International Journal of Multidisciplinary Research and Growth Evaluation.

Impact of Non-Renewable energy on economic growth in Nigeria: Autoregressive distributive lag model (ARDL)

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Article Info

ISSN (online): 2582-7138
Volume: 04
Issue: 02
March-April 2023
Received: 16-02-2023;
Accepted: 10-03-2023
Page No: 222-231

Abstract
The study examined the impact of non-renewable energy on economic growth in Nigeria. Specifically, the study sought to: investigate the impact of coal energy on economic growth in Nigeria; examine the impact of natural gas energy on economic growth in Nigeria and determine the impact of petroleum/crude oil energy on economic growth in Nigeria. This study made use of ex post-facto research design. These variables of the study consist of economic growth (RGDP); natural gas energy (GAS), petroleum/crude oil energy (CRUDE), coal energy (COAL), exchange rate (EXCHR) and inflation rate (INFLA) for a period of 1992 to 2022 as defined in our model specification. The pre-estimation and post-estimation tests were descriptive statistics, correlation matrix, ADF-Unit Root test statistic, Bound co-integration test, Ramsey Reset test, Breuch-Godfrey Serial Correlation LM Test respectively while the data analytical technique was Autoregressive distributive lag model (ARDL) technique. The empirical results show that petroleum/crude oil energy has 28% positive and significant impact on economic growth in short run (Probability value of 0.0051 < 0.05) but it was 20% positive and significant impact on economic growth in long run (Probability value of 0.0039 > 0.05); natural gas energy has 12 % positive and significant impact on economic growth in short run (Probability value of 0.0130 < 0.05) but it was 47 % positive and significant impact on economic growth in long run (Probability value of 0.0051 < 0.05) and coal energy has 5 % positive and insignificant impact on economic growth in short run (Probability value of 0.0130 > 0.05) but it was 26 % positive and significant impact on economic growth in long run (Probability value of 0.0078 < 0.05). The study recommends that government of Nigeria should encourage entrepreneurs to invest and/or facilitate human capital accumulation to promote the use of coal energy sources in producing goods and services.

Keywords: Natural gas energy, Petroleum/crude oil energy; Coal energy

Introduction

Energy is a vital element for economic growth and is generally viewed as the stimulus for most economic activities. The role of energy is equally important in income generation and employment. Non-renewable energy largely dominates energy supply in Nigeria. The growing concern is that they are exhaustible and adverse to the climate. In the country's electricity sector, natural gas (82 percent) and big hydro (18 percent) remain the major sources of electricity generation (IEA, 2021). No records of renewable energy exist, partly due to the fact that they are negligible in a size that will allow integration into the existing central grid system. Ojonugwa and Obi (2016) argued that the consumption of energy is proportional with the national product. Hence, the scale of energy consumption per capita is an important indicator of economic modernization. In general countries that have higher energy consumption are more developed than those with low level of consumption (IAE, 2021).

The importance of energy lies in other aspect of development - increase in foreign earnings when energy products are exported, transfer of technology in the process of exploration, production and marketing; increase in employment in energy industries; improvement of workers welfare through increase in worker's salary and wages, improvement in infrastructure and socio-economic activities in the process of energy resource exploitation (Awodumi & Adeolu, (2020). Thus in the quest for optimal development and efficient management of available energy resources, equitably allocation and efficient utilization can put the economy on the part of sustainable growth and development. Arising from this argument, adequate supply of energy thus becomes central to the radical transformation of the nation's economy. However, some energy economists contend that energy consumption cannot stimulate economic growth given that the small fraction of energy usage is used in the production process (Uzokwe & Onyije, 2020).

By 2009, Nigeria's energy consumption mix continued to be dominated by petroleum products (72.3 percent), followed by hydro-power (20.1 percent) and natural gas (7.5 percent). Though, the share of coal in total energy consumption has remained insignificant (0.04 percent), the recent increase in petroleum products prices that emanated from some proportional removal of subsidy has led to some observed increase in usage of coal for domestic energy consumption. It is important to note that nuclear and other renewable sources of energy have not been part of the country's energy consumption mix. Between 1984 and 2009, the share of petroleum products in Nigeria's energy mix decreased slightly from 77 percent to 72.3 percent. Natural gas consumption decreased from 18 percent to 7.5 percent during the same period while hydro-power experienced a significant increase in its share of total energy consumption from 5 percent in 1984 to 25.1 percent in 2009 (Oyaromade, Adagunodo & Bamidele, 2014).

Nigeria had an estimated 187 trillion cubic feet (Tcf) of proven natural gas reserves as of December 2010, which makes the country the ninth largest natural gas reserve holder in the world and the largest in Africa. In 2009, Nigeria produced about 820 Bcf of marketed natural gas and consumed about 255, mostly for electricity generation of which natural gas accounts for about 60 percent (Energy Information Administration, 2011). Due to lack of required infrastructure in the oil fields, Nigeria's gas is flared with 536 Bcf natural gas flared in 2010 – or about a third of gross natural gas produced in 2010 according to NNPC. In 2011, the NNPC claimed that flaring cost Nigeria US$2.5 billion per year in lost revenue (Energy Information Administration, 2011).

Statement of the Problem

Numerous energy resources in the form of oil, natural gas, coal and hydroelectric potential abound in Nigeria. The country ranks the six highest producer of crude oil and has an unlimited supply of natural gas. The hydroelectric potential is largely supported by the Rivers Niger and Benue while numerous smaller rivers have remained untapped with attempts being made to ascertain the coal reserve, which is estimated at over 2 billion tonnes. In spite of this endowment, the country ranks among lowest in energy performance in terms of energy consumption, efficiency, accessibility and quality.

Attempts by energy experts to give reasons to this problem in Nigeria, Awodumi and Adeolu, (2020); Oyaromade, Adagunodo and Bamidele (2014); Azeakpono and Amaghionyeodiwe, (2020); Gnangoin, Kassi, Edjoukou, Kongrong and Yuqing, (2022) studied non-renewable energy consumption and economic growth in Nigeria. Their studies mostly focused on the relationship without identifying the impact of petroleum/crude oil energy, natural gas energy and coal energy consumption pattern on economic growth (GDP) in Nigeria. Studying energy consumption on the aggregate may not tell which non-renewable energy components actual contribute more than the other. By implication their result may be misleading. Taking congnisance of the implication of studying the impact of non-renewable energy components on economic growth which little or no studies has been conducted on the area in Nigeria as a case study. It is against backdrops, this study examined the impact of non-renewable energy on economic growth in Nigeria to cover the literature gap.

Objectives of the Study

The broad objective of the study is to examine the impact of non-renewable energy on economic growth in Nigeria. The specific objectives are to:

1. Investigate the impact of coal energy on economic growth in Nigeria.
2. Examine the impact of natural gas energy on economic growth in Nigeria.
3. Determine the impact of petroleum/crude oil energy on economic growth in Nigeria.

Conceptual Literature

Non-renewable energy

Non-renewable energy resources are finite. They cannot be easily replaced on human timescales, and we are exploiting them faster than they are being made. There are two main types of non-renewable energy: fossil fuels and nuclear energy (Geological Society Report, 2020). Burning fossil fuels generates heat and electricity, but also released carbon dioxide (CO2) gas. The CO2 in the Earth's atmosphere traps excess heat from the sun in a process known as the 'greenhouse effect'. Over the past 250 years, increasing amounts of CO2 (currently at ~410 parts per million) have caused the Earth's atmosphere and oceans to heat up, this is known as global warming (Geological Society Report, 2020).

Non-renewable Energy referred as fossil fuels. Since the discovery fossil fuels, they are one of the most important mineral energy sources. Non-renewable Energy resources are a finite energy resource that means they are non-renewable resources and once consumed they are lost forever. There are three major forms of fossil fuels: coal, oil and natural gas and on worldwide basis they provide approximately 90% of energy consumed (Statistical Review of World Energy, June 2004). Since the industrial revolution, the major energy resources for the world have been fossil fuels formed from the remains of plants and animals lived in the distant past. Fossil fuels represent stored solar energy captured by plants in the past geological times. Coal, petroleum and natural gas are called fossil fuels, as they are the remains of prehistoric plants, animals and microscopic organisms that lived millions of year ago. These remain under the effect of intense heat and pressure underneath the earth's crust over long geological time and got transformed into fossil fuels.

Coal Non-renewable Energy (Fossil fuel)

Coal is formed from plants and vegetation buried. Coal is a solid fossil fuel and a sedimentary rock composed primarily of carbon. The proven global coal reserve was estimated to be 9,84,453 million tonnes by end of 2003. The USA had the largest share of the global reserve (25.4%) followed by Russia (15.9%), China (11.6%). India was 4th in the list with 8.6% (Statistical Review of World Energy, June 2004). There are three basic grades of coal: i) lignite (brown coal), ii) bituminous (soft coal) and iii) anthracite (hard coal). Coal is the result of plant material that grew in fresh water swamps approximately three hundred million years ago. As this plant material died and accumulated, peat also called peat bog was formed. Since the plant material accumulated under water, in the swamps decay was inhibited due to lack of oxygen. Oceans inundated many of the areas of peat and sediments from the sea were deposited, over the peat. The weight of these sediments and the heat of the earth gradually changed the composition of the peat bog and coal was formed. Today peat also is used as source of fuel in some parts of the world though its high water content makes it a low-grade fuel.

Petroleum or Crude Oil

Oil and gas were formed from the remains of plants and animals that once lived in the sea. For over millions of years these remains remained buried under mud and rock under great pressure and at high temperatures. Under these conditions marine biomass gradually changed into oil and gas. The global proven oil reserve was estimated to be 1147 billion barrels by the end of 2003. Saudi Arabia had the largest share of the reserve with almost 23%. (One barrel of oil is approximately 160 liters) (Statistical Review of World Energy, June 2004). Oil and gas are primarily found along geologically young tectonic belt at plate boundaries, where large depositional basins are more likely to occur. Petroleum or crude oil (oil as it comes out of the ground), is a thick dark liquid consisting of a mixture hundreds of combustible hydrocarbons along with small amounts of sulphur, oxygen and nitrogen impurities. It is also known as conventional oil or light oil. Deposits of crude oil and natural gas are usually trapped together under the sea floor or earth's crust on land. After it is extracted, crude oil is transported to a refinery by pipelines, trucks or ships (oil tanker). In refineries oil is heated and distilled to separate it into components with different boiling points. The important components are gases, gasoline, aviation fuel, kerosene, diesel oil, naphtha, grease and wax and asphalt. Some of the products of oil distillation are called petro-chemicals which are used as raw material for the manufacture of pesticides, plastics, synthetic fibers, paints and medicines etc. The consumption of petroleum products is rising worldwide (Statistical Review of World Energy, June 2004).

Natural Gas

Natural gas, primarily consist of methane, is often found above reservoirs of crude oil. The global proven gas reserve was estimated to be 176 trillion cubic metres by the end of 2003. The Russian Federation had the largest share of the reserve with almost 27% (Statistical Review of World Energy, June 2004). The natural gas is a mixture of 50 to 90% by volume of methane (CH_4), the simplest hydrocarbon. It also contains small amounts of heavier gaseous hydrocarbons such as ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) and also small amounts of highly toxic hydrogen sulphide (H_2S). Natural gas is formed through geological processes similar to the processes of crude oil formation described earlier except the organic material gets changed to more volatile hydrocarbons than those found in oil.

Economics Growth

Economic growth is the increase in the value of goods and services produced by a country over a period and Real Gross Domestic Product (RGDP) is used as a proxy for economic growth. Real gross domestic product is an inflation-adjusted measure which reflects the value of all goods and services produced by an economy in a given year, usually expressed in base-year prices, and is often graded as constant-price or inflation-corrected GDP. Unlike nominal GDP, real GDP can account for changes in price level and provide a more accurate figure of economic growth (Ojonugwa & Obi, 2016). According to Uzokwe and Onyije, (2020), economic growth can be defined as the sustained increase in a country's productive capacity, and per capita national output or net national product over a while. These increases are the basic causes of economic growth. Gross domestic product is the market value of all officially recognized final goods and services produced within a country in a given period of time ((Ikhide & Adjasi, 2018). It includes all of private and public consumption, government outlays, and investments and exports less imports that occur within a defined territory. GDP is commonly used as an indicator of the economic health of a country, as well as to gauge a country's standard of living. (Ikhide & Adjasi, 2018).

Theoretical Literature

The Neoclassical Economic Growth Theory

Neoclassical growth theory was formulated by Robert Solow and Trevor Swan in 1956. It was developed to introduce the model of long-run economic growth. Robert Solow and Trevor Swan in 1956 stipulated how a steady economic growth rate comes as a result of a combination of three driving forces—labor, capital, and technology. The model first considered exogenous population increases to set the growth rate but, in 1957, Solow incorporated technology change into the model. The theory states that short-term equilibrium results from varying amounts of labor and capital in the production function. The theory also argues that technological change has a major influence on an economy, and economic growth cannot continue without technological advances. Neoclassical growth theory outlines the three factors necessary for a growing economy. These are labor, capital, and technology. However, neoclassical growth theory clarifies that temporary equilibrium is different from long-term equilibrium, which does not require any of these three factors.

This growth theory posits that the accumulation of capital within an economy, and how people use that capital, is important for economic growth. Further, the relationship between the capital and labor of an economy determines its output. Finally, technology is thought to augment labor productivity and increase the output capabilities of labor. Therefore, the production function of neoclassical growth theory is used to measure the growth and equilibrium of an economy. That function is $Y = AF(K, L)$.

- Y denotes an economy's gross domestic product (GDP)
- K represents its share of capital
- L describes the amount of unskilled labor in an economy
- A represents a determinant level of technology

However, because of the relationship between labor and technology, an economy's production function is often re-written as Y = F (K, AL). Increasing any one of the inputs shows the effect on GDP and, therefore, the equilibrium of an economy. However, if the three factors of neoclassical growth theory are not all equal, the returns of both unskilled labor and capital on an economy diminish. These diminished returns imply that increases in these two inputs have exponentially decreasing returns while technology is boundless in its contribution to growth and the resulting output it can produce.

Empirical Literature

Prempeh, (2023) The impact of financial development on renewable energy consumption: new insights from Ghana. The study sought to explores the long-run impact of financial development on renewable energy consumption while controlling for energy prices and economic growth. Consistent with the aim of the paper, the ARDL bounds testing, Bayer-Hank, Gregory and Hansen cointegration, VECM, FMOLS, CCR and DOLS tests are employed. The empirical analysis supports cointegration between variables. Moreover, the findings indicated that financial development drives renewable energy use in Ghana, whereas energy costs and economic growth have a negative effect. This study offers a substantial addition to renewable energy literature and paves the way for policymakers to pursue alternative energy sources to help satiate the nation's growing energy needs.

Wen, Onwe, Haseeb, Saini, Matuka and Sahoo (2022) examined the role of technological innovation, renewable and non-renewable energy, and economic growth on environmental quality. Specifically, the study sought to examine the impact of renewable and non-renewable energy consumption on carbon emissions, considering the role of population density, urbanization, foreign direct investment, technological innovation, and trade openness for African countries from 1990 to 2019. We apply an advanced econometric methodology like the cross-sectional autoregressive distributed model (CS-ARDL) for long-run and short-run estimation, which allows for the cross-sectional dependencies and slope heterogeneity. Our finding shows that the non-renewable resources, population density, urbanization, and foreign direct investment contribute to the carbon emissions; in contrast, renewable resources and trade openness reduce the carbon emissions in African countries. Results also report a unidirectional causality from non-renewable energy consumption to carbon emissions, while there is evidence of a feedback hypothesis between renewable energy consumption and carbon emissions. The study recommends that policymakers in African countries should take the issues of population and urbanization severe. This could be carried out through population control measures such as family planning, women empowerment, education, etc., and the building of environmental friendly cities where CO_2 emissions will be reduced, and renewable energy encouraged.

Gnangoin, Kassi, Edjoukou, Kongrong and Yuqing, (2022), determined the relationship between renewable energy, non-renewable energy, economic growth and CO_2 emissions in the newly emerging market economies. The method of data analysis was Feasible Generalized Least Squares and the Two-Stage Least Squares estimators, we analyze the moderating impact of human capital on the link between renewable energy, nonrenewable energy, economic growth, and CO_2 emissions in the case of the 20 newly emerging market economies for the period 1990–2021. We find negative effects of renewable energy consumption, industrialization and trade openness on CO_2 emissions. We also find positive effects of non-renewable energy consumption, economic growth, and human capital on CO_2 emissions. In addition, our findings reveal that renewable energy consumption and human capital are complementary levers for reducing CO_2 emissions, whereas human capital mitigates the detrimental effect of nonrenewable energy consumption on environmental quality. Besides, the results underline that human capital has an inverted U-shaped effect on CO_2 emissions. The study recommends that policymakers should emphasize the complementarity between human capital and renewable energy consumption by facilitating the accumulation of human capital towards productive investments and the use of renewable energy technologies in these countries.

Uzokwe and Onyije, (2020) examined the relationship between renewable and non-renewable energy consumption and economic growth in Nigeria from 1984 to 2015, deploying the Autoregressive distributive lag model (ARDL) approach and the Vector autoregressive (VAR), the Granger Causality test was estimated and confirmed with the Wald test. The overall findings suggest the absence of causality, which supports the neutral hypothesis and the presence of a positive relationship between non-renewable energy consumption (NREC), renewable energy consumption (REC), and economic growth (GDP), both in the short run and long run. The study indicates that NREC and REC significantly stimulate economic growth in Nigeria. The positive relationship between the three variables implies that an increase in energy consumption is a strong determinant of economic growth. The policy consequences suggest the need for Nigeria to improve its energy supply mix and consumption, especially regarding renewable energy, because of environmental and climate change considerations by ensuring the implementation of the 2015 National Renewable Energy and Energy Efficiency Policy (NREEEP) without fear of jeopardizing economic growth.

Azeakpono and Amaghionyeodiwe, (2020) examined the effect of renewable energy consumption on economic growth in Nigeria for the period 1990 to 2016. It further investigated the direction of causality between renewable energy consumption and economic growth in Nigeria. This was with a view to providing information on the relationship between renewable energy consumption and economic growth in Nigeria within the period of the study. Data collected was analysed using both descriptive analysis and econometric technique, which included unit root, correlation, co-integration, regression, and granger causality tests. The result showed that although renewable energy consumption and economic growth increased between 1990 and 2016 in Nigeria, renewable energy consumption had no significant positive impact on economic growth in Nigeria. Furthermore, there was no causality between renewable energy consumption and economic growth in Nigeria during the period of study. The study recommends that investing in renewable energy should be encouraged and enhanced as this may be a way to reduce domestic fossil fuel consumption or to meet increasing energy demand without an increase of domestic fuel consumption to increase fuel exports and thus for higher revenues.

Awodumi and Adeolu, (2020) examined the role of non-renewable energy consumption in economic growth and carbon emission in oil producing economies in Africa. The study therefore investigates the role of non-renewable energy in economic growth and carbon emissions among the top oil producing economies in Africa during 1980–2015. After accounting for nonlinearity and structural break in unit root and cointegration analysis, the paper adopted non-linear autoregressive distributed lag (NARDL) technique. The study reveals evidence of asymmetric effect of per capita consumption of both petroleum and natural gas consumption on economic growth and carbon emission per capita in all the selected countries except Algeria. In Nigeria, although positive change in the non-renewable energy consumption retards growth, it reduces emission. In the case of Gabon, increase in the consumption of these energy products promotes growth and enhances environmental quality. Consumption of these energy types has negligible impact on environmental pollution in Egypt as it enhances economic growth. While positive change in the non-renewable energy consumption contributes to economic growth in Angola, the effect on carbon emission is mixed across time and energy type. In addition, the influence of negative change in petroleum and natural gas consumption is similar to those observed for positive change in Egypt and Nigeria. It is therefore imperative for policymakers in oil producing economies (in Africa) to explore avenues to invest in, and promote, carbon-reducing technology in production processes in their quest for economic growth if they must continue to increase the consumption of their abundant resources-petroleum and natural gas.

Ikhide and Adjasi, (2018) conducted a study to examine causal relationship between renewable and non-renewable energy consumption and economic growth in Nigeria. Specifically, the study sought to investigate the causal link between renewable and non-renewable energy sources and economic growth in Nigeria. A quarterly time series data was employed from the period of 1971-2013. The methods of data analysis were Augmented Dicky Fuller (ADF) and Philip Perron (PP), ordinary least square and granger causality test. The empirical result showed that causality runs from renewable energy to real GDP but not the other way round, and supports a long run causality running from Real GDP to Non-renewable energy. The results of ordinary least squares test show positive relation between Real GDP and energy sources in Nigeria. The elasticities values show that a unit change in renewable and non-renewable energy increases economic growth by 19.0% and 8%, respectively. The study recommended that government should pay more attention to comprehensive research on energy policies (renewable energy sources) as a long term plan that aim at reducing the use of fossil fuel energy for the sake of environmental quality knowing that the all-embracing use of conventional energy sources can no longer be sustained.

Ojonugwa and Obi, (2016) examined the impact of sectoral consumption of non-renewable energy on economic Growth in Nigeria. This study therefore contributes to existing literatures by examining the impact of sectoral consumption of non-renewable energy on economic growth in Nigeria. Descriptive statistics in the form of pie chart and error correction mechanism were employed to analyse time series data on non-renewable energy in the form of oil, gas, electricity and coal consumed by industrial sector, agricultural sector, transport sector, commercial and residential sector in Nigeria. The study revealed that the residential sector consumed more energy in Nigeria than other sectors. The ECM results further revealed that all the variables contribute significantly to economic growth in Nigeria. But the residential sector was identified to contribute more to economic growth than other sectors. The study finally recommends that, to drive economic growth in Nigeria, policies aimed at encouraging the industrial sector should be formulated and implemented to encourage energy consumption by industrial sector in Nigeria.

Methodology

This study made use of ex post-facto research design. The pre-estimation and post-estimation tests were descriptive statistics, correlation matrix, ADF Unit Root test statistic, Bound co-integration test, Ramsey Reset test, Breuch-Godfrey Serial Correlation LM Test respectively while the data analytical technique was Autoregressive distributive lag model technique. These variables of the study consist of economic growth (RGDP); natural gas energy (GAS), petroleum/crude oil energy (CRUDE), coal energy (COAL), exchange rate (EXCHR) and inflation rate (INFLA) for a period of 1992 to 2022 as defined in our model specification. All the variables were sourced from World Bank development indicator (World Bank database) and Central Bank of Nigeria's (CBN) statistical bulletin. The study employed e-view version (9) statistical application software to analysis the data because it is user- friendly software.

Theoretical Framework

The study adopted Neoclassical growth theory which was formulated by Robert Solow and Trevor Swan in 1956. It was developed to introduce the model of long-run economic growth. The theory stipulated how a steady economic growth rate comes as a result of a combination of three driving forces—labor, capital, and technology. Symbolically, the function represents that

$$Y = AF(K, L) \quad \textbf{(1)}$$

Where Y denotes an economy's gross domestic product (GDP), K represents its share of capital, L describes the amount of unskilled labor in an economy, A represents a determinant level of technology.

Model Specification

This study specifically adopts the model of Ojonugwa and Obi, (2016) that examined the impact of sectoral consumption of non-renewable energy on economic Growth in Nigeria. The functional relationship is expressed as: RGDP = (Oil, Gas, Electricity and coal) (2)

Where: Oil is crude oil energy, Gas is natural gas energy, Electricity is electricity consumption and coal is coal energy. Specifically, to achieve the objective of this study and based on the property of the linearity of variables, the functional relationship is modeled in a linear equation to yield Equation 2:

$$RGDP_{it} = a_o + \beta_1 Oil + \beta_2 Gas + \beta_1 Electricity + \beta_1 Coal + \mu it \quad (3)$$

Where: β0 = Constant term, β_1 to β_6 = Regression coefficient and Ut = Error Term.

Model Specification for the Study

The functional form of the model used in this work was specified in equation 3.5 as

RGDP = F (GAS, CRUDE, COAL, EXCHR, INFLA) (3.5)

Where RGDP is real gross domestic product; CRUDE is petroleum/crude energy, GAS is natural gas, COAL is coal energy, EXCHR is exchange rate and INFLA is inflation rate. Equation (3.5) was therefore re-written in linear form as follows:

$RGDP = \beta_0 + \beta_1 GAS + \beta_2 CRUDE + \beta_3 COAL + \beta_4 EXCHR + \beta_5 INFLA + \mu t$ (3.6)

Where: β0 = Constant term, β_1 to β_5 = Regression coefficient and Ut = Error Term.

To reduce the outliers among the variables, all variables will be expressed in logarithmic form.

$LogRGDP = \beta_0 + \beta_1 \text{Log } GAS + \beta_2 \text{Log } CRUDE + \beta_3 \text{Log } COAL + \beta_4 EXCHR + \beta_5 INFLA + \mu t$ (3.7)

Where: β0 = Constant term, β_1 to β_5 = Regression coefficient and Ut = Error Term.

Results and Discussion

Table 1: Descriptive Statistics of the Variables

	RGDP	GAS	CRUDE	COAL	EXCHR	INFLA
Mean	2.42E+11	53633.78	61.49902	139258.7	2.640865	65.06813
Median	2.33E+11	53409.86	62.60748	140750.0	2.147000	73.25600
Maximum	4.92E+11	80343.97	92.53267	181130.0	9.257344	254.9485
Minimum	5.55E+10	19354.43	35.76329	100990.0	0.056825	0.000000
Std. Dev.	1.63E+11	10763.16	10.99000	21982.39	2.452905	43.63889
Skewness	0.232868	-0.228523	0.442446	0.114322	0.899670	2.565263
Kurtosis	1.536033	5.981851	4.788506	2.451235	2.918620	12.79250
Jarque-Bera	3.048474	11.75459	5.143145	0.456502	4.190485	157.8615
Probability	0.217787	0.002802	0.076415	0.795924	0.123040	0.000000
Sum	7.51E+12	1662647.	1906.470	4317020.	81.86683	2017.112
Sum Sq. Dev.	7.99E+23	3.48E+09	3623.403	1.45E+10	180.5022	57130.57
Observations	31	31	31	31	31	31

Source: e-view's Result

The table shows descriptive statistics of the variables. In the model established in the study, there is one dependent variable and five independent variables. The descriptive statistics of the variables show the nature and status of mean, median, maximum, minimum, sum of the variable respectively.

Table 2: Result of Correlation Matrix

	RGDP	GAS	CRUDE	COAL	EXCHR	INFLA
RGDP	1.000000	0.524823	0.774166	0.853627	0.888586	0.787024
GAS	0.524823	1.000000	0.808307	0.728128	0.767401	0.835134
CRUDE	0.774166	0.808307	1.000000	0.837934	0.889031	0.839563
COAL	0.853627	0.728128	0.837934	1.000000	0.929205	0.901577
EXCHR	0.888586	0.767401	0.889031	0.929205	1.000000	0.897109
INFLA	0.787024	0.835134	0.839563	0.901577	0.897109	1.000000

Source: e-view's Result

This correlation matrix presents a table showing correlation coefficients between sets of variables. This result of correlation matrix helps to identify which pairs of variables have the highest correlation. This test is to detect whether exact or perfect relationship exist among explanatory variables (multicollinearity). The result of correlation matrix showed that every explanatory variable in the study is linearly independent of each other.

Unit Root Test using Augmented Dickey-Fuller Fisher Test

Table 3: Results of Stationarity (Unit root) test

Variables	Variables' Name	ADF- Statistic	5% Critical Value	Remark
RGDP	Real GDP	-5.050948	-2.963972	1(1)
GAS	Natural Gas Energy	-6.484595	-2. 963972	1(1)
CRUDE	Crude oil energy	-5.535829	-2. 963972	1(1)
COAL	Coal energy	-4.699514	-2.963972	1(0)
EXCHR	Exchange Rate	-7.394961	-2. 963972	1(1)
INFLA	Inflation rate	-5.945844	-2. 963972	1(0)

Source: Author's computation

In the table 3, the variables that were tested with unit root are shown, the values for Augmented Dickey Fuller (ADF) statistics are presented, the lag level of each variable was identified, and the P-values at 5% level of significant were pointed out. The order of integration of each variable was enumerated. The test detected that economic growth (RGDP); natural gas energy (GAS), petroleum/crude oil energy (CRUDE) and exchange rate (EXCHR) were stationary at first difference while inflation rate (INFLA) and coal energy (COAL) were stationary at level. It is now referable to use autoregressive distributive lag model to estimate the parameters.

Co-integration Test Results

Ho = There is no co-integration (no long run relationship among Variable)

Table 4: ARDL Bound Co-integration Test Results

ARDL Bounds Test		
Date: 03/15/23 Time: 16:34		
Sample: 1993 2022		
Included observations: 30		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	6.576029	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

***Source*:** E-view Results

The co-integration result in table 4.3 for the model real gross domestic product (RGDP); natural gas energy (GAS), petroleum/crude oil energy (CRUDE), inflation rate (INFLA), coal energy (COAL) and exchange rate (EXCHR) reveal that there is a long-run relationship among the variable RGDP; GAS, CRUDE, EXCHR, INFLA and COAL) since f-statistic (6.576029) is greater than 5% lower and upper bounds critical value (3.79). We therefore reject the null hypothesis of no co-integration amongst the variables and accept the alternative hypothesis.

Estimation of Regression Model

Table 5: Empirical Results of the ARDL

ARDL Cointegrating And Long Run Form				
Dependent Variable: LOGRGDP				
Selected Model: ARDL(1, 0, 0, 0, 0, 0)				
Date: 03/15/23 Time: 16:53				
Sample: 1992 2022				
Included observations: 30				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGCRUDE)	0.286534	0.054903	5.219203	0.0051
D(LOGGAS)	0.126890	0.047136	2.691972	0.0130
D(LOGCOAL)	0.053388	0.032741	1.630625	0.1166
D(INFLA)	-0.004071	0.002405	-1.692755	0.1040
D(EXCHR)	-0.004160	0.001716	-2.423401	0.0237
CointEq(-1)	-0.070583	0.070825	-0.996588	0.3293
Cointeq = LOGRGDP - (+ 0.205665*LOGCRUDE + 0.476079*LOGGAS + 0.2684				
*LOGCOAL + 0.0577*INFLA + 0.0589*EXCHR + 19.6256)				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGCRUDE	0.205665	0.026226	7.842065	0.0039
LOGGAS	0.476079	0.084009	5.667005	0.0051
LOGCOAL	0.268425	0.067741	3.962520	0.0078
INFLA	0.057672	0.081254	0.709779	0.4850
EXCHR	-0.058932	0.065789	-0.895764	0.3797
C	19.625571	12.104225	1.621382	0.1186

***Source*:** E-view Results

The result of the regression analysis represents the model for impact of non-renewable energy on economic growth in Nigeria. The empirical result shows that the coefficient of petroleum/crude oil energy (CRUDE) has positive and significant impact on real gross domestic product (RGDP) because its probability value of 0.0051 was less than 0.05 in short run but it was positive and significant impact on real gross domestic product (RGDP) because its probability value of 0.0039 was greater than 0.05 in long run. The natural gas energy (GAS) has positive and significant impact on real gross domestic product (RGDP) its probability value of 0.0130 was less than 0.05 but it was positive and significant impact on real gross domestic product (RGDP) its probability value of 0.0051 was less than 0.05 in long run. The coal energy (COAL) has positive and insignificant impact on real gross domestic product (RGDP) because its probability value of 0.1166 was greater than 0.05 but it was positive and significant impact on real gross domestic product (RGDP) because its probability value of 0.0078 was less than 0.05. The exchange rate (EXCHR) has negative and significant impact on real gross domestic product (RGDP) because its probability value of 0.0237 was less than 0.05 in short run but it was negative and insignificant impact on real gross domestic product (RGDP) because its probability value of 0.3797 was greater than 0.05 in long run. The inflation rate (INFLA) has negative and insignificant impact on real gross domestic product (RGDP) because its probability value of 0.1040 was greater than 0.05 in short run but it was positive and insignificant impact on real gross domestic product (RGDP) because its probability value of 0.4850 was greater than 0.05 in long run.

Econometric /Second Order Test
The null hypothesis; there is no autocorrelation Problem

Table 7: Result of Breuch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.933235	Prob. F(2,21)	0.4090
Obs*R-squared	2.448742	Prob. Chi-Square(2)	0.2939
Test Equation:			
Dependent Variable: RESID			
Method: ARDL			
Date: 03/15/23 Time: 17:20			
Sample: 1993 2022			
Included observations: 30			
Presample missing value lagged residuals set to zero.			

***Source*:** Author's Computation from E-view 9

The Breuch-Godfrey Serial correlation LM Test was used to identify whether the model suffers from autocorrelation problem. The autocorrelation problem violates ordinary least squares assumption that says there is no correlation among error terms of different observation. Breuch-Godfrey Serial correlation LM Test is a statistic that ensures that the assumption of ordinary least squares was not violated. The f-statistic result of Breuch-Godfrey Serial correlation LM Test is (0.933235) and it P-value is (0.4090). From the results of the above test, the probability values for Lagrange multiplier (LM) test (0.4090) is greater than 0.05. We accept the null hypothesis and reject alternative hypothesis. This implies that there is no serial correlation problem.

Result of Ramsey Reset Test
The null hypothesis; there is no Specification Error.

Table 8: Result of Ramsey Reset Test

Ramsey RESET Test			
Equation: UNTITLED			
Specification: LOGRGDP LOGRGDP(-1) LOGCRUDE LOGGAS LOGCOAL INFLA EXCHR C			
Omitted Variables: Squares of fitted values			
	Value	df	Probability
t-statistic	0.262464	22	0.7954
F-statistic	0.068887	(1, 22)	0.7954
F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	0.001383	1	0.001383
Restricted SSR	0.442997	23	0.019261
Unrestricted SSR	0.441614	22	0.020073
Unrestricted Test Equation:			
Dependent Variable: LOGRGDP			
Method: ARDL			
Date: 03/15/23 Time: 17:26			
Sample: 1993 2022			
Included observations: 30			
Maximum dependent lags: 1 (Automatic selection)			
Model selection method: Akaike info criterion (AIC)			
Dynamic regressors (0 lag, automatic):			
Fixed regressors: C			

***Source*:** Author's Computation from E-view 9

This second order test checks whether the model of the study suffers model specification error. The null hypothesis; there is no model specification error. From the results of the Ramsey Reset test, the probability values (0.7954) for Ramsey Reset's t-statistics is greater than 0.05. We accept null hypothesis and reject alternative hypothesis. This implies that model include core variables in the model. It does not include superfluous variables. The functional form of the model is very well specified, there is no error of measurement in the regressand and regressors.

Summary of Findings

The following are the major findings of the study**:**

1. Petroleum/crude oil energy has 28% positive and significant impact on economic growth in short run (Probability value of 0.0051 < 0.05) but it was 20% positive and significant impact on economic growth in long run (Probability value of 0.0039 > 0.05). Petroleum/crude oil energy has 28 percent positive and significant impact on economic growth in short run. A percent change in government education expenditure results to 28 percent increase in economic growth in short run. Again, petroleum/crude oil energy has 20 percent positive and significant impact on economic growth in long run. A percent change in petroleum/crude oil energy results to 20 percent significant increase in economic growth in long run.
2. Natural gas energy has 12 % positive and significant impact on economic growth in short run (Probability value of 0.0130 < 0.05) but it was 47 % positive and significant impact on economic growth in long run (Probability value of 0.0051 < 0.05). A percent change in natural gas energy results to 12 percent increase in economic growth in short run. Again, natural gas energy has 47 percent positive and significant impact on economic growth in long run. A percent change in natural gas energy results to 47 percent significant increase in economic growth in long run.
3. Coal energy has 5 % positive and insignificant impact on economic growth in short run (Probability value of 0.0130 > 0.05) but it was 26 % positive and significant impact on economic growth in long run (Probability value of 0.0078 < 0.05). A percent change in coal energy results to 5 percent increase in economic growth in short run. Again, coal energy has 26 percent positive and significant impact on economic growth in long run. A percent change in coal energy results to 26 percent significant increase in economic growth in long run.

Conclusion

This study concludes that there is impact of non-renewable energy on economic growth in Nigeria. The non-renewable energy consumption per capita in Nigeria is very small - about one-sixth of the energy consumed in developed countries. This is directly linked to the level of poverty in the country. The energy deficiency is one of the non-energy factors instigating poor economic growth, extreme and moderate poverty, income inequity, unemployment, and underemployment rates among others in Nigeria. Poor energy management practices have also resulted in energy-deficiency in the urban, suburban, and rural areas while increasing extreme poverty rate, unemployment rate, high business utility cost, crowding-out of multinational companies, and overall poor economic growth among others. Energy consumption patterns in Nigeria have the lowest rates of consumption. Nevertheless, Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy. Paradoxically, the country is potentially endowed with sustainable energy resources. Nigeria is rich in conventional energy resources, which include oil, national gas, lignite, and coal.

Recommendations of the Study

Based on the findings of this study, the following recommendations were made.

1. Government of Nigeria should encourage entrepreneurs to invest and/or facilitate human capital accumulation to promote the use of coal energy sources in producing goods and services. More emphasis should be placed on legal and regulatory policies that enhance the complementarity between human capital and coal energy consumption for sustainable development in Nigeria.
2. Government of Nigeria should formulate policy foster the use of non-renewable energy petroleum energy and continue to push companies that do so by offering incentives such as tax breaks or subsidies. They should also increase trade openness by creating a good economic environment for business.

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