



Green Investment and Renewable Energy Mix: Evidence from Indonesia

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ABSTRACT

This research aims to prove the moderating role of green investment in population growth, economic growth, and foreign investment in the renewable energy mix in Indonesia. Data from the Indonesian Central Statistics Agency, World Development Indicators, Indonesian Investment Coordinating Board, and companies in the LQ45 Index with data from 2017 to 2023. The data was analyzed using a quantitative time series data regression analysis model using the Eviews 10 program. Research findings show that economic and population growth has a positive and significant effect through the moderation of green investment in Indonesian LQ45-indexed companies on the renewable energy mix. Foreign investment does not significantly impact the renewable energy mix by moderating green investment in Indonesian LQ45-indexed companies. This research contribution provides insight into how certain economic factors influence renewable energy and the role of green investments in changing the dynamics of indexed corporate relationships in Indonesian financial markets.

Keywords: Green Investment, Renewable Energy Mix, Economic Growth, Population Growth, Foreign Investment

JEL Classifications: G11, G15, F21, F43

1. INTRODUCTION

The presence of natural resources stimulates economic growth through the facilitation of trade and the enhancement of productivity. However, an excessive availability of natural resources can lead to a decline in long-term development due to their depletion (Ashfaq et al., 2024). Human activities are primarily reliant on energy. Nevertheless, the utilization of renewable energy impacts the process of human growth. There is an inverse relationship between national income and human development (Osiolo, 2021). Poor countries' Energy usage is significantly lower than that of developed countries (Deka et al., 2023; Nuță et al., 2024). The more renewable energy is used, the less spending there tends to be on research and development, and carbon emissions tend to decrease as well (Wang et al., 2023). Initiatives and financial support aimed at encouraging renewable energy enterprises to play a more significant role in the energy sector

(Wang et al., 2023). The long-term sustainability of emerging market countries will heavily depend on their ability to secure a reliable and efficient energy supply to fuel economic expansion (Raihan et al., 2022; Xiong and Dai, 2023). When conducting energy simulations to predict future energy consumption, it is crucial to take into account urbanization, as well as aspects such as income and other relevant variables (Dilanchiev et al., 2023; Nuță et al., 2024)

The relationship between economic growth and energy efficiency, as well as the shift from nonrenewable to renewable energy sources, is influenced by each other (Chen et al., 2022; Espoir et al., 2023). As economies become more developed over time, there is a noticeable correlation between increased energy consumption and economic growth; there is a minor reduction in energy consumption, indicating improved energy efficiency (Acaroğlu and Güllü, 2022; Magazzino et al., 2022; Mohsin et al., 2022; Raihan

et al., 2022). The economic context and operational structure favorably impact competitive advantage, which is fostered by factors such as corporate reputation, customer happiness, and organizational dedication (Dai and Xiong, 2023). Prioritizing the promotion of environmentally friendly investments is the responsibility of political leaders to improve the link between economic growth, financial resources, and energy consumption (Xiong and Dai, 2023; Zhang et al., 2024). Alharbi et al. (2023) and Wang et al. (2023) stated that renewable energy consumption and financial development have a minimal impact on economic growth.

The integration of circular economy concepts promotes cost reduction, innovation, and competitiveness in the transition to sustainable resource management from renewable sources, hence reflecting economic viability and growth (Cicchello et al., 2023; Di Domenico et al., 2023; Kumar et al., 2023; Pan and Hashemizadeh, 2023). Higher levels of economic growth are positively associated with economic sophistication and the utilization of nonrenewable and renewable energy sources (Ivanovski et al., 2021; Mujtaba et al., 2022). Foreign investment in renewable energy can have a significant positive impact on the development of clean energy sources, reducing greenhouse gas emissions and supporting the transition to a sustainable economy (Alam and Hossain, 2024; Wang et al., 2023). However, it is important to note that foreign investors in renewable energy projects may face challenges, such as policy uncertainty, financial risks, and legal issues (Adjei-Mantey and Adams, 2023; Qamruzzaman et al., 2022). Therefore, good cooperation between the government and the private sector can play a key role in creating a stable and profitable investment environment (Boute, 2020; Liu et al., 2024) and an integrated approach involving economic empowerment, sustainable green investment, and a renewable energy mix (Ashfaq et al., 2024; Boute, 2020; Yang et al., 2022; Zeraibi et al., 2023; Endri et al., 2022).

This research aims to prove the moderating role of green investment in population growth, economic growth, and foreign investment in the renewable energy mix in Indonesia. It will also contribute to providing insight into how certain economic factors influence renewable energy and the role of green investment in changing the dynamics of company relationships indexed in the Indonesian financial market.

2. LITERATURE REVIEW AND HYPOTHESES

2.1. Circular Economy View

The circular economy is a strategy to create a closed-loop economic system that optimizes the utilization and worth of raw materials, components, and products while minimizing the generation of unused waste materials that are ultimately disposed of in landfills (Cicchello et al., 2023). Adopting a circular economy can promote greater green economic growth compared to the current standard approach (Di Domenico et al., 2023). This can be achieved by developing production systems that demand fewer resources, maximizing the extraction and utilization of raw materials, and enhancing the efficiency of product and service

utilization (Ioannidis et al., 2023). In other words, the circular economy can support sustainability and be a driving force toward economic transformation, especially supporting green economic strategies and low-carbon development (Kumar et al., 2023). The circular economy view reflects an awareness of conventional economic models' limitations and environmental impacts (Zhang et al., 2024). Besides environmental benefits, a circular economy can generate economic efficiency and innovation potential (Pan and Hashemizadeh, 2023).

2.2. Renewable Energy Mix

Renewable energy sources, as stated by (Al Naimat and Liang, 2023), are energy sources that are both environmentally sustainable and not responsible for climate change and global warming. Overutilizing several energy sources has resulted in widespread disruption and harm to the natural environment (Jiang et al., 2022; Lv and Spigarelli, 2015). Moreover, the consequence of discarding these energy sources is pollution, which poses a significant risk to human health (Appiah-Otoo et al., 2023). Renewable energy can be generated by harnessing advancing technology, establishing it as a viable alternative energy source (Hoa et al., 2024; Qamruzzaman and Karim, 2023). Renewable energy can effectively allocate resources and investments to yield long-term advantages (Deichmann et al., 2011).

2.3. Green Investment

Green investment refers to allocating funds and resources to projects or initiatives to support and promote environmental sustainability (Belaïd et al., 2023; Wahyuningsih et al., 2025). This investment focuses on environmentally friendly and sustainable solutions, aiming to reduce negative impacts on the environment and stimulate positive changes in economic and business practices (Qamruzzaman and Karim, 2023). Green investment includes allocating funds and resources to projects that support the development and implementation of renewable energy sources (Fadly, 2019). The main goal is to promote energy sustainability by reducing dependence on fossil fuels and mitigating environmental negative impacts (Dilanchiev et al., 2023; Sarkodie et al., 2020). Although the growth of green investment in renewable energy has increased, challenges remain, including consistent policy, infrastructure, and political changes (Wang et al., 2023). However, these positive trends show that renewable energy is increasingly being considered an integral part of a sustainable global energy mix (Belaïd et al., 2023; Murshed et al., 2022; Zhang et al., 2024; Dorothy and Endri, 2024).

2.4. Economic Growth

Economic growth is commonly understood as the rise in the total value of goods and services produced by an economy within a particular period (Alam and Hossain, 2024). This growth is measured by looking at changes in a country's national income (Shahbaz et al., 2020). Economic growth involves increasing production and improving people's living standards, employment, and the ability to meet their needs (Doytch and Narayan, 2021). Economic growth is often considered an indicator of economic development goals, but economic growth does not always reflect sustainability or equal distribution of income in a society (Wei et al., 2022; Yu et al., 2023). Economic growth in the renewable

energy sector is not only limited to financial aspects but also includes positive impacts on environmental sustainability and overall societal welfare (Dey et al., 2022; Fan and Hao, 2020). Sustainable development requires the integration of policies and business practices that support economic growth while maintaining a balance with environmental sustainability (Mujtaba et al., 2022). Economic growth associated with green investments generates financial benefits and positively impacts the environment and societal well-being (Murshed et al., 2022). Sustainability and economic growth can support each other in creating a better future overall. Economic growth that focuses on a mix of renewable energy and green investment provides a holistic positive impact, embracing sustainability and creating a more balanced economic ecosystem (Dai and Xiong, 2023; Li et al., 2021; Qamruzzaman and Karim, 2023).

H₁: Economic growth influences the renewable energy mix with green investment moderating.

2.5. Population Growth

Population growth is also an increase in energy use and an opportunity to increase investment (Eyraud et al., 2013). In the context of population growth, it is important to plan and implement policies that support the transition to a renewable energy mix, ensure energy supply sustainability, and reduce environmental negative impacts (Yang et al., 2022). The relationship between population growth and green investment can be influenced by contextual factors such as government policy, economic stability, and community support; governments and other stakeholders can design policies that support the growth of green investment along with population growth (Kurdyukov, 2020). This creates opportunities for sustainable development that combines economic, environmental, and social aspects in the long term (Xiong and Dai, 2023).

H₂: Population growth influences the renewable energy mix with green investment moderating.

2.6. Foreign Investment

Foreign investment can have various impacts depending on the type of investment, its objectives, and its impact on the host economy and society (Sarkodie et al., 2020). Some positive impacts involve the flow of new capital and technology, while some negative impacts may include the risk of economic colonialism or economic inequality (Saadaoui and Omri, 2023; Wang et al., 2023). Therefore, accepting and regulating foreign investment is often the focus of attention and debate in many countries (Caetano et al., 2022). Foreign investment for the renewable energy mix refers to the allocation of capital and resources from foreign investors to support projects focused on developing and deploying renewable energy sources (Li et al., 2021; Zhang et al., 2024). These investments can take many forms, including the construction of solar power plants, wind turbines, hydroelectric power plants, and other renewable energy projects (Wang et al., 2023). Foreign investment can significantly shape the mix of renewable energy and green investments (Belaïd et al., 2023; Qamruzzaman and Karim, 2023). These impacts can be positive or pose challenges depending on implementation, regulations, and local conditions. H₃: Foreign investment influences the renewable energy mix with green investment moderating.

3. METHODOLOGY

This research was carried out by taking data from the Indonesian Central Statistics Agency, World Development Indicators, the Indonesian Investment Coordinating Board, and companies in the LQ45 Index with data for the period 2017-2023. Twenty-five companies meet the criteria of being timely and consistent in providing reports. These criteria are established so researchers can obtain comprehensive results and answer research questions. Quantitative research with a time series data analysis model using the Eviews 10 program. The final result of this research is hypothesis testing that meets the requirements for normality, heteroscedasticity, and multicollinearity.

4. RESULTS AND DISCUSSION

Testing normality, the Jarque-Bera value is $0.536372 < 5.882$, and the $P = 0.635224$; it can be concluded that the data is normally distributed. There is no multicollinearity because the correlation coefficient value of the variables is smaller than 0.80. There is no heteroscedasticity problem because the $P \geq 0.05$. Value LM test is Prob. Chi-square (2) > 0.05 ($0.0552 > 0.05$), meaning that there is no autocorrelation. The adjusted $R^2 = 0.9880$.

Based on Table 1, the time series data regression equation is:

$$REM = 7.347873 + 0.000640 EG - 3.347644 PG - 0.738392 FI - 0.163748 GI$$

The constant α is 7.347873. If the value of EG, PG, FI, and GI Moderation is 0, then the amount of REM is 7.347873, and for every change in the value of EG, PG, FI, and GI moderation, the amount of REM will increase by a unit value. The calculated T value for economic growth is $0.004113 < 2.40$ and $P = 0.0471 > 0.05$, meaning that EG significantly positively affects REM. The calculated T value for population growth is $-5.758372 < 2.40$ and $P = 0.0653 > 0.05$, meaning PG has no significant effect on REM. The calculated T value for foreign investment is $-0.563731 < 2.40$ and $\pm 0.0328 < 0.05$, meaning that FI negatively and significantly affects REM. The calculated T value for green investment is $-0.325319 < 2.40$ and $P = 0.0462 < 0.05$, meaning that GI negatively and significantly affects REM. Based on Table 2, the calculated $F = 35.34894 > 3.60$ F table. Meanwhile, according to the probability value, F is $0.039584 < 0.05$; the conclusion is that the f test is that all variables have an effect.

In Tables 3 and 4, the coefficient results for economic and population growth have a probability level of t of $0.0002 < 0.05$. Economic and population growth has a positive and significant effect by moderating green investment in Indonesian LQ45-indexed companies on the renewable energy mix (Hypothesis 1 and Hypothesis 2 are accepted). In Table 5, the results show that the foreign investment coefficient has a probability level of t of $0.1036 > 0.05$. This means that foreign investment has no significant effect through moderating green investment in Indonesian LQ45 indexed companies on the renewable energy mix (Hypothesis 3 is rejected).

Increasing economic growth reflects the excellent performance of the Indonesian economy; the country can develop a renewable

Table 1: T-test results

Variable	Coefficient	t-Statistic	Probability
C	7.347873	1.204605	0.3516
EG	0.000640	0.004113	0.0471
PG	-3.347644	-5.758372	0.0653
FI	-0.738392	-0.563731	0.0328
GI	-0.163748	-0.325319	0.0462

Source: Processed by E-Views (2024)

Table 2: F test results

F-statistic	35.34894
Probability (F-statistic)	0.039584

Source: Processed by E-Views (2024)

Table 3: Economic growth in renewable energy mix moderated by green investment

Variable	Coefficient	Standard error	t-Statistic	Probability
C	3.910171	1.897836	2.060331	0.1084
GI	-0.147895	0.224995	-0.657329	0.5469
EG	-4.561342	0.359543	-12.68650	0.0002

Source: Processed by E-Views (2024)

Table 4: Population growth in renewable energy mix moderated by green investment

Variable	Coefficient	Standard error	t-Statistic	Probability
C	4.347939	1.348342	3.349393	0.2046
GI	-0.134873	0.585847	-0.573839	0.4483
PG	-3.344832	0.348393	-11.37347	0.0002

Source: Processed by E-Views (2024)

Table 5: Foreign investment in renewable energy mix moderated by green investment

Variable	Coefficient	Standard error	t-Statistic	Probability
C	-6.136485	29.27621	-0.245746	0.8180
GI	-0.450751	2.751082	-0.163845	0.8778
FI	1.677405	1.113516	1.506405	0.1036

Source: Processed by E-Views (2024)

energy mix that boosts income and positively impacts citizens. A good economy is accompanied by supportive and sustainable policies, including clear energy policies and incentives for investment in the renewable energy sector (Qamruzzaman et al., 2022). Increasing or decreasing population growth does not directly impact the creation of a renewable energy mix. Although population growth does not directly create a renewable energy mix, changes in population dynamics can create conditions that influence how countries respond to energy and environmental needs. Investors typically exhibit a greater inclination towards opportunities that provide few risks and substantial returns (Wang et al., 2023). When examining the circumstances and obstacles surrounding renewable energy development, a notable example is the matter of equipment costs, technological advancements, and the assurance of sufficient raw materials for power plants. Investors carefully evaluate these variables when considering the implementation of renewable energy initiatives in Indonesia. Creating a conducive investment environment, formulating clear policies, and providing appropriate incentives to support renewable

energy development, including bioenergy, can increase green investment and stimulus for the renewable energy mix. In this context, transparency, legal certainty, and partnerships between the public and private sectors are essential to overcoming investment barriers.

Issuers often fail to recognize the challenges associated with developing renewable energy, such as the impact of equipment prices, technology, and raw material guarantees, so this is one of the factors investors consider when developing renewable energy in Indonesia. Companies that start integrating sustainable strategies into operations will have the long-term potential to invest in renewable energy. Increased awareness of environmental and social issues and pressure from stakeholders and investors who increasingly emphasize sustainability may encourage more emitters to consider and invest in renewable energy in the future. Besides that, technological developments and innovations in the renewable energy sector can also help overcome some obstacles (Raihan et al., 2022; Xiong and Dai, 2023; Rheynaldi et al., 2023). The rising economic growth, as seen by the LQ45-indexed issuer companies, suggests that these issuers have adapted by offering alternative renewable energy solutions in Indonesia. This demonstrates that the correlation between green investment in LQ45-indexed issuer firms and the development of a renewable energy mix significantly impacts economic growth. Significant growth can stimulate green investment and garner assistance from a favorable investment climate to establish a diverse portfolio of renewable energy sources (Qamruzzaman and Karim, 2023).

The implementation of green investment in LQ45 indexed issuer companies has a significant impact on Indonesia's Population Growth by promoting the development of a renewable energy mix. Despite high population growth, the use of renewable energy sources offers a solution to meet the increasing energy demands in the future (Yang et al., 2022). Foreign investment exhibits skepticism towards Indonesia's new and renewable energy composition. Indonesia faces various constraints, including the potential for unappealing returns on renewable energy initiatives, substantial capital demands, a scarcity of financial products tailored to the needs of Renewable Energy Mix projects, less enticing opportunities in terms of scale for Renewable Energy Mix projects, and limited enthusiasm from local financial institutions. Overcoming these obstacles can help create certainty and increase the attractiveness of foreign investment in Indonesia's renewable energy sector. Economic and financial benefits can be obtained when energy sales and savings occur, primarily through energy efficiency, so that sustainable development in the share ownership sector in foreign investment by paying attention to social, economic, and environmental sustainability and the business ecosystem can be achieved optimally (Bujdosó et al., 2013; El Archi et al., 2023; Razak et al., 2020).

5. CONCLUSION

The concrete answer from this research is that economic growth can influence the renewable energy mix positively and significantly. Population Growth cannot significantly affect the renewable energy mix. The negative and significant influence of

foreign investment on the renewable energy mix. The negative and significant influence of green investment on the renewable energy mix. Economic and population growth have a positive and significant effect by moderating green investment in Indonesian LQ45-indexed companies on the renewable energy mix. Foreign investment does not significantly affect the moderation of green investment in Indonesian LQ45-indexed companies on the renewable energy mix. These findings provide insight into how certain economic factors can influence renewable energy adoption and the role of green investment in changing the dynamics of this relationship, especially at the level of companies indexed in Indonesian financial markets. The limitation of this research is that it only uses data from the LQ45 index, the period of the data taken is still relatively short, and a more complex conceptual model has not been developed. Future research can add global risk variables as mediation using hybrid methods and GARCH models.

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