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Determinants of Green Investment and Renewable Energy Production in Six Asean Countries

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ABSTRACT

Green investment and renewable energy production in ASEAN-6 countries (Indonesia, Malaysia, Thailand, Vietnam, Singapore, and the Philippines) play a crucial role in driving sustainable development and meeting climate commitments under the Paris Agreement. However, the relationship between these two variables and their determinants remains complex and underexplored in the Southeast Asian context. This study analyzes the determinants affecting green investment and renewable energy production in Indonesia, Thailand, Malaysia, Vietnam, Singapore, and the Philippines. The research employs panel data analysis with a simultaneous equation model to examine the relationships between variables such as information and communication technology (ICT), financial development, energy prices, non-renewable energy, and technological innovation. The findings reveal that ICT and financial development have a significant positive impact on green investment. Furthermore, energy prices and technological innovation also play essential roles in increasing renewable energy production capacity. This study provides insights into the importance of policies supporting clean energy transition and investments in the renewable energy sector.

INTRODUCTION

Energy is a vital element for economic activity and growth, but environmental challenges resulting from fossil fuel consumption (oil, coal, and gas) have triggered an urgent search for alternative energy sources. Damaging environmental impacts, such as global warming and climate change, are increasingly alarming as numerous species of animals and plants, as well as vital resources including farmland and water, face extinction threats. According to the International Energy Agency (IEA, 2024), global energy-related CO_2 emissions reached a record high of 37.4 gigatons in 2023, with the Asia-Pacific region contributing approximately 50% of these emissions. The increasingly costly dependence on fossil fuels adds to the economic burden, particularly for energy-importing countries such as many in the ASEAN region.

In addition, this growing dependence on fossil fuels exacerbates the economic burden, especially for energy-importing countries. Global measures have been taken to address these challenges, such as the Kyoto Protocol (1997) and the Paris Agreement (2015), which mark the world's commitment to reducing greenhouse gas emissions and protecting the environment. In this context, although energy use substantially supports economic growth, it often generates adverse environmental impacts. Therefore, governments are encouraged to pursue green development, which is not only ecologically beneficial but also economically advantageous in the long run, as explained by Song et al. (2019).

Moreover, renewable energies such as solar, wind, and biomass are viewed as key solutions to reducing dependence on depleting fossil fuels that contribute to global warming (R. Liu et al., 2021). This perspective emphasizes that the development of renewable energy technologies aims not only to reduce carbon emissions but also to improve energy efficiency and provide more affordable energy to all segments of society. It also highlights the synergy between government policies, technological innovations, and financial support needed to accelerate renewable energy adoption worldwide (Yan et al., 2020). In Indonesia, green investment has shown relatively rapid growth with a steady upward trend over the last two decades. This indicates a major opportunity to strengthen the energy transition, particularly in the renewable energy–based power generation sector, and reflects increasing investor interest in Indonesia's abundant energy resources, such as solar, hydro, and geothermal.

Green investment in ASEAN-6 countries is a crucial topic in sustainable development. Increasing the share of green investment (IG) is not only related to medium-term climate targets, but also serves as a vital strategy to strengthen energy security, reduce air pollution, and create new sources of economic growth (Eyraud et al., 2013). Green investment has contributed significantly to the development of power plants and the provision of renewable energy. This study selects six ASEAN countries (Indonesia, Singapore, Thailand, the Philippines, Vietnam, and Malaysia) because of their substantial economic contribution and renewable energy capacity, which together account for more than 70% of the region's renewable energy capacity.

Increased green investment contributes to more environmentally friendly energy diversification, strengthens energy security, creates green jobs, and reduces carbon emissions. This research shows that green investment is a key driver of the energy transition and the achievement of global climate targets. However, the relationship between green investment and renewable energy production remains debated, as empirical findings are not yet fully consistent (Sun et al., 2022b). Renewable energy production theory emphasizes the importance of production efficiency and technological innovation to increase green energy capacity (Johnson et al., 2020).

Most of the highest renewable energy production is currently found in Indonesia, but Vietnam is showing faster acceleration in its energy transition (Sun & Razzaq, 2022). This study confirms that the greater the green investment, the higher the renewable energy production capacity, which serves as an indicator of the success of sustainable development strategies (Vural, 2021).

In addition, Xin Xin Zhao (2022) reveals that energy insecurity increases green innovation. Digital transformation also plays an important role in green investment, as highlighted by Hao-Chang Yang (2022), who shows that the digitalization of China's economy improves the efficiency of green investments. Wei Bu and Zhongyi Yan (2025) emphasize that information and communication technology (ICT) has a positive relationship with renewable energy investment in high-pollution countries.

This study includes the financial development variable because of its vital role in supporting green investment. A well-developed financial system enables efficient allocation of funds, encourages green technology innovation (Fan et al., 2025), and provides investment instruments that reduce risk and improve access to capital. This role is critical in accelerating the clean energy transition, lowering carbon emissions, and strengthening environmental resilience in ASEAN-6. However, its effectiveness still depends on the readiness of each country's financial system.

Some of the factors that affect renewable energy production in ASEAN-6 countries include investment potential, renewable energy prices, non-renewable energy, and technological innovation. Elum and Momodu (2017) find that non-renewable energies such as petroleum, coal, and natural gas compete with renewable energy, and that declining fossil fuel prices can reduce incentives to switch to renewable energy. Rising fossil energy prices make renewable energy more competitive, encouraging green investment and environmentally friendly energy production, while declining fossil energy prices can slow the energy transition unless supported by government subsidies or incentive policies (Eyraud et al., 2013).

Technological innovation plays an important role in the clean energy transition, with ASEAN-6 countries showing variation in the adoption of renewable energy technologies. Indonesia and the Philippines stand out with investments in hydro- and geothermal-based energy, while Singapore is more focused on efficiency and advanced technology despite land constraints. Malaysia, Thailand, and Vietnam exhibit stable growth driven by energy diversification (Alam & Murad, 2020).

Previous research conducted by Rongjia Chen and Muhammad Tariq Majid (2023) addresses the challenge of how green investment responds to ICT and financial development. Their study analyzes aggregate data from the most highly polluting countries using 2SLS, GMM, and instrumental-variable quantile regression estimators. In addition, they conduct regional analysis by grouping data into four regions: Asia, America, Africa, and Europe, and the results show that ICT significantly influences green investment. Updating and extending this line of inquiry, the present study focuses on ASEAN countries and employs two endogenous variables analyzed using a panel data approach.

Based on the phenomena described above, the author's observation indicates that there has been no prior research that examines the relationship between the two development concepts in greater depth and explores the factors that influence them in the ASEAN-6 context. Therefore, the author is interested in conducting more comprehensive research than previous studies and in filling this research gap through a study titled "Determinants of Green Investment and Renewable Energy Production in Six ASEAN Countries".

The contributions of this research are both theoretical and practical. Theoretically, it advances understanding of the complex, bidirectional relationship between green investment and renewable energy production, contributing to the literature on energy economics and sustainable finance. It tests and extends theoretical frameworks including Green Investment Theory, Renewable Energy Transition Theory, and the Energy Price-Induced Innovation Model in the ASEAN context. Practically, the research provides: (1) evidence-based policy recommendations for ASEAN governments on promoting green investment and renewable energy; (2) insights for investors on the key drivers of clean energy markets in the region; (3) guidance for international development partners on priority areas for technical and financial assistance; (4) benchmarks for monitoring progress toward renewable energy targets; (5) input for regional cooperation frameworks such as the ASEAN Power Grid and Trans-ASEAN Gas Pipeline projects; and (6) foundational data for future research on energy transition in Southeast Asia. Ultimately, this research aims to support the achievement of Sustainable Development Goals (SDGs)—particularly SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action)—in one of the world's most dynamic and vulnerable regions.

RESEARCH METHODS

Variables in the Simultaneous Equation Model

The mention of independent variables (explanators) and dependent variables is no longer appropriate when used in simultaneous equation models, because dependent variables can also be independent variables. According to (Gujarati, 2012), in the context of the simultaneous equation model, there are 2 types of variables, namely:

1) Varibel Endogenous

Variables whose values have been specified in the model, because
This value is obtained by including the value of other variables in the model as a result of the relationship between variables. And endogenous variables are considered stochastic. The number of endogenous variables is equal to the number of equations in model.

2) Varibel Predetermine

Variables whose values have been determined outside the model. Variable
Predetermine is considered nonstochastic. In the predetermine variable, there are two types of categories, namely exogenous variables, both current and past exogenous (*lagged exogeneous*), and endogenous variables in the past (*lagged endogeneous*)

Simultaneous Equations

In this study, the author uses simultaneous equations, where the *simultaneous equation regression model* is a regression model that has more than one equation and there is a feedback relationship between variables. The simultaneous equation model of the title "Determinants of green investment and fossil energy production in six ASEAN countries" is as follows:

$Y1it = \alpha 0 + \alpha 1\ Y2it + \alpha 2X1it + \alpha 3X2it + \alpha 4X3it + \mu 1it$ ....1)

$Y2it = \beta 0 + \beta_{1Y1it} + \beta 2X3it + \beta_{3X4it} + \beta 4X5it + \mu 2t$ ....2)

Description :

b = Kostanta
Y1 = Green Investment
Y2 = Renewable Energy Production
X1 = Information and Communication Technology
X2 = Financial Development
X3 = Interest Rate
X4 = Energy Price
X5 = Non-Renewable Energy
X6 = Technological Innovation
ε = *Error Term*
t = Time

Steps Steps to Simultaneous Equations

a. **Identification Test**

There are three identification problems in simultaneous equations according to (Gujarati, 2006) where from each of these identification problems we can find out what is the right method to solve a system of simultaneous equations that we encounter, including:

a) *Underidentified*

In this case we cannot interpret the parameters where we cannot solve the existing system of simultaneous equations, because we lack information concerning the *predetermined variable.*

b) *Exactly identified*

In this case we can interpret the parameters of the equation uniquely. In the analysis, we can use the *Indirect Least square* (ILS) method to estimate the parameters.

c) *Overidentified*

In this case, sometimes more than one numeric value can occur for a single parameter. Where the existing system of simultaneous equations is actually an excess of information related to *predetermined variables*. In this case, we can use the *Two Stage Least Square* (2SLS) method to estimate the parameters.

There are two methods that can be used, namely *order condition* and *rank condition*. These two methods will produce the same final conclusion, therefore the *order condition identification method* is easier to use and understand, so in this study the order condition identification method is used.

So, in the identification test obtained *overdentified* for this study, the equation used is a simultaneous equation with the 2SLS method.

b. **Model Reduced form**

For the next time, we will do the process of *reducing the form* of each variable. After conducting an identification test with *an order condition*, each of the above equations. The *reduce form process* is carried out to find out the exogenous variables (*predetermine*) in the simultaneous equation system.

From the results *reduce from* It can be seen that the exogenous variables in this equation are Information and Communication Technology, financial development, investment potential, energy prices, investment potential, green investment, energy prices, non-renewable energy, technological innovation.

Pengujian Hypothesis

1) Test F

The F-test is used to show whether all the exogenous variables included in the model have a cohesive influence on their endogenous variables (Ghozali, 2011) The test uses a significance level of 5%, with the following hypothesis conditions:

- If the simultaneous value > 0.05 then Ho is unacceptable, which means that the exogenous variable simultaneously has no significant effect on the endogenous variable.
- If the simultaneous value < 0.05, then Ho is accepted, which means that the exogenous variable simultaneously has a significant effect on the endogenous variable.

2) T test

Hypothesis testing was partially carried out with a statistical t-test. To see if there was a significant difference in the two groups of variables in the study, this statistical t-test was carried out. According to (Ghozali, 2011) the t-statistic test basically shows how far the influence of one explanatory variable or Exogenous individually in explaining the variation of its endogenous variables. In this study, the t-test was carried out by looking at the magnitude of the significance probability value with a significance level of 5%. The terms of the hypothesis are as follows:

- If the probability value > 0.05 then Ho is unacceptable, which means that partially exogenous variables have no significant influence on endogenous variables.
- If the probability value < 0.05 then Ho is accepted, which means that the partial variable of the exogenous variable has no effect on the endogenous variable

RESULTS AND DISCUSSION

Results of Equation 1 Research

a. *Classical Assumption Test*

Normality Test

The *Jarque-Beta Test* value is 0.771807 > 0.05. This value is in the H0 receiving region which states that *the residual* is distributed normally. Since H0 is accepted, it can be concluded that the regression model of this study meets the assumption of normality.

Multicolonarity Test

The value of the Pearson correlation coefficient (r) > α (0.80) then the hypothesis that there is no multicollinearity problem in the model is accepted. This means that there is no problem of multicollinearity in the model.

Heteroskdasticity Test

The *chi-square probability* value > α (0.05) is a hypothesis that states that there is no heteroscedasticity in the model. So it can be concluded that this research can be continued at the next stage.

b. Results of Simultaneous Equation Analysis

Results of Estimation of Simultaneous Equations of Green Investment (GI)

Influence of exogenous variables on endogenous variables. However, if the exogenous variable does not exist, the growth of Green Investment is constant 14.84781. The influence of PEBT, ICT, FD, and SB variables can be seen from the Rsquared value of 0.220757 which means that exogenous variables are able to affect endogenous variables by 22.07% and the rest is explained by other variables outside the model with a standard error of 77.93%.

Results of Simultaneous Equation Analysis of Green Investment (GI)

Influence Renewable Energy Production (Y2) against Green Investments (Y1) show results that significant and negative value**,** with a probability value of 0,0000**,** that is less than the level of significance α = 0.05**.** With a coefficient value of - 9.951676 units. Cast These findings indicate that every one unit increase in renewable energy production is followed by a decrease in green investment by 9.951676 units. Theoretically, this result can be explained by the fact that in the early stages of increasing renewable energy production, high costs are required for the development of green infrastructure and technology, so investors tend to delay or reduce new investments.

The results of the analysis show that Information and Communication Technology (X1) has a significant influence significant and positive against Green Investment growth (Y1) with a probability value of 0.0001 which less than the level of significance α = 0.05**,** and a coefficient of 8.616341. This indicates that the development of information and communication technology is able to encourage an increase in green investment. An increase of one unit in the ICT variable will increase green investment by 8.616341 units. Theoretically, advances in ICT can accelerate the process of digitalization and energy efficiency, strengthen transparency of environmental data, and open up opportunities for green innovation in various economic sectors.

Furthermore, the results of the analysis show that Financial Development (X2) has a significant and positive influence on the growth of Green Investment (Y1) with a probability value of 0.0000 which is smaller than the significance level of α = 0.05**,** and a coefficient of 57.99213. This shows that the increase in the development of the financial sector contributes greatly to the increase in green investment. Every one unit increase in the financial development variable will encourage the growth of green investment by 57.99213 units. Theoretically, a strong and inclusive financial system can increase the availability of financing for green projects, expand access to capital for green companies, and lower the risk of sustainable investments.

Next, the results of the analysis show that the Interest Rate (X3) has a insignificant and positive influence on the growth of Green Investment (Y1) with a probability value of 0.5859 which is greater than the significance level of α = 0.05**,** and a coefficient of 0.040956. These findings indicate that changes in interest rates do not have a significant effect on the increase in green investments. Although the direction of the relationship is positive suggests that a slight increase in interest rates is followed by an increase in green investment, the effect is not statistically strong enough. Theoretically, this result could be due to other factors such as environmental incentive policies, government regulations, or macroeconomic conditions that are more dominant in influencing green investment decisions than changes in interest rates.

c. Pengujian Hypothesis

Hipotesis 1

Results of Equation 2 Research

a. Classical Assumption Test

Normality Test

The *value of the Jarque-Beta Test* is 0.451161 > 0.05. This value is in the H0 receiving region which states that *the residual* is distributed normally. Since H0 is accepted, it can be concluded that the regression model of this study meets the assumption of normality.

Multicollinearity Test

Value Pearson correlation coefficient (r) > α (0.80) then the hypothesis that there is no multicollinearity problem in the model is accepted. This means that there is no problem of multicollinearity in the model.

Heteroscedasticity Test

The *chi-square probability* value > α (0.05) is a hypothesis that states that there is no heteroscedasticity in the model. So it can be concluded that this research can be continued at the next stage.

***b.* Results of Simultaneous Equation Analysis**

Results of Estimation of Simultaneous Equation of Renewable Energy Production (PBET)

Influence of exogenous variables on endogenous variables. However, if the exogenous variable does not exist, then the growth of Green Investment of -2.031751 is constant. The influence of GI, HE, ETT, and IT variables can be seen from the Rsquared value of 0.455822 which means that exogenous variables are able to affect endogenous variables by 45.58% and the rest are explained by other variables outside the model with a standard error of 54.42%.

Results of Simultaneous Equation Analysis of Green Investment (GI)

Influence Green Investments (Y1) against Renewable Energy Production (Y2) show results that significant and Positive value**,** with a probability value of 0,0000**,** that is less than the level of significance α = 0.05**.** With a coefficient value of 0.002350 units. That is, when other variables are considered fixed or *ceteris paribus***,** Every one unit increase in green investment will increase renewable energy production by 0.002350 units**.** In theory, these results are in line with the concept *ceteris paribus***,** where the increase in green investment has a direct effect on increasing the production capacity of clean energy through funding for environmentally friendly projects, such as the development of solar, wind, and bioenergy energy infrastructure. Thus, the greater the allocation of green investment, the greater the ability of a country to produce renewable energy in a sustainable manner.

The results of the analysis show that Energy Price (X4) has a significant influence significant and positive against growth in Renewable Energy Production (Y2) with a probability value of 0.0003 which less than the level of significance α = 0.05**,** and a coefficient of 9.734261. This means that every one unit increase in energy prices will increase renewable energy production by 9.734261 units**,** assuming that other variables remain or *ceteris paribus.* Theoretically, these results are consistent with the view of energy economics, where rising prices of conventional energy (such as oil, gas, and coal) drive a shift in investment and production towards more efficient and environmentally friendly alternative energy sources.

Furthermore, the results of the analysis show that non-renewable energy (X5) has a significant and negative influence on the growth of Renewable Energy Production (Y2) with a probability value of 0.0000 which less than the level of significance α = 0.05**,** and a coefficient of -0.002811. This means that every single unit increase in the use of non-renewable energy will decrease renewable energy production by 0.002811 units**,** assuming the other variable remains ***(ceteris paribus).*** Theoretically, these results suggest a substitution relationship between the two types of energy, where increased consumption of non-renewable energies such as oil, gas, and coal can hinder the development of renewable energy.

Next, the results of the analysis show that Technological Innovation (X5) has a significant influence significant and positive against growth in Renewable Energy Production (Y2) with a probability value of 0.0000 which less than the level of significance α = 0.05, as well as a coefficient of 0.000220. This indicates that every single increase in technological innovation will increase the production of renewable energy by 0.000220 units**,** assuming the other variable remains (*ceteris paribus*) Theoretically, these results support the view that technological advances play an important role in accelerating the clean energy transition, as innovations are able to improve production efficiency, lower operational costs, and expand the adoption capacity of renewable energy sources such as solar, wind, and biomass.

d. Pengujian Hypothesis

Hipotesis 2

The first hypothesis in this study states that Green Investment, Energy Prices, Non-Renewable Energy and Technological Innovation simultaneously have a significant effect on Renewable Energy Production in ASEAN-6 countries**.** Based on the results of data processing using EViews 12 shown in Table 4.10**,** a F-statistical probability value of 0.0000 was obtained, which is smaller than the significance level of 0.05**.** Thus, Ha is accepted and H_0 is rejected**,** which means that together the four exogenous variables have a significant influence on Renewable Energy Production.

Discussion

The influence of Renewable Energy Production, Information and Communication Technology, Financial Development, and Interest Rates simultaneously has a significant effect on the growth of Green Investment in ASEAN-6 countries.

The results of the study, based on the estimation in Table 4.9, show the influence of exogenous variables on endogenous variables. However, if the exogenous variables do not exist, the growth of green investment is a constant 14.84781. The influence of PEBT, ICT, FD, and SB can be seen from the R-squared value of 0.220757, which means that the exogenous variables are able to explain 22.07% of the variation in the endogenous variable, while the remaining 77.93% is explained by other variables outside the model, with a standard error corresponding to 77.93%.

Based on the concept of Goodness of Fit in linear regression proposed by Gujarati (2011) and Wooldridge (2013), the R^2 value represents the extent to which the model is able to explain variations in the dependent variable. In their studies, R^2 values between 0 and 0.3 are generally categorized as a moderate level of explanation, because economic dynamics are influenced by various external factors that cannot be fully incorporated into the empirical model. Thus, the R^2 result in this study indicates that the model has explained part of the variation in green investment, while about 77.93% of the remaining variability is influenced by factors outside the study model.

In this regard, the limited range of impacts from the observed variables is in line with the Multidimensional Factor Theory of Green Investment, which posits that sustainable investment is influenced by a variety of complex elements such as tax policies, energy prices, carbon regulations, political risks, technological innovation, global investment conditions, and broader financial market aspects (OECD, 2017). Therefore, an R^2 value that is not very high actually reflects alignment with the nature of green investment, which is shaped by many aspects and not only by direct economic variables.

Furthermore, the influence of each exogenous variable on the endogenous variable will be discussed. First, the effect of Renewable Energy Production (Y2) on Green Investment (Y1) shows a significant and negative value in ASEAN-6 countries. This is due to the observed phenomenon that the increase in renewable energy generation in the region is not always in line with the growth of new green investments. From a scientific perspective, this negative correlation can be explained by several mechanisms. Notably, a number of ASEAN countries have entered the operation and maintenance phase of their renewable energy projects; as a result, the increase in generation capacity is driven by the utilization and performance of previously built renewable energy infrastructure rather than by the initiation of additional capital investment.

The results of this study are supported by Liu et al. (2023), who state that increasing production capacity often reduces the need for new financing in the renewable energy sector. Second, several ASEAN countries such as Vietnam and the Philippines exhibit a crowding-out effect, where public funding and government subsidies dominate renewable energy development, thereby reducing space for private green investment.

These results are reinforced by the findings of Pham et al. (2022). Based on these findings, renewable energy production does not have a significantly positive effect because increased production does not necessarily require new investment, and excessive government intervention can reduce private investor participation. These findings confirm that policy dynamics and funding structures play a major role in shaping the relationship between renewable energy production and green investment in the ASEAN region.

Second, the results of the analysis show that Information and Communication Technology (X1) has a significant and positive influence on the growth of Green Investment (Y1). These findings indicate that ICT enables the collection, processing, and analysis of large amounts of environmental and sustainability data. By providing information on elements such as energy use, carbon emissions, and resource efficiency, such data help investors make well-informed assessments of green projects.

These findings are supported by Alsagr and Ozturk (2024), who found that the relationship between information and communication technology and green investment is significantly positive because the use of digital resources and information leads to the creation of new ideas for promoting green investment. They further revealed that the integration of digital resources and green financial activities helps develop new market structures and economic frameworks that play a crucial role in driving green investment.

Furthermore, the study by Aydin et al. (2025) shows that ICT penetration (access to and use of ICT) plays an important role in promoting ecological sustainability. Although the study focuses on specific contexts, it emphasizes that ICT facilitates the deployment of green technologies and investment instruments in the renewable energy sector, thereby supporting long-term green capital flows.

Based on these findings, ICT has been proven to play an important role in encouraging green investment. Therefore, governments need to strengthen the use of digital technology in environmentally friendly projects. Such strengthening can increase the efficiency, reliability, and security of green systems so that they attract investor interest. Governments can also encourage the use of ICT in the renewable energy sector through subsidies and tax incentives to accelerate innovation and integration of renewable energy networks. In addition, policies that support public–private partnerships and information sharing between the technology sector and the green investment industry are needed. These efforts are important to maximize the deployment of smart grids and energy-efficient technologies.

Third, Financial Development (X2) has a significant and positive influence on the growth of Green Investment (Y1). A strong and inclusive financial system can increase the availability of financing for environmentally friendly projects, expand access to capital for green firms, and reduce the risks associated with sustainable investment. A strong financial structure helps reduce financing constraints, broaden access to capital, and lower the long-term investment risks typically inherent in green projects. In addition, financial sector development encourages the creation of green innovation through research funding and the adoption of low-carbon technologies, thereby increasing the attractiveness of green investment.

The results of this study are supported by He et al. (2019), who found that the relationship between financial development and green investment is significantly positive and described how financial development provides financing for green investments. They further note that financial development contributes to reducing financing costs, making green investments more economically viable. Furthermore, Bui (2025), in a specific study on ASEAN-6 countries, found that financial development directly promotes the growth of green investment through increased liquidity, market efficiency, and financial sector stability. Thus, the results of this study strengthen empirical evidence that financial development is a key factor in expanding green investment in the ASEAN region.

Fourth, Interest Rate (X3) has an insignificant and positive influence on the growth of Green Investment (Y1). Although interest rates affect the cost of capital, many green projects receive government support through subsidies, green credit schemes, or financing incentives, so interest rate fluctuations are not a major determining factor in investment decisions. In addition, green investments are long-term in nature and tend to be more sensitive to environmental policies, regulatory stability, and technological risks than to short-term interest rate changes, thereby weakening the contribution of interest rates to variations in investment.

The results of this study are supported by Suseno and Afdanisa (2025), who found that interest rates have a positive but insignificant influence on green financing, as well as by Prasetyo and Hendri Hermawan Adinugraha (2023), whose research shows that monetary variables such as interest rates are not significant determinants of green investment growth.

According to the findings of this study, interest rates do have an effect on green investment but not a significant one. This suggests that structural variables such as environmental regulations, government support, and the availability of green financing instruments have a greater influence on sustainable investment decisions in the ASEAN region than changes in borrowing costs. By showing that monetary policy is not a major driver of green investment, these findings contribute to the literature by highlighting the need for policymakers to enhance non-monetary instruments such as fiscal incentives, regulatory stability, and green financing facilities to increase sustainable investment flows.

The influence of Green Investment, Energy Prices, Non-Renewable Energy, and Technological Innovation simultaneously has a significant effect on the growth of renewable energy production in ASEAN-6 countries.

The results of the study, based on the estimation in Table 4.2, show the influence of exogenous variables on endogenous variables. However, if the exogenous variables do not exist, the growth of green investment is a constant value of -2.031751. The influence of the GI, HE, ETT, and IT variables can be seen from the R-squared value of 0.455822, which means that the exogenous variables are able to explain 45.58% of the variation in the endogenous variable, while the remaining 54.42% is explained by other variables outside the model.

Furthermore, this study states that Green Investment, Energy Prices, Non-Renewable Energy, and Technological Innovation simultaneously have a significant effect on Renewable Energy Production in ASEAN-6 countries. Based on the results of data processing using EViews 12 as shown in Table 4.10, a probability value for the F-statistic of 0.0000 was obtained, which is smaller than the significance level of 0.05. Thus, Ha is accepted and H_0 is rejected, which means that together the four exogenous variables have a significant influence on renewable energy production.

Conceptually, the simultaneous relationship between green investment, energy prices, non-renewable energy, and technological innovation and renewable energy production can be analyzed through energy economics approaches and sustainable development paradigms. Referring to the Sustainable Energy Transition theory put forward by Geels (2011), the transition to renewable energy use is the result of a complex interaction of various economic, technological, and energy market dynamics, so it does not occur partially. Thus, variables such as investment levels, energy price structures, dependence on fossil energy sources, and technological innovation capacity simultaneously influence and determine the rate of increase in clean energy production capacity.

Furthermore, the influence of each exogenous variable on the endogenous variable will be discussed. First, Green Investment (Y1) on Renewable Energy Production (Y2) shows a significant and positive effect. Increased investment allocations in environmentally oriented projects have been shown to make a significant contribution to the growth of renewable energy production capacity in ASEAN-6 countries. Conceptually, these results are in line with Green Investment Theory, which argues that intensifying investment in the environmental sector plays a role in strengthening clean energy infrastructure, expanding production capacity, and accelerating the diffusion of low-carbon technologies in energy systems (Eyraud et al., 2011).

The results of this study are supported by the findings of Lyeonov et al. (2019), who found that green investment has a significantly positive effect on renewable energy production. Green investment plays a key catalytic role in providing financial capital for the development of clean energy infrastructure, including solar, wind, and biomass power plants. Their findings show that financing flows to the green sector contribute to increasing technological capacity, encouraging the adoption of low-carbon energy innovations, and strengthening energy efficiency at the national level. The increase in capacity has direct implications for the growth of renewable energy output, so the link between green investment and renewable energy production is proven not only theoretically but also empirically.

This research thus confirms that green investment has a positive and significant influence on renewable energy production in ASEAN-6 countries. Increased investment in green projects has been shown to strengthen clean energy infrastructure, encourage the adoption of low-carbon technologies, and increase renewable energy capacity and output, in accordance with the Green Investment Theory framework and supported by previous empirical evidence.

Second, the results of the analysis show that Energy Price (X4) has a significant and positive influence on the growth of Renewable Energy Production (Y2). This suggests that rising prices of conventional energy, such as fossil fuel–based electricity, are likely to encourage increased investment and use of renewable energy. Economically, this mechanism can be explained through the principle of energy substitution: as the price of fossil energy increases, renewable energy becomes more cost-competitive, so producers and consumers are more encouraged to switch to clean energy sources. Conceptually, these results are consistent with the Energy Price-Induced Innovation Model, which argues that price pressures on traditional energy sources stimulate technological innovation and accelerate the adoption of renewable energy. This creates a market push for the development of solar, wind, and biomass power plants, expands production capacity, and accelerates the transition to low-carbon energy systems.

The results of this study are supported by the findings of Oru (2025) and Naimoglu (2023), who found that energy prices have a significantly positive effect on renewable energy production. Economically, rising conventional energy prices create cost pressures for industrial and household sectors, thereby driving a shift in demand toward increasingly price-competitive renewable energy. This condition provides a strong market signal for energy producers to increase clean energy production capacity to meet growing substitution demand. Thus, the contribution of these findings lies in explaining scientifically how the energy price mechanism operates as a catalyst to expand renewable energy production and support the achievement of sustainable energy transition targets.

Third, Non-Renewable Energy (X5) has a significant and negative influence on the growth of Renewable Energy Production (Y2), through mechanisms related to energy market dynamics and structural barriers arising from high dependence on fossil-based energy. When the supply of non-renewable energy is abundant or prices tend to be stable, economic incentives to switch to renewable energy become weaker. Under such conditions, consumers and producers tend to maintain the use of established energy sources because short-term costs are relatively lower than those of alternative energy sources. This situation creates path dependence, where fossil energy–oriented infrastructure, technology, and policies limit opportunities for clean energy development. Furthermore, the dominance of non-renewable energy reduces market pressure to encourage innovation in the green energy sector, resulting in gradual and relatively slow growth in renewable energy production capacity.

The results of this study are supported by the findings of Zhang (2024) and Osman et al. (2023), who found that non-renewable energy has a significantly negative effect on renewable energy production. Because fossil energy still dominates national energy systems, budget allocations, infrastructure development, and public policies are generally focused on strengthening fossil-based industries. This condition limits the space for expansion of the renewable energy sector. In addition, a high level of dependence on fossil energy reduces investor interest in shifting capital to clean energy, as conventional energy markets are perceived as more stable and promising short-term profits.

This study concludes that the dominance of fossil energy has a negative impact on the development of renewable energy because it creates policy, infrastructure, and investment barriers. To overcome this, strategic measures are needed in ASEAN-6 countries, such as diversifying energy sources, providing incentives for green energy developers, developing supporting infrastructure, reforming regulations, and strengthening public education.

Fourth, Technological Innovation (X6) has a significant and positive influence on the growth of Renewable Energy Production (Y2), because technological advances play an important role in accelerating the clean energy transition. Innovation can increase production efficiency, reduce operational costs, and expand the capacity for adopting renewable energy sources such as solar, wind, and biomass.

The results of this study are supported by the findings of Vural (2021), who found that technological innovation has a significantly positive effect on renewable energy production. Technological advances—including increased solar panel efficiency, wind turbine design innovations, and the development of energy storage technologies—contribute substantially to reducing production costs and increasing the competitiveness of renewable energy compared to fossil energy. Furthermore, these findings are supported by Zhao et al. (2024), who found that countries or industries that continue to invest in energy technology research and development (energy R&D) tend to experience faster and more sustainable increases in renewable energy output. Innovation has paved the way for power generation technologies that are more efficient, longer-lasting, and better able to adapt to the variability of renewable energy sources. As a result, their research strongly supports this study's conclusion that technological innovation helps increase production capacity, improve energy conversion efficiency, and lower cost barriers that previously hampered renewable energy growth.

CONCLUSION

Renewable energy production, information and communication technology, financial development, and interest rates simultaneously have a significant effect on Green Investment in ASEAN-6 countries. This means that any change in renewable energy production, information and communication technology, financial development, or interest rates leads to changes in the growth of green investment in ASEAN-6 countries. Partially, information and communication technology and financial development have a significant positive effect on green investment, while the growth of renewable energy production has a significantly negative effect on green investment in ASEAN-6 countries. In contrast, interest rates have a positive but not significant effect on green investment.

Green investment, energy prices, non-renewable energy, and technological innovation simultaneously have a significant effect on renewable energy production in ASEAN-6 countries. This means that any change in green investment, energy prices, non-renewable energy, or technological innovation results in changes in the growth of renewable energy production in ASEAN-6 countries. Partially, green investment, energy prices, and technological innovation have a significant positive effect on renewable energy production, while non-renewable energy has a significant negative effect on renewable energy production in ASEAN-6 countries.

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