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Impact of Energy Supply on Economic Growth in Nigeria

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ABSTRACT

Energy supply is an essential sector that can positively impact the other productive sectors of a developing economy to rapidly spur the growth process. This study investigated the impact of energy supply on economic growth in Nigeria between 1971 and 2020. The objective is to examine the extent to which energy supply has positively impacted the productive sectors of the economy to spur the growth process. The study utilized the Autoregressive Distributed Lag (ARDL) model with Bounds Testing for cointegration approach for analysis. The results of the error correction Model showed that there was a long-run relationship between the electricity supplied through hydropower, oil and gas and economic growth, and the speed of adjustment of equilibrium in economic growth, in the long run, was 49.9 per cent per annum. However, the results also showed that none of the independent variables had a significant short-run link with economic growth. Therefore, the study recommends that government should design policies and programmes to enhance hydroelectricity production and electricity from oil and gas to increase firms' productivity and economic growth in Nigeria.

JEL Classification: Q43, O44, Q48

Key Words: Energy supply, Electricity supply, Economic Growth, Hydropower, Oil, Gas

INTRODUCTION

Most activities, especially all man's economic activities, revolve around the energy supply in the nation. More importantly, energy has proved to be a significant factor that drives any nation's economic and technical progress and social life. It is mandatorily required in production, making it an essential factor that generally determines the productivity of any firm and the economy. Whenever the amount of energy supply changes, it transmits to the production of goods and services in the economy. Energy can be defined as a commodity that can be measured, bought, sold and generally traded. These include Crude oil, Coal, Hydropower, Solar, Wind, Uranium, Biomass, Geothermal, Electricity, and Natural gas. The most common types of energy supply in Nigeria, which has been significantly developed, are crude oil, hydroelectricity, natural gas, and electricity (Alenoghena et al., 2022). Crude oil produces other energy resources such as diesel, petrol, gas and kerosene. The crude oil products are used to power automobiles and machines and generate electricity in companies or homes.

A paramount concern in developing economies, especially Nigeria, has been the shortage of these energy resources or commodities, more importantly, its consequential effect on the productivity of the firms that are the engine of growth in the country. Accordingly, this interaction between energy supply, especially electricity and firms' output, has been positively strong over time (Sambo et al., 2010). The Nigerian economy's productive sector comprises small and Medium Enterprises (SMEs) (Ariyo, 1999). It has been observed that the electricity factor that could hamper productivity needs to be increased supply. According to Sambo et al (2010), electricity generation was anticipated to reach 103,000 MW in 2020 if economic industrialization expected will be achieved. However, generation reached an all-time high of 9,435MW in 2015. It has also been estimated that for the country to enjoy a stable electricity supply, generation must climb to about 180,000 MW.

Nigeria is Africa's largest crude oil producer, with four existing but non-functional refineries. Even if they are working at total capacity, they will only meet about 11.8 per cent of the nation's consumption needs (Ogbuigwe, 2018). Consequently, the country imports petroleum products to serve its needs both for industrial, transportation and domestic use. The importation of petroleum products has a lot of adverse effects on the economy. A substantial adverse effect is the cost of the products from the source and the effect of the undervalued exchange rate in the country. By the time the products get to the hands of the end users, more is needed, or the price has gone through the roof, especially diesel. This development creates untold side effects on productivity, the transportation sector and domestic consumption of these products.

The high price and shortage of supply of these energy commodities have always negatively influenced productivity and firms' profit. Adenikinju (2003) asserts that electricity supplied and industrial outputs are strongly correlated. The implication is that when there is a high efficiency of the supply of these commodities, the running cost of the firms is drastically reduced, leading to higher profitability and, consequently, higher productivity and growth in the economy. On the other hand, a shortage of the supply of diesel or petrol will impact the transportation cost of goods from firms to the market or end users, which translates to a higher cost of production which tends to reduce productivity and economic growth. Moreover, attempts by producing firms to source alternative power increase their production cost, which could translate to high production costs and low growth.

This work investigates the impact of energy commodity supply on economic growth in Nigeria by focusing on different sources of electricity supply and how they transmit into productivity and economic growth in the country. The rationale for this is that most productive agents in the country spend much money on sourcing alternative power supply. To a large extent, that raises the cost of production and dampens productivity and economic growth. The remaining part of the study is divided into six sections. Section two presents the available empirical literature; section three gives the theoretical framework for anchoring this work. Section four showed the model specification. Section five presented the sources and nature of data, section six presented and analyzed the result and finally, section seven gave the summary and policy recommendations.

LITERATURE REVIEW

Stungwa et al. (2022) conducted a study on the relationship between electricity supply and demand and economic growth in South Africa from 1971 to 2014. The work aimed to discover the effect that the supply of electricity and its demand had on the growth of the economy. The work employed the Autoregressive Distributed Lag model for the estimation. The findings revealed a significant positive relationship between the variables but showed an insignificant negative relationship between electricity consumption and growth in the long run. On the other hand, the result showed a positive relationship between renewable electricity supply and economic growth. On this note, the study recommends that policymakers design policies that would encourage investment and production of renewable electricity in the country and design policies that will enhance electricity consumption to boost electricity consumption and economic growth.

Samuel & Wale-Odunaiya (2021) empirically investigated the effect electricity supply and demand had on Economic growth in Nigeria from 1971 to 2014. The work used variables for electricity supply from oil and hydroelectric and for electricity demand to be residential and industrial. The methodology used was the Autoregressive Distributed Lag model, and the findings of the work showed a long-run and significant relationship among all the variables. However, in the short run, the relationships were positively insignificant. Therefore, the recommendation was that the power sector should be more liberalized to give more participation to the private sector for generation, transmission and distribution.

Lugman et al. (2021) examined the part that insufficient electricity supply quality has on firms' operations, especially their competitive ability in developing economies, particularly in South East Asia. The work employed the Stochastic Frontier method and Ordinary Least Squares with Beta regression techniques. The estimates revealed that power outages lead to efficiency loss in the firms operating in the country. Therefore, policy recommendations should be to design ways to achieve adequate investment spending on the energy sector to produce enough power for use in the industries to generate enough productivity and become competitively strong.

Abdisa (2018) critically studied the limitations of electricity supply's unreliability on firms' output in developing economies, specifically in Ethiopia, from 2011 to 2015. Data for the work was sourced from the World Bank data bank, and the results revealed that the productivity of firms has a negative relationship with the electricity supply, increasing the cost of production. It was also revealed that the cost of production was higher for smaller firms considering the size of their output.

The work of Cole et al. (2018) covered 14 countries of Sub-Saharan African countries and constructed an instrument to denote the power outages which depended on the size of electricity produced by the hydro stations. Their work employed the firm-level data of the World Bank Enterprise survey, and their findings showed that firms' sales and power instability showed a negative relationship. The results further revealed that the ability of these countries to reduce power outages to the level achieved by South Africa has the potential to boost their sales by about 85.1 per cent. Hence, the effect could go as high as 117.4 per cent for firms that do not use an alternative power source like generators. Therefore, the recommendation is to design policies that will boost the electricity supply to reduce power outages with the benefits of increased productivity and growth.

Magongo & Sacolo (2018) worked on Eswani in Swaziland and the economic effect of power fluctuations on the country. Their work observed direct and indirect costs and employed binary logistic regression to estimate the parameters. The estimation result showed that the highest price of power instability was higher in the industrial sector, which invariably implies that the cost of production of these industries is higher, which weakens the profitability and, consequently, reduces the output of this sector and ultimately falls in economic growth. Therefore, the study recommends that policymakers design policies that could boost the generation of alternative energy sources to bring down the cost of production and raise the living standard of the citizens.

Khobai (2018) explored the possibility of renewable electricity generation causing economic growth in South Africa. The study employed time series data and Johansen cointegration to establish if there is a long-run relationship among the variables. Furthermore, the parameters were estimated using the Vector Error Correction Model to determine if the variables could cause each other. The outcome of the tests showed that the variables have a long-run relationship and causality from renewable electricity to economic growth, which implies that renewable electricity has the potential to increase economic growth in the country. Therefore, appropriate energy policy strategies should be designed to enhance economic growth by increasing renewable electricity supply.

Alley et al. (2016) studied the relationship between electricity and growth in Nigeria using monthly data from 1980 to 2013. The work employed a three-stage least square regression estimation method for the parameters. The analysis showed that electricity supply has a positive but insignificant impact on economic growth in Nigeria, working through industrial output increase. The finding implied that policies that could boost electricity supply should be designed to boost electricity consumption and economic growth.

Awad & Yossof (2016) examined the link between electricity production and economic growth and employment between 1980 and 2013 in Sudan. The work used energy generation since it is what is generated that is supplied. Their work employed cointegration and Wald causality test methods. The cointegration test showed that the variables have a long-run relationship and a bi-directional causality

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between energy generation and economic growth. The results imply that even in the short run, a decrease in electricity supply leads to a fall in economic growth and vice versa. Therefore, policy design is to strengthen the existing electricity generation policy to boost economic growth.

Modi & Adamu (2016) examined the effect electricity supply has on the output of small and medium enterprises in Mubi. The work used primary data obtained by administering a questionnaire and using regression analysis to estimate the parameters. The outcome revealed that electricity supply has a negative relationship with the performance of these firms. Therefore, it was recommended that these firms do well in terms of higher productivity and growth if a more stable electric power supply is provided. The study's outcome was supported by Nyanzu & Adarkwah (2016), who examined how electricity affects SMEs' performance in two Ghana regions. Data from the World Bank consisted of 710 firms and employed chi-square and t-test for pattern analysis while using the Ordinary Least Square regression method for the estimation. The findings similarly revealed that the profitability of these firms was negatively affected by the unstable power supply in the country, especially those located in the northern area of the country. Recommendations include investing in an energy mix that will develop alternative sources of electricity supply and hence, improve the productivity and efficiency of the firms

THEORETICAL FRAMEWORK

This study is anchored on the theory propounded by Hirschman (1969) on Unbalanced Growth. The main thrust of the theory is that the growth or development of an economy can be spurred through the productive activities of firms. Therefore, growth can be achieved quickly by rapid spending (government or private investment) in the critical sectors of the economy, like the power sector. The idea is to help induce the other sectors into higher productivity and more rapidly. The process is that initial investment in the power sector will generally and ultimately spur the growth of the major productive sectors of the economy. The justification for the selection of this theory is based on the following argument: A deliberate and rapid investment in the power sector quickly transmits into a higher capacity to supply electricity, and a consistent and adequate electricity supply leads to direct productivity of firms and that cumulates into higher Gross Domestic Product. In addition, when supply is regular and consistent, it reduces the cost of production, which boosts profitability and subsequent reinvestment for higher productivity.

METHODOLOGY AND MODEL SPECIFICATION

This work employed an econometric model stemming from the Cobb-Douglas production function that relates production to factor inputs and their share of income, as shown in (i).

$$Q_t = GC^{\alpha}L^{\beta} \quad \dots \text{(i)}$$

Where $\beta = 1 - \alpha$, G = Total factor productivity, C = capital input, to be proxied by gross fixed capital formation (GFCF), L = labour input α and β are input elasticities or share of input in income, Q = Output level.

Therefore, the model for this work will be adapted from Stungwa et al. (2022) model, where electricity power generation from non-renewable sources and renewable sources along with electricity consumption were used as independent variables determining Gross Domestic Product. This work, therefore, has an electricity supply as a factor of production in the production process. Equation (i) can then be expressed as:

$$Q_t = GC^{\beta_0}L^{\beta_1}ELESS^{\beta_2} \quad \dots \quad \text{(ii)}$$

When we linearly log (2), we have:

$LnQ_t = \alpha_0 + \beta_0 LnC_t + \beta_1 LnL_t + \beta_2 LnELESS_t + \mu_t$ … (iii)

Where ELESS is the electricity supply factor, β_2 = share of electricity in income, μ_t = error term..

Major value addition of this work is the disaggregation of electricity supply into that generated from hydroelectric power (ELEHP), from oil (ELPOIL), from gas (ELEGS), which none of the works done in Nigeria and reviewed in this work carried out and that will produce equation (iv). Therefore, we can replace output (Q) with Real Gross Domestic Product (RGDP).

$LnRGDP_t = \alpha_0 + \beta_0 LnL_t + \beta_1 LnC_t + \beta_2 LnELEHP_t + \beta_3 LnELPOIL_t + \beta_4 LnELEGS_t + \mu_t$ (iv)

Whereis Real Gross Domestic Product, is electricity supplied from hydropower, is electricity supplied from oil, ELEGS is electricity supplied from gas, to are the parameters to be estimated.

Theoretically, to are expected to be positive since increasing labour, capital and electricity supply is meant to increase output.

Specification of Autoregressive Distributed Lag Model

The data for the variables were subjected to a unit root test, revealing that the variables were integrated at orders I(1) and I(0). The outcome of the test suggests that the study employed an estimation method that could accommodate I(1) and I(0), which is Autoregressive Distributed Lag (ARDL) and using Bounds Testing to confirm the cointegration among the variables and when found, the long-run model with Error Correction Model were estimated.

An ARDL of order (p, q) can be expressed as in (v):

$W_t = \alpha_{0j} + \sum_{i=1}^{p} \gamma_j W_{t-1} + \sum_{i=0}^{q} \theta_j^{\cdot} M_{t-1} + \varepsilon_{jt}$ … (v)

The following are the steps to carry out the estimation:

1. Determine if there is cointegration by employing Bounds testing approach
2. The long-run ARDL can then be estimated.
3. The long run can then be reparameterized to estimate the Error Correction Model

Given an ARDL of order five, (p, q1, q2, q3, q4, q5)

The long run model is expressed in (6)

$\text{LnRGDP}_t = a_{01} + b_{11} Ln\text{RGDP}_{t-1} + b_{21} LnGFCF_{t-1} + b_{31} LnLAB_{t-1} + b_{41} LnELEHP_{t-1} + b_{51} \text{LnELPOIL}_{t-1} + b_{61} Ln\text{ELEGS}_{t-1} + e_{1t}$ … (6)

The Error Correction Model (ECM) can be modelled as in equation (7) and will be estimated because there is cointegration among the variables.

$\Delta\,\text{LnRGDP}_t = a_0 + \sum_{i=1}^{p} a_{1j}\,\Delta\text{LnRGDP}_{t-1} + \sum_{i=1}^{q1} a_{2j}\,\Delta LnGFCF_{t-1} + \sum_{i=1}^{q2} a_{3j} \Delta LnLAB +$
$\sum_{i=1}^{p3} a_{4j}\,\Delta\text{LnELEHP}_{t-1} + \sum_{i=1}^{p4} a_{5j}\,\Delta\text{LnELPOIL}_{t-1} + \sum_{i=1}^{p5} a_{6j}\,\Delta Ln\text{ELEGS}_{t-1} + \gamma ECT_{t-1} + e_t \ldots$ (7)

Equation (7) can be derived from the ARDL model by a simple linear transformation that integrates short-run adjustments with long-run equilibrium and retains the long presence and characteristics.

NATURE AND SOURCES OF DATA

This work used secondary annual time series from 1971 to 2020. Real Gross Domestic Product (RGDP) and Gross Fixed Capital Formation (GFCF) were sourced from the National Bureau of Statistics of the country. Labour (LAB), which represents the number of those employed, was sourced from Penn World Trade, Electricity supplied from Hydropower (ELEHP), Gas (ELEGS) and Oil (ELPOIL) were obtained from the World Development Indicator. Data for ELEHP, ELEGS and ELPOIL stopped in 2014, and the authors generated the remaining up to 2020 by a moving average method just to have balanced data.

RESULTS AND INTERPRETATION

Unit root test result

The data were subjected to a unit root test, and the results are presented in Table I. The result showed a mixed order of integration, which indicated that the method to be employed is the ARDL estimation approach.

Table I: Unit Root test result

	At Level			**At First Difference**			
Variable	**5% Level**	**ADF Stat**	**Prob. Value**	**5% Level**	**ADF Stat**	**Prob. Value**	**Order of Integration**
LnRGDP	-2.92378	-2.84004	0.0603	-2.93694	-47.812	0.0001	I(1)
LnELPOIL	-2.92118	-5.36844	0				I(0)
LnELEHP	-2.92118	-1.73431	0.4082	-2.92245	-8.01264	0.0000	I(1)
LnELEGS	-2.92118	-3.89037	0.0041				I(0)
LnLAB	-2.92245	0.545935	0.9867	-2.92245	-4.64401	0.0004	I(1)
LNGFCF	-2.92118	-1.0193	0.7395	-2.92245	-5.35025	0.0000	I(1)

Source: Authors' Computation using Eviews 10

Cointegration test result

As a result of the unit root test result, the Bounds testing under the ARDL to cointegration method is applied, and the result is displayed in table II.

Table II: Cointegration results using Bounds Testing

F-Bounds Test		**Null: No cointegration**		
F-statistic	4.675763	Level of Significance.	I(0)	I(1)
		10%	2.08	3
		5%	2.39	3.38
		2.50%	2.7	3.73
		1%	3.06	4.15

Source: Authors' Computation using Eviews 10

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The condition for cointegration is that the F-statistic must be greater than the upper bound values, especially at a 5 per cent level. Table II shows that the F-statistic is obviously greater than the upper bound values at all levels of significance. It can then be concluded that a long-run relationship exists among the model's variables.

Long run model

Confirming the long-run relationship among the variables suggests that the Error Correction model 7 is to be estimated. The process involves first estimating the long-run model, extracting the residuals and running it along with the short-run model using the Ordinary Least Squares estimation method. The long-run ARDL model is presented in table III. The model's residuals are then extracted and renamed ECT to be added to the variables in the short-run model to generate the Error Correction Model, as displayed in table IV.

The long-run relationship between labour and RGDP was found to be positive but insignificant. Among all the other independent variables, only electricity supplied by gas was significant in the long-run model. However, the coefficient of determination, in the long run, is relatively high. The R-squared showed that 87 per cent of the variation in the RGDP is accounted for by the model's independent variables in the long run. That implies that they can influence RGDP in the long run.

Table III: Long run ARDL: Dependent Variable: RGDP

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	11.66864	13.56412	0.860258	0.3943
LNLAB(-1)	2.80254	3.151921	0.88915	0.3788
LNGFCF(-1)	0.298038	0.365787	0.814785	0.4196
LNELPOIL(-1)	1.25632	0.682199	1.84158	0.0723
LNELEHP(-1)	1.49114	1.052013	1.41741	0.1634
LNELEGS(-1)	3.79141	0.638197	5.940811	0.0000
R-squared	0.875225			
Adjusted R-squared	0.861046			
F-statistic	61.72716			
Prob(F-statistic)	0.0000			
Durbin-Watson stat		1.027338		

Source: Authors' Computation using Eviews 10

Error Correction Model and Short run relationships

The error correction model explains the relationship between the short-run and the long-run representation (the ECT). The software automatically made the lag selection, and the lag length1 was selected.

Table IV: Error Correction Model: Dependent Variable: RGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.05939	0.159479	0.3724	0.7115
D(LNLAB(-1))	4.360483	4.954264	0.880148	0.3838

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D(LNGFCF(-1))	0.501249	0.466179	1.075229	0.2884
D(LNELPOIL(-1))	0.14843	0.393312	0.37739	0.7078
D(LNELEHP(-1))	2.1406	1.186603	1.80397	0.0784
D(LNELEGS(-1))	0.23734	0.834186	0.28451	0.7774
ECT(-1)	-0.49997	0.105619	-4.73369	0.0000
R-squared	0.421369			
Adjusted R-squared	0.338707			
F-statistic	5.097521			
Prob(F-statistic)	0.000521			
Durbin-Watson stat		1.808149		

Source: Authors' Computation using Eviews 10

Table IV shows the error correction model where the short-run relationship between RGDP and all the independent variables is shown along with the long-run representation. Labour showed a positive relationship with RGDP, indicating that a 1 per cent change in labour input will produce about a 436 per cent increase in GDP, but the coefficient is insignificant. Capital, represented by GFCF, showed that a 1 per cent change in the variable would lead to a 50 per cent increase in RGDP; however, the coefficient is not significant. Electricity supply from oil, hydropower and gas all showed a positive relationship, but the coefficients are not statistically significant. The implication is that none of the independent variables significantly impact GDP in the short run. However, a priori expectations are satisfied. The economic sense of this result is that if the different sources of electricity supply can be improved, they may significantly impact economic growth since there is a positive relationship among them.

The Error Correction Term represents the long-run relationship in table IV. The conditions for the coefficient of the error correction term to be significant are that the coefficient must be negative and the probability value must be less than 5 per cent. The coefficient is negative (-0.49997), and the p-value is less than 5 per cent. This result signified that all the independent variables have a long-run relationship, which is significant in the long run.

The implication is that even though the independent variables may not have any significant impact on the dependent variable in the short run, they all move together and influence the dependent variable significantly in the long run. For example, this would mean that if the level of employment, capital stock, and electricity supplied by oil, gas and hydropower increases, economic growth will increase significantly in the long run.

The coefficient of the error correction term is referred to as the speed of adjustment. It shows that equilibrium in economic growth will be restored in the long run at the speed of 49.9 per cent per annum. The model's overall fit is also significant, representing the F-statistic probability of less than 5 per cent. The model is also free from serial correlation from the Durbin Watson Statistic (1.808) result, free from heteroscedasticity, and normally distributed with probability values of 0.060 and 0.20, respectively.

Residual Diagnostics

The residuals in the Error Correction Model were tested to establish if the assumptions underlying the Ordinary Least Squares were satisfied. In addition, the serial correlation was tested using Breusch-Godfrey Serial Correlation LM Test; the homoscedasticity was tested with Heteroskedasticity Test: The breach-Pagan-Godfrey test and the normality test was done using the Jarque-Bera test of normality. The results are displayed in table V.

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Table V: Residual Diagnostic test results

Types of test	Prob. Value
Breusch-Godfrey Serial Correlation LM Tes	0.6303
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.0603
Jarque-Bera normality test	0.2032

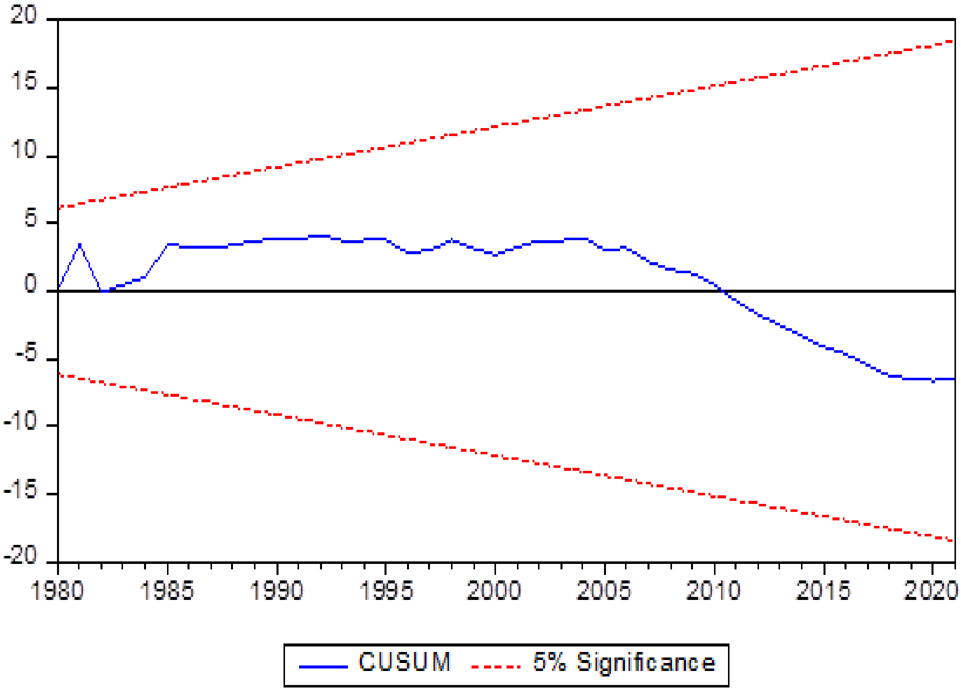
Source: Authors' Computation using Eviews 10

The condition for rejecting or accepting the null hypothesis is that if the probability value is less than 5 per cent, we accept that the assumptions are violated. Still, if they are greater than 5 per cent, we conclude that the assumptions are not violated. From table V, it can be observed that all the probability values of the chi-square of the tests are more than 5 per cent. The residual diagnostic tests revealed that all the assumptions of the residuals of Ordinary Least Squares are satisfied. This result implies that the model is excellent and suitable for prediction and forecast.

Stability Test

A stability test reveals the model's stability when the parameters are subject to specific shocks. This test is carried out using the CUSUM test.

Figure I: CUSUM test.



Source: Authors' Computation using Eviews 10

The model line must be within the 5 per cent significance levels for stability to be ascertained. Therefore, this model is stable, implying that over time, even when the model is exposed to a shock, it will remain predictable and suitable for a forecast.

CONCLUSION AND POLICY RECOMMENDATIONS

This work set out to investigate the impact of energy supply using electricity to represent energy on economic growth in Nigeria between 1971 and 2020. The data set was tested for stationarity, and it was discovered that they were integrated in a mixed order. All the variables were cointegrated, that is, having a long-run relationship. The findings revealed that energy supply and other independent variables did not have any significant short-run impact on economic growth. However, they all carry the correct positive sign. The findings also showed that there existed a long-run equilibrium relationship, and it is significant.

Based on these findings, it is therefore recommended that since the different electricity supply channels have a positive relationship with economic growth in the short run and significantly affect economic growth in the long run, a sound energy policy to boost electricity production both at hydropower source, gas source and oil source, especially since the country is endowed with crude oil and gas. Furthermore, more investment at the private and public levels should be encouraged through sound policy to increase production and supply to stimulate productivity and economic growth in the long run.

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