# Investigating the Relationship between Renewable Energy Consumption, Foreign Direct Investment, Fuel Exports and Economic Growth: Evidence from Countries Southeast Asia region

Khavid Normasyhuri[1], Ambya[2], I Wayan Suparta[3], Arivina Ratih Yulihar Taher[4]

{khavidnormasyhuri2@gmail.com[1], ambya.1959@feb.unila.ac.id[2], iwayansuparta_09@yahoo.com[3], arivinaratih@gmail.com[4]}

Faculty of Economics and Business, University of Lampung[1234]

**Abstract.** In recent decades, the Southeast Asian region has faced a complex dilemma regarding the interdependence between renewable energy consumption, foreign direct investment (FDI), and fuel exports in the context of economic growth. Increased consumption of renewable energy is driven by government policies to reduce dependence on fossil fuels and tackle climate change, but requires significant capital investment. FDI, which is often necessary to finance this energy transition, is an important catalyst in modernizing infrastructure and increasing production capacity. Meanwhile, fuel exports, a traditional source of income, are under pressure due to global price fluctuations and shifting global energy policies. The combination of these factors determines the dynamics of economic growth in the region, which requires adaptive and proactive policy management to navigate the transition to a more sustainable economy. This research aims to analyzethe relationship between renewable energy consumption, foreign direct investment (FDI), and fuel exports on economic growth in Southeast Asian countries. The research methodology used in this research is quantitative using Eviews 9 software. The research period is 2010-2020. Secondary data was obtained from World Bank reports with a total of 110 samples. Research findings show that Renewable Energy Consumption (REC) influences Economic Growth (EG) in Southeast Asian Countries. Foreign Direct Investment (FDI) and Fuel Exports (FE) have no effect on Economic Growth (EG) in Southeast Asian Countries.

**Keywords:**Renewable Energy Consumption (REC), Foreign Direct Investment (FDI), Fuel Exports (FE) and Economic Growth (EG)

ICEBE 2024, September 04-05, Shah Alam, Malaysia

DOI 10.4108/eai.4-9-2024.2353677

## 1 Introduction

The economic growth of ASEAN countries has a very important role in the regional and global context. Economic growth in the Asian region is a main topic in global economic discourse, especially because of its significant contribution to world economic dynamics. Economic growth is an important concept that refers to increasing the economic capacity of a region or area to produce goods and services. The 2010-2020 period is an important phase in the evolution of regional economic growth in Southeast Asia, where countries in this region experience various significant changes that shape their economic trajectories [1]. Strong economic growth strengthens countries' capacity to participate in international diplomacy and negotiations. Economic growth is also important in the context of increasing social welfare and reducing poverty. With growing economies, these countries can allocate more resources to social programs aimed at raising people's living standards, such as health, education, and social security[2]. This is important to ensure that the benefits of economic growth are felt by all levels of society, not just a few people or groups. Therefore, strong and sustainable economic growth is not only important for these countries, but also for the overall stability, prosperity and progress of the Southeast Asian region. Concerted efforts to maintain and enhance this momentum will continue to be a key focus for policymakers and stakeholders in the region [3]. Strong economic expansion in Southeast Asian countries also helps increase regional demand, which in turn supports economic growth throughout the region. Sustainable economic growth in these four countries strengthens ASEAN's role as a significant economic bloc at the global level [4].

The 2010-2020 period marks a significant era for ASEAN countries in facing the challenges of economic growth related to energy and environmental sustainability. These issues not only impact domestic policies but also regional and global commitments to sustainable development. Countries in Southeast Asia are experiencing significant economic growth, especially through the development of the renewable energy sector, increased foreign direct investment (FDI), and exports fuel. Growth in the renewable energy sector has become one of the main pillars in the economic development strategy in the Southeast Asia region [5]. With increasing concern about environmental issues and climate change, countries such as Indonesia, the Philippines, and Thailand are actively expanding their capacity in alternative energy production. On the other hand, foreign direct investment (FDI) in Southeast Asia experienced strong growth over the decade, especially in sectors such as manufacturing, infrastructure and renewable energy [6]. Singapore, with its position as a regional financial hub, is attracting large amounts of investment in the technology and financial sectors, while Indonesia and Vietnam are enjoying increased FDI in manufacturing and assembly, especially from multinational companies seeking lower production costs. However, the fuel export sector in several ASEAN countries remains strong and continues to dominate certain economic segments, particularly in Indonesia and Malaysia, two of the main oil and gas producing countries in the region. Despite global pressure to switch to cleaner energy, fossil fuel exports still account for a significant portion of their export earnings [7].

The 2010-2020 period in Southeast Asia highlights complex problems in the relationship between economic growth and the renewable energy sector, foreign direct investment (FDI), and fuel exports. These issues reflect tensions between sustainable development aspirations and regional economic and political realities. In the context of renewable energy, although there has been significant progress in the adoption of clean technologies, infrastructure and policy limitations are the main obstacles. Countries such as Indonesia and the Philippines, although rich in renewable resources such as solar, wind and hydro, often have difficulty integrating these

new energy sources into a grid dominated by fossil fuels [8]. This problem is exacerbated by underinvestment in transmission and distribution networks, which hampers energy efficiency and storage capacity. In addition, policy inconsistencies and unstable fiscal support from the government often create uncertainty for investors and project developers. Meanwhile, FDI has been an important catalyst for growth in many Southeast Asian countries, but its distribution is uneven and often concentrated in certain sectors such as manufacturing and real estate, raising concerns about economic diversification [9]. Fuel exports, meanwhile, continue to be the backbone of the economies of countries such as Indonesia and Malaysia, but the sector faces significant challenges. Fluctuations in global oil prices, often triggered by geopolitical events and changes in global energy policy, cause revenue instability for governments and industry players. At the same time, international pressure to reduce emissions and switch to cleaner energy sources is pushing governments to reform the energy sector, often with inconsistent results and resulting uncertainty for investors and businesses [10].

A country's economic growth is often influenced by the dynamics of the renewable energy consumption sector, foreign direct investment (FDI) and fuel exports. Renewable energy consumption is the use of energy resources produced from natural processes that can be renewed continuously and do not deplete these resources. Renewable energy includes sources such as solar, wind, water (hydro), biomass and geothermal energy. This concept is becoming increasingly important in the global discourse on sustainability and climate change, as it provides a cleaner and more sustainable alternative to traditional fossil energy sources such as coal, oil and natural gas. The use of renewable energy not only reduces dependence on fossil fuels which are often associated with greenhouse gas emissions, but also helps in reducing air pollution and improving a country's energy security [11]. Renewable energy consumption has a significant impact on economic growth, especially through several key mechanisms that support sustainable economic development and job creation. Increasing energy consumption from renewable sources not only aims to meet energy needs but also to form the basis of a greener economy that is more resilient to fluctuations in global energy prices. Diversifying energy sources through the adoption of renewable energy reduces dependence on fossil fuels, which are often subject to large price fluctuations and geopolitical risks [12]. By reducing this dependency, countries can achieve greater energy security and economic stability, being less affected by global energy price shocks. This is essential for stable and sustainable economic growth, enabling more effective and predictive long-term planning and investment. Overall, renewable energy consumption makes an important contribution to sustainable economic growth in a way that supports job creation, diversification of energy sources, increased energy security, reduced environmental impact, and stimulation of innovation and technology. With this, renewable energy is not only essential to meet today's energy needs but is also essential to ensure a sustainable and inclusive economic future [13].

However, on the other hand, the impact of renewable energy consumption is not as clear as expected. This contradiction arises from various aspects such as the initial costs for renewable energy technology are often higher compared to conventional energy sources. Investments in renewable energy such as solar, wind or bioenergy require large initial capital for infrastructure and technology that is not yet fully mature. This can result in high initial operational costs that are not immediately compensated by savings or economic benefits [14]. In the short term, this spending spree may not provide significant economic stimulation, and in some cases, may divert funds from other economic investments that may be more effective in driving immediate economic growth. Technological uncertainty and financial risks are often major barriers to the development and implementation of renewable energy. Technology such as solar panels and

wind turbines is still developing and continues to experience innovation. This creates a level of uncertainty for investors and governments in terms of long-term viability and reliability [15]. This uncertainty can lead to reluctance to invest, which in turn slows the pace of renewable energy adoption and its potential economic impact. Integrating renewable energy into the existing electricity grid is often challenging and expensive. Renewable energy sources such as solar and wind rely heavily on natural conditions that cannot be consistently predicted, resulting in fluctuations in energy supply. Integration of these unstable resources into a grid system designed for predictable and consistent inputs poses technical and financial challenges. This may require additional investments in energy storage infrastructure or grid management systems, which may reduce the economic effectiveness of renewable energy projects [16].

Foreign Direct Investment (FDI) is a crucial element in encouraging economic growth in various countries, especially in Southeast Asian countries. Foreign Direct Investment (FDI) is an important concept in the global economy that refers to investments made by individuals or companies in one country into businesses or assets in another country. FDI not only involves the transfer of capital, but also includes management and control over companies or assets. FDI not only brings capital into the recipient country, but also includes technology, managerial skills, and access to global markets. FDI contributes to increasing production capacity. Foreign companies that invest in other countries often bring with them advanced technology and more efficient management practices, which can increase total local industrial output [17]. This not only increases the GDP of the recipient country but also improves overall economic efficiency. By entering local markets, foreign companies are likely to spur healthy competition that can spark innovation and efficiency among domestic companies, encouraging them to improve and modernize their operations. FDI is an important source of job creation. Investments by multinational companies often require local labor for operations and management. This directly reduces unemployment rates and increases household income, which further contributes to economic growth through increased domestic consumption and investment [18]. The jobs created are not only limited to certain sectors but also spread to various sectors through knock-on effects, including from construction to services. FDI also strengthens the economic infrastructure of recipient countries. Foreign investment often requires upgrading or building new infrastructure such as roads, ports, and energy facilities. This infrastructure improvement not only supports the operational needs of foreign companies but also generally increases economic efficiency by improving connectivity and reducing transaction costs for all domestic economic actors [19].

Foreign Direct Investment (FDI) is often considered an important catalyst for economic growth, however, contradictions to this view indicate that FDI does not always have a positive or significant impact on a country's economic growth. Several factors and conditions can limit, negate, or even reverse the potential effects of FDI on local economies. This debate underscores the complexity of the interaction between foreign investment and domestic economic dynamics. The success of FDI in influencing economic growth is highly dependent on the internal conditions of the recipient country, including political stability, government policies, infrastructure and the quality of human resources [20]. In cases where countries have poor infrastructure and unsupportive policies, FDI may not be able to reach its full potential. Foreign companies may have difficulty operating efficiently and integrating into the local economy, causing such investments to have little real impact on economic growth. FDI is often concentrated in certain sectors such as resource extraction or manufacturing, which may not spread its benefits widely across the economy. This can lead to so-called 'enclave economies' where foreign operations are managed with little interaction or integration with the local

economy [21]. In such a scenario, little technology transfer or local skill building occurs, and the economic benefits of FDI are very limited. Although FDI can create jobs, the types of jobs produced are often temporary or do not require high skills, which does not contribute to human capital development in the long term. Additionally, multinational companies' work practices may be out of sync with local labor norms, which may involve the use of cheap labor with little regard for working conditions or long-term benefits for workers. Thus, although FDI has the potential to strengthen economic growth, there are certain conditions and factors that can limit or even negate the expected economic benefits of foreign direct investment. Wise policies and careful monitoring are needed to ensure that FDI produces desired and sustainable outcomes for recipient economies [22].

Fuel exports have long been recognized as an important pillar of economic growth, especially for countries rich in natural resources. The influence of fuel exports on the economy can be seen from several aspects, such as increasing state income, creating jobs, and investing in infrastructure. Fuel exports refer to the sale and delivery of fuel or energy resources from one country to another [23]. These fuels usually include petroleum, natural gas, coal, and derivatives such as gasoline and diesel. These exports play an important role in the global economy, facilitating the distribution of important energy resources between countries and regions that have variations in production capacity and energy needs. Fuel exports are often the main source of export earnings for producing countries, accounting for a significant proportion of national income. Revenue from these exports can be used to finance the state budget, including infrastructure development, education and health services. In many cases, these revenues also help in stabilizing the balance of payments, strengthening foreign exchange reserves, and providing necessary resources for other economic investments that drive overall economic growth [24]. The fuel export industry is also an important source of job creation, both directly and indirectly. Direct jobs are created through mining and production operations, while indirect jobs can arise in other sectors such as construction, logistics and services supporting the fuel industry. This increase in employment can reduce the unemployment rate and increase per capita income, which in turn increases domestic consumption and economic growth. Fuel exports often trigger investment in the infrastructure necessary to support extraction and transportation activities. This includes building roads, ports, pipelines, and storage facilities. This improved infrastructure not only benefits the fuel industry but also improves overall economic efficiency by facilitating trade and access to markets for other sectors of the economy [25].

This research aims to look at the relationship between renewable energy consumption, foreign direct investment (FDI), and fuel exports on economic growth in Southeast Asian countries. Research on the relationship between renewable energy consumption, foreign direct investment (FDI), fuel exports, and economic growth in Southeast Asian countries has several significant differences compared to previous studies. Studies conducted before 2010 tended to focus more on traditional economic dynamics without prioritizing aspects of environmental sustainability and long-term impacts. The 2010-2020 period marks an important shift in this focus, especially as global awareness of climate change and sustainability issues increases. Research prior to 2010 often explored the contribution of fuel exports to GDP growth without substantially considering the environmental impacts of fossil fuel extraction and burning [26]. In contrast, during the 2010-2020 period, research began to intensively include environmental sustainability variables. These studies are beginning to assess how renewable energy not only helps reduce dependence on fossil fuels but also contributes to long-term economic stability by reducing negative impacts on the environment, which previously received little attention. In the context of foreign direct investment, the focus of research has shifted from simply measuring the volume of FDI and its

impact on economic growth, to a more in-depth analysis of how FDI can encourage technology transfer, particularly in green technologies and sustainable practices. Research in the 2010-2020 period tends to view FDI more as a tool to increase local capacity in the production and use of renewable energy, a reflection of global demands for more environmentally friendly operations [27]. The 2010-2020 period was also marked by increased international and regional collaboration in research, with more coordinated policies and initiatives between Southeast Asian countries. This is different from the previous period which focused more on national policies without much linkage or consistency across countries. More recent studies often integrate regional policies and evaluate alignment between countries in adopting renewable energy technologies. The 2010-2020 period marks a paradigm shift in research on the relationship between renewable energy, FDI, fuel exports, and economic growth in Southeast Asia, with greater emphasis on sustainability, more sophisticated methodologies, and closer international cooperation [28].

Understanding this research brings benefits both theoretically and practically. Theoretically, this research contributes to regional economic theory by providing insight into how natural resources and energy policies influence local and regional economic dynamics. By focusing on renewable energy, this research adds to the economic literature by explaining how the transition from conventional to renewable energy sources can change regional and national economic structures. This research helps in developing more robust models that incorporate renewable energy variables, which are often ignored in traditional economic growth models. This allows economic theorists to take into account the long-term impact of sustainable energy policies on economic growth. From a practical standpoint, this research provides valuable guidance for policymakers seeking to stimulate economic growth through investment in the renewable energy sector. By understanding the impact of fuel exports on local economies, Southeast Asian countries can devise strategies to diversify their economies. This study can show ways in which dependence on fuel exports can be reduced and how renewable energy can become a critical component in economic diversification strategies. Thus, research on this relationship not only enriches the body of economics by integrating environmental variables and renewable energy, but also provides applicable insights that help in formulating economic policies and strategies that support sustainable growth in Southeast Asia.

## 2 Literature Review

### Economic Growth Theory

The theory of economic growth proposed by John Maynard Keynes in his 1936 work, "The General Theory of Employment, Interest, and Money," made substantial contributions to the understanding of modern macroeconomics. Keynes argued that total demand in an economy, or aggregate demand, is the key factor that determines the overall level of economic output and the rate of unemployment. Keynes emphasized the importance of consumption in the economy. According to him, consumption is the largest component of aggregate demand [29]. The income received by individuals tends to be mostly spent on consumption, and a small portion is saved. This proportion of income spent versus saved is what Keynes called the marginal propensity to consume (MPC). Keynes argued that the higher the MPC of an economy, the greater the impact of consumption expenditure on the economy as a whole, because any additional income earned tends to be spent back in the economy. investment is also a key component in Keynes's theory [30].

### Environmental Kuznets Curve Theory

The Environmental Kuznets Curve Theory, often referred to as the Environmental Kuznets Curve Hypothesis (EKC), is a very important theoretical development in environmental economics. This theory is an adaptation of the original Kuznets Curve, introduced by economist Simon Kuznets in the 1950s. The original Kuznets curve describes the relationship between economic growth and income distribution, proposing that income inequality will initially increase with economic growth and then decrease after reaching a certain point [31]. In an environmental context, this theory was adapted to explain the relationship between economic growth and environmental degradation. The Environmental Kuznets Curve Theory was first introduced in the early 1990s by economists such as Gene Grossman and Alan Krueger in a study entitled "Environmental Impacts of a North American Free Trade Agreement" in 1991 [32].

**Economic growth**

Economic growth is defined as an increase in a country's economic production capacity to meet the needs and desires of its population. It is often measured through the annual growth rate of increase in gross domestic product (GDP) which measures the total value of goods and services produced by an economy. Positive economic growth indicates an increase in the economy's ability to produce output, which is generally interpreted as a sign of increasing welfare [33]. Economic growth is not only about increasing output and efficiency but also about creating a more inclusive and sustainable society that is able to provide opportunities for all members of society [34]. Economic growth should be seen as a tool for expanding people's capabilities, which means enabling them to have the lives they value. This definition shifts the focus from simply increasing the production of goods and services to increasing human well-being and freedom [35].

**Consumption Renewable energy**

Renewable energy is an energy source obtained from sustainable natural processes and cannot be exhausted, which differentiates it from fossil fuels which have a limited supply and can run out. This definition includes a variety of energy sources that are continuously replenished by Earth's natural processes. Renewable energy includes energy sources such as sun, wind, water (hydro), geothermal, and biomass. Solar energy, for example, is produced through the use of solar panels that convert sunlight into electricity through a photovoltaic process or using the sun's heat for direct heating or large-scale electricity production. The definition of renewable energy consumption refers to the use of renewable energy resources, that is, energy sources that can naturally be recovered on a human time scale [36].

**Foreign Direct Investment (FDI)**

Foreign Direct Investment (FDI) is defined as an investment made to obtain long-term interests by an entity domiciled in one country (foreign investor) in an entity domiciled in another country (foreign entity), with the primary aim of having a significant influence on the management of the company the. Typically, this significant influence is assumed to be achieved when investors own at least 10% of the shares with voting rights of the foreign company. Foreign Direct Investment (FDI) includes the process by which investors make direct investments to establish new businesses, buy shares in existing companies, or re-invest profits from foreign-owned companies [37].

**Fuel Exports**

Fuel exports are defined as the process of sending fuel from one country to another, which usually involves bilateral or multilateral trade agreements. Fuel exports are the activity of selling fuel such as crude oil, natural gas and coal to other countries. This activity is an important part of international trade and plays a crucial role in the global economy. Fuels, especially fossil energy, have long been the backbone of industrial activity and energy consumption throughout the world. The main goal is to meet energy demand in recipient countries, which may not have sufficient natural resources to meet their domestic needs [38].

## 3. Method

This research is quantitative research with an associative approach. The associative approach is used to look for relationships or contributions between one variable and another variable, as well as testing and using the truth of a problem or knowledge that occurs [39]. The data used is secondary data obtained from World Bank reports. Research was conducted in countries in the Southeast Asia region including Indonesia; Malaysia; Singapore; Thailand; Philippines; Brunei Darussalam; Vietnamese; Laos; Myanmar; Cambodia. The research period was carried out from 2010 to January 2020. The research used panel data with a total sample size of 110. Variables in the research carried out included the dependent variable, namely economic growth (EG), then the independent variables included Renewable Energy Consumption (REC) , Foreign Direct Investment (FDI) and Fuel Exports (FE).

The statistical software used is Eviews 9. The data analysis technique is carried out in several stages, namely the panel data model selection test consisting of the Fixed Effect Model (FEM); Random Effect Model (REM); Common Effect Model (CEM) by carrying out the Chow Test, Hausman Test and Lagrange Multiplier (LM) Test. The Chow test is a statistical method used to determine whether there are significant structural changes in the regression relationship between two groups or different time periods. In the context of panel data, this test is very useful to assess whether the regression parameters of two subgroups in the data (for example, before and after policy implementation) are statistically different. The Hausman test is used to choose between the Fixed Effect Model (FEM) and the Random Effect Model (REM) in panel data analysis. This test is based on the difference between estimates from the two models. The null hypothesis in the Hausman Test is that the more efficient estimator (in this case, the estimator from REM) is consistent and unbiased, meaning that the specific effect is uncorrelated with the regressors in the model. The Lagrange Multiplier (LM) test, also known as the Breusch-Pagan test in the context of panel data models, is used to test for the presence of random effects in the model. The LM test evaluates the null hypothesis that the variance of the random component is zero, meaning there is no random effect. In panel data, this test is relevant when researchers want to ascertain whether the random effects model (REM) approach is more appropriate than the common effects model. The next selection test is the Classic Assumption Test which consists of: Normality Test then continued with the Multicollinearity Test and the next stage is the Heteroscedasticity Test and finally the Autocorrelation Test then the Multiple Regression Test, Partial Signification Test (T Statistical Test), Simultaneous Signification Test (F Statistical Test) and Coefficient of Determination (R2) [40].

## 4. Results and Discussion

### 4.1 Results

**Table 3.**Chow Test Results

| Effects Test | Statistics | df | Prob. |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Cross-section F | 3.640555 | 9.97 | 0.0006 |
| Chi-square cross-section | 32.011549 | 9 | 0.0002 |

Source: Data Processing Results (2024)

The Chow test is used to evaluate the stability of relationships between variables over time or between groups. The main advantage of the Chow Test is its ability to provide a clear and measurable method for detecting changes in dynamic relationships between variables. This test is particularly useful in policy impact analysis, where legislative or policy changes are often expected to produce clear effects on economic variables. From table 3, the results of the Chow test regarding the relationship between Renewable Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) with economic growth (EG) in Southeast Asian countries, the probability value is 0.00002 and below 0.05, then the Fixed Effect Model (FEM) model was selected. This shows that the very low probability value (0.00002), far below the general threshold of 0.05, indicates rejection of the null hypothesis that there are no fixed or individual-specific effects influencing the model. This implies that there are unique factors at the country level that consistently influence economic growth, which need to be modeled explicitly to produce accurate and unbiased estimates.

**Table 4.**Hausman Test Results

| Test Summary | Chi-Sq. Statistics | Chi-Sq. df | Prob. |
|---|---|---|---|
| Random cross-section | 0.801733 | 3 | 0.8491 |

Source: Data Processing Results (2024)

The Hausman test operates by calculating the difference between estimators obtained from FEM and REM. This is based on the assumption that if random effects (REM) are unbiased, then they should produce similar results. However, if a significant difference is detected, then this indicates a correlation between the unobserved effects in the FEM and the independent variables, which will cause the REM estimator to be biased. This test is important in providing statistical evidence of whether unobserved variables influence the study results, thereby influencing the choice of model. From table 4, the results of the Hausman test regarding the relationship between Renewable Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) with economic growth (EG) in Southeast Asian countries, the probability value is at number0.8491and above 0.05 then the Random Effect Model (REM) model was selected. This indicates that there is no significant difference between the Fixed Effect Model (FEM) and Random Effect Model (REM) estimators, so the Random Effect Model (REM) was chosen as the more appropriate model for this analysis. This implies that variability in Economic Growth in the region can be assumed to be more randomly distributed rather than having a systematic dependence on country-specific characteristics that remain constant over time.

**Table 5.**Lagrange Multiplier (LM) Test Results

| | Test Hypothesis | | |
|---|---|---|---|
| | Cross-section | Time | Both |
| Breusch-Pagan | 15.76541 | 0.384093 | 16.14950 |
| | (0.0001) | (0.5354) | (0.0001) |

Source: Data Processing Results (2024)

The Lagrange Multiplier (LM) test, often known in the context of regression models as the Breusch-Pagan test, is a statistical technique used to detect the presence of heteroscedastic

variance or random effects in a regression model. In the context of panel data, LM is specifically used to test the presence of random variable components in the Random Effect Model (REM). In panel data analysis, the use of the LM Test is very relevant when the researcher wants to assess whether there is individual or time-specific variation that is not explained by a regression model that only contains fixed effects or observed variables. This test is especially important in situations where failure to identify and model random variability can lead to model misspecification and biased parameter estimates. From table 5, the results of the Lagrange Multiplier (LM) Test regarding the relationship between Renewable Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) with economic growth (EG) in Southeast Asian countries, the cross section value is in number0.0001and below 0.05 then the Random Effect Model (REM) model was selected. This indicates that the use of the LM test and the selection of REM in this study helps in identifying and validating the specific and general effects of important variables such as REC, FDI, and FE on economic growth in Southeast Asia. These results suggest the need for a more nuanced approach to policy planning that not only targets general-based interventions but also accommodates the specific needs and conditions in each country. The very low probability values in the LM Test also add statistical validity to the REM selection, indicating that this analysis not only accounts for observed variables but also recognizes and incorporates unobserved variability that is important for fully understanding economic growth dynamics. This recognition is key to producing more precise and effective policy recommendations that take into account the complexity of local conditions as well as global influences.

**Table 6.**Normality Test Results

| Std. Dev | Jarque- Bera | Probability |
|---|---|---|
| 0.514208 | 0.724001 | 0.858540 |

Source: Data Processing Results (2024)

Normality test to see the distribution of data on the variables used in carrying out the research. In this context, normality tests were carried out using Jarque-Bera statistics implemented through EViews software. The Jarque-Bera test is an effective method for testing whether data samples have skewness and kurtosis that correspond to a normal distribution. From the results of the normality test presented in Table 6, the value of Jerque-Bera is 0.724 or if defined as a number smaller than number 2 and in obtaining the statistical test, the value of Probability is 0.858, meaning that the number is greater than the standard. The determination of passing the test is 0.05 so that from this normality test the data on the variable relationship between Renewable Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) with economic growth (EG) in Southeast Asian countries is stated is legally normal and of course the data on the variables used are very appropriate in representing both the sample size and population in the study. This shows that
The Jarque-Bera value of 0.724 which is smaller than 2 and the probability value of 0.858 which is far above the threshold of 0.05 statistically indicates that the data is considered normal. This condition is very important because the assumption of normality is the basis of many parametric statistical techniques, including linear regression analysis and analysis of variance, which may be used to more deeply analyze the relationships between these variables. Data normality indicates that parameter estimation will be more efficient and hypothesis testing carried out on the data will be valid. A declaration of data normality also implies that the data used in this research is representative of the wider population and that the sample used is suitable for further analysis. This means that the research can be relied upon to make generalizations that apply not

only to the sample analyzed but also potentially to the larger population of Southeast Asian countries. This is important in economic research, where the accuracy of data representation of a population can influence the resulting policies and recommendations.

**Table 7.**Multicollinearity Test Results

| Variables | Coefficient Variance | Uncentered VIF | Centered VIF |
|---|---|---|---|
| C | 31.761610 | 803.0609 | NA |
| Renewable Energy Consumption (REC) | 5.47E-08 | 7.368331 | 2.123480 |
| Foreign Direct Investment (FDI) | 2.75E-07 | 57.31860 | 1.787560 |
| Fuel Exports (FE) | 0.239082 | 657.8773 | 1.425350 |

Source: Data Processing Results (2024)

The multicollinearity test was carried out with the aim of finding out whether a very high correlation was found between the variables taken during the research implementation or whether no correlation was found. Multicollinearity testing is an important step to ensure that the regression model used does not experience the problem of excessive linear dependence between independent variables. The results of the multicollinearity test presented in Table 7 provide the results of the VIF or Variance Inflation Factor Renewable Energy Consumption (REC)2.123480, Foreign Direct Investment (FDI) amounting to1.787560, Fuel Exports (FE) amounting to1.425350and for each variable the VIF number value does not exceed the number limit of 10 so that from this multicollinearity test the data on the variables Renewable Energy Consumption (REC), Renewable Energy (RE) and Fuel Exports (FE) are free from correlation in each of these independent variables.

This shows that the independence between the independent variables (REC, FDI, FE) shows that the regression model used in this research is stable and provides reliable parameter estimates. Second, by eliminating concerns about serious multicollinearity, researchers can be more confident in the interpretation of the influence of each independent variable on the dependent variable, EG, without worrying that this effect is tainted by high internal correlations among the independent variables. The quality of a regression model in economic research depends greatly on its freedom from multicollinearity distortion. In this case, the model used in this study shows strength in modeling the relationship between variables with accuracy due to the lack of multicollinearity. This allows for sharper analysis and better informed policy, based on the results derived from these models.

**Table 8.**Heteroscedasticity Test Results

| F-statistics | Obs*R-squared | Prob. F | Prob. Chi-Square |
|---|---|---|---|
| 1.382130 | 5.264344 | 0.2101 | 0.2132 |

Source: Data Processing Results (2024)

The Heteroscedasticity Test is carried out with the aim of finding out whether the research implementation is similar to other observations that are in line. In regression analysis, the heteroscedasticity test is important to verify that the variation of the regression error is uniform across observations. Heteroscedasticity occurs when the variance of the errors is not constant, which can lead to inefficient coefficient estimates and biased standard errors, thereby interfering

with hypothesis testing. From the results of the heteroscedasticity test presented in Table 8, the results of the probability value by looking at Obs R*Square are obtained with the number 0.2132 or if defined as a number greater than 0.05, so from the heteroscedasticity test the data from the Renewable relationship variable research Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) with economic growth (EG) in Southeast Asian countries which are carried out are free from problems related to the similarity of variations in other observations.

This indicates that there is no evidence to support the existence of heteroscedasticity in the model tested. In econometric practice, a p value above the threshold of 0.05 in the context of a heteroscedasticity test indicates that the variance of the errors or residuals across the data is fairly homogeneous. The absence of heteroscedasticity indicates that the regression model used provides efficient and consistent estimates, with minimum variance. This allows researchers and policymakers to trust the results produced in terms of the influence of independent variables on EG, without needing to worry about potential bias or inefficiency in the estimates. This also ensures reliability in the statistical tests performed, such as t tests for coefficients, because the standard errors used in such tests are valid. By confirming that the data is free from heteroscedasticity, it can be interpreted that the data quality and model selection in this research are appropriate. This indicates that independent variables such as REC, FDI, and FE have been measured and modeled in an adequate way to capture their influence on EG without being distorted by inconsistent residual variability. This fit is important for hypothesis testing and further modeling that may be conducted in follow-up studies or policy applications. .

**Table 9.**Autocorrelation Test Results

| F-statistics | Obs*R-squared | Prob. F | Prob. Chi-Square |
|---|---|---|---|
| 0.790184 | 3.041507 | 0.5784 | 0.2041 |

Source: Data Processing Results (2024)

The autocorrelation test was carried out with the aim of finding out whether the variables in the research implementation occurred in the same research period or not. The autocorrelation test is an important step to ensure that the observations in the model are not serially correlated, that is, there is no error pattern that repeats itself over consecutive time periods. This is important because the presence of autocorrelation can undermine basic assumptions in standard regression models, which can lead to incorrect hypothesis testing and biased parameter estimates. From the results of the autocorrelation test presented in Table 9, the results of the probability values by looking at ObsR*Square are obtained with the number 0.2041 or if defined as a number greater than 0.05, so from this autocorrelation test the data from the research from research on the relationship variables between Renewable Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) with economic growth (EG) in Southeast Asian countries which was carried out without problems, there were similarities in the time sequence in other studies conducted aligned.

These results indicate that there is no significant evidence of autocorrelation in the analyzed model residuals, indicating that the residuals from the regression model are independent of each other over time. The absence of significant autocorrelation in the residuals implies that the regression model used in this study provides efficient and unbiased estimates. With serially uncorrelated residuals, the confidence intervals and hypothesis tests performed in the analysis are more likely to reflect the true accuracy and variability of the data. This is important for the

validity of the conclusions drawn from the model and for the reliability of policy recommendations that may be built on the results of the analysis. Autocorrelation test results showing the absence of autocorrelation also indicate the quality of the data and the validity of the regression model used. In the context of economic research using panel or time series data, ensuring that the data do not have autocorrelation is key to ensuring that the patterns identified in the data indeed represent cause-and-effect relationships and are not simply a reflection of temporal dependencies in the data collection. Therefore, these results confirm the methodological strength of the study and increase confidence in generalizing the findings.

**Table 10.**Random Effect Model (REM) Selected Model Test Results

| Variables | Coefficient | Std. Error | t-Statistics | Prob. | Prob (F-statistics) | Adjusted R-squared |
|---|---|---|---|---|---|---|
| C | 0.420657 | 1.111235 | 0.378549 | 0.7058 | 0.017450 | 0.265052 |
| Renewable Energy Consumption (REC) | 0.191643 | 0.063859 | 3.001058 | 0.0034 | | |
| Foreign Direct Investment (FDI) | 0.999380 | 1.092179 | 0.915034 | 0.3623 | | |
| Fuel Exports (FE) | 0.110784 | 0.154356 | -0.717716 | 0.4745 | | |

Source: Data Processing Results (2024)

Selected model test analysis Random Effect Model (REM) is a very relevant approach in panel data analysis which involves repeated observations of the same subjects under different conditions. REM is particularly useful in economic research that includes data from various countries, such as studies that look at the relationship between Renewable Energy Consumption (REC), Foreign Direct Investment (FDI), and Fuel Exports (FE) with Economic Growth (EG) in a country. -Southeast Asian countries. This model allows for random variation at the country level, which can include unobserved factors that influence economic growth. Using REM to analyze the relationship between REC, FDI, and FE on EG allows researchers to capture the general influence of these variables across regions by accommodating random fluctuations specific to each country.

The Partial Significance Test (T Statistical Test) is a test for implementing the direction of the relationship between the independent variable and the direction of the dependent variable individually or for each variable. From the results of the Partial Significance Test (T Statistical Test) presented, obtained from table 10, it shows that Renewable Energy Consumption (REC) has an influence on Economic Growth (EG) in Southeast Asian countries. The very small probability value (0.0034), well below the threshold of 0.05, and the positive t-value (3.001058) confirm the strength and statistical significance of this relationship. These findings confirm that initiatives and investments in renewable energy not only support environmental sustainability but also contribute significantly to economic growth in the region. Thus, RECs can be considered as an effective catalyst for improving regional economic performance. In contrast to REC, Foreign Direct Investment (FDI) shows an insignificant relationship with Economic Growth, as indicated by a probability value higher than 0.05 (0.3623) and a relatively low t-

value (0.915034). These findings indicate that, in the context of the data and study period, FDI does not have a statistically significant effect on economic growth in Southeast Asian countries. This can be caused by various factors, including possible structural obstacles, economic policies, or market conditions that do not support the direct effect of FDI on economic growth. Fuel Exports (FE), similar to FDI, also do not show a significant relationship with Economic Growth. The high probability value (0.4745) and negative t-value (-0.717716) indicate that there is no significant relationship between fuel exports and economic growth in this context. These results may indicate that the economies of Southeast Asian countries are less dependent on revenues from fuel exports or that global market dynamics and fuel prices have a more complex influence that is not directly visible in economic growth.

The Simultaneous Signification Test (F Statistical Test) is a test for implementing the direction of the relationship between independent variables and the direction of the dependent variable in a comprehensive and joint manner. From the results of the Silmutan Signification Test (F Statistical Test) which are presented in table 10, the numbers obtained from F Count with numbers0.378549and obtained a probability number from the test results of0.017450or if defined as a number smaller than 0.05. Because this probability value is smaller than 0.05, the results of the F test show that overall, the regression model with these three variables significantly explains the variability in Economic Growth in Southeast Asian countries. This means that although some variables such as FDI and FE individually do not show statistical significance, they still make an important contribution when considered together with other variables in the model. These findings have important implications for economic policy and strategy in the Southeast Asia region. The finding that these variables collectively have a significant effect on EG suggests that policies targeting any or all of these aspects of renewable energy development, FDI attraction, and fuel export strategies can have far-reaching effects on the economy. Additionally, it emphasizes the importance of a holistic approach in formulating economic policies that considers how these variables interact with each other and influence overall economic growth.

The Coefficient of Determination Test or more often called the R2 Test is an implementation test to see the amount of contribution from the independent variable to the dependent variable. From the results of the Determination Coefficient Test presented in table 7, the Adjusted R-squared with numbers is obtained0.265052or if defined as 26.5%, it shows that Renewable Energy Consumption (REC), Foreign Direct Investment (FDI) and Fuel Exports (FE) have contributed to Economic Growth (EG) in Southeast Asian Countries with the remaining 73.5% being a contribution from other variables. These results have several important implications. Firstly, while 26.5% appears to be a moderate contribution, it remains significant in a macroeconomic context, where Economic Growth is influenced by a variety of complex factors. Second, the remaining 73.5% of EG variability not explained by the model suggests that there are still other factors, beyond the selected variables, that contribute to economic growth in these countries. These factors may include, but are not limited to, government policies, political conditions, demographic changes, technological innovations, and global market dynamics not captured in the model.

## 4.2 Discussion

**Renewable Energy Consumption and Economic Growth**

From the results of the resulting statistical tests, it was found that Renewable Energy Consumption (REC) had an effect on Economic Growth (EG) for the 2010-2020 period in Southeast Asian Countries, this is because the increase in renewable energy consumption in Southeast Asia has been proven to strengthen the country's energy infrastructure. -this country. Policies supporting the development of renewable energy sources have encouraged investment in clean technologies, which not only reduce dependence on fossil energy sources but also lower energy costs in the long term. These investments, in turn, stimulate economic activity and create new jobs, both within the energy sector itself and in related sectors. The transition to renewable energy also contributes to economic stability. Countries that rely on fossil fuel imports often experience price uncertainty that can disrupt the macroeconomy. Renewable energy, which is generally produced locally, offers greater price certainty and helps reduce the risk of energy price fluctuations. This indirectly supports stable economic growth by reducing unexpected costs and supporting more effective long-term planning by governments and businesses. The use of renewable energy supports environmental conservation efforts, which is very important considering the increasingly pronounced impacts of climate change. Reducing greenhouse gas emissions and more sustainable management of natural resources helps ensure environmental sustainability which, ultimately, is the basis of long-term economic growth. This also improves the image of Southeast Asian countries internationally, often attracting bigger and better foreign direct investment. The application of renewable energy technology often encourages domestic innovation and technological development. This can be seen from the increase in the number of patents and industrial designs in the field of renewable energy in several Southeast Asian countries. Education and research in the sector also received a boost, strengthening the country's intellectual and innovative foundations. In this way, it not only produces energy, but also creates an ecosystem that supports the development of advanced technology. Renewable energy consumption has increased energy independence in the Southeast Asian region, enabling these countries to reduce their dependence on volatile global energy markets. This not only strengthens national security but also provides a more stable foundation for economic growth. In the long term, this energy independence has the potential to provide greater economic stability, allowing these countries to allocate resources more efficiently and focus on internal economic development.

These findings are in line with the hypothesis developed by research researchers (Lie, 2021) showing a positive correlation between renewable energy and GDP development, which shows that renewable energy sources have a significant impact on the economic growth of South Asian countries [41]. Research (Chen, 2023) provides results that the economic benefits of using renewable energy in electricity have an impact on economic growth, employment and driven productivity growth [42].

**Foreign Direct Investment (FDI) and Economic Growth**

From the results of the statistical tests produced, it was found that Foreign Direct Investment (FDI) had no effect on Economic Growth (EG) for the 2010-2020 period in Southeast Asian Countries, this is because the quality and type of FDI entering Southeast Asian countries can be the main factor. Many countries in the region receive FDI that is primarily focused on extractive industries or low-intensity manufacturing, providing little technology transfer or local capacity building. This type of investment may not be enough to trigger sustainable economic growth or significant economic transformation, which relies more on innovation and increased productivity. The economic structure of Southeast Asian countries and the readiness of their

infrastructure also play an important role. In many cases, inadequate basic infrastructure and a lack of skilled labor can hinder FDI's ability to contribute to local economic growth. For example, if foreign investment is made in sectors that are not well integrated into the local economy or if supporting infrastructure (such as transport and communications) is underdeveloped, then the positive impact of FDI on economic growth may be minimal. Political stability and inconsistent economic policies can also reduce the effectiveness of FDI in driving economic growth. In some Southeast Asian countries, political instability or frequently changing economic policies make foreign investors hesitant to invest in long-term or high-risk projects that may be more beneficial to the local economy. In addition, corruption and lack of transparency in licensing and regulatory processes can also reduce the efficiency and effectiveness of FDI. The impact of the global financial crisis and trade wars between major countries such as the United States and China may also have affected FDI and economic growth in Southeast Asia. In the 2010-2020 period, global economic uncertainty and changes in global supply chains may have led to a decline in foreign investment in the region, which in turn affected economic growth. The nature of FDI, which is more oriented towards seeking short-term profits than long-term investment in infrastructure and productive capacity, may also have reduced its potential to support economic growth. Foreign investors often seek quick returns and may not commit to building industries or sectors that can provide long-term economic benefits to the host country.

This finding does not have a direction that is in line with the hypothesis developed but is in line with research (Siddikee, 2021) which provides different results that the impact of FDI was found to be very negative in the long term on GDP which shows vulnerability [43]. Research support (Le, 2022) provides different results that the disproportionate impact of foreign direct investment on economic growth is recorded in the long term, and the disproportionate impact of environmental pollution on the economy occurs in both the short and long term [44].

**Fuel Exports and Economic Growth**

From the results of the resulting statistical tests, it was found that Fuel Exports (FE) had no effect on Economic Growth (EG) for the 2010-2020 period in Southeast Asian Countries, this is because excessive dependence on fuel exports often causes what is known as ' Dutch Disease' or Dutch disease, where other sectors in the economy experience a setback because the national currency exchange rate strengthens due to increased income from exports. This stronger exchange rate makes other products less competitive in international markets, thereby reducing non-fuel exports. Countries in Southeast Asia that rely heavily on fuel exports may have experienced declines in other economic sectors that could have encouraged more diversified and sustainable economic growth. Investments in the fuel sector often do not provide many employment opportunities for local residents due to the highly automated and technology intensive nature of the industry. This means that although there is an increase in income from fuel exports, this does not directly increase employment opportunities or economic welfare for the wider community. Thus, revenues from fuel exports may not have a major impact on increasing household income or domestic consumption. Volatility in fuel prices in global markets can cause economic instability in countries that depend on fuel exports. Extreme price fluctuations, which often occur due to changes in international political policies or other global market dynamics, can cause difficulties in macroeconomic planning and management. This

instability could reduce the effectiveness of fuel exports as a driving force for stable and sustainable economic growth. A focus on fuel exports often diverts attention and resources from investment in domestic infrastructure and other more sustainable sectors of the economy. Countries that invest excessively in fuel exports may neglect local industrial development or innovation in green technology, which in turn may put the economy at a disadvantage in the long term, especially as the world shifts to alternative energy sources. Environmental challenges arising from fuel extraction and export also have the potential to limit economic growth. Environmental damage, such as pollution and ecosystem degradation, can have a significant negative impact on other sectors such as tourism and agriculture, which are also important for local economies in Southeast Asian countries.

This finding does not have a direction that is in line with the hypothesis developed but is in line with the results of research by (Edo, 2020) that the estimation results reveal an insignificant impact of exports on economic growth, in the short term [45]. Research support (Wang, 2021) provides evidence that export quality causes a decrease in emission levels and real GDP, non-renewable energy, and urbanization contribute to an increase in emissions and real GDP [46].

## 5. Conclusion

The research findings show that Renewable Energy Consumption (REC) has an effect on Economic Growth (EG) in Southeast Asian Countries, this is because increasing renewable energy consumption in Southeast Asia has been proven to strengthen energy infrastructure in these countries. Policies supporting the development of renewable energy sources have encouraged investment in clean technologies, which not only reduce dependence on fossil energy sources but also lower energy costs in the long term. Foreign Direct Investment (FDI) has no effect on Economic Growth (EG) in Southeast Asian Countries, this is because the quality and type of FDI entering Southeast Asian countries can be a major factor. Many countries in the region receive FDI that is primarily focused on extractive industries or low-intensity manufacturing, providing little technology transfer or local capacity building. This type of investment may not be enough to trigger sustainable economic growth or significant economic transformation, which relies more on innovation and increased productivity. Fuel Exports (FE) has no effect on Economic Growth (EG) in Southeast Asian Countries, this is because excessive dependence on fuel exports often causes what is known as 'Dutch Disease', in other sectors in the economy experienced a setback due to the strengthening of the national currency exchange rate due to increased income from exports. This stronger exchange rate makes other products less competitive in international markets, thereby reducing non-fuel exports. Countries in Southeast Asia that rely heavily on fuel exports may have experienced declines in other economic sectors that could have encouraged more diversified and sustainable economic growth..

This research provides valuable insights but also faces several limitations that are important to note. Southeast Asia is a very diverse region economically, politically and socially. Research that combines data from different countries may obscure country-specific results. This limitation limits the ability to apply the findings specifically to each country, as each country has unique policies, priorities, and economic contexts. It is recommended that for further research approaching research with individual case studies for countries within the region can help identify unique dynamics that may not be visible in aggregate analysis. This research may also be limited by the inadequate use of cross-time data to analyze long-term trends and changing

dynamics in renewable energy consumption, FDI, and fuel exports. A short period of time may not be enough to observe the long-term effects of policy or economic changes. Using panel data covering longer periods and more comprehensive variables can help overcome the problem of data across time and provide insight into long-term effects. Taking these suggestions into account, future research can deepen and expand understanding of the influence of renewable energy, FDI, and fuel exports on economic growth, especially in a context as diverse and dynamic as Southeast Asia.

## References


[1] N. Carlos and D. B. Lorente, "Trade : The Evidence for the European Union," *Energies*, vol. 13, no. 18, 2020, [Online]. Available: https://www.mdpi.com/1996-1073/13/18/4838.

[2] A. Kwilinski, O. Lyulyov, and T. Pimonenko, "Inclusive Economic Growth: Relationship between Energy and Governance Efficiency," *Energies*, vol. 16, no. 6, pp. 1–16, 2023, doi: 10.3390/en16062511.

[3] M. Kahia, A. Omri, and B. Jarraya, "Does green energy complement economic growth for achieving environmental sustainability? Evidence from Saudi Arabia," *Sustain.*, vol. 13, no. 1, pp. 1–12, 2021, doi: 10.3390/su13010180.

[4] M. Kahia, A. Omri, and B. Jarraya, "Green Energy, economic growth and environmental quality nexus in Saudi Arabia," *Sustain.*, vol. 13, no. 3, pp. 1–13, 2021, doi: 10.3390/su13031264.

[5] J. Chontanawat, "Dynamic modelling of causal relationship between energy consumption, CO2 emission, and economic growth in SE Asian countries," *Energies*, vol. 13, no. 24, 2020, doi: 10.3390/en13246664.

[6] K. E. Elfaki, R. D. Handoyo, and K. H. Ibrahim, "The impact of industrialization, trade openness, financial development, and energy consumption on economic growth in Indonesia," *Economies*, vol. 9, no. 4, 2021, doi: 10.3390/economies9040174.

[7] M. Piłatowska, A. Geise, and A. Włodarczyk, "The effect of renewable and nuclear energy consumption on decoupling economic growth from CO2 emissions in Spain," *Energies*, vol. 13, no. 9, 2020, doi: 10.3390/en13092124.

[8] R. Nepal, H. Phoumin, and A. Khatri, "Green technological development and deployment in the association of southeast Asian economies (ASEAN)—At crossroads or roundabout?," *Sustain.*, vol. 13, no. 2, pp. 1–19, 2021, doi: 10.3390/su13020758.

[9] T. T. Nguyen and V. C. Nguyen, "Financial development and renewables in southeast asian countries—the role of organic waste materials," *Sustain.*, vol. 13, no. 16, pp. 1–18, 2021, doi: 10.3390/su13168748.

[10] S. Suriyankietkaew and S. Nimsai, "COVID-19 impacts and sustainability strategies for regional recovery in southeast asia: Challenges and opportunities," *Sustain.*, vol. 13, no. 16, 2021, doi: 10.3390/su13168907.

[11] M. Madaleno and M. C. Nogueira, "How Renewable Energy and CO2 Emissions Contribute to Economic Growth, and Sustainability—An Extensive Analysis," *Sustain.*, vol. 15, no. 5, pp. 1–15, 2023, doi: 10.3390/su15054089.

[12] M. Yang and J. Kim, "Revisiting the relation between renewable electricity and economic growth: A renewable-growth hypothesis," *Sustain.*, vol. 12, no. 8, 2020, doi: 10.3390/SU12083121.

[13] S. Ali, S. Akter, and C. Fogarassy, "The role of the key components of renewable energy (Combustible renewables and waste) in the context of co2 emissions and economic growth of selected countries in europe," *Energies*, vol. 14, no. 8, 2021, doi:

10.3390/en14082034.
[14] K. Makieła, B. Mazur, and J. Głowacki, “The Impact of Renewable Energy Supply on Economic Growth and Productivity,” *Energies*, vol. 15, no. 13, 2022, doi: 10.3390/en15134808.
[15] Y. He, X. Li, P. Huang, and J. Wang, “Exploring the Road toward Environmental Sustainability: Natural Resources, Renewable Energy Consumption, Economic Growth, and Greenhouse Gas Emissions,” *Sustain.*, vol. 14, no. 3, 2022, doi: 10.3390/su14031579.
[16] M. Žarković *et al.*, “Effects of Renewable and Non-Renewable Energy Consumption, GHG, ICT on Sustainable Economic Growth: Evidence from Old and New EU Countries,” *Sustain.*, vol. 14, no. 15, 2022, doi: 10.3390/su14159662.
[17] E. Jushi, E. Hysa, A. Cela, M. Panait, and M. C. Voica, “Financing Growth through Remittances and Foreign Direct Investment: Evidences from Balkan Countries,” *J. Risk Financ. Manag.*, vol. 14, no. 3, 2021, doi: 10.3390/jrfm14030117.
[18] R. Sijabat, “The Association of Economic Growth, Foreign Aid, Foreign Direct Investment and Gross Capital Formation in Indonesia: Evidence from the Toda–Yamamoto Approach,” *Economies*, vol. 10, no. 4, 2022, doi: 10.3390/economies10040093.
[19] J. Dempere, M. Qamar, H. Allam, and S. Malik, “The Impact of Innovation on Economic Growth, Foreign Direct Investment, and Self-Employment: A Global Perspective,” *Economies*, vol. 11, no. 7, pp. 1–22, 2023, doi: 10.3390/economies11070182.
[20] C. E. Bazán Navarro and V. J. Álvarez-Quiroz, “Foreign Direct Investment and Exports Stimulate Economic Growth? Evidence of Equilibrium Relationship in Peru,” *Economies*, vol. 10, no. 10, 2022, doi: 10.3390/economies10100234.
[21] M. Belloumi and K. Touati, “Do FDI Inflows and ICT Affect Economic Growth? An Evidence from Arab Countries,” *Sustain.*, vol. 14, no. 10, 2022, doi: 10.3390/su14106293.
[22] F. C. Wehncke, G. Marozva, and P. L. Makoni, “Economic Growth, Foreign Direct Investments and Official Development Assistance Nexus: Panel ARDL Approach,” *Economies*, vol. 11, no. 1, 2023, doi: 10.3390/economies11010004.
[23] E. Karakostas, “What Determines the Fuel Exports: The Case of Norway,” *Eur. J. Energy Res.*, vol. 2, no. 1, pp. 8–12, 2022, doi: 10.24018/ejenergy.2022.2.1.40.
[24] J. U. Shepard and L. F. Pratson, “Maritime piracy in the Strait of Hormuz and implications of energy export security,” *Energy Policy*, vol. 140, pp. 1–32, 2020, doi: 10.1016/j.enpol.2020.111379.
[25] A. M. Hutagalung, D. Hartono, M. J. Arentsen, and J. C. Lovett, “The economic implications of natural gas pricing adjustment in Indonesia,” *Int. Energy J.*, vol. 20, no. 2, pp. 129–140, 2020.
[26] R. V. Caetano, A. C. Marques, and T. L. Afonso, “How Can Foreign Direct Investment Trigger Green Growth? The Mediating and Moderating Role of the Energy Transition,” *Economies*, vol. 10, no. 8, pp. 1–14, 2022, doi: 10.3390/economies10080199.
[27] F. Zeren, N. Gülcan, S. Gürsoy, İ. H. Ekşi, M. I. Tabash, and M. Radulescu, “The Relationship between Geothermal Energy Consumption, Foreign Direct Investment, and Economic Growth in Geothermal Consumer Countries: Evidence from Panel Fourier Causality Test,” *Energies*, vol. 16, no. 3, pp. 1–15, 2023, doi: 10.3390/en16031258.
[28] H. Mahmood, A. Asadov, M. Tanveer, M. Furqan, and Z. Yu, “Impact of Oil Price, Economic Growth and Urbanization on CO2 Emissions in GCC Countries: Asymmetry Analysis,” *Sustain.*, vol. 14, no. 8, 2022, doi: 10.3390/su14084562.

[29] H. Qudrat-Ullah and C. M. Nevo, “Analysis of the Dynamic Relationships among Renewable Energy Consumption, Economic Growth, Financial Development, and Carbon Dioxide Emission in Five Sub-Saharan African Countries,” *Energies*, vol. 15, no. 16, 2022, doi: 10.3390/en15165953.

[30] M. Bildirici, S. Y. Genç, and Ö. Ö. Ersin, “Effects of Fiscal and Monetary Policies, Energy Consumption and Economic Growth on CO2 Emissions in the Turkish Economy: Nonlinear Bootstrapping NARDL and Nonlinear Causality Methods,” *Sustain.*, vol. 15, no. 13, 2023, doi: 10.3390/su151310463.

[31] J. Kinnunen, I. Georgescu, and I. Nica, “Evaluating the Environmental Phillips Curve Hypothesis in the STIRPAT Framework for Finland,” *Sustainability*, pp. 1–25, 2024.

[32] A. Pavlović *et al.*, “The impact of foreign direct investments and economic growth on environmental degradation: The case of the balkans,” *Energies*, vol. 14, no. 3, 2021, doi: 10.3390/en14030566.

[33] K. Szymczyk, D. Şahin, H. Bağcı, and C. Y. Kaygın, “The effect of energy usage, economic growth, and financial development on co2 emission management: An analysis of oecd countries with a high environmental performance index,” *Energies*, vol. 14, no. 15, 2021, doi: 10.3390/en14154671.

[34] A. H. To and D. H. Vo, “The balanced energy mix for achieving environmental and economic goals in the long run,” *Energies*, vol. 13, no. 15, pp. 1–21, 2020, doi: 10.3390/en13153850.

[35] G. Ekonomou and G. Halkos, “Exploring the Impact of Economic Growth on the Environment: An Overview of Trends and Developments,” *Energies*, vol. 16, no. 11, pp. 1–19, 2023, doi: 10.3390/en16114497.

[36] R. Radmehr, S. Shayanmehr, E. B. Ali, E. K. Ofori, E. Jasińska, and M. Jasiński, “Exploring the Nexus of Renewable Energy, Ecological Footprint, and Economic Growth through Globalization and Human Capital in G7 Economics,” *Sustain.*, vol. 14, no. 19, 2022, doi: 10.3390/su141912227.

[37] H. Asada, “Effects of Foreign Direct Investment and Trade on Labor Productivity Growth in Vietnam,” *J. Risk Financ. Manag.*, vol. 13, no. 9, 2020, doi: 10.3390/jrfm13090204.

[38] M. Chepeliev, T. Hertel, and D. van der Mensbrugghe, “Cutting Russia’s fossil fuel exports: Short-term economic pain for long-term environmental gain,” *World Econ.*, vol. 45, no. 11, pp. 3314–3343, 2022, doi: 10.1111/twec.13301.

[39] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D*. Alfabeta : Bandung, 2019.

[40] listya R. Retno Tri Vulandari, *Statistika Dengan Aplikasi Eviews : Referensi Olah data Penelitian*. Gava Media : Yogyakarta, 2021.

[41] Q. Li *et al.*, “Exploring the relationship between renewable energy sources and economic growth. The case of SAARC countries,” *Energies*, vol. 14, no. 3, pp. 1–14, 2021, doi: 10.3390/en14030520.

[42] Y. Chen, J. Lin, D. Roland-Holst, X. Liu, and C. Wang, “Declining Renewable Costs, Emissions Trading, and Economic Growth: China’s Power System at the Crossroads,” *Energies*, vol. 16, no. 2, pp. 1–14, 2023, doi: 10.3390/en16020656.

[43] M. N. Siddikee and M. M. Rahman, “Foreign Direct Investment, Financial Development, and Economic Growth Nexus in Bangladesh,” *Am. Econ.*, vol. 66, no. 2, pp. 265–280, 2021, doi: 10.1177/0569434520938673.

[44] T. T. H. Le, V. C. Nguyen, and T. H. N. Phan, “Foreign Direct Investment, Environmental Pollution and Economic Growth—An Insight from Non-Linear ARDL

Co-Integration Approach," *Sustain.*, vol. 14, no. 13, 2022, doi: 10.3390/su14138146.
[45] S. Edo, N. E. Osadolor, and I. F. Dading, "Growing external debt and declining export: The concurrent impediments in economic growth of Sub-Saharan African countries," *Int. Econ.*, vol. 161, pp. 173–187, 2020, doi: 10.1016/j.inteco.2019.11.013.
[46] Z. Wang, M. Ben Jebli, M. Madaleno, B. Doğan, and U. Shahzad, "Does export product quality and renewable energy induce carbon dioxide emissions: Evidence from leading complex and renewable energy economies," *Renew. Energy*, vol. 171, pp. 360–370, 2021, doi: 10.1016/j.renene.2021.02.066.