THE EFFECT OF GROSS DOMESTIC PRODUCT, ENERGY INTENSITY, POPULATION, AND URBANIZATION ON TOTAL CO_2 EMISSIONS (STUDY ON BRICS MEMBER COUNTRIES)

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Abstract

The balance between accelerating the rate of economic growth and protecting the quality of the environment is one of the challenges faced by both developed and developing countries. Without a commitment to carry out sustainable development, the use of natural resources and the environment will increase. This increase in utilization increases CO_2 emissions every year from the combustion of fossil fuels. The increase in CO_2 emissions is triggered by economic development activities. The purpose of this study is to examine the effect of the variables of gross domestic product, energy intensity, population, and urbanization on total CO_2 emissions in 2005 to 2018 in BRICS member countries. This research is a quantitative research type. The data used is secondaru data obtained through library search with panel data totalling 70 observations. The data analysis technique used is multiple linear regression analysis with the analysis model used in this study is panel data regression with Fixed Effect Model. The results of this study indicate that the variables of energy intensity and population have a positive and significant effect, while the variables of gross domestic product and urbanization do not have a significant effect. Simultaneously, the independent variable affects the dependent variable.

Keywords: *Total CO_2 emissions, gross domestic product, energy intensity, population, urbanization, fixed effect model*

1. INTRODUCTION

Policymakers in every country experience tough challenges in dealing with global challenges such as poverty, natural disasters, climate change, financial crises, and issues of sustainable development that focus on integrating economic development and environmental sustainability. The balance between accelerating the rate of economic growth and protecting the quality of the environment is one of the challenges faced by both developed and developing countries. Without a commitment to sustainable development, the use of natural resources and the environment will increase. As a result, problems often arise in economic development, namely the trade-off between meeting community needs and efforts to maintain environmental sustainability.

According to Todaro and Smith (2004), economic development has activities that tend to concentrate on exploiting natural resources for an increased standard of living for the people without any implementation in conserving the raw materials used for the production process. Sustainable development starts with using natural resources on a large scale to improve people's welfare without regard to environmental sustainability. One of the problems that often occurs in sustainable development, especially the ecological aspect, is global warming. The most significant factor of global warming is greenhouse gases consisting of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and three categories of gases containing fluorine. Greenhouse gases fluctuate from year to year with insignificant growth rates.

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The Intergovernmental Panel on Climate Change (2014) reports that the most significant contribution to CO2 emissions is burning fossil fuels and industrial processes related to human activities and high economic growth. Based on research conducted by the World Resource Institute (WRI), six countries emitted the most significant CO2 emissions in 2018, namely China (10.26bt), the United States (6.135bt), European Union (4.263bt), India (2.358bt), and Russia (2,217bt). Overall total CO2 emissions at the world level can be seen in Table 1.

Table 1
Total World CO2 Emissions 2005-2018 (billion metric tons)

Year	Total Emissions CO_2	Year	Total Emissions CO_2
2005	27.078	2012	31.806
2006	27.9423	2013	32.3707
2007	28.9893	2014	32.3886
2008	29.2094	2015	32.3655
2009	28.7921	2016	32.3747
2010	30.5824	2017	32.8374
2011	31.4595	2018	33.5133

Source: International Energy Agency, 2020

Economic development is progressing because many countries participate and contribute to global economic development. Developing countries have an essential role in supporting the economies of developed countries because of the many promising consumer market targets in developing countries. These countries include Brazil, Russia, India, China, and South Africa, better known as the BRICS. The term BRICS appeared after South Africa joined in 2010. According to BRICS (2020), BRICS is an acronym for grouping the world's leading developing countries. BRICS is an organization formed as an economic association with an important role in global economic growth. Countries members of the BRICS membership have just developed into industrialized countries, which are differentiated based on their size, fast growth, and economic effect.

The BRICS member group has a less developed but fast-growing economy, a large population, an influential government, and a desire to join the global market. The highest average economic growth for BRICS countries is China, which is 9.18% annually. Then India at 6.59% per year, Russia at 3.83% per year, South Africa at 2.77% per year, and the lowest was Brazil at 2.46% per year. Periodically, the economies of BRICS member countries continue to move towards advanced industrialization, with an increase in the economy every year resulting in increased human needs. Energy is needed to support the productivity activities of a country so that the availability of energy can affect the results or output of a country's productivity.

Economic development activities, such as population, also affect CO2 emission levels. The world's population is estimated to increase to 7.8 billion in 2025, and 6.7 billion people will live in developing countries. An increase in population means an increase in demand. Therefore, humans make various efforts to meet their needs by processing natural resources. If the exploitation process is not controlled, it will harm the environment, namely, an increase in the pollution load into the air or atmosphere. According to (Priangani, 2015) BRICS member countries have contributed significantly to the world's population by 40% and have a land area of a quarter of the total land area in the world.

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One of the reasons for the increase in population is urbanization because, along with the increase in population growth, the needs of the community in terms of settlements, space for movement, and mobilization are also increasing. In addition, economic development in the industrial sector is the biggest trigger for increased urbanization. According to (Sadorsky, 2013), more than 50% of the world's population lives in urban areas. Over time, urbanization will increase because people's tendency to get a decent life is increasing.

2. LITERATURE REVIEW

1. Sustainable Development Concept

According to Jazuli (2015), sustainable development is a process that optimizes the benefits of natural and human resources by harmonizing natural resources with humans in development. According to Kurniawati (2012), three aspects affect sustainable development, namely:

a. Economic Aspect

Sustainable development is closely related to economic growth. It looks for ways to advance the economy in the long run and can improve the welfare of the present generation without future generations.

b. Social Aspect

Social aspects as community supporters regarding interaction, interrelation, and interdependence.

c. Environmental Aspect

Environmental or ecological factors are needed to support sustainable development. It is because this aspect is directly related to natural factors that exist on Earth, so things that show environmental damage are more pronounced.

2. Emission CO_2

Air pollution can be interpreted as the presence of one or more substances (pollutant gases) that can harm living things, disturb comfort, or are destructive. According to (Thistlethwaite et al., 2013), pollutant gases can be divided into two, namely:

a. A natural pollutant gas

This type of pollutant tends to balance ecosystems long-term such as pollutants released by volcanoes.

b. Anthropogenic pollutant gas

This type of pollutant does not appear naturally. However, it is due to effects caused by human activities, such as air waste produced by industry, motor vehicle exhaust, the decomposition process from burning waste, and food processing activities carried out by households.

3. *Gross Domestic Product*

According to (Todaro & Smith, 2012), the Environmental Kuznets Curve or EKC is an inverted U-shaped graph that illustrates the relationship between per capita income and environmental quality, whether it is pollution or other environmental damage in a country which will increase and then decrease with an increase in per capita income.

In another sense, EKC theory explains that economic growth will initially increase environmental damage because the state will make increased production its main focus without paying attention to environmental aspects. If this is continuously carried out, it will result in increasingly severe environmental pollution, such as water, soil, and air pollution. However, at a certain level of per capita income, environmental pollution will decrease.

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4. *Energy Intensity*

According to the Directorate General of New, Renewable Energy and Energy Conservation (EBTKE), energy intensity is the ratio between the amount of energy consumption per gross domestic product and is used to assess a country's energy efficiency. The lower the energy intensity number, the more efficient energy use in a country. The size of energy intensity does not fully describe energy efficiency, but at least it can show that the smaller the ratio, the better the use of energy in the production process.

5. Population

According to the World Bank, population numbers are based on a de facto definition of the population, which counts all residents regardless of legal status or citizenship, just like one of the population theories pioneered by Malthus. Thomas Robert Malthus, an English priest, pioneered Malthus' theory. In his article "An Essay on the Principle of Population," he stated that a country's population generally tends to increase according to a geometric/geometric progression that doubles every 30-40 years. At the same time, since every fixed factor (land) experiences diminishing returns, the food supply can only increase arithmetically. When the land owned by each person becomes smaller, the population's contribution to production will eventually decrease (Todaro & Smith, 2012).

Malthus' theory also emphasizes the importance of balancing population growth with food supplies because land, as a natural resource, cannot provide food to meet the needs of an increasing population. Therefore, the carrying capacity of the soil as an environmental component decreases due to the increasing human burden. The total population must be balanced with the environmental threshold not to disturb the environment's carrying capacity so that natural disasters such as floods, droughts, crop failures, and other disease outbreaks do not occur.

6. Urbanization

According to (Tjiptoherijanto, 2016), urbanization is defined as the proportion of the population living in urban areas (urban areas). According to (Todaro & Smith, 2012), the positive relationship between urbanization and per capita income is the most obvious and prominent specific fact of the development process. Generally, the more advanced a country is based on per capita income, the greater the number of people living in urban areas. Therefore, urbanization can be considered as a natural phenomenon that is in line with economic development and population welfareUrbanization.

3. RESEARCH METHODOLOGY

This study uses secondary data types with the library research data collection method. The data on CO2 gas emissions was obtained from the International Energy Agency. Data on gross domestic product, population, and urbanization were obtained from the World Bank. Meanwhile, energy intensity was obtained from the Statistical Review of World Energy. The data analysis technique used is multiple linear regression analysis, which aims to see the effect of each independent variable on the dependent variable.

The samples in this study are total CO2 emissions, gross domestic product, energy intensity, population, and urbanization of BRICS member countries, namely Brazil, Russia, India, China, and South Africa in 2005-2018.

Data Analysis Method

The analytical tool used in this study is multiple linear regression analysis with the selection of the fixed effect model. The research model to be estimated is as follows:

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$$LnCO2_{it} = \alpha_0 + \alpha_1 LnGDP_{it} + \alpha_2 LnEI_{it} + \alpha_3 LnPP_{it} + \alpha_4 LnUP_{it} + AR(1) + \mu \quad \text{.....(3.1)}$$

$LnCO_2$ = natural logarithm of total CO2 emissions produced in 5 BRICS member countries
LnGDP = natural logarithm of gross domestic product per capita in 5 BRICS member countries
LnEI = natural logarithm of energy intensity in 5 BRICS member countries
LnPP = natural logarithm of population in 5 BRICS member countries
LnUP = natural logarithm of urbanization in 5 BRICS member countries
α_0 = intercept
α = coefficient value of each variablel
i = cross-sectional data of 5 BRICS member countries
t = time series data of 5 BRICS member countries
AR (1) = rho
μ = error term

4. RESULTS AND DISCUSSION

Object Description

a. BRICS Overview

According to (BRICS, 2020), BRICS is an acronym for the grouping of the world's leading developing countries, namely Brazil, Russia, India, China, and South Africa. BRICS is an organization formed as an economic association with an important role in global economic growth. The emergence of the BRICS as an economic association was through an economist from England, Jim O'Neill, who contributed his ideas to form an international organization in the field of finance.

BRICS was formed to uphold peace, security, and shared prosperity.

1) In the field of peace and security, the aim is to spread equality in international relations and spread democracy to avoid strife and war.
2) Leaders have a goal to create strategies in the area of topical cooperation.
3) It maintains the stability of the country's growth in an economic crisis caused by European and American influences.
4) Reforming global governance and financial reform.

b. Environment Overview in BRICS Member Countries

Currently, the focus is on the BRICS economy while considering environmental interests and rapid economic development and their contribution to global economic growth. More precisely in 2007, the BRICS economy was rich in natural resources. On average, the largest energy supply in BRICS member countries is coal. China's interest in coal partly drives this.

c. CO2 Emission Conditions in BRICS Member Countries

China became the first country to produce the highest CO2 emissions among other countries in the BRICS member countries. From year to year, there is always an increase in total CO2 emissions, with an average of 8,050.5 million tons. The high level of CO2 emissions in China is caused by China's high dependence on coal and China's very high energy needs, which contribute to the world's most considerable pollution. Then in second place is India with total CO2 emissions, which tend to increase yearly. However, India has targeted reducing emissions below 33-35% by 2030. In addition, India is also targeting to acquire 450 GW of

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electricity from EBT by 2030. With this, India's energy capacity will be obtained from generators that do not use fossil fuels. In third place are Russia, then Brazil, and South Africa.

d. Gross Domestic Product Condition in BRICS Member Countries

Countries that are members of the BRICS are countries that are heading towards industrialization. Economic power within BRICS member countries varies widely. Brazil with its agricultural products, Russia with its energy, China with its increasing manufacturing, India with its services, and South Africa with its wealth of mineral resources. Based on data (IMF, 2013), the BRICS countries have a total gross domestic product of US$16.6 trillion, equivalent to 22% of the world's gross domestic product. The contribution of BRICS countries in overall economic growth over the last decade has reached 50%, which makes this group of countries develop as essential leaders in global economic development.

e. Energy Intensity Condition in BRICS Member Countries

Energy Intensity, also known as economical energy efficiency, refers to the amount of energy consumption per unit of economic output. Russia consumes the highest per capita energy among other BRICS countries, with an average of 196.85 gigajoules per capita. It relates to Russia's natural resource wealth, and it is predicted to remain the largest net exporter of energy, with exports reaching 4% of world energy demand in 2035. Meanwhile, India is the country that consumes the lowest at 19.39 gigajoules per capita.

f. Population Condition in BRICS Member Countries

The BRICS has continuously contributed to almost half of the world's population resulting in increasing demand for energy. The highest total population is China, with a population in 2018 of 1,392,730,000 million people. The number shows an increase from the previous year, which was 1,386,395,000 million people. Then in the following sequence, India has the second highest population density, with a total population of 1,352,617,328 million people. While in third place with a significant difference from the previous country, namely Brazil with 209,469,333 million people, followed by Russia with a total population of 144,477,860 million people, and South Africa with a population of 57,779,622 million people.

g. Urbanization Condition in BRICS Member Countries

The BRICS countries have experienced rapid urbanization in the last three decades. However, it has created various problems, such as air pollution, congestion, habitat destruction, and other problems that threaten the sustainable development of urbanization.

Data Analysis

a. Model Selection

1) Chow Test

Table 2. Chow Test

Redundant Fixed Effects Tests
Equation: FEM
Test cross-section fixed effects

	Statistic	d.f.	Prob.
Cross-section F	131.724290	(4,61)	0.0000
Cross-section Chi-square	158.597472	4	0.0000

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Source: Output Eviews, 2021

The probability value of the F test and chi-square is 0.0000, which means it is smaller than the significance level α = 5% (0.05). Thus, the initial hypothesis was rejected, and the model chosen was the fixed effect model or fixed effect. Then further testing is needed namely the Hausman test.

2) Hausman Test

Table 3. Hausman Test

Correlated Random Effects - Hausman Test
Equation: REM
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	526.897162	4	0.0000

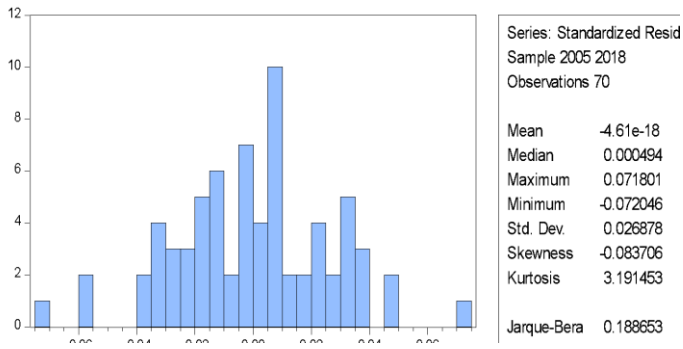
Source: Output Eviews, 2021

The probability value of the F test and chi-square is 0.0000, which means it is smaller than the significance level α = 5% (0.05). Thus it can be concluded that in this study, it is better to use the fixed-effect model.

b. Classic Assumption Detection Results

1) Normality Detection

Figure 1. Normality Detection Result



Source: Output Eviews, 2021

Based on Figure 1, the normality test results showed that the Jarque-Bera Probability value is 0.909986, which is greater than α = 5% (0.05), so these results meet the normality test requirements. It means that the data used in the research is normally distributed.

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2) Autocorrelation Detection

Table 4 Autocorrelation Detection Results After Level 1 Differential

Cross-section fixed (dummy variables)

R-squared	0.999616	Mean dependent var	7.159621
Adjusted R-squared	0.999553	S.D. dependent var	1.131635
S.E. of regression	0.023925	Akaike info criterion	-4.487119
Sum squared resid	0.031483	Schwarz criterion	-4.152598
Log likelihood	155.8314	Hannan-Quinn criter.	-4.355129
F-statistic	15902.55	Durbin-Watson stat	1.969762
Prob(F-statistic)	0.000000		

Inverted AR Roots .68

Source: Output Eviews, 2021

Based on Table 4 above, the Durbin Watson stat value, after being estimated, is 1.969762. The Durbin Watson stat value, after being estimated, is between dU and 4-dU or dU < d < 4-dU, it can be concluded that there is no autocorrelation problem in the model.

3) Heteroscedasticity Detection

Table 5. Heteroscedasticity Detection Results

Dependent Variable: RESABS
Method: Panel Least Squares
Date: 08/03/21 Time: 00:40
Sample: 2005 2018
Periods included: 14
Cross-sections included: 5
Total panel (balanced) observations: 70

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.271382	1.133488	-2.003888	0.0495
LOGGDP	0.030235	0.052769	0.572981	0.5688
LOGEI	0.022970	0.048755	0.471135	0.6392
LOGPP	0.126045	0.063824	1.974868	0.0528
LOGUP	-0.148884	0.127688	-1.165998	0.2482

Source: Output Eviews, 2021

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Based on Table 5, the results of heteroscedasticity using the Glejser Test show that there are no statistically significant independent variables affecting the dependent variable because the significance probability value is above α = 5% (0.05).

4) Multicollinearity Detection

Table 7. Multicollinearity Detection Results

	LOGGDP	LOGEI	LOGPP	LOGUP
LOGGDP	1.000000	0.528311	-0.191058	0.048959
LOGEI	0.528311	1.000000	-0.593804	0.729695
LOGPP	-0.191058	-0.593804	1.000000	-0.694788
LOGUP	0.048959	0.729695	-0.694788	1.000000

Source: Output Eviews, 2021

Based on the results of the correlation matrix in Table 7, the value of the correlation coefficient between independent variables does not exceed the rule of growth (0.80). Therefore it can be concluded that the estimation model in this study did not detect any multicollinearity.

c. Statistical Test Results

1) Determination Coefficient Test (R^2)

Table 8. Determination Coefficient Test Results R^2

R-squared	0.999616
Adjusted R-squared	0.999553
S.E. of regression	0.023925
Sum squared resid	0.031483
Log likelihood	155.8314
F-statistic	15902.55
Prob(F-statistic)	0.000000

Source: Output Eviews, 2021

Based on the estimation results in Table 8 above, the R-squared value for total CO2 emissions is 0.999616. It means that the total CO2 emission variable in the model is 99.96% influenced by independent variables such as gross domestic product, energy intensity, population, and urbanization. While other variables outside the model explain the rest.

2) Simultaneous Significance Test (F Test)

In Table 8, the probability value of the F statistic is 0.0000. In other words, this value is smaller than α = 5% (0.05), so it can be concluded that the independent variables simultaneously influence the dependent variable.

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3) Partial Significance Test (T-Test)

Table 9. Partial Significance Test Results (T-Test)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-26.64829	6.621003	-4.024812	0.0002
LOGGDP	0.262455	0.177643	1.477424	0.1453
LOGEI	1.036819	0.165558	6.262556	0.0000
LOGPP	1.621361	0.382883	4.234611	0.0001
LOGUP	-1.282239	0.578788	-2.215386	0.0309
AR(1)	0.677332	0.111593	6.069655	0.0000

Source: Output Eviews, 2021

Based on the results of the T-test in Table 4.8, it can be seen that:

- The gross domestic product (GDP) variable has a t value of 1.477424 with a t-table value of 1.99714, so the gross domestic variable does not partially affect the total CO2 emission variable.
- The energy intensity variable (EI) has a t value of 6.262556 with a t table value of 1.99714, so it can be concluded that the energy intensity variable partially affects the total CO2 emission variable.
- The population variable (PP) has a calculated t value of 4.234611 with a t table of 1.99714, so it can be concluded that the population variable partially affects the total CO2 emission variable.
- The urbanization variable (UP) has a t value of -2.215386 with a t table of 1.99714, so it can be concluded that the urbanization variable does not partially affect the total CO2 emission variable.

Discussion

Based on the test results with the multiple linear regression method, the regression equation is obtained as follows:

$$LnCO2_{it} = -26.64829 + 0.262455 * LnGDP_{it} + 1.036819 * LnEI_{it} + 1.621361 * LnPP_{it} - 1.282239 * LnUP_{it} + AR(1) + \mu \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Effect of Gross Domestic Product on Total Emissions CO_2

The statistical test results show that the GDP variable has no significant effect on CO2 emissions. This is because the countries studied in this study, namely countries that are members of the BRICS, have just developed into industrialized countries or have not yet fully become industrialized countries. Evidenced by the economic strength within the BRICS member countries varies greatly. Brazil with its agricultural products, Russia with its energy, China with its increasing manufacturing, India with its services, and South Africa with its wealth of mineral resources. It is a concern that every country needs to apply the concept of sustainable development so that economic and environmental sustainability can be aligned in the future and anticipate changes in the economy's direction.

These results follow the research of Noor and Saputra (2020), which states that the existence of EKC cannot be validated in the four countries because energy and transportation

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policies in each country have been unable to suppress environmental degradation. In addition, GDP does not have a significant effect on CO2. This shows that the increase in energy use, which results in CO2 emissions, is still a driver of economic activity in the countries studied.

Effect of Energy Intensity on Total Emissions CO_2

The value of the energy intensity coefficient (EI) produces a positive value for total CO2 emissions of 1.036819, meaning that every 1% increase in energy intensity, assuming other variables are constant, will cause an increase in total CO2 emissions in BRICS member countries by 1.037%. In addition, the energy intensity variable has a t-count value of 6.262556 which is greater than the t-table of 1.99714, meaning that the energy intensity variable has a positive and significant effect on the level of environmental damage as measured using the total CO2 emission variable.

These results are consistent with Wang et al. (2017), stating that energy intensity positively affects CO2 emissions in each model. This means that technological improvements will reduce carbon emissions, and the impact of energy intensity on emission reductions in the eastern and central regions is more significant than in the western regions.

Effect of Population on Total Emissions CO_2

The value of the population coefficient (PP) produces a positive value for total CO2 emissions of 1.621361, meaning that every 1% increase in population, assuming other variables are constant, will cause an increase in total CO2 emissions in BRICS countries by 1.621%. In addition, the population has a t-count value of 4.234611 which is greater than the t-table of 1.99714, meaning that the population variable has a positive and significant effect on the level of environmental damage as measured using the total CO2 emission variable.

This research aligns with the statement of Todaro and Smith (2012), which states that environmental damage is worsening due to a surge in population growth. The rapid rate of population growth and the development of economic activities in developing countries tend to result in widespread environmental damage.

Effect of Urbanization on Total Emissions CO_2

The urbanization coefficient (UP) value produces a negative value on total CO2 emissions of 1.282239, meaning that every 1% increase in population, assuming other variables are constant, will reduce total CO2 emissions in BRICS countries by 1.282%. In addition, the population variable has a t-count value of -2.215386 which is smaller than the t-table of 1.99714, meaning that the urbanization variable has a negative and insignificant effect on the level of environmental damage as measured using the total CO2 emission variable.

The results of this study state that urbanization in BRICS countries has a negative effect on CO2 emissions. CO2 emissions in BRICS countries have begun to decline, especially in Brazil, Russia, and South Africa. In these countries, the more people who live in cities tend to reduce or minimize CO2 emissions. This is because the energy use of urban residents is currently more efficient. Meanwhile, in China and India, with urban populations that are not too many, there is a tendency for CO2 emissions to increase as the year progresses.

These results are consistent with the research by Huo et al. (2020) entitled "Exploring the Impact of Urbanization on urban building carbon emissions in China: Evidence from a provincial panel data model" which states that urban residents negatively affect urban building carbon emissions at a significant of 1% on a scale national and in the eastern and western regions. With the increasing urban population, people will shift their energy from traditional fuels to modern energy sources.

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5. CONCLUSION

Based on the results of panel data regression analysis using the Fixed Effect Model, which aims to determine the effect of gross domestic product, energy intensity, population, and urbanization on total CO2 emissions in BRICS member countries in 2005-2018, several conclusions can be drawn as follows:

1. Gross Domestic Product generates a positive value but does not significantly affect total CO2 emissions. This is because the countries in this study, namely countries that are members of the BRICS, have just developed into industrialized countries or have not yet fully become industrialized countries.
2. Energy Intensity has a positive and significant effect on total CO2 emissions. Increasing energy intensity will increase total CO2 emissions in BRICS member countries. These results follow previous research stating that technology can reduce CO2 emissions. Nevertheless, on the other hand, technological development also requires time which cannot be offset due to the rapid use of energy, which results in CO2 emissions.
3. Population has a positive and significant effect on total CO2 emissions. This means that an increase in population will increase total CO2 emissions in BRICS member countries. These results are consistent with previous research, which states that population is the main contributor to CO2 emissions among all variables.
4. Urbanization has a negative and insignificant effect on total CO2 emissions. This means that increased urbanization will reduce total CO2 emissions in BRICS member countries. This is indicated by Brazil, Russia, and South Africa, where more than 50% of the population lives in urban areas. While in 2011, China had just stepped on 50% and continued to increase, and India was only around 31%.

Based on the results and discussion, several suggestions can be submitted:

1. GDP can be increased by not destroying the environment or increasing CO2. Therefore, it is necessary to make adjustments to economic growth that are more environmentally friendly.
2. Energy intensity has a positive and significant effect. Therefore, it needs to be handled from two sides of energy. From the demand side, it is maximizing technology that can save energy. It is expected to switch to alternative or renewable energy from the supply side.
3. Urbanization can reduce CO2 emissions with indications that urban communities are much more educated and can save energy consumption. If so, better education is needed for the whole community. The hope is that even though the higher the population increases CO2 emissions if people are educated to save energy, they can reduce their energy consumption and be wise in their use.
4. Future researchers are expected to be able to increase the research period and variables outside the model to get better results in decision making.

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