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Does The Consumption of Energy, Renewable Energy, Natural Resources and Emissions Affect Gross Domestic Product?: The Study of Southeast Asia

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Abstract: We face the challenges of economic growth productivity which still uses dirty energy and minimal efforts to cleaner energy transition. The debate on efforts to increase productivity by diverting dirty energy into clean energy while still preserving nature has long been discussed. Southeast Asia is a region that has massive development potential with valuable natural resources facing regional threats in addition to decreasing environmental quality but also prosperity. This study aims to identify initial steps are needed to control energy consumption, which is still considered dirty, the extent of the scope of Southeast Asia's current clean energy transition and how emissions can be a determinant of the decline in regional economic productivity. This is the first study to combine the Cobb-Douglas production function model with three models that focus on (1) energy consumption, (2) renewable energy and natural resources, and (3) emissions. The data used is secondary data for the period 2004-2018 sourced from the World Bank Development Indicator and ourworlddata.org. Panel data regression was used as an analytical technique. This study was conducted in the Southeast Asia region (with selected countries with developing economies and industries, namely Indonesia, Malaysia, Thailand, the Philippines and Vietnam). The results of this study show that in the energy consumption model, only labor has a significant effect on GDP, in model B there is renewable energy consumption and the labor force which significantly affects GDP and in model C there are CO2 emissions and GHG emissions that affect GDP in the Southeast Asia region. This research will provide input to policy makers and growth analysts to form policies for sustainable economic development in Southeast Asia.

Kata Kunci: Emission, Energy Consumption, GDP, Natural Resources, Renewable Energy

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Introduction

The dilemma in encouraging regional economic growth productivity has long been faced related to environmental degradation. ASEAN has become an organization that is always useful for encouraging regional growth that is based on quality economic transformation. In this journey of higher quality economic transformation, the role of controlling energy consumption which is still considered dirty, encouraging the clean energy transition and controlling emissions is one of the goals of Sustainable Development Goals (SDGs) number 7 for Clean and Affordable Energy. SDGs are a real urgency in the globalization era. Increased economic growth that is not accompanied by the consumption of environmentally friendly energy and environmentally friendly technologies will lead to environmental degradation. This causes a dilemma from choosing to accelerate economic growth and development or carry out environmental protection (Aye & Edoja, 2017; Chen & Huang, 2013). Environmental issues and energy consumption have become one of the contemporary issues faced by developing and developed countries, which discuss environmental quality, climate change and global warming (Sajeev & Kaur, 2020; Wang, 2019).

The effect of FDI on GDP in current studies has a dependence on a country's existence of adequate absorptive. This is closely related to the need for development in human resources, the quality of development in financial markets and minimizing the technology gap that occurs from foreign companies and local companies (S. Anwar & Nguyen, 2010). In the technological relationship implied in the FDI model, it is often assumed that foreign high-tech firms can increase their domestic economic impact if they provide an overall level of domestic technology (Berthelemy & Demurger, 2000). Human capital plays an important role in generating the economic growth of a country especially at the level of higher education. Now, in line with the rapid advancement and improvement of technology, competition has brought great changes in the labor market. This situation has led to an increase in job demand (Amir et al., 2015; Rambeli et al., 2016). Today, the contemporary economy requires people with higher education to cater for a knowledgeable and skilled workforce. The pattern of education is one of the keys to economic growth in the labor force (Amir et al., 2015). In its development, in addition to education, wage increases and more decent work in management will increase the capabilities and capacities of a country's labor force. This causes the labor force and capital to have a great influence on long-term economic growth (Rambeli et al., 2016).

Current economic activities that prioritize growth and development still ignore the impact on environmental quality and from time to time give more emphasis to natural resources (Munir & Ameer, 2018). A number of activities that cause climate change, decreased environmental quality and global warming such as consumption of non-renewable energy, and increased emissions. Both of these can lead to environmental degradation which can reduce the quality of natural resources such as water, soil and air. In the course of the problem, the relationship between human activities and natural genes in industrial communities is influenced by two aspects, namely the relationship between development and ecology and the relationship between development and resources (Ding, 2021). However, a number of countries have tried to develop environmentally friendly energy consumption and sustainable technologies. This is needed by increasing recycling and advance technology as well as technology investment which so far is expected to be more efficient but has a big impact on economic growth (Wang, 2019).

Increasing population, economic development, energy consumption and rising emissions are one of the consequences of the world turning to the industrial revolution (Jia et al., 2021). Efforts to create growth and development are reflected in a number of different levels of economic growth in each country, which depend on several factors such

as growth-oriented planning, different economic mechanisms, involving participation in development, and utilizing available natural resources (Aye & Edoja, 2017). In this effort, it is undeniable that it uses a number of energy consumption that is not environmentally friendly and results in increased emissions. Both of these are the result of the use and the effect of consumption in sectors that have the potential to increase economic growth such as industry, transportation, household consumption etc. Creating growth and development by adapting to traditional production functions often involves aspects of capital and labor as basic aspects. These two things have different paradigms in productivity but complement each other, namely the capital aspect that is oriented to capital incentives and the labor aspect that is oriented to labor incentives. These two orientations are critically expected to be able to overcome a number of economic problems with a multiplier effect from their impact on other sectors.

Productivity as reflected in economic growth is still quite dominantly driven by energy consumption which is still dirty and not yet environmentally friendly, this is the first highlight in this research issue. Current energy consumption can be categorized into renewable and non-renewable energy consumption. Every country, especially developing countries, still prioritizes a major share in non-renewable energy which is included in the part of mixed energy consumption (Karedla et al., 2021). This is conditioned when renewable energy consumption has not developed or cannot compete with the large contribution of non-renewable energy consumption to economic growth. A number of examples of non-renewable energy consumption are the consumption of fossil fuels and energy consumption where the characteristics of countries that have a dominance of energy producers are not environmentally friendly (such as the consumption of energy created from coal, oil, etc.). This indicates that every country with characteristics, especially developing countries or having dependence on non-renewable energy sources, will have an orientation towards total energy consumption which is not environmentally friendly either. Consumption of fossil fuels is still one of the largest sources of energy driving broad economic activity for now in the world. There are still few countries that try to periodically divert economic growth created by the encouragement of more environmentally friendly sources and consumption of energy. This makes the transition to renewable energy an urgency, but still faces constraints on whether the transition capacity is adequate or not.

Another issue that needs to be discussed is the increase in regional emissions that cannot be controlled from the linear economic activities that are currently being carried out. The current increase in emissions resulting from the industrial revolution, transportation developments and other economic activities has increased from year to year. The general perception raised from seeing economic growth that continues to increase is that the increase in emitting economic activity (industry, transportation, etc.) will be in line with the increase in CO2 emissions. This increase in emissions, one of which is CO2 emissions, is believed to have a negative impact on the environment such as a decrease in environmental quality, pollution and even climate change. In addition to CO2 emissions, there are greenhouse gas emissions, which are emissions that can cause environmental degradation, global warming and climate change on earth. The increase in energy consumption that is not environmentally friendly and technology that does not switch to environmentally friendly technologies can accelerate environmental degradation. The impact of environmental degradation caused by both the consumption of non-renewable energy and the increase in uncontrolled emissions can result in disruption of the quality of fresh water resources, food supply, ecosystems, human health and biodiversity and result in a decline someday in the decline of economic performance in the future. By looking at the enormous impact of emissions on the environment, it is important to

consider the implications of sustainable economic growth, which include controlling emissions.

Theoretically, by responding to a few issues above, the key to this is the transition of three important aspects of regional environmental issues (energy consumption, sustainable energy transition and emission control) through the concept of economic growth which must be in harmony with improving environmental quality. The development of studies on the interaction between GDP and a number of environmental economic variables has been carried out separately according to the focus of each study. The main focus that is currently developing from almost all economic studies is how to create a world of growth and development (Muftau et al., 2014). In its development in creating growth, a number of alternatives that are often discussed are creating an ever-increasing industrial sector that creates capital turnover and employment, besides that the central role of energy is very much needed (Osadume & University, 2021). The development of this industry can be related to a number of notions of traditional production functions (as applied to the Cobb-Douglas production function) in which aspects of capital and labor can encourage productivity. This productivity element can be assumed as a sector increase in gross domestic product (GDP). Economic problems such as unemployment, poverty, inflation and lack of employment have caused the urgency of a more massive industrial application to be carried out, especially in developing countries (Muftau et al., 2014). In addition to productivity from GDP, which is supported by the encouragement of capital and labor absorption, it is also supported by the consumption of various types of energy, both renewable and non-renewable. Apart from energy consumption, a number of studies have analyzed the relationship between emissions to GDP which is one of the bases for looking at the impact of economic activity on environmental degradation.

This is the main basis for the researcher's aim to identify how gross domestic product can be influenced by energy consumption, sustainable energy and emissions and which controls should be prioritized. This research focuses on identifying the relationship between energy consumption aspects which reflect how the scope of Southeast Asia's economic growth conditions are driven by energy sector consumption which still does not separate clean energy from dirty energy, renewable energy aspects which show the contribution of the clean energy transition in Southeast Asia whether it has contribute to economic growth as well as emissions aspects to see how much emissions influence economic growth so that they need to be controlled regionally in Southeast Asia. These three things are very important to study to formulate regional policies starting from existing policies regarding energy use in the Southeast Asia region, how far the Southeast Asia region has made efforts to encourage cleaner and more sustainable energy and minimize emission losses in greener economic growth.

This study aims to identify initial steps are needed to control energy consumption, which is still considered dirty, the extent of the scope of Southeast Asia's current clean energy transition and how emissions can be a determinant of the decline in regional economic productivity. This study attempts to bring out novelty in explaining the gap phenomenon from the existence of energy consumption, which is still common and predominantly dirty, efforts to adopt cleaner energy consumption as well as looking at emissions conditions in economic growth which have not been fully analyzed so far. This research is the first research to combine the Cobb-Douglas production function model with three models (in this study, using model A for energy consumption, model B for renewable energy and natural resources and model C for emissions). This can contribute academically to help design the ideal concept of a sustainable energy transition in the agenda of controlling energy consumption, which is still considered dirty, encouraging clean energy consumption and minimizing the negative impact of emissions on economic growth.

By dividing it into three different models, it can show the position of the GDP of several countries in the Southeast Asia region in terms of energy consumption, renewable energy consumption and emissions. In addition to looking at the GDP response from interactions with environmental economic subjects, this research puts forward the novelty of seeing empirically what sustainable development policies need to be done from the results of the combined estimation findings of the three models analyzed.

Research Method

In conducting research and looking for scientific evidence, a systematic, comprehensive research method is needed and can produce answers to the formulation of the research problem that was initiated. significance. In this research we use data collection in the process of longitudinal research. This type of data collection explores and investigates data in multiple time of dataset (Venkatesh & Vitalari, 1991). This study uses secondary data using the variable gross domestic product as the dependent variable. As for forming the model, three forms of variables are used, namely the main variable (which is an independent variable that estimates the theoretical dependent variable; in this case it refers to the basis of the Cobb-Douglas production function), using the production function variable as the basic variable and the energy consumption variable (it is assumed that model A as non-renewable energy, model B as renewable energy and model C as the party using energy) as the response variable.

Sample used in this research using the countries with the largest economies in the Southeast Asia region those are Indonesia, Malaysia, Thailand, the Philippines and Vietnam in the 2004-2018 period. In conducting the research, it is realized that differences in variables will cause differences in the estimation results of the main variables, so that by forming a combination of two aspects in two different models, it will show the condition of the variables in various scenarios better. For the description of variables, symbols, measurements and data sources, it is shown in the variable operationalization table below:

Table 1 . Variable Operations

Variable Name	Symbols	Measurement	Data Sources
A. Aspects of Gross Domestic Product			
Gross Domestic Product (Y)	GDP	The unit used is according to the constant price of US$ 2015	World Development Indicator
Foreign Direct Investment (X1)	FDI	The flow of capital funds by *inflows* originating from abroad in US$	World Development Indicator
Labor Force (X2)	LF	The total number of people living in a certain country zone obtained from the results of the population census by soul	World Development Indicator
B. Energy Consumption Aspect			
Energy Consumption (X3)	EC	Overall energy consumption in economic activities with the unit used is Twh	ourworlddata
Fuel Fossil Consumption (X4)	FFC	Consumption of non-renewable fossil fuels in units used is Twh	ourworlddata
C. Renewable Energy and Natural Resources			
Renewable Energy Consumption (X5)	REC	Consumption of renewable energy that is renewable and environmentally friendly with the	World Development Indicator

		data used is % of the total final energy consumption	
Total Natural Resources Consumption (X6)	TNR	The total consumption of natural resources carried out in a particular country in raw with the data used is % of GDP	World Development Indicator
Emission Aspect			
CO2 Emission (X7)	CO2	CO2 emissions in kg per 2015 US$ of GDP	World Development Indicator
Total Greenhouse Gas Emissions (X8)	GGE	This emission is used in units of kt of CO2 equivalent	World Development Indicator

Research in the field of causality between economic growth, energy consumption and CO2 emissions as well as other energy and environmental variables has developed a lot and has become one of the controversies in traditional neo-classical growth models (Banday & Aneja, 2019). However, its development cannot be separated from the development of the concepts of globalization, privatization and consumerism which encourage growth (Banday & Aneja, 2019; Esen & Bayrak, 2017). The use of the Cobb-Douglas production function is commonly used as a basis, such as the research developed by (Vidyarthi, 2015)in relation to energy consumption and growth, (Adabor et al., 2021)in the causal relationship between natural resources and economic growth, (Amir et al., 2015)in the causal relationship of educated labor force on economic growth, and (Shastri et al., 2020)in the causal relationship of energy consumption. By looking at the theoretical relationship and previous research, for the purpose of studying environmental economics in inclusive energy based on the Cobb-Douglas production function, it is as follows:

$$PDB\ constant = f(FDI, JP, KE, BBF) \rightarrow Model\ A \quad (1)$$

$$PDB\ constant = f(FDI, JP, RE, TNR) \rightarrow Model\ B \quad (2)$$

$$PDB\ constant = f(FDI, JP, CO2, GGE) \rightarrow Model\ C \quad (3)$$

For example, in the theoretical relationship and previous research, the constant value of GDP is a function of FDI, labor force, energy consumption, fossil fuel consumption for modeling A. Then model B is formed where GDP is a function of FDI, labor force Renewable Energy Consumption and total natural resources consumption. Meanwhile, in modeling C, an equation is formed that GDP is a function of FDI, labor force CO2 emission and total greenhouse gas emission. FDI and JP are production functions for capital *and* labor *so* that they can be denoted as $Y_{it}^{M,TK}$, while model A for estimation of energy consumption is denoted as Y_{it}^{EC} and model B for estimation of renewable energy is denoted as Y_{it}^{RE}. By following the conceptual framework of the Cobb-Douglas equation created above by dividing it into two models, a growth model can be formed with the following equation:

$PDB_{it} = f\left(Y_{it}^{M,TK}, Y_{it}^{EC}\right)$ where $Y_{it}^{M,TK} = f(FDI_{it}, JP_{it})$ and (4)

$Y_{it}^{EC} = f(KE_{it}, BBF_{it})$

By carrying out theoretical adaptations in the formation of models from the Cobb-Douglas equation in this study, a new equation is formed which is the same as using the basic Cobb-Douglas equation for this research, which is as follows:

$PDB_{it} = f\left(Y_{it}^{M,TK}, Y_{it}^{RE}\right)$ where $Y_{it}^{M,TK} = f(FDI_{it}, JP_{it})$ and (5)

$Y_{it}^{RE} = f(RE_{it}, TNR_{it})$

In the equation for industrialization, the Cobb-Douglas equation model is as follows:

$PDB_{it} = f\left(Y_{it}^{M,TK}, Y_{it}^{IND}\right)$ where $Y_{it}^{M,TK} = f(FDI_{it}, JP_{it})$ and (6)

$$Y_{it}^{RE} = f(CO2_{it}, GGE_{it})$$

The above equation defines the effect of energy consumption as model A (by being modeled in energy consumption and consumption of fossil fuels) and energy sustainability (by being modeled in terms of renewable energy consumption and consumption of natural resources) as explanatory variables in each model A and model B, and the fixed variables used are labor force and FDI. The first model to identify the impact of environmental aspects on GDP is shown in the following equation:

$$GDP_{it} = + _1 LB_{it} + _1 FDI_{it} + _2 EC_{it} + _3 FFC\,it + \varepsilon_{it} \quad (7)$$

$$GDP_{it} = + _4 LB_{it} + _5 FDI_{it} + _6 REC_{it} + \beta\ 7\ _{TNRC}\,it + \varepsilon_{it} \quad (8)$$

$$GDP_{it} = + _4 LB_{it} + _5 FDI_{it} + _6 CO2_{it} + _7 TGGE\,it + \varepsilon_{it} \quad (9)$$

The description of a number of symbols used in the regression equation above is explained as follows:

GDP = Gross Domestic Product in Southeast Asian Countries
LB = Labor force
EC = Energy Consumption
FFC = Fossil Fuel Consumption
RE = Renewable Energy Consumption
TNR = Total Natural Resources Consumption
α = Konstanta
β_n = Slope coefficient
ε = Error term
i = Number of countries
t = Number of years

This study uses panel data analysis techniques, which according to Gujarati & Porter (2012) panel data combines two types of data, namely *time-series* and *cross-section* . In this study, the object of research is the countries with the largest economies in the Southeast Asia region (Indonesia, Malaysia, Thailand, the Philippines, and Vietnam) in the period 2001-2018. This study uses a different panel data analysis technique when we use pooled data analysis techniques. The results of this study do not explain the individual cross-section so that it will produce a single equation output. Unlike the *pooled data* analysis technique which produces different constants in each equation in each *cross-section*. This study uses panel data analysis techniques, which according to Gujarati & Porter (2012) panel data combines two types of data, namely *time-series* and *cross-section* . This analytical method was chosen to see the magnitude of the effect of the difference in intensity and period and to determine the functional relationship between the variables to be studied under study. The model used in this study refers to the panel data equation model with the Cobb- Douglas function approach to reflect the dependent variable which is part of the factors supporting the productivity concept in economic growth.

In panel data processing, three approaches are known, namely the *common least square* (CEM), *fixed effect model* (FEM), and *random effect model* (REM). In this study, two models were used, namely model A for energy consumption, model B for renewable energy and natural resources, and model C for emissions. The research stages are the first to determine the best model, this study will choose the best mode among *the common effects model* (CEM), *fixed effect model* (FEM), and *random effect model* (REM) (Firmansyah et al., 2021; Gujarati & Porter, 2012; Nisa & Budiarti, 2020; Srihardianti et al., 2016). To determine the best model, the Chow Test, Hausman Test and lagrange multiplier were carried out.

In terms of data analysis and validity, this reseach use ordinary least squares (OLS) as an econometric analysis that is concern to fulfill a validity such as classical assumptions in order to avoid BLUE (the best linear unbiased estimator.). It is include a normality test, multicollinearity test, and heteroscedasticity test. This study uses simultaneous significance testing using the F-statistical test using the probability value F. Partial significance testing is using the t-statistical test using the probability value and the coefficient of determination to see how much the dependent variable (X) can explain the independent variable (Y) when compared with the residual value on variables that are not included in the econometric modeling

Result

The first part will discuss the results of selecting the best model. The second part looks at the classical assumptions, the third part will discuss the estimation results of the regression panel, the fourth part is an explanation of the significance test and the fifth part is a discussion of the research findings.

Table 2. Results of the Chow Test and Hausman Test for the A . model

Chow Test			
Effects Test	**Statistics**	**df**	**Prob.**
Cross-section F	110.469627	(4,66)	0.0000
Cross-section Chi-square	153.044064	4	0.0000
Hausman Test			
Test Summary	**Chi-Sq. Statistics**	**Chi-Sq. df**	**Prob.**
Random cross-section	441.878506	4	0.0000

Source: Processed by the Author

Table 3. Results of Chow Test and Hausman Test for Model B

Chow Test			
Effects Test	**Statistics**	**df**	**Prob.**
Cross-section F	256.189978	(4,66)	0.0000
Cross-section Chi-square	210.373137	4	0.0000
Hausman Test			
Test Summary	**Chi-Sq. Statistics**	**Chi-Sq. df**	**Prob.**
Random cross-section	1024.759906	4	0.0000

Source: Processed by the Author

Table 4 . Chow Test and Hausman Test Results for Model C

Chow Test			
Effects Test	**Statistics**	**df**	**Prob.**
Cross-section F	45.892850	(4,66)	0.0000
Cross-section Chi-square	99.756772	4	0.0000
Hausman Test			
Test Summary	**Chi-Sq. Statistics**	**Chi-Sq. df**	**Prob.**
Random cross-section	183.571399	4	0.0000

Based on tables 2, 3 and 4, the value of Prob is obtained. *The Chi-square cross-section* is 0.0000 which means it is smaller than 0.05 or 0.0000 < 0.05. Based on this, the best model is the Fixed *Effect Model*. Therefore, the next test will be conducted, namely the Hausman test to determine the best model between the *Fixed Effect Model* and the *Random Effect Model*. Furthermore, in the selection of the model with the Hausman test, the value of Prob is obtained. *The random cross-section* is 0.00000, which means it is smaller than 0.05 or 0.00 00 < 0.05. Based on this, the best model is the Fixed *Effect Model*. Furthermore, data processing and data interpretation will use the *Fixed Effect Model* for all panel data processing.

Classic assumption test

In detecting the classical assumption test in panel data, normality test, multicollinearity test and heteroscedasticity test are used. autocorrelation test is not used because it is more suitable in testing the classical assumption test in times series econometrics. The results of the classical assumption test in this study are as follows:

1. Normality Test

The results of the normality test using Jarque-Bera and the histogram are shown in the figure below as follows:

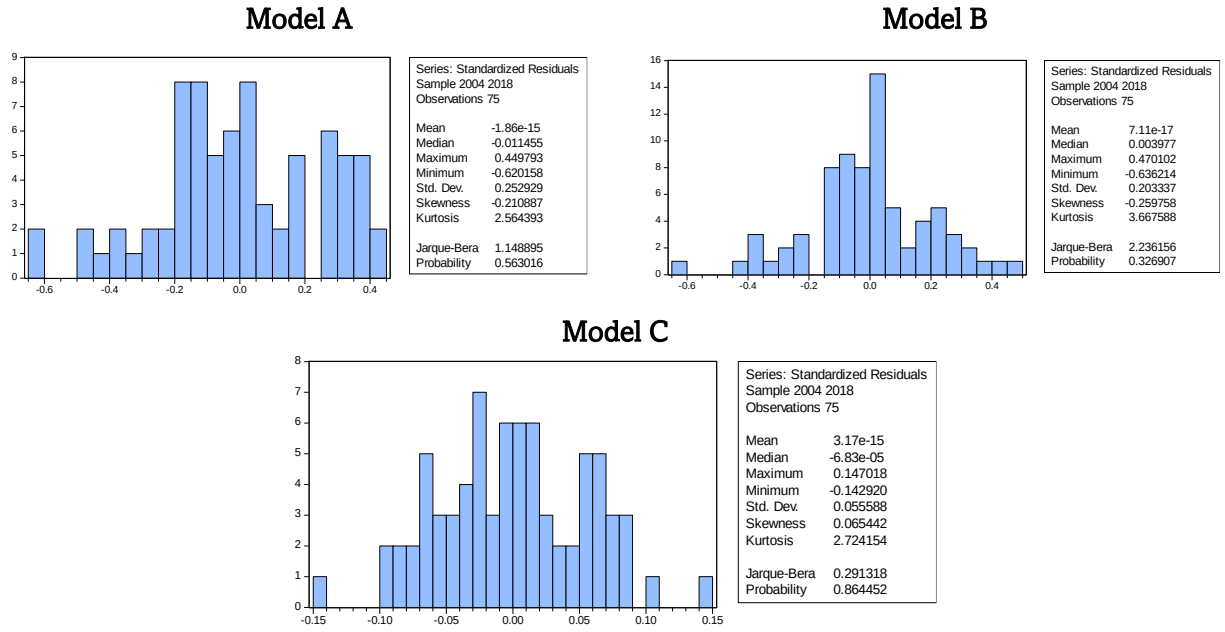

Figure 1. Normality Test Results (Model A, Model B, Model C)

In Figure 1, it can be seen that the jarque fallow value of model A is 3.388571 and the probability value is 0.183730, and the jarque fallow value of model B is 2.070377 and the *probability value* is 0.355159. So, it can be concluded that this model has a normal distribution. With the model free from the heteroscedasticity problem, it can be concluded that the next test can be carried out, namely the *heteroscedasticity test*.

2. Heteroscedasticity Test

The results of the heteroscedasticity test using the Glejser test are shown in table 3 below below as follows:

Table 3. Heteroscedasticity Test Results with Glejser Test

Variable el	**Southeast Asia**		
	Model A	**Model B**	**Model B**
Selected model	**Prob (FEM)**	**Prob (FEM)**	**Prob (FEM)**
***Dependent Variable*: RESID**			
Constant	0.6515	0.4245	0.5738
LaborForce Logs	0.5543	0.4923	0.5181
FDI logs	0.3574	0.9489	0.0468
EC logs	0.8651		
FFC logs	0.9231		
REC		0.1218	
TNRC		0.7918	
CO2 logs			0.4288
TGGE logs			0.2563

In table 3 it can be seen that the *probability value of* each variable is greater than 0.05. So, it can be concluded that in this model there is no heteroscedasticity. With the model free from the heteroscedasticity problem, it can be concluded that the next test can be carried out, namely by testing multicollinearity.

3. Multicollinearity Test

Multicollinearity test using the serial correlation are shown in table 4 below below as follows:

Tabe 4. Correlation Series

Model A					
	GDP	**Labor Force**	**FDI**	**EC**	**FFC**
GDP	100000	0.82081	0.59874	0.88539	0.88139
FDI	0.82081	100000	0.46272	0.65069	0.62805
Labor Force	0.59874	0.46272	100000	0.66200	0.63862
EC	0.88539	0.65069	0.66200	100000	0.99707
FFC	0.88139	0.62805	0.63862	0.99707	100000
Model B					
	GDP	**Labor Force**	**FDI**	**REC**	**TNRC**
GDP	100000	0.82081	0.59874	0.07313	-0.21184
FDI	0.82081	100000	0.46272	0.56751	-0.05208
Labor Force	0.59874	0.46272	100000	-0.13283	-0.01524
REC	0.07313	0.56751	-0.13283	100000	-0.06977
TNRC	-0.21184	-0.05208	-0.01524	-0.06977	100000
Model C					
	GDP	**Labor Force**	**FDI**	**CO2 Emission**	**TGGE**
GDP	100000	0.82081	0.59874	-0.30336	0.93517
FDI	0.82081	100000	0.46272	-0.13826	0.89697
Labor Force	0.59874	0.46272	100000	0.17978	0.60072
CO2 Emission	-0.30336	-0.13826	0.17978	100000	-0.03277
TGGE	0.93517	0.89697	0.60072	-0.03277	100000

In table 4 it can be seen that the correlation value of each dominant variable in below 0, 8. So it can be concluded that in this model there is no multicollinearity. By freeing the model from the problems of normality test, heteroscedasticity test and multicollinearity test, it can be concluded that the model has met the classical assumption test.

Panel Data Regression Results

The results of the panel data regression estimation using the *fixed effect model* (FEM) approach are as follows:

Table 5. Panel Data Regression Estimation

Variable el	Southeast Asia		
	Model A	Model B	Model C
Selected model	Coefficient (FEM)	Coefficient (FEM)	Coefficient (FEM)
Dependent Variable: Log PDB			
Constant	1.273002	-3.886725	4.449834 *
	(1.7436)	(2.8140)	(1.1307)
LaborForce Logs	1.215187 *	1.722547 *	0.360198 *
	(0.1142)	(0.1664)	(0.0952)
FDI logs	0.004154	0.018997	0.009266 ***
	(0.0092)	(0.0144)	(0.0055)
EC logs	0.085816		
	(0.2844)		
FFC logs	0.476233		
	(0.3010)		
REC		-0.010402 *	
		(0.0030)	

TNRC		-0.00968 1 (0.0061)	
CO2 logs			-0.646702 * (0.0547)
TGGE logs			1.196995 * (0.0523)
F-Statistics	1069,658	457.9332	3056,936
Prob (F-Statistic)	0.000000	0.000000	0.000000
R -squared	0.992346	0.982303	0.997308
Adjusted R -squared	0.991419	0.980158	0.996982

Description: *=significant 1%, **=significant 5%, ***=significant 10%,
model A=energy consumption, model B=consumption of renewable energy

Table 5 shows the results of panel data regression using the FEM approach. It was found that statistically only FDI variable had no significance <0.05 so it did not significantly affect GDP. While other variables have a significance <0.05 s so that it can affect GDP. The results of processing using panel data regression are shown in the table below below:

Table 6. *Fixed Effect Model* Regression Results for F . Test

Effects Specification			
Cross-section fixed (dummy variables)			
Indicator	***Value***	***Indicator***	***Value***
Model A			
R-squared	0.992346	Mean dependent var	26,41599
Adjusted R-squared	0.991419	SD dependent var	0.551009
SE of regression	0.051043	Akaike info criterion	-3000116
Sum squarerd resid	0.171958	Schwarz criterion	-2.722018
Likelihood logs	121.5044	Hannan-Quinn Criter.	-2.889075
F-statistics	1069,658	Durbin-Watson stat	0.445142
Prob(F-statistic)	0.000000		
Model B			
R-squared	0.982303	Mean dependent var	26,41599
Adjusted R-squared	0.980158	SD dependent var	0.551009
SE of regression	0.077616	Akaike info criterion	-2.161918
Sum squarerd resid	0.397601	Schwarz criterion	-1.883819
Likelihood logs	90.07193	Hannan-Quinn Criter.	-2.050876
F-statistics	457.9332	Durbin-Watson stat	0.255472
Prob(F-statistic)	0.000000		
Model C			
R-squared	0.997308	Mean dependent var	26,41599
Adjusted R-squared	0.996982	SD dependent var	0.551009
SE of regression	0.030269	Akaike info criterion	-4.045203
Sum squarerd resid	0.060471	Schwarz criterion	-3.767104
Likelihood logs	160.6951	Hannan-Quinn Criter.	-3.934161
F-statistics	3056,936	Durbin-Watson stat	0.356687
Prob(F-statistic)	0.000000		

Based on table 6, it is known that the probability value of the F-statistic is 0.0000 00 , where 0.0000 00 < 0.05 in both values in model A, model B and model C. These results indicate that in model A the variables of FDI, labor force, energy consumption and fossil fuel consumption have a significant effect on GDP simultaneously. Furthermore, in model B it is found that the variables of FDI, labor force, consumption of renewable energy and total consumption of natural resources have a significant effect on GDP simultaneously. Finally,

in model C, it is found that FDI, labor force, CO2 emission and total greenhouse gas emission have a significant effect on GDP simultaneously.

In measuring the significance individually then a test approach can be used with a t-test which will measure the effect partially. This study uses a 95% confident interval so that the significance value must be less than 0.05. However, it is also presented for several variables that have significant values in other assessments such as 1%, 5% and 10%. The results of processing using panel data regression are shown in table 7:

Table 7. *Fixed Effect Model* Regression Results for t Test

Variable	Coefficient	Std. Error	t-Statistics	Prob.	Decision
(1)	(2)	(3)	(4)	(5)	(6)
Model A					
Constant	1.273002	1.743604	0.730098	0.4679	Not significant
LF logs	1.215187	0.114234	10.63770	0.0000	Significant
FDI logs	0.004154	0.009293	0.447061	0.6563	Not significant
KE logs	0.085816	0.284497	0.301643	0.7639	Not significant
BBF logs	0.476233	0.301081	1.581742	0.1185	Not significant
Model B					
Constant	-3.886725	2.814045	-1.381188	0.1719	Not significant
LF logs	1.722547	0.166424	10.35035	0.0000	Significant
FDI logs	0.018997	0.014460	1.313805	0.1935	Not significant
RE	-0.010402	0.003027	-3.436741	0.0010	Significant
TNR	-0.009681	0.006100	-1.587056	0.1173	Not significant
Model C					
Constant	4.449834	1.130744	3.935315	0.0002	Significant
LF logs	0.360198	0.095276	3.780568	0.0003	Not significant
FDI logs	0.009266	0.005515	1.680176	0.0977	Not significant
CO2 logs	-0.646702	0.054775	-11.80656	0.0000	Significant
TGGE logs	1.196995	0.052391	22.84745	0.0000	Significant

Description: if it is assumed that the significance value must be below 0.05

Based on table 7 presents information about the partial relationship between variables in the three models. By using a significance value that must be below 0.05, it is found that in model A only labor force can affect GDP in the energy consumption model. In model B, it is found that labor force and renewable energy can affect GDP in a model that represents renewable energy and natural resources. For model C, it is found that labor force CO2 emission and GHG emission can affect GDP. From these results, it can be seen that the Southeast Asia region is still classified as a developing region. This can be seen from the response that occurs in model A which represents energy consumption that labor force is still one of the drivers of economic growth in the Southeast Asia region, this is different when looking at developed countries that have a choice of boosting economic growth not only through labor force but also through management assets and capital.

In model B which represents renewable energy and natural resources, it is found that the consumption of renewable energy has a negative impact on economic growth in Southeast Asia, this is because the adoption of environmentally friendly energy has not been widely carried out in Southeast Asia and when it is implemented it may not necessarily have an impact on the environment. economic growth (when compared to energy consumption that is not environmentally friendly). In model C, it is found that emissions (both CO2 emissions and GHG emissions) have an impact on economic growth. In this position, it is found that CO2 emissions have a significant negative impact which means that increasing emissions will reduce economic growth. This is in line with increasing emissions which will lead to environmental degradation so that economic growth is disrupted. Furthermore, in line with the issue of climate change, a significant

positive position occurs in GHG emissions where every increase in GDP will increase GHG emissions. This is in line with the increase in human activities in developing countries that still do not use environmentally friendly energy.

The calculation results presented in table 10 above can be interpreted that when the independent variable is zero, the gross domestic product decreases in the environmental context. This means that energy consumption has an important role to increase GDP in Southeast Asia. The equation of model A and model B shows that an increase in FDI will increase GDP in the Southeast Asia region, this is in line with the labor force which has the same positive effect. So, the increase in labor force will increase GDP. In model A, which assumes non-renewable energy consumption, it is found that energy consumption can increase GDP while consumption of fossil fuels will decrease GDP if it increases. It can be seen that the condition of indirect cause and effect of environmental pollution from the direct relationship of fossil fuel consumption and GDP occurs. In model B, it is found that both the consumption of renewable energy and the total consumption of natural resources, if there is an increase, the GDP will decrease. This is a *trade-off* that occurs from the choice to encourage GDP growth through consumption of non-renewable energy. This means that removing non-renewable energy consumption and replacing it with renewable energy consumption is currently not possible, and if enforced it will cause a regional decline in GDP in Southeast Asia.

Coefficient of Determination

This test is carried out to measure the percentage of the total variation of the dependent variable that can be explained by the regression model. This is done to determine the good accuracy in the analysis which is indicated by the magnitude of the coefficient of determination R-squared. It was found that the R-squared value of model A is 0.992346 or 99.23%, which means that the independent variable in the equation is able to explain the dependent variable by 99.23% and the remaining 0.77% is explained by other variables outside the model. For model B, which is 0.982303 or 98.23%, it can be interpreted that the independent variable in the equation is able to explain the dependent variable by 98.23% and the remaining 1.77% is explained by other variables outside the model. For model C, which is 0.997308 or 99.73%, it can be interpreted that the independent variable in the equation is able to explain the dependent variable by 99.73% and the remaining 0.27% is explained by other variables outside the model.

Discussion

In understanding economic development, we can analyze it through the concepts of growth and development which have long been discussed in economics. Economic growth has long been a measure of macroeconomic performance, economic growth is represented as an increase in the size of the current year's economy which is greater than the size of the previous year's economy (Dumairy, 2007). Economic growth focuses on data performance, both in various approaches, this data increase is expected to increase from year to year. The fundamental weakness of economic growth is that the ideal pattern cannot be known to show an improvement in the quality of welfare from economic growth (Todaro & Smith, 2011). This will be different from the concept of economic development which has an orientation in how to improve the quality of life welfare. Economic development provides a strategic position in determining a certain level of output in data-based economic performance so that this increase in economic size will be accompanied by an ideally measurable improvement in the quality of life welfare. Utilization of new strategic sectors in economic growth such as in controlling the stability of national political communication and tourism development potential (Firmansyah & Nasution, 2020; Kuswantoro, 2009; Masripatin et al., 2017).

The new growth theory explains that FDI plays an important role in economic growth through the efficiency of technology transfer that occurs between foreign companies and domestic companies (Koojaroenprasit, 2012). The belief in FDI in a number of countries that can have a good impact on the economy has been practiced for a long time. The impact of FDI which is normally believed to be providing jobs, increasing economic productivity, increasing exports and the occurrence of technology transfer (Falki, 2009). In this context, we can find that this era of globalization and modernization has caused many countries to depend on one another, a condition where international culture has entered the economic zone. A number of developed countries have begun to enjoy welfare conditions, in addition to that in developing countries they have not been able to stabilize economic conditions. This causes FDI which is driven from interests in international trade to have an important role in the economy of each country (Louzi & Abadi, 2019).

A study conducted by Koojaroenprasit (2012) which examined the effect of FDI on economic growth in South Korea found that FDI had a strong and significant effect on economic growth in South Korea, but domestic investment did not have a significant impact. Research conducted by Antwi et al., (2013) in Ghana found that GDP which represents a sectoral increase or economic growth has a significant impact on FDI. A regional study was conducted by Hlavacek & Bal-domanska, (2016) who conducted research in central and eastern european which found that there was a significant impact between economic growth, FDI and investment growth. A study conducted in Pakistan by Falki (2009) found that by using the production function based on the theory of endogenous growth, there was an insignificant negative relationship between GDP and FDI in Pakistan. Another study found in Jordan by Louzi & Abadi, (2019) which found that FDI does not have an independent relationship with economic growth which makes it necessary to mix policies in the future in utilizing FDI to encourage economic growth in Jordan. A study conducted in Sri Lanka by Athukorala, (2014) found that FDI has a positive impact on economic growth through FDI that can support investment and domestic economic activities.

Research conducted by (Shahid, 2014)found that there is a long-term and short-term relationship between labor force participation, gross fixed capital formation and economic growth in Pakistan. A study conducted in Vietnam by Cung & Hung, (2020) found that empirically there was a significant positive relationship between FDI, labor force, exports and inflation on economic growth. A study conducted by Muzdalifah & Siregar, (2017) in South Kalimantan, Indonesia found different results, namely there was a negative relationship between the labor force and significant economic growth. A study conducted in Bangladesh by Haque, (2019) found that there is a significant short-term relationship between labor force participation and female labor force participation on economic growth.

This study found that in various models of interaction between variables using the Cobb-Douglas production function, there will be different characteristics and responses. In model A, which represents energy consumption, it shows insignificant results between energy consumption and fossil fuel consumption on economic growth in Southeast Asia. However, partially energy consumption and fossil fuel consumption have positive coefficients, this shows that an increase in energy consumption and fossil fuel consumption can increase economic growth. This positive concept is in line with research conducted by Banday & Aneja, (2019); Vidyarthi, (2013); Vidyarthi, (2015) and Asiedu & Aboagye, (2022). In a number of literature studies as described by Bloch et al., (2012) stated that in identifying the relationship between energy consumption and output that can be related to the economy, it is divided into two approaches, namely supply-side and demand-side. The supply-side explains that the contribution of energy consumption in economic activity can be done through a number of applications of the traditional production function, while the

demand-side approach analyzes the relationship between energy consumption and has a causal relationship with gross domestic product (GDP) as well as fluctuations in energy prices.

Each country's demand for energy consumption continues to increase every year, depending on projected economic growth and changes in the socio-economic structure that will continue to change (Esen & Bayrak, 2017). Therefore, the challenge to be able to maintain economic growth is to regenerate biological capacity on earth and as soon as possible to implement sustainable development (Ibrahiem & Hanafy, 2020). A study on G7 member countries conducted by Banday & Aneja, (2019) found that there is a long-term relationship between economic growth, energy consumption and CO2 emissions, in addition to the short-term positive relationship between economic growth, energy consumption and CO2 emissions. A study conducted by Vidyarthi, (2013) in India found that in the long term there is a positive relationship between energy consumption and CO2 emission on economic growth which recommends the need to implement energy efficiency and conservation policies to reduce the use of fossil fuel consumption in India. Research conducted by (Vidyarthi, 2015) in the South Asian region found that energy consumption has a positive impact on economic growth. In Sub-Saharan Africa, research conducted by Asiedu & Aboagye, (2022) found a positive relationship between GDP and energy consumption positively.

Furthermore, for fossil fuel consumption which has a positive value in line with research conducted by Sasana & Ghozali, (2017) and Ali et al., (2021). Fossil fuels have long occupied a central and important role in economic growth and industrial development. This causes a number of consequences from the existence of dominant economic growth supported by significant consumption of fossil fuels as well. In recent decades, a number of studies have been conducted to analyze and determine the relationship between fossil fuel consumption and economic growth where each region and country has a different relationship and impact Lim et al., (2014). The increase in fossil fuel consumption can cause influencing the atmosphere which has a negative impact on the earth such as global warming which will cause extreme climate change Ouahrani et al., (2011). From a number of literatures and previous research, it provides a concept where economic growth supported by industry and manufacturing with a lack of adaptation to environmentally friendly technologies will make the consumption of fossil fuels a major driver. Research conducted by Sasana & Ghozali, (2017) which analyzes Brazil, Russia, India, China and South Africa found that fossil fuel consumption has a significant positive impact on economic growth in BRICS countries. In a study conducted by Ishida (2013) which examined Japan, it was found that in the long term there is a relationship between fossil fuel consumption and GDP, where growth-oriented macroeconomic policies must be immediately revised and improved in line with the prospects for the Japanese economy in the future. Research conducted in Iran by Lotfalipour et al., (2010) found that carbon emissions, petroleum products, and total consumption of fossil fuels do not lead to economic growth, although gas consumption does.

In model B, which represents renewable energy and natural resources, it is found that renewable energy has a significant negative impact on economic growth. This is in line with research conducted by Ali et al., (2021). Furthermore, total natural resources consumption which has insignificant positive results occurs in the results of this study which indicates that the economic growth that occurred in Southeast Asia was not fully driven by the consumption of raw natural resources, this could happen with the possibility that Southeast Asian countries began to develop other potential sectors so that economic growth is more likely to occur in other sectors such as industry, banking, trade etc. A country gets a number of advantages in applying renewable energy, such as reducing emissions and having a diminishing impact on the inequality of distribution of income

(Ghosh, 2022). Implementing renewable energy is not as easy as one might imagine, this is related not only to government policies and commitments but also to business and company policies. The energy industry often uses an on-site energy investment approach where technology projects focus on calculating payback periods and returns from invested energy production (Leskinen et al., 2020).

A study conducted in BRICS countries by Sasana & Ghozali, (2017) found that there is a negative influence between renewable energy consumption on economic growth. Research conducted by Jamshid et al., (2021) in the South Asian Association of Regional Cooperation (SAARC) found that education and economic growth significantly increased renewable energy consumption, while foreign direct investment, financial development, CO2 emissions and urbanization decreased. On the other hand, research conducted by Can & Korkmaz, (2019) in Bulgaria found that renewable energy consumption and renewable electricity output can affect economic growth, on the other hand, economic growth and renewable electricity can affect renewable energy consumption. If we talk about green economic growth (where economic growth is driven by a circular economy) it can happen where research conducted by Tas & Okan, (2020) found that renewable energy consumption and trade openness exert positive effects on green economic growth. Research conducted by comparing developed and developing countries by Ali et al., (2021) found that fossil fuel consumption has a significant positive impact while renewable energy consumption has a significant negative impact on developed countries, but visa-versa on developing countries.

In addition to renewable energy, consumption of natural resources is one of the concerns of the increasing population level which is not matched by natural resources that will continue to meet human needs. on the other hand, based on the volatility of natural resources, economies that depend on income from natural resources can be exposed to pressure due to fluctuations in the prices of basic commodities in global markets. Any gain achieved in times of prosperity is offset by a decrease in natural resource prices, which results in a contraction of economic performance (Ibrahiem & Sameh, 2021). Research conducted by Zeeshan et al., (2021) in Latin countries found that FDI, energy consumption and natural resources have a significant positive impact on economic growth. This indicates that the government must be able to reform the energy sector by adapting environmentally friendly technologies to reduce environmental degradation from energy consumption that is not environmentally friendly and natural resources are dwindling. Research conducted by He et al., (2022) in China pointed out that economic growth and natural resources hinder environmental sustainability due to their positive effects on greenhouse gas emissions.

In model C, which represents emissions, it is found that CO2 emissions have a significant negative impact on economic growth. This significant result is in line with the research found by Aye & Edoja, (2017) and A. Anwar & Younis, (2020). This negative finding validates the notion that CO2 emissions can have an impact on decreasing economic performance due to environmental degradation caused by CO2 emissions. Furthermore, for GHG emissions, a significant positive position was found, this is in line with research conducted by Saqib, (2018); Hamit-haggar, (2012) and Lu, (2017). CO2 emissions are one of the dominant types of emissions used in environmental economics research. This is caused by potential sectors such as industry, manufacturing, transportation and other sectors that have an environmental impact that tend to dominantly emit the same emission potential, namely CO2 emissions. Research conducted by Bouznit & Pablo Romero, (2016) in Algeria found that there is a significant positive relationship between CO2 emissions and economic growth both in the short and long term. The research developed by Lim et al., (2014) found that there is a uni-directional causality of CO2 emissions on economic growth if the economy continues to grow without CO2

emission growth. The study conducted by Muftau et al., (2014) there is a significant relationship between economic growth and CO2 emissions using regression, this recommends that economic growth must be focused and supported by policies in maintaining environmental quality.

Research developed by Aye & Edoja, (2017) with a focus on developing countries found that by using panel causality methods there was a significant relationship between CO2 emissions, economic growth, energy consumption and financial development. This discovery encourages the need for a low-carbon technological transformation that aims to reduce emissions and lead to sustainable economic growth. Research using regional studies for the far east Asian countries was carried out by A. Anwar & Younis, (2020). This study found that urbanization, economic growth and trade openness significantly determine CO2 emissions. This provides a number of policy proposals, namely the need for green and sustainable urbanization, regulations that support the impove of industrial structure and increase the portion of renewable energy towards energy consumption.

In addition to CO2 emissions, other types of emissions that have a negative impact on the environment resulting from economic activities are greenhouse gas emissions. A number of studies on the environment have given a very threatening status to the environment for greenhouse gas emissions, including those proposed by the Intergovernmental Panel on Climate Change (IPCC). Research conducted by Saqib, (2018) found that there is a two-way causal relationship between economic growth and greenhouse gas emissions for the region as a whole at the Six Gulf Cooperation Council (GCC), which brings together Saudi Arabia, Kuwait, United Arab Emirates, Qatar, Bahrain and Oman. This study suggests the formation of policies that support sustainable economic growth in the GCC region. Research conducted by Hamit-haggar, (2012) on the Canadian industrial sectors found that in the short term there is a unidirectional Granger causality ranging from energy consumption to greenhouse gas emissions; from economic growth to greenhouse gas emissions. Furthermore, there is a weak unidirectional causality originating from greenhouse gas emissions for energy consumption; from economic growth to energy consumption. In the longer term, however, there appears to be a weak one-way causality flowing from the energy consumption and economic growth of greenhouse gas emissions. Research conducted by Lu, (2017) found that in the long run, a two-way Granger causality between energy consumption, GDP and greenhouse gas emissions and between GDP, greenhouse gas emissions and energy consumption was established.

In a number of economic analyzes of natural resources and the environment in high-income and lower-middle-income countries we can discern a number of differences in terms of economic growth, energy consumption, industrialization and population size. High-income countries have a growth tendency that is at an optimal point, this can be seen from the low economic growth of high-income countries, which is in the range of 0.9%-3%. This is caused by the optimal utilization of a number of resources (natural and human), or in some popular theories of economic growth the stage experienced by high-income countries is the stage of high mass consumption (WW Rostow). Industrialization with the application of technology that creates efficiency has been implemented. A number of other indicators in high-income countries such as controlled population growth rates, quality of education and adequacy of energy consumption (especially green energy consumption) have been carried out due to the advanced bureaucratic system and success in investing in human resources.

This will be in contrast to what happens in lower-middle income countries such as Southeast Asia. In low-middle income countries, there is no optimal economic growth so that economic growth can grow 5%-7% annually. This is due to the fact that there are still many sectors that are not yet optimal and have great potential to be developed. On the other hand, there are still dualistic problems (poor and rich, urban and rural), inequality

based on this dualism will cause socio-economic problems in a particular community. As is the case in the structure of society, the enrichment of the traditional sector of society will be evenly distributed in income distribution but not so large, compared to the enrichment of the modern sector which provides a high income distribution but also contributes to the increase in poverty and inequality due to dualistic mastery of the economic sector and mastery of technology Todaro & Smith, (2011). Other variables in lower-middle income countries are high inflation, energy consumption that is not environmentally friendly, a bureaucracy that cannot control dirty practices in natural resource management and the quality of education is still low.

Conclusion

Southeast Asia is a region with huge development potential with valuable natural resources facing regional threats as well as declining environmental quality but also prosperity. Early identification is needed to know what initial steps are needed to control energy consumption that is still considered dirty, the scope of the current clean energy transition in Southeast Asia and how emissions may be a determining factor for declining regional economic productivity. We face the productivity dilemma of economic growth that still uses dirty energy and makes minimal efforts to transition to clean energy. The debate on efforts to increase productivity by converting dirty energy into clean energy while preserving nature has been debated for a long time. The dilemma of encouraging the productivity of regional economic growth has been around for a long time. The Association of Southeast Asian Nations (ASEAN) has become an ever-useful organization for promoting regional growth that depends on good economic transformation. In this journey of high-quality economic transformation, the role of controlling energy consumption that is still considered dirty, promoting the transition to clean energy and controlling emissions is one of the goals of SDG 7 for clean and affordable energy. The Sustainable Development Goals represent a real urgency in the era of globalization.

This study is the first study to combine the Cobb-Douglas production function model with three models that focus on (1) energy consumption, (2) renewable energy and natural resources, and (3) emission. The novelty that results from this research is the discovery of the GDP response as a response to a number of topics in environmental economics in economic growth by estimating it in three different models. By dividing it into three different models, it can show the position of the GDP of a number of countries in the Southeast Asia region in terms of energy consumption, renewable energy consumption and emissions. This study found that in various models of interaction between variables using the Cobb-Douglas production function, they have different characteristics and responses. This difference can occur due to differences in the range of data used with different assumptions in each model set in the modeling.

The results of the Cobb-Douglas production function modeling state that the labor force has a significant positive impact on model A (energy consumption) and model B (renewable energy and natural resources). This indicates that energy consumption can run if the sector that uses it is running, where the running sector requires a labor force which is one of the important production factors. Furthermore, FDI was found to be insignificant in each model, this indicates that the need for foreign capital is still not able to help drive economic growth in Southeast Asia. Other alternatives are needed such as encouraging effective domestic investment, making regulations that support the absorption of FDI for the sake of economic growth and establishing a competitive and fair business competition climate. In model A, which represents energy consumption, it shows insignificant results between energy consumption and fossil fuel consumption on economic growth in Southeast Asia. However, partially energy consumption and fossil fuel consumption have positive coefficients, this shows that an increase in energy consumption and fossil fuel

consumption can increase economic growth. Furthermore, for fossil fuel consumption, which has a positive value, it means that an increase in fossil fuel consumption will increase economic growth.

In model B, which represents renewable energy and natural resources, it is found that renewable energy has a significant negative impact on economic growth. Furthermore, total natural resources consumption which has insignificant positive results occurs in the results of this study which indicates that the economic growth that occurred in Southeast Asia was not fully driven by the consumption of raw natural resources, this could happen with the possibility that Southeast Asian countries began to develop other potential sectors so that economic growth is more likely to occur in other sectors such as industry, banking, trade etc. In model C, which represents emissions, it is found that CO2 emissions have a significant negative impact on economic growth. This negative finding validates the notion that CO2 emissions can have an impact on decreasing economic performance due to environmental degradation caused by CO2 emissions. Furthermore, for GHG emissions, a significant positive position was found which means that an increase in GHG emissions will increase economic growth in the Southeast Asian region.

The recommendations that are expected to be input for policy makers are as follows.

1. The need to increase human capital by forming policy strategies both short and long term in the Southeast Asia region.
2. Strengthening of agencies/organizations under the government appointed to be supervisors of environmental pollution from the regional level to the national level in each country. In addition, as a joint commitment, it is necessary to strengthen the appointed agency/organization in organizing the importance of emission control and sustainable economic development in Southeast Asia.
3. Creating a climate for business and industry that is environmentally friendly by implementing a circular economy as part of the opening of a new strategic industrial area in Southeast Asia.
4. Raise public awareness at various levels and circles on the negative impact of forest fires, environmental pollution and CO2 emissions in Southeast Asia.
5. Encouraging strategic cooperation between universities and the government that focuses on developing an environmentally friendly circular economy . This can support the quality aspects of economic growth that can be created from the use of research and application of environmentally friendly appropriate technologies in Southeast Asia.

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