter of 2015 and a low record of 40.1% in the second quarter of 2020 (Trading Economics, 2020). Capacity utilization increased to 45.4% in the fourth quarter of 2020 from 43.8% in the third quarter of 2020 (CBN, 2020).

Electricity is a major driver of industrial and manufacturing production as well as the main stay in the production of key social and economic services. Thus, in the view of Ayodele, Ogunjuyigbe and Oladele (2016), apart from serving as a pillar of wealth creation in Nigeria, electricity is the nucleus of operation and consequently the engine of growth for all sectors of the economy. However, electricity crisis has plagued the Nigeria economy during the past four decades in form of under-supply, outright outage or blackouts and persistent upward movement in tariff. This has led to sustained reliance on privately generated electricity from generators by households and corporate entities operating in Nigeria. Electricity crisis has grown to a point that Nigeria is said to be running a generator economy with its adverse effects on cost of production. The electricity market in Nigeria is dominated on the supply side by a public monopoly; Power Holding Company of Nigeria (PHCN) which has been unable to meet the growing demands from the households and business community. This has led to business closures and relocation of businesses to neighbouring economies, rising cost of production, employment cuts and increase in final consumer prices for goods and services produced in Nigeria. This has created a general business uncertainty and lower returns on investment, which has affected the manufacturing sector.

The GDP growth rate was negative during the first and second quarters of 2016. It fell by -2.06% and -0.36% in the first and second quarters of 2016, respectively (National Bureau of Statistics, 2016). This negative growth rate recorded in Nigeria during the first half of 2016 was preceded by a significant fall in the supply of electricity. Also, the Nigeria economy suffered similar fate of recession in 2020, a period that witnessed inadequate supply of electricity and yet the tariff was increased by about 200% basis. The questions that arise from the issues raised above are, what is the implication of inadequate electricity supply for economic growth in Nigeria? Does electricity consumption cause economic growth in Nigeria? Or is it economic growth that leads to electricity consumption in Nigeria? The focus of this paper is to provide answers to these questions.

## Theoretical Framework

Electricity consumption as a concept has been widely regarded as the use of a quantum of electricity for the purpose of production of goods or services or for household uses. It is also considered as electricity energy consumed in a process or system, or by an organization or society (Energy Efficiency, 2019). This implies a form of measurement of the flow of electric energy used to perform certain actions. Consequently, electricity consumption represents the actual amount of electrical energy or charged subatomic particle that has been consumed over a specific time usually measured in units of KWh (Energy Efficiency, 2019).

According to Conventional Energy in North America (CENA, 2019), electricity consumption is an essential and crucial component of modern life. It does not only provide clean and safe light, but also refreshes homes. Odike (2015) argued that for any meaningful improvement in the productivity of the manufacturing sector to take place in any economy, electricity supply and demand must remain uncompromising elements of the process. This implies that in the process of production, electricity is a critical component and factor required for creating the needed output or value in the economy. Chontanawat, Hunt and Pierse (2006) conceptualised energy consumption as an important factor both to the demand and supply sides of an economy. From the supply side of the economy perspective, energy acts as a crucial factor in the production process as well as economic growth and development, while from the demand side of the economy, customers, or consumers see energy as a product necessary to the maximization of their utility.

According to Todaro (2000), economic growth refers to an increase in a country's national output of goods and services within a specific period. In this regard, growth is usually taken to represent economic progress which is the rate at which the annual output of goods and services grow in real terms. In the view of Jhingan (2006), economic growth is related to quantitative sustained increase in a country's per capital output or income accompanied by expansion in its labour force, consumption, capital and volume of trade. Thus, economic growth is often viewed as the increase in the total output of an economy over a certain period of time. The concept of economic growth is an increase in the productivity of an economy as compared from one period of time to another.

Generally, economic growth is characterised by high rates of increase in per capita output and total factor productivity, especially labour productivity. Ochejele (2010) characterized economic growth as the quantitative and sustained increase in the per capita income accompanied by expansion in labour force, consumption, capital and volume of trade. Thus, economic growth is essentially the aggregation of all output produced in an economy in a given year (Mohammed & Omale, 2020). The desirability of economic growth is derived from the follow-up of increase in individual and institutional income, upward movement in employment of human and non-human resources, improvement in standard of living and domestic investment growth.

There are two key theories that have relevance for explaining the fundamentals of the relationship between electricity consumption and economic growth in this study. These are the Solow-Swan growth theory and the Mead growth theory. The Solow-Swan growth theory (1970) is a model of long-run economic growth. It explains the long-run path of economic growth that takes into account capital accumulation, labour/population growth and increases in productivity that is driven by technological progress. The theory proceeds from the assumption that a necessary condition for equilibrium of the economic system is the equality of aggregate demand and aggregate supply. From the perspective of the Solow-Swan model of growth, aggregate supply is determined on the basis of the Cobb-Douglas production function that shows the functional relationship between production and combination of inputs. The model illustrates the connection between three key sources of growth; investment, the labour workforce and technological progress. What creates a significant impact on economic growth in Solow-Swan (1970) model is the combination of labour, capital and technological advances in the right combination (Marin, 1992; Mohammed & Aliyu, 2020). Thus, the model stresses that economic growth will not take place unless there are technological advances. The theory also assumes that in the long run, the constant returns to scale would apply, and at that point no technical progress takes place in the economy; the stock of capital can then be adapted in the capital intensive technology and that labour and capital are substitutes (Krugman, Obstfeld & Melitz, 2012; Mohammed & Aliyu, 2020). Electricity is capital investment needed to engineer the production process in order to achieve sustained output growth in the economy. Sustained and consistent supply of electricity represents technological progress requisite for economic growth.

The theoretical framework for the model used in this study is derived from the Mead growth model (1961, as cited in Jhingan, 1997). The model shows the path and behaviour of an economic system during a process of equilibrium growth. The model is built on the following assumptions; a closed laissez-faire economy with perfect competition, constant returns to scale, two commodities, consumption goods and capital goods that are produced in the economy, machines are the only form of capital that exists in the economy, all machines are alike, price of consumption goods is constant, full utilization of land and labour resources, perfect malleability of machines both in short and long run, production of capital and consumption goods are perfect substitute, and percentage of depreciation by evaporation of machines each year.

On the basis of these assumptions, the Mead model showed that the net output of an economy is a function of the following factors of production; the net capital stock available in the form of machine, available amount of labour force, availability of land and natural resources, and state of technology; being the continued improvement in technical knowledge over time. The functional relationship therefore, is expressed in the form of production function;

$$Y = f(K, L, N, t) \quad (1)$$

Where Y is net output (net national income), K is the existing capital stock (machine), L is the labour force, N is land and natural resources and t is time; signifying technical progress (Technology). Assuming the amount of land and natural resources to be fixed, net output in this economy can increase in any one year with the growth in K, L and t. the Mead model showed that this relationship is as indicated by;

$$\Delta Y = V\Delta K + W\Delta L + \Delta Y^1 \quad (2)$$

Where Δ in each case represents an increase (positive change), V is the marginal product of capital, W is the marginal product of labour and $Y^1$ is used in place of t. thus, the increase over the year in the rate of annual net output (ΔY) is equal to the increase in the stock of capital (ΔK) multiplied by its marginal products (V) plus the increase in the amount of labour (ΔL) multiplied by its marginal products (W) plus the increase in the rate of annual output that is due simply to technical progress ($\Delta Y^1$), (Jhingan, 2003). The annual proportional growth rate of output takes the form;

$$\Delta Y/Y = VK/Y.\ \Delta K/K + WL/Y.\ \Delta L/L + \Delta Y^1/Y \quad (3)$$

Where ΔY/Y is the proportionate growth rate of output, ΔK/K is the proportionate growth rate of stock of capital, ΔL/L is the proportionate growth rate of labour force and $\Delta Y^1/Y$ is the proportionate growth rate of technical progress in a year. A key submission of the Mead growth model is the critical impact of changes in the capital component of the production function.

This amplifies the role of electricity as an essential input in industrial production with implications for output growth in an economy.

## Empirical Review

From the empirical perspective several studies have examined the relationship between electricity consumption and economic growth in Nigeria and other countries. Orhewere and Machame (2011) investigated the relationship between energy consumption and economic growth in Nigeria for the period 1970-2005. The study used unit root test, co-integration, and vector error correction model-based Granger causality test. The results showed a unidirectional causality from electricity consumption to Gross Domestic Product (GDP) both in the short-run and long-run. Unidirectional causality was found from Gas consumption to GDP in the short-run and bidirectional causality in the long-run in Nigeria during the study period. Also, Atoyebi, Adekunjo, Kadiri, and Ogundeji (2012) examined the direction of causality between energy consumption and economic growth in Nigeria from 1981 to 2009. The study used the ordinary least square (OLS) test to establish the statistical significance of the variables used and augmented form of Granger causality test to identify the direction of the relationship between these variables in the short run. The results showed that electricity consumption negatively influenced real GDP but not statistically significant; while the Granger causality test indicated a non-causal relationship between electricity consumption and economic growth in Nigeria for the study period. Furthermore, Adegbemi, et al. (2013) examined the causal relationship between energy consumption and Nigeria economic growth in Nigeria from 1975 to 2010. Time-series secondary data were analysed using co-integration and ordinary least square method of analysis. The results showed that total energy consumption and economic growth had a long run relationship in Nigeria during the period of study.

Adeyemi and Ayomide (2013) examined the relationship between electricity consumption and economic growth in Nigeria for the period 1980-2008; using the Vector Error Correction Model (VECM) and the Pairwise Granger Causality (PGC) test. The results revealed existence of a unique co-integrating relationship among the variables modelled, with electricity consumption significantly impacting economic growth in Nigeria. While Ologundudu (2015) investigated the causal and long-run relationship between electricity supply, industrialization and economic development in Nigeria from l972-2010 using the Granger Causality test and the ARDL bounds test approach to cointegration. The Granger Causality results showed that there was a feedback causal relationship between GDP per capita and electricity supply. The results of the long run and error correction model showed that industrial development, electricity supply, technology and capital employed are important determinants of economic growth in Nigeria for the period of study.

Aminu and Aminu (2015) investigated the causal relationship between energy consumption and economic growth in Nigeria between the period 1980 and 2011. The study applied the Granger causality test, impulse response and variance decomposition tool of analysis. The causality test results indicated an absence of causality between energy consumption and economic growth; while the variance decomposition showed that capital and labour are critical to output growth when compared to energy consumption in Nigeria for the study period. On the other hand, Umeh, Ochuba and Ugwo (2019) examined the impact of energy consumption on economic growth in Nigeria for the period 1980-2017. The key variables of interest were petroleum, natural gas, electricity and real gross domestic product (RGDP). The study used ex-post facto research method and the results showed that energy consumption significantly influenced economic growth in Nigeria during the study period.

With respect to other countries; Ozun and Cifter, (2007) used a wavelet analysis as a semi parametric model to test for multi scale causality between electricity consumption and economic growth in Turkey for the period 1968-2002. The results of the test revealed that in the short run, there is a feedback relationship between gross national product (GNP) and electricity consumption, while in the long run, GNP leads to increased electricity consumption. The Wavelet correlation between GNP and electricity consumption is maximum at 3$^{rd}$ time scale (i.e. 5 to 8years); implying that the GNP influenced electricity consumption maximally around 5 to 8 years in the long-run. Enu and Havi (2014) examined the extent to which electricity consumption influences economic growth in Ghana using Vector Error Correction Model (VECM) and Granger Causality test. The results revealed in the long run, a hundred percent increase in electricity consumption will cause real gross domestic product per capita to increase by approximately fifty-two percent. While in the short run, electricity consumption negatively influenced real gross domestic product per capita. It also revealed that unidirectional causality run from electricity consumption to economic growth.

The empirical studies on Nigeria reviewed so far have clear implications for the choice of methodology used in this study. For instance, most of the studies relied predominantly on causality test (Orhewere & Machame, 2011; Harrison, 2012; Atoyebi, et al.; 2012; Adegbemi, et al.; 2013; Adeyemi and Ayomide, 2013; Ologundodu, 2015; Aminu & Aminu, 2015). Causality test does not imply correlation and is not capable of measuring strength of relationship between any sets of variables. Again, quite a number of the findings indicated non-causation between electricity consumption and economic growth; which is tantamount to theoretical expectations. This could be due to specification error. Also, regression analysis as used by Atoyebi, Adekunjo, Kadiri, and Ogundeji (2012) is not capable of measuring the implications of short-term fluctuations in electricity supply that is a common feature in Nigeria economy. Such fluctuations have cost implications for production and consequently output growth. Also, the use of cointegration alone by Adegbemi *et al* (2013) to measure the relationship between electricity consumption and economic growth is methodology wise, inadequate. Cointegration is essentially a diagnostic tool and does not take into account details of changes in variables that have implications for the speed of adjustments of other variables that are interdependent. Clearly, changes in the electricity subsector in Nigeria have been quite large in terms of tariff that affects the unit cost of electricity as a critical input for the production of goods and services that constitute economic growth both in the short and long term. The findings may not have adequately estimated the relationship between electricity consumption and economic growth in Nigeria for the study period.

This study used the autoregressive distributed lag (ARDL) model in order to include the volatility of tariff and supply shocks in electricity that are common features in Nigeria. Also, this study has included electricity consumption, electricity generation, consumer price index, industrial production growth rate, trade balance, as critical explanatory variables of changes in real output growth for the period 1986-2021. The key motivation for this study is the need to account for short term changes in electricity supply and tariff, and reflect the implications for economic growth in order to drive the debate on electricity as critical infrastructure for the growth process in Nigeria.

**Methodology**

The focus of this study is to evaluate the relationship between electricity consumption and economic growth in Nigeria for the period 1986-2021. The objective is to account for the speed of adjustment in economic growth in response to electricity use both in the short run and long run in Nigeria. The estimation is carried out using autoregressive distributed lag (ARDL) model as used in Mohammed and Omale (2020), Mohammed and Aliyu (2020), Omale (2018), and Musbau and Muhammad (2011).

## Sources of Data

The data in this study are annual time series for the period 1986-2021. The data was sought from Central Bank of Nigeria (CBN) Statistical Bulletin, World Bank Country Report on Nigeria, World Development Indicator (WDI), and Country Economy Report. Specifically, RGDP and inflation were sought from CBN Statistical Bulletin; ELC and ELG were sought from Country Economy Report on Nigeria; INGP and TDB were sought from World Bank Country Report in World Development Indicator.

## Model Specification

The empirical framework that provided the basis for the methodology used in this study is the Meade Growth Model (1961) as cited in Jhingan (1997). The model derives its framework from the neoclassical theory of economic growth. The basic assumptions of the Meade's model are that the rate of economic growth is a function of the growth rate of capital, labour supply, land and natural resources and technical progress over time.

According to Meade's model the relationship between the national output and the variables that produced that output can be expressed in the form of a linear production function:

$$Y = f(K, L, N, t) \quad (4)$$

Where Y = net output (net national income), K = existing capital stock (machine), L = labour force, N = land and natural resources and t = is time, signifying technical progress (Technology).

Thus, the model for this study is specified with real gross domestic product (RGDP) as an implicit function of electricity consumption (ELC), electricity generation (ELG), inflation rate proxy by consumer price index (CPI), industrial productivity growth (INPG) and trade balance (TDB) following from Mead's model. The linear equation for this study is:

RGDP = *f (ELC, ELG, CPI, INPG, TDB, t)* where all the variables are as defined above. The consequent output equation is thus:

$$RGDP_t = \beta_0 + \sum_{i=1}^{p} \gamma_i RGDP_{t-1} + \sum_{j=1}^{h} \sum_{i=0}^{q_i} X_{j,t-i}{'}\beta_{j,1} + \delta D_t + \varepsilon_t \quad (5)$$

Where RGDP = Real gross domestic product, $\beta_0$ = intercept of the output equation, X = is a vector of electricity consumption (ELC), electricity generation (ELG), consumer price index (CPI), industrial production growth (INPG), trade balance (TDB) and error term (Ut).

## Estimation Technique

Given that the result of the unit root test indicated the order of integration of the variables as I(0) and I(1), Autoregressive Distributed Lag (ARDL) approach to co-integration was used to estimate the long run and short run relationship simultaneously with simple modifications. And in order to determine the long-run relationship and short run dynamic interactions among the variables in the model, the ARDL Bound Testing for co-integration developed by Pesaran et al. (2001) was used as in Mohammed and Omale (2020).

ARDL model equation is given as;

$$\Delta Yt = \beta o + \beta_1 \Delta Yt\text{-}_1 + \beta_2 \Delta Yt\text{-}_2 + \ldots\ldots + \beta_n \Delta Yt\text{-}_k + Y_1 Yt\text{-}_1 + Y_2 Yt\text{-}_2 + Y_n Y_y\text{-}k + \sum t \quad (6)$$

Where Et stand for white noise error term, and the model is autoregressive, hence, Yt represent a vector of the variables employed in the model. The ΔYt can be explained (in part) by change and lagged values of itself. It also has a distributed lag component, in the form of successive lags of the other independent variables.

The ARDL co-integration approach to estimating the long run relationship in the model is stated in its general form as:

$$\Delta logRGDP_t = \beta_0 + \beta_1 logELC_{t-1} + \beta_2 logELG_{t-1} + \beta_3 logCPI_{t-1} + \beta_4 logINP_{t-1} + \beta_5 logTDB_{t-1} + \sum_i^p \gamma_i \, \Delta logELC_{t-1} + \sum_i^p \gamma_i \, \Delta logELG + \sum_i^p \gamma_i \, \Delta logCPI_{t-1} + \sum_i^p \gamma_i \, \Delta logINPG_{t-1} + \sum_i^p \gamma_i \, \Delta logTDB + \varepsilon_t \quad (7)$$

Following from equation 7 the null hypothesis of no co-integration $H0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ was tested against the alternative hypothesis of co-integration$H1 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$. The study used equation 7 after modification to estimate the long-run relationship between the variables in the model as in equation 8:

$$logRGDP_t = \beta_0 + \sum_{i=1}^{p} \gamma_i \, logRGDP_{t-1} + \sum_{i=1}^{q^1} \gamma_i \, logELC_{t-1} + \sum_{i=1}^{q^2} \gamma_i \, logELG_{t-1} + \sum_{i=1}^{q^3} \gamma_i \, logCPI_{t-1} + \sum_{i=1}^{q^4} \gamma_i \, logINPG_{t-1} + \sum_{i=1}^{q^5} \gamma_i \, logTDB_{t-1} + \varepsilon_t \quad (8)$$

The Schwarz Bayesian criterion (SBC) was used to select the lag length of the model and error correction model was applied in order to determine the short-run dynamics of the model's variables as shown in equation 9:

$$\Delta logRGDP_t = \beta_0 + \sum_i^p \gamma_i \, \Delta logRGDP + \sum_i^q \gamma_i \, \Delta logELC_{t-1} + \sum_i^q \gamma_i \, \Delta logELG_{t-1} + \sum_i^q \gamma_i \, \Delta logCPI_{t-1} + \sum_i^q \gamma_i \, \Delta logINPG + \sum_i^q \gamma_i \, \Delta logTDB_{t-1} + \vartheta ecm_{t-1} + \varepsilon_t \quad (9)$$

### A Priori Expectation

The variables in the model are expected to have the following signs a priori.

**Table 1: A priori expectation**

| S/N | Variables | A priori expectation |
|---|---|---|
| 1 | Electricity consumption (ELC) | Positive (+) |
| 2 | Electricity generation (ELG) | Positive (+) |
| 3 | Consumer price index (CPI) | Positive (+) |
| 4 | Industrial production growth (INPG) | Positive (+) |
| 5 | Trade Balance (TDB) | Positive (+) |

***Source: Author's estimated output***

Thus, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5 > 0$. This implies that the growth rate of output (RGDP) is a function of electricity consumption, electricity generation, consumer price index, industrial production growth and trade balance.

## 5. Results and Discussion

The data was tested for unit root using Augmented Dickey Fuller (ADF) and Phillip-Peron (PP) tests; and the results are presented on tables1 and 2.

**Table 2: ADF Test Results**

| | ADF Test at Level | | | ADF Test at 1st Difference | | |
|---|---|---|---|---|---|---|
| | With Constant | With Constant & Trend | Without Constant & Trend | With Constant | With Constant & Trend | Without Constant & Trend |
| LogRGDP | -0.682 | -3.495 | 2.656 | -3.700*** | -3.668** | -2.294** |
| LogELC_KWH | -0.399 | -1.965 | 1.864 | -7.235*** | -7.113*** | -2.827*** |
| LogELG_KWH | -0.848 | -3.262* | 1.841 | -7.314*** | -7.239*** | -6.504*** |
| LogCPI | -1.181 | -3.092 | 0.79 | -3.557** | -3.893** | -1.53 |
| LogINPG | 1.409 | -2.298 | 2.734 | -4.255*** | -4.991*** | -3.025*** |
| TDB | -3.018** | -2.953 | -2.727*** | -9.092*** | -9.059*** | -9.225*** |

Where ** indicates significance at 5% level.

**Source:** Author's estimated output.

The ADF results in table 2 reveals that the variables were at mixed order of integration I (0) and I (1)). Specifically, RGDP was stationary at first difference, while TDB was at level. Other variables such as ELC, ELG, CPI, and INPG attained stationarity at first difference. The results of the PP test as presented in table 3 are more or less the same with the ADF test results, indicating a mixed order of integration I (0) and I (1); with RGDP stationary at first difference, while TDB is stationary at level. On the other hand, ELC, ELG, CPI and INPG were stationary at first difference. Given that the dependent variable (RGDP) was stationary at first difference, while ELC, ELG, CPI. INPG and TDB are a combination of level and first difference stationary series; the adoption of the ARDL model in this study is thus justified.

**Table 3: Phillip Peron (PP) Test Results**

| | PP Test at Level | | | PP Test at 1st Difference | | |
|---|---|---|---|---|---|---|
| | With Constant | With Constant & Trend | Without Constant & Trend | With Constant | With Constant & Trend | Without Constant & Trend |
| LogRGDP | -0.555 | -1.393 | 4.413 | -3.584** | -3.551** | -2.132** |
| LogELC_KWH | -0.369 | -2.545 | 1.944 | -7.052*** | -6.948*** | -6.400*** |
| LogELG_KWH | -0.848 | -3.288* | 2.112 | -7.324*** | -7.253*** | -6.464*** |
| LogCPI | -3.784*** | -1.813 | 2.016 | -2.840* | -3.503* | -1.257 |
| LogINPG | 2.627 | -0.57 | 4.327 | -2.765* | -3.419* | -2.661*** |
| TDB | -3.056** | -2.987 | -2.707*** | -9.509*** | -10.585*** | -9.621*** |

Where ** indicates significance at 5% level

*Source: Author's estimated output*

## Bounds Test Result

**Table 4: Bounds Cointegration Test**

| **F-Bounds Test** | | **Null Hypothesis: No levels relationship** | | |
|---|---|---|---|---|
| Test Statistic | Value | Signifi.. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 15.08367 | 10% | 2.08 | 3 |
| K | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

**Note:** K= number of variables

*Source: Author's estimated output*

From the bounds test result presented in table 4 the bounds test value of 15.084 is above the lower I (0) and upper bounds I (1) at the 5% level of significance. This indicates that there is long run relationship between the variables of our model in the study, and as such we went ahead to estimate the short run and long run form of the equation.

## ARDL Estimation Results: Long Run and Short Run

The estimated results of the ARDL for the long run are presented in table 5. The long run results indicate that electricity consumption is positively related to economic growth and it is significant at the 5% level. In other words, a unit increase in electricity consumption increased economic growth by 2.6% in Nigeria during the period covered by the study. This is an indication that electricity consumption by economic agents in the production of goods and services induces higher productivity, which in turn translates to higher output and consequently a rise in the GDP.

**Table 5: ARDL Estimated Result: Long Run**

| **Regressors** | **Coefficient** | **Std. Error** | **Prob.** |
|---|---|---|---|
| LogELC_KWH | 2.602 | 0.643 | 0.001** |
| LogELG_KWH | -3.363 | 1.118 | 0.007** |
| LogCPI | 0.196 | 0.063 | 0.006** |
| INPG | 0.001 | 0.003 | 0.633 |
| TDB | 0.004 | 0.001 | 0.013** |

**Note:** ** represents significance at 5%

*Source: Author's estimated output*

Furthermore, the positive effect of electricity consumption on economic growth in Nigeria during the study period can also be explained from the point of view that production of goods and services is mainly carried out through the use of plants and equipment that require the use of electricity. Thus, most production processes cannot be completed without electricity consumption. Hence, in the long-run, as firms or businesses consume more electricity in their production processes, it is expected to translate into increase in output, and by extension economic growth.

Electricity generation is negatively related to economic growth in the long run and it is significant at the 5% level in Nigeria during the period covered by the study as indicated in table 5. This implies that a unit increase in electricity generation decreased economic growth by 3.4% during the same period (1986-2021) in Nigeria. This is contrary to a priori expectation for the study. Electricity generation is expected to make electric power available at an affordable cost to both businesses (industries and manufacturers, small and medium scale enterprises, and service providers) and households. This is expected to boost production and enhance household social standard of living. However, the negative effect of electricity generation on economic growth in Nigeria during the period of the study is reasonably valid, given that Nigeria relies significantly on non-renewable electricity generation sources from gas powered plants. Over the years the country has continued to maintain and increase its generation from these gas powered plants at an enormous cost. Thus, to increase electricity generation using these plants also demands increasing spending on them, and which has negative effects on the economy in the long-term. This is because such huge cost may crowd-out scarce funds needed for other critical infrastructure in the country. And also, breakdown in the national grid transmission occurred frequently during the period covered by the study. This clearly meant that what was generated was not transmitted, implying that the demand for electricity was not met, and the consequences are that there was short supply in electricity and unit cost of electricity rose in view of increasing demand, with clear implications for cost of production and final output fell during the period.

As indicated in table 5, inflation is positively related to economic growth in the long run and it is significant at the 5% level. This is consistent with the study's a priori expectation. This demonstrates that a level of price increase is required to stimulate output growth; which is consistent with monetary theory. This is because a moderate rise in the general level of prices is theoretically acceptable because it encourages spending in anticipation of price rise which encourages more investment, higher productivity, and higher wages. Higher wages will lead to increased demand and generally growth in the economy. Although, industrial output (INPG) has a positive effect on economic growth in the long run, it is however, not significant at the 5% level as shown in table 5. Two issues can be adduced for the non-significance of the industrial production variable in the determination of the size of growth in Nigeria economy. First, the cost of imported inputs has become prohibitive due to exchange rate bottlenecks, and second, Nigeria is a net importer of most household consumer goods. Importation of finished consumer goods serves as a disincentive to domestic production. The trade balance variable has a weak but positive relationship with economic growth that is significant at the 5% level as indicated in table 5.

**Table 6: ARDL Estimated Result: Short Run**

| | Coefficient | Std. Error | Prob. |
|---|---|---|---|
| Constant | 29.045 | 12.066 | 0.0264** |
| dlogRGDP(-1) | -0.514 | 0.11 | 0.000** |
| dlogELC_KWH(-1) | -0.245 | 0.046 | 0.000** |
| dlogELG_KWH(-1) | 0.339 | 0.054 | 0.000** |
| dlogCPI | -0.105 | 0.018 | 0.000** |
| dTDB(-1) | -0.0004 | 0.0002 | 0.045** |
| Ecm(-1) | -0.163 | 0.014 | 0.0000** |

**Note:** ** represents significance at 5%.

***Source: Author's estimated output***

The estimated results of the ARDL for the short run are presented in table 6. The result indicates that electricity consumption has a negative relationship with economic growth in the short run that is significant at 5% level. In other words, a unit increase in electricity consumption decreases economic growth by 0.25%. this is contrary to the a priori expectation for the study. Electricity generation has a positive relationship with economic growth in the short run that is significant at the 5% level. This implies that a unit increase in electricity generation increased economic growth by 0.34%. Inflation is negatively related to economic growth; decreasing economic growth by 0.10% in response to a unit increase in inflation rate in the short run as indicated in table 6. This is contrary to a priori expectation for the study. However, this result is supported by the findings of Sidrauski (1969) as cited in Fischer (1979) which showed that for a "class of utility function in which consumption and real money balances are separable, inflation has a negative impact on consumption" as a result of decrease in demand which will further lead to a fall in productivity and output, and ultimately a decline in economic growth. Specifically, continuous increase in the general price level in the short run in Nigeria during the study period affected consumption demand which slowed down growth in output.

The trade balance coefficient is negative; indicating that a unit increase in trade balance decreases economic growth that is significant at the 5% level. This is contrary to the a priori expectation for the study. Nigeria economy is import dependent, and imports more than she exports; especially household consumer goods. Thus, Nigeria has trade deficits with her major trading partners that reflects a negative balance of trade and unfavourable terms of trade. For instance, Nigeria exports more of raw materials and imports finished goods from her major trading partners. This has negative consequences on the economy as import of finished goods creates employment for the exporting country.

The ECM has the right sign of -0.16 and it is significant at 5% level as indicated in table 6. This implies the presence of disequilibrium or distortion in the short run. The ECM coefficient shows that about 16% of the disequilibrium will be corrected on annual basis. In real terms, it will take about 6years 3months to restore equilibrium. Short term distortion could result from policy shock in form of government fiscal policy. There were a number of fiscal policy decisions by the government during the study period that could have been responsible for the disequilibrium in the economy. The key driver of growth in this study is electricity consumption, the ECM coefficient in essence indicates that it will take consistent investment in electricity infrastructure in order to increase the supply of electricity over a period of 6years 3months to meet the growing demand for electricity to impact on output.

### Post-Diagnostic Tests

### Heterosckedasticity Test

The Bresuch-Pagan-Godfrey Heterosckedasticity test was used and the result is presented in Table 7. The test result shows the probability value of the observed R-squared is greater than 0.05%. This indicates the absence of heterosckedasticity.

**Table 7: Heteroskedasticity Test: Breusch-Pagan-Godfrey**

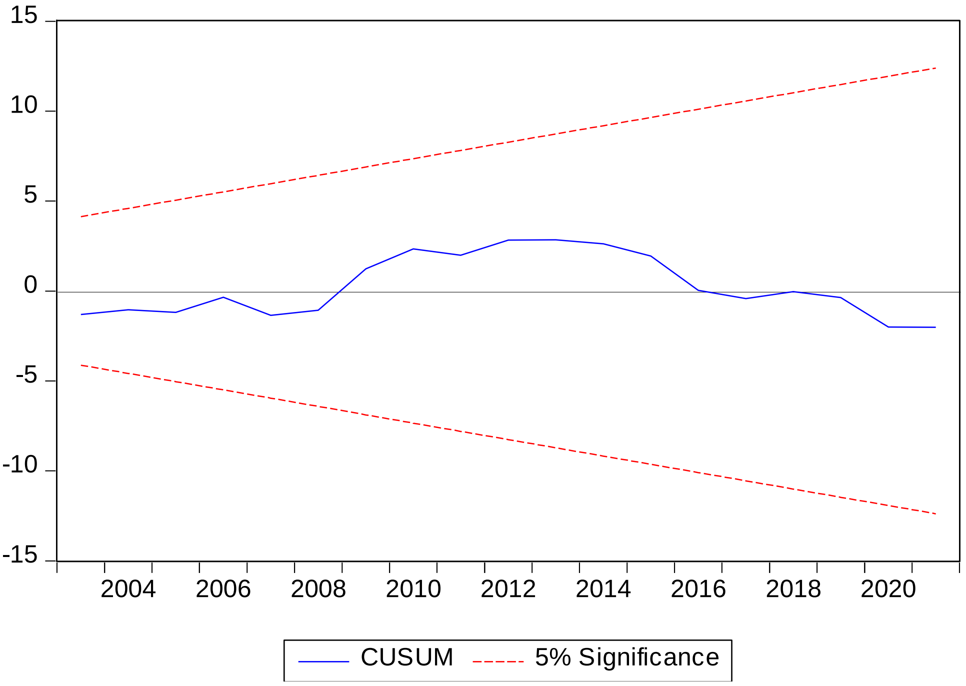
| | | | |
|---|---|---|---|
| F-statistic | 1.499053 | Prob. F(14,19) | 0.2029 |
| Obs*R-squared | 17.84464 | Prob. Chi-Square(14) | 0.2139 |
| Scaled explained SS | 2.801773 | Prob. Chi-Square(14) | 0.9994 |

***Source: Author's estimated output***

### Stability Test

The result of the residual stability test using CUSUM and CUMSUM square at 5% level of significance is shown in figure 1. The result indicates that the residuals of the model are stable for the study period.

**Figure 1: Residual Stability Test Result**




### Conclusion

The study concludes that electricity consumption has a significant positive impact on economic growth in the long run; while electricity consumption has a negative impact on economic growth in the short run in Nigeria during the period covered by the study. The short run negative impact of electricity consumption on economic growth is arguably as a result of infrastructural deficiency, poor supply and frequent breakdown in transmission lines.

## Recommendations

The study recommends sustained efforts by both the government and private entities to improve generation, efficient transmission and distribution of electricity to the key productive sectors such as manufacturing, and small and medium enterprises in order to have sustained growth in output in the long run that would lead to economic growth in Nigeria. Also, electricity energy policy in Nigeria should include a shift towards alternative sources such as renewable energy sources such as solar power, terrestrial heat, hydrocarbon and biomass in order to address the short run negative relationship between electricity consumption and economic growth in Nigeria that is essentially due to supply bottle necks. Finally, electricity infrastructure development should be prioritized in the national development plan to improve on generation and transmission thus raising supply to meet the growing demand for electricity for production.

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