Akinwale, Yusuf Opeyemi

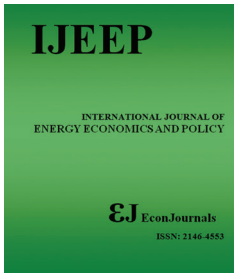
Article

Energy consumption, trade openness and economic growth : empirical evidence from Nigeria

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Akinwale, Yusuf Opeyemi (2021). Energy consumption, trade openness and economic growth : empirical evidence from Nigeria. In: International Journal of Energy Economics and Policy 11 (6), S. 373 - 380. https://www.econjournals.com/index.php/ijeep/article/download/11617/6139. doi:10.32479/ijeep.11617.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(6), 373-380.

Energy Consumption, Trade Openness and Economic Growth: Empirical Evidence from Nigeria

Yusuf Opeyemi Akinwale*

Department of Economics, College of Business Administration, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia.
*Email: yoakinwale@iau.edu.sa

Received: 19 May 2021 **Accepted:** 22 August 2021 **DOI:** https://doi.org/10.32479/ijeep.11617

ABSTRACT

This paper explores the link between energy consumption, trade openness and economic growth in Nigeria between 1971 and 2015 using Vector error correction model (VECM). The result of Johansen co-integration test shows that the three series are co-integrated, hence long-run relationship was established among them. Causality analysis in VECM shows that there is a long run causality from economic growth and trade openness to energy consumption as well as from economic growth and energy consumption to trade openness. The results of the short run causality indicate the Granger causality from economic growth to trade openness only. These outcomes suggest that trade openness could be boosted by improving production in all sectors of the economy and not the other way round. Also, decisive improvement in economic activities would lead to increase in energy use in the country as the size of the current energy consumption is too weak to cause economic expansion in Nigeria. Furthermore, due to the huge energy gap between demand and supply, Nigerian government should utilise the low carbon energy options towards a sustainable economic growth trajectory.

Keywords: Economic Growth, Vector Error Correction Model, Energy Consumption, Co-Integration, Trade Openness
JEL Classifications: C01, F14, F41, Q43

1. INTRODUCTION

Globalisation has brought countries that are far apart to be close to one another which have made the exchange of goods and services easier and cheaper through international trade. Arguments abound about the contribution that trade has made towards economic growth in different countries but this is yet concluded. Energy usage and consumption has been recognised to play a significant role towards the production of goods and services which improve trade and economic activities in a country. Energy is seen as an important resource that each and every sector of the economy requires to add values to goods and services it produces. Since energy is viewed as an important element of modern life, its usage creates a strong base for economic development (Hasson and Masih, 2017), because it would engender wealth creation, higher standard of living and a sustainable economic development. International trade motivates economic activities which call for more energy usage (Kyophilavong et al., 2015). Most of the emerging economies are transiting from agricultural-based sector towards industrial sector which further requires additional energy demand, though newly imported technologies which could cause low-energy intensity is also possible through trade openness (Ohlan, 2018). Energy is considered as an essential factor in the production and distribution of goods. Attaining the sustainable development goals (SDGs) like high literacy rates, food security and poverty reduction among others, require a regular energy supply and usage without which these goals would remain a mere paper goals (Akinwale and Ogundari, 2017). Inadequate access to energy in sub-Saharan African in general and Nigeria in specific, despite the abundance of various natural resources, is appalling. Although there have been studies between energy use and economic growth with differing outcomes in the past research studies (Dorgan, 2016; Ozturk and Acaravci, 2013; Lean and Smyth, 2010) but the link between energy use, trade

and economic growth is yet to be widely studied especially in Africa. The framework for developing an efficient energy and environmental policy is consequent upon comprehending the connection between energy consumption, trade and output in an economy (Sadorsky, 2011; 2012).

There are many rationales that give credence to the study of linkage between energy consumption and trade. For instance, if energy use is established to engender trade, then energy conservation policies intended to decrease greenhouse gas emissions will impair trade due to the reduction in energy consumption which lessen the benefits of trade (Akinwale and Muzindutsi, 2019). This creates a conflicting interest between energy reduction policies and trade liberalization policies (Sadorsky, 2012). Suppose no relationship exist between them or a unidirectional Granger causality from trade to energy is stablished, then energy conservation policies will have no effect on any trade liberalization strategies aimed to improve economic growth. The same explanation goes for the association between energy consumption and economic growth. More so, trade liberalization could serve as a stimulant to domestic production causing an improvement to economic development and foreign trade which enables less developed countries to import advance technologies from industrialised countries (Nasreen and Anwar, 2014). Empirical studies have found differing results for different countries without a general consensus of what the direction of causality should be. Against this background, an assessment of the presence and direction of a causal relationship between energy consumption, trade openness and economic growth in Nigeria has important implications towards formulating and implementing robust energy policies.

2. LITERATURE AND EMPIRICAL REVIEWS

This section discusses the energy usage, international trade and economic situation of Nigeria as well as the empirical studies relating to the study.

2.1. Energy Consumption, International Trade and Economic Growth Situation of Nigeria

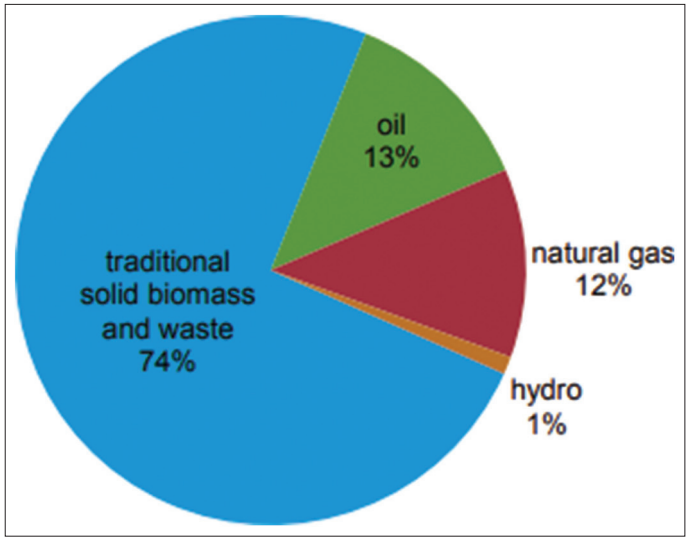
Energy has been recognised as the lubricant for sustainable economic development (Ohlan, 2018), and access to energy is essential for achieving industrialisation in any economy. Energy commodities foster economic development by improving the country's level of productivity, income and employment generation (Akinwale and Muzindutsi, 2019; Nasreen and Anwar, 2014). The emerging economies including Nigeria were able to improve the wellbeing of citizens in the 1990s as a result of economic development which arises through important role that energy played in market liberalisation and globalisation (Central Bank of Nigeria, 2015).

Nigeria is endowed with both non-renewable fossil fuels and renewable energy. Nigeria is among the world top ten largest producers of crude oil and gas. Despite the abundance of the energy resource in Nigeria, the country still experience deficiency in energy consumption (Akinwale and Ogundari, 2017). The total crude oil domestic refining capacity in Nigeria is 445,000 barrels per day (bpd) from the three main refineries (Portharcourt, Warri and Kaduna), meanwhile they all operate below 30% of the capacity which ordinarily fall below the daily needs (532,000 barrels per day) of the country as at December 2019 (Knoema, 2020). However, an insignificant amount of 98,108 and 110,508 bpd was refined in 2004 and 2014 as a result of poor utilisation of the refineries which made Nigeria to largely depend on huge importation of refined products so as to meet the domestic demand. The on-going private Dangote refinery that is expected to start operation in 2021 would refine 650,000 barrels of oil per day and this would enable Nigeria to meet its refined oil demand (The New York Times, 2018). On the other hand, the total installed electricity generation capacity evolved around 12,000 MW with little or no addition in the last few decades, whereas the average electricity generation capacity fluctuates between 2,623.1 MW/h in 2007 and 3,485.5 MW/h in 2019 against the average consumption of 10,000MW per day (Adepoju et al., 2018). There is a large variant between the installed and operational capacity in electricity sub-sector which resulted into a low and unstable capacity utilisation (Makwe et al., 2012).

According to Energy Information Administration (EIA, 2016), it was reported that traditional biomass and waste (comprises crop residues, wood, charcoal and manure) constituted approximately 74% of total primary energy consumption in Nigeria as at year 2015 as shown in Figure 1. There are large numbers of Nigeria residents, especially in the backcountry, who are yet to connect to the national grid, and thus use biomass to meet their daily energy needs. Figure 1 further showed that oil, natural gas and hydro accounted for 13%, 12% and 1% of the primary energy consumption.

The sectoral consumption of energy is also shown in Figure 2. Approximately 78% of energy generated is consumed by the residential sector, followed by the industrial sector which consumed 7.8%, transport sector accounted for 7.5%, whereas commercial and public service sector consumed approximately

Figure 1: Primary energy consumption in Nigeria



3%, and Agriculture and Forestry consumed insignificant amount of energy.

The energy consumption per capita in Nigeria was 765.23 kg of oil equivalent as at 2015 which is actually higher than the energy consumption (in kg of oil equivalent) of most African countries such as Ghana 335, Cameroon 341, Senegal 272, Ethiopia 496, Tanzania 475, Cote d' Ivoire 615; but lower than that of South African energy consumption of 2,695.73 ktoe in the same period (World Bank, 2019). Comparing the population of Nigeria of approximately 190 million people with that of South Africa of approximately 55 million people, the per capita energy consumption in Nigeria is relatively very low. In addition to this, the population of Nigeria was approximately 60 million people as at 1973 while the energy consumption per capita in the same year was approximately 600 kg of oil equivalent; meanwhile the population of Nigeria was approximately 190 million in 2015 while the energy consumption per capital was 765 kg of oil equivalent in the same year. This clearly showed that while the population of Nigeria is growing rapidly, the energy consumption per capita is growing very slowly. It could also be inferred that the size of industrial activities going on in the country is relatively small as majority of the energy use is also concentrated in the residential sector. Several efforts are on-going in the country to improve the value-chain of many primary produce so as to be able to improve the manufacturing and service industry. A good example is the rice mills being constructed in some states such as Anambra, Cross River, Lagos and Kogi among others. This would not only meet the local needs but would also foster trade export of such products.

Trade openness is one of the fundamental channels which most countries utilise to achieve economic growth (Sadorsky, 2011). Trade liberalisation promotes effective allocation of factor inputs through economies of scale/scope and increased competition (Silajdzic and Mehic, 2018). This promotes knowledge acquisition, assimilation, diffusion and technology transfer which significantly reduced cost and improve productivity (Akinwale et al., 2018; Silajdzic and Mehic, 2018). Figure 3 shows the trade balance of Nigeria between 1995 and 2017. According to the report of The Observatory of Economic Complexity (OEC, 2018), the trade exports and imports of Nigeria stood at $46.8 billion and $34.2 billion respectively in 2017, yielding a trade surplus of approximately $13 billion. This made the country the 49th largest exporter and 58th largest importer in the world.

While Nigeria's exports have decreased between 2012 and 2017 at an annualized rate of -17.4% from $123 billion in 2012 to $46.8B in 2017, imports have shrunk from $47.3B in 2012 to $34.2B in 2017 at an annualized rate of -6.2%. In recent time, Crude Petroleum, Petroleum Gas, Refined Petroleum, Cocoa Beans, Rough Wood and Raw Sugar are the topmost trade exports of Nigeria whereas Refined Petroleum, Passenger and Cargo Ships, Wheat, Cars and Raw Sugar are Nigeria's topmost trade imports (OEC, 2018). Furthermore, most of the Nigeria's trade exports go to India, the United States, Spain, France and the Netherlands. Meanwhile most of the Nigeria's imports are originated from China, Belgium-Luxembourg, the Netherlands, South Korea and the United States.

Furthermore, the overall trade openness as considered in this study is the proportion of the summation of both export and import to GDP in a country (Akinwale and Grobler, 2019). Figure 4 shows trade as a percentage of GDP at 5 years interval between 1980 and 2015 in Nigeria. There have been fluctuations in Nigeria's trade openness over time which could be as a result of the government policies regarding international trade. The country's trade openness

Figure 2: Nigeria's energy consumption per sector in ktoe

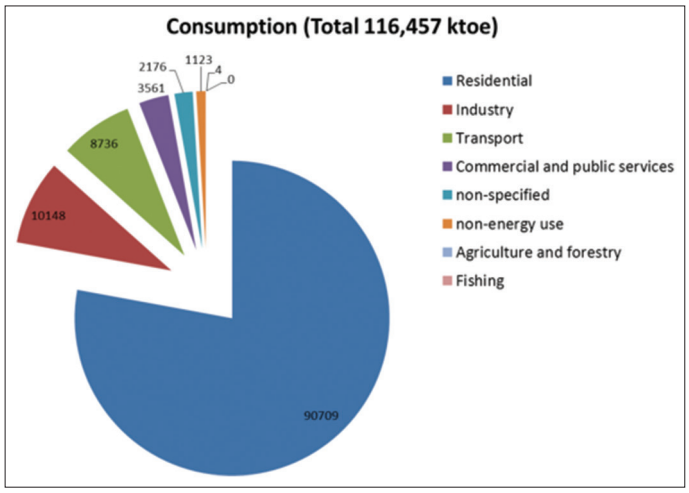
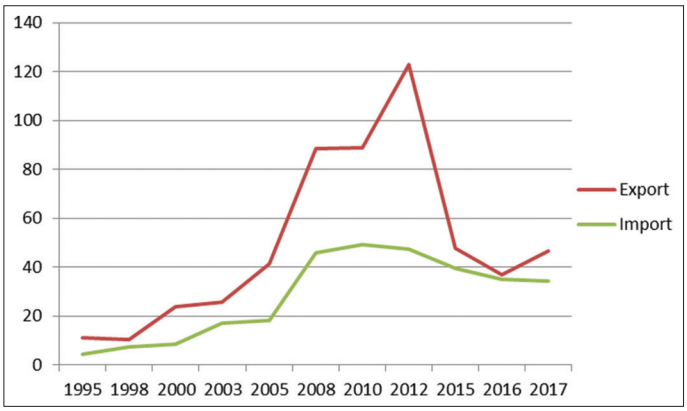
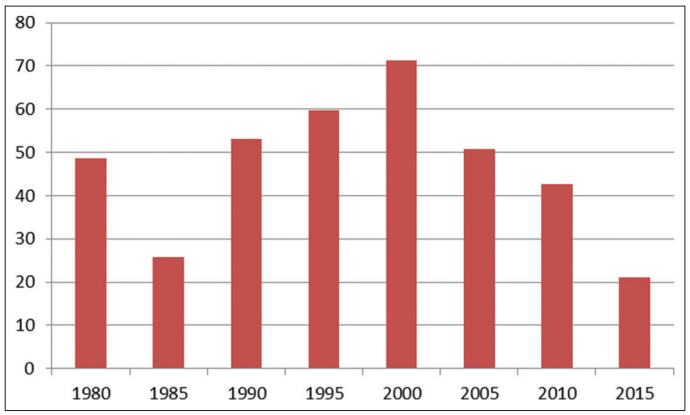


Figure 3: Nigeria's Trade Balance in Billion USD



Source: The Observatory of Economic Complexity, 2018

Figure 4: Nigeria's Trade (as a % of GDP)



Source: World Bank Development Indicators, 2019

fell to 21.12% in 2015 which was the lowest in the last 40 years. This could be as a result of foreign trade policy of the government that followed the global oil crunch which dragged Nigeria into recession.

Whether the economic recession experienced in the country adversely affected the country's trade openness in 2015 or the low level of international trade transactions in the country caused poor economic performance in 2015, an interactive mode is observed between trade openness and economic growth.

Nigeria is the largest economy in Africa and grew approximately by 5.7% per year between 2006 and 2016 with the highest value of 8% in 2006 and to a lowest of -1.5% in 2016 with global changes in oil prices continue to determine the country's growth pattern (World Bank report, 2019). The country bounced out of recession in 2017, and grew at 1.94% year-on-year in the second quarter of 2019 as against that of the first quarter 2.1% of the same year. According to Trading Economics (2019), Service sector is the largest sector in the economy as it dominates an approximately 50% of Nigeria's GDP with ICT as the fastest growing sub-sector. Also, Agriculture accounted for an average of 23% of GDP whereas crude oil and natural gas constitute 11% of the GDP despite that crude and natural gas generate above 70% and 90% of the country's revenue and foreign exchange earnings respectively. The current Buhari-led government champion anti-corruption practices and this is expected to block the leakages in the country's income and channel the economy towards a sustainable economic growth, though the effects of the policies are yet to be felt by the Citizens.

2.2. Empirical Studies

This section discusses the past literature across differing countries relating to the concerned variables. While there are many studies which focus on the relationship between any two of the three variables considered, very few others considered the three variables.

The study of Hu et al. (2015) examined energy use and economic growth using panel data from different sectors in China between 1998 and 2010. The results indicated that a 1% rise in energy use raises the sectoral productivity by 0.871%, and a 1% increase in sectoral productivity raises energy use by 1.103%. Furthermore, a system generalized moment method (GMM) was used to assess the causality tests and the results indicated unidirectional causal relation from economic growth to energy use in the short run, a unidirectional causality from energy use to economic growth in the long run whereas bidirectional relation was observed in the strong run. The study of Dhungel (2017) in five South Asian countries between 2000 and 2011 using VAR method affirmed the growth hypothesis which is energy-caused economic growth. The results of Ameyaw et al. (2017) conducted in Ghana between 1970 and 2014 VECM result indicated a one-way causality from GDP to electricity consumption. This is also similar to the result obtained in the study of Akinwale et al. (2013) in Nigeria for the period 1970-2005. Furthermore, Akinwale (2018) explored the association between energy use, technology innovation and GDP in Saudi Arabia between 1980 and 2015 using ARDL. The findings established long run relationships between the series, with one-way causality from GDP to energy use which suggests that Saudi Arabia can actually implement energy conservation policy and sought for renewable energy as this would not impair the economic activities of the country.

Shahbaz et al. (2014) investigated the association between trade openness and energy consumption in 91 high, medium and low income nations for a data set between 1980 and 2010. Their results showed the presence of an inverted-U shaped association in high income nations and vice versa in middle and low income nations. The result further indicated the bidirectional causality between energy consumption and trade openness. Kyophilavong et al. (2015) in their study conducted in Thailand affirmed the two-way causality between energy use and trade openness. Meanwhile, the study of Hossain (2012) conducted in Pakistan, India and Bangladesh could not establish any causality between exports and electricity usage.

Yusuf and Omar (2019) examined the effect of trade openness and GDP of Tanzania over the period 1981-2017. While the result of VECM revealed a positive long run connection between them, the granger causality test indicated no causality between them. Hence, the study suggested that the capabilities of indigenous firms should be enhanced so as to support local production for export purpose. Awokuse (2008) used VAR, granger causality within ECM framework and Impulse response function to examine the connection between import, export and GDP for selected Latin American countries. The overall findings showed that the strength of the influence of imports on economic growth is relatively stronger than that of the export. This study concludes that imports play a greater role to economic expansion in the Latin American nations as against many studies which focused mainly on export-led growth. Lawal and Ezeuchenne (2017) analysed the connection between international trade and economic growth in Nigeria and the results revealed a long run connection them. The result further showed one way causality from economic growth to trade openness, and no causality was established between economic growth and imports, exports and balance of trade.

Ohlan (2018) assessed the association between trade openness, electricity consumption and GDP in India between 1971 and 2016. The ARDL results showed that the variables are cointegrated and there exists a long-run causation running from electricity consumption and openness to economic growth suggesting growth hypothesis which encourages the continuous generation of eco-friendly energy in boosting economic growth in the future. The panel study conducted by Nasreen and Anwar (2014) in 15 Asian countries showed the presence of long run association between energy consumption, trade openness and GDP, and there is a feedback effect between GDP and energy consumption, and also between energy consumption and trade openness. A study of Sadorsky (2012) conducted over the period 1980-2007 in seven South America countries revealed a feedback-type of connection between energy use and trade (exports and imports) in the long run, but unidirectional connection from energy use to imports in the short run. The findings indicated that any environmental policies aimed at decreasing the use of energy would impair international

trade and economic progress. Akinwale and Muzindutsi (2019) in their study in South Africa for the period 1984–2015 using ARDL model confirmed the positive and significant influence of electricity consumption and trade openness on economic growth in the long run; and also the causality test showed that electricity consumption and trade openness cause economic growth without any feedback effects.

Shakeel et al. (2014) explored the link between GDP, energy consumption and international trade in five South Asian countries and their results revealed a feedback effects of the variables on one another in the short run. While a feedback effect is also observed between energy and economic growth in the long run, a unidirectional causality from exports to energy and GDP is also established. Shahbaz et al. (2013) in their study conducted in China revealed an existence of a long run association among energy use, economic growth, trade, financial development and capital. Furthermore, the findings also showed one-way causality from energy use to economic growth but feedback effects in other connection paths. The study of Chaudhry et al. (2012) in Pakistan revealed one-way causality from energy use (of each variable electricity, oil, gas and coal) to GDP as well as from GDP to trade openness; there is no causality between energy use and trade openness except that of movement from trade openness to oil only. The research conducted by Acaravci et al. (2015) in Turkey indicated a long run connection among electricity consumption, trade openness, real GDP per capita and FDI. Meanwhile, a unidirectional causality from electricity consumption to GDP was found with no other form of causality. This result supports the growth-hypothesis theory. Also, Satrovic (2019) conducted similar study for Turkey and observed that a unit growth in energy consumption improves GDP by 1.35 whereas a unit growth in trade openness reduces GDP by 0.13. The study concludes that economic growth is energy consumption elastic but trade openness inelastic.

The empirical studies showed differing results emanating from different countries, and this could be attributed to the proxies used to capture the variables, the methods used, the years considered and the intricacies of the country. Lots of the studies make use of electricity consumption to capture energy consumption, and either export and/or import to capture trade openness. Also, some of the studies only concentrate on two variables with limited studies from Nigeria. This study uses energy consumption which goes beyond that of electricity consumption, and trade openness which captures the addition of import and export as a proportion of GDP. Hence, there is need to assess the connection between energy consumption, trade openness and economic growth taking together in Nigeria as this will assist in policy making considering the energy-path the country needed.

3. METHODOLOGY AND DATA

This section describes the data and model specification of the study.

3.1. Data

This research paper used yearly data which covered between 1971 and 2015 for the time series analysis, and this is obtained from 2019 World Development Indicators (WDI) on line (2019). Energy consumption (EC) is proxied by energy used (kg of oil equivalent) per capita; trade openness (TRO) is proxied by [(total export + total import)/GDP × 100%]; and economic growth (GDP) is proxied by real GDP per capita. The annual data used are limited by the information available on energy use and trade openness.

3.2. Model Specification

This research article assessed the relation between economic growth, energy consumption and economic growth in line with few studies (Sadorsky, 2012; Lean and Smyth, 2010). The linear model could be written as per equation 1 and 2:

$$GDP = f(EC, TRO) \quad (1)$$

$$GDP_t = \alpha_o + \alpha_1 EC_t + \alpha_2 TRO_t + \gamma_t \quad (2)$$

In order to remove the stochastic error in the model, natural logarithms of Equation (2) was considered which resulted in Equation (3) as follows:

$$lGDP_t = \alpha_o + \alpha_1 lEC_t + \alpha_2 lTRO_t + \gamma_t \quad (3)$$

Where by *l*GDP is the natural logarithm of economic growth series; *l*EC and *l*TRO are natural logarithms of energy consumption and trade openness respectively; subscript *t* indicates the years from 1971 to 2015; γ_t signifies the error term.

The first test to be conducted is unit root tests using Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979) and Phillips Perron (PP) test (Phillips and Perron, 1988), and this is because the variables are required to be stationary before conducting co-integration and causality analysis. A non-stationary series have high tendencies of given spurious results. The null hypothesis of ADF and PP tests is that there is a unit root in the series, whereas the alternative hypothesis indicates that there is no unit root in the series. Each of the series would be differentiated until it becomes stationary. A series which is stationary at level is denoted by *I(0)* and stationary at first difference is denoted by *I(1)*, and stationary at second difference is denoted by *I(2)* etc. The number such as 0, 1 and 2 in the bracket of the previous sentence represent the level of the order of integration. To conduct co-integration analysis, it is expected that the order of integration of each of the variable is stationary at *I(1)*. Co-integration analysis would not be appropriate if the three series are stationary at different levels of order (Johansen, 1991).

Co-integration test is conducted once unit root test ascertained the absence of unit root of each series at first difference. This study applied Johansen co-integration test to determine the existence of long run relationship between energy consumption, economic growth and trade openness. Johansen co-integration test establishes the joint movement of the series and the residual term which could be used to predict the future relationship of the variables (Johansen, 1991). Both Maximum Eigen-value and Trace statistics are deployed to evaluate the existence and number of co-integration equation(s).

VECM is used to evaluate both long run and short run causality between the series (Engle and Granger, 1987). This is done after

co-integration test must have established the existence of long run connections. The establishment of co-integration between the series by VECM indicates the existence of an error correction mechanism whereby any changes in the endogenous variable is modelled as a function of the level of the disequilibrium in the co-integrating relationship and changes in the other exogenous variables (Sadorsky, 2011). The VECM for equation (3) are stated below:

$$\Delta GDP_t = \hat{A}_1 + \sum_{i=1}^{p} [\delta_{1i}\Delta GDP_{t-i} + \beta_{1i}\Delta EC_{t-i} + \psi_{1i}\Delta TRO_{t-i}] + \mu_1\varepsilon_{t-1} + \gamma_{1t} \quad (4)$$

$$\Delta EC_t = \hat{A}_2 + \sum_{i=1}^{p} [\delta_{2i}\Delta GDP_{t-i} + \beta_{2i}\Delta EC_{t-i} + \psi_{2i}\Delta TRO_{t-i}] + \mu_2\varepsilon_{t-1} + \gamma_{2t} \quad (5)$$

$$\Delta TRO_t = \hat{A}_3 + \sum_{i=1}^{p} [\delta_{3i}\Delta GDP_{t-i} + \beta_{3i}\Delta EC_{t-i} + \psi_{3i}\Delta TRO_{t-i}] + \mu_3\varepsilon_{t-1} + \gamma_{3t} \quad (6)$$

From the equations 4-6 above, the coefficients of the lagged regressors are represented by δ, β and ψ, whereas the constant term is represented by $\hat{A}$. The short run effects of the exogenous variables on the endogenous variable are represented by these regressors. The F-statistic of joint significance of these lagged terms depicts the short-run Granger causality. Suppose all the coefficient values ψ in equation (4) are jointly significant, this confirms short run causality from trade openness to economic growth. The coefficient $\propto$ of the error correction term ε_{t-1} indicates the speed of adjustment back to the long run equilibrium. For instance, when the coefficient $\propto$ is significant in equation (4), hence it could be inferred that there is long run causality from trade openness and EC to GDP.

4. RESULTS ANALYSIS

This segment presents and discusses the outcomes of this research.

4.1. Descriptive Analysis

Table 1 displays the descriptive information about the three series considered in this study. The mean of the natural logarithm of GDP, EC and TRO are 7.4, 6.5 and 3.8 respectively, whereas their standard deviations are 0.25, 0.08 and 0.37 respectively. This shows that despite that TRO has the lowest mean among the three series; TRO still has the highest deviation. However, the standard deviations of the three series are generally low, indicating low variability around the mean of the series.

Table 1: Descriptive statistics

	LGDP	LEC	LTRO
Mean	7.412917	6.542453	3.816761
Maximum	7.848970	6.682488	4.404434
Minimum	7.048496	6.361469	3.050426
Std. Dev.	0.245371	0.078966	0.365379
Observations	45	45	45

4.2. Test of Unit Root and Co-integration

Table 2 reveals the outcomes of unit root tests. ADF tests and PP tests disclose that all the series are not stationary at levels as their probability values are greater than 5%; however, all the series became stationary at I(1) as their probability values are less than 5%. This suggests the use of Johansen co-integration test to determine the long run relationship between the variables.

Table 3 shows that both maximum eigenvalue test and trace statistic rejected the null hypothesis at 5% level of significance, whereas the two tests could not reject the null hypothesis of presence of at most one co-integrating relation (R≤1) at 5% level of significance. This implies that there is a long run connection among the three variables with one co-integrating equation.

4.3. Vector Error Correction Model and Causality Analysis

The outcomes of short-run and long-run Granger causality tests are reported in Table 4. Based on equation (4), the coefficient of ε_{t-1} is not negative which is against our expectation though it is significant at 5% level. This implied that there is no long run causality from EC and TRO to GDP. More so, there is no short run causality running from each of EC and TRO to GDP. This is against the results obtained in some relevant studies (Ohlan, 2018; Nasreen and Anwar, 2014). In equation (5), long run causality was established from GDP and TRO to EC as the coefficient of is negative and significant at 5%. Conversely, there is no short run causality running from each of GDP and TRO to EC. The result of causality from economic growth to energy consumption is similar to that of Ameyaw et al. (2017) in Ghana and Akinwale (2018) in Saudi Arabia. Furthermore, long run causality was also established from EC and GDP to TRO in equation (6). In addition to this, the results of the short-run causal analysis show Granger causality from GDP to TRO and no causality from EC to TRO.

The results indicate that there is no short run causality running from any of the variables to others except unidirectional causality running from economic growth to trade openness. These short run results could be attributed to the weak manufacturing base and poor energy generation which are not strong enough to support economic growth and exportation in Nigeria. Meanwhile, in the long run economic growth and

Table 2: Unit root tests

Variable	Levels		First difference		Order of integration
	ADF *(t-statistic)*	PP *(t-statistic)*	ADF *(t-statistic)*	PP *(t-statistic)*	
lGDP	–0.0760	–0.4979	–5.4739***	–5.5858***	I (1)
lEC	–2.0856	–2.3615	–5.7148***	–5.7550***	I (1)
lTRO	–2.0811	–2.1006	–7.8348***	–7.7509***	I (1)

(***), (**), (*) indicate 1%, 5% and 10% level of significance, respectively

Table 3: Co-integration test

Hypotheses		Test statistics		
Null	Alternative	Eigenvalue	Trace	Max. eigenvalue
R=0	R>0	0.712*	57.16*	41.19*
R≤1	R>1	0.148	8.74	6.71
R≤2	R>2	0.047	2.03	2.03

(*) indicate 5% level of significance

Table 4: Granger causality test

Causality	Long run	Short run
	Error correction term	Chi-square
Equation (4) ΔGDP	0.05**	
ΔEC		0.15
ΔTRO		2.07
Equation (5) ΔEC	–0.24**	
ΔGDP		0.09
ΔTRO		1.42
Equation (6) ΔTRO	–0.33**	
ΔGDP		6.99**
ΔEC		1.44

Note: ***, **, * Significant at 1%, 5% and 10% level respectively

Table 5: Summary of diagnostic tests results

Test	P-values	Decision
ARCH	0.2810 (F) 0.2672 (Chi-Square)	Do not reject H_0
Breusch-Godfrey Serial Correlation LM Test	0.3421 (F) 0.3123 (Chi-Square)	Do not reject H_0
Jarque-Bera (JB)	4.0049 (Jarque-Bera) 0.1350	Do not reject H_0

trade openness have been recognised to drive consumption of energy; and also economic growth and energy consumption would also drive trade openness; whereas energy consumption and trade openness could not drive economic expansion in the long run equation. This implied that developing all sectors of the economy such as manufacturing, services and agriculture among others would boost the economy which would in the long run drive trade export and energy usage. At the moment, this study has established that energy consumption is too meagre to drive the desired economic growth in the country; and that trade openness, which has encouraged more consumable imports and crude oil exports, has not contributed significantly to the growth of Nigerian economy. The managerial implication of this is that there is need for developing robust and implementable policies which would encourage the growth of all sectors of the economy through indigenous innovative capabilities, as this would drive energy consumption and trade openness. Also, concerted efforts should be made by the government to improve the energy base of the country as the current energy generation is too small to drive economic development. More so, since the energy requirements of the country is still relatively huge, Nigerian government should utilise the sustainable low carbon energy options towards the growth trajectory.

Table 5 presents the results of the diagnostic test of the co-integration and VECM. The null hypotheses for presence of a normal distribution, absence of autocorrelation and absence of heteroscedasticity could not be rejected.

This signifies that the residuals are normally distributed, no serial correlation in the model and that the variance of the error term is uniform.

5. CONCLUSION

This research article investigated the linkage between economic growth, energy consumption and trade openness in Nigeria for the period 1971-2015. Cointegration and VECM analyses were conducted to determine the presence of long run linkage among the three series as well as determine the causal direction between them. The presence of long run linkage was established as revealed with the outcome of co-integration equation. Granger causality within the context of VECM showed that long run causality ran from economic growth and trade openness to energy consumption, and also from energy consumption and economic growth to trade openness but no long run causality from energy consumption and trade openness to economic growth. On the other hand regarding short run causality, no form of causality was established between the variables except from economic growth to trade openness. Growth-led trade openness and energy conservation policy hypotheses are implied from the results.

However, the energy conservation policy hypothesis should be explained with caution, as it could signify that the present energy usage in the economy is too weak to cause economic growth. So, Nigerian government could focus on sustainable economic development through an intensive investment and incentives in building low carbon energy system. Model fit was also good as the result of the diagnostic tests revealed that the residual of the model is normally distributed, and there is absence of serial correlation and heteroscedasticity in the model. The study suggests that Nigerian government should develop robust and implementable policies which would encourage the growth of all sectors of the economy through indigenous innovative capabilities.

REFERENCES

Acaravci, A., Erdogan, S., Akalin, G. (2015), The electricity consumption, real income, trade openness and foreign direct investment: The empirical evidence from Turkey. International Journal of Energy Economics and Policy, 5(4), 1050-1057.

Adepoju, A., Akinwale, Y., Ogundari, I. (2018), Feasibility economic analysis for electricity generation in internal combustion engine sets using landfill gas in Lagos State. African Journal of Science, Technology, Innovation and Development, 10(5), 593-599.

Akinwale, Y. (2018), An empirical analysis of short run and long run relationships between energy consumption, technology innovation and economic growth in Saudi Arabia. International Journal of Energy Economics and Policy, 8(4), 139-146.

Akinwale, Y., Grobler, W. (2019), Education, openness and economic growth in south Africa: Empirical evidence from VECM analysis. The Journal of Developing Areas, 53(2), 51-64.

Akinwale, Y., Jeseleye, O., Siyanbola, W. (2013), Empirical analysis of the causal relationship between electricity consumption and economic growth in Nigeria. British Journal of Economics, Management and Trade, 3(3), 277-295.

Akinwale, Y., Muzindutsi, P. (2019), Electricity consumption, trade openness and economic growth in South Africa: An ARDL approach.

Journal of Economic Cooperation and Development, 40(1), 135-156.
Akinwale, Y., Ogundari, I. (2017), Exploration of renewable energy resources for sustainable development in Nigeria: A study of the federal capital territory. International Journal of Energy Economics and Policy, 7(3), 240-246.
Ameyaw, B., Oppong, A., Abruquah, L., Ashalley, E. (2017), Causality Nexus of electricity consumption and economic growth: An empirical evidence from Ghana. Open Journal of Business and Management, 5, 1-10.
Awokuse, T. (2008), Trade openness and economic growth: Is growth export-led or import-led? Applied Economics, 40, 161-173.
Central Bank of Nigeria. (2015), Analysis of energy market condition in Nigeria. Occasional Paper No. 55. Nigeria: Central Bank of Nigeria.
Chaudhry, I., Safdar, N., Farooq, F. (2012), Energy consumption and economic growth: Empirical evidence from Pakistan. Pakistan Journal of Social Sciences, 32(2), 371-382.
Dhungel, K. (2017), Linkages between electricity consumption and economic growth: Evidences from South Asian economies. Hydro Nepal: Journal of Water, Energy and Environment, 20, 18-22.
Dickey, D., Fuller, W. (1979), Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74, 427-431.
Dorgan, E. (2016), Analyzing the linkage between renewable and non-renewable energy consumption and economic growth by considering structural break in time-series data. Renewable Energy, 99, 1126-1136.
Energy Information Administration. (2016), Energy Situation: Nigeria. Available from: https://www.eia.gov/beta/international/analysis.php?iso=NGA.
Hasson, A., Masih, M. (2017), Energy Consumption, Trade Openness, Economic Growth, Carbon Dioxide Emissions and Electricity Consumption: Evidence from South Africa Based on ARDL, MPRA Paper No. 79424. South Africa: MPRA. p. 1-22.
Hossain, M. (2012), Multivariate Granger causality between economic growth, electricity consumption, exports and remittances for the panel of three SAARC countries. Global Journal of Management and Business Research, 12, 41-54.
Hu, Y., Guo, D., Wang, M., Zhang, X., Wang, S. (2015), The relationship between energy consumption and economic growth: Evidence from China's industrial sectors. Energies, 8, 9392-9406.
International Energy Agency. (2012), World Energy Outlook 2014, Electricity Database (2012 Estimates). Paris, France: International Energy Agency.
Knoema. (2020), Nigeria-total Petroleum Consumption. Available from: https://www.knoema.com/atlas/Nigeria/topics/Energy/Oil/Petroleum-consumption.
Kyophilavong, P., Shahbaz, M., Anwar, S., Masood, S. (2015), The energy-growth nexus in Thailand: Does trade openness boost up energy consumption? Renewable and Sustainable Energy Reviews, 46, 265-274.
Lawal, E., Ezeuchenne, K. (2017), International trade and economic growth in Nigeria. IOSR Journal of Humanities and Social Science, 22(6), 35-43.
Lean, H., Smyth, R. (2010), On the dynamics of aggregate output, electricity consumption and exports in Malaysia: Evidence from multivariate Granger causality tests. Applied Energy, 87, 1963-1971.
Makwe, J., Akinwale, Y., Atoyebi, M. (2012), An economic assessment of the reform of Nigerian electricity market. Journal of Energy and Power, 2, 24-32.
Nasreen, S., Anwar, S. (2014), Causal relationship between trade openness, economic growth and energy consumption: A panel data analysis of Asian countries. Energy Policy, 69, 82-91.
Ohlan, R. (2018), Relationship between electricity consumption, trade openness and economic growth in India. OPEC Energy Review, 42(4), 331-354.
Ozturk, I., Acaravci, A. (2013), The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. Energy Economics, 36, 262-267.
Phillips, P., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75, 335-346.
Sadorsky, P. (2011), Trade and energy consumption in the Middle East. Energy Economics, 33, 739-749.
Sadorsky, P. (2012), Energy consumption, output and trade in South America. Energy Economics, 34, 476-488.
Satrovic, E. (2019), Energy consumption, trade openness and growth nexus in Turkey: Evidence from VECM. Journal of Economics and Administrative Sciences, 20(1), 1-12.
Shahbaz, M., Khan, S., Tahir, M. (2013), The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from multivariate framework analysis. Energy Economics, 40, 8-21.
Shahbaz, M., Nasreen, S., Ling, C., Sbia, R. (2014), Causality between trade openness and energy consumption: What causes what in high, middle and low income countries. Energy Policy, 70, 126-143.
Shakeel, M., Iqbal, M., Majeed, M. (2014), Energy consumption, trade and GDP: A case study of South Asian Countries. The Pakistan Development Review, 53(4), 461-476.
Silajdzic, S., Mehic, E. (2018), Trade openness and economic growth: Empirical evidence from transition economies. In: Bobek, V., editor. Trade and Global Market. Ch. 2. India: IntechOpen.
The New York Times. (2018), In Nigeria, Plans for the World's Largest Refinery. Available from: https://www.nytimes.com/2018/10/09/business/energy-environment/in-nigeria-plans-for-the-worlds-largest-refinery.html?
The Observatory of Economic Complexity. (2018), Trade Balance: Nigeria Profile. Available from: https://www.oec.world/en/profile/country/nga.
Trading Economics Report. (2019), Nigeria GDP Annual Growth Rate. Available from: https://www.tradingeconomics.com/nigeria/gdp-growth-annual.
World Bank Report. (2019), Country Overview: Nigeria. Available from: https://www.worldbank.org/en/country/nigeria/overview.
Yusuf, S., Omar, M. (2019), Trade openness and economic growth in Tanzania. Asian Journal of Economics, Business and Accounting, 12(3), 1-10.