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IS GROSS DOMESTIC GROWTH A CAUSE OR A SOLUTION FOR ENVIRONMENTAL DEGRADATION?

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ABSTRACT
The main aim of this article was to examine the relationship between GDP and Carbon emissions by answering the question 'Is Gross Domestic Growth a Cause or a Solution for environmental degradation?'Ordinary Least Square regression model was used because only one variable was included in the study. Regression analysis was conducted both independently and collectively for China and Kenya. China was selected to represent the high– income economies and also because, it is one of the greatest emitters of Carbon dioxide to the environment according to World bank data. Kenya was selected to represent the lower–middle income economies. The study found out a positive significant relationship between GDP and Carbon emissions for both Countries. Carbon emissions in high income economies however increased more rapidly compared to low income economies.Based on these findings, it can be observed that, growth of the economy does not guarantee investments in green technologies and projects that help reduce environmental degradation. It is therefore, recommended that governments must put in place deliberate initiatives to accelerate green investments and innovations to match economic goals with sustainable goals.

KEYWORDS: *Economic Growth, Carbon Emissions and Environmental Degradation.*

1. Introduction

Global warming has become a serious threat to the world's economy, human survival and the environment at large. Increased level of carbon emissions as a result of human economic and industrial activities play a big role in accelerating global temperatures. The effect of human activities to the environment is measured in form of the greenhouse gases (GHS). Carbon dioxide (CO_2), one of the (GHS) has received great attention as a popular measure of effects of climate change due to its

significant contribution to greenhouse gases. According to IPCC (2013), CO_2 accounts for about 76.7% of the greenhouse gases and therefore, measuring the causes of CO_2 is vital in understanding the effect of economic activities on the environment.
There are several studies carried out seeking to examine the causal relationship between economic development and Carbon dioxide (CO_2) emissions. According to Menyah and Wolde- Rufael (2010), understanding the relationship between economic development and CO_2 is important especially in designing the corresponding policies such as those relating to energy conservation and reducing carbon emissions.Some studies have identified a positive relationship between these two variables while others argue that there exist a bi-directional casualty relationship and that environmental degradation is non-avoidable. It is clear that there lacks consistent conclusions among the existing literature on this issue a reason why the linkage between these two variables is among the most debated topics among the scholars.
Dogan et al., (2019), Wang and Lee (2012) and Romero & Gramkow (2021)observes that the production structure of a country contributes to the the volume of CO_2 emitted to the environment. Hidalgo et al., (2007) adds that each country has a different production structure and so is its production and technological capability.Dinda (2004), adds that countries have continued to change their production structures over time due to changes in technology and as a result causing a major shift from agriculture to industry. This shift in return leads to extensive consumption of fossil fuels which have a harmful effect on the environment.For instance, manure derived from animals was traditionally used as fertilizers for agricultural production but in the modern agriculture practice, chemical fertilizers have replaced the organic animal manure (Gozgor & Can, 2016).
Neagu and Teodoru (2019), notes that there is great need to conserve energy and increase its efficiency. Chiu and Lee (2020), notes that innovation of green technologies has played a great role in reducing the negative effects on the environment. As a result, there has been redistribution of factors of production and emergence of new energy conserving technologies such as hydroelectricity and solar panels which are beneficial to the environment.As observed, past literature establishes a linkage between the economic activities and climate change which is popularly measured using CO_2 emissions to the environment. This paper therefore seeks to enhance more understanding on the relationship between the economy and climate change by examining the specific relationships between various macroeconomic factors such as GDP, population and unemployment levels on the level of Carbon emissions to the environment.

2. Literature Review

2.1 Theoretical Framework

2.1.1 The Environmental Kuznets Curve Theory (EKC)

This theory dates back to the year 1992 and was first recognized in the World Development Report of the same year. The theory attempted to explain the relationship between Sulphur dioxide concentration and the GDP per capita in 31 countries. The theory follows a U-shaped relationship between Sulphur dioxide concentrations and per capita income whereby a positive relationship was identified up to a certain pointafter which an opposite trend was observed. This observation was similar to that identified by Kuznets (1955), who found a similar correlation between economic growth and income inequality.

The EKC theory was based on the observed transition of agriculture based economy to industrialization.It was observed that pollution increased as industrial production increased in the urban areas.The industrialized system was later phased out with high-technological centered production system a transition that helped to decrease pollution. Dinda (2004), argues that these innovations were motivated by the high demand from the consumers for clean climate as well as the high political pressure to conserve the environment. Grossman & Krueger (1991) referred the consequent increase in pollution and economic growth as the *scale effect*. Economic growth demanded more inputs and therefore, there was increased utilization of the natural resources and consequent rise in pollution due to increased output. The later transition was described as *technological effect* and was characterized by increased efficiency which counteract the *scale effect* by reducing the level of pollution. According to Komen et al., (1997), amore efficient production system requires less input, results to less pollution creating the diminishing effect of pollution. It was therefore, economically viable for companies to invest more resources in research and development as the technological innovations aligned economic development goals to those of sustainability environment.

2.1.2 The Brundland Curve

The Brundland curve also presents a different view regarding the relationship between economic growth and the environment (Kumar & Kumar, 2017). The authors of the Brundland curve argued that environmental degradation is initially high for the poor countries and continues to decrease as the economies continue to grow up to certain turning point where environmental degradation starts to decrease. Unlike the EKC curve which identifies a consistent increase in environmental damage with increase in the level of carbon emissions, Brundland Curve is based on a U-shaped relationship.

The theory argues that poor countries lack enough resources to invest in the well-being of the environment. The poor economies therefore tend to overexploit the available resources and activities such as deforestation as they try to make a living.The main focus is on increasing the production level of the economy which consequently increase pollution levels. As the production and consumption increase, the economy also grows and generate enough resources. With increased economic growth, the economies can now prioritize green technology and development.

Bratt (2012) argues that grown economies have the opportunity to prioritize in innovative and green investments that help in reducing the impact to the environment. Larsson et al., (2011), adds that developed economies can accelerate the growth of clean environment if there is willingness to invest in ecofriendly technology.

2.1.3 Dally Curve

Dally (1973),questioned the effectiveness of human innovations and creativity in resolving environmental challenges. Dally argued that the incentives of green technology investments were not sufficient to curb environmental pollution. Dally argued that although such initiatives will have positive effects on the environment, the environmental damage will still be much severe. An increase in GDP per capital will lead to an increase in pollution regardless of the willingness of policy makers and citizens (Dally & Farley, 2004). Dally Curve hypothesis however, does not result to a turning point at any specific level of wealth as indicated earlier by Brundtland and EKC curves.

2.1.4 Summary of the theories

All the three theories presented above all agree that economic growth which is measured in form of GDP per capita has an effect on environmental pollution each theory identifies a different relationship. The EKC theory identifies a U- shaped relationship in which an increase in GDP per capita causes an increase in the level of environmental pollution up to a certain level upon which further economic growth results to decrease in pollution. Brundtland theory on the other hand presents an opposite argument in which the poorest and wealthiest economies causes the highest levels of pollution. This relationship presented graphically takes an inverted- U shape. Gally Curve argues for a consistent increase in economic growth along with a constant increase in pollution levels without identifying a turning point.

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2.2 Literature Survey

According to Bratt (2012), it is possible that the relationship between economic growth and the environmental degradation could take any of the three shapes described by EKC, Brundtland and Gally theories however, Bratt argues that a positive monotonic relationship between the economic gowth and the environment is most likely.
Dinda (2004) in a survey concluded that there is no specific level of economic growth at which further growth in GDP starts to decrease the level of pollution. Dinda identified this situation as challenging to policy makers as they cannot easily identify the turning point.
Stern et al., (1996) while examining the relationship between the Environment and the economy noted that in some situations, the Environmental Kuznets Curve would hold but fail to hold in some other situations. The authors argued that such observations would be as a result of different incentives to conserve the environment among different economies as well as the different willingness by citizens to reduce pollution levels.
Selden & Song (1994) examined the relationship between economic growth and air pollution which was measured in terms of Sulphur Oxide, Carbon Monoxide, Nitrogen Oxide and Suspended Particulate Matter. The study found out that high economic growth was associated with reduction in of Sulphur Oxide, Nitrogen Oxide and Suspended Particulate Matter. Similar relationship did not hold for Carbon Monoxide. The authors argued that economies with low levels of income has a long way to go, before they can start to experience economic growth with low emissions at the same time.
Acaravci & Ozturk (2010), also examined the relationship between economic growth, Carbon dioxide emissions and energy consumption in Europe. The empirical analysis showed that some countries experienced a positive long-run positive relationship between the variables under study while others did not indicate such trends. The authors concluded that the EKC hypothesis does not hold for most of the economies under study.
A study examining the relationship between economic growth and Carbon Dioxide Emissions (CO_2) identified a diminishing propensity to emit as economies continued to grow (Cederborg & Snöbohm, 2016). The study also concluded that although the emission of Carbon Dioxide decreased as economic growth increased, the aggregate level of pollution would still continue to increase from one year to another. This finding was supported by the argument that countries with high levels of GDP equally experience high levels of population growth. The authors also attempted to forecast future carbon emissions as a result of economic growth through a carrying out a sensitivity analysis and the study concluded that economic growth rate did not result to any dramatic changes in the level of carbon dioxide emissions.

3. Methodology

This section presents results of regression analysis for the study. Ordinary Least Square regression model was used because only one variable was included in the study. Regression analysis was conducted both independently and collectively for China and Kenya. China was selected to represent the high– income economies and also because, it is one of the greatest emitters of Carbon dioxide to the environment according to World bank data. Kenya was selected to represent the lower–middle income economies. The Regression model adopted for the analysis include:

$Y_1 = B_0 + B (X_1)$
$Y_2 = B_0 + B (X_2)$
Where B_0 = Constant
X_1 = GDP/ Capita for Lower Middle economy
X_1 = GDP/ Capita for High Income economy

Carbon dioxide emissions per capita (CO_2) is the dependent variable while Gross Domestic Per Capita is the independent variable for both equations. CO_2 is expressed in terms of tons emitted per capita while GDP is calculated as the market value of goods and service. According to Solomon et al., (2009), the Carbon Dioxide is great contributor of global warming and is therefore an appropriate measure for environmental degradation. Data for both the dependent and Independent variables are sourced from the World Bank database.

4.0 Results and Discussion

4.1 Regression results on GDP and Carbon Dioxide Emissions.

Table 3.1 below presents the results of the relationship between economic growths measured in form of Gross domestic product (GDP) and Carbon emissions (CO_2). The results of the analysis are based on 41observations for the year starting 1998 to 2018. Economic growth was measured in form of GDP in Current US dollars per capita while Carbon emissions was measured in form of metric tons per capita. The result of the study implies that, 1 unit increase in gross domestic product causes carbon to increase by 0.000911 and statically significant at 1 percent significance level.

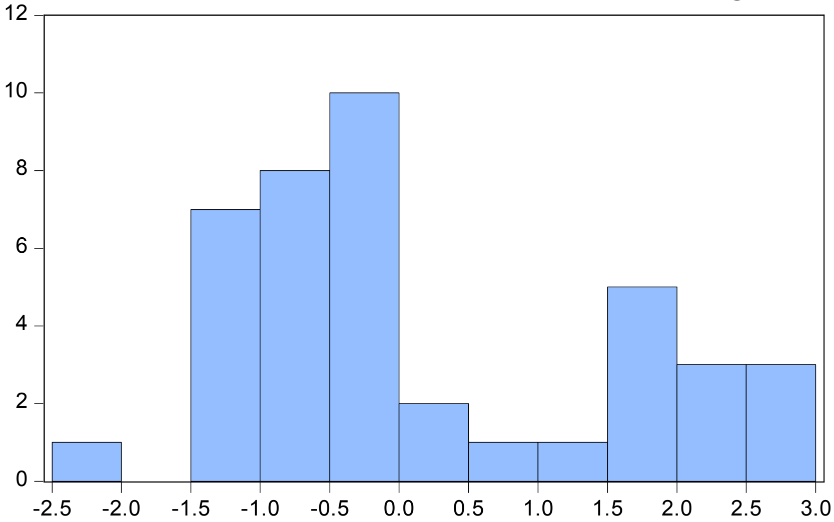
The results revealed a positive significant relationship between GDP and Carbon emissions as indicated by (p = 0.0000). Increase in GDP was found to have a consequent increase in the level of Carbon emissions. The Lest Square model was also found to be fit for the analysis as indicated by R-squared value (R^2 =0.757329) implying that changes in GDP explains 84.78% of changes in Carbon emissions. The data was also tested for normality test using the probability of Jarque-Bera (0.172586). The study revealed that the data was normally distributed since the Jarque Bera probability was more than 5 percent. The results are presented in the table below as follows:

Dependent Variable: CO_2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	0.000911	8.12E-05	11.21749	0.0000
C	0.408666	0.304744	1.341012	0.1877
R-squared	0.763395		Mean dependent var	2.768237
Adjusted R-squared	0.757329		S.D. dependent var	2.866184
Prob(F-statistic)	0.000000			

Table 3.1: Regression results for GDP and Carbon Dioxide Emissions.
Source: Authors work.

The regression equation for predicting the CO_2 emissions in relations to GDP can be derived as follows:
Co2 = 0. 408666+ 0.00091 (GDP).

Table 3.1: Regression Results.



Series: Standardized Residuals	
Sample 1998 2018	
Observations 41	
Mean	0.195816
Median	-0.222293
Maximum	2.862071
Minimum	-2.292306
Std. Dev.	1.375025
Skewness	0.559119
Kurtosis	2.102026
Jarque-Bera	3.513721
Probability	0.172586

Table 3.2: Normality test results
Source: Authors work.

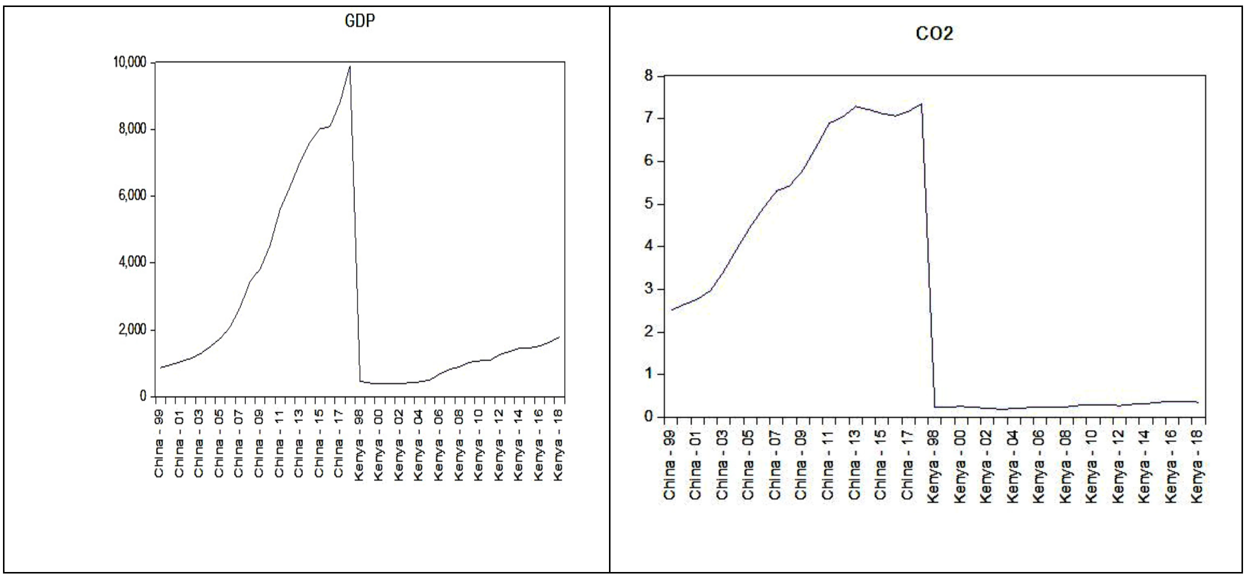


Table 3.4 Graphical Representation of GDP and CO_2 trends based on the 20 years data observations under analysis.
Source: Authors work.

4.2China- High Income Economy

The table below presents the results of the relationship between economic growths measured in form of Gross domestic product (GDP) and Carbon emissions (CO_2) for China. The data used for the analysis included observations from the last 21 years starting from 1998 to 2018. Economic growth was measured in form of GDP in Current US dollars per capita while Carbon emissions was measured in form of metric tons per capita.The results revealed a positive significant relationship between GDP and Carbon emissions as indicated by ($p = 0.0000$). Increase in GDP was found to have a consequent increase in the level of Carbon emissions. Data autocorrelation was tested using Durbin-Watson Stat and the variables were found to be independent. According to Genest and Rémillard (2004), when d value lie within the range of 1.5 to 2.5, it implies that there was no autocorrelation among variables and hence there is independence among variables. The Lest Square model was also found to be fit for the analysis as indicated by R-squared value (R^2 =0.847849) implying that changes in GDP explains 84.78% of changes in Carbon emissions in China.The results are presented in *table 3.3* as shown below:

Dependent Variable: CO_2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	0.000541	5.23E-05	10.33810	0.0000
C	3.040507	0.275597	11.03244	0.0000
R-squared	0.855857	Mean dependent var		5.384055
Adjusted R-squared	0.847849	S.D. dependent var		1.796956
Prob(F-statistic)	0.000000			

Source: Authors work.

The regression equation for predicting the CO_2 emissions in relations to GDP for China can be derived as follows:

CO_2 (*China*)= 3.040507 + 0.000541*gdp*

4.3 Kenya- Lower Middle Economy

Table 3.4 below presents the results of the relationship between economic growths measured in form of Gross domestic product (GDP) and Carbon emissions (CO_2) for Kenya. The results revealed a positive significant relationship between GDP and Carbon emissions as indicated by (p = 0.0000). Increase in GDP was found to have a consequent increase in the level of Carbon emissions. The Lest Square model was also found to be fit for the analysis as indicated by R-squared value (R^2 =0.847849) implying that changes in GDP explains 84.78% of changes in Carbon emissions in China. The results are presented in *table 3.3* as shown below:

Dependent Variable: CO2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	0.000110	1.06E-05	10.36927	0.0000
C	0.174798	0.011024	15.85665	0.0000
R-squared	0.849828	Mean dependent var		0.276982
Adjusted R-squared	0.841924	S.D. dependent var		0.056947
Prob(F-statistic)	0.000000			

The regression equation for predicting the CO_2 emissions in relations to GDP can be derived as follows:

CO_2*(Kenya)* = 0.174798+ 0.000110*gdp*.

5. Conclusion

The study aimed at determining whether economic growth measured in form of GDP is a cause or a solution to global warming. This study sought to contribute in attempting to understand the existing dilemmas relating to the relationship between the economy and the environment while addressing the conflict that exist between economic and sustainable goals. As discussed above in Environmental Kuznets Curve Theory (1992), theconsequent increase in pollution as a result of economic activities which was referred to as the *scale effect* would be counteracted by what was referred to as the *technological effect* and increases in economic activities would not necessarily result to increases in environmental degradation in form of carbon dioxide emissions. The argument was that as the economy continue to grow, countries would gain more resource capacity to invest in technologies that helps in reducing the overall level of Carbon emissions or allocate more resources to green projects. The regression results between GDP growth and Carbon emissions for both China and Kenya however indicate a continuous increase the level of carbon emissions as GDP growth increases.

As revealed in the line graphical presentations, the level of CO_2 emissions in China increase more rapidly than carbon emissions in Kenya. The graphs do not reveal a turning point as argued by Brundtland theory which argued for a U-shaped relationship between GDP and CO2 emissions whereby the poorest and wealthiest economies causes the highest levels of pollution. The results are however consistent with the arguments of Dally theory who argued that the incentives of green technology investments that would result as a result of economic growth would not be sufficient to curb environmental pollution.Dally argued that although such initiatives will have positive effects on the environment, the environmental damage will still be much severe. An increase in GDP per capital will lead to an increase in pollution regardless of the willingness of policy makers and citizens (Dally & Farley, 2004). Based on the study results, it is clear that increases in economic growth results to increases in Carbon emissions. The results however, also shows that the level of carbon emissions for low income economies such as Kenya is less severe compared to that of high income economies (China).

Based on these findings, it can be observed that, growth of the economy does not guarantee investments in green technologies and projects that help reduce environmental degradation. It is therefore recommended that economies must have deliberate initiatives to accelerate green investments and innovations at the same pace as their economic growth so as to curb the growing trends of carbon emissions. Governments should therefore, put in place environmental protection policies that matches the levels of economic growth with the volume of resources allocated towards green investments and projects. The market clearing concept fails to apply in the case for environmental protection and the government must deliberately intervene to solve the conflict between economic growth and sustainability goals. If no initiatives are done, it is clear that countries are less likely to achieve the sustainable goals of 2030. More aggressive sustainability initiatives are required match economic growth and sustainable goals.

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