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CARBON EMISSION ACROSS MANY SPECTRUMS USE IN MULTI-INCOME GROUPS COUNTRIES IN THE WORLD

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ABSTRACT

The purpose of the study is to determine specifically examine the quadratic impact of economic growth, consumption of renewable and non-renewable energy, depletion of natural resources, and population levels in all countries in the world which are grouped into 4 income groups namely high-, low-, middle- and upper-income groups. and lower middle. The data used in this study is panel data from all countries in the world for 29 years from 1990 to 2018 with 6 variables. The model has been developed and the instrument used in this research is STATA version 14. Regression result show that for countries in the low, upper middle and lower middle-income groups, the results are significant for square of economic growth contributes to the increase in the amount of carbon dioxide emissions. Consumption of non-renewable energy for countries in the high- and low-income groups were significant to the amount of carbon dioxide emissions. Consumption of renewable energy in all income groups of countries in the world, the correlation between increased consumption of renewable energy and total carbon dioxide emissions is negative with significant alpha value. Increasing deforestation has a negative correlation with the amount of carbon emissions. Countries in the high- and low-income groups were found to be significant and countries in the upper and lower middle-income groups were not significant.

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1. INTRODUCTION

All countries in the world have experienced many negative impacts due to the covid 19 pandemic. However, something else that is more dangerous and terrible besides the temporary covid 19 pandemic is climate change caused by an increase in the amount of carbon dioxide emissions and various other types of pollution [1]. This increase in the amount of carbon dioxide emissions causes erratic climate change that can result in flooding, hunger, and economic instability. Apart from that, it can also cause air temperatures to increase and cause global warming [2]. The latest IPCC report in 2021 shows code red for humanity where global surface temperature was 1.09C higher in the ten years between 2011-2020 compared to 1850-1900. He further said that the last five years were the hottest temperatures in history since 1850. The rate of sea level rise recently was almost three times that of 1901-1971. Human influence is very likely (90%) to be the main reason for the global melting of glaciers since the 1990s and a decrease in the amount of ice in the Arctic Sea.

The increase in the amount of carbon dioxide emissions is influenced by several factors including the need for consumption of non-renewable energy and increasing socio-economic needs with the aim of developing countries' economies. The increase in consumption of non-renewable energy has a negative externality impact. Other challenges that are closely related to this are the depletion of energy resources, other pollution, extinction of animals and climate change [3]; [4]; [5]; [6].

The purpose of this study is to specifically examine the quadratic impact of economic growth, consumption of renewable and non-renewable energy, depletion of natural resources, and population levels in all countries in the world which are grouped into 4 income groups namely high-, low-, middle- and upper-income groups. and lower middle. Regardless of the existing research, however, empirical evidence remains controversial and inconclusive for effective policy recommendations in all countries in the world [3].

2. LITERATURE REVIEW

Over the last few decades, the relationship between energy consumption, economic growth and carbon emissions has fostered serious policy debate in various socio-economic forums. Addressing this issue, various types of econometric methods have been used, including cointegration, the Auto Regressive Distributed Lag Model (ARDL), and the Environmental Kuznets Curve, a hypothesis for measuring the relationship between growth and carbon. Some research results show that increased economic growth contributes to carbon emissions to a certain extent, after which any further increase in economic growth reduces carbon emissions in developing countries.

Markandya et al [7] found an inverse U-shape relationship between income and air pollution in twelve Western European countries by applying a cointegration test. Other studies also found that there is an inverse U-shaped relationship between gross domestic product (GDP) per capita and environmental degradation in 48 states of America [8]. Research in other areas as well as conducted by Lee & Oh [9] also found a relationship between economic growth and environmental degradation in China. Wang et al [5] also say that the impact of urbanization and economic growth on sulfur dioxide emissions in China, and their work also shows an inverse U-shaped relationship between these emissions and economic growth.

The hypothesis developed in this study based on existing literature is:

H1: The square of economic growth (KPE) reduces the amount of carbon emissions in the 4 income groups of countries in the world?

H2: Consumption of non-renewable energy by KETT increases the amount of carbon emissions in the 4 income groups of countries in the world?

H3: Consumption of renewable energy (REE) reduces the amount of carbon emissions in the 4 income groups of countries in the world?

H4: The measure of population increase (UPP) increases the amount of carbon emissions in the 4 income groups of countries in the world?

H5: Increased deforestation increases carbon dioxide emissions?

The dependent variable (Y) is CO2 emissions - EKD measured per capita per year in metric tons. The independent variables used in this study are:

1. The square of economic growth – KPE (X1). According to the hypothesis that after reaching a certain level of economic growth, any further increase in growth will reduce carbon emissions.
2. Consumption of non-renewable energy – KETT (X2). For fossil fuel energy consumption is the annual per capita equivalent of a kilogram of oil per capita used.
3. Consumption of renewable energy – KET (X3). Renewable energy consumption is measured by annual per capita renewable (water, wind, solar) energy consumption in kilograms of oil equivalent.
4. Population size – UPP (X4). To measure the population of a country, the annual population growth rate (in millions) is used.
5. Depletion of Natural Resources – PSDA (X5). Deforestation used as a proxy for natural resource depletion is measured by subtracting the percentage of Forested Area by 100.

Deforestation = 100-percentage of forest area

3. METHOD

The data used in this study is panel data from all countries in the world which are grouped into 4 major groups based on their income.

Table 1. Four Major Groups based on their Income

No.	State Income Group	Amount	Total Variable	Total Years	Total
1	High Income	77	6	29	13,398
2	Low Income	27	6	29	4,698
3	Upper Middle Income	53	6	29	9,222
4	Lower Middle Income	55	6	29	9,570
Total		212			36,888

The method used is the fixed effect model with the panel data regression equation as follows:

$EKdit = \alpha + \beta 1kpeit + \beta 2kettit + \beta 3ketit + \beta 4uppit + \beta 5psdait + \varepsilon it$

Ekdit : Carbon dioxide Emissions

Kpeit : square of economic growth i period t

Kettit : Consumption of non-renewable energy to i period t

Ketit : Renewable energy consumption to i period t
UPPit : Population Size i period t
PSDAit : Depletion of Natural Resources i period t
A : combined intercept
β1, 2, 3, 4, 5: regression coefficient or slope
εit : error individual i-time t

The instrument used in this research is STATA version 14.

4. RESULT AND DISCUSSION

The results that will be displayed are based on the state revenue sharing group.

1. High Income Countries

Regression results using Stata can be seen in the following table:

Table 2. Regression Result for High Income Countries

yekd	t	Sig
kpe	-1.03	0.306
kett	1.76	0.084
kett	-2.52	0.015
upp	2.22	0.030
psda	-0.13	0.901
_cons		0.068

From the results in the table will be discussed in accordance with the hypotheses that have been built before:

H1: the square of economic growth affects the reduction of carbon dioxide emissions.
An increase in the square of economic growth affects a decrease in carbon dioxide emissions, this is evidenced by the direction of the negative relationship between the two variables. However, the effect is not significant as indicated by the p value of 0.306 > 0.05. So, it can be concluded that in the group of countries with high income the square of economic growth influences reducing carbon dioxide emissions but not significantly.

H2: Consumption of non-renewable fuels contributes to increased carbon dioxide emissions.
The direction of the relationship between the fuel consumption variable and the carbon dioxide emission variable is positive. Which means that the consumption of fossil fuels contributes to an increase in carbon dioxide emissions. The p value of 0.08 is not significant at the 0.05 error level but is significant at the 0.1 level. So, if using an error level of 10%, the consumption of fossil fuels contributes significantly positively to the increase in carbon dioxide emissions.

H3: Consumption of renewable energy reduces the amount of carbon dioxide emissions.
The direction of the relationship between renewable energy consumption is negative with the variable amount of carbon dioxide emissions and the p value shows the number 0.015 which is less than 0.05 which means that the consumption of renewable energy has a significant effect on reducing the amount of carbon dioxide emissions.

H4: Increasing population increases the amount of carbon dioxide emissions.
At the 5% error level, the addition of population has a significant positive effect on increasing the amount of carbon dioxide emissions, which is shown at the p value of 0.03 which is less than 0.05.

H5: increased deforestation increases carbon dioxide emissions.
From the negative relationship shown in the results table it can be said that increased deforestation decreases the amount of carbon dioxide emissions. However, the p value of 0.901 is greater than 0.05 so that it can be said that increased deforestation has no significant effect on increased carbon dioxide but has a negative correlation.

2. Low Income Countries

The regression results for the low-income country group are as follows:

Table 3. Regression Result for Low Income Countries

yekd	t	Sig
kpe	1.64	0.113
kett	1.86	0.074
kett	-1.36	0.186
upp	0.35	0.730
psda	-1.10	0.279
_cons	1.34	0.192

From the results in the table will be discussed in accordance with the hypotheses that have been built before:

H1: the square of economic growth affects the reduction of carbon dioxide emissions.

The correlation between the squared variable of economic growth and carbon dioxide emissions is positive. This means that the square of economic growth increases carbon dioxide emissions. The p value of 0.113 is significant at the 10% level. This means that the square of economic growth has a significant effect on increasing carbon dioxide emissions.

H2: Consumption of non-renewable energy contributes to an increase in carbon dioxide emissions.

The direction of the relationship between the fuel consumption variable and the carbon dioxide emission variable is positive. Which means that the consumption of non-renewable energy contributes to an increase in carbon dioxide emissions. The p value of 0.07 is not significant at the 0.05 error level but is significant at the 0.1 level. So, if using an error level of 10%, consumption of non-renewable energy has a significant positive contribution to increasing carbon dioxide emissions.

H3: Consumption of renewable energy reduces the amount of carbon dioxide emissions.

The correlation between the consumption of renewable energy is negative with the variable amount of carbon dioxide emissions and the p value shows the same 0.1 at the 10% error level, which means that the consumption of renewable energy has a significant effect on reducing the amount of carbon dioxide emissions.

H4: Increasing population increases the amount of carbon dioxide emissions.

The p value shows the number 0.730 more than the error terms at both the 5% and 10% levels. The correlation of the two variables shows a positive direction. This means that the addition of population increases the amount of carbon dioxide emissions, but the effect is not significant.

H5: increased deforestation increases carbon dioxide emissions.

From the negative relationship shown in the results table it can be said that increased deforestation reduces the amount of carbon dioxide emissions. However, from the p value of 0.279, increased deforestation has no significant effect on increased carbon dioxide, although it has a negative correlation.

3. Upper Middle-Income Countries

Regression results are shown in the following table:

H1: the square of economic growth affects the reduction of carbon dioxide emissions.

The correlation between the squared variable of economic growth and carbon dioxide emissions is positive. And the p value of 0.000 is smaller than 0.05. This means that the square of economic growth has a significant positive effect on increasing carbon dioxide emissions.

H2: Consumption of non-renewable energy contributes to an increase in carbon dioxide emissions.

The direction of the relationship between the fuel consumption variable and the carbon dioxide emission variable is positive. Which means that the consumption of non-renewable energy contributes to

an increase in carbon dioxide emissions. The p value of 0.508 is less than 0.05 so it can be said that consumption of non-renewable energy contributes to an increase in carbon dioxide emissions but not significantly.

H3: Consumption of renewable energy reduces the amount of carbon dioxide emissions.

The correlation between the consumption of renewable energy is negative with the variable amount of carbon dioxide emissions and the p value shows the number 0.020 which is less than 0.05, which means that the consumption of renewable energy has a significant effect on reducing the amount of carbon dioxide emissions.

H4: Increasing population increases the amount of carbon dioxide emissions.

The p value shows the number 0.282 more than the error terms at both the 5% and 10% levels. The correlation of the two variables shows a positive direction. This means that the addition of population increases the amount of carbon dioxide emissions, but the effect is not significant.

H5: increased deforestation increases carbon dioxide emissions.

From the negative relationship shown in the results table it can be said that increased deforestation reduces the amount of carbon dioxide emissions. However, from the p value of 0.161 it can be seen that increased deforestation has no significant effect on increasing carbon dioxide but has a negative correlation.

4. Lower Middle-Income Countries

Regression results are shown in the following table:

Table 4. Regression Result for Lower Middle-Income Countries

yekd	t	Sig
kpe	3.18	0.002
kett	0.44	0.665
kett	-2.44	0.018
upp	0.41	0.681
psda	-1.73	0.090
_cons	3.85	0.000

H1: the square of economic growth affects the reduction of carbon dioxide emissions.

The correlation between the squared variable of economic growth and carbon dioxide emissions is positive. And the p value of 0.002 is smaller than 0.05. This means that the square of economic growth has a significant positive effect on increasing carbon dioxide emissions.

H2: Consumption of non-renewable energy contributes to an increase in carbon dioxide emissions.

The direction of the relationship between the fuel consumption variable and the carbon dioxide emission variable is positive. Which means that the consumption of fossil fuels contributes to an increase in carbon dioxide emissions. The p value of 0.665 is less than 0.05 so it can be said that consumption of non-renewable energy contributes to an increase in carbon dioxide emissions but not significantly.

H3: Consumption of renewable energy reduces the amount of carbon dioxide emissions.

The correlation between the consumption of renewable energy is negative with the variable amount of carbon dioxide emissions and the p value shows the number 0.018 which is less than 0.05, which means that the consumption of renewable energy has a significant effect on reducing the amount of carbon dioxide emissions.

H4: Increasing population increases the amount of carbon dioxide emissions.

The p value shows the number 0.681 more than the error terms at both the 5% and 10% levels. The correlation of the two variables shows a positive direction. This means that the addition of population increases the amount of carbon dioxide emissions, but the effect is not significant.

H5: increased deforestation increases carbon dioxide emissions.

From the negative relationship shown in the results table it can be said that increased deforestation reduces the amount of carbon dioxide emissions. However, from the p value of 0.09 increased deforestation has a significant effect at the 10% level on reducing carbon dioxide emissions.

The overall regression results can be seen in the following table:

Table 5. Summary of regression results for every income based group

Income Based Group	Variables	Correlation	PVALUE	sig at 5% dan 10% level
High Income Countries	KPE	-	0.306	Not Significant
	KETT	+	0.084	Significant
	KET	-	0.015	Significant
	UPP	+	0.030	Significant
	PSDA	-	0.901	Not Significant
Low Income Countries	KPE	+	0.113	Significant
	KETT	+	0.074	Significant
	KET	-	0.186	Significant
	UPP	+	0.730	Not Significant
	PSDA	-	0.279	Not Significant
Upper Middle-Income Countries	KPE	+	0.000	Significant
	KETT	+	0.508	Not Significant
	KET	-	0.020	Significant
	UPP	+	0.282	Not Significant
	PSDA	-	0.161	Significant
Lower Middle-Income Countries	KPE	+	0.002	Significant
	KETT	+	0.665	Not Significant
	KET	-	0.018	Significant
	UPP	+	0.681	Not Significant
	PSDA	-	0.090	Significant

4. CONCLUSION

For the quadratic variable of economic growth, only the high-income country group has a negative correlation to the carbon dioxide emission variable and the effect is not significant. But for countries in the low, upper middle and lower middle-income groups the results are significant, and the correlation is positive. Which means that the square of economic growth contributes significantly to the increase in the amount of carbon dioxide emissions. The variable consumption of non-renewable energy for countries in all income groups has a positive correlation to the amount of carbon dioxide emissions, which means that consumption of non-renewable energy contributes to an increase in the amount of carbon dioxide emissions. Based on the p value it was found that countries in the high- and low-income groups were significant while countries in the upper middle and lower middle-income groups were not significant. For the consumption of renewable energy in all income groups of countries in the world, the correlation between increased consumption of renewable energy and total carbon dioxide emissions is negative and the alpha value is significant. This means that the consumption of renewable energy contributes significantly to reducing the amount of carbon dioxide emissions. The population growth variable has a positive correlation with the amount of carbon dioxide emissions. Only the high-income group of countries has a significant contribution but in the group of countries with low, upper middle and lower middle incomes, population growth is found to have no significant effect on the increase in carbon dioxide emissions. The variable increasing deforestation has a negative correlation with the amount of carbon emissions. Countries in the high- and low-income groups were found to be significant and countries in the upper and lower middle-income groups were not significant.

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