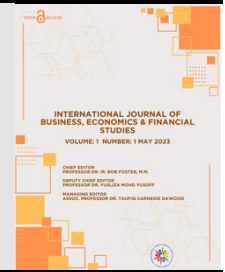


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Original Article

Sustainable Development in ASEAN-5: Renewable Energy, Natural Resources Rent and Economic Globalization

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Abstract

Sustainable development has emerged as a critical global concern, particularly in the context of energy consumption and environmental quality. In Southeast Asia, the heavy reliance on fossil fuels, especially oil, poses significant challenges to achieving sustainability goals. This study investigates the impact of renewable energy consumption, natural resource rents, and economic globalization on the Sustainable Development Index (SDI). Using panel data from five ASEAN countries—Indonesia, Malaysia, Thailand, Singapore, and the Philippines—from 2000 to 2020, the analysis applies panel quantile regression to explore the relationships among the variables. The findings reveal that renewable energy consumption and economic globalization contribute positively to the Sustainable Development Index, whereas natural resource rents exhibit a negative impact. A distinctive aspect of this research is its use of the Sustainable Development Index as a metric, offering a novel approach not extensively employed in prior studies. The insights derived from this study can inform the development of policies promoting sustainable development, particularly through adopting renewable energy and managing economic globalization. Additionally, the findings underscore the need to address the adverse effects of natural resource exploitation to enhance regional sustainability outcomes.



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1. Introduction

Sustainable development has become a major focus worldwide, especially regarding energy consumption and environmental quality (Dincer & Rosen, 1998; Omer, 2008). Many institutions encourage countries to adopt environmentally friendly policies such as low-carbon use and effective energy (Chien *et al.*, 2023). In 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development, which includes a specific goal on energy in the seventh goal or Sustainable Development Goals 7 (SDGs-7). The call of SDGs-7 is to ensure access to affordable, reliable, sustainable, and modern energy for all. Energy is at the heart of the 2030 agenda for sustainable development and the Paris Agreement on climate change. The success of a country in achieving sustainable development goals is measured

by the value of the sustainable development index (Sachs *et al.*, 2023).

The sustainable development index in ASEAN-5, as shown in Figure 1, has an increasing trend. However, several countries experienced a decrease in the sustainable development index score in 2020 compared to 2019, namely Thailand (from 73.82 to 73.78) and the Philippines (from 67.21 to 66.41). In 2020, Thailand had the highest development index score in ASEAN-5 at 73.78, while the Philippines had the lowest. The ASEAN Secretariat of Indonesia stated that the Southeast Asia region has a large energy demand. Indeed, it is estimated that energy consumption in Southeast Asia will continue to increase in the coming years. If it is not anticipated by utilizing clean and renewable energy, it is feared that there will be a spike in greenhouse gas emissions in the

Southeast Asia region. According to the report ASEAN Centre for Energy (ACE), The ASEAN region historically still relies on fossil fuels to meet its energy needs, and the proportion of oil to total energy consumption was 43.8 percent in 2020.

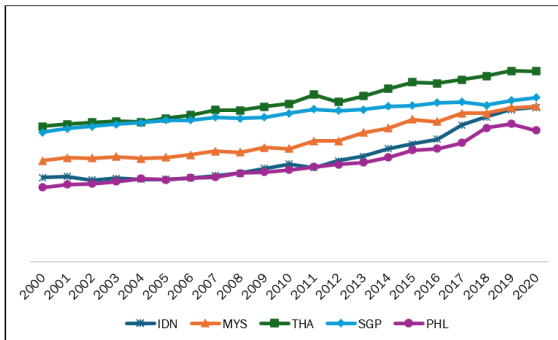


Figure 1. The trend of the sustainable development index in ASEAN-5, the year 2000-2020
Source: Sustainable Development Report (2023)

The ASEAN region has made efforts to encourage greater economic integration, the use of renewable energy, and social development through cleaner fuels. According to the International Renewable Energy Agency, ASEAN countries have beneficial climate conditions for renewable energy sources such as wind and solar (Mohsenzadeh et al., 2021). However, suppose this potential is not supported by adequate infrastructure. In that case, it will become an obstacle to achieving sustainable development goals, especially in the face of rapidly increasing economic development and urbanization.

This study aims to see how much renewable energy consumption influences the sustainable development index in the ASEAN 5 region. Apart from focusing on renewable energy consumption, this study also examines the role of natural resource rents and globalization in sustainable development. Natural resource rents are often associated with dependence on fossil energy. Countries rich in oil or natural gas often depend on the export of these resources. This has a negative impact on sustainable development and economic stability (Larsen, 2004).

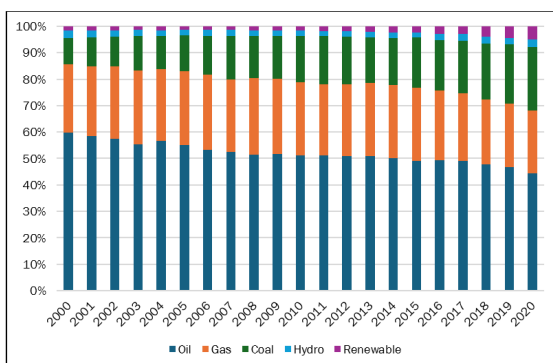


Figure 2. Energy consumption in ASEAN-5, year 2000-2020
Source: Statistical Review of World Energy Data, (2023)

Furthermore, economic globalization plays an important role in sustainable development. However, there are some differences in the relationship results from previous studies, such as Li et al. (2023) found a positive relationship between globalization and carbon emissions. Globalization will increase production and consumption, leading to an increase in carbon emissions, thus holding back the achievement of sustainable development. Meanwhile, research by Yang et al. (2021) found that economic globalization significantly reduces long-run carbon emissions, and there is a unidirectional relationship between the two, which promotes increased sustainable development.

2. Literature Review

Renewable energy is very important in sustainable development because renewable energy can help reduce greenhouse gas emissions, environmental pollution, and dependence on non-renewable fossil fuels. In the long term, using renewable energy can help reduce energy costs, increase energy security, and create new jobs in the renewable energy sector (Saint Akadiri et al., 2019). Studies on the relationship between renewable energy consumption and sustainability continue to grow. Bishoge et al. (2020) argued that renewable energy consumption is critical in achieving sustainable development goals and emphasized increased investment in renewable energy.

In his research, Bekun et al. (2019) highlighted the potential of renewable energy consumption for sustainable development as it can reduce carbon emissions. Then, research from Zaki et al. (2023) shows a negative relationship between renewable energy consumption and carbon emissions in several APEC countries. This shows that renewable energy consumption can reduce carbon emissions and increase sustainable development. Research conducted by Guo et al. (2023) and Tranchant et al. (2019) also concluded that renewable energy consumption positively impacts long-term economic growth. These findings have important implications for sustainable energy policies that contribute to sustainable development in these countries. Then, research by Saint Akadiri et al. (2019) and Güney (2021) also found that energy consumption impacts increasing sustainable development.

Natural resources have an equally important impact on environmental sustainability. Sachs & Warner (2001) suggest that natural resources are often negatively related to economic growth. Bekun et al. (2019) suggest that excessive use of natural resources can lead to environmental degradation, including increased carbon dioxide emissions and a larger ecological footprint. Over-reliance on natural resource revenues can also impact environmental sustainability as it can discourage investment in renewable energy and environmentally friendly technologies. The results of research conducted by Destek et al. (2023). Regarding the impact of natural resource rents on sustainable development, there is

evidence that long-term and short-term natural resource rents hinder sustainable development. Meanwhile, the research results by Guo *et al.* (2023) found that natural resource rents do not significantly affect sustainable development.

The impact of globalization on sustainable development is still a topic of debate. Economic globalization makes activities related to trade and production increase rapidly, but at the same time, this increases energy use, causing pollution and environmental damage (Erdoğan *et al.*, 2020). The results of a study conducted by Güney (2017) found that sustainable development declines as trade openness increases. Kwabena Twerefou *et al.* (2017) also found the same things. Globalization has a negative impact on the quality and sustainability of the environment, and the negative impact is greater than the positive impact of income on the quality and sustainability of the environment. Meanwhile, Awan *et al.* (2020) research shows a negative relationship between globalization and carbon emissions in the Middle East and North Africa. The same thing was also found by Adebayo *et al.* (2021). Meanwhile, a study conducted by Atici (2009) found that trade openness was insignificant regarding carbon emissions, which shows that globalization does not contribute to sustainable development.

3. Materials and Methods

This study uses panel data from ASEAN-5 countries, namely Indonesia, Malaysia, Thailand, Singapore, and the Philippines, for the period 2000-2020 to examine the effect of renewable energy, natural resources rent, and economic globalization on sustainable development.

Table 1. Data description and source

Variables	Description	Source
SDI	Sustainable development index	SDG/Sustainable Development Report
RENC	Renewable energy consumption (TJ)	Statistical review of world energy data
NRR	Natural resources rent (percentage of GDP)	World development indicators
EGI	Economic globalization index	kof globalization index ¹

Note: an institution from Switzerland that measures the globalization index

The study model used in this study is written in the following equation:

$$SDI_{it} = \alpha + \beta_1 RENC_{it} + \beta_2 NRR_{it} + \beta_3 EGI_{it} + \varepsilon_{it} \quad (1)$$

To simplify data interpretation, the variables are converted into natural logarithm form (except the natural resources rent variable) so that the equation becomes:

$$LSDI_{it} = \alpha + \beta_1 LRENC_{it} + \beta_2 LNRR_{it} + \beta_3 LEGI_{it} + \varepsilon_{it} \quad (2)$$

In equation (2), *i* and *t* denote the number of countries and time, α is the intercept, β is the regression coefficient, and ε is the error term. This study used quantile regression as the statistical method. Quantile regression is a statistical approach to estimate the conditional quantiles of many dependent variables simultaneously. This method is useful when there is interest in examining the relationship between multiple dependent variables and a set of independent variables at different distribution quantiles. In the ASEAN countries dataset, we use simultaneous quantile regression to analyze the impact of renewable energy consumption (LRENC), natural resources rent (NRR), and economic globalization index (LEGI) on the sustainable development index (LSDI) at different quantiles. Specifically, we estimate conditional quantiles of the sustainable development index using (Khan *et al.*, 2023):

$$Q_{y_{i,t}|x_{i,t}(\tau)} = \alpha_{\tau} + x'_{i,t}\beta_{\tau} + \varepsilon_{i,t,\tau} \quad (2)$$

Where $y_{i,t}$ represents LSDI, $x_{i,t}$ represents a vector of independent variables including LRENC, NRR, LEGI, and τ represents the conditional quantile of interest. α_{τ} and β_{τ} are the intercept parameters and quantile-specific coefficients, respectively, and $\varepsilon_{i,t,\tau}$ is the error term.

4. Results and Discussion

Table 2 shows the descriptive statistics of the variables used in the study for the ASEAN-5 countries (Indonesia, Malaysia, Thailand, Singapore, and the Philippines) from 2000-2020. On average, the sustainable development index value in ASEAN 5 was 65.80, with the maximum value recorded in Thailand at 73.82 and the minimum value recorded in the Philippines at 59.27.

Table 2. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
SDI	65.800	3.826	59.270	73.825
RENC	82938.8	99624.95	2815.52	569305.30
NRR	3.983	4.079	0.000	13.884
EGI	68.919	14.515	47.334	94.922

Table 3 reports the results of the quantile regression analysis for the proposed variables: LRENC, NRR, and LEGI. The coefficient for each variable is shown in the table at various quantiles (0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, and 0.90), along with the standard error values. This study shows that LRENC significantly and positively affects the sustainable development index at the 40th to 90th quantiles, with the 50th quantile showing the largest positive impact (coefficient = 0.0437**, SE = 0.0105). The coefficient indicates that a one percent increase in renewable energy consumption will increase the sustainable development index by 0.0437 percent. This is in line with the findings of Guo *et al.* (2023), namely that a percentage change in renewable energy will lead to an increase in the

sustainable development index by 0.402 percent for the augmented mean group estimator (AMG) and by 0.133 percent for the common-correlated effect mean group estimator (CCEMG) model. These results are also in line

with research conducted by Bekun *et al.* (2019), Zaki *et al.* (2023), Saint Akadiri *et al.* (2019), and Güney (2021) who show that renewable energy can improve sustainable development.

Table 3. Result of Quantile Regression Coefficients

Quantiles	Variables								Pseudo R ²
	LRENC		NRR		LEGI		Cons		
	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error	
0.1	-0.0064	0.0205	-0.0013	0.0022	0.1935	0.1506	3.3799**	0.8563	0.2204
0.2	-0.0011	0.0209	-0.0023	0.0019	0.181	0.1301	3.3986**	0.7672	0.2522
0.3	0.0284	0.0182	-0.0012	0.0016	0.3003**	0.0979	2.6101**	0.6018	0.294
0.4	0.0420**	0.0129	-0.0005	0.0012	0.3563**	0.0696	2.2363**	0.4273	0.3527
0.5	0.0437**	0.0105	-0.0007	0.0012	0.3560**	0.0602	2.2245**	0.3626	0.3446
0.6	0.0367**	0.0093	-0.0026	0.0016	0.2596**	0.0706	2.7297**	0.4005	0.3223
0.7	0.0344**	0.0087	-0.0033**	0.0016	0.2061**	0.0734	2.9946**	0.4065	0.3206
0.8	0.0276**	0.0046	-0.0050**	0.0012	0.1314**	0.0496	3.4019**	0.2544	0.3418
0.9	0.0229**	0.0034	-0.0063**	0.001	0.0943**	0.0402	3.6221**	0.1996	0.4311

Note: ** is significant at the level 5 percent

Güney (2021) argues that while non-renewable energy consumption undermines sustainable development, renewable energy consumption enhances it. According to the Granger causality estimation results obtained in his research, renewable energy drives short- and long-term sustainable development. Bekun *et al.* (2019), in their study of 16 EU countries, found that long-term and short-term renewable energy consumption has a statistically inverse relationship with carbon emissions. The results are interesting for energy and environmental economists because a 1 percent increase in renewable energy consumption leads to a 0.18 percent decrease in the long term and a 0.13 percent decrease in short-term environmental pollution. This negative relationship between renewable energy consumption and carbon emissions provides the impetus for increased sustainable development.

Afonso *et al.* (2019) argue that low-income countries generally use fossil fuels as their main energy source, while high-income countries have switched to clean energy to realize sustainable development. Saint Akadiri *et al.* (2019) provide examples of European Union countries that tend to reduce their dependence on fossil fuel imports, thus making their energy production and consumption more sustainable for the economy and the environment.

The results of this study suggest that the ASEAN 5 region should further intensify renewable energy consumption, such as solar energy and hydropower, to generate significant impacts from renewable energy sources and promote the achievement of the SDGs, especially through good health and well-being (SDGs 3), affordable and clean energy (SDGs 7), and increased responsible production and consumption (SDGs 12).

Furthermore, Table 3 shows that natural resource rents negatively and statistically significantly affect the sustainable development index at the 70th to 90th quantiles. The 90th quantile shows the largest negative

impact (coefficient = -0.0063**, SE = 0.0010). The coefficient implies that a one percent increase in natural resource rents will decrease the sustainable development index by 0.0063 percent. This is in line with the findings by Destek *et al.* (2023), Sachs & Warner (2001) and Bekun *et al.* (2019). Larsen (2004) argues that natural resource rents can potentially increase exploitation, hindering sustainable development. Meanwhile, in the 10th to the 80th quantile, natural resources rent is not statistically significant, which is in line with the research of Guo *et al.* (2023) in Sub-Saharan Africa.

ASEAN countries generally have large natural resources, so natural resource rents can encourage over-exploitation of natural resources without considering long-term impacts, hindering sustainable development. Unsustainable resource extraction can lead to deforestation, land degradation, water pollution, and other ecosystem damage. Larsen (2004) argues that natural resource rents can also increase the risk of corruption and lack of transparency in resource management.

Then, the quantile regression results in Table 3 show that economic globalization positively and significantly affects the sustainable development index in the 30th to 90th quantiles. The 40th quantile shows the largest positive impact (coefficient = 0.3563**, SE = 0.0696), indicating that a one percent increase in the economic globalization index will increase the sustainable development index by 0.3563 percent. This is in line with the findings by Yang *et al.* (2021), Awan *et al.* (2020), and Adebayo *et al.* (2021). Sustainable economic globalization encourages the globalization of renewable energy to promote sustainable development (Hao *et al.*, 2022). Different countries can quickly access and adopt green technologies and knowledge through economic globalization. Efficient technology transfer can increase

productivity and provide innovative solutions to sustainable development challenges.

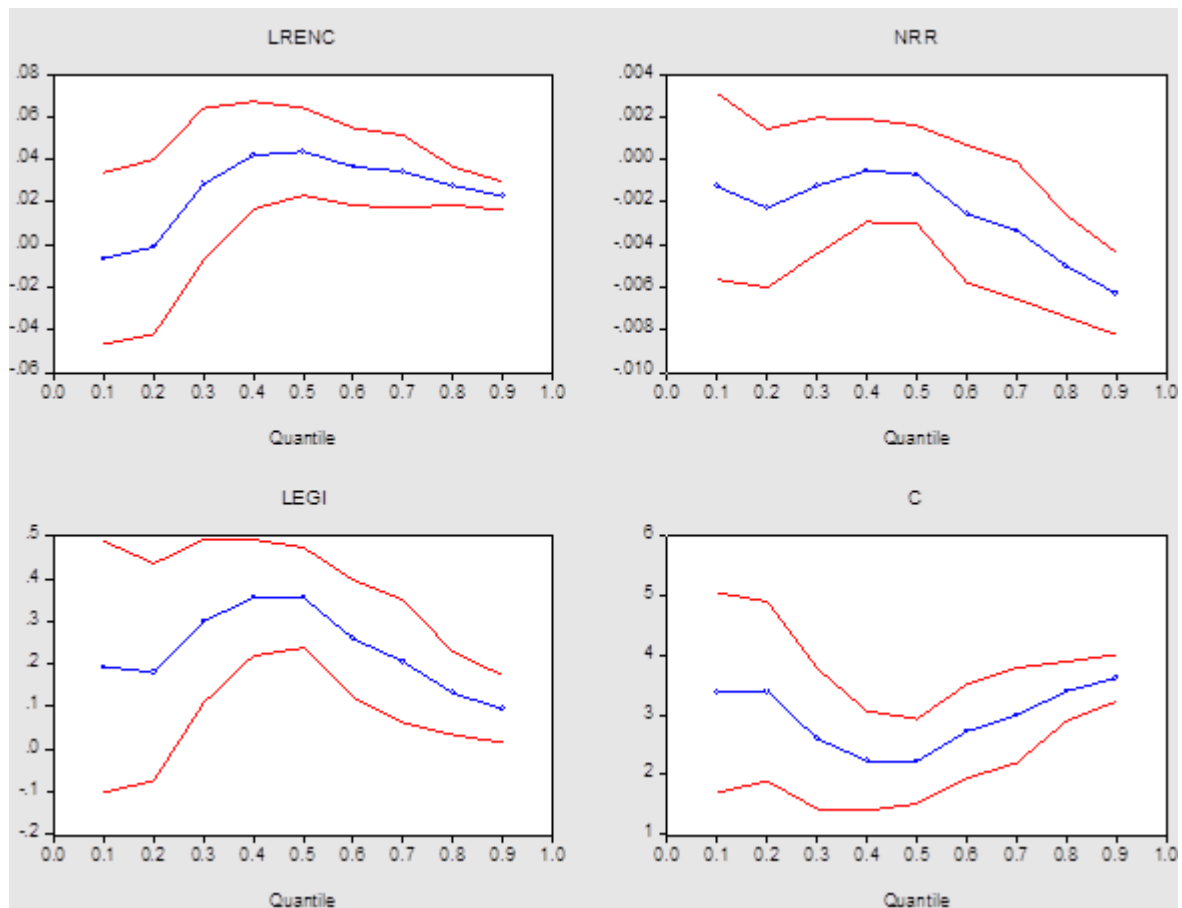


Figure 3. Quantile Regression

Awan *et al.* (2020) argued that environmental problems can be addressed by opening up the economy to trade and developing relationships with trading partners. This proves the EKC (Environmental Kuznets Curve) hypothesis: when countries' economic levels reach a certain threshold, environmental quality will improve as per capita income increases. Countries with low levels of economic globalization should actively formulate environmental policies to attract foreign investment and trade exchanges.

The pseudo-R-squared values, which range from 22.04 percent at the 10th to 43.11 percent at the 90th quantile, indicate that the independent variables in this study account for a considerable percentage of the variation in the sustainable development index at different quantiles.

5. Conclusions

This study examined the influence of renewable energy consumption, natural resource rents, and economic globalization on sustainable development in ASEAN-5 countries—Indonesia, Malaysia, Thailand, Singapore, and the Philippines—from 2000 to 2020 using quantile regression analysis. The findings indicate

that renewable energy consumption significantly and positively impacts sustainable development, aligning with the results of previous studies. To leverage this potential, ASEAN countries should implement policies to increase renewable energy adoption. Key strategies include expanding investments in renewable energy infrastructure, such as solar panels, wind turbines, and biomass power plants, and streamlining regulatory frameworks to facilitate project implementation by reducing bureaucratic barriers.

Engaging local communities in renewable energy projects and allocating resources for research and development to enhance the efficiency and cost-effectiveness of renewable technologies are also crucial. The study also reveals that natural resource rents significantly negatively impact sustainable development. To mitigate this, governments should enforce strict regulations to curb overexploitation, promote sustainable resource management, and invest in human capital to enhance expertise in resource-efficient industries.

Strengthening monitoring and law enforcement mechanisms is essential to prevent illegal activities and ensure compliance with sustainability guidelines. Additionally, increased investment in research and

development can support technological advancements for efficient resource utilization. Economic globalization was found to have a positive and significant effect on sustainable development. Encouraging environmentally friendly production practices, promoting sustainable industries, and fostering international collaboration are critical to maximizing these benefits. Joint efforts among nations to address transnational resource challenges and advance renewable energy technology can further enhance sustainable development outcomes in the ASEAN region.

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