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Carbon Emissions, Mortality Rate and Economic Growth Nexus in Nigeria

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Abstract:
The paper examined the nexus existing among carbon emissions, mortality rate and economic growth in Nigeria using the annual time series data spanning from 1981 to 2019 by employing the Autoregressive Distributed Lags (ARDL) Model application to cointegration and Error Correction Model techniques. Unit root test was conducted on all the variables of interest in the study. The study finds evidence of a long-run relationship existing among Carbon emissions, mortality rate, education expenditures and economic growth in Nigeria. The findings of this study has implications for energy policy as policy makers and economic planners need to formulate and implement policies aimed at conserving energy use, improving energy efficiency and designing energy demand management in such a way that the Nigerian government should embark on the alternative use of energy that generates less emission of carbon dioxide as this will unequivocally help Nigeria to achieve the sustainable development goals of good health and well-being alongside with affordable, reliable and sustainable use of energy for all. In addition, there is the pressing need for the government and other relevant stakeholders to formulate and enforce policies aimed at curbing the emission of carbon into the environment, given its hazardous, debilitating and deleterious consequences on human health status and the environment as this is believed to go a long way in reducing mortality rate that might be associated with depletion in ozone layer causing exposure to high heat stress, ultraviolet radiation and air pollution in Nigeria.

Keywords: *Carbon emissions, mortality rate, education expenditure, economic growth*

1. Introduction

The process of continuous increase in energy consumption, the rapid economic growth leads to the rise of carbon dioxide emissions. The problem of global climate change caused by the aggravation of greenhouse gas emissions is threatening the survival and development of human beings, which has become a global concern (Zou and Zhang, 2020). Fossil fuel utilization as a source of energy generates carbon-dioxide (Co_2) emissions into the atmosphere. Carbon emissions are defined as those stemming from the burning of fossil fuels which include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. Pollution is basically as a result of carbon emission, otherwise known as carbon dioxide ($C0_2$) (Sanglimsuwan, 2011). The issue of carbon emissions due to increased human activities as well as geometric increase in population is a disturbing phenomenon, which cannot be shoved aside and ignored as it has adverse and disastrous impact on global temperature, environment and human lives (Osadome and University, 2021). Carbon emissions such as burning of fossil fuel, carbon dioxides among others have brought about negative externalities across the globe. This is due to the fact that energy usage, especially fossil fuel alongside manufacturing and construction activities has shown a negative impact on the environment in the form of environmental degradation, poor health outcomes and reduced life expectancy (Matthew et al., 2019; Matthew et al., 2018; Balan, 2016; Mesagan and Ekundayo, 2015).

Industrialization, globalization, population growth and changes in lifestyles are major factors that increase energy consumption. As energy consumption increases, the level of carbon emissions invariably increases due to economic activities for enhanced GDP (Apergis and Ozturk, 2015). In the light of this, Youmanli (2017) argues that economic growth affects the natural chemistry of the environment positively or negatively depending on the composition effect. With over 173 million people, Nigeria is the most populated country in Africa. As the continent's main exporter of oil, Nigeria faces the challenge of balancing global energy demands and domestic economic stability with the need to address climate and environmental considerations (World Health Organisation, 2015). Consumption of fossil fuel has been found to be a critical source of CO_2 emission orchestrating climate change globally and Nigeria has been identified as one of the highest producers and consumers of fossil fuel (Alege et al., 2017). It is important to state that consumption of fossil fuel deteriorates environmental quality and constitutes serious human health implications in the economy. In the same vein, degradation of the environment increases budgetary allocation in terms of health care financing (Balan, 2016). More importantly, Torras and Boyce (2008) said that economic growth leads to the emission of more carbon. This is because

growth results from industrialization, which promotes the consumption of fossil fuels and natural gases. However, the hazards associated with environmental emissions, especially as it relates to the possibility of shortening the life span of people exposed to it, and the depletion of the ozone layer calls for serious concern.

In fact, diminishing and unsustainable economic growth is seen when the quality of life and health status is poor but if otherwise then a fueled upswing of the economy is developed (World Health Organization, 1999). For a stable economy, the united nation layout a vision for 2030 which is known as the '17 Sustainable Development Goals (SDGs)' which part includes good healthcare services that reduce mortality at all level and engender sustainable economic growth. Economic growth, sustainability, education, is a lifetime asset concerning building undiminishing and strong economic development are partnership to achieve the goal. These life-changing goals signify that a healthy population is proportional to the economic growth of the country (Fernandes, 2020; Yaqub, Ojapinwa and Yussuff, 2012).

As such, this study examined the nexus among carbon emissions, mortality rate and economic growth in Nigeria. The remaining part of the paper is structured as follows: Section 2 reviews relevant literature, Section 3 covers the methodology, Section 4 deals with the results and discussions while Section 5 concludes the paper.

2. Literature Review

2.1. Empirical Review

The relationship between economic growth and CO_2 emissions has been the subject of intense research over the years. Many countries are facing a major challenge, namely, to ensure stable economic growth and to protect the environment. The increase of CO_2 emissions is the major factor in the climate change threat. Economic growth of countries propels an intensive and continuous use of energy which results in growing CO_2 emissions; hence pollution is directly linked with economic growth and development. In the light of this, Pao and Tsai (2011) and Zamula, and Kireitseva (2013) found a strong positive bi-directional causal relationship between energy consumption, CO_2 emission, foreign direct investment, and growth in the BRIC countries and Ukraine. Niu, Ding, Niu, Li, and Luo (2011) revealed that there are long-term equilibrium relationships between energy consumption, GDP growth and CO_2 emissions for the eight Asia-Pacific countries. Causality runs from energy consumption to CO_2 emissions, GDP is responsible for the increase in energy consumption, and there is strong causality between GDP and CO_2 emissions over the long run-in developed countries, in contrast to the developing countries where the relationship is not present.

Chang (2010) investigated the causal relationships between CO_2 emissions, energy consumption and economic growth. The results of their study demonstrate bi-directional causality running: from GDP to CO_2 emissions and the consumption of crude oil and coal; and from electricity consumption to GDP. Furthermore, increased GDP growth or energy consumption stimulates CO_2 emissions. Kasperowicz (2015) investigated the relationship between CO_2 emissions and economic growth. They verified that the long-run relationship between GDP and CO2 emissions is negative, because the development of new low-carbon technologies enables in the long-run reaching the same production level at lower CO_2 emissions and that the short-run relationship between GDP and CO_2 emissions is positive, because the fast increase in production can be reached due to more intensive energy use by the existing technologies, then the capacity increases as well CO_2 emissions. Azam, Khan, Abdullah and Qureshi (2016) analyzed the impact in the same vein, Ogungbenle (2021) examined the relationship between energy consumption and manufacturing output in Nigeria using the annual time series data spanning from 1981 to 2019 by employing the Autoregressive Distributed Lags (ARDL) Model application to cointegration and Error Correction Model techniques. The study finds evidence that electricity, premium motor spirit and gas consumption have a positive and significant effect on manufacturing output in Nigeria. In addition, the study reveals that there is long run relationship among electricity, gas, coal, premium motor spirit and manufacturing output in Nigeria. The finding of this study has implications for energy policy as policy makers and economic planners need to formulate and implement policies aimed at conserving energy use, improving energy efficiency and designing energy demand management. Odusanya et al. (2014) assessed the nexus between real per capital health expenditure and per capita CO_2 emissions between 1960 and 2011 in Nigeria. The study posited that both the short-run and the long-run estimates proved that increase in CO_2 emission led to a significant rise in health expenditures. Afolayan and Aderemi (2019) utilized Dynamic Ordinary Least Square (DOLS) and Granger causality approach to evaluate the impact of environmental quality on health effects in Nigeria from 1980 to 2016. - From another perspective, Igbinedion (2019) examined the nexus between environmental emissions and life expectancy using Johansen co-integration and error correction modeling in Nigeria, applying time series data spanning 1990-2016. The finding reveals that environmental emission (proxied by per capita carbon dioxide) is a significant determinant of life expectancy at birth in Nigeria. Also, their results reveal that both improved sanitation facilities and public expenditure on health positively and significantly impact on longevity level in Nigeria. In the same vein, Ogungbenle, Olawumi and Obasuyi (2013) empirically analyzed the relationship existing among life expectancy, public health spending and economic growth in Nigeria. A vector Autoregressive (VAR) model approach was employed in analyzing the data. The results of the study revealed that there is no bidirectional causality between life expectancy and public health spending in Nigeria. In addition, the study also revealed that there is no bidirectional causality between life expectancy and economic growth in Nigeria over the years. However, the study confirmed that there is bidirectional causality between public health spending and economic growth in Nigeria. Nwani, Kelani, Ozegbe, and Babatunde (2018) investigated into the influence of the environment on health status and the effect of health expenditure on Nigeria health status from 1981 to 2017 by ARDL estimation technique. The result points out a significant negative effect of environmental pollution on Nigerians with attendant bad effect of capita CO_2 gas consumption emission on human

health as they confirmed that $C0_2$ emission has a negative and significant impact on life expectancy. Ali and Ahmad (2014) revealed that, in the short-run, CO_2 emissions have inverse and significant relationship with life expectancy at birth.

Zou and Zhang (2020) established a spatial Durbin model including economic growth, energy consumption equation, and CO_2 emissions and studied the dynamic relationship and spatial spillover among economic growth, energy consumption, and CO_2 emissions effects. The results showed that the economic growth can significantly improve carbon dioxide emissions, and China's economic growth level has become a positive driving force for carbon dioxide emissions. However, economic growth will not be significantly affected by the reduction of carbon dioxide emissions. There is a two-way relationship between energy consumption (ENC) and carbon dioxide emissions (CO_2). Energy consumption and carbon emissions are interrelated, which has a negative spatial spillover effect on the carbon dioxide emissions of the surrounding provinces and cities.

Osadume and University (2021) investigated the impact of economic growth on carbon emissions on selected West African countries between 1980 and 2019 by employing Simon-Steinmann's economic growth model which provided the relevant theoretical foundation. The outcome of the study indicates that the independent variable showed a positively significant impact on the dependent variable for the pooled samples in the short-run, with significant cointegration. The study concluded that economic growth significantly impacts the emissions of carbon and a 1% rise in economic growth will result to 3.11121% unit rise in carbon emissions.

Conversely, Saidi and Hammani (2015) reported that a positive and statistically significant relationship exist between CO_2 and energy consumption in the four panels considered. This outcome is similar to that of Delavari, Zandiyan, Razaei, Miradinazar, Delavari, Sabor, and Fallah (2018) for Iran, and Amuka, Asogwa, Ugwuanyti, Omeje and Onyechi (2016) for Nigeria, with both studies confirming that CO_2 emission tend to have a positive but insignificant association with life expectancy at birth in Nigeria. Alhasan, Agabo, Adedoyin and Bekun (2020) employed recent annual time-series data to conceptualize the hypothesized claim via Pesaran's Autoregressive distributed lag techniques. Empirical findings from the bounds test traces the long-run relationship between public health expenditure and economic growth over the study span. However, unlike previous studies, they introduced life expectancy and death rates in the model framework. Although health expenditure is not significant, empirical results show that a 1% increase in life expectancy and death rate increases and decreases economic growth by 3.85 and 1.84%, respectively.

Most of the empirical studies in the literature focused on either testing the nexus between real per capital health expenditure and per capita CO_2 emissions and economic growth or examining the direction of causality among these variables while few empirical studies have been carried out in this context in Nigeria. However, a general observation from these empirical studies is that the literature produced conflicting results and there is no distinct and consensus on the nexus existing among CO_2 emissions, mortality rate and economic growth in Nigeria as few past studies have been inconclusive as to what type of relationship might exist among these macroeconomic variables in Nigeria. In order to bridge the identified knowledge gap, this study empirically investigated into the relationship among CO_2 emissions, mortality rate and economic growth in Nigeria.

2.2. Theoretical Framework

However, emphasizing on the pollution-growth relationship, Forster's growth and pollution model assesses some major factors. Batimoore and Tudok (2010) said the three major factors are considered in this model. These include large direct effects of pollution on growth, high technology side which enhances growth, and rapidly inclining marginal utility of consumption which puts more pressure on industrial production. This model could be stated explicitly as follows:

$GDP = \alpha_0 + \alpha_1 POL + \alpha_2 TCH + \alpha_3 CON + \varepsilon_i$ ……1

According to Batimoore and Tudok (2010), pollution has negative effect on growth, while technology and consumption have positive effects on growth.

3. Methodology

3.1. Model Specification

A multiple regression model is specified in this study to assess the nexus among carbon emissions (CO_2), mortality rate (MOR), education expenditure (EDX) and economic growth (GDPR). This is specified implicitly as follows:

$GDP = f(CO_2, MOR, EDX)$ ……2

Linearizing the above growth model and stating it in explicit form, we will have:

$GDP = \alpha_0 + \alpha_1 CO2_t + \alpha_2 MOR_t + \alpha_3 EDX_t + U_t$……3

3.2. Description of Variables

From the model specified above, the specific variables used in the study are described below.

GDP t = Gross Domestic product which captures economic growth

CO2 t = CO2 is emissions of Carbon dioxide (in kiloton) from consumption of solid, liquid and gas fuel

MORt = Mortality rate measured as number of deaths occurring in a given population at risk during a specified time period usually expressed as deaths per 1,000 persons per year

EDXt = EDX is used to capture government education expenditure which is measured as proportion of total government expenditure spent on education. It is expressed in percentage.

Ut = Ut is error term.

The expected signs of the explanatory variables on economic growth are discussed as stated below:

The 'a priori' expectation is that: $\alpha_1 < 0$, $\alpha_2 < 0$ and $\alpha_3 > 0$. This implies that the coefficient of carbon emissions, burning of fossil fuel (energy from fossil fuel) negatively affect economic growth, meaning that their estimated coefficient should be less than one, but greater than zero.

This literally means that, fossil fuel and carbon emissions, when inhaled has a negative effect of human health which invariably reduces life expectancy as it increases mortality rate while education expenditure has positive impact on economic growth.

3.3. Estimation Techniques

3.3.1. Unit Root Test

The stochastic characteristics of each time series will be tested at levels for stationary in this study using Phillip-Perron unit root test.

3.3.2. Autoregressive Distributed Lag (ARDL) Approach to co-integration Test

This study employs the autoregressive distributed lag approach to co-integration (ARDL) proposed by Pesaran, Shine and Smith (2001) to investigate the linear empirical model specified in equation 2. The implementation of the ARDL test for Equation 2 involves the estimation of the following model:

$GDPR_t = \phi_t + \phi_1 CO2_{t-1} + \phi_2 MOR_{t-1} + \phi_3 EDX_{t-1} + Ut$ ……4

Where, GDPRt, CO2t, MORt, EDXt are stationary variables and Ut is a white noise.

The final step is to obtain the error of the short-run dynamic elasticities by estimating an error correction model associated with the long run estimates. This is specified as follows:

$\Delta GDPR_t = \boldsymbol{C} + \sum \boldsymbol{\Pi} \Delta GDPR_{t-1} + \sum \Omega \Delta CO2_{t-1} + \sum \mu \Delta MOR_{t-1} + \sum \boldsymbol{\beta 3} \Delta EDX_{t-1} + + \boldsymbol{\lambda ECM} \sum_{t-1}$ ……5

The symbols $\boldsymbol{\Pi}$, Ω, μ, β, and γ are the short run dynamic elasticities of the model's convergence to long run equilibrium and λ is the speed of adjustment. Δ represents the first difference operator and ECM_{t-1} is the one period lagged error correction term.

$\Delta GDPR_t$ is the change in current Economic growth, $\Delta GDPR_{t-1}$ is the change in previous Economic growth, $CO2_{t-1}$ is the lagged Carbon emissions, ΔMOR_{t-1} is the lagged Mortality rate, ΔEDX_{t-1} is the lagged Education expenditure.

Source and Nature of Data

The data used in the study are mainly secondary in nature. The major source is World Economic Indicators.

4. Results and Discussions

4.1. Testing the Stationarity of the Series using Unit Root Test

Series	At Levels		1st Difference		Level of Integration
	Statistics	Probability	Statistics	Probability	
GDPR	0.0058	20.8063	0.0000	122.294	1(0)
CO_2	0.0254	20.8063	0.0000	122.294	1(1)
MOR	0.8077	20.8063	0.0000	122.294	1(1)
EDX	0.2562	20.8063	0.0000	122.294	1(1)

Table 1: Phillip-Perron Unit Root Test
Source: Author's Computation (2022)

The result in Table 1 confirms that GDPR is stationary at level while CO_2, MOR and EDX are integrated of order one which indicates that the condition for Johansen cointegration is not met. Therefore, the Bounds Testing (or Autoregressive distributed lag (ARDL) cointegration procedure is adopted.

4.2. Testing the Long-run Relationship among the Series

F- Statistic	7.255553	
K	3	
Level of Significance	I(0) Bound	I(1) Bound
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Table 2: Co-integration Test based on Bound Test for GDP
Source: Author's Computation (2022)

This result in Table 2 indicates the rejection of the null hypothesis of no cointegration between the dependent variable, GDPR and all the explanatory variables in the model implying that the estimated model for Economic growth establishes that the fact that a valid long-run relationship is found in the bound test. This is because the F-statistic value of

7.255553 is greater than the critical values at both the lower bound (2.79) and upper bound (3.67) using 5% significant level. Based on this, the study confirms that there is evidence of a long-run relationship existing among CO_2, MOR, EDX and GDPR in Nigeria.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
GDPR	-0.836968	0.147771	-5.663938	0.0000
CO_2	-15.33714	9.096965	-1.685962	0.1029
MOR	85.67976	105.2744	0.813871	0.4226
EDX	6.22E-11	6.59E-10	0.094290	0.9256
C	15.36140	6.980289	2.200682	0.0362
R-squared	0.613746	Mean dependent var	0.217409	
Adjusted R-squared	0.589605	S.D. dependent var	4.872036	
S.E. of regression	3.121126	Akaike info criterion	5.196081	
Sum squared resid	311.7257	Schwarz criterion	5.329397	
Log likelihood	-87.93142	Hannan-Quinn criter.	5.242102	
Durbin-Watson stat	1.701347			

Table 3: Estimated Long-run Coefficients using ARDL Technique
Source: Author's Computation (2022)

The estimated long-run coefficients for ARDL model in Table 3 confirms that in the long-run, Carbon emissions (CO_2) at -1.69 t-statistic value has a negative impact on economic growth in Nigeria. Furthermore, mortality rate (MOR) at 0.81 t-statistic was found to have a positive and significantimpact on economic growth in Nigeria at 5% level of significance. In addition, government expenditure on education (EDX) at 0.09 t-statistic has a positive and insignificant impact on economic growth in Nigeria at 5% level of significance.

4.3. The Short-run Dynamic Relationship among the Series

ARDL Error Correction Regression				
Dependent Variable: D(GDPR)				
Selected Model: ARDL (1, 1, 0, 1)				
Sample: 1981-2019				
Included observations: 35				
ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(CO_2)	3.480102	6.082968	0.572106	0.5718
D(MOR)	3.71E-09	1.01E-09	3.662783	0.0010
CointEq(-1)*	-0.836968	0.129985	-6.438967	0.0000
R-squared	0.613746	Mean dependent var	0.217409	
Adjusted R-squared	0.589605	S.D. dependent var	4.872036	
S.E. of regression	3.121126	Akaike info criterion	5.196081	
Sum squared resid	311.7257	Schwarz criterion	5.329397	
Log likelihood	-87.93142	Hannan-Quinn criter.	5.242102	
Durbin-Watson stat	1.701347			

Table 4: Short-Run Dynamic Relationship among the Series Using ARDL Error Correction Regression
Source: Author's Computation (2022)

Table 4 confirms the error correction term is well defined since it is negative and statistically significant at 5% significant level which further affirms the presence of long-run relationship between Economic growth and all the independent variables in Nigeria. The coefficient is -0.836968 which implies that about 84% of any disequilibrium in economic growth (GDPR) is corrected by the explanatory variables within one period (one year). This also shows the speed at which the model converges to equilibrium.

4.4. Testing for Structural Stability

In order to test for the stability of the model used in this study, we applied the recursive test, cumulative sum of the recursive residuals (CUSUM) and cumulative squares of the recursive residuals. The test finds parameters instability if the plots of the Recursive test and cumulative sum of the recursive residuals (CUSUM) go outside the area between the two critical lines. Theplots are shown in figures 1, 2 and 3 below:

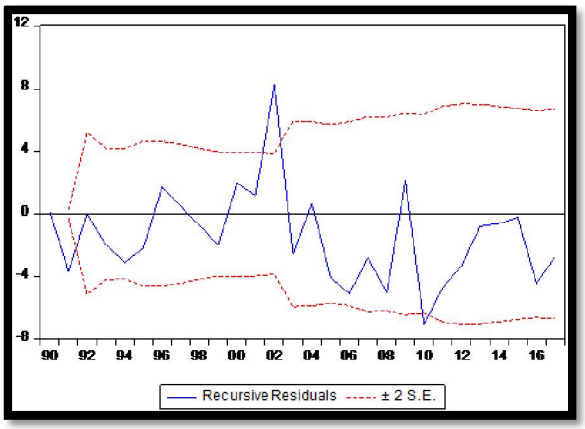

Figure 1: Recursive Test for Structural Stability of the Parameters

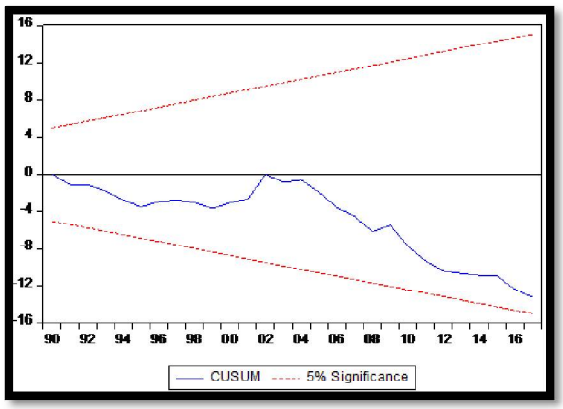

Figure 2: CUSUM Test for Structural Stability of the Parameters

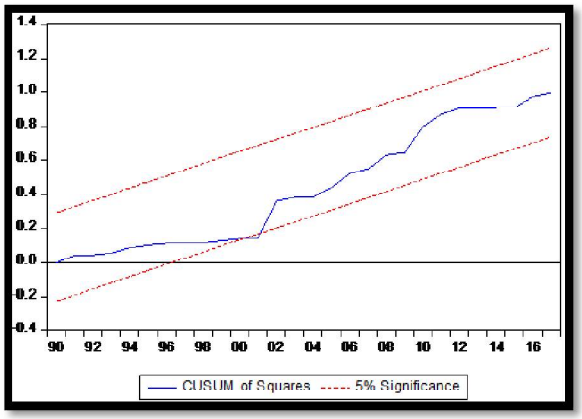

Figure 3: CUSUM of Squares Test for Structural Stability of the Parameters

As shown in fig 1, fig 2 and fig. 3, the results are suggestive of coefficient stability since the plots did not move outside the 5% critical bound. This confirms the existence of coefficient stability for the estimated parameters for the short run dynamics and long run of economic growth function over the sample periods as the results indicate tendency of further coefficients stability. One can conclude that the model is well estimated and the observed data fit the model specification adequately, hence the coefficients are valid for policy discussions in Nigeria.

5. Discussion of Findings

Carbon emissions have a negative and significant relationship with economic growth in Nigeria. This result is in congruence with Kasperowicz (2015) who confirmed that Carbon emissions have a negative and significant relationship with economic growth. This is in contrast with Pao, Tsai (2011) and Zamula, and Kireitseva (2013) who found a strong positive bi-directional causal relationship between energy consumption, CO_2 emission, foreign direct investment, and growth in the BRIC countries and Ukraine. In the same vein, Mortality rate has a positive and significant relationship with economic growth in Nigeria. Nevertheless, government expenditure has a positive and insignificant impact on economic growth in Nigeria.

The study also confirms that there is evidence of a long-run relationship existing among Carbon emissions, mortality rate, education expenditures and economic growth in Nigeria. This result is in congruence with Niu, Ding, Niu, Li, and Luo (2011).

6. Conclusion and Policy Recommendations

The findings of this study has implications for energy policy as policy makers and economic planners need to formulate and implement policies aimed at conserving energy use, improving energy efficiency and designing energy demand management in such a way that the Nigerian government should embark on the alternative use of energy that generates less emission of carbon dioxide as this will unequivocally help Nigeria to achieve the sustainable development goals of good health and well-being alongside with affordable, reliable and sustainable use of energy for all. The government should embark on the sensitization of the Nigerian populace on the need for a clean environment more importantly as it affects their health status and can increase mortality rate.

Government expenditure has a positive and insignificant impact on economic growth in Nigeria. The findings ascertain that education expenditure is a key macroeconomic variable that can improve the economic growth and development of the Nigerian economy. Since it is clear that the education sector in Nigeria is underfunded, this is a clarion call on the government to increase expenditure on education substantially so as to provide basic educational facilities and infrastructures that guarantee human capital formation in order to enhance sustainable economic growth in Nigeria. This indicates that Nigeria could achieve higher level of productivity from well trained, skilled and quality labor force if more investments are directed towards improving the education sector which will invariably translate to an increase in the productive capacity of the country and consequently an increase in economic growth.

There is the pressing need for the government and other relevant stakeholders to formulate and enforce policies aimed at curbing the emissions of carbon into the environment, given its hazardous, debilitating and deleterious consequences on human health status and the environment as this is believed to go a long way in reducing mortality rate that might be associated with depletion in ozone layer causing exposure to high heat stress, ultraviolet radiation and air pollution in Nigeria.

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