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The Effect of Energy Consumption and Taxes with the Mediation of Economic Growth on Pollution in 9 ASEAN Countries

Kenedi*

Universitas Bina Bangsa, Indonesia
*Corresponding email: 17satriaforbangsa@gmail.com

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Abstract

Global warming and climate change over the last ten years caused by greenhouse gas emissions have become severe problems faced by countries globally, both developed and developing countries, including ASEAN countries. The relationship between energy consumption, applying the tax burden, economic growth and its effect on pollution are essential things to be investigated further. This study aims to analyze the impact of energy consumption and taxes by mediating economic growth on pollution in nine ASEAN countries (Indonesia, Cambodia, Laos, Myanmar, Malaysia, Philippines, Singapore, Thailand and Vietnam). This study uses data from 2004 – 2020 with an analytical method using the PLS-SEM approach and SmartPLS version 3.0 as a data analysis tool. The study results show that energy consumption has a positive effect on economic growth and pollution, taxes have a positive impact on economic growth and hurt pollution. Economic growth has a positive impact on pollution. Besides that, economic growth can mediate the relationship between energy consumption and pollution and the relationship between taxes and pollution.

Keywords: Energy Consumption, Taxes, Economic Growth, Pollution.
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I. Introduction

Environmental issues have become a global concern in today's world. Problems about environmental issues arise with increasing global warming and climate change mainly caused by greenhouse gas emissions. Gases consisting of Carbon dioxide (CO_2), Methane (CH_4), Nitrogen (N_2O) and three other gases containing Fluorine accumulate in the atmosphere, thereby changing the radiation balance, which causes the earth's surface to be warmer (Shazhad, 2015).

Based on the World Meteorological Organization (WMO) report in the Greenhouse Gas Bulletin 2021, the most considerable contribution of greenhouse gas emissions comes from carbon dioxide (CO_2), which is 66% of the total greenhouse gas emissions. In 2020 the buildup of heat-trapping gases in the atmosphere hit a new record where annual growth was higher than the yearly average between 2011–2020, and this trend is expected to continue. The same report states that carbon dioxide (CO2) concentration in 2020 will reach 413.2 ppm (parts per million).

From the 2019 World Research Institute (WRI) report, until the beginning of 2018, more than half of global greenhouse gas emissions were contributed by ten countries in the world, of which China was the most significant contributor to global greenhouse gas emissions of 12,399.6 million metric tons of carbon dioxide equivalent ($MtCO_2e$). Equivalent to 26.1% of total global emissions, followed by the United States by contributing 6,018.2 $MtCO_2e$, equal to 12.7% of global emissions and the European Union in third position contributing 3,572.6 $MtCO_2e$ or equivalent to 7.52% of global emissions. The ASEAN region itself contributes quite a lot to greenhouse gas emissions. According to a WRI report in 2016, ten countries members of ASEAN accounted for 7.35% of CO2 emissions or around 1841.14 $MtCO_2e$ of total global emissions.

Based on *Climate Watch* data, global greenhouse gas emissions are generated from various sectors where energy consumption is the most significant contributor to greenhouse gas emissions. The energy sector contributed 71.5% or 36.44 gigatons of carbon dioxide equivalent ($GtCO_2e$) of total emissions in 2017. From the International Energy Agency (IEA) data, in 2020, CO_2 emissions produced by fossil fuels reached 31.5 $GtCO_2e$ Globally, this is quite a concern because both developed and developing countries still rely on fossil fuels as the primary energy source in industrial and business activities as well as other activities carried out by the community.

Southeast Asia is a region with the fastest economic growth in the world. Rapid economic development will lead to high energy demand according to the IESR (Institute for Essential Services Reform) forecast that energy demand in the region will increase by up to 70% by 2040. This is not without reason because countries in the Southeast Asia region, especially those that are members of ASEAN, are currently in industrialization.

According to Carfora (2019), energy is one of the most critical factors in economic growth, the use of energy will encourage economic productivity and industrial growth

where energy is also the operational centre of the modern economy besides energy is also a driver of household consumption which will ultimately drive the economy. On the other hand, economic growth has led to environmental degradation, which is often the result of development and industrialization in developing and developed countries. Economic growth depends on various factors, which can negatively impact the environment, such as unsustainable exploitation of natural resources, environmental pollution and climate change. (Phimphanthavong, 2013).

Challenges regarding the environment are increasing pressure on countries globally. This increases the pressure on the Government to find ways to reduce environmental damage but, on the other hand, minimizes the stress on economic growth. Based on the guidelines issued by the OECD in 2011, applying the tax burden is one tool that the Government can utilize. One reason for using taxes is that they can directly address market failures to account for environmental impacts by incorporating them into prices. A well-designed environmental tax increases the price of a good or service to reflect the cost of the ecological damage it causes to others.

Based on this background, the purpose of this study is to examine the effect of energy consumption (ECP) and taxes (TAX) by mediating economic growth (EG) on pollution (CO2 emissions).

II. Methodology

This study uses the Structural Equation Modeling (SEM) method with a variant based on Partial Least Square (PLS) and SmartPLS version 3.0 as a data analysis tool to evaluate the effect between latent variables. The use of PLS-SEM is based on the PLS method is the proper method in testing the predictive impact of the relationship between variables in a model. In addition, PLS can also be used on tiny data that is not normally distributed, does not require various assumptions, and can be tested on research models with a weak theoretical basis (Ghazali and Latan, 2014). This study uses time-series data for 2004 – 2020 in 9 (nine) ASEAN countries, including Indonesia, Cambodia, Laos, Myanmar, Malaysia, Philippines, Singapore, Thailand and Vietnam. Data comes from the World Development Indicators except for taxes from the Economic Freedom Index published by the Heritage Foundation. The research variables used are as follows: CO2 emissions (metric tons per capita) as a proxy for pollution, GDP per capita (PPP, constant 2017 international $) as a proxy for economic growth, electricity consumption (kWh per capita) as a proxy for energy consumption and Fiscal Freedom (index) as a Tax proxy. The data used is then transformed into a natural logarithm (ln).

Table 1. Research Variable

Variable	Proxy	Symbol	Unit	Source
Pollution	CO_2 Emissions	CO_2	Metric tons per capita	WDI

Economic growth	GDP per capita	EG	PPP, constant 2017 internasional $	WDI
Energy Consumption	Electrical Energy Consumption	EPC	kWh per capita	WDI
Tax	Fiscal Freedom	TAX	Index	Heritage Foundation

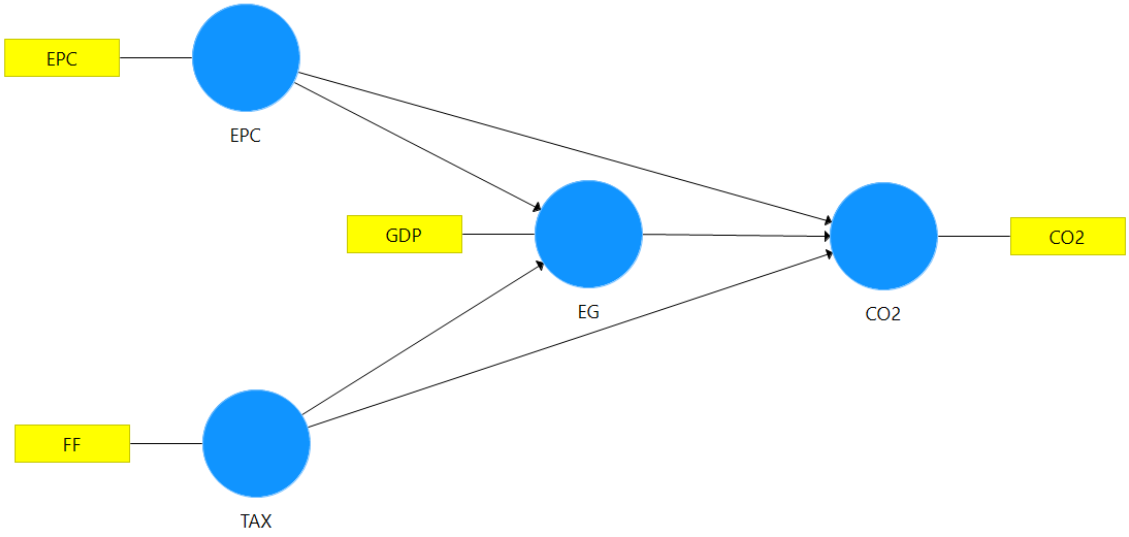

Figure 1. Structural Model

Hypothesis:

H1 There is a significant effect of energy consumption on economic growth

H2 There is a significant effect of energy consumption on pollution

H3 There is a significant effect of taxes on economic growth

H4 There is a significant effect of taxation on pollution

H5 There is a significant effect of economic growth on pollution

H6 Economic growth mediates the relationship between energy consumption and pollution

H7 Economic growth mediates the relationship between taxes and pollution

III. Results and Discussion

4.1. Measurement Model

The measurement model aims to measure the dimensions that make up a factor and is a model that describes pre-existing hypotheses, namely the relationship between indicators and factors. The model is then evaluated to determine the relationship between latent variables and their indicators. Testing is done by looking at the results of convergent validity, discriminant validity and composite reliability and Cronbach's alpha. The Convergent Validity test is seen from the loading factor value. Individual indicators are considered reliable if they have a correlation value greater than 0.70. However, in the research development stage of the loading scale, 0.5 to 0.6 is still acceptable (Ghozali, 2014). The discriminant validity test uses the results of cross-loading. A reflective indicator will be declared to meet discriminant validity if the value of the cross-loading indicator on the variable is the largest compared to other variables. Another test is to assess the validity of the construct by looking at the AVE value, and a good model has required if the AVE value of each construct is more significant than 0.5 (Ghozali, 2014).

Table 2. ***Loading Factor*** **and AVE**

Variable	Loading Factor	AVE
Pollution	**1.00**	**1.00**
Economic growth	**1.00**	**1.00**
Energy Consumption	**1.00**	**1.00**
Tax	**1.00**	**1.00**

Table 3. ***Cross Loading***

	CO2	EG	EPC	TAX
CO2	1.000	0.894	0.856	0.351
EPC	0.856	0.903	1.000	0.374
FF	0.351	0.503	0.374	1.000
GDP	0.894	1.000	0.903	0.503

In Tables 2 and 3, it can be seen that the loading factor value of all latent variables is more significant than 0.7, and AVE is greater than 0.5. To test the reliability of the indicators on the variables, it is seen from the value of composite reliability and Cronbach's alpha value. A variable can be declared to meet composite reliability if its composite reliability value > 0.7 and Cronbach's alpha value > 0.7.

Table 4. ***Internal Consistency***

	Cronbach's Alpha	*Composite Reliability*
CO2	**1.000**	**1.000**
EG	**1.000**	**1.000**
EPC	**1.000**	**1.000**
TAX	**1.000**	**1.000**

From table 4, the output results of Cronbach's alpha and composite reliability show that all variables have a value above 0.7, so it can be concluded that all variables have good reliability.

4.2. Structured Model Assessment

Testing of the structural model (Inner Model) is done by looking at the value of the R-square, which is a goodness-fit model test (Ghozali 2014), effect size and hypothesis testing. A model is robust if the R-square value is 0.75, an intermediate model if the R-square value is 0.50, and a weak model if the R-square value is 0.25 (Latan & Ghozali, 2012). Hair et al. (2014) explained that the closer the R2 value to 1, the greater the percentage of variance explained by all exogenous latent variables.

Table 5. R-Square

	R Square	Range
CO2	0.820	Strong
EG	0.847	Strong

Based on table 5, the variance that can be explained by the model (R2) is 82% for pollution and 84.7% for economic growth. The value of the f square model is used to determine the effect size of the endogenous latent variable on the exogenous latent variable. If the value of f square is equal to 0.35, it can be interpreted that the latent variable predictor has a significant effect. If it is similar to 0.15, it has a medium impact, and if it is equal to 0.02, it has a small effect (Ghozali, 2014).

Table 6. Effect Size (f^2)

Path	f^2	Range
EG -> CO2	0.481	Strong
EPC -> CO2	0.047	Weak
EPC-> EG	3.871	Strong
TAX ->CO2	0.047	Weak
TAX-> EG	0.206	Medium

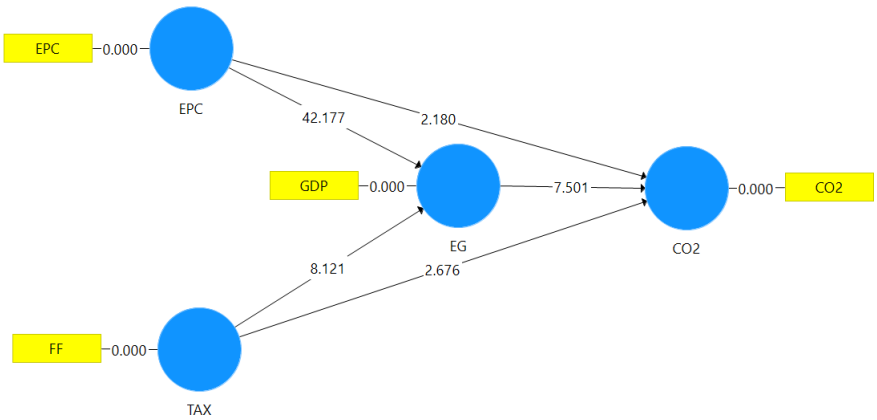

Figure 2. Bootstrapping Inner Model

The structural model shows a causal relationship between the constructs, the path coefficient (direct effect) and indirect effect (mediation effect) in the model that estimates

the t-count value, which must be greater than 1.96 and the p-value, which must be less than 0. 05.

Table 7. Path Coefficients

Path	Original Sample (O)	T Statistics (|O/STDEV|)	P Values
EG -> CO2	0.751	7.437	**0.000**
EPC -> CO2	0.218	2.150	**0.032**
EPC -> EG	0.831	41.669	**0.000**
TAX -> CO2	-0.109	2.725	**0.007**
TAX -> EG	0.192	8.482	**0.000**

Table 8. Specific Indirect Effects

Path	Original Sample (O)	T Statistics (|O/STDEV|)	P Values
EPC -> EG -> CO2	0.624	7.661	**0.000**
TAX -> EG -> CO2	0.144	6.996	**0.000**

Table 9. Total Effects

Path	Original Sample (O)	T Statistics (|O/STDEV|)	P Values
EG -> CO2	0.751	7.437	**0.000**
EPC -> CO2	0.843	28.600	**0.000**
EPC -> EG	0.831	41.669	**0.000**
TAX -> CO2	0.036	0.897	**0.370**
TAX -> EG	0.192	8.482	**0.000**

4.3. Hypothesis test

4.3.1. The Effect of Energy Consumption on Economic Growth

From the results of hypothesis testing, the path coefficient value is 0.831 with a P-value of 0.000 <0.05. It can be concluded that energy consumption has a positive and significant influence on economic growth, meaning that the greater energy consumption, the higher economic growth, then H1 received. The results of this study are consistent with research conducted by Jabeur and Sghaler (2018), Gozgor et al. (2018) and Chen et al. (2020), which conclude that energy consumption has a positive and significant effect on economic growth. According to Rezki (2011), energy is inseparable from increasing economic development. An increase in energy consumption will encourage business and industrial growth, which will impact economic growth. This opinion is in line with Arcandra (2017), which states that the greater electricity consumption for a country will make business and industrial activities more vibrant to support economic growth.

4.3.2. Effect of Energy Consumption on Pollution

From the results of hypothesis testing, the path coefficient value is 0.218 with a P-value of 0.032 > 0.05. It can be concluded that energy consumption has a positive and

significant effect on pollution, meaning that the greater the energy consumption, the higher the level of pollution in a country. , then H2 is accepted. The results of this study are in line with research conducted by Sasana and Jaka (2019), Bakri (2020), Khan et al. (2020) and Osobajo et al. (2020), which state that energy consumption has a positive and significant effect on increasing pollution. According to Rehman (2017), energy consumption will impact the environment in the uncontrolled exploitation of natural resources and the pollutants produced, such as CO2 emissions. This is confirmed by Jabeur and Sghaler (2018), which states that CO2 emissions are influenced by energy consumption in the short term.

4.3.3. The Effect of Taxes on Economic Growth

From the results of hypothesis testing, the path coefficient value is 0.192 with a P-value of 0.000 > 0.05. It can be concluded that taxes have a positive and significant effect on economic growth, meaning that the higher tax revenues, the higher economic growth, then H3 is accepted. . The results of this study support previous research conducted by Syahputra (2017), Saragih (2018), Sihaloho (2020) which concludes that tax revenue has a positive and significant effect on economic growth. Stoilova (2017) explains that taxes received by a country will support the country's economic growth, while Adkisson and Mohammed (2014) state that even during a recession, tax revenues impact a country's economic growth.

4.3.4. The Effect of Taxes on Pollution

From the results of hypothesis testing, the path coefficient value is -0.109 with a P-value of 0.007 > 0.05. It can be concluded that taxes have a negative and significant effect on pollution, meaning that the higher the tax rate, the lower the pollution level, then H4 is accepted. The results of this study support research conducted by Farajzadeh (2018), which concludes that a high tax scenario reduces pollutant emissions by at least 20%.

4.3.5. The Effect of Economic Growth on Pollution

From the results of hypothesis testing, the path coefficient value is 0.751 with a P-value of 0.000 > 0.05. It can be concluded that economic growth has a positive and significant influence on pollution, meaning that the higher the economic growth, the higher the pollution level of a country, then H5 received. The results of this study are consistent with the research conducted by Sasana and Aminata (2019) and Osobajo et al. (2020), and Khan et al. (2020), which concluded that there is a positive and significant effect of economic growth on CO2 emissions, but the results of this study are different from research conducted by Bakhri (2020) which found that economic growth had a negative and significant effect on CO2 emissions in 5 ASEAN countries. Khan et al. (2020) mention that economic activities in developing countries cause environmental degradation because these countries usually use non-renewable energy resources for industry and other economic activities carried out by the community, which cause an increase in CO2 emissions.

4.4. Mediation Effect Test

According to Jogiyanto (2014), there are two conditions before conducting the mediation test: a. The independent variable must influence the intervening variable, b. The intervening variable must affect the dependent variable. The mediation effect can be seen in the Specific Indirect Effect if the P-Value <0.05, then there is a mediation effect to determine whether this mediation effect is pseudo or complete; it is seen in the total effects. Full mediation (fully mediating) occurs if the total effects found the relationship of the independent variable to the dependent variable to be insignificant (Hartono and Abdillah, 2014).

4.4.1. Economic Growth Mediates the Relationship between Energy Consumption and Pollution

Based on tables 1.8 and 1.9, it can be seen that energy consumption has a positive and significant effect on pollution through economic growth where the P-Values value is 0.000 <0.05, so it can be concluded that economic growth can mediate the relationship between energy consumption and pollution even though the mediation is pseudo or partial. Then H6 is accepted. The calculation results can also be concluded that the indirect effect of energy consumption on pollution is greater than the direct effect.

4.4.2. Economic Growth Mediates the Relationship between Taxes and Pollution

Based on tables 1.8 and 1.9, it can be seen that taxes have a positive and significant effect on pollution through economic growth where the P-Values value is 0.000 <0.05, so it can be concluded that economic growth can mediate the relationship between taxes and pollution where the nature of the mediation is whole (fully mediation). , then H7 is accepted. From the calculation results, it can also be concluded that the indirect effect of taxes on pollution is greater than the direct effect.

IV. Conclusion

The main objective of this study is to examine the effect of energy consumption and taxes by mediating economic growth on pollution in 9 ASEAN countries from 2004 – 2020. From the test results, it can be concluded that: energy consumption has a positive effect on economic growth and pollution, taxes have a positive impact on economic growth has a negative impact on pollution, and economic growth has a positive impact on pollution, besides that economic growth can mediate the relationship between energy consumption and pollution and the relationship between taxes and pollution. For further research, it is recommended to add variables not included in this study, such as population, government subsidies, carbon trading or using other indicators such as renewable energy, fossil fuels and other environmental issues that can describe the level of pollution more broadly.

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