WEST AFRICAN JOURNAL OF BUSINESS AND MANAGEMENT SCIENCES
FACULTY OF BUSINESS ADMINISTRATION
IMO STATE UNIVERSITY, OWERRI
NIGERIAN EDITION
VOL. 10 NO. 2 JUNE 2021

ENERGY CONSUMPTION AND ECONOMIC GROWTH IN NIGERIA: A VECTOR ERROR CORRECTION MODEL

LAWAL. ESTHER
Babcock University, Nigeria
Department of Economics

MUSA, DASAUKI
Babcock University, Nigeria
Department Of Economics

And

EHIJELE, CLINTON
Babcock University, Nigeria
Department of Economics

Abstract

The study examined the relationship between energy consumption on economic growth in Nigeria, using the Vector Error Correction Model (VECM). Annual time series data were gathered from the World Bank and the Central Bank of Nigeria from 1980-2018. The result showed that there is a positive relationship between energy consumption and economic growth. There is need for policies the improve power conditions in Nigeria. Energy conservation policies should be put in place in such a way that the growth ambition of the country will not be compromised.

Keywords: Urbanization, Vector error correction model, oil price, Gross domestic product (GDP), World Bank.

Introduction

The role of energy in developed and developing countries cannot be overemphasized. It is the driving force behind any industrial generation and several activities in any economy. When energy is stable in an economy, it can increase technological utilization and vice visa (Onakoya et al., 2013). Energy consumption is low due to low the generation capacity of the Country and this has caused a drawback to the development of the country.

The most critical metric of the energy balance of Nigeria is the net consumption of 24.72bn kWh of electric energy per year. Per household, this is an estimate of 123 kWh. The combined production of all-electric energy generating facilities is 29 billion kWh in 2018, energy net consumption increased from 8.36 billion kWh in 1999 to 29.1 billion kWh in 2018 growing at an average annual rate of 7.56% which is also 119 % of the country's own needs.

The contribution of Nigeria's urbanization to GDP has been increasing over time.

There is no question that the world is being rapidly urbanized, and the twentieth century saw massive and unprecedented urbanization. The urban population rose from 13% in 1900 to 29% in 1950, 49% in 2005, and it is expected that by 2030, 60% of the world's population will live in cities. This trend reflects the growth of the urban population, which has risen from 220 million in 1900 to 732 million in 1950 and is projected to reach 4.9 billion by 2030. (Annual urban growth rate of 1.8%). This pattern reflects the rise of the urban population, from 220 million in 1900 to 732 million by the year 1950, and 4.9 billion urban dwellers are projected by 2030.

Electricity in Nigeria has added to the overall gross domestic product, but the country also faces many electricity supply problems. The power industry has not been able to satisfy the country's electricity demand, and this has caused many issues as it affects economic development. Most people in Nigeria require fossil fuel and wood for fuel (firewood), and the Overdependence on fossils and fuel wood (used mostly by poor rural commuters) has not provided the adequate capacity to satisfy the energy demands. Since energy has become the main feature of any nation's economic development, it increases the country's production and productivity.

The use of more oil, particularly in developing countries such as Nigeria, has been increased by extensive industrialization, urbanization, and growing population size. In the recent decade, there has been a large analysis of the relationship between energy use and development in Sub-Saharan Africa. Furthermore, the electricity subsector of the energy sector has been a key cause of concern for Nigerians. Electricity generation falls well short of the national standard. Nigeria produces less than 5000MW for a population of more than 170 million people. As a result, the majority of the country is reliant on personal generators and, to a lesser extent, inverters and solar for a small fraction of middle- and upper-income earners who can afford it.

According to the World Bank (2015), Nigeria's total energy generation increased over the previous decade, rising from 14.73 billion kilowatthours in 2000 to 27.03 billion kilowatt hours in 2011, a 54.5 % increase. However, this has had little effect on the electrical situation. The share of total power generation from hydroelectric sources fell from 38.2 % in 2000 to 20.9 % in 2011. The ratio of total power output to natural gas and oil sources, on the other hand, improved from 60.3 and 1.5 % in 2000 to 63.3 and 15.8 % in 2011. When it comes to renewable energy sources, the contribution from the year 2000 to the year 2004 was 5.6 billion kilowatthours, whereas the contribution from 2005 to 2013 was 7.8 billion kilowatthours. In Nigeria, private sector energy investment grew significantly from US$295 million in 2001 to US$828 million in 2005, before the global financial crisis.

The goal of this study is to examine the relationship between energy consumption, and economic growth in Nigeria. The rest of this paper is structured as follows. Section 2 will contain the review of literature; Section 3 is the methodology, data and estimation technique while section 4 and 5 contains the discussion of result and conclusion respectively.

Literature

Olusegun, (2020) research explores the relationship between energy consumption and economic development, using Nigerian annual time series data from 1970-2005. Using the non-causality approach to testing causality and co-integration based on Autoregressive Distributed

Lag (ARDL) and Toda and Yamamoto (1995), the causality is determined. The study suggests the Nigerian Government should ensure significant investment in the energy sector, especially in the growth of energy infrastructure, to grow energy demand through the availability, accessibility, and affordability of energy services.

Ekeocha et al., (2020) use alternative model specifications to re-evaluate the relationship between energy consumption and economic growth in Nigeria over the 1999-2016 period. Therefore, the research findings constitute a wake-up call on Nigerian and other sub-Saharan economies that share systemic similarities to develop and adopt policies to meet these economies' energy challenges.

Chinedu et al., (2019) investigated the impact of energy utilization on economic growth over the time frame from 1980 to 2017. The error-correction model was the strategy for analysis. The investigation inferred that Nigeria's economic growth is influenced by energy utilization. Consequently, this investigation recommends that organizations responsible for oil refining and transport should expand oil accessibility all through the nation by connecting the significant urban communities with pipelines.

Zakaria, (2018) investigates the interconnections between energy utilization and economic growth in the best ten nations that devour energy, i.e., Germany, China, the United States, Russia, India, Japan, Canada, Brazil, France, and South Korea, Using a quantile-on-quantile approach. The discoveries of this examination propose that the negative/low impact of financial development on lower-quantile energy utilization in China, India, Germany, and France is reflected in the way that lower-quantile energy utilization is a lower need and more center is paid to energy utilization as economics growth ascends at more elevated levels of yield. Personal & Archive, (2018) explores the non-linear asymmetric relationship between energy consumption and economic growth by transforming government expenditures and oil prices into an output function using the Nigerian economy from 1980 to 2014. They stated that there is evidence of a positive relationship between energy consumption and economic growth in Nigeria.

Mustapha, (2015) re-examines the causal relationship between energy consumption and economic growth in a multivariate context using Nigerian data from 1980 to 2011 using Labour and capital to study causality. Applying the Granger causality test, a survey of impulse response and variance decomposition; the causality test's findings reported the absence of causality, and decomposition of variance showed that capital and Labour are more significant than energy consumption influencing production growth.

Dogan, (2015) Using time-series econometrics, investigate the causal relationship between energy use and economic growth in four low-income countries in Sub-Saharan Africa. The findings of the ADF Root Test demonstrate that the time series for both countries are not stationary at any point in time. The findings of the Johansen Co-integration Test, on the other hand, show that the variables LEC and LGR for Kenya and Zimbabwe are not co-integrated, indicating that these variables have no long-term association in either area.

Yakubu & Jelilov, (2015) investigates the causality between energy consumption and economic development. The study shows that causality runs in Nigeria from energy consumption to total capital accumulation, and causality also runs from economic growth to energy consumption, but not vice versa. This study concluded that energy-saving policies could be successfully implemented without affecting Nigeria's economic development.

Abalaba, (2013) researchers looked at the long-run relationship and trajectory of causality between energy consumption and economic growth. The findings revealed that all of the factors in the sample had a positive pattern. As a result, the report concluded that while energy demand has a short-term positive effect on the economy, it has not boosted Nigeria's long-term economic growth during the study period.

Onakoya et al., (2013) analyzed the empirical research from 1975 to 2010, which examined the impact of energy consumption and Nigeria's economic increase. Using ordinary least square techniques, the results show that total energy demand had a similar pattern with economic growth in the long run, except for coal use. As a result, the study recommends that the Government diversify its power generation portfolio to create a level field for all available energy sources in the region.

Ouedraogo, (2013) Using new panel co-integration approaches; this study examines the long-term relationship between energy access and economic growth for ECOWAS from a panel perspective from 1980 to 2008. The Research shows that long-term GDP, energy use, and GDP, as well as electricity, move together. About the short-term data dynamics, the analysis showed that ECOWAS is optimistic and statistically important for the short-term effect of economic growth on energy consumption.

Olumuyiwa, (2012) investigates the drawn-out connection between energy utilization and financial development in Nigeria from 1985 to 2010. The exploration utilizes the OLS for various relapse investigations. The primary discoveries of the examination are that real GDP has a positive relationship with oil and also has a positive relationship with power.

Yildirim & Aslan, (2012) explores the relationship between energy usage, economic development, employment, and gross fixed capital creation for 17 highly developed OECD countries. The research concluded that there are bidirectional causal links between energy consumption and actual GDP for Italy, New Zealand, Norway, and Spain.

Johnson, (2011) used a multiple regression model for 1985-2009 to assess the relationship between human capital development and economic growth. The study show evidence that systematically and scientifically that human resources production is having a positive effect on economic growth.

Jude, (2011) aims to provide new analytical data for 21 African countries from 1970 to 2006 on the relationship between energy use and economic development. Using recently created panel co-integration and causality measures. The study showed that a long-term balance exists between energy consumption, real GDP, the index of consumer prices, Labour, capital for each group of countries, and the entire group of countries.

Soytas et al., (2010) by using both the Toda-Yamamoto procedure and the bootstrap-corrected causality test, discusses the effects of energy use and production on carbon emissions in the United States. We were able to discover that, in the long run, Granger's income does not cause greenhouse emissions in the US, but electricity consumption does.

Ewah et al., (2009) analyze Nigeria's economic growth impact of capital market results using time-series data from 1961 to 2004 on market capitalization, cash supplies, interest rate, market total operation, and government output stock. The study showed that the capital market in Nigeria could lead to growth but it did not make a significant contribution to economic growth in Nigeria.

Apergis & Payne, (2009) explores the association between energy consumption and economic growth in eleven Commonwealth of Independent States (CIS) countries. The result shows that unidirectional causality from energy consumption to short-term economic growth. In contrast, bidirectional causality between energy usage and longer-lasting economic growth by applying the error correction model.

Mohsen Mehrara (2007) explores the causal association between per capita energy demand and per capita GDP. Panel unit-root experiments and co-integration methods were used in this study. The study concluded an exact one-way trigger for energy consumption varying from GDP and without feedback effects for countries supplying petroleum, so the electricity consumption is powered on a GDP basis, not vice versa.

Methodology

The data used in this study were obtained from the Central Bank of Nigeria statistical bulletin and World Development Indicators from the years 1980 to 2016, covering 36 years. The variables in the study include GDP, energy consumption, population, urbanization, oil price. These data will be analysed using the Vector Error Correction Model (VECM).

The following model is defined to analyze the relationship between energy consumption and economic growth, as the variables have been explained above. Functionally speaking;

y = f(x)……………………………………. (1)

RGDP = f (EC, POP, URB, OP)…………. (2a)

EC = f (RGDP, POP, URB, OP) …………. (2b)

In a linear econometric form, the model can be expressed as;

RGDP = $\beta_0 + \beta_1$EC + β_2POP+ β_3URB + β_4OP + μ_t ………………… (3a)

EC = $\beta_0 + \beta_1$RGDP + β_2POP+ β_3URB + β_3OP+ μ_t …………… ……. (3b)

RGDP ⇒ Real Gross Domestic Product

EC ⇒ Energy Consumption

POP ⇒ Population

URB ⇒ Urbanization

OP ⇒ Oil price

Where;

β_0 is the intercept, which is the value of GDP, EC, POP, URB, and OP when all the independent variables are zero. β_1, β_2, β_3, and β_4 are the Coefficients of the Independent Variables μ_t signifies error term concerning period t. Meanwhile, due to the four variables' high values (in billions), all the variables would be logged in the model to prevent the regression from having a spurious outcome. Thus, we have the equation as:

$$LogRGDP = \beta_0 + \beta_1 LogRGDP_{t-1} + \beta_2 LogEC + \beta_3 LogPOP + \beta_4 LogURB + \beta_5 LogOP + \mu_t \dots\dots\dots\dots\dots 4(a)$$

$$LogEC = \beta_0 + \beta_1 LogEC_{t-1} + \beta_2 LogRGDP + \beta_3 LogPOP + \beta_4 LogURB + \beta_5 LogOP + \mu_t \dots\dots\dots\dots\dots 4(b)$$

$$\Delta GDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 EC_{t-1} + \beta_3 POP_{t-1} + \beta_4 URB_{t-1} + \beta_5 OP_{t-1} + \sum_{i=1}^{P} \alpha_1 \Delta EC_{t-1} + \sum_{i=1}^{q} \alpha_2 \Delta POP_{t-1} + \sum_{i=0}^{r} \alpha_3 \Delta URB_{t-1} + \sum_{i=1}^{v} \alpha_4 \Delta OP_{t-1} + \mu_t \dots\dots\dots\dots\dots (5a)$$

$$\Delta EC_t = \beta_0 + \beta_1 EC_{t-1} + \beta_2 GDP_{t-1} + \beta_3 POP_{t-1} + \beta_4 URB_{t-1} + \beta_5 OP_{t-1} + \sum_{i=1}^{P} \alpha_1 \Delta GDP_{t-1} + \sum_{i=1}^{q} \alpha_2 \Delta POP_{t-1} + \sum_{i=0}^{r} \alpha_3 \Delta URB_{t-1} + \sum_{i=1}^{v} \alpha_4 \Delta OP_{t-1} + \mu_t \dots\dots\dots\dots\dots (5b)$$

$\beta_1 - \beta_5$ ⇒ represents the long-run parameter to be estimated. They tell the impact of $GDP_{2,t-1}, EC, POP, URB\ and\ OP\ respectively\ on\ GDP_{2t}$.
$\alpha_1 - \alpha_4$ ⇒ Short-run parameter to estimated. They show the short-run impact of $GDP_{2,t-1}, EC, POP, URB\ and\ OP\ respectively\ on\ GDP_{2t}$.
P, q, r, v ⇒ maximum lag length to be determined based on SIC lag
µ (Random Error Term) this is the stochastic variable that is used in a model to account for variables that have been omitted in the model but influence the dependent variables. A random error has its probabilistic features. It is also expected to be white noise, i.e., zero mean and continuous variance.

4. RESULT

Results of the Estimated VECM Long-Run

Cointegrating Eq:	CointEq1
LGDP(-1)	1.000000
LEC(-1)	0.008209 (0.08967) [0.09155]
LURB(-1)	-0.822683 (0.21546) [-3.81823]
LOP(-1)	-0.146397 (0.03426) [-4.27366]
C	-3.992279

Standard errors in ( ) & t-statistics in [ ]
*, **, *** represents statistical significance at 10%, 5% and 1% respectively

VECM Short-Run Result

Error Correction:	D(LGDP)	D(LEC)	D(LURB)	D(LOP)
CointEq1	-0.582683***	0.614870	-0.019768*	-

				0.287674
	(0.10503)	(0.54302)	(0.01071)	(1.18382)
	[-5.54769]	[1.13231]	[-1.84563]	[-0.24300]
D(LGDP(-1))	-0.002429	0.771988	-0.018636	-1.544169
	(0.12245)	(0.63307)	(0.01249)	(1.38013)
	[-0.01984]	[1.21943]	[-1.49244]	[-1.11886]
D(LGDP(-2))	0.300040***	-0.186014	-0.003371	2.301277*
	(0.11354)	(0.58703)	(0.01158)	(1.27977)
	[2.64249]	[-0.31687]	[-0.29116]	[1.79820]
D(LEC(-1))	0.007281	-0.332894	0.000881	-0.806800*
	(0.03980)	(0.20578)	(0.00406)	(0.44862)
	[0.18293]	[-1.61769]	[0.21696]	[-1.79841]
D(LEC(-2))	0.002837	-0.364731*	0.001152	-0.262125
	(0.04025)	(0.20810)	(0.00410)	(0.45366)
	[0.07050]	[-1.75269]	[0.28065]	[-0.57780]
D(LURB(-1))	3.665708*	0.855153	0.862481***	19.22767
	(2.01322)	(10.4086)	(0.20530)	(22.6912)
	[1.82082]	[0.08216]	[4.20106]	[0.84736]
D(LURB(-2))	2.499313	-4.477532	0.146234	-12.09849
	(2.23562)	(11.5584)	(0.22798)	(25.1979)
	[1.11795]	[-0.38738]	[0.64143]	[-0.48014]
D(LOP(-1))	-0.035024	-0.020908	-0.001811	0.152002
	(0.02355)	(0.12174)	(0.00240)	(0.26540)
	[-1.48743]	[-0.17175]	[-0.75423]	[0.57274]
D(LOP(-2))	-0.029800	0.005527	-0.001043	-0.191922
	(0.02244)	(0.11601)	(0.00229)	(0.25291)
	[-1.32805]	[0.04764]	[-0.45598]	[-0.75886]
C	-0.124450***	0.129860	-0.000437	-0.103451
	(0.02696)	(0.13939)	(0.00275)	(0.30388)
	[-4.61597]	[0.93163]	[-0.15882]	[-0.34044]

Standard errors in ( ) & t-statistics in [ ]
*, **, *** represents statistical significance at 10%, 5% and 1% respectively

The error correction term (ECT-1) is negative and statistically significant indicating that the deviations from the long-run equilibrium are corrected in the current period as an adjustment speed of -0.582683 for LGDP. A percentage change in LEC is associated with a 0.007281 increase in LGDP on the average ceteris paribus in the short run. In lag (1) and lag (2) period has a positive relationship but is not statistically significant. In lag (2) period of LGDP has a positive and statistically significant impact of 0.300040 on GDP on an autoregressive effect, so GDP impact itself but lag(1) is not statistically significant and it is negative.

An increase in Energy consumption will lead to an increase in the production of energy to meet up with the demand for energy in the economy. This increases revenue gotten from energy and hence increases GDP. A percentage change in LURB is associated with a 3.665708 increase in LGDP on the average ceteris paribus in the short run. In the lag (1) period positively significant and the lag also positive but not significant. When people move from the rural to the urban area it tends to increase innovation, industrialization and also increases the consumption level which leads to an increase in the production level in an economy.

An increase in oil prices will lead to a high cost of production of goods and services which will reduce the purchasing power of an individual in the economy, and hence reduce the level of consumption and will decline the GDP of that economy. The results showed that the change in LOP with the impact of -0.035024 decrease on LGDP on average in the short run. It is negative in the first lag period and also negative in the second lag period. It was not statistically significant at any of the lag periods.

In the current period, the previous year's deviation from the long-run equilibrium is corrected as an adjustment speed of 0.614870 for LEC, according to the coefficient relating to the VECM term. In the short run, a percentage change in LGDP is associated with a 0.771988 increase in the lag (1) period and is not significant, whereas a -0.186014 decrease in the lag (2) period is positively significant on LEC on average ceteris paribus. According to the findings, a change in LURB with an impact of 0.855153 increases LEC on average in the short run. It is positive during the first lag period and negative during the second. At any of the lag periods, it was not statistically significant.

The Breusch-Pagan-Godfrey heteroscedasticity tests revealed the absence of heteroscedasticity in the model. The Breusch-Godfrey Serial Correlation Lm test for autocorrelation revealed the presence of positive autocorrelation in the model. The normality tests revealed that the variables were normally distributed.

Conclusion

The result showed that there is a positive relationship between energy consumption and economic growth. That means if the consumption of energy increases economic growth will also increase. The result showed that there is a positive relationship between urbanization and economic growth. Urbanization brings innovation and industrialization to an economy and this will increase the economic growth of a nation. The result showed that there is a negative relationship between oil prices and economic growth and it is not significant.

The government should diversify the energy mix in the country to increase energy security. Solar, wind, and other sources of renewable energy will help diversify the energy mix and will hedge the nation from the spill-over effect of any negative shock that negatively affects energy consumption and economic growth. There is a need for policies that will create a favourable business climate and attract foreign direct investment (FDI) into the energy industry to boost the power supply. Barriers to entry should be removed to promote competition among electricity generating companies and distribution companies.

References

Ã, M. M. (2007). *Energy consumption and economic growth : The case of oil-exporting countries*. *35*, 2939–2945. https://doi.org/10.1016/j.enpol.2006.10.018

Abalaba, B. P. (2013). *Energy Consumption and Economic Growth Nexus : New Empirical Evidence from Nigeria*. *3*(4), 412–423.

Apergis, N., & Payne, J. E. (2009). Energy consumption and economic growth : Evidence from the Commonwealth of Independent States. *Energy Economics*, *31*(5), 641–647.

https://doi.org/10.1016/j.eneco.2009.01.011

Chinedu, U. A., Daniel, O. C., Ezekwe, U. C., & Chinedu, U. A. (2019). *Impact of Energy Consumption on Economic Growth in Nigeria : An Approach of Time Series Econometric Model Impact of Energy Consumption on Economic Growth in Nigeria : An Approach of Time Series Econometric Model*. *8*(2), 65–77. https://doi.org/10.6007/IJAREMS/v8-i2/6203

Dogan, E. (2015). *Energy Consumption and Economic Growth : Evidence from Low-Income Countries in Sub-Saharan Africa Energy Consumption and Economic Growth : Evidence from Low-Income Countries in Sub-Saharan Africa*. *April 2014*.

Ekeocha, P. C., Penzin, D. J., & Ogbuabor, J. E. (2020). *Energy Consumption and Economic Growth in Nigeria : A Test of Alternative Specifications*. *10*(3), 369–379.

Ewah, S. O. E., Esang, A. E., & Bassey, J. U. (2009). *Appraisal of Capital Market Efficiency on Economic Growth in Nigeria*. 219–228.

Johnson, O. (2011). *Human Capital Development and Economic Growth in*. *3*(9), 29–39.

Jude, C. (2011). *CESifo Working Paper no. 3590*.

Mustapha, A. M. (2015). *Energy Consumption and Economic Growth in Nigeria : A Causality Analysis*. *6*(13), 42–54.

Olumuyiwa, S. (2012). *Longrun Relationship Between Energy Consumption And Economic Growth : Evidence From Nigeria. 3*(3), 40–51.

Olusegun, O. A. (2020). *Energy Consumption and Economic Growth in Nigeria : A Bounds Testing Cointegration Approach*. *2*(4), 118–123.

Onakoya, A. B., Onakoya, A. O., & Odedairo, B. O. (2013). *ENERGY CONSUMPTION AND NIGERIAN ECONOMIC GROWTH : AN EMPIRICAL ANALYSIS*. *9*(4), 25–40.

Ouedraogo, N. S. (2013). Energy consumption and economic growth : Evidence from the economic community of West African States (ECOWAS). *Energy Economics*, *36*, 637–647. https://doi.org/10.1016/j.eneco.2012.11.011

Personal, M., & Archive, R. (2018). *Munich Personal RePEc Archive Economic growth, energy consumption, and government expenditure : evidence from a nonlinear ARDL analysis*. *87527*.

Soytas, U., Sari, R., & Ewing, B. T. (2010). *Energy consumption, income, and carbon emissions in the United States*. *2*, 2–9. https://doi.org/10.1016/j.ecolecon.2006.07.009

Yakubu, M. M., & Jelilov, G. (2015). *Economic Growth and Energy Consumption in Nigeria*. *14*(December).

Yildirim, E., & Aslan, A. (2012). Energy consumption and economic growth nexus for 17 highly developed OECD countries : Further evidence based on bootstrap-corrected causality tests. *Energy Policy*, *51*, 985–993. https://doi.org/10.1016/j.enpol.2012.09.018

Zakaria, M. (2018). *Munich Personal RePEc Archive The Energy Consumption and Economic Growth Nexus in Top Ten Energy-Consuming Countries : Fresh Evidence from Using the Quantile-on-Quantile Approach*. *84920*.