

Analysis of Factors that Affect CO₂ Emissions in 5 ASEAN Country in 2011-2018

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ARTICLE INFO

ABSTRACT

Article history

Received : 2022-03-08

Revised : 2022-03-28

Accepted : 2022-04-23

Keywords

Emissions of Carbon Dioxide (CO₂)

Economy Growth

City Population

Import and Export of High Technology

Panel Data

Changes in the quality of the environment at this time until the next few years need to be considered. Changes in the quality of the environment are caused by the various activities of the economy that do humans. This change in environmental quality is represented by the variable emission of carbon dioxide (CO₂) gas. This research aims to analyze the effect of the growth of the economy, city population, and the import and export of technology high on the emissions of gas carbon dioxide (CO₂) in the five countries of ASEAN (Indonesia, Myanmar, Malaysia, Thailand, Vietnam) during 2011-2018. This study uses panel data (time series and cross-section). In using the method of regression of panel data is performed by Chow test and Hausman test, and elected, namely the fixed effect model. Furthermore, the classical assumption test was carried out on the selected model, including the normality test, multicollinearity test, heteroscedasticity test, and autocorrelation test. Results of the study are to prove that the only variable city population affects positively and significantly emissions of gas carbon dioxide (CO₂). While variable independent more like a growth economy, import and export of high technology do not affect significantly emissions of gas carbon dioxide (CO₂).

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Introduction

In the era of globalization, the issue of global warming is a serious topic of the environment. Effects of global warming are like a shift in seasons and the weather is extreme. The experts concluded that warming global is caused due to occur an increase in Greenhouse gas (GHG) emissions CO₂ in the greenhouse, which is approximately 75% (Sukadri, 2012). When other gases in GHG decrease, emissions of CO₂ increase (ÖZÇAĞ, 2005)

Sources of emissions CO₂ are mostly large (80%) caused by the activities of humans or

referred to as "anthropogenic emission", namely fossil fuels burning while the rest (20%) comes from the activities of deforestation and degradation of forests (Sukadri, 2012).

ASEAN is an association collection of Parts of a great country developing with a high population and fast growth. ASEAN has predicted residents of its 700 million people in the year 2030 will provide contributions great to the growth of emissions of CO₂ as a whole (OECD, 2011). According to Dietz & Rosa (1997) driving factor emissions of CO₂ are caused by many factors anthropogenic, for example : (1) a resident; (2) economic activities; (3) technology; (4) political and economic institutions; (5) attitudes and beliefs. Of the five factors mentioned, population, income, and technology are considered the driving principle of the emission of CO₂.

Suparmoko (1998) argues that the increasing population will increase the demand for goods and services that must be provided to fulfill the needs of the population. So, it will have an impact on the number of production sources of nature to fulfill the consumption of energy residents. As a result, the resource of nature is getting decreased, and pollution of the environment is getting increased along with the growth of the population. This causes the Gas House Greenhouse (GHG) to thin.

Another factor that affects population is, namely activities economy is reflected in economic growth. Each country will always try to improve the economic growth and make economic growth a target economy and the success of the economy of a country in long term. Economy growth is a measure of the achievement of the country from one period to the next period to produce goods and services. Economic growth is needed and one of the sources of increasing the standard of living of a population whose numbers continue to increase. Another variable to affects emissions of CO₂ is economic activities such as international trade (export and import). This study is represented by high technology export and import variables.

Based on the background behind the above, the authors are interested to know the effect of economic growth, city population, imports, and high technology export on the emission of carbon dioxide (CO₂) in the 5 ASEAN countries in 2011-2018. This research is very important because it relates to the phenomenon of declining quality of an environment, it is necessary to analyze the factors that affect the emissions of CO₂.

Method

This research is using research descriptive methods with a quantitative approach, research descriptive is used to determine the effect of economic growth, city population, and import and export of high technology on the emissions of gas carbon dioxide (CO₂).

While the quantitative approach emphasizes more on measurement theories with numerical variables and data analysis. The data used in this research is secondary data. Data obtained from the World Bank and several articles from the journal are related. Data prime is used in this research, on economic growth, city population, import, export of high technology, and emissions of gas carbon dioxide (CO₂) in 2011-2018. This study took 5 ASEAN countries (Indonesia, Myanmar, Malaysia, Thailand, and Vietnam) due to the limited availability of data from the World Bank.

The dependent variable in this research is emissions of gas carbon dioxide (CO₂), measured in Metric Tons per capita. While the first independent variable is economic growth (PE), measured in percent. The second independent variable is city population (POPU), measured in percent. The third independent variable is imported (IMP), measured in percent. The fourth independent variable is high technology exports (ETT), measured in percent. The analytical tool used is the panel method. There are 3 methods used to work with panel data, namely: Pooled Least Square (PLS), Fixed Effect Model (FEM), Random Effect Model (REM) (Gujarati, D. dan Dawn C, 2009). In this panel data, a Chow test is carried out to determine whether an appropriate model for this study is the Chow test. The Chow test looks at the right common effect or fixed-effect model to determine panel data. Furthermore, the Hausman test is used to determine the appropriate estimation model, whether Fixed Effect or Random Effect will be selected. The Hausman test follows a Cross-section random assessment, so the decision to choose the suitability of the model can be decided correctly. Next, the Lagrange multiplier test is used to determine the right estimation model and whether a random effect or common effect will be selected. In this study, the Lagrange multiplier test was not carried out because the results on the Chow and Hausman tests were consistent with the selected fixed-effect model. This study modifies Akram's (2012) model so that it becomes:

$$CO2_t = \alpha_1 + \sum_{j=1}^k \beta_{11} PE_{t-j} + \sum_{j=1}^k \beta_{12} POPU_{t-j} + \sum_{j=1}^k \beta_{13} IMP_{t-j} + \sum_{j=1}^k \beta_{14} ETT_{t-j} + \varepsilon_t \quad (1)$$

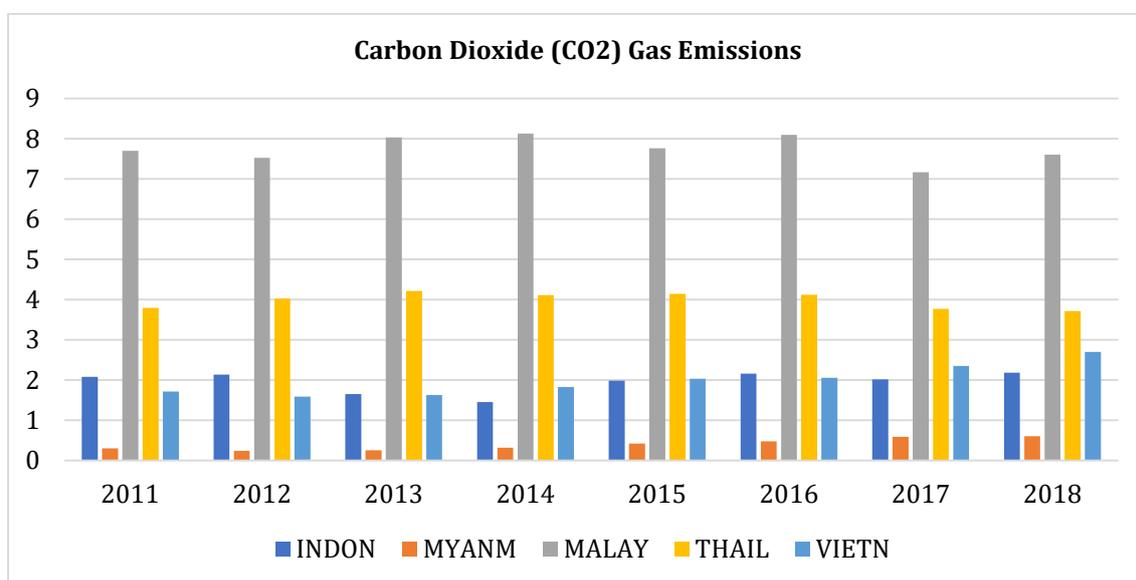
Where CO₂ is the emission of carbon dioxide; PE is economic growth, POPU is city population; IMP is an import; ETT is a high-technology export; α is Constanta; t is a time; j is a country; β is the coefficient of each variable, and ε is the error term.

The next step is to test the statistical determination (R^2), t-test, and F test. The coefficient of determination (R^2) is essential to measure how far the model's ability to explain the dependent variable is. The t-test is used to see whether each independent variable is significant to the dependent variable. The F test is carried out to see whether or not the independent variable is simultaneously (overall) significant to the dependent

variables (Kuncoro, 2011). After panel data regression and the selected model were taken, the classical assumption test was carried out which included a normality test, test multicollinearity, heteroskedasticity test, and autocorrelation test.

Result and Discussion

The development of carbon dioxide gas (CO₂) emission in 5 ASEAN countries during the 2011-2018 period was the highest, namely Malaysia with a range of 7-8 metric tons per capita. The second is Thailand with a range of 3-4 metric tons per capita. The third is Indonesia and Vietnam with a range of 1-2 metric tons per capita. The last is Myanmar with a range of 0.2-0.4 metric tons per capita (Figure 1)



Source: World Bank, processed data (2021)

Figure 1. Emissions in 5 Asean Countries (Metric Tons Per Capita)

Table 1 show panel data regression result. Base on the result, the value of R² is 0.985241 this shows that the independent variables together can explain the diversity of the dependent variable by 98 percent. Furthermore, the probability of F is 0.000 smaller than 5%, which suggests that overall the independent variables together have a significant influence on the dependent variable. To determine whether the independent variables in the regression equation are partially/individually significant in predicting the value of the dependent variable, namely by conducting a t test. The test is carried out by comparing the probability value to a significance level of 0.05. From the output results in table 1, it can be seen that the probability of economic growth (PE) is 0.5720, the probability of import (IMP) is 0.8820 and the probability of exporting high technology (ETT) is 0.9748 is greater than 0.05 significance level. This shows that the PE, IMP, and ETT variables individually have no significant or no effect on the variable carbon dioxide (CO₂) emissions. Meanwhile, for the

city population variable (POPU) the probability value is 0.0000 which is smaller than the 0.05 significance level, this indicates that the POPU variable is individually significant or has an effect on the carbon dioxide (CO₂) gas emission variable.

Classic Assumption Test

Normality test results shown in Figure 6, the probability value is 0.279285 which is greater than 5% alpha. This states that the research model is normally distributed. Based on the results of the multicollinearity test, it shows that there is no value between the independent variables more than > 0.8, so the research model does not have a correlation between the independent variables (there is no multicollinearity). Furthermore, the probability t of each independent variable, namely PE, POPU, IMP and ETT is greater than alpha 0.05, then in this case there is no heteroscedasticity. Another assumption classic is autocorrelation test, we used Durbin Watson test. From the results of the Durbin-Watson test the selected fixed effect estimation model is 1.307865. Based on data from the Durbin-Watson table with k=4; n=40; alpha = 5% then the value of dL = 1.284 and dU = 1.720, if $dU < dW < 4-dU$, it can be said that the model does not have positive or negative autocorrelation. Based on the data obtained, it can be arranged $DW = 1.307865 < DU = 1,720$ then in the area of doubt or not in the autocorrelation area, so it can be concluded there is no autocorrelation

Table 1. The results of panel data regression with the selected fixed effects model

| Variable | Coefficient | T-statistic | Prob |
|-------------------------|-------------|-------------|--------|
| C | 4.218 | 1.444 | 0.159 |
| PE | 0.015 | 0.571 | 0.572 |
| POPU | 0.097 | 8.365 | 0.000* |
| IMP | 0.0002 | 0.149 | 0.882 |
| ETT | 0.0004 | 0.032 | 0.975 |
| R-squared | 0.985 | | |
| Adjusted R-squared | 0.981 | | |
| F-statistic | 258.677 | | |
| Prob(F-statistic) | 0.000 | | |
| Diagnostic Tool | | | |
| Normality test | Valid | | |
| Multicollinearity | Valid | | |
| Heteroscedasticity Test | Valid | | |
| Autocorrelation Test | Valid | | |

Source: Eviews, processed data (2021)

Discussion

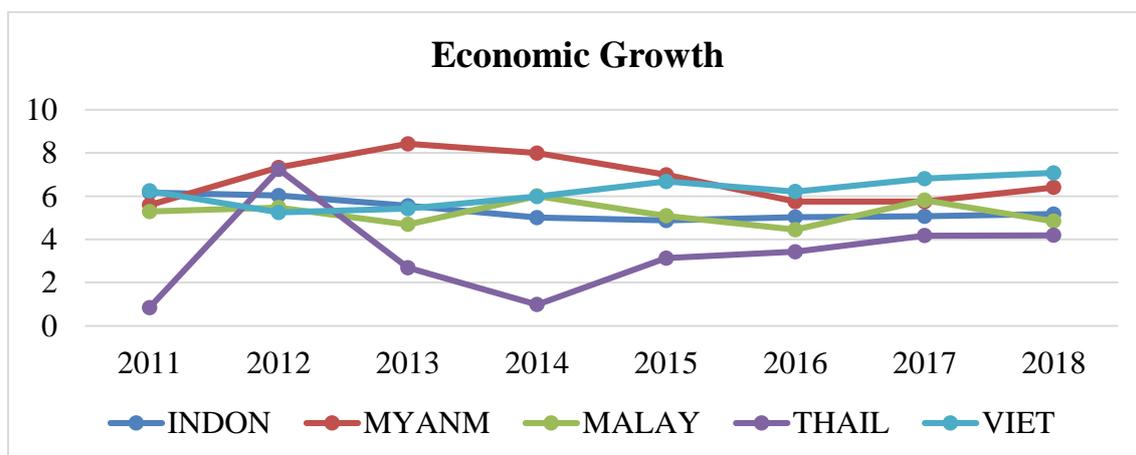
From the results of panel data regression with the Fixed Effect Model, the following regression equation is obtained:

$$CO2it = 4.218 + 0.015 PEit + 0.097 POPUit^* + 0.0002 IMPit + 0.0004 ETTit + eit \quad (2)$$

The further discussion of the factors that affect the emission of carbon dioxide gas is explained below:

Effect of economic growth (PE) on carbon dioxide (CO2) gas emissions

Economic growth in 5 ASEAN countries during 2011-2018 fluctuated. In 2011, the highest economic growth among these five countries was Vietnam at 6.2%, the second was Indonesia at 6.1%. In 2012 the highest economic growth was Myanmar at 7.3%, the second was Thailand at 7.2%, and the lowest was Vietnam at 5.2%. In 2013 the highest economic growth was Myanmar at 8.4% and the lowest was Thailand at 2.6%. In 2014 the highest percentage of economic growth was Myanmar 7.9% and the lowest was Thailand 0.9%. In 2015 the highest economic growth was Myanmar 7.9% and the lowest was Thailand 3.1%. In 2016, the highest economic growth was Vietnam at 6.2% and the lowest was Thailand at 3.4%. In 2017, the highest economic growth was Vietnam at 6.8% and the lowest was Thailand at 4.1%. In 2018, the highest economic growth was Vietnam at 7.0% and the lowest was Thailand at 4.1%. The following is a picture of the rate of economic growth in 5 ASEAN countries (Figure 2).



Source: World Bank, processed data (2021)

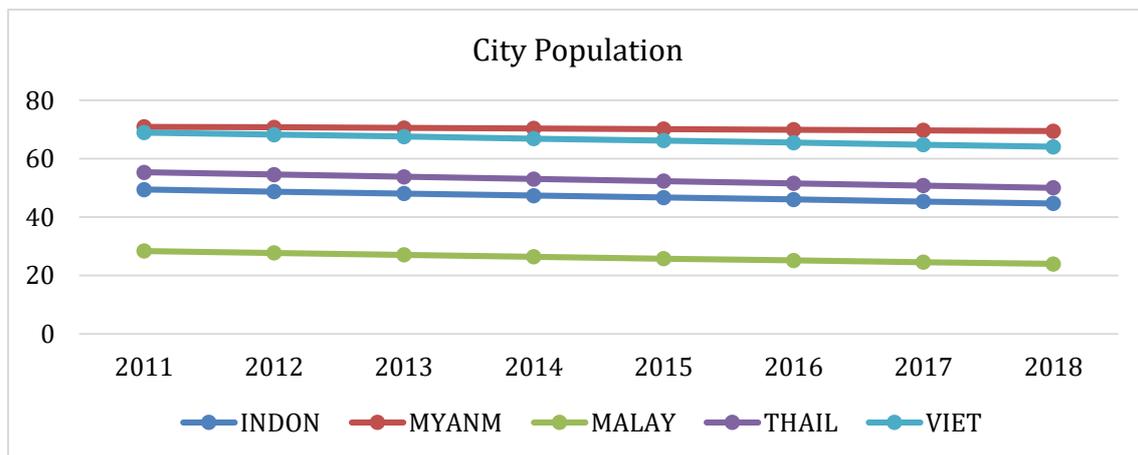
Figure 2. Economic Growth in 5 ASEAN Countries (percent)

The results of this study indicate that when economic growth (PE) increases by 1 percent, it will not increase carbon dioxide emissions by 0.014622 percent. Economic growth will be seen to have a significant effect on increasing CO2 emissions in the long term, while in this study it is still necessary to add a range of years to see the long-term effects. In this study, it means that economic growth has no significant effect on CO2 emissions, but the increase in global CO2 emissions can also be caused by other countries that produce the highest CO2 emissions. This is in accordance with research conducted by (Sun, Samuel, Yong, Kai, Joshua (2019) that there is a long-term causal effect between trade openness,

economic growth, and energy consumption on carbon dioxide (CO₂) emissions in the Belt and Road in 1991-2014. Economic growth will gradually affect CO₂ emissions in the long term. This study is also in accordance with the results of research from Muhammad and Khan (2019), where the results of his research state that economic growth has a negative and no significant effect on CO₂ emissions in ASEAN-5.

The effect of city population (POPU) on carbon dioxide (CO₂) gas emissions

During the period 2011-2018, the population density of the city population in these 5 ASEAN countries was the highest, namely Myanmar with a range of 69% - 70%. The second is Vietnam between 64% - 68%. The third is Thailand between 50% - 55%. Fourth, Indonesia is between 44% - 49%. The fifth is Malaysia between 23% - 28%. Below is a picture of the development of city population in 5 countries in Asean during the period 2011-2018 (Figure 3).



Source: World Bank, processed data (2021)

Figure 3. City Population in 5 Asean Countries (Percent)

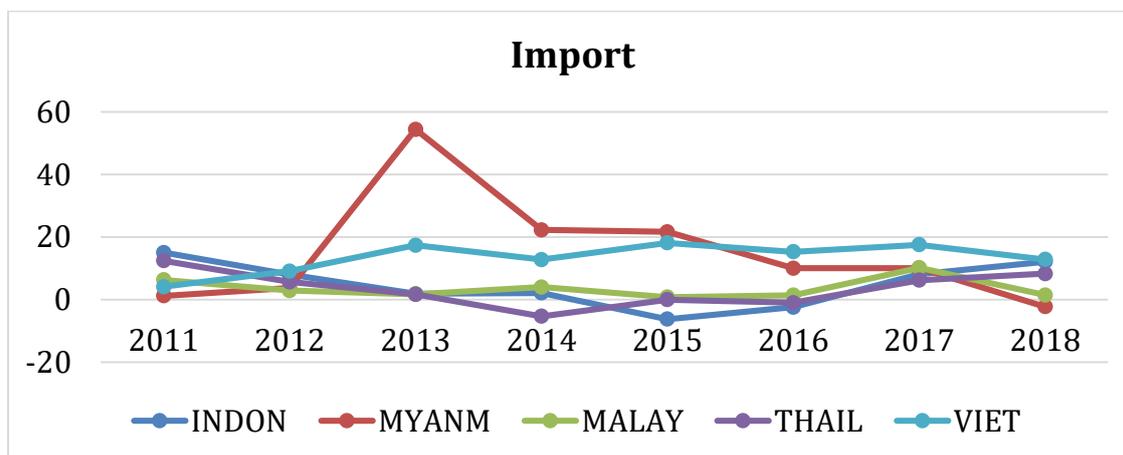
The results show that simultaneously and partially the city population has an effect on carbon dioxide gas emissions. The coefficient of the city population variable is 0.096922 with a probability of 0.0000 explaining that a 1% increase in the urban population will be followed by an increase in carbon dioxide (CO₂) emissions of 0.096922 percent. In general, pollution caused by CO₂ emissions comes from 2 (two) activities, namely: natural (natural) and human (anthropogenic) such as CO₂ emissions from transportation, waste, and consumption of household (domestic) electrical energy. Usually, CO₂ emissions resulting from human activities (anthropogenic) are relatively high in concentration so it will disrupt the balance system in the air and in the end can damage the environment and human welfare. The increasing population causes human activities to increase as well. Human activities are inseparable from energy consumption, both electrical energy and others, the

use of fuel for cooking for the community, both from LPG, oil soil and firewood, this is a pollutant source of increased emissions of carbon dioxide (CO₂) gas.

This study is in accordance with research conducted by and Rahman, Saidi, Mbarek (2020) that in the short term and long term there is a unidirectional relationship between population density on carbon dioxide (CO₂) gas emissions in 5 South Asian countries during period 1990 - 2017. This study is also in accordance with Yeh and Liao (2017) research, which stated that population size and age structure greatly affect energy consumption which will ultimately increase carbon dioxide (CO₂) emissions in Taiwan during the 1994-2014 period.

The effect of the Import variable (IMP) on carbon dioxide gas emissions (CO₂)

The development of imports fluctuated, in 2011 Indonesia imported up to 15.02%, the second was Thailand at 12.40% and the lowest import was Myanmar, only 1.18%. In 2012 the highest imports were Vietnam at 9.09%, and the second was Indonesia at 7.99%. In 2013 the highest import was Myanmar 54.36%, and the second was Vietnam 17.34%. In 2014 the highest imports were Myanmar with 22.26% and then Vietnam with 12.80%. In 2015 the highest imports were from Myanmar 21.63% and then Vietnam 18.11%. In 2016 the highest imports were from Vietnam 15.28% and then Myanmar 10.03%. In 2017 the highest imports were from Vietnam 17.49% and then Malaysia 10.19%. In 2018 the highest imports were from Vietnam 12.80% and then Indonesia 12.13% (Figure 4).



Source: World Bank, processed data (2021)

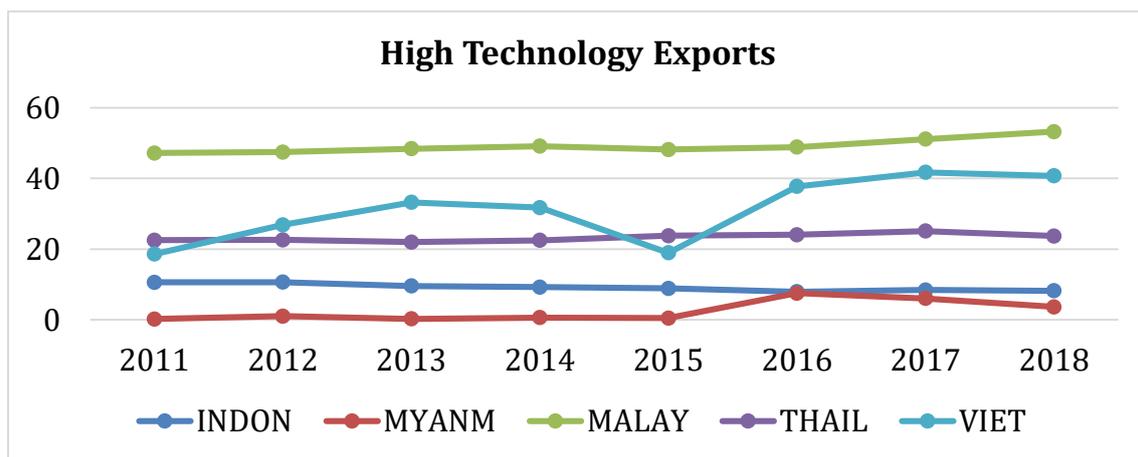
Figure 4. Imports in 5 ASEAN Countries (Percent)

The results show that the value of imports has no significant effect on carbon dioxide gas emissions. The IMP variable coefficient of 0.000216 with a probability of 0.8820 explains that every 1% increase in imports will not increase carbon dioxide gas emissions by 0.000216 percent. This is because the imported variable is not the main factor affecting the emission of carbon dioxide (CO₂) gas, there are other factors that have a stronger

influence on the emission. Carbon footprint is a measure of the total amount of carbon dioxide (CO₂) emissions directly or indirectly caused by activities or accumulations from the use/process of products and services in everyday life. The carbon footprint due to CO₂ emissions caused directly or indirectly, among others, comes from the energy used for various activities that can be grouped into domestic activities, transportation, waste management and configuration of building materials and environmental facilities and infrastructure. Changes in land use and environmental physical conditions also affect CO₂ gas generation, especially with the decreasing green open space and vegetation in an environment/area. The finding study is not in accordance with the research of and Mahmooda, Alkhateeb, Furqan (2020) which states that imports have a positive direct effect on CO₂ emissions and a negative indirect effect on neighboring CO₂ emitting countries in 5 North African countries during the period 1990-2014.

The effect of high technology exports (ETT) on carbon dioxide (CO₂) emissions

The results show that when high technology exports (ETT) increase by 1 percent, it will not increase carbon dioxide emissions by 0.000360 percent. This is because these 5 Asean countries (Indonesia, Myanmar, Malaysia, Thailand, Vietnam) are different from other countries. Export diversification in these 5 ASEAN Countries is still not very developed, this can be seen in the news, such as in Indonesia, which has a trade balance deficit. Pollution or high CO₂ emissions in these countries are still strongly influenced by domestic factors including pollution from vehicle fumes and factory waste products and so on (Figure 5).



Source: World Bank, processed data (2021)

Figure 5. High-Technology Exports in 5 ASEAN Countries (Percent)

This finding is not in accordance with research conducted by Mahmooda, H., Alkhateeb and Furqan (2020) that an increase in exports has a positive impact as an environmental consequence, this indicates that export producers are using cleaner technology and cleaner

standards, which help protect and reduce CO₂ emissions for 5 North African countries during the period 1990-2014. Exports have a negative direct effect on CO₂ emissions and a positive indirect effect on neighboring countries' CO₂ emissions.

Conclusions

This study discusses the effect of variables such as economic growth, city population, imports and high technology exports on CO₂ emissions in 5 ASEAN countries (Indonesia, Myanmar, Malaysia, Thailand, Vietnam). The results of this study, the variables that have a significant effect on increasing CO₂ emissions in the 5 ASEAN countries are only city population. Thus, an increase in the number of city population can increase CO₂ emissions in a country in a certain period.

These results have implications where the Government should pay attention to environmental aspects, especially related to the declining environmental quality caused by human activities, such as CO₂ emissions from transportation, waste, and household (domestic) electrical energy consumption. Usually, CO₂ emissions resulting from human activities (anthropogenic) are relatively high in concentration so it will disrupt the balance system in the air and finally can damage the environment and human welfare. Therefore, appropriate policies are needed to support the control of CO₂ emissions, namely by reducing the rate of population growth.

REFERENCES

- Akram, N. (2012). Is Climate Change Hindering Economic Growth of Asian Economies? *Asia-Pacific Development Journal*, 19(2), 1-18.
- Dietz, T., & Rosa, E. A. (1997). Effects of population and affluence on CO₂ emissions. *Proceedings of the National Academy of Sciences, USA*, 175-179. <https://doi.org/doi:10.1073/pnas.94.1.175>
- Gujarati, D. dan Dawn C, P. (2009). *Basic Econometric, 5th ed.* New York: McGraw-Hill.
- Kuncoro, M. (2011). *Metode Kuantitatif: Teori dan Aplikasi Untuk Bisnis dan Ekonomi. Ed.4.* Yogyakarta: YKPN.
- Mahmooda, H., Alkhateeb, T, T, Y., Furqan, M. (2020). Exports, imports, Foreign Direct Investment and CO₂ emissions in North Africa: Spatial analysis. *Energy Reports*, 6, 2403-2409. <https://doi.org/https://doi.org/10.1016/j.egy.2020.08.038>
- Muhammad, B., dan Khan, S. (2019). Effect of bilateral FDI, energy consumption, CO₂ emission and capital on economic growth of Asia countries. *Energy Report*, 5, 1305-1315.
- OECD. (2011). *Asia Tenggara: Pertumbuhan Tetap Kokoh dalam Jangka Menengah - 5.6% Pada 2012-2016, Menurut OECD.* Retrieved from <https://www.oecd.org/dev/49136551.pdf>
- ÖZÇAĞ, E. K. and M. (2005). Driving Forces of CO₂ Emissions In Central Asia: A Decomposition Analysis of AirPollution From Fossil Fuel Combustion. *ARID*

ECOSYSTEMS JOURNAL, 11(26-27), 49-57.

- Rahman, M, M., Saidi, K., Mbarek, M. B. (2020). Economic growth in South Asia: the role of CO₂ emissions, population density and trade openness. *Heliyon*, 6(5). <https://doi.org/https://doi.org/10.1016/j.heliyon.2020.e03903>
- Sukadri, D. S. (2012). *REDD dan LULUCF (Kerjasama antara Kementerian Kehutanan, DNPI, dan UN-REDD Indonesia)*. Retrieved from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi1voycwtPxAhXjhOYKHbydDmAQFnoECAIQAA&url=https%3A%2F%2Fwww.unredd.net%2Findex.php%3Foption%3Dcom_docman%26task%3Ddoc_download%26gid%3D8850%26Itemid%3D53&usg=AOvVaw371YquQiZgpvI3UrWBc00S
- Sun, H., Samuel A, C., Yong, G., Kai, F., Joshua, C, K., A. (2019). Trade Openness and Carbon Emissions: Evidence from Belt and Road Countries. *Journal Sustainability*, 11, 11-20.
- Suparmoko, M. (1998). *Ekonomi Sumber Daya Alam dan Lingkungan*. Yogyakarta: BPFE.
- Yeh, J, C., Liao, C, H. (2017). Impact of population and economic growth on carbon emissions in Taiwan using an analytic tool STIRPAT. *Sustainable Environment Research*, 27(1), 41-48. <https://doi.org/https://doi.org/10.1016/j.serj.2016.10.001>