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Interactive Effect of Energy Consumption and Poverty on Life Expectancy in Nigeria (1980-2017)

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Abstract

The consumption of energy and its resulting effect on the population health is very crucial to the development of any nation. Hence, this study investigated the interactive effect of poverty and energy consumption on life expectancy in Nigeria from 1980 to 2017. Secondary data were used for the study. Autoregressive Distributive Lag (ARDL) approach was used to anaylse the time series data. The study revealed that poverty had negative and significant impact on life expectancy in the short-run and in the long-run. Also, energy consumption had positive and significant impact on life expectancy in the long-run. The coefficient of interactive effect of poverty and energy consumption is negative and significant on life expectancy in the short run and in the long-run. This result affirms that fossil fuel consumptions dominate energy consumption mix in Nigeria which showed that majority of Nigerian populace do not have access to renewable energy. This fact is buttressed by the coefficient of interactive effect of poverty and petroleum products consumption on life expectancy which is negative and significant in both short run and long-run. Therefore, in order to increase the life expectancy in Nigeria, government should reduce poverty and also ensure that people make use of clean energy that is healthy as a source of energy.

Key words: *Energy Consumption; Poverty; Life Expectancy.*

JEL Classification: *Q430; I320; I150.*

Introduction

Energy is the indispensable force driving all economic activities (Alam, 2006). The roles of energy in supporting job creation, economic growth, agriculture, transport, and commerce which are key factors for overcoming poverty cannot be over emphasized; it is generally defined as ability to do work. Energy comes in different forms: Heat (thermal), Light (radiant), Motion (kinetic), Electrical, Chemical, Nuclear energy and Gravitational.

Researchers have identified major categories of Energy namely: Stored (potential) energy and Working (kinetic) energy. Energy sources are divided into two groups: Renewable (an energy source that can be easily replenished) and Nonrenewable (an energy source that cannot be easily replenished). Renewable and nonrenewable energy sources can be used as primary energy sources to produce useful energy such as heat or used to produce secondary energy sources such as electricity. There are five main renewable energy sources: Solar energy (from the sun), Geothermal energy (from heat inside the earth), Wind energy, Biomass (from plants), Hydropower (from flowing water) (Umeh, Ochuba and Ugwo, 2019).

However, most of the energy consumed in the Nigeria is from nonrenewable energy sources: Petroleum products, Hydrocarbon gas liquids, Natural gas, Coal, Nuclear energy. Crude oil, and coal are called fossil fuels because they were formed over millions of years by the action of heat from the earth's core and pressure from rock and soil on the remains (or fossils) of dead plants and creatures such as microscopic diatoms. Nuclear energy is produced from uranium, a nonrenewable energy source whose atoms are split (through a process called nuclear fission) to create heat and, eventually, electricity (Umeh et-al, 2019).

In developing countries, especially in rural areas, 2.5 billion people rely on biomass, such as fuel wood, charcoal, agricultural waste and animal dung to meet their energy requirements for cooking (IEA, 2006). Household use of biomass in developing countries alone accounts for almost 7% of world primary energy demand (IEA, 2006). An estimated 72% of Nigerians depend solely on wood as a source of fuel for cooking (NBS-CNB-NCC, 2011).

There is global awareness that poverty anywhere is dangerous to health everywhere. Developed and developing countries have understood that persistent poverty makes poor countries vulnerable not only to insecurity, social discrimination but also to poor health conditions (Peter and Bassey, 2009). Energy consumption is a panacea to poverty and a tool for sustaining and enhancing economic growth particularly in developing nations (Abdur and Khorshed, 2010; Boardman and Kimani, 2014; Legros et al. 2009), poverty influences and determines the energy choices of people (Cecelski, 2000). The rate of poverty is reflected in the amount of energy consumed and a nation with low energy consumption is an indication that a large percentage of the population are not productive and/or earns little income such that they cannot afford the minimum amount of energy needed for survival. In Nigeria for instance, poverty rate kept increasing in the face of an average growth rate of 2.4 per cent over the past 20 years (World Bank, 2012).

The lack of access to consumption energy by the masses could be referred to as “Energy Poverty which negatively affects life expectancy. High access to food, medicine, shelter, education, and low levels of disease and violence results in high life expectancy of any nation. Many healthcare facilities in developing countries are incapacitated due to lack of energy access which is essential for storing vaccines and carrying out life-saving operations (Franco et al, 2017). Improved energy access in the healthcare facilities will help to raise life expectancy by ensuring timely provision of services. The availability of energy and the efficiency with which it is used enable humans to improve their living standards, live longer, and increase their numbers (Lambert,2014).

Nigeria, like many other developing countries is faced with a number of development challenges, of which energy poverty, and poor health outcomes cannot be overlooked. Developing countries such as Nigeria need to have access to improved energy services in order to overcome poverty, especially the most extreme forms faced by the lowest fifth of income earners around the world. Despite Nigeria endowments in energy resources, there has been a wide disparity in the country energy demand and supply over the last two decades, access to energy services has been continuously challenging (Odunlara and Okonkwo, 2009). Evidence from Nigeria indicates that a considerable number of households still remain consistent on fuel wood energy consumption (Nnaji et.al., 2012; Onyeneke et. al., 2015).

With several challenges been faced by Nigeria, especially on energy consumption, low poverty rate and low life expectancy, is there a nexus between these variables; when poverty and energy poverty interact do they contribute to the life expectancy rate in Nigeria? And if they do, to what extent or what is the magnitude of this effect? In order to provide answers to these questions, this study seeks to examine the interactive effect of consumption energy and poverty on the life expectancy in Nigeria. The rest of the paper is organized as follows: Section two presents a review of related literature on the linkage between energy consumption, poverty and life expectancy. In Section three, we present data and research method. Section four presents the empirical results and discussion. Concluding remarks are presented in Section five.

Literature Review

Just like energy-GDP relationship, the study of energy and poverty is becoming a paramount issue among energy economist because energy poverty could be a catalyst for unrest and instability (Basilian and Yumkella, 2015). According to Pachauri, et al. (2004) high level of poverty affects the pattern of energy consumption in terms of the quantity and quality of energy. The poor are always prone to the use of traditional and inefficient energy sources such as wood and coal which are unlikely to increase economic growth. Few studies have assessed the effect of energy consumption on poverty (Gertler, *et al.* 2011) most of the studies focused on theoretical relationship between energy and poverty (Short, 2002). Only few examine the magnitude of the impact of energy consumption on poverty. Njiru and Latema (2018) review the energy poverty situation in Kriuyaga, Kenya and its implications on standard of living. It was found that Kriuyaga residents are facing energy poverty as manifested in reliance in traditional fuels by households, educational institutions and agro-processing industries, coupled with low access to electricity. Furthermore, it was reported that energy poverty affected physical health, well-being and utility and ability to prosper.

Darby (2011) argued that energy should not just be viewed as a commodity or an ecological resource but also a social necessity capable of increasing the social and economic wellbeing of people. According to the author, adequate energy supply to some extent affect economic growth and in some cases may determine the level of development, socio-cultural and economic ideology governing a nation. Fatih (2007) also pointed out that strong political will in the improvement of the general welfare of citizens is the main strategy to reducing poverty but not neglecting energy supply. Such improvement in the welfare of the citizens comes via increase in public and private investment in infrastructures and human capital, which serves as a prerequisite to efficient energy use. According to Hodgson (2000), institutional factors play a big difference between developed and developing economy. Countries with strong institutions tend to have strong infrastructural base, provide reliable economic and political environment necessary for economic growth. Although other factors apart from energy may account for the differences in the impact of energy consumption on poverty reduction. Very few works has been carried out on the relationship between poverty and life expectancy. Fritzell et al (2013) investigates the relationship between relative poverty and mortality across 26 countries overtime, with pooled cross-sectional time series analysis. Data were utilized from the Luxemburg income study to construct age –specific poverty rates across countries and time covering the period from 1080 to 2005, merged on data on age-and gender-specific mortality data from the Human Mortality Database. Results suggest not only an impact of relative poverty but also clear differences by welfare regime that partly goes beyond the well-known differences in poverty rates between welfare regimes.

Meikle and Bannister (2003) studied the linkages between energy and poverty in poor urban households in Indonesia, Ghana and China. The study found that the poor are more vulnerable to shocks in the energy market. In another study, Gertler, et al. (2011) studied the nexus between poverty, growth and the demand for energy. Using a panel analysis, they found that the demand for energy increases among countries that are pro-poor than among countries that are not. They argued that not taking into consideration the pro-poor growth could grossly underestimate future energy use. When households' incomes go up, so is their demand for energy because they buy energy using assets. Filho and Hussein (2012) examine the link between energy availability and improvement in the standard of living. They found that the living standard is likely to improve with increased availability of modern energy. They pointed out that rural area stands to benefit more with increased availability of renewable energy technologies. The study used a comparative analysis, which tends to be subjectively bias.

Sa'ad and Bugaje (2016) analysed the demand for and policy implications of consumption of biomass energy in Nigeria. A correlation analysis conducted shows a highly positive relationship between biomass consumption and poverty levels as well as highly negative correlations between incomes and biomass consumption in all the six geopolitical regions in Nigeria. The study also revealed that biomass played an important role as a source of energy in all the six geopolitical the regions as well as both rural and urban households and this would likely to remain so in the near future. Although the importance of biomass was declining in relative terms, in absolute terms its use appears to be increasing; suggesting there is high level of energy poverty in Nigeria. Factors identified as responsible for such phenomenon include poverty, inaccessibility to alternative energy sources and cultural factors.

Shobande (2019) examined the effect of energy use on the infant mortality rate in Africa using a panel of 23 African countries for the period from 1999 to 2014.While adopting the Gary Becker hypothesis and the Grossman models to examine the relationship between energy related predictors and infant mortality fundamentals, the result of the study show that energy predictors have a negative and significant on infant mortality rates among the African countries examined. Also, it was found that a high degree of pollution causes rise in mortality rates, whereas proceeds from natural resources rents reduce the level of infant mortality. In the same line of effect of energy consumption on health status, Shaobin wang and Haixia pu (2019) examine the relation between residential energy consumption and life expectancy at birth in mainland china. Close association were found between household coal/ household electricity and life expectancy at birth at the provincial level in mainland china in 1990, 2000 and 2010. Household coal showed significant negative relations to life expectancy at birth while household electricity showed positive relations to life expectancy at birth. It was reported that household coal showed a negative relation to life expectancy in Chinese rural area than in urban areas. Furthermore, geographically weighted regression showed spatial non-stationary of the relations between residential energy consumption and life expectancy at birth in mainland china especially for the household coal and household electricity.

Furthermore, Youssef *et al* (2016) examined then casual links between energy consumption and health indicators (mortality rate under 5, life expectancy, greenhouse effect, and government expenditure per capita) for a sample of 16 African countries over a period of 1971 – 2010. The study adopted the panel data approach, based on SUR system and wald test with country specific bootstrap critical values, it was found that health and energy consumption are strongly linked in Africa. Unilateral casualty was found from energy consumption to life expectancy and child mortality for Senegal, Morocco, Benin, DRC, Nigeria, Egypt and South Africa. Also a bilateral casualty between energy consumption and health indicators was found in Nigeria. It was suggested that electricity consumption granger causes health outcome for several African countries. Similarly, in order to quantify the effect of fossil energy use and pollutant emission on public health from global perspective, X. Xing *et al* (2019) investigates 33 countries with high GDP and fossil energy consumption from 1995 to 2015 using a fixed effect model. Also the study utilizes heterogeneity analysis to characterize the disparity of countries with different features. It was reported that total fossil energy consumption is beneficial to the life expectancy of the population (LEP), but pollutant emissions has a negative effect on LEP. Moreover, the heterogeneity test indicates that pollutant emissions lowers LEP in net energy importers more than in net energy exporters, and the effect of such emissions in low- and middle- income countries on public health is more harmful than that in high- income countries.

Also, Okwanya and Abah (2018) investigate the impact of energy consumption in poverty reduction in a panel of 12 African countries over a period of 1981 to 2014. While using the fully modified ordinary least square (FMOLS) method, the study shows that a long run negative relationship exists between energy consumption and poverty level, which under-scores the importance of energy reduction in the selected African countries. It was also found that the granger casualty test shows a short-run unidirectional casualty from energy consumption to poverty from the literature reviewed above, it can be gathered that most of the studies have not focused on the contributions of consumption energy and poverty on the life expectancy in Nigeria, hence this study.

Data and Methodology

Secondary data were used for the study. The study covered 38 years from 1980 to 2017. The dependent variable is the Life Expectancy which was proxied by the life expectancy at birth. The explanatory variables are Energy Consumption (ENEC), Poverty (POV), Health Expenditure as percentage of total expenditure (HEXP), Oil revenue as percentage of GDP (ORV), Corruption (CORR), Exchange Rate (EXCR) and Inflation Rate (INFR). (See Table 1 for variables, measurement and sources).

Based on previous theoretical and empirical findings as articulated in the literature, as well as the structure of the Nigerian economy, the life expectancy depends on poverty, energy consumption, health expenditure, petroleum products consumption, oil revenue, exchange rate and inflationary rate. This can be expressed as:

$$LEXP_t = \alpha_0 + \alpha_1 POV_t + \alpha_2 ENEC_t + \alpha_3 PPC_t + \alpha_4 DEP_t + \alpha_5 CORR_t + \alpha_6 ORV_t + \alpha_7 HEXP_t \varepsilon_t + \alpha_8 EXCR_t + \alpha_9 INFR + e_{it} \quad (1)$$

The interactive effect of poverty and energy consumption on life expectancy can be expressed as:

$$LEXP_t = \alpha_0 + \alpha_1 POV_t + \alpha_2 ENEC_t + \alpha_3 PPC_t + \alpha_3 (ENEC_t * POV) + \alpha_4 (PPC_t * POV) + \alpha_3 \alpha_4 DEP_t + \alpha_5 CORR_t + \alpha_6 ORV_t + \alpha_7 HEXP_t \varepsilon_t \quad + \alpha_8 EXCR_t + \alpha_9 INFR + e_{it} \quad (2)$$

The ARDL approach yields consistent estimates of the long –run coefficients that are asymptotically normal, irrespective of whether the underlying are I(1) or I(0), (Pesaran and Shin, 1995). One particularly attractive reparameterisation to researchers is the error-correction model (EC); which uses have increased over time (Engle and Granger (1987)).Thus, Equation (3) forms the basis of our ARDL model .The error correction representation of equation (2) can be specified as follows:

$$LEXP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\, \Delta POV + \sum_{i=1}^{n} \alpha_{2i}\, \Delta ENEC_{t-1} + \sum_{i=1}^{n} \alpha_{3i}\, \Delta PPC_{t-1} + \sum_{i=1}^{n} \alpha_{4i}\, \Delta POV * ENEC_{t-1} + \sum_{i=1}^{n} \alpha_{5i}\, \Delta POV * PPC_{t-1} + \sum_{i=1}^{n} \alpha_{6i}\, \Delta DEP_{t-1} + \sum_{i=1}^{n} \alpha_{7i}\, \Delta CORRR_{t-1} + \sum_{i=1}^{n} \alpha_{8i}\, \Delta ORV_{t-1} + \sum_{i=1}^{n} \alpha_{9i}\, \Delta HEXP_{t-1} + \sum_{i=1}^{n} \alpha_{10i}\, \Delta EXCR_{t-1} + \sum_{i=1}^{n} \alpha_{11i}\, \Delta INFR_{t-1} + \beta_1 POV_{t-1} + \beta_2 ENEC_{t-1} + \beta_3 PPC_{t-1} + \beta_4 POV * ENEC_{t-1} + \beta_5 POV * PPC_{t-1} + \beta_6 DEP_{t-1} + \beta_7 CORR_{t-1} + \beta_8 ORV_{t-1} + \beta_9 HEXP_{t-1} + \beta_{10i} EXCR_{t-1} + \beta_{11} INFR + ECT_{t-1} \quad (3)$$

Subjective evidence from literature reveal that the autoregressive distributed lag model (ARDL) is one of the major workhorses in dynamic single- equation regression. Once cointegrating relationship is ascertained, the error correction estimates of the ARDL model are obtained. The diagnostic test statistics of the selected ARDL model can be examined from the short run estimates at this stage of the estimation procedure. Similarly, the test for parameter stability of the model can be performed. The ARDL model testing procedure starts with conducting the bound test, which states the null hypothesis of zero cointegration, that is:

$$\beta_I = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$$

$$\beta_I \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq \beta_{11} \neq 0$$

The statistic underlying the procedure is the F-statistic which is used to test the significance of lagged levels of the variables, in order to establish the existence of cointegration. Two sets of critical values are reported in Pesaran and Pesaran (1997), Pesaran et al (2001). The critical values are divided into upper and lower critical bounds. The upper critical values assume that all the series are I(1) while the lower critical values assume that all the series are I(0). In the bound testing approach, the calculated F-statistic is compared with the critical values provided by Pesaran and Pesaran (1997), Pesaran et al (2001) or Narayan (2004). However, due to the limited number of sample observations, the critical values in this study will be extracted from Narayan (2004). If the computed F-statistic falls outside the critical bound, a conclusive inference can be made without considering the order of integration of the underlying regressors. For instance, if the F-statistic is higher than the upper critical bound, then the null hypothesis of no cointegration is rejected. Alternatively if the F-statistics is lower than the lower critical bound, then the null hypothesis of no cointegration cannot be rejected. If however the calculated F-statistic lies within the lower and upper bounds, then the test is said to be inconclusive. In this context, the unit root tests should be conducted to ascertain the order of integration of the variables. If all the variables are found to be I(1), then the decision is taken on the basis of the upper critical value. On the other hand, if all the variables are I(0), then the decision is based on the lower critical bound value.

Table 1. The Measurements of Variables and Sources of Data

Variables	Measurements	Sources
Oil Revenue(ORV)	Oil revenue as a percentage of GDP	World Development Indicator(WDI)
Poverty (POV)	Absolute Poverty Index	WDI
Petroleum Products Consumption(PPC)	Petroleum Products Consumption as Percentage of energy consumption	International Energy Agency(IEA)
Life Expectancy(LEXP)	Life Expectancy at birth	WDI
Energy Consumption(ENEC)	Energy Consumption Per Capita in KWh per person	IEA
Exchange Rate (EXCH)	Exchange rate to dollar	WDI
Corruption (CORR)	Corruption Perspective Index	International Country Risk Guild (ICRG)
Health Expenditure (HEXP)	Government budget on health as percentage of total budget	Central Bank of Nigeria (CBN)
Inflation Rate(INFR)	Consumer price index.	WDI
Dependency Ratio(DEP)	Population (65+)/Population (30-64)	UN population

Source: Author's compilation

Empirical Result and Discussion

This section provides interactive effect of poverty and energy consumption on life expectancy. By the theoretical postulation, the working hypotheses are that *ceteris paribus*:

i) Poverty is negatively related to energy consumption and life expectancy;
ii) Energy consumption is positively related to life expectancy;
iii) Fossil fuel consumption is negatively related to life expectancy.

As to the interactive effect of poverty and energy consumption on life expectancy, it is an empirical issue for investigation.

Stationarity Tests

The empirical analysis in this study starts with the test for a unit root in order to examine the nature of stationarity of the series. This is very important because using a non-stationary series to explain another non-stationary series may generate spurious regressions, thereby yielding biased and inconsistent estimates (see Engle & Granger, 1987). Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and Dickey-Fuller test statistic using a generalized least squares unit root tests (DF GLS) are performed on the series to determine their order of integration. Results from unit root tests would determine the procedure to be employed to estimate. For instance, if all series are integrated of order 0, then ordinary least squares procedure (OLS) may be used; in contrast, if series are unit root non-stationary, then OLS would result in a spurious regression.

Although common practice in time series modeling has involved the application of (augmented) Dickey-Fuller and Phillips-Perron tests to determine whether a series possesses a unit root, improved and efficient tests with much better statistical properties are now Dickey-Fuller test statistic using a generalized least squares (DF GLS). This modified test not only has the best overall performance in terms of small-sample size and power, but also has substantially improved power when an unknown mean or trend is present (Stock, 1994; Elliott *et al* 1996). The test unit root result in Table 2 shows that the null hypothesis of a unit root cannot be rejected for the level series of some variables using KPSS and DF GLS techniques. However, the null hypothesis of a unit root can be rejected for the first difference of all the series at a 5 per cent level of significance. The stationarity property of variables under consideration are mixture of I(1) and I(0), hence the ARDL technique is appropriate for estimation.

Table 2. Unit Root Result

	KPSS			**DF GLS**		
	Levels	First Difference	Remark	Levels	First Difference	Remark
PPC	-1.934	-3.992***	I(1)	-2.932	-6.299***	I(1)
PO V	-1.780	-4.155***	I(1)	-1.358	-5.466***	I(1)
DEP	-2.475	-7.047***	I(1)	-1.177	-2.803*	I(1)
CORR	-2.903*	-4.692***	I(1)	-2.241	-3.468**	I(1)
LEXP	-1.968	-3.675***	I(1)	-3.612**		I(0)
HEXP	-1.694	-4.354***	I(1)	-2.74	-6.820***	I(1)
FUELS	-2.659*	-3.292**	I(1)	-4.032***		I(0)
GRT	-3.746***		I(0)	-3.541**		I(0)
ENEC	-3.463**		I(0)	-5.142***		I(0)
INFL	-2.181	-4.428***	I(1)	-2.924	-5.815***	I(1)
INTR	-2.667*	-5.319(1)***	I(1)	-2.369	-6.804***	I(1)
OILR	-1.920	-3.544**	I(1)	-4.008***		I(0)

Sources: Authors Compilation (2020);***, **, and * are 1%, 5% and 10% respectively.

Interactive Effect of Poverty and Energy Consumption on Life Expectancy

The results of the co-integration test based on the ARDL-bounds testing method are presented in upper part of Table 3. The results indicate that the F-statistic is greater than the upper critical bound from Pesaran *et al.* (2001) at 5% significance level using restricted intercept and no trend. This study therefore rejects the null hypothesis of no cointegration among the variables. This shows that there is a long-run causal relationship between life expectancy, energy consumption, poverty, dependency ratio, petroleum products consumption, exchange rate and inflation rate in Nigeria. F-test results indicate that we reject the null hypothesis of no cointegration between variables, since computed value of F-statistics, 5.717, is greater than I(1) bound value at 5% level of significance. Thus, we concluded that variables are cointegrated which implies that there is a long-run relationship among the variables. The bounds test result shows that there exists cointegration because the bounds F-statistics value is greater than the

I(0) and I(1) series, the study then proceeds to present both the short run and long run result for the models.

Table 3 presents the long-run coefficients and short-run coefficients of the model estimated using ARDL approach. The estimated energy consumption has a positive and significant impact on life expectancy in long-run ($t_c = 3.126;\ P < 0.05$). The result is statistically significant as their probabilities are less than percent. The results further indicate that for every 1 percent positive change in energy consumption, life expectancy balance improves by about 2.873 percent long run respectively. Interestingly, this result shows that while energy consumption has insignificant impact on life expectancy in the short-run, its impact is not only significant but also strong on life expectancy in the long-run. This findings support that of Youssef *et al* (2016), Shaobin wang and Haixia pu (2019) and in disagreement with was obtained by Shobande (2019) that found negative relationship between energy consumption and child mortality. The difference could as result of variable which this study considered which is life expectancy not infant mortality. This is also consistent with theoretical proposition that an access to energy services is expected to increase life expectancy. Poverty has negative and significant impact on life expectancy in the short –run($t_c = 2.493;\ P < 0.05$) and long-run($t_c = 2.526;\ P < 0.05$). The result revealed that a unit increase in poverty reduces life expectancy by 0.92 and 1.19 in the short run and long run respectively. This result showed that poverty is one of the contributors to premature death in Nigeria. This result agrees with the findings of Meikle and Bannister (2003), Gertler, et al. (2011), Sa'ad and Bugaje (2016).

The coefficient of petroleum products consumption is negative and significant on life expectancy in the short run($t_c = 2.60;\ P < 0.05$) and long run($t_c = 2.164;\ P < 0.05$). This shows that as the consumption of fossil fuel like petroleum products increases, life expectancy declines. A unit increase in consumption of petroleum products reduces life expectancy by 0.039 and 0.171 in the short –run and long –run respectively. This could be attributed to the fact that fossil fuel consumption contribute to carbon emission which is detrimental to the health, hence reduces life expectancy. The coefficient of government expenditure on health has positive and significant impact on life expectancy in both short-run($t_c = 2.11;\ P < 0.05$) and long-run($t_c = 2.63;\ P < 0.05$) which is in line with our a priori expectation. The government expenditure on health is not robust enough to have much impact on life expectancy as evident by the value of coefficients which are 0.019 and 0.029 in the short- run and long- run respectively. Health expenditure shows little impact though significant on life expectancy in Nigeria. This could be attributed to the fact that government budget on health sector is too small to impact much on life expectancy. Corruption has negative and significant impact on life expectancy in both short-run ($t_c = 2.35;\ P < 0.05$) and long-run($t_c = 2.52;\ P < 0.05$) . As reflected in the results, the major short-run determinants of life expectancy are poverty, energy consumption, petroleum products consumption, health expenditure, corruption, dependency ratio and inflationary rate, all of which have contemporaneous effects on life expectancy. Conspicuously missing among these short-run and long- run determinants are the real effective exchange rate and oil revenue, including the real exchange rate and oil revenue variables in the model give a negative but insignificant coefficient and reduces the fit of the model both in terms of the coefficient of determination and the information criteria. This therefore implies that, while the real effective exchange rate and oil revenue may be an important policy variable in developmental model in Nigeria, oil receipts and exchange rate policies aimed at improving life expectancy in Nigeria may not have been effective in the both short-run and long-run. This could the attributed to the fact that government oil revenue fiscal budget on health sector is too small to impact on life expectancy. The spending on health facilities are not adequate to take care of health challenges in Nigeria despite oil windfall over the years. This study found strong support for the short-run and long -run relationship between poverty, energy consumption and life expectancy in Nigeria.

The coefficient of interactive effect of poverty and energy consumption is negative and significant on life expectancy in the short run ($t_c = 2.90;\ P < 0.05$) and in the long- run($t_c = 2.83;\ P < 0.05$). This result affirms that fossil fuel consumptions dominate energy consumption in Nigeria. Majority of Nigerian populace do not have access to renewable energy. This fact is buttressed by the coefficient of interactive effect of poverty and petroleum products consumption on life expectancy which is negative and significant in both short run ($t_c = 2.83;\ P < 0.05$) and long- run($t_c = 3.71;\ P < 0.05$). This result shows there is energy poverty in Nigeria which acts as hindrances in accessing safer and cleaner energy. Majority of the populace use fossil fuel for lighting, cooking, automobile and production process which contributes to carbon emission and reduce life expectancy.

Table 3. Interactive effects of poverty and energy consumption on Life expectancy in Nigeria

Bound Cointegration	**Result**	**DEPENDENT VARIABLES (Life Expectancy)**		
Bound F-Statistics	**5.**			
Critical Value Bound		**5%**		
I(0)		**2.45**		
1(1)		**3.61**		
Variable	**Coefficient**	**Std. Error**	**t-Statistics**	**P Value**
PPC	-0.171	0.079	-2.164	0.010
POV	-1.190	0.471	-2.526	0.030
POV*ENEC	-1.051	0.371	-2.832	0.037
POV*PPC	-0.791	0.213	-3.712	0.011
FSP	-0.127	0.071	-1.788	0.178
DEP	0.439	0.192	-2.286	0.011
GRT	0.059	0.317	0.186	0.618
CORR	-0.174	0.069	-2.521	0.037
HEXP	0.029	0.011	2.630	0.001
ENEC	2.873	0.919	3.126	0.014
OILR	0.286	0.416	0.687	0.510
EXCR	0.049	0.067	0.731	0.711
INFR	0.262	0.191	1.371	0.410
Constant	0.291	0.501	2.781	0.001
		Short Run		
D(PPC)	**-0.039**	**0.015**	**-2.600**	**0.001**
D(POV)	**-0.920**	**0.369**	**-2.493**	**0.021**
D(POV*ENEC)	**-0.189**	**0.065**	**2.907**	**0.000**
D(POV*PPC)	**-0.619**	**0.218**	**2.839**	**0.000**
D(POV(-1)	**0.501**	**0.215**	**-2.330**	**0.008**
D(HEXP)	**0.019**	**0.009**	**2.111**	**0.043**
D(DEP)	**-0.121**	**0.059**	**-2.051**	**0.029**
D(CORR)	**-0.814**	**0.091**	**-2.358**	**0.009**
D(CORR(-1)	**-0.731**	**0.215**	**-3.401**	**0.000**
D(CORR(-2)	**-0.191**	**0.081**	**-2.358**	**0.030**
D(ENEC)	**0.118**	**0.307**	**0.384**	**0.691**
D(OILR)	**-0.051**	**0.118**	**-0.432**	**0.181**
D(OILR(-1)	**0.031**	**0.211**	**0146**	**0.149**
D(EXCR)	**-0.101**	**0.197**	**-0.512**	**0.311**
D(INFR)	**-0.154**	**0.063**	**-2.444**	**0.035**
ECT_{t-1}	**-0 .601**	**0.295**	**2.037**	**0.010**
R-squared	**0.736**			
		F-statistics	**3.582**	**0.000**
		Diagnostic Tests		
F –Statistics		**Prob.**		
Serial Correlation	1.614	0.016		
Functional form	0.701	0.191		
Normality	0.292	0.331		
Heteroscedasticity	0.977	0.751		

Source: Author's compilation

Considering the statistical properties of the ARDL result reported in Table 3 for Nigeria, the R-squared value of 0.736 indicates that about 74 % variation in life expectancy is explained in the model by the explanatory variables. The F-statistics is statistically significant as its probabilities are less than 0.05 and this shows that there is a considerable relationship between life expectancy and the explanatory variables put together. This confirms that all the independent variables jointly have significant influence on the dependent variable. The negative and statistically significant estimate of the ecm(−1) coefficient provides another evidence for established long run relationship between changes in life expectancy, energy consumption, poverty, interest rate, dependency ratio, petroleum products consumption and exchange rate. The error correction term is negative, thus establishing that the system is able to converge to the long-run position each time we have a shock in the model.

According to estimated value of ECM(−1) coefficient, it will take less than a year to reach the stable path of equilibrium implying that the adjustment process is very fast for the Nigerian economy. The coefficient of the ECM (−1) is negative and significant at 5% level. The coefficients indicate that a deviation from the long-run equilibrium as a result of a short-run shock is adjusted at a speed of over 60% each year. The rate of adjustment to the long-run position is high, as evidenced by the size of the coefficient at 0.601. The Jarque-Bera test suggests that the residuals are normally distributed since the probability value is greater than the 5% significance level. Hence, the hypothesis of normal distribution for the residuals cannot be rejected. Confirming the absence of serial correlation among the residuals, the Breusch-Pagan serial correlation (LM) test result suggests the non-rejection of the null hypothesis at the 5% level of significance. Also, The ARCH and Ramsey-Reset results whose probability values are greater than 5% indicate that there is neither heteroscedasticity nor functional misspecification in the estimated model. Thus, the hypotheses of constant variance and linear relationship cannot be rejected. Since these assumptions have not been violated, it therefore follows that the results of the models presented in Table 3 are consistent, efficient and feasible for forecast and policy making. Also, the plot of CUSUM for the model under consideration is within the five per cent critical bound as shown in figure 1. This implies the plots of CUSUM and CUSUMSQ statistics are well within the critical bounds, we conclude that the coefficients of the error-correction model are stable implying that the coefficients seem to follow a stable pattern during the estimation period; thus, one can use these coefficients for policy decision-making purposes since the model do not suffer from any structural instability over the period of study.

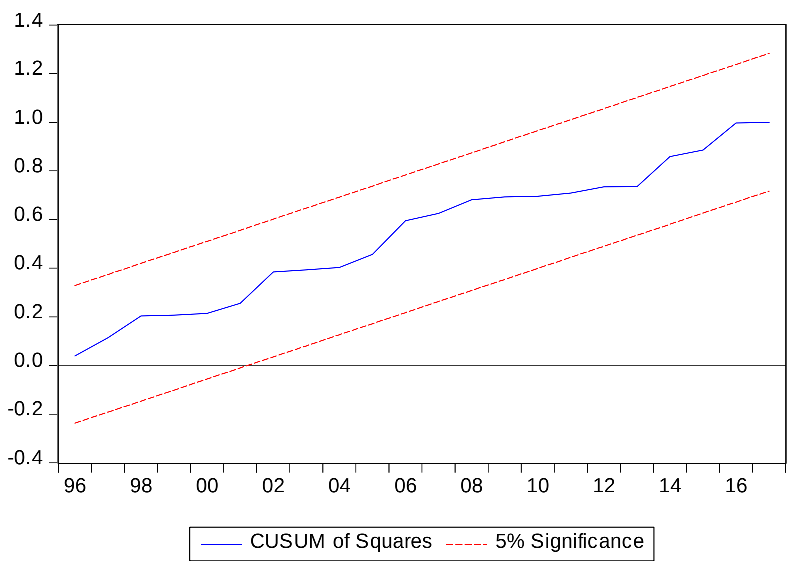

Fig. 1. CUSUM and CUSUMSQ

Conclusion

This study investigated on the interactive effect of energy consumption and Poverty on Life Expectancy in Nigeria from 1980 to 2017. The dependent variable is life expectancy at birth while the explanatory variables are energy consumption, poverty, health expenditure, oil revenue, corruption, exchange rate and inflation rate.

The time series properties of the variables were tested for stationarity. The Autoregressive Lag Model (ARDL) was employed to analyse the data. The study found out that poverty had a negative and significant impact on life expectancy both in the short-run and in the long-run. Energy consumption had a positive and significant impact on life expectancy in the long-run. The coefficient of interactive effect of poverty and energy consumption is negative and significant on life expectancy in the short run and in the long-run. This result revealed that fossil fuel consumptions dominate energy consumption mix in Nigeria. This implied that most people in Nigeria do not make use of renewable energy. This fact is buttressed by the coefficient of interactive effect of poverty and petroleum products consumption on life expectancy which is negative and significant in both short run and long-run. Therefore, in order to increase the life expectancy in Nigeria, government should reduce poverty through poverty alleviation programmes that will address energy poverty. There should be increased awareness and accessibility for people to make use of clean energy that is healthy as a source of energy.

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