Energy consumption, production and Environmental pollution in Nigeria

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Abstract
For the past two decades, international communities have emphasized on the need to mitigate the level of CO_2 globally for better environment. In this regard, the study examine the influence of renewable energy use, financial progress, economic performance and trade on environmental pollution in Nigeria by utilizing the ARDL method from 1980 to 2017. The bound test outcome confirm that the variables are cointegrated. The short run estimated outcome shows that energy use and production increase the level of environmental dilapidation while GDP and trade decelerates it in Nigeria. However, financial progress does not influence CO_2 discharge. The estimated long run analysis indicates that energy use, economic performance and trade decreased the level of environmental pollution. Meanwhile, energy production promotes the level of environmental quality. Therefore, the study suggests that Nigerian policy makers should design more appropriate policies that will mandate industries and households to use renewable energy like wind, solar, and hydro power for environmental quality and sustainable economic performance.

Keywords: Energy use, energy production, CO_2, ARDL, Nigeria

JEL Classifications: Q52, Q54

1. Introduction

The excessive discharge of CO_2 has become a threat to the global environmental quality in the recent time (Sehrawat et al., 2015). According to IPCC (2018) the trends in the world's CO_2 emission has increased by 36 billion tonnes and is projected increase in the next coming years. It is argued that the growth of CO_2 discharge deteriorates the climate condition and accelerates the level of global heat (Meratizaman et al. 2015). The average atmospheric temperature has reached more than 2^0C from pre-industrial era (IPCC, 2018; Tiwari, 2011). This situation affects agricultural productivity, raising sea level, increase in poverty level, health condition, welfare as well as economic progress and development (Asongu, 2018). In this regard, the international community such as the United Nations has urged that the

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developed and emerging nations should emphasized on the use of renewable energy consumption and production for sustainable economic performance.

In Nigeria, the level of CO_2 discharge has been on increasing trend for the past few decades. For instance, 79,170.53 kt of CO_2 was recorded in 2000 and 96,280.75 kt has been estimated in 2014. This indicates that in span of fourteen years CO_2 discharge increased by 17, 110.22 kt (WDI). However, the level of energy production and consumption in the nation have been on improving capacity to influence the capacity of CO_2 discharge as shown in figure 1.

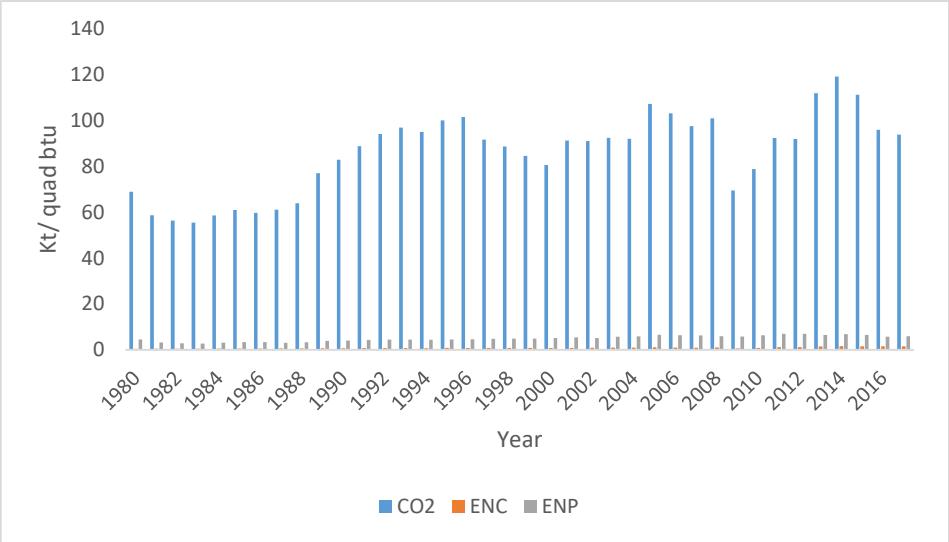

Figure 1: Trends on the CO_2 discharge and energy use, energy production in Nigeria
Source: (EIA, 2016; WDI, 2017)

Hence, this condition could be the reason of the increased CO_2 discharge in Nigeria. Therefore, the study examined the performance of energy consumption and production on environmental pollution in Nigeria.

2. Literature review

The association among energy resources use, financial progress, economic performance, FDI and CO_2 discharge have been discussed in the economic literature. For example, BOlük and Mert (2014) stressed that energy resource use in European nation has accelerate the level of CO_2 discharge. Heidari, Katirciog, and Saeidpour (2015) use 5 Asian countries to analyze the influence of energy use on

CO_2 discharge. The outcome reveals that use of energy upsurge the level of CO_2. Ohlan (2015) in his analysis for India argued that energy influence CO_2 discharge positively. Meanwhile, a study by Zoundi (2017) estimate the influence of renewable energy resources on CO_2 discharge in African nations. The analysis found that energy utilization reduces the level of CO_2. In the same regard, Jebli et al. (2017) analyses the extent to which energy use affect CO_2 in OECD nations. The finding indicates that energy condense the CO_2 emission. Sarkodie and Adams (2018) studied the performance energy resources on quality of environmental in South by utilizing ARDL method from 1971 to 2017. The study found that energy use enhances environmental quality.

Furthermore, Saboori et al. (2014) use FMOLS method to analyze the association among GDP and CO_2 discharge for 27 OECD economies. The outcome indicates that economic performance accelerates CO_2. Shahbaz et al. (2014) argued that economic progress upsurges CO_2 discharge in UAE. Wang et al. (2018) analyze the effect of growth performance on CO_2 for 170 economies. The outcome illustrates that GDP accelerates CO_2 discharge. Zheng-xin Wang and Li (2019) argued that increase in economic performance is associated with high CO_2 discharge in China. In another development, a study by Boutabba (2014) emphasize on the positive link among financial progress and CO_2 in India. Cetin and Ecevit (2017) mainted that development of financial structure promotes CO_2 discharge in Turkey. However, Zafar, Saud and Hou (2019) conclude that financial progress in OECD nations reduce the level of CO_2 discharge. Moreover, Al-mulali and Ozturk (2015) analyze the connection trade and CO_2 in the selected 14 MENA countries, by applying FMOLS method from 1996 to 2012. They conclude that trade accelerates CO_2 discharge. Jamel and Maktouf (2017) emphasize that trade openness, economic performance, and financial progress accelerate the explosion of CO_2 in European nations. Nevertheless, Liobikienė and Butkus (2019) examine the influence of trade on CO_2 using GMM technique for 147 nations from. It indicates that trade openness reduce the level of CO_2 discharge.

Based on the above literature reviewed several studies have examine the effect of energy utilization and nonrenewable energy on environmental pollution in developed and industrialize nation. However, very few studies analyze the effect of aggregates of energy use and production in Africa, particularly Nigeria. Thus, the study examine the influence of energy consumption and production on environmental pollution.

3. Methodology and Data
3.1 Data

The study used yearly data on CO_2 emission (kt), energy consumption (quad Btu), energy production (quad Btu), GDP percapita (current USD), financial development (percentage of GDP), and trade (total exports and imports) from 1980 to 2017. Data on CO_2, energy consumption and production were obtained from EIA, while other variables were from WDI. All the variable were transformed into their elasticity form.

Table 1 denotes the summary of the nature of the variables utilize in the study. The result illustrates that energy utilization obtained the lowest minimum and mean values while economic performance has the maximum value for the model.

Table 1. Summary of the variable's statistical nature

Variables	Min	Max	Mean	SD
LCO_2	4.015	4.780	4.431	0.215
LENC	0.874	0.505	0.174	0.341
LENP	1.019	1.945	1.567	0.275
LFD	1.600	3.104	2.172	0.397
LGDP	5.599	8.077	6.871	0.512
LTO	2.212	3.975	3.385	0.512

3.2 Stationarity test for the variables

The study applies ADF test to ascertain the status of stationarity level and order of integration in the model's variables. This done in order use an appropriate estimation technique and better outcome that could be reliable for efficient and effective policies. In addition, Phillip Peron (PP) test was also employed to confirm the validity of the ADF test outcome. Hence, equation 1 and 2 illustrate the ADF and PP tests.

$$\Delta Z_t = \beta + \theta_{yt-1} + \beta T + \sum_{j-1}^{k} \vartheta_j \Delta Z_{t-j-1} + \varepsilon_t \quad (1)$$

In equation 1, Z denotes series of the time t, the coefficient is denoted by β, and, k illustrates the lags while ε_t represents the residuals.

$$\delta^2 = T^{-1} \sum_1^T \bar{e}_r^2 + 2T^{-1} \sum_{t-1}^{l} w(t,l) \sum_{r=t+1}^{l} \bar{e}_t \bar{e}_{t-1} \quad (2)$$

From equation 2, w(r, l) = 1[t/ (1+l)] and l denotes the lags.

3.2.1 Model of analysis

For the purpose of the study's analysis a modified model by Ohlan (2015) is used and it is illustrated in equation 3.

CO_2 = f (ENC, ENP, FD, GDP, TO) (3)

In equation 3, $C0_2$, ENC, ENP, FD, GDP and TO denotes carbon discharges, energy utilization, energy production, financial progress, economic performance and trade. Therefore, ARDL is utilized for the analysis. The technique has the power to produce efficient estimation in comparison with other methods (Pesaran et al., 2001). Hence, it is illustrated in equation 4:

$$\Delta LCO_{2t} = \beta_0 + \sum_{j=1}^{n} \beta_1 \Delta LCO_{2t-j} + \sum_{j=0}^{n} \beta_2 \Delta LENC_{t-j} + \sum_{j=0}^{n} \beta_3 \Delta LENP_{t-j} + \sum_{j=0}^{n} \beta_4 \Delta LFD_{t-j} + \sum_{j=0}^{n} \beta_5 \Delta LGDP_{t-j} + \sum_{j=0}^{n} \beta_6 \Delta LTO_{t-j} + +\alpha_1 LCO_{2t-1} + \alpha_2 LENC_{t-1} + \alpha_3 LENP_{t-1} + \alpha_4 LFD_{t-1} + \alpha_5 LGDP_{t-1} + \alpha_6 LTO_{t-1} + \varepsilon_t \quad (4)$$

Equation 4, ε represent the error term, t, illustrate the period and the first variance element is denoted byΔ. Consequently, the cointegration among the variables in the model is confirm if the value of F-statistic is higher than the critical bond value. In addition, the value of ECT in the model must be negative and significant.

4. Result of the model analysis

Table 2 illustrates the stationarity test results, the outcome illustrates that all the variables are found first difference stationary for the ADF and PP tests. Hence, the ARDL technique is appropriate of the model estimation.

Table 2. Stationarity test results

Variable	ADF LEVEL		PP LEVEL		ADF First Diff		PP First Diff	
LCO_2	-1.580	(0.482)	-1.628	(0.458)	-5.931***	(0.000)	-5.933***	(0.000)
LENC	-1.444	(0.550)	-1.444	(0.157)	-7.620***	(0.000)	-7.620***	(0.000)
LENP	-0.809	(0.804)	-0.809	(0.423)	-6.415***	(0.000)	-8.063***	(0.000)
LFD	-1.522	(0.510)	-1.637	(0.453)	-4.777***	(0.005)	-15.35***	(0.000)
LGDP	-0.706	(0.832)	-0.806	(0.806)	-6.253***	(0.000)	-6.059***	(0.000)
LTO	-2.021	(0.276)	-2.313	(0.173)	-7.314***	(0.000)	-7.314***	(0.000)

Notes: *** shows significance at 1percent level.

Table 3 indicates the outcome of the bound test, it shows that the variables in the model are cointegrated meaning that they have long run association. This is confirmed as the value of F-statistics obtained is higher than the value of UBC bound at 1 percent level.

Table 3. Cointegration test

	1%		5%	
F-statistics	I(0)	I(1)	I(0)	I(1)
8.67	3.41	4.68	2.26	3.79

Table 4 illustrates the short and long run estimate. The estimated short run analysis reveals that energy use deteriorates environmental quality in Nigeria. This is justified by the fact that 1 percent upsurge in the energy utilization cause to 0.30 percent increase in the level of CO_2 discharge and it imply an upsurge in the level of environmental pollution. Similarly, trade reduce CO_2 discharge. However, it is reveals that energy production increases the capacity of CO_2 explosion. It illustrates that a percent increase in energy production cause 1.15 percent raise in CO_2 discharge. Economic growth performance also accelerates the level of CO_2 discharge in Nigeria. In addition, the value of the error correction term reveals that about 54 percent of the variation of the model's variables are adjust to long run.

Moreover, the long run estimated analysis reveals that energy use reduce the level of CO_2 discharge which is directly associated with increased environmental quality in Nigeria. The outcome indicates that 1 percent rise in the use of energy use in Nigeria cause environmental pollution to reduce by 0.38 percent. It is not Surprise, energy consumption to be a decreasing factor of environmental pollution that reduce the level of environmental dilapidation. The outcome is consistent with the findings of earlier studies (Heidari, Katirciog & Saeidpour, 2015). Nonetheless, energy production in Nigeria increase the capacity of environmental pollution. This means that a percent raise in energy production results to CO_2 discharge to upsurge by 2.6 percent. The condition is worrisome due to a reason that 2.6 percent environmental destruction annually in the country is associated with energy production. This outcome is similar with the report of the previous studies (Danlami, Aliyu, & Danmaraya, 2019). Nevertheless, financial development does not influence environmental pollution. Output growth and trade influence CO_2 discharge positively in Nigeria. It implies that a percent upsurge in GDP results environmental pollution to increase by 0.39 percent. Furthermore, a 1 percent rise in trade performance leads to 0.45 rise in environmental degradation in Nigeria. The implication of this outcome is that it is clearly shown that in the short run energy production and consumption deteriorates environmental quality, however in the

long run energy consumption improve environmental quality. This indicates that policy makers in Nigeria need to design more appropriate measure on utilizing renewable sources of energy like wind, solar and hydro power and to ensure a mandatory mechanism for industries and household consumption on the use renewable energy so as to promote the level of environmental quality for sustainable economic performance.

Table 4. Estimate for short and long run outcome

Variables	Coefficient	SE	t-Statistic	Prob
Short run analysis				
ΔLENC	0.305*	0.088	3.456	0.008
ΔLENP	1.154*	0.144	7.991	0.000
ΔLFD	-0.054	0.033	-1.628	0.142
ΔLGDP	-0.221*	0.050	-4.390	0.002
ΔLTO	-0.086**	0.032	2.673	0.028
ECT(-1)	-0.544*	0.117	-4.626	0.001
Long run analysis				
LENC	-0.382***	0.204	-1.866	0.099
LENP	2.618*	0.499	5.237	0.000
LFD	0.014	0.136	0.109	0.915
LGDP	-0.395*	0.082	-4.800	0.001
LTO	-0.452*	0.122	-3.696	0.006
C	4.517*	0.254	17.74	0.000

Notes: * and ** shows 1 and 5 percent significant level

Table 5 illustrates post diagnostic tests. The outcome shows that the model is free from serial correlation, Heteroskedasticity problems as well as the errors are distributed normally.

Table 5. Diagnostic tests

Test	F-statistic	Prob.	Result
Breusch-Pagan Test.	1.492	0.287	No Heteroskedasticity
Breusch-Godfrey Test	3.407	0.179	No Serial Correlation
Jarque-Bera	0.332	0.846	Normally Distributed

5. Conclusion

The study analyzes the influence of energy use, energy production, financial progress, economic performance and trade on environmental pollution in Nigeria by utilizing the ARDL method from 1980 to 2017. The bound test outcome confirm that the variables are cointegrated. The short run estimated outcome shows that energy use and energy production increase the level of environmental dilapidation

while GDP and trade decelerates it in Nigeria. However, financial progress does not influence CO_2 discharge. The estimated long run analysis indicates that energy use economic performance and trade decrease the level of environmental pollution. Meanwhile, energy production promotes the level of environmental quality. The implication of the analysis is that energy use and production increases the level of CO_2 discharge in the short run while energy use decelerate the environmental pollution in the long run. Therefore, Nigerian policy makers should design more appropriate policies that will mandate industries and households to use renewable energy like wind, solar and hydro power for environmental quality and sustainable economic performance. The inability of the current study incorporate variables like corruption, disaggregate energy use are some of its limitation. Hence, futures studies should incorporate corruption in their model in order to analyses its effects on the level of CO_2 discharge for policy analysis.

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