Sustinere
Journal of Environment and Sustainability

Volume 2 Issue 2 (2018) 65–75

Print ISSN: 2549-1245 Online ISSN: 2549-1253
Website: https://sustinerejes.com E-mail: sustinere.jes@iain-surakarta.ac.id

RESEARCH PAPER

The effect of environmental quality on economic growth: The evidence from 10 ASEAN Countries

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Article history:
Received 23 May 2018 | Accepted 26 August 2018 | Available online 30 August 2018

Abstract. The environment is often regarded as affected by the economic activity. Many studies have attempted to prove the Environmental Kuznets Curve (EKC) phenomenon, but few aimed to look beyond the impact of environmental quality and its contribution to the economic growth. This research aims to fill the gap of the literature. ASEAN is a region which is currently trying to maximize the potential of its natural resources to increase the economy of the region. With the abundance of existing natural resources, it is expected to make the region as a new economic source in the world. Panel data from 10 countries from 1994-2015 was employed to look at the environmental impacts of the ASEAN region on economic growth. Empirical results indicated that population, forest area, and CO_2 emissions significantly affect economic growth. Nevertheless, it is suggested to be more prudent in using existing resources to maintain the stability of the economic growth without sacrificing the environment that has the very essential importance in the human life.

Keywords: Environmental quality; economic growth; ASEAN-10; panel data

1. Introduction

The degradation in the environmental quality which is one of the main factors generating a number of problems in today's world results from the economic and population growth. Economic growth and its impact on the environment go hand in hand yet there is a trade-off between the two variables. Many countries including ASEAN members encounter the same problem to grow their economic but could maintain the environmental quality is maintained. In another word, or how the condition of an environment can affect productivity so as to increase economic growth.

ASEAN has the high potential to have the countries in its region to be advanced although perhaps not instantly. The quick population growth will lead to the increasing demand for food, energy, water, and other resources, which at the end, might cause excessive pressure and exploitation to the environment. Bran et al. (2009) explained that such a relationship will

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DOI 10.22515/sustinere.jes.v2i1.36

become more complicated given the dependence of most population on natural resources. This condition potentially worsens the environmental degradation and even might cause natural disasters.

In the early twentieth century, the world population fluctuated in around 6 billion. 80% of them were developing countries and most of them [were Asian countries. ASEAN consisting of ten autonomous countries, i.e. Malaysia, Brunei Darussalam, Singapore, Philippines, Thailand, Vietnam, Indonesia, Myanmar, Cambodia, and Laos is one of the fastest growing regions in the world. The population of South East Asia is equivalent to 8.59 per cent of the total world population. Indonesia has the largest population while Brunei has the smallest one. In the sub-region of South East Asia, the population increased by an average annual rate of 1.3 per cent (Nazeer and Furuoka, 2017).

Countries in the ASEAN region also have a high population density. Normally, it is 133 per cent per square kilometre including substantial intra and inter-state differences. In fact, the population density in the two big cities, Jakarta and Manila is about 10.000 people per square kilometre, compared to Mumbai and Delhi (Nazeer and Furuoka, 2017). During that period, various arguments on the impact of the population on economic development were complex. Economists believe that larger populations can lead to "pushed technology" and "demand pull". In the other words, the rapid population growth can increase the demand for goods and drive the development in technological. Therefore, it can increase the labour productivity, economic growth, per capita income and life quality.

The negative effect caused by the increasing population is the economic growth which can lead to the environmental problems. Human activities are believed to be the major contributors to the rise of the global temperature since principally, they are continuously producing greenhouse gases, such as CO_2 into the atmosphere. Like a blade, economic growth can improve the welfare of the community but also, on the other hand, it can damage the surrounding environment, especially forests. We should note that indeed, forests are able to contribute to the economy. In fact, it has become the major economic source for many countries. Forests do not only serve the needs of wood, wild foods, medicines, soil conservation, carbon dioxide storage, and scenic beauty but also contribute to stimulating foreign exchange earnings, employment, and economic growth. Forests are productive assets that can be utilized to achieve national development goals, including equity, stability, investment and growth (FAO, 2016).

Southeast Asia has the very wide areas of forests. This makes these regions to be the world's leading tropical timber producer (85.56 million m^3 in 2012 compared to tropical Africa = 28.50 million m^3 and Latin America=39.94 million m^3). The typical characteristic of the forests in Southeast Asia is the prevalence of the dipterocarp trees family, which dominantly grow in the forests of Kalimantan, Sumatra, Java, Peninsular Malaysia and the moister part of Philippines (FAO, 2016).

A well-known theory from Kuznet stated that there is a negative correlation between the economic growth and the environmental quality as the latter is a negative effect of the occurrence of the former one (Panayotou, 2003). Nevertheless, Kuznets theory actually analyzed the environmental degradation as the dependent variable while the economic growth as the explanatory variable. Several studies focusing on the impact of environmental quality as explanatory variables and economic growth as dependent are still limited. Some consider environmental quality does not directly affect economic growth. Although it is undeniable that there have been some researches attempting to analyze it e.g. (Varvarigos, 2008) which

concluded that environmental quality could influence the long-term economic growth. Another study by Azam (2016) also explained that environmental quality can adversely affect the economic growth.

The environmental sustainability which can retain the economic growth is usually closely linked to forests. In addition, the high emission in a country is often believed as the result of high industrial activities. A big industry certainly requires a lot of labours so that it will employ more workers. The big number of population in a country will greatly benefit the economy by maximizing the role of the industry. The relationship between the environment and economic growth is very interesting to investigate because most studies on this subject are more interested in looking at the impact of economic growth on environmental degradation whereas, in fact, the environment is indeed able to influence the economic growth in a country or region.

2. Literature review

Several studies were more interested in proving whether the Environmental Kuznets Curve (EKC) phenomenon prevails in every research context. Many studies were looking to prove the theory that economic growth will cause environmental degradation in accordance with the economic phase of the country under study. Nevertheless, several other studies have tried to see whether an environment and some associated aspects can have either a direct or an indirect impact on economic growth. Research by (Omri et al., 2015) found that the environmental quality peroxided using CO_2 emissions in Middle Eastern and Northern Africa affects the economic growth and vice versa.

A study on the interrelated relationship between environmental quality and economic growth was also conducted by (Toman, 2003). The findings in his research more specifically explain that there should be government policies that focus not only on savings rates and human resource investment but also on doing investment in the natural resource sector. Furthermore, Toman (2003) highlighted that natural resources are not allocated efficiently in practice not only because of the market and institutional failures affecting natural resources and the environment but also because of the wider market and institutional failures that also impede the development and use of the excessive natural resources.

A research discovering that there is a reciprocal relationship between environmental quality and economic growth, one of them, was by Borhan et al. (2012). They found that the environmental quality projected using CO_2 had a significantly negative influence on the economic growth peroxided using budget from the community. They argue that the pollution increases will result in decreased income as it directly lowers the output by reducing the productivity of capital and labour. For example, due to the health problem, a number of labours may be absent for work. Furthermore, because the air or water is contaminated with pollution, there will be deterioration in the quality of the industrial equipment. The air pollution indicator coefficients show the significant effect of the population density and CO_2 has a negative relationship with population density. This suggests that if the pollution increases, the population density might decreases as it could cause human death.

A study by Azam (2016) explained that there is a negative and significant relationship between environmental quality that is projected using CO_2 emissions to economic growth in countries situated around ASEAN e.g. Bangladesh, China, India, Indonesia, Mongolia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam. Both studies by Omri et al. (2015) and Azam (2016) showed the similarities that CO_2 emission is a proxy for the environmental quality.

Studies by Omri et al. (2015) and Azam (2015) were consistent with research conducted by Ejuvbekpokpo (2014) in Nigeria, that environmental quality negatively and significantly affected the economic growth where the proxy for environmental quality was used equally ie CO_2. Furthermore, Nigeria is known as a country with the high level of gas emissions in the world which increased the number of emissions produced into the atmosphere and further reduces the productivity and economic growth in that country.

Another study conducted by Varvarigos (2008) found that environmental quality, the total capital, and life expectancy had an effect on the economic growth. Furthermore, if technology produces pollution above the critical threshold, then the economy will experience a downward growth cycle and will return to the balance position in the long term. On the contrary, if the use of technology produces pollution below the critical limit; it will lead to a better economic growth in the long term. Thus, this study confirmed the earlier ones that environmental quality is negatively related to economic growth.

A question arises whether a country can promote the economic growth without damaging the quality of the environment or in another word, how to improve the quality of the existing environment without compromising the stable economic growth. Charfeddin et al. (2018) tried to answer that question. His research found that it was very difficult to improve the environmental quality without compromising the economic growth. Furthermore, the findings of the research indicated that if the quality of the environment is improved by reducing the energy and electricity consumption, it will reduce the productivity which will further slow the economic growth.

A country consumes energy to meet the needs of major industries and fuels. Unfortunately, this sometimes ignores environmental sustainability factors, especially in the case of non-renewable energy use. However, it is done to drive the economy through production and distribution activities. Obradović and Lojanica (2017) reinforced this in their research. They found that, in the short term, there was no relationship between the energy consumption and CO_2 emissions. However, in the long term, there will be a significant relationship where energy consumption and CO_2 emissions were simultaneously able to influence the economic growth in Greece and Bulgaria.

3. Data and methodology

The data used in this study was the panel data from 10 ASEAN countries namely Indonesia, Malaysia, Singapore, Brunei Darussalam, Thailand, Philippines, Vietnam, Myanmar, Cambodia, and Laos with series from 1994-2015 obtained from the World Bank. Incorporating all ASEAN countries into observational objects will enrich the analysis of environmental quality impacts on the economic growth in ASEAN. The variables used as the proxy for environmental quality were forest area, population, and CO_2 emission while for economic growth was the constant GDP price. The selection of these proxies was modified from the study conducted by Azam (2016) and Borhan et al. (2012). Furthermore, the variables in the study are described in Table 1.

Table 1. Variable Identity

Variables	Definition
Growth	The total of GDP per capita (constant) in million US dollars
Forest	The total wide of forest in kilometres
Population	The total number of population in ASEAN country
Emissions	The total emissions of CO_2 in metrics ton per capita

The selection of the panel data model was to increase the degree of freedom, reduce the collinearity among the dependent variables and improve the efficiency of estimation. Panel data is also often used to identify the differences among individuals. In addition, panel data is also used to overcome the limitations of the observation number because a great number of observations will increase the degree of freedom. The basic model of panel data equation is presented in the Equation 1.

$$y_{it} = \beta_{it} + \beta_{it} x_{it} + \varepsilon_{it} \quad (1)$$

In the equation (1), y is categorized as the dependent variable, x is the independent variable and ε is the stochastic disturbance variable while β is the regression parameter. The subscript i denotes the -i observation and t denotes the -t time. The β_{it} parameter was estimated on the basis of available data for variables y and x. There are K independent variables at x (not including the constants). Individual characteristics (heterogeneity) are present in β_{it} where β_{it} consists of constants and specific groups.

In this study, the models adopted the ones in Azam (2016) describing the panel data model as presented in Equation 2 and 3 follows:

$$G_{it} = \beta_i + \beta_1 EN_{it} + \beta_2 EC_{it} + \beta_3 IN_{it} + \beta_4 GS_{it} + \beta_5 HK_{it} + \varepsilon_{it} \quad (2)$$

$$G_{it} = \beta_i + \beta_1 EN_{it} + \beta_2 EC_{it} + \beta_3 IN_{it} + \beta_4 GS_{it} + \beta_5 HK_{it} + I_i + m_{it} \quad (3)$$

where i = 1, 2, ..., N = 11, t = 1, 2, ..., T = 22. G is the economic growth measured by GDP per capita, EN is the environmental degradation proxied by CO_2 emissions, IN is the net FDI, EC is the energy consumption, GS is the gross saving, HK is the human capital measured by life expectancy, ε_{it} is the error terms and Ii is the country-specific random effect that varies across countries. It is supposed to be random and not correlated with the independent built-in variables in the model. Likewise, the mid-term is the country-specific error.

With a little modification on the existing models, then the model of the panel data in this study was as follow:

$$Growth_{it} = \beta_i + \beta_1 For_{it} + \beta_2 Pop_{it} + \beta_3 Em_{it} + \varepsilon_{it} \quad (4)$$

where For is the forest area, Pop is the total population, and Em is the total CO_2 emissions produced. ε_{it} is the error term whereas subscript i denotes the-i observation and t denotes the-t time.

The first information indicated by Table 2 is that each variable which was used as a proxy had the different rate. The most visible is that Indonesia had the widest forest area and the highest number of population among other ASEAN countries while Singapore was in the lowest rank. Secondly, the highest average economic growth was in Indonesia while the lowest one was Laos. The above statistics show that Indonesia was the "strongest player" in ASEAN. As the consequence, policies related to the environment would greatly affect the economic growth in that region. However, this study used panel data so that policies related to the environment and economic growth were not only investigated in one country but all countries were involved.

The panel data analysis focused on the overall estimation results of the ASEAN countries. Somehow, the estimation might be unable to be generalized to other countries in the panel. However, the panel provided a better analysis than investigating only one country (cross section) or time series.

Table 2. Descriptive Statistics

Country	Statistics	Growth	Forest	Population	Emissions
Panel	Mean	5.658	218,463.1	5.54e+07	100280
	Minimum	15.240	1108,906.0	2.58e+08	637078.9
	Maximum	-13.12673	163.5	289525	275.025
	Std. Dev	3.74541	274014	6.50e+07	123688
	Observations	220	220	220	220
Indonesia	Mean	4.41e+11	986064.4	2.26e+08	363709.8
	Minimum	1.02e+11	910100	1.94e+08	214200.5
	Maximum	9.18e+11	1108906	2.58e+08	637078.9
	Std. Dev	2.96e+11	55459.36	1.99e+07	121166.9
	Observations	22	22	22	22
Philippines	Mean	1.41.e+11	70882.64	8.51e+07	77583.99
	Minimum	6.41e+10	67438	6.82e+07	54799.65
	Maximum	2.93e+11	80400	1.02e+08	121951.2
	Std. Dev	7.84e+10	3227.108	1.03e+07	15414.59
	Observations	22	22	22	22
Malaysia	Mean	1.73e+11	217101.1	2.54e+07	169154.2
	Minimum	7.22e+10	208900	2.00e+07	94010.88
	Maximum	3.38e+11	221950	3.07e+07	249917.1
	Std. Dev	9.35e+10	4143.364	3291289	48497.33
	Observations	22	22	22	22
Singapore	Mean	1.62e+11	163.5	4453591	44803.21
	Minimum	7.38e+10	163.5	3419048	19926.61
	Maximum	3.08e+11	163.5	5535002	61682.61
	Std. Dev	8.49e+10	0	665510.2	11364.8
	Observations	22	22	22	22
Thailand	Mean	2.35e+11	162603.8	6.46e+07	230498.3
	Minimum	1.14e+11	152074	5.89e+07	139159
	Maximum	4.21e+11	170110	6.87e+07	316212.7
	Std. Dev	1.90e+11	3966.613	3039628	51317.6
	Observations	22	22	22	22
Vietnam	Mean	7.69e+10	127692.1	8.17e+07	95214.02
	Minimum	1.63e+10	103086	7.08e+07	26230.05
	Maximum	1.93e+11	147730	9.17e+07	205847.7
	Std. Dev	5.87e+10	14521.82	6323967	50337.65
	Observations	22	22	22	22
Brunei Darussalam	Mean	9.88e+09	3905.273	357853.8	6315.01
	Minimum	4.05e+09	3800	289525	3909.022
	Maximum	1.90e+10	4066	417542	9695.548
	Std. Dev	5.18e+09	93.28001	38555.36	2020.581
	Observations	22	22	22	22
Laos	Mean	4.83e+09	173088.3	5725941	1251.789
	Minimum	1.28e+09	165259.9	4740380	275.025
	Maximum	1.44e+10	187614.1	6663967	4198.9
	Std. Dev	4.21e+09	6910.306	590994.3	804.7836
	Observations	22	22	22	22
Cambodia	Mean	7.87e+09	108793.5	1.31e+07	3322.036
	Minimum	2.79e+09	94570	1.03e+07	1477.801
	Maximum	1.80e+10	123848	1.55e+07	6684.941
	Std. Dev	4.97e+09	9200.194	1536225	1686.758
	Observations	22	22	22	22
Myanmar	Mean	3.21e+10	334336.4	4.79e+07	10947.92
	Minimum	6.48e+09	290410	4.27e+07	6244.901
	Maximum	6.54e+10	374780	5.24e+07	21631.63
	Std. Dev	2.33e+10	24287.66	2906586	3468.07
	Observations	16	22	22	22

Baltagi (2005) explained three of the advantages of panel data was that it could control the heterogeneity of individuals, companies, or regions, provided more complete information, more varied but less collinear variables and more degree of freedom. Furthermore, the data panel was better in observing the dynamics of adjustment.

4. Result and discussion

The estimation analysis was conducted employing fixed-effects (FE) and random-effects (RE) models. Furthermore, the Hausman test showed that the fixed-effects model was better in explaining the model. This was in line with the state of the data used ie unbalanced panel because the GDP data for Myanmar was available only for the year 2000-2015. Nevertheless, in order to strengthen the analysis, the study continued to investigate 10 ASEAN countries and with the use of fixed-effects models in explaining the model, the missing data could be accommodated from biased estimation.

The model of equation (4) was first transformed into a log-log model to determine the size of the elasticity of the dependent variable (Growth) against the independent variable (Forest, Population, Emissions). The strength of the log-log model was that the β coefficients in the model depicted the size of elasticity from y to x (Fauzi, 2017). A log-log model that could be developed for descriptive purposes to find out the rate of change in the economic growth when there was a change in the wide of a forest, the number of population and the amount of emission was as follow:

$$\log Growth_{it} = \beta_i + \beta_1 \log For_{it} + \beta_2 \log Pop_{it} + \beta_3 \log Em_{it} + \varepsilon_{it} \quad (4)$$

Table 3. The Estimation Result

Variables	Fixed-Effects		Random-Effects	
	Coefficients	t-statistics	Coefficients	t-statistics
For	0.1366557	0.36	-0.2555029*	-3.05
	(0.0789355)		(0.0838628)	
Pop	3.557403*	12.32	0.3130797**	2.39
	(0.2887954)		(0.1310444)	
Em	0.6068104*	7.69	0.9609277*	13.61
	(0.0789355)		(0.070583)	
Cons_	-43.04068*	-6.69	12.19599*	9.03
	(6.435587)		(1.350596)	
R-squared	0.4707		0.9722	
Adj. R-squared	0.4445		9104	
F-statistics	239.77		405.06	
Prob(F-Stat)	0.0000		0.0000	

Note: Response variable is Growth
standard errors in parentheses
* significant at level 0.01
** significant at level 0.05
*** significant at level 0.10

Based on the estimation in Table 3, and the model above, the fixed-effects approach stated that among three independent variables, two of them were significant, i.e. population and CO_2 emissions. Accordingly, the present finding was consistent with the one by Kumar (2011) indicating that emissions had an effect on the economic growth. The increasing CO_2 emissions in

ASEAN empirically boosted the economic growth. In the research by Hwang and Yoo (2014), it was found the similar fact but with different transmissions. Bi-directional CO_2 emissions affected the economic growth along with the energy consumption. This means that an increase in the energy consumption directly affected the CO_2 emissions which subsequently also stimulated a further energy consumption. In addition, the results supported the occurrence of uni-directional causality from the economic growth to the energy consumption and CO_2 emissions without feedback effects.

The research conducted by Saidi and Hammami (2015) attempted to see the broader perspective on the impact of CO_2 emissions on the economic growth. His research finding was consistent with the previous one indicating that CO_2 emissions empirically had a positive and significant impact on the economic growth in 58 countries.

Particularly in the ASEAN, the positive and significant impact of CO_2 emissions on the economic growth was reasonable considering the growth of the industry in developing countries like most ASEAN countries should employ more labours. As the consequence, many factories ignored the surrounding environment. Nevertheless, along with the increasingly widespread industrial development, the number of the employment increased and triggered an increase in the worker's expenditure. As the result, it increased the consumption and boosted the economic demand of the society. Ultimately, it would drive a faster economic growth.

CO_2 emissions per capita are very low in many ASEAN countries (except in Singapore), but it increases rapidly due to the rapid economic growth and increasing dependence on fossil fuels. Industries in many countries experience an increase in their emission intensity. However, with a shift towards the economy that is more service-oriented and the increases on GDP per capita, this intensity starts to decrease. Unfortunately, the tendency of increasing CO_2 emissions is difficult to cut because of the economic growth and increasing population.

Furthermore, CO_2 emissions of ASEAN countries are relatively low compared to OECD countries. However, in ASEAN, it can grow faster (5.5% per year between 1990 and 2010) compared to OECD countries (0.7%). The source of CO_2 emissions is mostly (80%) caused by human activities which are called anthropogenic emission. It burns fossil fuels. While the rest (20%) comes from deforestation and forest degradation activities (Sukardi, 2012).

The population reveals positive and significant results on the economic growth. CO_2 emissions and the population are indirectly related to each other. The high level of CO_2 emissions indicates that an area is in the stage of building an enterprising industry. It means that the number of labours who work in available industries is quite high. Inhabitants with productive age will be absorbed by many industries and produce certain products according to their industry and sold on the market. This will certainly contribute revenue to the country that will then continue to drive the economic growth. This is consistent with the study by Ali et al. (2013), Chang et al. (2014), Koduru and Tatavarthi (2016), Tartiyus et al. (2015) and Thuku et al. (2013). This study reinforced the finding in previous studies that the population is able to support the economic growth.

On the other hand, the high number of population in ASEAN also affects the growth of the middle-income group which of course also results in the increased economic growth (Brueckner et al., 2017). Obviously, Indonesia with total inhabitants of nearly 60% of the total population of ASEAN has the largest human resource. The abundance population in Indonesia especially becomes a the demographic bonus which is very much in line with the spirit of ASEAN to grow its economy. In fact, it is predicted that in the next few years the ASEAN region potentially excels

the European Union. This is because ASEAN has fewer members so that the economic growth can be concentrated more easily.

In the estimation using the fixed-effects model, the Forest variable does not show any statistical influence. This is very different from some studies that also used forest variables as environmental proxies having the random-effects model approach to show the opposite. Somehow, further research regarding forest and economic growth is needed considering that this paper concludes no relationship between two variables. However, in the Hausman test, the fixed-effects model is more preferable in explaining the model.

To enrich the data analysis, Robust Least Square method was used to investigate and verify the impact of environmental quality on the economic growth. Robust least square method also accommodates the autocorrelation data. Furthermore, it will also accommodate the existence of extreme data and at the same time eliminate its influence on the analysis without identifying it initially. Chen (2002) suggested the use of Ordinary Least Square (OLS) as a robust regression method for estimator control. If the two results are not much different, OLS results can be used more confidently whereas if there are striking differences then the residuals from the robust regression method can further explain which observations need further attention without the need for special diagnostic techniques. Estimates using the robust method are explained in the following table.

Table 4. Estimation Result using Robust Least Square Method

Variabel	Coefficient	t-statistics
For	-0.3553927*	-3.26
	(0.1091464)	
Pop	0.7243055*	4.29
	(1.543096)	
Em	0.3323082*	4.07
	(0.0817395)	
Cons_	12.9261*	8.38
	(1.543096)	
R-squared	0.9805	
Prob(F-Stat)	0.00000	

Note: Response variable is Growth
standard errors in parentheses
* significant at level 0.01
** significant at level 0.05
*** significant at level 0.10

The estimation using robust least square method more deeply verifies the influence of environmental quality on the economic growth. The coefficient and direction are consistent with the hypothesis constructed and also consistent with the previous estimates using fixed-effects and random effects. Both estimation using the fixed-effects, random effects, and robust least square models reinforced the finding stating that forests, populations, and CO_2 emissions affect economic growth.

5. Policy Implication and Conclusion

The importance of the environment to the economy should be taken into account. If so far we are more concern to the environment as variables affected by economic activity, then we should be aware that in the future, it will be able to affect the economic growth While traditionally we knew factors affecting production were only four ie nature, human,

capital, and skill, now we have recognized that the environment is another one. In this study, forests, emissions, and populations are a proxy for the environmental quality showing a positive and significant relationship to the economic growth. Thus, in all efforts to boost the economy to achieve the target, policymakers, in this case, the government considers the environments.

In terms of timber commodities, that material is derived from the forest then processed into a paper by an industry which in this case, employs workers who are part of the population. Thus, this simple flow clearly illustrates how the environment can stimulate the economic growth. The question is how long the environment can support the sustainable economic growth. This important question must be answered through a further research. However, the discovery that concludes a positive and significant relationship between CO_2 emissions and the population could be one input to be considered by the economic and environmental decision makers that these two have strong relationships to each other. Ultimately, environmental growth and preservation must be a major concern for all stakeholders such as governments, economists, and environmentalists to create sustainable harmony.

Acknowledgement

Many thanks to Indonesia Endowment Fund for Education (LPDP) for kindly providing funding to the first author during the study, particularly always encouraging to be productive both as a student and as a researcher. My best gratitude is to all lecturers at Master of Science and Doctorate Program FEB UGM for their excellent teaching and inspiring motivation every day in class. Thanks to the second author for kindly providing the data and becoming a great discussing partner until the paper finished.

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