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THE MODERATING EFFECTS OF ENERGY CONSUMPTION ON STANDARD OF LIVING IN NIGERIA: AN AUTOREGRESSIVE DISTRIBUTED LAG APPROACH

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Abstract

This study assessed the nexus among energy consumption, electric power consumption, access to electricity and Standard of living in Nigeria between 1990 and 2022. The study adopted Autoregressive Distributed Lags to Co-integration approach as estimation technique. The study verified that access to electricity (ATE), fossil fuel energy consumption (FFE), renewable energy consumption (REC) and electric power consumption (EPC) have significant effect on standard of living (ACE) in the short run and long run respectively. In addition, the R^2 value of 0.83 indicates that all the macroeconomic variables of interest in the study explain about 83% of the variation in standard of living (ACE) in Nigeria. Evidence from the study also confirmed the existence of a long-run nexus among access to electricity, fossil fuel energy consumption, renewable energy consumption, electric power consumption and standard of living in Nigeria. The causality result attests that there is a unidirectional causal link between access to electricity and standard of living. From the findings, the study concludes that government should improve on supply of energy as this development will go a long way in facilitating access to electricity consumption among Nigerians as this step will unequivocally improve the standard of living of Nigerians.

Keywords: Standard of Living, Access to Electricity, Fossil Fuel Energy Consumption, Renewable Energy Consumption and Electric Power Consumption.
JEL Classification: Q42, Q43.

1.0 INTRODUCTION

Energy and electric power consumption is essential and germane in economic progress most importantly in economies with high economic growth rate. Most researchers aligned with the postulation that increase in energy consumption is an antidote to poverty as well as an impetus for sustaining and enhancing economic growth particularly in developing nations. In the light of this, most economic planners and policy makers tend to solicit for an increased supply of energy for energy demand of their countrymen. In recent times, investment in energy in developing countries has risen appreciably to access modern energy. Without mincing words, energy is needed to provide services that could impact the living condition of the poor. However, it is not automatic that abundant supply of energy will have a significant effect on the downtrodden (Okwanya and Abah, 2018).

Without gainsaying the fact that energy consumption has risen appreciably in the previous years in some African countries, it is noteworthy to assert that this has not mitigated poverty rate as the government in some countries subsidized the price of energy consumed and also ensures access to energy by citizens. In Nigeria, industry's share in gas consumption rose from 14% in 2010 to 32% in 2021. Since 2014, oil product consumption has been relatively stable. Previously, it rose by 17% per year between 2009 and 2014. As regards total energy consumption, it was 0.8 tons in 2021 which was about 40% higher than the average for Sub-Saharan Africa. Electricity consumption per capita is low when compared with close African countries and reached 140 kWh/hab in 2021which was not up to the average for Sub-Saharan Africa. Since 2012, total consumption has moved up with an average of 1.7% per year to 164 Mtoe in 2021(Enerdata, 2022).

In Nigeria, electricity consumption has shown much slower growth than before, following the fall in economic growth (3% per year compared to about 9% per year between 2000 and 2012). Residential sector's share in electricity consumption has been increasing at a regular pace since 2000 from 51% to 58% in 2021, whereas the industry's sharein electricity consumption was on a slight downward trend from 21% to 14% in 2021.The country targets 29% of her electricity production from renewable source by 2030, including 20% in large hydro in 2021 with 13.8 GW of capacity. For this target to be actualized, Nigeria in December 2022 unveiled her Energy Efficiency Policy, which includes a "30:30:30" scheme that plans to add 30 GW of power capability by 2030, with renewable source contributing 30% of the country's energy mix (Nigerian Renewable Energy Action Plan, 2016).

It has been discovered that high income countries tend to consume more quality energy than poor countries. This is simply because access to energy is a vital and verifiable tool to any poverty reduction strategy and policy as energy deprivation inhibits production and limits level of economic activities (Pachauri and Spreng, 2004, Kaygusuz, 2011 and Sovacool, 2012).Energy and electricity have been recognized as the drivers of standard of living and economic growth.

However, previous studies carried out in Nigeria concentrated more on the nexus between either energy or electricity consumption and economic growth without taking cognizance of the specific nexus existing among access to electricity, fossil fuel energy, renewable energy, electric power and standard of living in Nigeria, hence a gap.

From the research gap identified, the following questions were raised: (1) Does electric power consumption have significant and long-run nexus with standard of living in Nigeria? (2) Does fossil fuel energy consumption have significant and long-run nexus with standard of living in Nigeria? (3) Does renewable energy consumption have significant and long-run nexus with standard of living in Nigeria? (4) Does access to energy have significant and long-run nexus with standard of living in Nigeria? Having identified the gap and to bridge the gap, the study will be contributing to knowledge gap by investigating into the impact of access to electricity, fossil fuel energy consumption, renewable energy consumption, electric power consumption on standard of living in Nigeria.

2. LITERATURE REVIEW

2.1Theoretical Framework

Energy plays predominant roles in growth process of many countries (Akinlo, 2008). This assertion is founded on some studies which examined the nexus between poverty rate and energy consumption such as: Foster and Tre (2000) and Barnes, Khandker and Samad (2010). The concept of linking energy consumption to poverty level is premised on the energy transition theory. The theory links the kind of energy used to income. The theory opines that the kind of energy utilized by a country highly relies on the level of per capita income.

In addition, the consumer theory which states that as income rises, energy users seem to change from traditional energy to modern energy by virtue of ease of use. The theory asserts the existence of a direct relationship between the level of income and energy consumption which implies that high income nations seem to use higher quality energy than poor nations. This is because access to energy is key to poverty alleviation strategy as energy deprivation restricts the level of economic progress (Pachauri and Spreng, 2004).

2.2 Empirical Literature

Okwanya and Abah (2018) carried out a study on the impact of energy consumption on reduction of poverty using a panel data focusing on twelve (12) countries in Africa. The study used Fully Modified Ordinary Least Square (FMOLS) method and their results revealed that a long-run negative nexus existed between energy consumption and poverty level in the selected African countries. Furthermore, the causality test confirms that a unidirectional causality ran from energy consumption to poverty rate. It was concluded in the study that increased energy consumption could lead to poverty alleviation.

Pachauri, et al. (2004) carried out their study on how high poverty rate affects the pattern of energy consumption in terms of the quantity and quality of energy. They opined that the downtrodden are vulnerable to the use of traditional energy sources which might have adverse effect on economic growth. Meikle and Bannister (2003) examined the causal link between energy and the level of poverty among the poor urban families in China, Indonesia and Ghana. They detected that the poor are more susceptible to the shocks in the energy market. Gertler, et al. (2011) examined the causal linkage among growth, level of poverty and propensity for energy. The study found that the demand for energy rises among the nations that are pro-poor than among the nations that are not. The study concluded that when households' incomes rise, so is their demand for energy. This is because households buy energy-using gadgets. In addition, they asserted that the rate at which households come out of poverty has effects on their purchasing decisions. Therefore, improvement in the income of the vulnerable raises their demand for energy.

In addition, Filho and Hussein (2012) examined the causality between availability of energy and improvement in standard of living. They discovered that the living standard will improve with availability of more modern energy. They found that rural areas would benefit more from increased supply of renewable energy. Darby (2011) observed that energy could be seen and

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regarded as a social necessity that has the capability of improving the economic and social wellbeing of the people.

Ezeh, et al. (2020) determined the effect of electricity consumption on the standard of living using Nigeria as a case study by capturing standard of living with poverty rate, life expectancy, the level of education and per capita income. They focused on the impact of electricity consumption on the components of standard of living within the period of 1981 to 2017. The study used Bound Test as the estimation technique. The study confirmed that there existed a positive long-run nexus among all the variables of interest. The study concluded that electricity consumption by the households in Nigeria had positive effect on standard of living.

Ogwumike, et al. (2014) investigated into determinants of household's energy use in Nigeria. The study utilized descriptive statistics and found that most Nigerian households did not have adequate access to environmentally-friendly modern energy sources. They opined that energy use in Nigeria did not support energy ladder hypothesis but favoured fuel stacking. They pointed out that the living standard of the people equally determines the level of household energy use, which further ascertains that consumption of electricity by the household in Nigeria might have significant effect on the standard of living.

Okwanya, et al. (2015) examined the nexus between energy consumption and the level of poverty in Nigeria and verified that the total energy consumed significantly affects the rate of poverty. In addition, it was confirmed that that there existed a bi-directional causal linkage between poverty rate in Nigeria and total energy consumption. This means people could be pooled out of the vicious cycle of poverty by energy consumption.

However, some previous studies carried out and reviewed concentrated more on the nexus between either energy or electricity consumption and economic growth without taking cognizance of the specific nexus existing among access to electricity, fossil fuel energy, renewable energy, electric power and standard of living in Nigeria, hence a knowledge gap identified which this empirical study intended to bridge.

3. METHODOLOGY

The theoretical underpinning of this paper is the Extended Neoclassical Growth Theory which shows how effective combination of energy and other factors of production could increase economic growth and social welfare as supported in Solow (1956). The theory shows that capital, labor as well as energy plays a vital role in economic growth.

From the above, we therefore derive the aggregate production function as follows:

$Y = A\, f(K, L)$---(3.1)

Where: Y = aggregate real output, K = stock of capital as proxy for capital formation, L = stock of labor or labor force, A = Technology (or technological advancement as proxy for electricity consumption (EEC)). Since aggregate output is directly related to the standard of living, the Solow growth model in equation (3.1) can be modified according to Okwanya and Abah (2018) as: $SOL = f(EEC, K, L)$---(3.2)

Where: SOL is standard of living.

3.1 Model Specification

With reference to Solow (1956) and Okwanya andAbah (2018), the model for this study is revised version of Solow Growth Model in equation 3.1 stated above and specified in an implicit form as follows:

ACE = f(ATE, EPC, FFE, REC) ---------------------------------(3.3)

The model is stated in an explicit form as:

$$\text{ACE}_t = \beta_0 + \beta_1\text{ATE}_t + \beta_2 EPC_t + \beta_3 FFE_t + \beta_4 REC_t + \varepsilon_t - - (3.4)$$

Where:
ACE is the standard of living in Nigeria as proxy for social welfare which is captured by GDP per capita, ATE is access to electricity (% of population), FFE is fossil fuel energy consumption (% of total energy consumption), REC is renewable energy consumption(% of total final energy consumption) and EPC is electric power consumption ((KWH Per Capita).

3.2 A-priori expectations

A-priori expectations as regards the expected relationship among ACE, access to ATE, FFE, REC and EPC in Nigeria are stated as follows:

$\beta_1 > 0$, $\beta_2 > 0$ $\beta_3 > 0$ $\beta_4 > 0$

4. EMPIRICAL RESULTS

4.1. The Normality Test in the Data Set.

Table 4.1: Descriptive Statistics.

	ACE	ATE	EPC	FFE	REC
Mean	4004.467	46.31265	71.42449	17.27065	85.14329
Median	3854.008	47.00511	80.45448	18.95003	85.55129
Maximum	5516.386	59.30000	100.8853	22.84479	88.74930
Minimum	2901.768	27.30000	28.57044	5.967770	79.65420
Std. Dev.	971.7662	7.763354	21.66810	4.831158	2.344724
Skewness	0.275483	-0.383794	-0.624228	-1.100560	-0.502642
Kurtosis	1.456233	2.507574	2.136293	3.029707	2.545380
Jarque-Bera	3.246526	1.004940	2.784767	5.855361	1.470876
Probability	0.197254	0.605034	0.248482	0.053521	0.479296
Sum	116129.6	1343.067	2071.310	500.8488	2469.155
Sum Sq. Dev.	26441229	1687.551	13146.19	653.5226	153.9365
Observations	29	29	29	29	29

Source: Authors' computation

Descriptive statistics result in table 4.1 shows the behavior of the data distribution. Jarque-Bera Statistics confirmed that there is normality in the distribution of the standard of living (ACE),access to electricity (ATE), renewable energy consumption (REC), fossil fuel energy consumption (FFE) and electric power consumption (EPC) as their distribution is symmetrical at 5% when compared with their probabilities as this implies that the population from which the sample was drawn is quite consistent with the null hypothesis and assumption of zero skewness and zero excess kurtosis of normality in their distribution.

4.3. Time Series Properties of the Variables.

The results of Augmented Dickey-Fuller (ADF) unit root test presented in Table 4.2 confirm that ACE is stationary at level while ATE, EPC, FFE, MOU and REC are stationary at their first difference. The results obtained revealed that all the variables are not of the same order of integration. This indicates that Johansen co-integration cannot be used because its condition was not met. Hence, Autoregressive Distributed Lag (ARDL) to co-integration procedure developed by Pesaran, Shin and Smith (2001) was employed as the best technique as suggested by Fosu and Magnus (2006).

Table 4.2:Augmented Dickey-Fuller (ADF)Unit Root Test.

Variables	ADF Statistics	5% critical Value	ADF Statistics	5% critical Value	Order of Integration
ACE	0.0329	-1.70173	-	-	I(0)
ATE	0.2123	-1.70173	0.0003	-6.93076	I(1)
EPC	0.2958	-1.70173	0.0000	-6.93076	I(1)
FFE	0.0651	-1.70173	0.0065	-6.93076	I(1)
REC	0.6511	-1.70173	0.0005	-6.93076	I(1)

Source: Authors' computation

4.5. Testing the Long-run nexus Among the Series

The test of co-integration is necessary to establish whether there is long run relationship among the variables. The appropriate co-integration test is the Bound test proposed by Pesaran et al (2001) which is adopted and result presented in table 4.3.

Table 4.3: ARDL Bounds (Co-integration)Test for ACE

F- Statistic =14.34469		
Level of Significance	I(0) Bound	I(1) Bound
10%	2.08	3
5%	2.39	3.38
2.5%	2.7	3.73
2.73	3.06	4.15

Source: Authors' Computation

Table 4.3 indicates that the estimated model for ACE establishes that a long-run relationship is found in the bound test. Since, the calculated F-statistic value of14.34469 is greater than the critical values for the upper bound at 5% significant level. Based on this, the study confirms that there is evidence of long-run relationship among the standard of living (ACE),access to electricity (ATE), fossil fuel energy consumption (FFE), renewable energy consumption (REC)and electric power consumption (EPC) in Nigeria. Following the Bound test result, the study proceeds to estimate ARDL for both short run and long run dynamism.

Table 4.4: ARDL Long Run Analysis Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
ACE(-1)	0.990263	0.053281	18.58557	0.0000
ATE	-23.01207	9.101181	-2.528470	0.0224
EPC	1.139236	2.132983	0.534104	0.6006
EPC(-1)	4.928404	2.103132	2.343364	0.0324
FFE	-10.49377	13.64962	-0.768796	0.4532
FFE(-1)	-10.11044	19.08505	-0.529757	0.6036
FFE(-2)	37.67215	14.16277	2.659942	0.0171
REC	-16.22122	12.02816	-1.348604	0.1962
REC(-1)	9.764358	14.08754	0.693120	0.4982
REC(-2)	21.89694	11.88820	1.841905	0.0841
C	-846.8076	1288.947	-0.656976	0.5205
R-squared	0.996481	Mean dependent var	4062.253	
Adjusted R-squared	0.994282	S.D. dependent var	983.1556	
S.E. of regression	74.34206	Akaike info criterion	11.74680	
Sum squared resid	88427.87	Schwarz criterion	12.27473	
Log likelihood	-147.5818	Hannan-Quinn criter.	11.90378	
F-statistic	453.1248	Durbin-Watson stat	1.517927	
Prob(F-statistic)	0.000000			

Source: Authors' Computation

The results in table 4.4 showed that ATE, FFE, REC and EPC have significant effect on standard of living in the long-run. The value of R^2 of 0.99 shows that ATE,FFE, REC and EPC explained about 99% of the variation in the ACE which is standard of living.

Table 4.5: ARDL Error Correction Model (ECM)(short-run test) Result

ARDL Error Correction Regression				
Dependent Variable: D(ACE)				
Selected Model: ARDL(1, 0, 1, 2, 2)				
Case 2: Restricted Constant and No Trend				
Date: 10/14/23 Time: 16:16				
Sample: 7/01/1990 7/01/2022 IF 1990-2020				
Variable	Coefficient	Std. Error	t-statistic	Prob.
D(EPC)	1.139236	1.293523	0.880723	0.3915
D(FFE)	-10.49377	9.750371	-1.076243	0.2978
D(FFE(-1))	-37.67215	9.620123	-3.915974	0.0012
D(REC)	-16.22122	7.995516	-2.028790	0.0595
D(REC(-1))	-21.89694	8.460004	-2.588289	0.0198
CointEq(-1)*	-0.009737	0.000916	-10.62847	0.0000

R-squared	0.828525	Mean dependent var	72.81433
Adjusted R-squared	0.787698	S.D. dependent var	140.8340
S.E. oftheregression	64.89107	Akaike info criterion	11.37643
Log likelihood	-147.5818	Hannan-Quinn criter.	11.46205
Durbin-Watson stat	1.517927		

Source: Authors' Computation

It is revealed in table 4.5 that access to electricity (ATE), fossil fuel energy consumption (FFE), renewable energy consumption (REC)and electric power consumption (EPC)have significant impact on the standard of living (ACE) in Nigeria in the short run. The coefficient of the ECM which is -0.009737is significant with the appropriate (negative) sign as revealed in table 4.5. The significance of the ECM confirms the existence of a long run equilibrium relationship among the variables of interest in Nigeria. This shows a stable error which eventually converges to the long-run equilibrium when there is disequilibrium from short run equilibrium level, hence, the negative coefficient of the ECM confirms the existence of a long-run equilibrium relationship of the model. Father more, the R^2 value of 0.83 indicates that the macroeconomic variables explain about 83% of the variation in standard of living. Therefore, standard of living in Nigeria is significantly determined by all the explanatory variables the in the short run.

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Table 4.6: Pairwise-Granger Causality Test Results

Pairwise Granger Causality Tests
Date: 10/14/23 Time: 16:28
Sample: 7/01/1990 7/01/2022 IF 1990-2020
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
ATE does not Granger Cause ACE	28	3.38064	0.0516
ACE does not Granger Cause ATE		2.66347	0.0911
EPC does not Granger Cause ACE	29	4.99670	0.0153
ACE does not Granger Cause EPC		0.22004	0.8041
FFE does not Granger Cause ACE	29	4.88973	0.0165
ACE does not Granger Cause FFE		0.23288	0.7940
REC does not Granger Cause ACE	27	0.99933	0.3842
ACE does not Granger Cause REC		1.39603	0.2687
EPC does not Granger Cause ATE	28	2.19962	0.1336
ATE does not Granger Cause EPC		0.26612	0.7687
FFE does not Granger Cause ATE	28	0.71700	0.4988
ATE does not Granger Cause FFE		0.18204	0.8348
REC does not Granger Cause ATE	27	0.00202	0.9980
ATE does not Granger Cause REC		1.90691	0.1723
FFE does not Granger Cause EPC	31	2.02430	0.1524
EPC does not Granger Cause FFE		0.21128	0.8109
REC does not Granger Cause EPC	27	0.26106	0.7726
EPC does not Granger Cause REC		0.69781	0.5084
REC does not Granger Cause FFE	27	1.50429	0.2442
FFE does not Granger Cause REC		1.37763	0.2731

Source: Authors' Computation

It is revealed in table 4.6 that access to electricity (ATE) has a unidirectional causality with standard of living (ACE). In addition, electric power consumption (EPC) has a unidirectional causality with standard of living (ACE). In the same vein, fossil fuel energy consumption (FFE) has a unidirectional causality with standard of living (ACE).

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Testing for Structural Stability

The plots confirming the stability of the model are shown in figures1and2 below:

Fig.1: CUSUM of Squares Test for Structural Stability of the Parameters

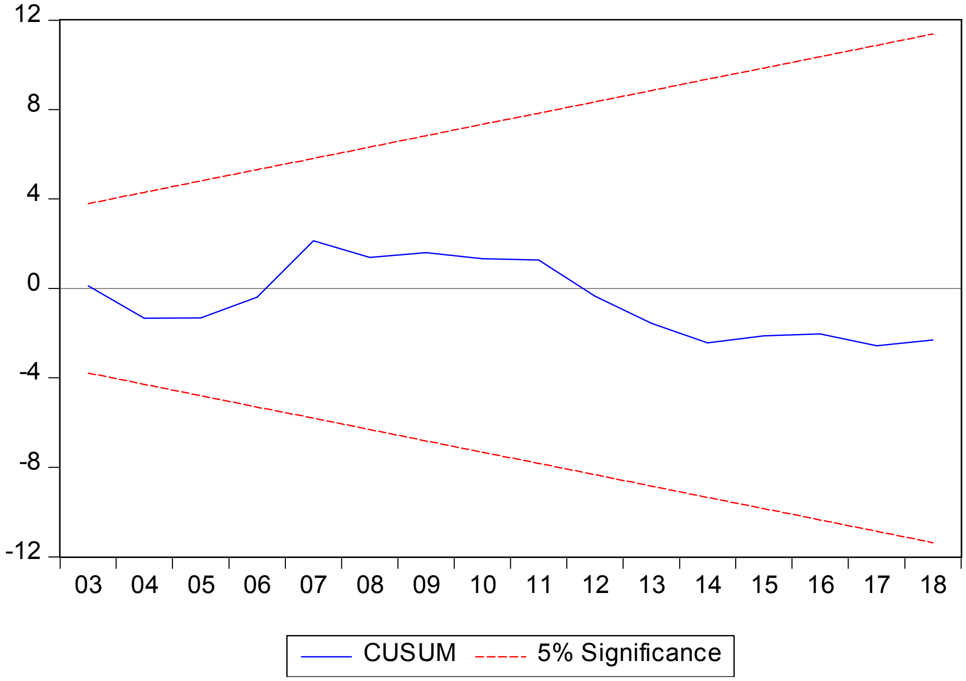
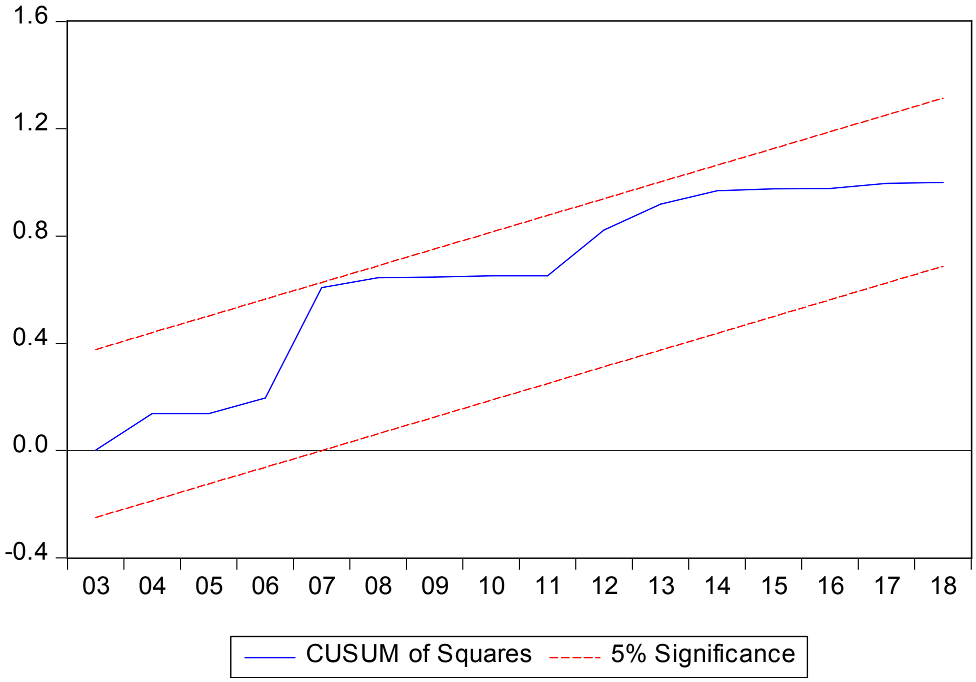


Fig.2:CUSUMofSquaresTestforStructuralStabilityoftheParameters



As shown in fig 1and fig 2 the results are suggestive of coefficient stability since the plots did not move outside the 5% critical bound. This confirms the existence of coefficient stability for the estimated parameters for the short run dynamics and long run of the standard of living function over the sample periods as the results indicate tendency of further coefficients stability. One can conclude that the model is well estimated and the observed data fit the model specification adequately, hence the coefficients are valid for policy discussions in Nigeria.

F-statistic	0.318188	Prob. F(2,10)	0.7346
Obs*R-squared	1.615413	Prob. Chi-Square(2)	0.4459

Source: Authors'

Table 4.8: **Heteroskedasticity Test: Breusch-Pagan-Godfrey**

F-statistic	0.832198	Prob. F(10,16)	0.6061
Obs*R-squared	9.238290	Prob. Chi-Square(10)	0.5096
Scaled explained SS	2.523256	Prob. Chi-Square(10)	0.9905

Source: Authors' Computation

Discussion of Findings

The study finds that access to electricity (ATE), fossil fuel energy consumption (FFE), renewable energy consumption (REC) and electric power consumption (EPC) have significant impact on the standard of living in Nigeria. The result is in congruence with Ezeh, et al. (2020) who observed that households' electricity consumption in Nigeria has positive effect on standard of living. In addition, the study confirms that there is a bidirectional causal link between access to electricity in Nigeria and standard of living implying that the standard of living of the people equally determines the level of household energy use, which further suggests that in Nigeria, the use of energy and electricity by the household has significant effect on the people's standard of living. The result is in agreement with Pachauri and Spreng (2004), Filho and Hussein (2012), Darby (2011) and Ogwumike, et al. (2014) confirmed that the living standard would improve as long there is more supply of modern energy and they opined that energy should be seen and regarded as a social necessity that has the capability to increase the economic and social wellbeing of the people. Okwanya, et al. (2015) also discovered that the level of total energy consumed in Nigeria significantly reduces the level of poverty. In contrast, Okwanya and Abah (2018) argued that it is not automatic that abundant supply of energy would have a significant effect on the income of the poor.

5. CONCLUSION

The study finds in Nigeria that access to electricity (ATE), fossil fuel energy consumption (FFE), renewable energy consumption (REC) and electric power consumption (EPC) have significant effect on standard of living. The study also reveals that there is an existence of a long-run nexus among all the variables of interest in the study in Nigeria. The causality result attests that there is a unidirectional causal link between access to electricity and standard of living. Furthermore, the study confirms that there is a unidirectional causal link between electric power consumption and standard of living. In addition, the study establishes a unidirectional causality between fossil fuel energy consumption and standard of living. This suggests that in Nigeria, the utilization of electricity and energy by the household would considerably impact the standard of living. This also means that energy consumption plays some noteworthy role in pooling people out of the vicious cycle of poverty. The study, therefore, concludes that government should improve on electric power production and supply as this development will go a long way in facilitating right to use electricity among Nigerians and this step will unequivocally improve the standard of living of Nigerians. In addition, government should embark on policies geared toward providing a stable and efficient energy as this will enhance increased access to modern energy at an affordable rate. This step will undoubtedly be in the right direction to improve Nigerians' standard of living.

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