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CARBON EMISSION AND POPULATION GROWTH: EVIDENCE FROM THE MAGNA CUM LAUDE OIL PRODUCING AFRICAN COUNTRIES

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Abstract. Ample amount of scientific effort has been applied to question the potentials of fossil fuel combustion and other carbon emission sources which in turn has impact on human population growth. This study sought to find the extent of which carbon emissions impact population growth among the Magna cum Oil producing Africa countries. The study utilises panel data analysis within the sample period: 2000–2019 using the Pooled Ordinary Least Squares and the Feasible General Least Square. The results of the research revealed the existence of a significant and negative relationship. This therefore, makes this subject an issue of critical policy interest and requires immediate actions and makes this research very significant in recent times as it considers several countries within the study's scope.

1. Introduction

Economic activities have been seen to promotes wealth creation however, it has continued to leave behind negative and harmful effects on the environment. The industrial and production structures and systems used in recent times in the industrialized countries create and generate enormous quantities of waste materials and contamination, resulting in and triggering degradation to natural resources and the eco-system in general. These effects are more severe when attended by demographic growth, given that population increases lead to rises in consumption of energy and consequently increase in levels of atmospheric pollution. Africa's population is on a steady growth rate same as its environmental challenges which mostly arise from its Natural resources [1]. The case of when the resources become a curse justifies the position of Magna cum Laude oil Africa producing countries which consists of Nigeria, Angola, Egypt, Algeria, Libya, Gabon, Sudan, Equatorial Guinea, Republic of Congo and South Africa.

With all evidence abounding, it is clear that global warming is principally produced by means of emitted greenhouse gases (GHG), mainly from industrial, production, agricultural, and transportation activities. Carbon emissions are the foremost contributor to the total GHG emissions (Intergovernmental Panel on Climate Change (IPCC), 2015). According [2], GHG constitutes over 60 percent of the carbon. Furthermore, Yunfeng and Laike (2010) stated that 72 percent of global warming effects is as a result of carbon emissions. [3] states that one of the significant effects of emissions of carbon is the rise in temperature, which resultantly causes sea level rises from current/thermal expansion of the water. This has produces floods in various regions that has resulted drownings, loss of properties, injuries and ultimately loss of several lives. Likewise, increasing temperature implies an intensifying sea level via the buildup of thaw water flowing into the seas from glaciers melting, this poses a great peril both economically and socially. Rising sea levels result in cumulative coastal erosion, high level flood occurrences, the damage of properties and high probability of loss of lives in lowland coastal countries whom consist our study.

More recently, oil producing Africa countries of the magna cum laude class aim for advanced economic growth through the execution of some set plan which necessitates advanced energy consumption for industrial production. Implying the salient part played by energy in the growth of the economy of all countries. According to [4], a crucial driver in the growth of economies founded on the economic growth hypothesis is energy use, this theory which unswervingly supports that labour and capital are major factor inputs in production processes. Furthermore, the search for growth has continuously made many countries to increase their consumption of energy to meet up with their productive capacities. Simultaneously, a rise in energy consumption is credited to rising levels of emissions and as empirically reported by [4-9]. The drive for growth and the carbon-rise impact indirectly has an impact on the health of the population / labour force which is a literature gap not yet explored in the literature.

Drawing from the above, the study makes an inquiry into the nature of impact of these rising carbon emissions on population. The study specifically addresses the extent to which carbon emission crude oil spillovers affect population of the magna cum laude oil producing Africa countries What coping strategies or mechanism are available in addressing this critical peril that has been regarded salient? The study however, utilises the pooled ordinary least squares and feasible generalized least squares. The remainder of the paper is patterned following [10] as follows. Section two presents the issues relating to literature surrounding carbon emission and population growth; the third section presents the research methodology as is appropriate for the study; Section 4 provides the empirical results. The fifth section of the study gives the conclusion and section 6 the recommendations of the study.

2. Literature Review

Theoretical and empirical studies linking carbon emission and population growth have been related research which a major part carried out were focused either on an energy consumption–growth nexus or on an energy consumption–carbon emissions growth nexus.

[11] started the search of the relationship existing between energy use and the levels of income using United States' data cover time period from 1947 to 1974 period. This has been a springboard for other several empirical studies across different regions and in various countries of the world. Some of the various studies include [12-18]

Furthermore, [19] studied the causal relationship between economic growth, carbon emissions and energy use in some carefully chosen 19 European countries from year 1960 to 2005. Using the ARDL approach and the error-correction Granger causality test, findings from the study shows the evidence of a long-run relationship between levels of energy use, carbon emissions and real GDP in Switzerland, Portugal, Germany, Italy, Iceland, Greece and Denmark. It shows that there exists a unidirectional causality is existing in these countries. Similarly, another empirical study by [20] explored the causality between levels of economic growth, energy consumption levels and pollutant emissions in South Africa from the year 1995 to 2006. The research work also used the ARDL bounds test approach, the study discovered that a long-run relationship exists between the variables used and a bi-directional causality runs from energy consumption to pollutant emissions and also from pollutant emissions and levels of energy consumption to economic growth.

Using a panel data study, [21] observed the relationship existing between energy consumption, real GDP and carbon emissions in 12 selected middle-income countries in the east and north of Africa (MENA) from 1981-2005. The applied bootstrap panel method was used in the study and results revealed, there is a significant positive impact of levels of energy consumption on carbon emissions. Additionally, [22] studied the effect of energy consumption, population density, levels of economic growth and trade openness on carbon emissions from year 1970- 2013 in India.

[23] the coefficient of the energy use is significant and positive, and this was consistent with the coefficient of the long-run ARDL estimators. Nevertheless, the effect of the growth in levels of population is insignificant on the levels of carbon emissions for the economy of Malaysia. According to a UN study states that an extra of 1 to 2 billion tonnes in quantity of carbon dioxide is expected to be released each year as human population grows by about 2.2 billion people in 2050 - the United Nations "medium-growth" synopsis — an extra quantity level of 1 to 2 billion tonnes of carbon dioxide is very likely to be emitted yearly, when compared with a "low-growth" situation which results in 8 billion people as against 9 billion people by 2050.

Conclusively, relevant literature on carbon dioxide to population nexus largely focused on relating pollutant emissions, energy consumption levels and economic growth or GDP. The closest to this study observed the role of population on carbon emission. Nevertheless, the activities of human beings like deforestation, ranching, bush burning and other activities are alleged to aid GHG emissions, primarily the carbon component. The earlier mentioned activities are presumed to additionally surge with population growth but while examining the reverse case, there is uncertainty about the nature of relationship between carbon dioxide and population. In agreement with this reasoning, this research study aims to fill this gap by examining the impact of carbon emissions on the levels on growth in population empirically.

3. Methodology

3.1. Empirical Model Specification

In line with both theoretical and empirical literature, the general model specification of the population growth function as adopted from [24] is shown in equation 1.

$$PGR = f\,(CBN, EI, EU, GDPGR, GDPPCGR) \qquad (1)$$

Where population growth is used as the dependent variable expressed as PG, CBN is carbon emissions, EI is energy import, EU is energy use/usage, GDPGR is Gross Domestic Product growth rate and GDPPCGR is Gross Domestic Product per capita growth rate. The expression in equation 1 is presented in equation 2 as an econometric estimation model to give:

$$PGR_{it} = \beta_1\, CBN_{it} + \alpha_i + \beta_2 EI_{it} + \beta_3 EU_{it} + \beta_4 GDPGR_{it} + \beta_5 GDPPCGR_{it} + \mu_{it} \qquad (2)$$

3.2. Technique of Estimation

3.2.1. Pooled Ordinary Least Squares (POLS). Panel data analysis is referred to as the statistical analysis of data set containing or consisting multiple observations on each sampling unit. It is a combination of a variety of cross-sectional units (cross sectional data) over time (time series). Three (3) generally acceptable methods of regression could be utilised for basic panel data and these include: pooled OLS, fixed and random effects. The POLS is a pooled linear regression without any fixed and/or random effects. This technique assumes constant intercept term and slopes regardless of the group and the time period. A pooled OLS is a stationary balanced panel. This method of estimation, does not recognize the distinct heterogeneities in the data. We assume that the cross-sectional units or groups are the same, that is the cross-sectional units in data exhibit the same characteristics. It is homogenous. No dummies/ dummy variables are required. This study is using a sample of 10 countries and 40 time periods. This model has a common intercept and can be expressed:

$$y_{it} = \beta_0 + \beta_1 x_{it,1} + \beta_2 x_{it,2} + \beta_3 x_{it,3} + \beta_4 x_{it,4} + \beta_5 x_{it,5} + \varepsilon_{it} \quad (3)$$

Note: β_0 is the intercept term, β_1 is the slope or coefficient or parameter estimate of carbon emissions, β_2 is the slope of energy imports, β_3 is the slope of energy use, β_4 is the slope of GDP growth rate, β_5 is the slope of GDP per capita growth rate, and ε is the error term. Here, only significant coefficients are interpreted giving the ceteris paribus argument. This holds on the premise that we do not reject the null hypothesis stating that the individual-specific and time-specific error variance components are equaled to zero, that is H_0: σ^2.

3.2.2. Feasible Generalized Least Squares (FGLS). The Generalized Least Squares is an estimation technique used in the presence of heteroscedasticity to correct for heteroscedasticity. Here the expected value of the square of the error term (variance of the error term) is not constant. This reflects a problem as a result of having observations with high variability and low variability. The importance of the observations in the sample varies, as observations in areas of low variability are more important than observations in populations of high variability. This results in the need to assign weights to the observations [25]. However, the FGLS could be biased as it is not centered around the true population parameters in a finite sample. Additionally, in larger samples like this study sample (where N>50) it is asymptotically unbiased, this implies that it is consistent (BLUE). This therefore makes the FGLS appropriate for this study [25-26].

3.3. Data and Variable sources

This study utilises panel data for the selected macroeconomic variables to examine the carbon emissions – population nexus within selected African countries. The time dimension for the dataset spans 15 years (2000 – 2019). The magna cum laude oil Africa producing countries which consists of Nigeria, Angola, Egypt, Algeria, Libya, Gabon, Sudan, Equatorial Guinea, Republic of Congo and South Africa. The variables' identifiers, definitions, indicators, and the source of data are presented in Table 1. The average population density and population growth rate are found in the Appendix section.

Table 1: Variables Definition, Mean and Source of Data

Data	Data Source	Measurement
Carbon dioxide emissions	[27-36]	Metric tons per capita
Energy Usage	[27-36]	KG of Oil Equivalent per capita
Energy Import	[27-36]	Percentage of Energy Use
Gross Domestic Product growth rate	[27-36]	Annual percentage
Gross Domestic Product per capita growth rate	[27-36]	Annual percentage
Population Density	[27-36]	People per square kilometer
Population growth rate	[27-36]	Annual Percentage

Source: Compiled by the Authors

4. Results and Discussion

4.1. Econometric Estimation

Based on the study's objective to find the impact of carbon emissions on population in the selected region, the POLS and the FGLS techniques of estimation were utilised as discussed in section 3. The POLS and the FGLS results were similar in terms of the findings. The results reported a significant negative effect of carbon emissions on human population in the selected top 10 oil producing countries.

Table 2: Panel Estimation Results (Dependent Variable: Carbon Emission)

	POLS	**POLS**	**Robust POLS**	**FGLS**	**FGLS**
Dependent Variable	Population Growth rate	Populatio Growth ra	Population Growth rate	Population Growth rate	Population Density
Carbon dioxide	-0.02* (-4.13)	-0.34* (-11.46)	-0.34 (-14.01)	-0.10 (3.29)	0.09 (0.08)
Energy Import	-0.0003 (-1.14)	-0.0005* (-2.65)	-0.0005 (-2.78)	0.0003 (1.56)	
Energy Usage	0.00005* (3.70)	0.0005* (5.31)	0.0005 (6.34)	0.000007* (0.06)	-0.008 (1.05)
Gross Domestic Produc Growth Rate	0.914* (84.7)	0.0015 (0.44)	0.0015 (0.22)	-0.0004 (0.15)	
Gross Domestic Produc Per capita growth rate					0.13 (1.47)
Population Density	-0.0004 (-2.99)	-0.002 (1.89)	-0.002 (-3.22)		
Constant	0.16*	2.73*	2.73*	2.85*	16.54
F-statistics	3922.01	51.30	65.22		
Prob> F	0.000	0.000	0.000		
Wald Chi2(5)				289.27	11.36
Prob> chi2				0.000	0.02
Corr (u_i, Xb)				0	0
R Squared	0.99	0.69	0.69		
Adj R Squared	0.99	0.67			
Root MSE	0.06	0.49	0.49		

Note: The values in the round parenthesis '()' are the t statistic values; * denotes that the coefficients are significant at 5percent level. **denotes that the coefficients are significant at 10 percent level. POLS: Pooled Ordinary Least Squares; GLS: Generalised Least Squares

From the results of the above POLS regression analysis, this model fits the data at 5 percent level of significance (F= 42). An R^2 of 0.67 to 0.99 reveals that the model accounts for about 67 percent to 99 percent of total variations in the population growth rate. Also, at 5 percent significance level (F= 21.04), an R^2 of 0.24 shows that the model accounts for 24 percent of the total variance in the population density. This shows that holding all other variables constant, there is a constant growth in population levels by about 0.16 to 2.75 units. This implies that given zero carbon emissions, zero energy imports, zero energy use, zero GDP growth rate, zero GDP per capita growth rate, each country is expected to have a growth in population by 2.75 units at 5 percent significance level.

Furthermore, if all other variables are held constant, one unit decrease in carbon emissions result in a rise in population growth by 0.02 units to 0.34 units on the average. Also, whenever energy imports decrease by one thousand units, population growth increases by 3 units to 5 units on the average, holding all other variables constant at 5 percent significance level. All other variables held constant; a ten thousand units rise in energy use results in a rise in population growth by about 2 units on the average at 5 percent significance level. If GDP growth rate increases by one thousand units, population growth rises by about 4 to 15 units, holding all other variables constant at 5 percent significance level.

Based on this result we see that a significant connection and relationship exists between population growth and carbon emissions in the top 10 oil producing countries in Africa. This relationship however, negative shows similarity with the study carried out by [37]. We can also see in the study by [38] that a negative relationship exists between carbon emissions and numbers of premature deaths in India and China specifically, with these effects too in USA and a few other countries, Europe, Russia and east Asia having same results however different sources. Nevertheless, the overall impact of carbon emissions on population growth proves significant and negative.

5. Conclusion

The study was motivated by the unclear and multidirectional argument on the relevance of carbon emissions on population in the top oil producing countries in Africa. The selection of these countries was informed by the relatively high carbon waste emissions by these countries within the African region and the relatively high population. The study utilized panel data for the selected 10 African countries within the period 1980 to 2019. This study supports the argument that continuous increase in carbon emissions leads to a negative effect on the human population of these countries and this poses threats for the general African populations as there are no air pollution restrictions across borders.

6. Recommendation

This study findings have shown the negative impacts of carbon emissions on population growth. This implies that there is a major threat to population level at the expense of high levels of fossil fuel production processes and high-level industrializations amongst others that produce carbon dioxide and this is harmful to the population. Therefore, it must be the quick next step on the part of the government to switch to renewable sources of energy and production. This helps to reduce the levels of carbon emissions and pollution and preserve human life.

This study recommends that several urgent actions and measures be taken towards capping, monitoring and limiting carbon emissions like that of the International Panel of Climate Change's (IPCC) recommendation should be implemented seriously with full enforcement of the penalties for African countries to save the future of the human race (population).

As suggestions for future studies, examining the impact of carbon emissions on rural development could extend this study. Furthermore, research could be done on the impact of other greenhouse gases on population growth, life expectancy and other crucial variables in the sub-Saharan region. Also, this study could be extended by conducting a comparative study on the role of CO2 emissions on rural populations in Africa and other continents. Finally, the investigation of whether the carbon has significantly affected the mortality rate of the top ten oil producing nations in Africa should be taken up especially by researchers in the medical sciences for a significant contribution to knowledge

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APPENDIX

List of Countries and Average Population Density and Growth Rates

Country	Year	Average Population density	Average Population Growth rate
Algeria	2000 to 2019	15.05558	1.691205
Angola	2000 to 2019	18.38258	3.492622
Congo, Dem. Rep.	2000 to 2019	28.05743	3.182814
Egypt, Arab Rep.	2000 to 2019	82.64792	1.9838
Equatorial Guinea	2000 to 2019	32.8982	4.268019
Gabon	2000 to 2019	6.276521	2.997594
Libya	2000 to 2019	3.442854	1.240786
South Africa	2000 to 2019	41.95928	1.393588
Sudan	2000 to 2019		2.373818