Analysis of Green Economic Growth and Environmental Degradation in Upper-Middle-Income ASEAN Countries

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Abstract: The objective of this research is to examine the connection between green economic growth and environmental degradation in upper-middle-income nations within the ASEAN region (specifically, Indonesia, Malaysia, and Thailand) throughout the years 2000 to 2020, using a simultaneous panel model. The key findings of this research can be categorized into two analytical models. First, cleaner energy has a positive effect on green economic growth, while technological innovation has a negative effect. The positive impact of trade openness and population on environmental degradation is evident. Green growth and environmental degradation do not affect each other in upper-middle ASEAN countries. A different finding in this research is that green growth and environmental degradation do not have any influence on each other in ASEAN upper middle-income countries. The problem is believed to stem from the policy direction and focus on technological innovation that has not been optimal for green economic development. The policy implication that can be implemented is increasing the use of renewable energy in developing a green economy.

1 INTRODUCTION

The increase in CO_2 emissions due to economic activities in ASEAN member countries has an impact on environmental degradation. Although there are abundant natural resources and strong economic performance. ASEAN countries face challenges in creating environmentally sustainable economic activities.

The rapid economic acceleration in ASEAN nations is driving up the usage of fossil fuels, resulting in elevated pollution levels and increased emissions of CO_2. Increasing energy consumption has increased environmental degradation (Afridi et al., 2019; Jian et al., 2019). Especially in ASEAN upper-middle income countries, which are currently spurring economic performance by increasing economic growth. The heightened CO_2 emissions render the ASEAN region increasingly susceptible to challenges posed by climate change (Sandu et al., 2019).

The ASEAN region was found to contribute 3.6% of global greenhouse gas emissions in 2013, partly because of its strong economic growth and population growth. (Chontanawat, 2018). The growth of the economy has accelerated deforestation, resulting in a swift exhaustion of natural resources. The 2017 edition of the fifth ASEAN Environmental Economics Report affirms that the rise in energy consumption is the primary driver behind the escalating CO_2 emissions, and it is projected to surge by 61% between 2014 and 2025. (ASCCR, 2021). According to a 2015 report from the Asian Development Bank, it is projected that greenhouse gas emissions from the energy sector in ASEAN economies will see a threefold increase by the year 2050 (ADB, 2015).

This phenomenon is of particular concern in ASEAN countries, especially upper-middle-income countries (Indonesia, Thailand, and Malaysia). The country is persistently striving to implement measures aimed at sustaining natural resources in an environmentally responsible way, with the aim of boosting economic growth and curbing environmental degradation. One of them is through an agreement in the formulation of Sustainable Development Goals (SDGs) (Alam et al., 2007; Janoušková et al., 2018; Rosati & Faria, 2019).

Previous literature studies have proven that there are many factors that influence the growth of green economics and environmental degradation. Analyzing the impact of energy consumption on sustainable growth in China from 1997 to 2016, the

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research revealed that green growth was primarily driven by natural gas consumption and other forms of energy use, while the utilization of coal and oil acted as impediments to green growth (Hongxian, 2018).

An examination of green growth in Turkey from 1980 to 2017, employing the ARDL methodology, indicated that sustainable growth in the long term is predominantly steered by cleaner energy sources and technological advancement. Conversely, long-term green growth is negatively affected by militarization (Sohag et al., 2019)

Other studies have been conducted to investigate the impact of economic expansion, energy utilization, and CO2 emissions in nations categorized as developed, developing, and those in the MENA region from 2001 to 2017. The finding is that in developed and developing countries, economic growth rises in tandem with heightened energy consumption, whereas in MENA countries, it experiences a decline (Muhammad, 2019).

An empirical study on the impact of energy consumption and economic growth on environmental deterioration in the Asian region between 1991 and 2013. The panel causality analysis using VECM confirms the existence of a bidirectional causal relationship between energy consumption, economic growth, and environmental deterioration. (Jamel, 2016).

The primary cause of environmental degradation is rapid industrialization due to the consumption of natural resources to fuel economic expansion. (Burki & Tahir, 2022). Environmental deterioration, particularly in developing nations undergoing swift industrialization, is driven by energy consumption (Afridi et al., 2019; Al-mulali & Binti Che Sab, 2012; Jian et al., 2019).

Environmental degradation is caused by many factors (Jan et al., 2021; Shah et al., 2021). Increased environmental degradation can also be caused by trade openness. The impact of international trade on environmental degradation is determined by the volume, quantity, and production technique employed. (Grossman & Krueger, 1991). A substantial increase in the production of goods and services resulted in a greater use of resources, resulting in increased pollution (Liobikienė & Butkus, 2019).

The influence of trade on heightened environmental deterioration is a result of its impact on the magnitude and composition (Halicioglu, 2009; Nasir et al., 2021; Nguyen et al., 2021). However, the effect of using production technology has a negative impact on environmental degradation (Tachie et al., 2020).

In Pakistan, environmental degradation is also affected positively and significantly by population, energy consumption, and industrialization. Meanwhile, economic growth contributes negatively to environmental degradation (Ur Rehman & Zeb, 2020). Other research has explored the causal link between carbon dioxide emissions, energy usage, the adoption of renewable energy, population expansion, and economic growth in five ASEAN nations (Indonesia, Myanmar, Malaysia, the Philippines, and Thailand) from 1971 to 2014. The unidirectional causal effect of economic growth on renewable energy consumption, CO2 emissions, and energy consumption in Indonesia is found (Vo, 2019)Click or tap here to enter text.

At the beginning, economic growth has a negative impact on the environment, but as time goes on, it leads to environmental improvement. (Rahman et al., 2020). The N-shaped Environmental Kuznets Curve (EKC) demonstrates that as growth progresses, it initially heightens environmental degradation, subsequently diminishes it, and then exhibits a renewed increase in degradation (Afridi et al., 2019; Ahmad et al., 2019; Allard et al., 2018). This study aims to contribute to new and comprehensive literature on the determinants of green growth and environmental degradation in the economies of ASEAN upper-middle-income countries. This study also discusses the possible consequences for future generations due to environmental degradation and policy measures to promote green growth and reduce environmental degradation in ASEAN upper-middle-income countries.

2 RESEARCH METHODOLOGY

The data used in this study consists of secondary data that has been published by specific organizations or authorities. The data employed in this analysis is panel data, encompassing a time series spanning 21 years from 2000 to 2020, and covering three ASEAN upper-middle-income nations, namely Indonesia, Thailand, and Malaysia. The study encompasses both internal and external variables. The variables that control the economy are green economic growth and environmental degradation. The variables that are outside of the system include technological innovation, clean energy, militarization, health spending, population, and trade openness.

Each of the endogenous variables utilized in this research also serves as an exogenous factor in other equations. The connection between these variables is illustrated in Figure 1, displayed below.

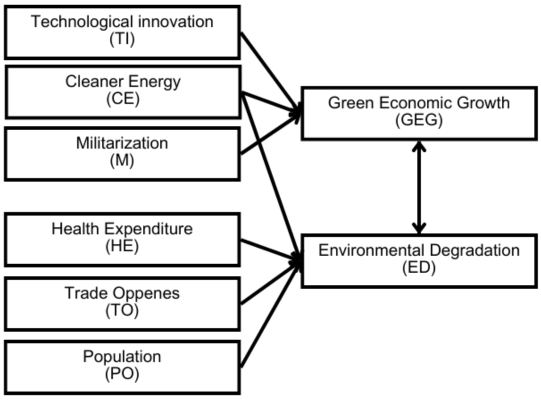

Figure 1: The conceptual framework of the research.

In accordance with the research's conceptual model presented in Figure 1, the study utilizes specific indicators to measure the variables being investigated.

Environmental Degradation (ED) ➔ CO2 emissions resulting from the use of petroleum-derived fuel as an energy source are expressed in kilotons.

Green Economic Growth (GEG) ➔ Renewable energy supply, percentage of total energy supply

Technological Innovation (TI) ➔ Development of environment-related technologies, percentage all technologies

Cleaner Energy (CE)➔Renewable energy's share in the overall final energy consumption is expressed as a percentage.

Militarization (M)➔ The capital spending allocated to the military is measured as a percentage of the Gross Domestic Product (GDP).

Health Expenditure (HE)➔The present healthcare expenditure is represented as a percentage of the Gross Domestic Product (GDP).

Population (PO)➔The total population is determined using the de facto population definition, which includes all residents, regardless of their legal status or citizenship.

Using the conceptual framework depicted in Figure 1, this research employs two analytical models, encompassing green economic growth and environmental degradation. The econometric equations for these models are presented as Equations (1) and (2) below:

$$GEG_{it} = \alpha_{1.0} + \beta_{1.1}\,Log(ED_{it}) + \beta_{1.2}TI_{it} + \beta_{1.3}CE_{it} + \beta_{1.4}M_{it} + \varepsilon_{1it} \quad (1)$$

$$Log(ED_{it}) = \alpha_{2.0} + \beta_{2.1}\,GEG_{it} + \beta_{2.2}CE_{it} + \beta_{2.3}HE_{it} + \beta_{2.4}Log(PO)it + \beta_{2.5}TO_{it} + \varepsilon_{2it} \quad (2)$$

In this context: α represents the parameter, i signifies the cross-sectional dimension, t denotes the time-series component, and ε signifies the error term.

This research employs a simultaneous panel model methodology to accomplish the established research goals. The description of the econometric phases within this model approach consists of: Selection of the appropriate model for the regression model estimation method using panel data can be done through three approaches, including:

First, the Common Effect Model (CEM) is the most straightforward panel data approach, as it simply merges time series and cross-sectional data. It neglects the temporal and geographical dimensions, assuming uniform data behavior within a country across different time periods.

The Fixed Effect Model (FEM) argues that differences in intercepts can be responsible for variations between countries.

Third, the Random Effects Model (REM) calculates panel data in which the disturbance variables can related associations across time and among different countries.

Furthermore, the panel analysis model that was most suitable was chosen from the three models. The model is selected through testing as follows:

First, the Chow test was performed to ascertain the suitability of using either the CEM or FEM model. The selection was carried out by comparing the p-values obtained from the cross-sectional chi-square test with a significance level of <unk> = 0.05.

In the second step, should the Chow test favor the FEM as the preferable model, the Hausman test will be conducted. This additional examination will determine whether FEM or REM is the more suitable choice. The decision will be based on comparing the p-value of the random cross-section test at a significance level of $\alpha = 0.05$

Next, in the event that the Hausman test favors REM as the preferred model, the Lagrange multiplier test will be performed. Additional analysis will determine whether REM or CEM is the more suitable model. The decision will be based on comparing the p-value of the cross-sectional test hypothesis for Breusch-Pagan at a significance level of $\alpha = 0.05$.

Simultaneous equation models are models that have more than one equation that are interrelated and have a causal relationship between endogenous and exogenous variables. Obtaining the numerical value for each parameter in each equation is unfeasible due to the indistinguishable nature of the equations or their strong resemblance to each other. Hence, it is essential to perform an identification test utilizing the order condition as depicted in Equation (3) below:

$$K - k \geq m - 1 \quad (3)$$

Where: M represents the quantity of endogenous variables within the model, while m represents the count of endogenous variables in the equation. K indicates the total number of predefined variables in the model, and k represents the number of variables predetermined in the equation.

If $K - k = m - 1$, this equation is identified. Simultaneous equation estimation using the indirect least squares (ILS) method

If $K - k > m - 1$, this equation is overidentified. Simultaneous equation estimation using the two-stage least square (2SLS) method.

If $K - k < m - 1$, this equation is not identified.

Equations that can be solved using a system of simultaneous equations are equations that result in identified and over-identified order conditions.

3 RESULTS AND DISCUSSION

3.1 Panel Analysis Results

Following the execution of the Chow and Hausman tests to ascertain the most suitable model for this study, the results show that the Fixed Effect Model was selected as the best panel model. The analytical findings have been presented in Tables 1 and 2.

Table 1: The results of the Chow test for the panel analysis model.

Equation	Prob. Cross-Section Chi-Square
GEG	0.0000
ED	0.0000

Table 2: The results of the Hausman test for the panel analysis model.

Equation	Prob. Cross-Section Random
GEG	0.0000
ED	0.0000

Table 1 shows that for all models, the probability values are low, having a chi-square value of 0.05. Consequently, the Fixed Effect Model (FEM) is appropriate the most model use choice across all analysis models. Next, the Hausman test was conducted to determine the appropriate model selection between the Fixed Effect Model (FEM) and Random Effect Model (REM). The data presented in Table 3 reveals that all models have probability values with a small chi-square value of 0.05. Therefore, the Fixed Effect Model (FEM) is the most suitable choice for all analytical models, and there is no need to proceed with the Lagrange Multiplier test.

3.2 Simultaneous Equation Analysis Results

The necessary prerequisite test for conducting simultaneous equation analysis involves performing an identification test based on the order conditions outlined in Equations (4) and (5) provided below.

Equation GEG ➔ $6 - 3 > 2 - 1$

$3 > 1$ (overidentified) (4)

Equation ED ➔ $6 - 4 > 2 - 1$

$2 > 1$ (overidentified) (5)

The identification test result indicates that all analytical models employed in this study are estimated using the two-stage least square (TSLS) approach due to the over-identification of all equations.

Drawing from the conclusive outcomes of both panel analysis and simultaneous equation analysis conducted in accordance with predefined steps, the result of the simultaneous panel model analysis for each analysis model is shown in Tables (3) and (4) provided below:

Table 3: Results of simultaneous panel estimation of the green economic growth model.

Variable	Coefficient	Prob.
C	-15.40643	0.6197
LOG(ED)	1.591296	0.4763
TI	-0.077794	0.0474
CE	0.643581	0.0000
M	1.024559	0.2584

Table (3) provides a summary of the outcomes from estimating the simultaneous panel model for the equation related to green growth.

This study revealed that environmental degradation did not exhibit an impact on green growth. Furthermore, the limited contribution of renewable energy sources in clean energy management, leading to environmental harm, does not influence green economic growth (Panayotou, 1993).

Technological innovation was found to have a negative and significant effect on green economic growth in ASEAN upper-middle-income countries ($\beta 1.4 = - 0.077794$, $P < 0,05$). This negative impact is most likely caused by the type of technology being developed that is not integrated with efforts to utilize environmentally sustainable resources. Sometimes, technological innovations can have undesirable side effects, such as air pollution or hazardous waste, which can harm the environment (Huesemann, 2011). Technological innovation often enables greater exploitation of natural resources. Overexploitation of these resources can damage ecosystems and create negative impacts on the green economy (Dernis, 2017).

The study revealed a noteworthy positive impact of clean energy on green economic growth (β1.4 = 0.643581, P < 0.001). Clean energy involves the utilization of renewable energy through efficient technology. The effective deployment of clean energy relies on a substantial contribution from renewable sources, ensuring that an expansion of clean energy leads to an enhancement of green economic growth. The increased adoption of clean energy serves as a key driver in fostering long-term green economic growth (Sohag et al., 2019).

The research revealed that militarization in upper middle-income countries in ASEAN did not have a significant effect on green economic growth. The reason for this was the cautious and limited utilization of natural resources for military purposes, which minimized their broader environmental repercussions and impact on green economic growth (Dincer, 2013).

Table 4: Results of simultaneous panel estimation of the environmental degradation model.

Variable	Coefficient	Prob.
C	-33.21688	0.0000
GEG	-0.016726	0.6304
CE	0.002958	0.8638
HE	0.072542	0.0523
TO	0.003174	0.0001
LOG(PO)	2.496564	0.0000

Table (4) provides an overview of the findings from the simultaneous panel model estimation related to the environmental degradation equation. The outcomes of this investigation confirm the hypothesis that trade openness contributes positively to environmental degradation (β2.5 = 0.003174, P < 0.001). The findings reveal that the upper-middle-income countries in ASEAN are strongly inclined towards trade openness, resulting in an increase in environmental degradation. Greater trade openness is associated with a heightened level of global environmental deterioration (Le et al., 2016; Yu et al., 2019).

The study uncovered a positive correlation between population and environmental degradation in upper-middle-income ASEAN countries (β2.6 = 2.496564, P < 0.001). Environmental degradation increases with population growth due to an inverse relationship between population and the environment. The combination of rapid population growth and sustainable economic development is likely to create significant environmental challenges. Consequently, countries should establish measurable economic development strategies to manage and mitigate the environmental impacts stemming from economic activities (Ur Rehman & Zeb, 2020).

Green economic growth does not contribute to reducing environmental deterioration, as it exhibits a detrimental pattern in upper-middle-income ASEAN countries. The considerable expenses associated with environmental harm pose a substantial challenge to fostering environmentally sustainable economic development (Kang et al., 2019). The limited extent of green economic growth suggests that the utilization of natural resources hasn't adequately considered the environmental consequences when advancing sustainable economic development.

The empirical findings indicate that despite the expectation that cleaner energy would promote environmental sustainability, this is not the situation in upper-middle-income ASEAN countries. There is a need for enhancements in the management of eco-friendly energy to genuinely foster environmental quality (Pata et al., 2023)

Health expenditure was found to have a positive but statistically insignificant relationship with environmental improvement in upper-middle-income ASEAN nations. To effectively address carbon emission reduction and promote a healthier environment, a reevaluation of the health expenditure sub-policy program is warranted (Ganda, 2021).

4 CONCLUSIONS

According to the analysis performed, this research suggests that promoting green economic growth can be accomplished by boosting the adoption of cleaner energy sources and curbing environmental degradation through the regulation of both trade and population.

The innovation of technology will contribute to the promotion of environmentally sustainable economic growth. The direction of developing innovative technology can balance the benefits of exploitation and prevention of environmental damage if institutional and financial commitments are supported. Health expenditure needs to be increased in overcoming environmental degradation. Although it does not have a significant impact, it is effective in reducing environmental degradation.

The government should consider policy measures to maintain environmental quality and foster sustainable economic growth by implementing a clean development mechanism that focuses on advancing renewable energy.

The growth of renewable energy not only helps in reducing CO2 emissions but also offers multiple benefits. These advantages encompass lowering investment expenses for nations in the upper middle-income bracket, such as those in the ASEAN region, facilitating technology transfer, and gaining access to sustainable technologies. Renewable energy has prospects for development in ASEAN upper middle-income countries, due to the availability of sufficient natural resources. The government is expected to be able to encourage the clean energy development mechanism with various policies such as subsidies, in order for renewable energy to become cost-effective and competitive with the development of fossil fuels.

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