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Electricity Power Supply And Output Growth In Nigeria

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***Abstract:** The paper examined the extent to which Nigeria's electricity supply has affected output growth in the country using the Auto regressive distribution lag (ARDL). Data used were sourced from the CBN and World Bank statistical data bases and were analyzed using the ARDL technique. The result showed that there exists a significant and positive relationship between electricity supply and output growth both in the short and long run periods. The paper thus recommends that government should deepen actions in providing the enablers that were discovered in its reviewed literature as key variables of interest that could trigger increased electricity output which include: adequate funding of the electricity power sector; prompt and proper maintenance of equipment; adequate and consistent gas supply to the electricity generating stations; improved security for electricity power installations to forestall vandalization of installed equipment and facilities.*

I. INTRODUCTION

There are three dynamics to electricity supply to consumers: generation, transmission and distribution. It has been widely acknowledged in literature that the adequate, stable and efficient supply of electricity to end-users (industries and households) represent the bedrock for the growth and development of any nation. (Ogunjobi, 2015, Attigah, *et al.*, 2013; Zarma, 2006).

Literature on industrialization in the world is replete with successes derived from the electricity revolution showing that electricity reduced the cost incurred by businesses and revolutionized the development of industrialization. It has also changed the traditional ways of livelihood to improved modern living. Electricity has come to be so important that nations are investing lots of resources to take it to all nooks and crannies of their nations.

Modern life revolves around affordable and reliable electricity as it has improved the chances of providing clean and safe light around the clock. Electricity helps in regulating temperature to suit humans in harsh or uncomfortable weather conditions like providing some cooling effect through the air conditioners under hot and warm weather and providing heat effects in cool and cold conditions. The digitalization of modern society today would not have been possible without the advent of electricity as it provides the backbone through which all the processes of digitalization rely and thrives.

It is interesting to note that the world had known about electricity long before it was harnessed for use 250 years ago. Notably, electricity experiments by Benjamin Franklin in 1752- which includes his famous kite experiments – proved just how little the world knew about electricity, especially during the period of the American Revolution and the first industrial revolution. There has been tremendous leap in our grasp of electricity since that legendary kite experiment by Franklin. In the time since Franklin's experiments, our grasp of electricity has grown tremendously, as the world consistently conquers new frontier in her quest to improve lives with electricity provision.

Electricity is an essential intermediate good and it does not represent an end, rather it is an input factor to a large set of activities that can improve welfare, increase productivity or generate income. The complex interactions and synergies between multiple development factors, including other infrastructure investments next to electricity and enabling political, socio-economic and cultural conditions enhance the impact of electrification. Indeed, it is increasingly recognized that certain "complementary" inputs or services – such as business development services (BDS) or access to finance – can increase the chances that access to electricity leads to significant income generation and poverty alleviation (Motta and Reiche 2001, Peters *et al*., 2009).

Literature on electricity supply in Nigeria agrees that such has been generally appalling. That Nigeria had continued to grope in low and inefficient electricity power supply over the years, even with the increase in demand for the product. Even Government, which retains extensive and majority control over most activities in the electricity power sector is lethargic about increasing the supply of electricity in the country to meet the increasing demand for the product. Theory posits strongly that electricity can stimulate growth of nations and is, therefore, a very essential enabler for output growth of economies. The Nigerian government, for instance, puts the growth of her economy as a priority in every fiscal planning. Also, the government controls majorly the electricity power resource sector that theory concludes that if harnessed can stimulate growth, even exponentially. Why then is the Nigerian government not aligning to the known theoretical underpinning to experience desired output growth in her economy?

This paper, therefore intends to interrogate the theoretical conclusion on the efficacy of electricity supply positively affecting output growth with the Nigerian data, which may help us to understand the reasons as to why government is not deepening electricity supply in Nigeria.

II. LITERATURE REVIEW

Electricity has risen to be the dominant source of industrial power, since Electricity could be packaged in almost any size, thus it has become indispensable to socio-economic and industrial development of any nation. (Odili and Mokwunye, 2003).

Archibong (1997) argued that the positive side of SAP could not be fully established due to administrative bottle-necks, rigidities and poor infrastructure, especially electricity supply. That electricity supply undermined the effectiveness of fiscal and other incentives designed to stimulate the growth and diversification of the economy. Proffering a solution, he maintained that proper maintenance of electricity supply equipment be carried out to avoid incessant breakdown. In addition, he recommended that applying the use of simple plant designs in power stations will save cost of running the power stations.

Iwayemi (1998, 2008), using two (2) approaches of measuring efficiency, that is, economic techniques and non-parametric programming opined that there is a strong feedback relationship between the energy sector and the national economy. According to him, there are two angles to the statement, firstly he explains that energy supply and consumption have enormous impact on social and economic development as well as on the living standard and the overall quality of life of the population, then on the other hand, he argues that the economic structure, as well as the prevailing macro-economic conditions are key determinants of energy demand and supply. Rapid economic growth and steadily rising income and higher living standards combined have all contributed to produce rapidly rising global energy demand and supply.

Oke (2006), using the simple ordinary least square (OLS) method in conducting his research, attributed the non-competitiveness of Nigeria's export goods to poor infrastructure especially electricity supply - which of course has a direct relationship with the quantity of electricity generated- which drives the running of cost of firms. In his opinion, he feels that Nigeria should set aside at least 30% of her annual budget to take care of power generation expansion programs for the next twenty (20) years, and also develop new ideas for efficient pricing of electricity, so that the price of electricity will not be lower than the average production cost. This he says will encourage private partnership participation, thus causing more investments in the power sector and boosting power generation.

Sambo (2008) in analyzing the challenges affecting electricity generation, transmission and distribution in Nigeria insisted that power supply remains an unavoidable pre-requisite to any nation's development. He further stated that electricity generation, transmission and distribution are capital intensive activities requiring huge resources of both funds and capacity. Sambo (2008) insists that some of the major constraints affecting electricity power supply include poor utilization of existing assets and deferred maintenance, delays in implementing new projects, lack of sustained, sound and practicable relationship between the Federal Government and stakeholders, particularly the Joint Venture International Oil Companies and independent power projects. He also insists that erratic gas supply for power generation, inadequate power evacuation at newly completed power plants, poor technical staff recruitment and inappropriate tariff structure were responsible for electricity power supply not meeting electricity power demand in Nigeria. Sambo (2008) conclusively affirms that if all these challenges are adequately addressed, then the supply would increase exponentially.

In the same vein, Arobieke *et al.* (2012) explained that electricity played a vital role in modern society. They emphasized that a country only becomes a twenty-four (24) hour society because of the level of power she generates. They further noted that the discrepancy between electricity demand and actual generation was mostly due to lack of funds, unavailable gas to power the turbines and inadequate plant maintenance. They went ahead to suggest that in order to check the shortfall (where demand for is higher than supply of electricity in Nigeraia), full autonomy should be given to the private sector to participate fully in the power generation sector.

Theophilus *et al*. (2016) carried out an investigation on the efficient electricity supply to industrial production in Nigeria using the error correction mechanism (ECM). Their study revealed that the Nigerian industrial development over the years had been stunted by series of problems, paramount of which was the epileptic nature of electricity supply, resulting from poor electricity generation. They attributed this largely to factors like, lack of equipment maintenance, vandalism, and low gas supply. The study showed empirically that poor electricity supply contributed to the poor performance of the nation's industrial sector.

From the reviewed literature it is seen that vast literature exists that seek to show the importance of electricity on output growth of nations, indicating that electricity is key in order to achieve accelerated growth. This conviction gives this work the desire to probe into the efficacy of this conclusion on the contemporary Nigerian economy.

III. METHODOLOGY

This research work utilized secondary data sourced from Central Bank of Nigeria (CBN) and the World. The study seeks to investigate the extent to which Nigeria's electricity supply affected output growth in the country.

A. MODEL SPECIFICATION

The Auto-regressive distribution lag (ARDL) is a statistical tool is actually an ordinary least square (OLS) based model which is applicable for both non-stationary time series as well as for time series with mixed order of integration.

It was used to analyse the secondary data sourced from the World bank and CBN statistical bulletins; and following Gould and Ruffin (1995), the study considered the Cobb Douglas production function which is specified as thus;

$Y = AL^{\alpha}K^{\check{R}}$ Equation 3.1

Where Y is economic growth measured by GDP, K is the capital stock measured by Gross fixed capital formation and A is the total factor productivity.

Given that the key objective is to examine the extent to which Nigeria's electricity supply and consumption led to the growth of the Nigerian economy, secondary data was utilized for the analysis. These data were sourced from the various annual reports of the CBN and World Bank. The data covered twenty-eight (28) years from 1990-2018 of the dependent variables (GDP) and the independent variables (exchange rate, inflation, electricity consumption, labour force and gross fixed capital formation).

Our model is specified thus;

GDP = f(EC, inf, EX, GFCG, LF) Equation 3.2

The above equation can be written in econometric model and in their respective natural log form as thus;

$Ingdp = \beta_0 + {}_1InEC + \beta_2 inf + \beta_3 EX + \beta_4 InGFCF + \beta_5 InLF + έ_t$ Equation 3.3

Variable	Description	Source
InEC	Electricity consumption	World bank Development indicators (2019)
Inf	Inflation	Central Bank of Nigeria statistical bulletin (2018)
EX	Exchange rate	World bank Development indicators (2019)
InGFCF	Gross Fixed Capital formation	World bank Development indicators (2019)
/InLF	Labour force	World bank Development indicators (2019)
Ingdp	Gross domestic product	Central Bank of Nigeria statistical bulletin (2018)

Where; β_0 is the intercept and $έ_t$ is the error term.

Source: CBN/World Bank bulletins (2019

Table 3.1: Variables in the ARDL model

S/N	Variables	COEFFICIENT	Interpretation
1.	Electricity consumption	+ve	Increased electricity consumption causes a rise in GDP.
2.	Exchange Rate	-ve	Increased exchange rate causes a drop in GDP.
3.	Inflation Rate	-ve	Increased inflatin causes a drop in GDP.
4.	Labour Force	+ve	Increased labour force causes a rise in GDP.
5.	Gross fixed capital formation	+ve	Increased Gross fixed capital formation causes a drop in GDP.

Source: Field data (2019).

Table 3.2: Apriori expectations of variables

IV. STYLIZED FACT

Electricity generation and supply started in 1896 (Kayode *et al*, 2012). The Nigerian electricity supply company (NESCO) was set up as an electricity utility company operating a hydro-electric power station near Jos. The Government and native authority-owned systems remained separate operational entities for several years until 1946. By 1950, a central body known as the electricity corporation of Nigeria (ECN) was established to take over all various electricity supply outlets within the country. The new body officially took over all electricity supply activities in Nigeria by 1st April 1951. (Adegboyega, 2015).

By 1962, an act of parliament established the Niger dam authority (NDA) to explore the possibilities of expanding capacity of hydro-generated electricity in Nigeria, and with this, construction started with the Kainji dam in 1962 with eventually completion in 1968. The vast nature of the country's grid power transmission system started operations in 1966 with the collaborative efforts of the defunct ECN and NDA, which linked kainji with Lagos.

On 1st of April 1972, ECN and NDA merged to form a unified body known as *National Electric Power Authority (NEPA)* with the actual merging taking place on the 6th of January 1973 when the first manager was appointed. The network continued to grow under NEPA and between 1978 and 1983 the Federal Government had sponsored two panels of enquiry to fashion out models for restructuring NEPA into an independent unit or toward privatizing it out of monolithic nature. This led to the establishment of the electrification boards whose work is to take power supply to the rural areas and new cities.

By 1999-2005 (The advent of democratic government), an act was enacted establishing PHCN, an Initial Holding Company (IHC), as a result of Government effort to revitalize power sector. This was an intended name for privatization which was meant to transfer assets and liabilities of NEPA to PHCN. It was officially commissioned on the 5th of May 2005 and was to carry out business of NEPA which is still on. In the same vein, the *National Integrated Power Projects (NIPP)* was inaugurated in 2004 to be able to catalyze and fast track the upgrading of adding more capacity to the current available electricity capacity in the country. This was basically a private initiative which is currently being supervised by the *Niger Delta Power Holding Company (NDPHC).* (Rmop, 2018)

The administration of President Umar Yar'adua had set for the Country the Vision 20:2020, which simply is the target of being one of the world's 20 (twenty) best economies by the year 2020, and In order to achieve this Vision, an efficient electricity sector is a pre-requisite, as there can be no industrial development without electricity. Over time various targets had been set by the Government in order to achieve increase in the generation capacity. A short-term target of 6,000MW had been set by the Government, with a deadline for 31 December 2009, while the power sector intended to achieve a medium-term target of 10,000 MW by 2011. In furtherance of its objective, $5.37 billion had been approved from the Excess Crude Account to finance the NIPP, while funding was also expected from the fiscally challenged 2009 Budget for projects which cut across power. Again for 2016, a target of 12,000MW was set and according to the management of the Nigeria Electricity Regulatory Commission (NERC), electricity generation nationwide would soon be so efficient that the target of 12,000 MW by 2016 would be surpassed. (Oputa, 2014). Presently, Nigeria aims to increase its electricity capacity to 30 giga watts (or 30,000Mw) by 2030. Out of this figure, Nigerians would be able to access 75% (or 22,500Mw) by 2020 and 90% (or 27,000Mw) by 2030. This is as contained in the country's 30:30:30 vision. The figures are an increase from the current level of 5 giga-watts (or 5,000Mw), (Temitope, 2017).

It is pertinent to note that as a nation, Nigeria has a generating capacity of only about 12,522 Mw of electricity, and only able to actually generate about 3,887Mw for its population of over 170 million people at peak periods, because most power infrastructural facilities are poorly maintained. This figure is poor when compared to South Africa which generates about 40,000Mw for a population of 50 million people; Brazil generates about 100,000Mw for a population of 192 million people; USA has 700,000Mw for a population of 308 million people. This translates to a very disappointing level of electricity consumption per capita, thereby leaving our industries to perform at epileptic levels, producing goods and services that are sold at prices that automatically adjust to power outages and account for the expensive cost of production via generating sets and a populace that is unable to take advantage of the latest advances in technology and appliances (Darling *et al.*, 2008).

V. DATA ANALYSIS AND FINDINGS

Here we present the results of the Auto regressive distribution lag (ARDL) used to analyze the study data.

A. DATA PRESENTATION

Year	GDP ($B)	Gross Fixed Capital Formation	labour force (Millions)	Electricity Consumption. (Kilowatts Per Capita)	Inflation (%)	Exchange Rate (%)
1990	54.04	15.8	32,063,705	87.079	7.36	8.04
1991	49.12	15.9	32,867,042	89.61	13.01	9.91
1992	47.79	16.6	33,665,896	90.05	44.59	17.3
1993	27.75	18.4	34,567,538	100.88	57.17	22.07
1994	33.83	15.1	35,589,738	95.56	57.03	22.01
1995	44.06	9.8	36,476,000	91.48	72.84	21.9
1996	51.08	10.2	37,359,536	85.9	29.3	21.88
1997	54.46	11.7	38,306,243	82.004	10.7	21.89
1998	54.6	12.2	39,308,944	76.96	7.9	21.89
1999	59.37	10.1	40,378,166	75.76	6.6	92.34
2000	69.45	10.1	41,439,753	74.49	6.9	101.7
2001	74.03	10.8	42,444,295	75.57	18.9	111.23
2002	95.39	10.1	43,376,698	104.66	12.9	120.58
2003	104.91	14.1	44,463,287	101.92	14.1	129.22
2004	136.39	10.5	45,568,177	123.63	17.9	132.89
2005	176.13	7.8	46,768,187	129.63	8.2	131.27
2006	236.11	11.8	47,945,348	111.75	5.4	128.65
2007	275.63	13.2	49,185,878	138.9	11.6	125.81
2008	337.04	11.8	50,482,323	127.24	12.5	118.55
2009	291.88	17.2	57,791,903	120.63	13.7	148.9
2010	361.46	16.6	57,143,750	136.42	10.8	150.3
2011	404.99	15.5	54,535,980	150.198	12.2	153.86
2012	455.5	14.2	57,636,192	156.79	8.5	157.5
2013	508.69	14.2	52,794,893	142.72	6.1	157.31
2014	546.68	15.1	53,696,550	144.52	8.1	158.55
2015	486.8	14.8	54,557,232	139.41	9.1	192.44
2016	404.65	14.7	55,285,984	141.33	15.7	253.49
2017	375.75	14.7	57,856,178	138.27	16.4	305.79
2018	397.19	14.2	60,577,072	141.29	12.1	306.08

Table 5.1: Data for time series analysis on the model

B. ECONOMIC ANALYSIS

This analysis is an investigation into the impact of electricity consumption on GDP. Hence it is pertinent to examine the time series characteristics of the variables included in the model; that is, testing the time series properties of Gross domestic product, inflation, exchange rate, Gross fixed capital formation and labour force in order to avoid the occurrence of a spurious regression. To do this, the variables were subjected to a unit root test. Here the Augmented Dickey Fuller (ADF) and Phillip-Peron unit root test were adopted, and after ascertaining the order of integration, we proceeded to estimating the ARDL Bounds analysis test for the existence of a co-integrating relationship among the variables.

C. RESULT INTERPRETATION

Variables	ADF	5%	Prob.	Oder	PP	5%	Prob.	Order
LELECCON	6.3529	2.9762	0.0000	I(1)	6.0188	2.9763	0.0000	I(1)
LEXR	3.7788	3.6999	0.0083	I(1)	4.8765	2.9763	0.0006	I(1)
LGDP	3.3766	3.3999	0.0210	I(1)	4.0663	2.9763	0.0042	I(1)
LGFCF	5.3525	3.7115	0.0002	I(1)	8.3117	2.9762	0.0000	I(1)
LINFR	6.4984	3.7529	0.0000	I(1)	3.9288	2.9763	0.0058	I(1)
LLABOUR	6.0191	3.6999	0.0000	I(1)	5.9364	2.9763	0.0000	I(1)

Source: Author's computation from EViews 10

Table 5.3.1: Unit Root Test Result

Table 5.3.1 shows the result of the unit root test for stationarity of the variables in the model (Augmented Dickey Fuller / Phillip Peron). The result shows that all the variables, that is, Electricity consumption, Exchange rate, Gross Domestic Product, Gross fixed capital formation, Inflation and

Labour force are integrated of order one I(1), that is, stationary at first difference.

***LNELECCON + 0.5989*LNLABOUR)**

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	13.69589	10%	2.26	3.35
K	5	5%	2.62	3.79
		2.5%	2.96	4.18
		1%	3.41	4.68

Source: Author's computation from EViews 10.

Table 5.3.2: ARDL Co-integration Test (F-Bounds Test)

Table 5.3.2 result gives the F-statistic of 13.6959 which is greater than 3.79 the value of the upper bound I(1). Based on this, the null hypothesis of no cointegration is rejected which implies that there is evidence of long run relationship among the variables. Since the variables are I(1), it is therefore appropriate to estimate both the short and long run models.

Dependent Variable: LNGDP
Method: ARDL

Variable	Coefficien	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	-0.362113	0.159492	-2.270413	0.0350
EXR	-0.004396	0.001267	-3.468354	0.0026
EXR(-1)	0.003158	0.001397	2.260205	0.0357
GFCF	0.060132	0.011119	5.408252	0.0000
INFR	-0.000277	0.002072	-0.133522	0.8952
LNELECCON	0.047603	0.201418	0.236339	0.0157
LNLABOUR	0.815703	0.443123	1.840804	0.0313
C	-13.54453	7.219125	-1.876201	0.0761

R-squared	0.706898	Mean dependent var	0.077413
Adjusted R-squared	0.598913	S.D. dependent var	0.178641
S.E. of regression	0.113136	Akaike info criterion	-1.279258
Sum squared resid	0.243195	Schwarz criterion	-0.895307
Log likelihood	25.26999	Hannan-Quinn criter.	-1.165089
F-statistic	6.546253	Durbin-Watson stat	2.342967
Prob(F-statistic)	0.000510		

**Note: p-values and any subsequent tests do not account for model selection.*

Source: Author's computation on Eviews 10.

Table 5.3.3: Estimation of the Regression Parameters (Short Run Model)

Examining the short run dynamics of the model (Table 5.3.3), the result shows that the joint impact of electricity consumption, Exchange rate, Gross fixed capital formation, Inflation and Labour force on the GDP of Nigeria within the period under investigation is 59.8% (Adjusted R-Squared 0.5989). The coefficient of EXR is -0.0044 which means that a unit depreciation in exchange rate will cause a reduction of 0.0044 units in GDP. This shows that depreciation of the local currency (Naira) in the short run has a negative effect on economic growth of Nigeria within the period under study. This may be caused by a fall in production. Currency depreciation, followed by increase in demand for locally produced goods should grow the economy, however when local production is low, domestic currency depreciation weakens economic output. Added to this, is the fall in the price of crude oil in the international market. Nigeria as an oil dependent economy has witnessed fall in her domestic currency which adds to dipping economic output witnessed in the study. The p-value of 0.0026 implies that depreciation of the Naira has a significant negative effect on GDP in the short run. Exchange rate at the previous lag (lag 1) has a significant positive effect on GDP ($b = 0.0032$, $p<0.05$). The coefficient of GFCF is 0.0601 means that a unit appreciation in GFCF will cause an increase of 0.0601 units in GDP. The p-value of 0.0000 implies that increase in GFCF has a significant effect on GDP in the short run. The coefficient of Inflation is -0.0003 which means that a unit increase in inflation will cause a reduction of 0.0003 in GDP. The p-value of 0.8952 implies that increase in inflation has no significant effect on GDP in the short run. Electricity consumption with the coefficient of 0.0476 implies that a unit increase in electricity consumption will increase the GDP by 0.0476. The p-value of 0.0157 means there is significant short run relationship between electricity consumption and GDP. Labour force with the coefficient of 0.8157 implies that a unit increase in labour force will increase the GDP by 0.8157. The p-value of 0.0313 implies that there is significant effect of labour force on GDP.

ARDL Long Run Form and Bounds Test

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficiet	Std. Error	t-Statistic	Prob.
EXR	-0.000909	0.000515	-1.764859	0.0237
GFCF	0.044146	0.007606	5.804474	0.0010
INFR	-0.000203	0.001526	-0.133131	0.0425
LNELECCON	0.034948	0.147674	0.236656	0.0351
LNLABOUR	0.598851	0.317182	1.888034	0.0531

EC = D(LNGDP) - (-0.0009*EXR -0.0441*GFCF + 0.0002*INFR + 0.0349 *LNELECCON + 0.5989*LNLABOUR)

Source: Author's computations from E views 10.

Table 5.3.4: ARDL Long Run Form and Equation

The long run equation is estimated since the F-Bounds test indicates the existence of co-integration among the variables. Table 5.3.4 shows that the long run coefficient of exchange rate is -0.0009, which implies that a unit depreciation in the domestic currency will cause a reduction of 0.0009 in the GDP in the long run. (The fall in production observed in the short run, extends into the long run) The t-value of 1.765 and the P-value of 0.0237<0.05 (level of significance) shows that the relationship between local currency depreciation and GDP is statistically significant in the long run. The coefficient of gross fixed capital formation is

0.0441, which implies that a unit increase in GFCF will increase the GDP by 0.0441 units in the long run. The P-value of 0.0010<0.05 (level of significance) shows a statistically significant impact of gross fixed capital formation on GDP in the long run. The coefficient of inflation is -0.0002, which implies that a unit increase in inflation will reduce the GDP by 0.0002 in the long run. The P-value of 0.0425<0.05 (level of significance) shows a significant impact of inflation on GDP in the long run. The coefficient of electricity consumption is 0.0349, which implies that a unit increase in ELECCON will increase the GDP by 0.0349 in the long run. The P-value of 0.0351<0.05 (level of significance) shows that the relationship between ELECCON and GDP is statistically significant in the long run. The coefficient of labour force is 0.5989, which implies that a unit increase in LABOUR will increase the GDP by 0.5989 units in the long run. The P-value of 0.0001<0.05 (level of significance) shows that the relationship between LABOUR and GDP is statistically significant in the long run.

ARDL Error Correction Regression

Dependent Variable: D(LNGDP)

ECM Regression

Case 3: Unrestricted Constant and No Trend

Variable	Coefficien	Std. Error	t-Statistic	Prob.
C	-44.51720	5.944020	-7.489410	0.0000
D(LNELECCON)	0.574336	0.195845	2.932610	0.0093
D(LNABOUR)	0.783207	0.556185	1.408176	0.1771
D(GFCF)	-0.466507	0.104776	-4.452432	0.0003
D(INFR)	0.060888	0.041410	1.470386	0.1597
CointEq(-1)*	-0.597163	0.079582	-7.503769	0.0000

R-squared	0.779485	Mean dependent var	0.071239
Adjusted R-squared	0.729368	S.D. dependent var	0.178320
S.E. of regression	0.092766	Akaike info criterion	-1.730064
Sum squared resid	0.189322	Schwarz criterion	-1.444592
Log likelihood	30.22089	Hannan-Quinn criter.	-1.642792
F-statistic	15.55333	Durbin-Watson stat	2.711639
Prob(F-statistic)	0.000001		

** p-value incompatible with t-Bounds distribution.*

Source: Authors computation from E Views 10

Table 5.3.5: ARDL Error Correction Model

Having estimated both the short and long run relationships among the variables, it is imperative to measure the speed of adjustment from short run to the long run using the ARDL error correlation mechanism (Table 4.6). Negative ECM (CointEq(-1)) indicates convergence in the long run. The ECM value of -0.5972 implies that the speed of adjustment to long run equilibrium is about 60%. That is, the reversion to long run equilibrium is at an adjustment speed of 60% and is statistically significant (P<.05).

D. GRANGER CAUSALITY TEST

Date: 04/14/21 Time: 11:02
Sample: 1990 2018
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
EXR does not Granger Cause LNGDP	28	1.56661	0.2223
LNGDP does not Granger Cause EXR		0.26250	0.6129
GFCF does not Granger Cause LNGDP	28	2.64025	0.1167
LNGDP does not Granger Cause GFCF		2.48488	0.1275
INFR does not Granger Cause LNGDP	28	0.02143	0.8848
LNGDP does not Granger Cause INFR		1.84465	0.1865
LNELECCON does not Granger Cause LNGDP	28	0.37852	0.5440
LNGDP does not Granger Cause LNELECCON		5.04256	0.0338
LNLABOUR does not Granger Cause LNGDP	28	12.8525	0.0014
LNGDP does not Granger Cause LNLABOUR		0.96990	0.3341
GFCF does not Granger Cause EXR	28	0.04171	0.8398
EXR does not Granger Cause GFCF		0.29891	0.5894
INFR does not Granger Cause EXR	28	0.70684	0.4085
EXR does not Granger Cause INFR		1.50606	0.2312
LNELECCON does not Granger Cause EXR	28	0.49225	0.4894
EXR does not Granger Cause LNELECCON		4.32183	0.0480
LNLABOUR does not Granger Cause EXR	28	0.03627	0.8505
EXR does not Granger Cause LNLABOUR		2.03026	0.1666
INFR does not Granger Cause GFCF	28	1.86129	0.1846
GFCF does not Granger Cause INFR		8.36798	0.0078
LNELECCON does not Granger Cause GFCF	28	1.32127	0.2612
GFCF does not Granger Cause LNELECCON		1.56008	0.2232
LNLABOUR does not Granger Cause GFCF	28	0.55231	0.4643
GFCF does not Granger Cause LNLABOUR		0.95064	0.3389
LNELECCON does not Granger Cause INFR	28	0.49694	0.4874
INFR does not Granger Cause LNELECCON		0.84458	0.3669

LNLABOUR does not Granger Cause INFR	28	3.63678	0.0681
INFR does not Granger Cause LNLABOUR		0.00373	0.9518
LNLABOUR does not Granger Cause LNELECCON	28	4.62759	0.0413
LNELECCON does not Granger Cause LNLABOUR		0.01242	0.9122

Source: Author's computations from E Views 10

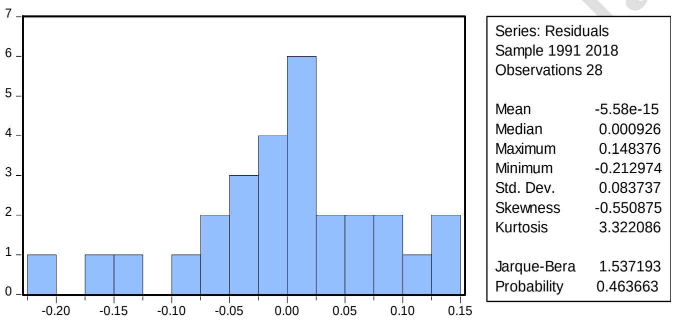
Table 5.4.1: Pairwise Granger Causality Tests

The Granger causality test is essentially a statistical hypothesis test which is used in determining whether one time series is useful in forecasting another. This was first proposed by Granger (1969).

The result in the above table shows a unidirectional causality. The result shows that causality follows from GDP to ELECCON, Labour to GDP, EXR to ELECCON, GFCF to INFR, labour to ELECCON but not vice versa.

The Granger causality test for the study revealed a unidirectional flow from GDP to electricity consumption, which suggests that a permanent growth in GDP, may cause a permanent rise in electricity consumption, and to sustain this growth, Government should encourage high investment in the electricity sector in order to meet the ever rising demand for electricity. This result is actually in tandem to an earlier study of the electricity consumption pattern in Malawi conducted by Jumbe (2004) in which the Granger causality and the error correction method were used to test causality between electricity consumption and GDP.

E. DIAGNOSTICS TESTS



Source: Author's computation from E Views 10

Figure 5.5.1: Normality Test

The diagnostic tests using Jarque-Bera test for the normality of the residual gives the probability value of 0.4637 which means that the null hypothesis that the residual is normally distributed cannot be rejected (Table 4.7). The visual inspection of the Histogram shows that it approximately or roughly symmetrical which is a sign of normality. The result for auto and partial correlation show that the plots stay within the 5% critical bounds, which means that the null hypothesis of no autocorrelation cannot be rejected. The probability values F-statistic, Obs*R-sqaured and Scaled explained SS for the heteroskedasticity test are all greater than 0.05 which implies that there is no presence of heteroskedasticity in the residual.

Date: 04/12/21 Time: 06:15
Sample: 1990-2018
Included observations:

Autocorrelation	Partial Correlation		AC	PAC	Q-Stats	Probs*
		1	-0.072	-0.072	0.1605	0.689
		2	-0.245	-0.251	2.0968	0.350
		3	0.010	-0.032	2.1005	0.552
		4	0.035	-0.031	2.1432	0.709
		5	0.166	0.173	3.1456	0.678
		6	-0.020	0.015	3.1603	0.788
		7	-0.102	-0.020	3.5801	0.827
		8	-0.066	-0.091	3.7624	0.878
		9	0.278	0.255	7.1672	0.620
		10	-0.100	-0.144	7.6379	0.664
		11	-0.148	-0.035	8.7273	0.647
		12	0.253	0.229	12.097	0.438

******Probabilities may not be valid for this equation specification*

Source: Author's computation from E Views 10

Table 5.5.2: Autocorrelation and Partial correlation

Heteroskedasticity Test: Breusch-Pagan-Godfrey

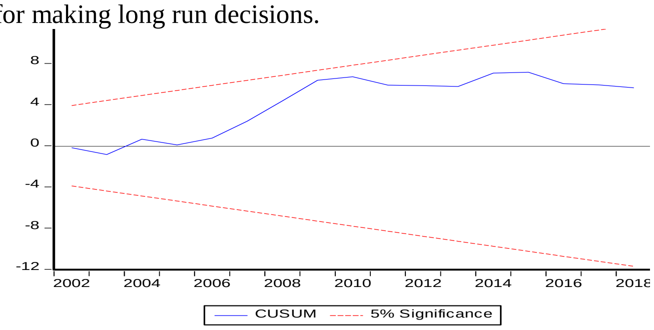
F-statistic	0.970424	Prob. F(10,17)	0.5012
Obs*R-squared	10.17512	Prob. Chi-Square(10)	0.4253
Scaled explained SS	4.354812	Prob. Chi-Square(10)	0.9299

Source: Author's computation from E Views 10

Table 5.5.3: Heteroskedasticity

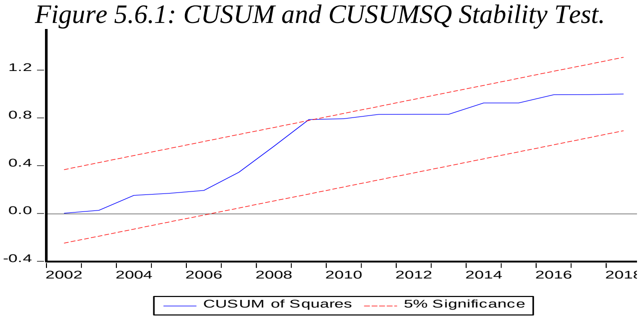
F. STABILITY TEST

This test was conducted using CUSUM and CUSUM of squares test at 5% significance level. Figure 5.6.1 and 5.6.2 show that the CUSUM and CUSUMSQ plots stay within the 5% significance critical bounds, which implies that the null that all the parameters are stable cannot be rejected. This shows that the estimated ARDL model is stable and suitable for making long run decisions.



Source: Author's computation from E Views 10

Figure 5.6.1: CUSUM and CUSUMSQ Stability Test.



Source: Author's computation from E Views 10

Figure 5.6.2: CUSUM and CUSUMSQ Stability Test.

From our empirical analysis, it is seen that electricity output/ consumption relates positively with growth, meaning that if supply of electricity or consumption increases, then output will also increase. However, the country from our data has been indicated as one whose output and supply of electricity over the years had been rather erratic, discouraging and low, notwithstanding her investment and spending in the sector.

The result (Figure 5.6.2) clearly shows that electricity consumption is fundamental to growth and development of the economy. But considering the huge funds spent by the Government over the last decade; it is worrisome that supply of electricity still falls short of the twenty two thousand megawatts (22,000MW) required by the Nigerian economy (Rmop, 2018) as at 2017. Presently, Nigeria generates about 3,822Mw of electricity (NERC, 2018), which is a far cry from the required minimum.

VI. CONCLUSION AND RECOMMENDATIONS

This paper has empirically examined the impact of electricity power supply on output growth in Nigeria. The ARDL results which estimated the variables in the short and long run showed that electricity supply had a positive coefficient both in the short and long run and also showed a statistical significance in both periods. This implies that electricity supply does indeed affect output growth in Nigeria under the period reviewed.

Drawing form literature reviewed in the work, this paper has reported various empirical studies that sought to find reasons for low supply of electricity in Nigeria. If, as in this work's empirical conclusions that electricity power supply is positively and significantly related to output growth, then those limiting factors that work against the optimization of electricity power supply in Nigeria in order to ignite output growth must be addressed. The factors identified include: dearth of equipment maintenance due to lack of funds, over-loaded transformers, vandalization of power lines by thieves, winds, construction projects, soil erosion, delaying and ignoring equipment upgrade, as well as low gas supply.

This work, thus, recommend that the Nigerian government should set policies aimed at addressing the factors outlined above in order to optimize the supply of electricity power for improved output growth.

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