



The Impact of Socio-Economic Activities on Carbon Dioxide Emissions in Middle-Income Countries in the ASEAN

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Abstract. This study is a study conducted to analyze the impact of socio-economic activities on carbon dioxide (CO₂) emissions in Middle-Income Countries in the ASEAN Region, by examining the impact of independent factors (GDP, FDI, and Population) on dependent variables (CO₂). The decline in environmental quality cannot be separated from CO₂ emissions which are caused by various economic activities, especially industrial sector activities. The United Nations (UN) as a world organization, global environmental issues that every year become more complex and worrying for countries. According to information from the World Bank, carbon dioxide (CO₂) emissions in middle-income countries in the ASEAN Region increase every year. The results show that GDP has a positive and significant influence on carbon dioxide (CO₂) emissions, while FDI and population have no effect and have a negative value on carbon dioxide (CO₂) emissions. So based on this, it is necessary for government policies regarding the environment to be able to reduce the increase in carbon dioxide emissions by directing investment and residents to environmentally friendly practices.

Keywords: GDP, FDI, Population, CO₂ Emissions

1 Introduction

In 1972, for the first time, the world paid serious attention to the impact of socio-economic activities on the deterioration of environmental quality. Responding to the issue of environmental problems, the United Nations (UN) as a world organization held an international conference to discuss and establish World Environment Day which falls on June 5 every year. Global environmental issues that every year become more complex and worrying for all countries. Requires serious handling to balance socio-economic activities and the quality of the available environment.

The notion of sustainable development discusses several aspects that are important points in encouraging sustainable development. Development that is sustainable can be said that the evolution of the current Future generations shouldn't be forced to make concessions by sacrificing social welfare that is less than that of the present generation

Sustainable development is defined by the World Commission on Environment and Development as an effort to satisfy current demands without compromising the

capacity of future generations to fulfill their living requirements. Development that is sustainable emphasizes harmonizing economic growth and the environment so that it can run together to be enjoyed in the present and into the future. However, often in encouraging economic growth, they do not pay attention to the impact of externalities that cause pollution and reduce environmental quality.

The decline in environmental quality cannot be separated from CO emissions² which is mostly caused by various economic activities, especially industrial sector activities. stated that the transportation sector is one of the sources of environmental quality decline as measured by the level of CO emission expenditure [1]. In several studies, it is explained that a connection exists between economic expansion and positive effects on environmental quality. However, there is also research that says that economic growth adversely impacts the quality of the environment.

The 7 middle-income countries in Indonesia, Malaysia, the Philippines, Vietnam, Thailand, Cambodia, and Myanmar are the ASEAN countries included in this study. In a journal written by, Singapore is the country that has the highest number of emissions in the [2] ASEAN This is because Singapore has a small area and increasing economic activity with a very large amount of GDP per capita in ASEAN. Not only that, the lack of green open space, so CO emissions² not absorbed properly.

An increase in economic activity can have an impact on environmental quality when a country experiences growing economic expansion and environmental quality also decreases, which is marked by an increase in CO emissions [3]. Countries have opened themselves up to international trade since the last few decades and as Thus, there have been significant shifts in industrialization, economic development, foreign direct investment (FDI), and greenhouse gas emissions [4].

The connection between FDI and economic expansion is dependent upon many factors that substantially alter the relationship between FDI growth and economic growth. Not only that, FDI also affects CO emissions² where the improvement of technology in developing countries will increase efficiency [5].

The environmental problem that is being faced by many countries is the depletion of the ozone layer which causes global warming, in the form of carbon dioxide (CO₂), nitric dioxide (N₂O), methane (CH₄), and chlorofluorocarbons (CFCs) are a supporting factor for the occurrence of greenhouse gas and CO effects become the largest contributor to greenhouse gas emissions [6].

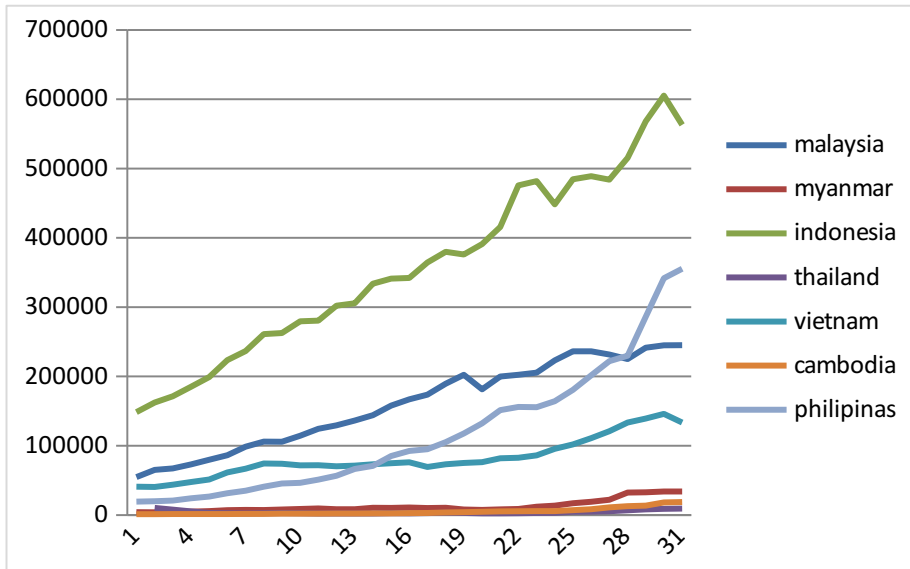


Fig. 1. Total CO₂ Emissions in 7 Middle-Income Countries in ASEAN

The increase in CO₂ emissions that occurred in middle-income countries in ASEAN in 1990-2020 was contributed by the Indonesian state with a CO₂ emission level of almost 600,000 kilotons. Second, the country of Vietnam almost reached 350,000 kilotons. An increase in CO₂ emissions can occur due to socio-economic activities such as economic growth driven by the industrial sector and the number of populations.

The flow of economic growth in middle-income countries causes the country to be able to achieve the targeted growth rate. The high acceleration of industrialization, the increase in the number of populations, and energy consumption without being accompanied by the behavior of people who are aware of environmental quality are certainly very influential factors in triggering the emergence of various environmental problems [7].

FDI is expected to drive long-term economic growth in recipient economies through technological improvements and knowledge abundances, it can be seen that the degree to which FDI increases the degree of complementarity and substitution between FDI and domestic investment determines growth. In a study conducted by, 1% China's foreign direct investment (FDI) equities in Africa rose sharply. Africa's gross domestic product rose 0.607% in GDP, because of the relationship between China's FDI and Africa's GDP growth in one direction [8, 9].

The increase in the number of people is getting higher resulting in the land no longer being able to supply agricultural goods in order to fulfill the demand for food. Damage to the environment will arise from a decline in the carrying capacity of soil as an environmental component [10].

So that the environmental damage that occurs will result in a decrease in the environment's ability to process CO emissions to O₂ which makes CO emissions will

continue to increase. In the research carried out by explaining that the population has a noteworthy and favorable impact on carbon dioxide (CO₂) in the ASEAN area [11].

Problems regarding CO₂ emissions occur in almost all countries, especially in middle-income countries in the ASEAN region. Thus, it is necessary to create a policy to harmonize socio- Economic activity and environmental conditions reviewed from CO₂ emissions.

2 LITERATURE REVIEW

Environmental Kuznets Curve (EKC) is a theory that links deterioration of the environment with the rate of economic growth. In the journal written by Explained that EKC is the first idea to explain the connection between a nation's environmental deterioration and economic growth [12].

When a nation's GDP is still low, its focus will be on ways to boost state revenue, including through investment and manufacturing that boosts income and ignores issues with environmental quality. Thus, an increase in economic growth will be followed by an increase in pollution levels and then decrease again with continued growth.

Numerous investigations that have already been carried out show that the short-term results of economic growth have a favorable and noteworthy impact on the quality of the environment. However, some research also shows results where Economic expansion has drawbacks. and insignificant impact on the quality of the environment [13, 14].

3 RESEARCH METHODS

This study uses panel data for 7 middle-income countries in the region ASEAN in 2017 to 2022 which is sourced from the site/website World Bank and Energy Institute. Panel data regression analysis is used in this work. Model of Random Effects (REM) to determine the values of each independent variable impact on the bound variable. Type random effects were used after the Chow test, Hausman test, and Lagrange Multiplier (LM) Tests were carried out. on the research data. This research was processed using the help of software Eviews 12.

The equation for regression can be seen as follows:

$$CO2_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 FDI_{it} + \beta_3 JP_{it} + \epsilon_{it} \quad (1)$$

Where:

CO ₂	: Carbon Dioxide Emissions
b ₀	: Constant
GDP	: Gross Domestic Product
FDI	: Foreign Direct Investment
JP	: Population
B ₁	: Coefficient of Gross Domestic Product
B ₂	: Coefficient of Foreign Direct Investment
ε	: Residual Value

4 RESULTS AND DISCUSSION

4.1 Model Selection

This study uses panel data and is quantitative in nature. analysis. In determining the model that can be used, Chow, Hausman and LM tests are first conducted in order to identify the most effective model in conducting panel data regression tests.

Table 1. Chow Test

“Effects Test”	“Statistic”	“d.f”	“Prob”
“Cross-section F”	“48.738425”	“(6,32)”	“0.000”
“Cross-section Chi-square”	“97.286095”	“6”	“0.000”

Source: Eviews Data Processing Results 12

Model testing using Chow Test on data, can determine the best model that can be used. According to the p-value, or probability value, obtained is 0.0000, indicating that the amount is less than the significance threshold of 0.05. Consequently, it may be that The Fixed Effect Model (FEM) is considered to be better suitable for use in this research. The FEM model can be chosen because of its ability to control unobserved variables that may affect the results; thus, it can provide more accurate estimates of the relationships of the variables being studied.

Table 2. Hausman Test

“Test Summary”	“Chi-Sq. Statistic”	“Chi-Sq. d.f”	“Prob”
“Cross-section random”	“1.329765”	“3”	“0.7221”

Source: Eviews Data Processing Results 12

The results of the Hausman test explained that in the choice of this study's panel data model, it is more suitable to use the Random Effect Model. In determining the model using the hausman test, conclusions can be obtained via examining the value of probability. The p-value, or probability value in the hausman test of 0.7221 exceeds the importance threshold value of > 0.05 which means that in this research, it is more appropriate to utilize the Random Effect Model (REM) model because of its ability to capture variations between individual or group variables in the data and enable analysis that considers the influence of unobserved variables.

Table 3. Lagrange Multiplier (LM) Test

	“Cross-section”	“Test Hypothesis Time”	“Both”
“Breusch-Pagan”	79.26085	2.884609	82.14546

	(0.0000)	(0.0894)	(0.0000)
“Honda”	8.902857	-1.698414	5.094310
	(0.0000)	(0.9553)	(0.0000)
“King-Wu”	8.902857	-1.698414	4.747943
	(0.0000)	(0.9553)	(0.0000)
“Standardized Honda”	11.64229	-1.550011	3.626299
	(0.0000)	(0.9394)	(0.0001)
“Standardized King- Wu”	11.64229	-1.550011	3.177765
	(0.0000)	(0.9394)	(0.0007)
“Gourieroux. et al”	-	-	79.26085
			(0.0000)

Source: Eviews Data Processing Results 12

After the LM test was carried out, the p-value, or probability value of 0.000 was obtained which was less than the significance of the LM test's cutoff value which was 0.005. So, according to the findings of the Chow, Hausman, and LM tests, it can be said that in this study it is more appropriate to use the Random Effect Model (REM) model. This decision was taken after considering the results of the three trials. After the REM model's selection, the classical assumption test is no longer necessary because the REM model intrinsically addresses several assumption problems that are usually associated with regression analysis such as homoscedasticity assumptions and error independence.

4.2 Panel Data Estimation

Drawing on the findings of the Hausman, LM, and Chow tests, it can be said that the model that can be used in estimating the research variables *Gross Domestic Product* (GDP), FDI, or foreign direct investment, as well as the Number of Population or Carbon Dioxide (CO₂) Emissions in Middle-Income Countries in the Region *ASEAN* be *Random Effect Model* (REM). Based on this, the linear regression equation of panel data in this study is obtained as follows:

$$\text{CO}_2 = 53.43661 + 5.90448\text{e-}10 \cdot \text{X}_1 - 0.00083248 \cdot \text{X}_2 - 1.93717\text{e-}07 \cdot \text{X}_3 \quad (2)$$

The explanation of the linear regression of the panel data is as follows:

1. The Y variable will increase by 53.43661 when all independent variables (X₁ and X₂) have a value equal to zero.
2. Every increase of one unit in the variable X₁ will cause an increase in the value of Y by 5.90448e-10, assuming that the variables X₂ and X₃ are constant. A positive sign indicates a direct relationship between X₁ and Y.
3. Every increase of one unit in variable X₂ will cause a decrease in the value of Y by 0.0008324, assuming that variables X₁ and X₃ are constant. A negative sign indicates an inverse relationship between X₂ and Y.

4. Every increase of one unit in the variable X3 will cause a decrease in the value of Y by $1.93717e-07$, assuming that X1 and X2 are constant. A negative sign indicates an inverse relationship between X3 and Y.

Table 4. Estimated results of the t test

“Variable “	“Coefficien t”	“Std.Error ”	“t- Statistic”	“Prob”
C	53.43661	48.81954	1.094574	0.2806
X1	5.90E-10	8.20E-11	7.202770	0.0000
X2	-0.000832	0.006642	-0.125329	0.9009
X3	-1.94E-07	5.54E-07	-0.349784	0.7284

Source: Eviews Data Processing Results 12

The partial influence can observe the relationship between independent and dependent variables. Considering the GDP (X1) variable's t-test findings, a calculated t-value of 7.202770 and a significance value of 0.000 were obtained. Decision making can be done by looking at the value of significance. $0.000 < 0.05$, which means that GDP has an effect on carbon dioxide emissions (Y).

1. The FDI variabel (X2) discovered a relevance value of $0.9009 > 0.05$ and a t-count value of -0.125329 , indicating that there was no relationship between the FDI variable (X1) and carbon dioxide emissions (Y).
2. The variable of population number (X3) discovered a relevance value of $0.7284 > 0.05$ and a t-count value of -0.349784 , indicating that there was no relationship between the population variable (X3) and carbon dioxide emissions (Y).

Table 5. Estimated results of test F

“R-squared”	0.729190
“Adjusted R-squared”	0.707811
“S.E. of regression”	21.12194
“F-statistic”	34.10665
“Prob (F-statistic)”	0.000000

Source: Eviews Data Processing Results 12

The F value is calculated from the regression result of 34.10665 having a substantial value of 0.000000, so we may say that the factors of GDP, FDI, and Population together affect the carbon dioxide emission variable.

Table 6. Determination Coefficient Test Results (R2)

“R-squared”	0.729190
“Adjusted R-squared”	0.707811
“S.E. of regression”	21.12194
“F-statistic”	34.10665
“Prob (F-statistic)”	0.000000

Source: Eviews Data Processing Results 12

The value of the corrected R-squared value is 0.707811 or 70.78%. The value of the determination coefficient is a value that shows that the value of independent factors made of GDP, FDI and Population is able to explain the carbon dioxide (CO₂) emission variable of 70.78%, whereas the rest of 29.22% is explained by other factors outside the scope of the study variable.

Based on the results of research that has been carried out using the help of Eviews 12 software. Table 4 demonstrates that the amount calculated GDP as 7.202770 with a significant value of $0.0000 < 0.05$. One may contend that the GDP variable has a major impact on the carbon dioxide emission variable. The same thing was found in a study conducted by Wilda et al. [15] GDP is one of the indicators in measuring the economic performance of a country so that it can be said to grow or not. The Environmental Kuznets Curve developed by Somon Kuznets also states that economic development affects the quality of the environment. When a country encourages economic growth, there will be environmental damage both in the short and long term. Environmental quality will improve and economic growth will continue to improve.

The FDI variable showed a t-value of -0.349784 with a significant value of $0.9009 > 0.05$. It can be said that the FDI variable does not have a noteworthy impact on carbon dioxide emissions. FDI can eventually lower carbon dioxide emissions, but in the short term it does not have a significant effect. This happens because of many factors, one of which is regulation from the government regarding the receipt of foreign investment funds that can be used to make environmentally friendly technology and make improvements to the nation's ecology.

The variable Number of populations shows a t-calculated value of -0.349784 with a significant value of $0.7284 > 0.05$. It can be said that the population variable does not have a significant effect on carbon dioxide emissions. A different thing was found in the studies that were executed by Fahrudin et al. [11] explaining that the population has an influence and is significant on carbon dioxide emissions. This can happen because of government policies that encourage environmentally friendly practices so that even though it has a large population, environmental policies can maintain carbon dioxide emissions in a country.

The outcome of the calculation in the Table 5 F test indicates that the F value is calculated from the regression result of 34.10665 with a noteworthy value of 0.000000, indicating that the variables of GDP, FDI, and Population together affect the carbon dioxide (CO₂) emission variable.

5 Conclusion

The following conclusions can be made in light of the foregoing study and discussion:

1. GDP (X1) has a favorable and noteworthy influence on carbon dioxide emissions (Y). This happens because GDP is driven from various sectors that can cause carbon dioxide emissions such as factories.
2. FDI (X2) has no significant influence and has a negative value on carbon dioxide emissions (Y). This can happen because the flow of funds from FDI can be used in environmentally friendly sectors,

3. The number of population (X3) has no significant effect on carbon dioxide emissions (Y). This can happen because of environmental policies that encourage environmentally friendly practices.

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