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# NON-RENEWABLE ENERGY CONSUMPTION AND ENVIRONMENTAL POLLUTION IN NIGERIA

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## *ABSTRACT*

This study examined the effect of nonrenewable energy use, output, domestic credit and FDI on environmental pollution in Nigeria through the use of ARDL method from 1980 – 2016. The outcome of the study's estimation reveals that all the variables possess the long run association. It is indicated that in short and long run conditions, nonrenewable energy use, FDI and trade increased environmental dilapidation, thereby adversely affect environmental quality in Nigeria. However, financial development has negative influence on environmental degradation. The finding clearly illustrates that nonrenewable energy utilization rise environmental pollution in Nigeria. Hence, policymakers should design appropriate policies to enhance environmental quality through policies that will regulate the use nonrenewable energy and backed the policies in promoting the utilization of renewable energy resources, inform of wind, solar and hydro energy. It is essential for government to take anti-corruption measures, that the designed policies are implemented appropriately to achieve the benefits of the policies. This would be very vital in achieving environmental quality, welfare enhancement, poverty reduction as well as sustainable economic development.

**Contribution/Originality:** The study contributes in the existing literature by examining the effect of nonrenewable energy use on environmental pollution in Nigeria, as studies on environmental quality are few in African and Nigeria in particular. The outcome of the study would help policymakers in designing appropriate and effective policies for environmental quality.

## 1. INTRODUCTION

Due to excessive discharge of greenhouse gas emissions (GHGs) in the past few decades, environmental pollution has become a greatest global issue (Dogan & Seker, 2016). It is emphasized that $CO_2$ accounted for a greater portion of the greenhouse gases that upsurge the level of global heat, so environmental pollution has turned to be a greatest issue of concern (IPCC. 2018). Over the previous years the extent of $CO_2$ explosion in the world has been increasing that seriously affect the ecosystem, economic performance and welfare of the global nations (Danlami, Applanaidu, & Islam, 2018). Thus, the growing nature of the global $CO_2$ discharge has extend more fear of deteriorating effects of the climate change (Tiwari, 2011). The world outflow of the $CO_2$ discharge has increased by 16.49 percent from 1980 – 2013. It implies that about 84 percent rise of $CO_2$ with in the same time span. Banday and Aneja (2018). Furthermore, $CO_2$ explosion from developed and emerging nations increases at 1.3 percent yearly and if the trend continuous it may be double by 2030 in the absence of control measures (IPCC, 2014).

According to Global Carbon Project (2018) $CO_2$ from non-renewable energy consumption increased by 33.1 % to 36.2 % from 2010 to 2017 and are projected to rise by 2.7% with China and India accounting for greater portion. Several studies have illustrates that factors like energy consumption, increase in population, urbanization and the need for greater economic performance in emerging nations are among the causes of low environmental quality (Acaravci & Ozturk, 2010; Sehrawat, Giri, & Mohapatra, 2015). Hence, it is documented that $CO_2$ mitigation measures has to be emphasize for grater environmental quality and sustainable economic performance.

In African countries $CO_2$ have been on growing track since 1950s. Emissions from fuel energy have increased overtime that account for 35 percent as well as gas fuel 16.9 percent. Based on the report documented by the WRI that in Africa the percapita $CO_2$ discharge was 0.8 kt per individual in 2008 and raised to 0.86 kt in 2013. Gbatu (2018) projected that carbon-based pollution in African nations may rise to about 50 percent of the total world share by 2030. In addition, it predicts a severe climate deterioration such as drought, water heat and flood, in most nations for which African countries are no exception. Therefore, African nations have experience high level of heat due to increased temperature level. This situation may result drought, floods, increase in diseases outbreak, loss of the natural ecosystem as well as less agricultural production (IPCC, 2007).

Nigeria is among the greatest nation responsible for the region growth of emissions from non-renewable energy resource. For instance, Figure 1. indicates that in Nigeria $CO_2$ upsurge from 39,196 kt in 1990 to 96, 280 kt in 2014 (WDI, 2017). The current situation reveals that Nigerians $CO_2$ have coming more severe and dangerous. In this regard, the high explosion of $CO_2$ in Nigeria, may be linked to the increase in economic activities which has resulted from more utilization of non-renewable energy due to the fact that it is the major oil producers in the African continent. For example, according to WDI (2017) non-renewable energy consumption in Nigeria possessed an increasing trend which shows that energy consumed had increase from 697,613.4003 kg of oil equivalent in 1990 to 763.631.9766 kg of oil equivalent 2014. In addition, the share of biomass and waste energy consumption such as charcoal and other residues have been increased to the turn of 83 percent and it is predominantly from the rural areas (EIA, 2013). Hence, the growth of non-renewable energy consumption in Nigeria may increase the explosion $CO_2$ that cause severe heat deterioration of climate condition. This would result to diseases outbreak, low agricultural performance, increase level of extreme poverty and unemployment. Thus, knowing the influence of nonrenewable energy consumption on environmental pollution in Nigeria will aid the policy makers in formulating appropriate policies to mitigate $CO_2$ and achieve sustainable economic growth and development.

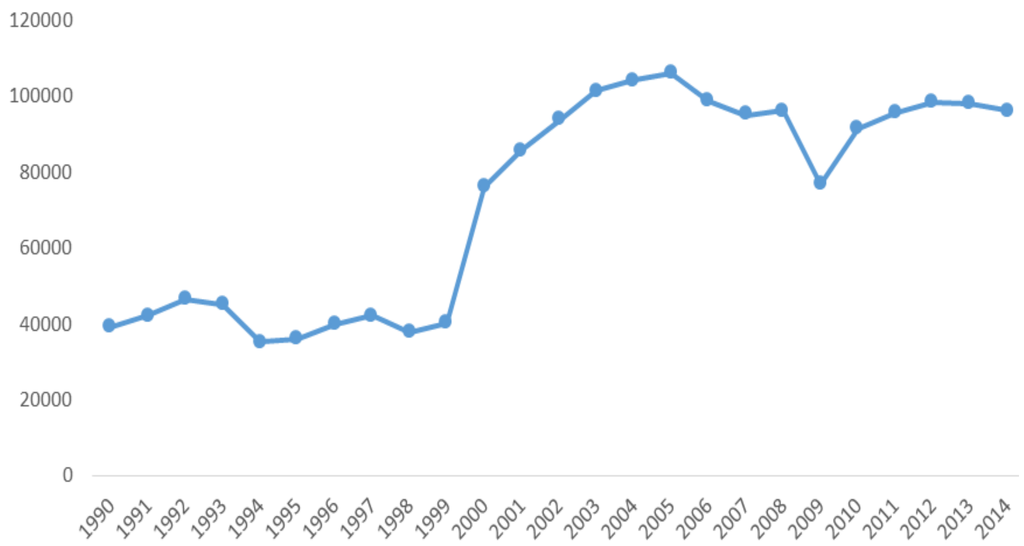


**Figure-1.** $CO_2$ kilotonne.

**Source:** WDI (2017).

The present study differs from earlier studies in such way that application of ARDL technique in the analysis of environmental studies is very limited especially in Nigeria context. Moreover, the present study possess larger sample period in comparison with the earlier studies (Bento & Moutinho, 2016; Farhani & Shahbaz, 2014; Shafiei & Salim, 2014). Furthermore, the study used aggregate form of non-renewable energy consumption (coal, natural gas and oil) and its relationship with environment as most of the earlier studies utilizes total energy consumption and environment (Shafiei & Salim, 2014).

## 2. LITERATURE REVIEW

Earlier studies in the literature have analyzes the association among nonrenewable, renewable energy use, Gross Domestic Product (GDP), financial sector performance and $CO_2$. For instance, Shafiei and Salim (2014) employ STIRPAT technique to estimate the influence of nonrenewable energy consumption on $CO_2$ in OECD nations from 1980 – 2011. It is documented that nonrenewable energy promotes $CO_2$. Similarly, Farhani and Shahbaz (2014) applies FMOLS method to investigate the effect of nonrenewable energy on $CO_2$ in MENA countries from 1980 – 2009. The outcome indicates that nonrenewable energy resource increases the level of $CO_2$. Long (2015) documents that nonrenewable energy consumption accelerates the explosion of $CO_2$ in China from 1952 – 2012. Dogan and Seker (2016) use multiple nations analysis to explore the link between nonrenewable energy, GDP, trade and $CO_2$ emissions in European Union nations from 1980 – 2012. The outcome shows that nonrenewable energy promotes the level of $CO_2$. Bento and Moutinho (2016) estimate the association among nonrenewable energy production and $CO_2$ in Italy from 1960 – 2011. The estimate reveals that nonrenewable energy production influence $CO_2$ positively.

Moreover, Wang, Li, and Fang (2018) estimate influence of energy resources on $CO_2$ in Pakistan from 1970 – 2012. They reveal that use of energy upsurges $CO_2$. Sharif (2018) argued that nonrenewable energy accelerates environmental dilapidation in 74 nation from 1990 - 2015. Chen, Wang, and Zhong (2019) use yearly data of china to evaluate the effect of energy production on $CO_2$ using ARDL approach from 1980 – 2014. The outcome indicates nonrenewable energy production explore more $CO_2$. Sarkodie and Strezov (2019) finds positive influence of energy resources on $CO_2$ in emerging nations. Bekun, Alola, and Sarkodie (2019) explore the impact of renewable, nonrenewable consumption of energy and GDP on $CO_2$ for 16 EU nations from 1996 to 2014. The outcome of the study indicates that nonrenewable energy increases $CO_2$ in the selected EU countries, while renewable energy condenses $CO_2$.

In another development, study by Shahbaz, Mutascu, and Azim (2014) studied the association among industrial growth, use of energy resource and $CO_2$ for Romania. It finds that industrial performance and energy increases $CO_2$. Cetin and Ecevit (2017) noted that GDP influenced $CO_2$ positively in Turkey. Wang, Zhang, and Wang (2018) investigate the influence of output performance on $CO_2$ in 170 nations. They finds that GDP influence $CO_2$ positively. Meanwhile, Javid and Sharif (2016) explore the influence of financial development (FD), income, energy with trade on $CO_2$ in Pakistan. Outcome shows that FD, income, and consumption of energy promote $CO_2$. In another development, Cetin and Ecevit (2017) reveal that financial progress increases $CO_2$ in Turkey. Charfeddine and Kahia (2019) argued that financial sector performance upsurges the capacity of $CO_2$ in MENA economies. Similarly, Gokmenoglu and Sadeghieh (2019) examine the performance of FD, fossil fuel and growth performance on $CO_2$ in Turkey. The outcome shows linkage among FD and $CO_2$. This outcome is in line with the result obtained by Zakaria and Bibi (2019) that FD increase level of environmental dilapidation in South Africa. However, Dogan and Turkekul (2016) analyze the performance of trade on $CO_2$ in the USA and conclude that trade openness improves environmental quality. Zhang (2018) reaffirms that trade openness influenced $CO_2$ negatively in newly industrialized countries.

From the above it is observed from the reviewed literature most of the studies on nonerasable energy resources and environment are concentrated in developed nations and very few studies in Africa, especially Nigeria. In addition, the use of aggregate of coal, oil and natural gas as measurement of nonrenewable energy consumption has not been much utilized by the earlier studies. Hence, the present study examine the effect of nonrenewable energy consumption using aggregate of coal, oil and natural gas on pollution in Nigeria.

## 3. DATA AND TECHNIQUE OF ANALYSIS

### *3.1. Data*

Yearly data for $CO_2$ per capita (metric tons), non-renewable energy (aggregate of coal, gas and oil consumption in in quadrillion Btu), GDP per capita (current USD), financial progress (domestic credit percent of GDP), foreign direct investment (net inflow percent of GDP) and trade (aggregate imports and exports percent of GDP) from 1980 – 2016. The data on non-renewable energy was obtained from Energy Information Administration (EIA), while other variables were from world development indicator (WDI). For easy interpretation the variable are changed to log. Table 1 denotes the statistical nature of the variables used in the study. It is clearly indicated that GDP obtains greater value for the mean variation and standard deviation.

**Table-1.** Statistical nature of the variables.

| Variables | Min | Max | Mean | SD |
|---|---|---|---|---|
| LCO2 | 4.01 | 4.67 | 4.42 | 0.20 |
| LNRC | 0.26 | 0.89 | 0.29 | 0.25 |
| LGDP | 5.59 | 8.07 | 6.87 | 0.72 |
| LFD | 1.60 | 3.10 | 2.17 | 0.39 |
| LFDI | 1.35 | 1.75 | 0.33 | 0.77 |
| LTO | 2.21 | 3.97 | 3.38 | 0.51 |

### *3.2. Model Specification*

#### *3.2.1. Stationarity Test*

Augmented dicky fuller ADF test was used in the study to be sure about the intergradation order and stationarity level. In addition, Philips Peron (PP) test was also employed to reconfirm the stationary of the variables. Hence, the following equation describe the ADF test:

$$\Delta L_t = \alpha + \theta_{yt-1} + \lambda T + \sum_{j-1}^{k} \sigma_j \Delta L_{t-j-1} + \varepsilon_t \qquad (1)$$

From Equation 1 L signifies the sequence of time t, whereas α denotes the coefficient, k specifies lags as well as $\varepsilon_t$ represents the residual error. Hence, the decision on presences of stationarity or not among the series is lies on the basses of comparison between the ADF and the critical value. Therefore to consider no unit root in the series ADF value most be higher to critical value. Moreover, Equation 2 describe the PP test.

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

In this equation N (t, l) = 1[t/ (1+l)] and l symbolizes the lags

#### *3.2.2. The Model of Analysis*

The link among environmental pollution and the independent variables is analyzed by the use of a modified model of Farhani and Shahbaz (2014) and it is specified in Equation 3.

LENP = f (LNRC, LGDP, LFD, LFDI, LTO) (3)

From the above equation LENP, LNRC, LGDP, LFD, LFDI and LTO indicates the environmental pollution, non-renewable energy utilization, economic performance, financial progress, foreign direct investment and trade, respectively. The study applies Autoregressive Distributed Lag (ARDL) technique for the long-run estimation.

This is for the reason that the method came up with the efficient estimation. Therefore, Equation 4 demonstrates the model.

$$\Delta LENP_t = \lambda_0 + \sum_{j=0}^{n} \lambda_1 \Delta LENP_{t-j} + \sum_{j=1}^{n} \lambda_2 \Delta LNRC_{t-j} + \sum_{j=0}^{n} \lambda_3 \Delta LGDP_{t-j} + \sum_{j=0}^{n} \lambda_4 \Delta LFD_{t-j} + \sum_{j=0}^{n} \lambda_5 \Delta LFDI_{t-j} + \sum_{j=0}^{n} \lambda_6 \Delta LTO_{t-j} + \varphi_1 LENP_{t-1} + \varphi_2 LNCR_{t-1} + \varphi_3 LGDP_{t-1} + \varphi_4 LFD_{t-1} + \varphi_5 LFDI_{t-1} + \varphi_6 LTO_{t-1} + \varepsilon_t \quad (4)$$

Where $\Delta$ represent the difference element, t signifies time and as well as $\varepsilon$ specifies the residual term. Thus, to ascertain the existence of long-run connotation among the variables, F-statistics most be higher than UCB as reaffirmed by Pesaran, Shin, and Smith (2001). Furthermore, the adjustment for the variables to long run is reaffirm by the nagetaive and significant value of error correction term.

## 4. RESULT

It is essential to know the stationary of the variables. Thus,the study applies ADF and PP tests for staionarity. The outcome in Table 2 shows that all the variables are stationary in the first defference.

**Table-2.** Stationarity tests.

| Variable | ADF LEVEL | | PP LEVEL | | ADF First Diff | | PP First Diff | |
|---|---|---|---|---|---|---|---|---|
| LENP | -1.467571 | (0.5383) | -1.489647 | (0.5274) | -6.045920* | (0.0000) | -6.045920* | (0.0000) |
| LNRC | -1.274320 | (0.6308) | -1.065555 | (0.7186) | -8.283121 | (0.0000) | -8.456220 | (0.0000) |
| LGDP | -0.706361 | (0.8325) | -0.806799 | (0.8051) | -6.253656* | (0.0000) | -6.059980* | (0.0000) |
| LFD | -1.522669 | (0.5109) | -1.637134 | (0.4538) | -4.777802* | (0.0005) | -15.35809* | (0.0000) |
| LFDI | -2.492898 | (0.1255) | -2.492898 | (0.1255) | -10.16182* | (0.0000) | -10.1500* | (0.0000) |
| LTO | -2.021591 | (0.2767) | -2.313555 | (0.1733) | -7.314498* | (0.0000) | -7.314498* | (0.0000) |

**Notes:** * signifies statistically significance at one percent level.

Table 3 illustrates The outcome of the bound test. It shows that cointegration exists among the variables since the F-statistc value is higer than the UBC value.

**Table-3.** Outcome of the bound test.

| F-stat | 1%I(0) | I(1) | 5% I(0) | I(1) |
|---|---|---|---|---|
| 8.80 | 3.41 | 4.68 | 2.62 | 3.79 |

Table 4 explains the estimated outcome of the model. Thus, it indicated that in the short-run nonrenewable energy resources, FDI and trade promote environmental pollution in Nigeria. The table further illustrate that adjustment toward long-run is estimated to about 84 percent significant at 1 percent. Furthermore, the long-run estimation reveals that the aggregate of coal, gas and oil became the major influential factor in instigating environmental pollution in Nigeria. This implies that an increase in aggregate of coal, gas and oil by 1 percent results to increase in environmental dilapidation by 0.53 percent. The explosion of emissions from coal, oil and gas is justified in Nigeria due to the fact that the country produce enormous amount of nonrenewable resource that promote higher energy consumption. It means by implication of this outcome environmental pollution increased by 0.53 percent due consumption of coal, gas and oil. Hence, this effect will dependently, endorse high cost in attaining sustainable economic development, reduction in poverty and welfare improvement. Therefore, policymakers should take appropriate policies to enhance environmental quality. This could be achieved through regulations on nonrenewable energy consumption and backed the policies in promoting the use of renewable energy resources, like wind, solar and hydro energy. This outcome is in line with result obtained by Farhani and Shahbaz (2014); Dogan and Seker (2016). Likewise, a 1 percent rise in FDI leads to 0.156 percent increase in environmental degradation. Also, a 1 percent upsurge in trade result in environmental pollution to increase by 0.082 percent. However, it indicates that a percent upsurge in financial progress cause environmental pollution to decline by 0.23 percent.

**Table-4.** Estimated outcome.

| Variables | Coeff | SE | t-Stat | Prob |
|---|---|---|---|---|
| Short run estimates | | | | |
| ΔLNRC | 0.621307** | 0.080847 | 7.684963 | 0.0000 |
| ΔLGDP | 0.061171*** | 0.055329 | 1.105594 | 0.2863 |
| ΔLFD | -0.072849 | 0.057077 | -1.276321 | 0.2213 |
| ΔLFDI | 0.094463** | 0.019814 | 4.767550 | 0.0002 |
| ΔLTO | -0.102062** | 0.031580 | -3.231879 | 0.0056 |
| ECT(-1) | -0.849475 | 0.167596 | -5.068594 | 0.0001 |
| Long run estimates | | | | |
| LNRC | 0.530391** | 0.073723 | 7.194413 | 0.0000 |
| LGDP | 0.072153 | 0.041222 | 1.750321 | 0.1005 |
| LFD | -0.232772 | 0.087512 | -2.659896 | 0.0178 |
| LFDI | 0.156317 | 0.030102 | 5.192935 | 0.0001 |
| LTO | 0.082762 | 0.040654 | 2.035761 | 0.0598 |
| *C* | 3.946651 | 0.194162 | 20.326540 | 0.0000 |

**Notes:** ***, ** as well as * signifies significant of the Coeff on 1, 5 and 10 percent.

Table 5 came up with post estimation checks of the model utilizes in the study. The outcome reveals that the free from heteroscedasticity and serial correlation problems as well as the residual are normally distributed.

**Table-5.** Checks of the model.

| Test | F-statistics | Probability | Result |
|---|---|---|---|
| Breusch-Pagan Test. | 0.539140 | 0.8742 | No Heteroskedasticity |
| Breusch-Godfrey Test | 0.570058 | 0.5773 | No Serial Correlation |
| Jarque-Bera | 0.223489 | 0.8947 | Normally Distributed |

## 5. CONCLUSION

In this study the effect of nonrenewable energy resources, output growth, financial sector performance and FDI on environmental pollution examined in Nigeria through applying ARDL method from 1980 – 2016. The outcome of the study's estimation reveals that all the variables possess the long run association. It is reveal that in both the short-run and long run nonrenewable energy use, FDI and trade increased environmental dilapidation, thereby adversely affect environmental quality in Nigeria. However, financial development improves environmental quality as it reduce environmental degradation.

Hence, policymakers in Nigeria should take appropriate policies to enhance environmental quality through policies that will regulate the use nonrenewable energy and backed the policies in promoting the utilization of renewable energy resources, like wind, solar and hydro energy. This would be very essential in achieving environmental quality, welfare enhancement, poverty reduction as well as sustainable economic development. Meanwhile, the limitations of the present study is on the fact that it does not capture some important factors that may influence environmental quality due to unavailability of data and the study is based on single country analysis. Hence, studies in the future should consider other variables like energy price in their model and to extend their studies on cross country analysis.

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