The Influence of Gross Domestic Product and Human Development Index on CO₂ Emissions

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Abstract: Economic development runs hand in hand with a reduction of durability and functionality of the environment. Development-oriented in the pursuit of growth is too often ignored aspect of environmental management. Development that aims to prosper the people, ultimately becoming the life support system of the destroyer (in this case the environment). The object of this research is to analyze the effect of Gross National Product and the Human Development Index against the CO₂ Emissions in 6 countries of the ASEAN countries and Japan. The methods used in this research is a panel data regression is a combination of the time series and cross section of 6 countries of ASEAN countries and Japan. The results of this study found that Gross National Product effect was positive but not significantly to CO₂ while Human Development Index positive and insignificant effect against CO₂.

Keyword: CO₂, Gross Domestic Product, Human Development Index

1. Introduction

1.1 Background

The development of the environment covers various aspects, by terms of economic, technology, social, and culture. This is closely related to the development of various sectors such as industry, agriculture, forestry, mining and energy, transportation, education, health, tourism, trade and foreign affairs, technology, business and regional development.

Economic development goes hand in hand with declining endurance and environmental functions. Development that is too oriented in the pursuit of growth often ignores aspects of environmental management. Development that aims to prosper society eventually become a destructive life support system (in this case environment). Development must be maintained by not forgetting the environmental management. In general, sustainable development relies on economic, environment, and socio-cultural.

Therefore, economic growth itself is not enough, but it needs a conception of development or sociable environment [27] In six ASEAN countries and Japan, CO₂ emissions per capita rate is growing constantly every year. It can be seen from the following data:
Figure 1. CO2 Emission Levels Per Capita, GDP and HDI in Six ASEAN Countries and Japan
Source: World Bank, Our World in Data, UNDP (2020)

In no human condition, the natural environment must undergo continuous changes. This may last for hundreds of millions of years, such as continental lift and volcano formation; or within a period of tens of thousands of years such as the ice age and the changing sea levels that accompany it; or within a period of hundreds of years as well as natural eutrophication and siltation of shallow lakes; or even within a few years, some of these natural changes are irreversible like lake eutrophication, while others are cyclical like the annual climatic cycle, or transients like drought.

Along with such naturally occurring changes in the environment, changes in human activities arise. At the cultural level of forest hunter and gatherer communities, the use of fire has modified some of the natural environment. Then with domestication of animals and agricultural introductions, the effects of these activities become wider, especially if more and more people are involved. The rate of change is increasing with the development of the industry because muscle power is replaced with energy derived from fossil fuels up to the last few decades. The impact of human activities has reached an unexpected intensity and affects the whole world as the population increases rapidly and the consumption of each of the higher capita [38]. Environmentalists use the term "sustainable" as an effort to explain the most desirable balance between economic growth on one side, and the preservation of the environment or natural resources on the other. The process of economic development can continue if it is maintained so that the ecosystem can function in a sustainable manner. In line with the capital/business approach, sustainable development is interpreted as development that can guarantee no decrease in national wealth per capita by substitution in energy use, and saving of resources which includes stock, social, human and natural capital.

Economic development has at least polluted the surrounding environment and resulted in a deterioration
in the quality of the environment. Environmental issues have actually existed long ago, and are not a problem that only developed or poor countries have or has faced, but environmental problems are already a world problem. Decline in environmental quality can occur due to emissions from industry, domestic transport and forest fires in the dry season that has exceeded the carrying capacity of the environment that can no longer be neutralized. Most developing countries are beginning to shift from agriculture-focused countries to industrial sectors, certainly for one purpose of increasing GDP from the industrial sector to GDP per capita. The industrial sector is the largest producer of waste, since almost all industries in ASEAN are waste-generating industries that do not use sociable environment technologies. Just as most industries such as refineries liberate sulfur dioxide (SO2), carbon dioxide, methane, and nitrogen oxide (NO) into the air and combine with water vapor and gather in the clouds.

According to the Global Environmental Monitoring System, the United Nations estimates that by 1987 two-thirds of urban dwellers lived in cities whose concentrations of sulfur dioxide in the surrounding air were above or right on WHO's threshold. This pungent but colorless gas can cause asthma attacks and as this gas settles in the air, it reacts with other compounds to form fine particles and acidic substances to form acid rain. Sulfur emissions primarily arise from the burning of fossil fuels that contain sulfur especially coal used for power generation or household heating.

1.2 Problem Formulation

Based on the above background, then the problem formulation is as follows:

a. What is the effect of GDP on CO2 emissions?
b. How does the HDI affect CO2 emissions?

1.3 Purpose and Use of Research

The purpose and use of this study are to analyze the effect of GDP and Human Development Index on CO2 emissions in six ASEAN countries and Japan. This research is expected to provide additional information and study materials on the effect of GDP and Human Development Index on CO2 emissions for future researchers.

2. Research Future

Economic development goes hand in hand with declining endurance and environmental functions. Development that is too oriented in the pursuit of growth often ignores aspects of environmental management. Development that aims to prosper society eventually become a destructive life support system (in this case environment). Development must be maintained by not forgetting the environmental management. In general, sustainable development relies on economic, environment, and socio-cultural. In no human condition, the natural environment must undergo continuous changes. This may last for hundreds of millions of years, such as continental lift and volcano formation; or within a period of tens of thousands of years such as the ice age and the changing sea levels that accompany it; or within a period of hundreds of years as well as natural eutrophication and siltation of shallow lakes; or even within a few years, some of these natural changes are irreversible like lake eutrophication, while others are cyclical like the annual climatic cycle, or transients like drought.

This research uses a panel data approach in estimating research data. The use of panel data in estimating data is driven by problems in research related to the availability of data to represent the variables used. Baltagi (2005) explains that there are several advantages gained from the use of panel data analysis. In explanation of the advantages of panel data, Baltagi uses the previous explanation put forward by Klevmarken (1989) and Hsiao (2003). The advantages of using panel data, in question, are able to
control individual heterogeneity, provide more information, better data panels for study dynamics of adjustment studies, and can build and test behavioral models that are more complex than pure cross section or time series data.

3. Literature Review

3.1 Economic Development

Economic development is defined as an increase in the per capita income of the people, namely the rate of increase in Gross Domestic Product (GDP) in a certain year that exceeds the rate of population growth. The development of GDP applies in a society accompanied by changes and modernization in a generally traditional economic structure, whereas economic growth is defined as an increase in GDP regardless of whether the increase is higher or less than population growth or whether structural change occurs or not [25].

Todaro says that the success of economic development is represented by three core values:

a. The development of society's ability to fulfill its basic needs (base needs).

b. Increasing the sense of self-esteem (self-esteem) of society as human beings.

b. Increasing people's willingness to choose (freedom from servitude) which is one of human rights.

From this definition it is clear that economic development has four important properties: a process that means continuous change, the effort to raise per-capita income must continue in the long run, and the improvement of institutional systems in all sectors (e.g., economics, politics, law, social and cultural).

3.2 Economic Growth

Economic growth can be interpreted as increasing the output (output) of society caused by the increasing number of production factors used in the process of community production. There are three main factors or components in the economic growth of each nation [27]. All three are:

a. Capital accumulation, covering all forms or types of new investments invested in physical equHDIent, land and human capital and human resources.

b. Population growth, which in the next few years will increase the number of labor force.

c. Technological advances.

Economic growth is one of the most important indicators in analyzing the economic development occurring in one country. Economic growth indicates the extent to which economic activity will generate an additional income for a given period of time, because basically economic activity is a process of using production factors to produce output, which in turn will result in a flow of remuneration to the factor of production owned by society. With the economic growth it is expected that the income of the community as the owner of the factors of production will also increase.

3.3 Human Development Index

The Human Development Index (HDI or Human Development Index) is a composite index calculated based on life expectancy, education level, and income. HDI is made as one of the indicators to measure the development of an area and is also one of the single statistical indicators that can be used as a reference for social and economic development (undp.org, 2012).
At the beginning of the HDI development period by UNDP (officially used in 1990) many criticisms have sprung up on the measurement aspect. A particularly prominent criticism is the simplicity of the size of "development" which consists only of health, education, and income so as to be the point of press "development" back again on the aspect of economic growth.

The use of HDI over the last two decades shows the recognition of hegemonic growth-centric thinking as Jon Gartner reviewed in "The Rise and Fall of the G.D.P.". Subsequent developments emerged various composite indexes used to complement development measures such as: GDI (Gender-related Development Index), GEM (Gender Empowerment Measure), HPI (Human Poverty Index), etc.

Usage will increase if other types of indices are used, for example: EPI (Environmental Performance Index) that can be linked to fossil fuel use, pollution, CO2 emissions, climate change threats, and related data in the main/supporting sectors.

3.4 Kuznets Theory

The theory that links environmental degradation to the per capita income level of a country is known as the Environmental Kuznets Curve (EKC). This hypothesis suggests that when a country's earnings are still low, the country's attention will be on how to increase state revenues, both through production, investments that encourage income generation by putting aside environmental quality issues. Revenue growth will be accompanied by an increase in pollution levels, and then decline again with conditions of steady income growth. This theory is based on the demand for environmental quality that enhances social oversight and government regulation so that society will be more prosperous (Mason and Swanson, 2003).

![Figure 2. Kuznets Curve](source: Andreoni & Levinson, 2004)

As the income of a country continues to grow as economic development, manufacturing production will contribute a large percentage of the national domestic product. In general, industrialization starts from a small industry and then moves into a heavy industry. This is the stage of the medium income level, the increased use of natural resources, and the intensification of environmental degradation. And finally, the stage of development controls industrialization by expanding its share of national domestic products, as industrial activity grows steadily. At this stage raw material utilities will decrease, while disposal or waste per unit of production will increase.

4. Methodology

This research is a quantitative research by analyzing secondary data in testing the proposed hypothesis.
The scope used in this study is a study of Macro Economy and International Economics. The study was conducted using panel data regression by analyzing the effect of GDP and HDI on CO2 emissions in 6 ASEAN countries (Indonesia, Thailand, Malaysia, Philippines, Singapore, Vietnam) and Japan.

4.1 Types and Sources of Data

The type of data used in this study is in the form of secondary data which is time series and cross section during the period 2007-2018. The data is a representation of the variables of CO2, GDP and HDI from Indonesia, Thailand, Malaysia, Philippines, Singapore, Vietnam and Japan.

All data used in this study were obtained from the publication of World Bank metadata. In summary the data used in this study can be explained as follows:

a. GDP data per capita of Indonesia, Thailand, Malaysia, Philippines, Singapore, Vietnam, and Japan 2007-2018 (Source: World Banks).

b. CO2 Emission data per capita of Indonesia, Thailand, Malaysia, Philippines, Singapore, Vietnam, and Japan 2007-2018 (Source: World Banks).

c. HDI data of Indonesia, Thailand, Malaysia, Philippines, Singapore, Vietnam, and Japan 2007-2018 (Source: World Banks).

This research uses a panel data approach in estimating research data. The use of panel data in estimating data is driven by problems in research related to the availability of data to represent the variables used. Baltagi (2005) explains that there are several advantages gained from the use of panel data analysis. In explanation of the advantages of panel data, Baltagi uses the previous explanation put forward by Klevmarken (1989) and Hsiao (2003). The advantages of using panel data, in question, are able to control individual heterogeneity, provide more information, better data panels for study dynamics of adjustment studies, and can build and test behavioral models that are more complex than pure cross section or time series data.

5. Result and Discussion

5.1 Panel Data Estimation Result

In analyzing research data with panel data, the researcher uses three types of model estimation, i.e. pooled least square (PLS), fixed effect method (FEM), and random effect method (REM). The results to be used in drawing the conclusions are the results of the best model of the model testing performed, using software eviews 10, while the estimation results that have been done are as follows: Criteria for Selection of Research Models Test

a. Significance Test Fixed Effect (F Test/Chow Test)

Fixed Effect model is often called a least square dummy variable. To choose between common effect (pool least square) and fixed effect, uses Chow Test.

The hypothesis of Chow Test is:

H₀ (CEM) = Accepted if the Cross-Section F> 0.05
H₁ (FEM) = Accepted if the Cross-Section F <0.05
Table 1. F Test/Chow Test

| Effects Test            | Statistic | d.f.   | Prob.         |
|-------------------------|-----------|--------|---------------|
| Cross-section F         | 21.527069 | (6.75) | 0.0000        |
| Cross-section Chi-square| 84.119927 | 6      | 0.0000        |

From the results of the Chow test it was found that the probability value of the cross section was 0.0000, which means that the value is smaller than \( \alpha \) value of 0.05 so that H1 or the FEM model is more feasible to use.

b. **Hausman Test**

To find out and/or to determine the choice between using *fixed effect* model or *random effect* model in estimation of panel data regression model, Hausman test is done, where this Hausman test is based on the idea that least square dummy variable (LSDV) in fixed effect method and generalized least square (GLS) is efficient, while the ordinary least square (OLS) method is inefficient. On the other hand, the alternative OLS method is efficient and GLS is not efficient.

The framework of the hypothesis is as follows:

- \( H_0 \) (REM): Accepted if the probability > 0.05
- \( H_1 \) (FEM): Accepted if the probability < 0.05 **Hausman**

**Test Results**

| Test Summary Statistic | Chi-Sq.       | d.f. | Prob. |
|------------------------|---------------|------|-------|
| Cross-section random   | 7.727582      | 2    | 0.0210|

The results of the Hausman test show that the probability value is 0.0210, which means that it is smaller than the value of \( \alpha \), namely 0.05 so that \( H_1 \) is accepted, namely the FEM model is the chosen *model 3. Simultaneous Test (F Test)*.

The significance test of the parameter or the F test is performed in order to see the effect of independent variables simultaneously or overall. The parameter is if the value of F arithmetic is higher than the F table value or if the F-statistic probability value is less than the alpha (\( \alpha \)) value of 5 percent, it can be said that overall independent variables in the model have a significant effect to the dependent variable.
or if the opposite happens then overall independent variables in the model has no a significant effect to the dependent variable. From the regression model obtained the probability value of F Statistic 144,802 which is higher than alpha (α) 5 percent, which means that the independent variable as an overall or simultaneous has no significant effect on the dependent variable. 4. Partial Test (t Test)

Individual significance tests intend to see the significance of the influence of independent variables individually to the dependent variable. The parameter used is a dependent variable when the value of t arithmetic is higher than the value of t table or also can be known from the t-statistic probability value which is smaller than the value of alpha (α) 5 percent.

Table 3. Statistical t Test Results

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C        | -8.047251   | 15.70450   | -0.512417   | 0.6099|
| X1       | 0.265585    | 0.852319   | 0.311602    | 0.7562|
| X2       | 7.621330    | 11.54327   | 0.660240    | 0.5111|

Based on the table above it can be seen that from the existing model of GDP variable individually has no significant effect on CO2 variable, which can be known from its probability value (0,7562) which is higher than the 5% alpha (α) value. Then HDI individually also has no significant effect on the CO2 variable, which can be known from its probability value (0,5111) which is higher than the 5% alpha (α) value.

c. Regression Function

This study examines the effect of GDP per capita and HDI on environmental degradation (CO2). Based on the results of multiple regression analysis, obtained a model or regression function in the form of influence of GDP and HDI to CO2 as follows:

\[
Y_{it} = -8.047 + 0.266 X1 + 7.621 X2 + 13.767 e
\]  \hspace{1cm} (1)

Explanation:

\[Y\] = Emissions of Carbon Dioxide/CO2
\[X1\] = GDP
\[X2\] = HDI
\[i\] = country
\[t\] = time

From the regression function, it can be said that the GDP and HDI variable has a positive effect on CO2.

d. Variable Analysis Affecting CO2

To find out the factors that influence carbon dioxide emission level (CO2), this research uses
specification from panel data model sorting, which is Fixed Effect Model, so that it can be found out what factors become determinant of CO2 level in 6 ASEAN countries and Japan, which will be described as follows.

e. GDP

The GDP variable based on the estimation shows that the GDP coefficient has positive and insignificant effect on $\alpha = 5\%$. This means that with increasing GDP, it will have a positive impact on CO2 levels but not significantly. The regression coefficient 0.266 indicates that if GDP rises by 1% per year, ceteris paribus will reduce CO2 emissions by 0.266%.

This is in line with findings in a study conducted by Jan-Erik Lane (2011), GDP variables have a positive and significant effect on CO2 emissions. It is also in line with the findings of Muchammad Arief (2016), GDP variables have a positive effect on CO2 emissions.

f. HDI

Estimation results show that the coefficient of HDI has positive and insignificant effect on $\alpha = 5\%$. This means that the height of HDI has a positive impact on increasing CO2 emissions. The regression coefficient of 7.621 indicates that if HDI increases by 1 percent per year, ceteris paribus will increase CO2 emissions by 7.621 percent.

These results are different and not in line with the findings conducted by Andrei Ramani (2014), where the research results by Andrei Rama (2014) indicates that HDI has a negative and significant effect on the environmental disease (greenhouse gas).

6. Future Trends and Conclusion

The conclusions of the research conducted in six ASEAN countries and Japan, with the observation period 2007-2018 are as follows:

a. The estimation results show that the GDP coefficient has a positive and insignificant effect on $\alpha = 5\%$. This means that the increase in GDP has a positive impact on CO2 levels but not significantly. The regression coefficient 0.266 shows that if GDP increases by 1% per year, ceteris paribus will increase CO2 emissions by 0.266%.

b. The estimation results show that the HDI coefficient has a positive and insignificant effect on $\alpha = 5\%$. This means that the high HDI is indicated to have a positive impact on increasing CO2 emissions. A regression coefficient of 7.621 indicates that if HDI increases by 1 percent per year, ceteris paribus will increase CO2 emissions by 7.621 percent.

7. Suggestion

From some conclusions above, the authors submit some recommendations as follows:

a. Further research needs to be done by adding other independent variables that are thought to be influential and related to CO2 emissions in ASEAN and other Asian countries, so that more solutions
can be obtained to reduce the amount of carbon dioxide emissions so that in the development and progress of economic conditions, global environmental conditions can be maintained well.

b. It is hoped that governments in the six ASEAN countries (Indonesia, Thailand, Malaysia, Philippines, Singapore, Vietnam) and Japan will continue to increase GDP and HDI but still have to look at the preservation of the existing natural environment, because the results of this study show that the increase in the value of GDP and HDI can also bring a bad impact on environmental conditions in the form of increased CO2 Emissions, so the authors hope that stable natural conditions will be the responsibility of both the community and the government.

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