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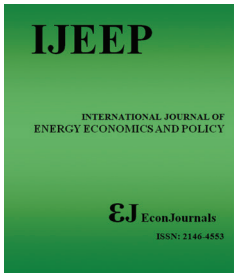

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Influence of Economy, Energy, and Population on Foreign Direct Investment and CO_2 Emissions in ASEAN-5 Countries

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ABSTRACT

This research aims to examine foreign direct investment and carbon dioxide (CO_2) emissions in ASEAN-5 countries, including Indonesia, Malaysia, the Philippines, Singapore and Thailand during the 2000-2020 period. The analytical method used is simultaneous equation analysis. The results of the foreign direct investment simultaneous equation research show that CO_2 emissions, economic growth, international trade, and renewable energy consumption simultaneously have a significant effect on foreign direct investment in ASEAN-5 countries. Partially, CO_2 emissions have a significant and negative effect on foreign direct investment. International trade has a significant and positive effect on foreign direct investment. Meanwhile, economic growth and renewable energy consumption have no effect on foreign direct investment. Furthermore, the results of the simultaneous equation analysis of CO_2 emissions show that foreign direct investment, renewable energy consumption, population, and energy intensity simultaneously have a significant effect on CO_2 emissions in ASEAN-5 countries. Partially, foreign direct investment, population, and energy intensity have a significant and positive effect on CO_2 emissions, while renewable energy consumption has a significant and negative effect on CO_2 emissions in ASEAN-5 countries.

Keywords: Foreign Direct Investment, CO_2 Emission, Economic Growth, Renewable Energy Consumption, Energy Intensity
JEL Classifications: F21, Q54, O47, Q42, Q43

1. INTRODUCTION

The Association of Southeast Asian Nations (ASEAN) is a regional organization consisting of 10 Southeast Asian countries, namely Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, Vietnam, Laos, Myanmar and Cambodia. Initially, ASEAN was founded by 5 countries, namely Indonesia, Malaysia, the Philippines, Singapore and Thailand on August 8 1967 in the main hall of the foreign affairs department building in Bangkok, Thailand. Basically, the formation of this organization is a political statement which aims to declare the independence of each country from various interests and legitimize the independence of member countries in order to achieve stability for countries in the Southeast Asia region. Where this can be achieved through cooperation in the economic and socio-cultural fields, as well as by increasing peace at the regional level.

The ASEAN-5 founding countries selected in this research are Indonesia, Malaysia, the Philippines, Singapore and Thailand. Where these five countries have more advanced economies and have a dominant role when compared to other ASEAN countries. A developed economy is an attraction for foreign investors to invest in the country. Economic benefits and the importance of Foreign Direct Investment (FDI) are considerations for some countries to promote economic growth, so that a policy is formed which aims to attract FDI (Tripathi et al., 2026). This FDI inflow contributes to a country in two ways, namely first, through increasing total investment in the host country, and second, through increasing productivity with technology (Mahmood et al., 2019). Furthermore, it is suggested that FDI plays a role in replacing domestic companies and introducing inappropriate technology which is a major source of pollution (Tripathi et al., 2026).

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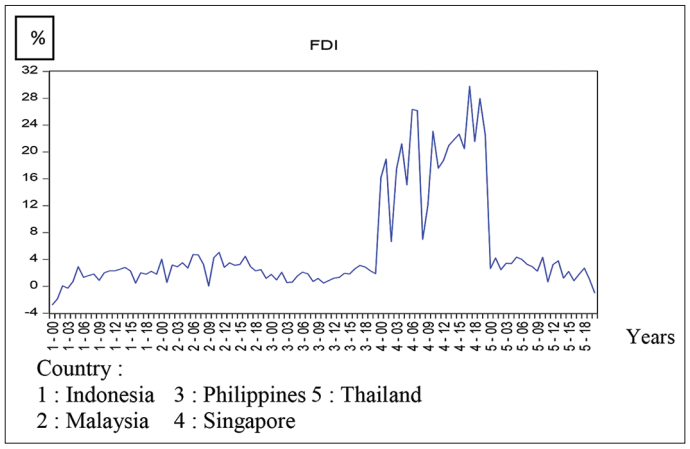
FDI is an important factor in the economy, not only increasing economic growth and employment in the destination country, but also encouraging technology transfer from the country of origin to the country of destination (Amin et al., 2022). FDI in ASEAN-5 countries is also an important topic to research, an increase or decrease in FDI flows raises important questions regarding the environmental impacts (Zeng and Eastin, 2012). The industrial sector is the main sector in FDI flows because this sector supports the country's economy so that the influx of FDI can encourage the country's economy to continue to grow (Amar, 2024). The smoother the flow of FDI, the more economic activity will increase, such as industrial activities in production which will increase levels of carbon dioxide (CO_2) emissions. The impact of environmental degradation, especially higher CO_2 emissions, can worsen environmental quality. Previous research found that the rate of natural gas emissions causes a decrease in the carrying capacity of the environment, especially air quality indicators (Goncharuk and Cirella, 2020). In this research, we will look at the variables that influence CO_2 emissions, such as energy intensity, population and renewable energy consumption. Then, the foreign direct investment (FDI) variable was also examined, whether it plays a role in CO_2 emissions or not. Comfortable environmental standards in developing countries with predictable tests, it is recommended that FDI triggers increased CO_2 emissions (Pao and Tsai, 2011; Adi et al., 2023).

Southeast Asia's Green Economy 2023 report, published on Tuesday by Bain and Company, Temasek, GenZero, and Amazon Web Services, found that the Southeast Asia region is projected to require investment of more than US 1.5 trillion by 2030 to meet its legally determined contribution. National level (NDC) of each country (Phung et al., 2023). According to the report, more than half of Green Investment in 2022 will be in Singapore and Indonesia. The government is focusing first on proven solutions to balance rising energy demand while reducing CO_2 emissions. This was pointed out by Dale Hardcastle, head of global carbon markets and director of the global sustainability innovation center at consultancy Bain and Company.

In Graph 1 you can see the development of FDI flows in 5 ASEAN countries. The highest FDI value is Singapore, while the lowest FDI value is Indonesia because it reached minus below 0 in 2000. Low FDI in various countries is a cause for concern for these countries because it is feared that it will have an impact on the economy. FDI can have an impact on the economy and environmental quality in ASEAN-5 countries. Thus, ASEAN-5 countries must be able to encourage increased FDI because it has many benefits for a country but pays attention to environmental quality. Long-term foreign direct investment can increase growth, reduce unemployment by providing jobs, providing capital, and transferring technology and skills that encourage high production. This shows how important FDI is researched. Zeng and Eastin (2012) state that overall FDI flows in developing countries encourage increased environmental awareness. In pollution-intensive sectors such as the industrial sector, FDI flows can be associated with increased CO_2 emissions, but in other sectors the same relationship does not apply to FDI. So, the benefits of this research can benefit policy makers (Essandoh et al., 2020).

Graph 1: Foreign direct investment in Association of Southeast Asian Nations-5 countries 2000-2020



Source: World Bank, 2023 (data processed)

Safe environmental standards in developing countries with predictable tests, it is recommended that FDI triggers increased CO_2 emissions (Pao and Tsal, 2011). CO_2 is a type of pollutant that dominates, accounting for 80% of air pollution. Where CO_2 emissions mostly come from developing economic activities because economic growth tends to be fast (Nosheen, 2021).

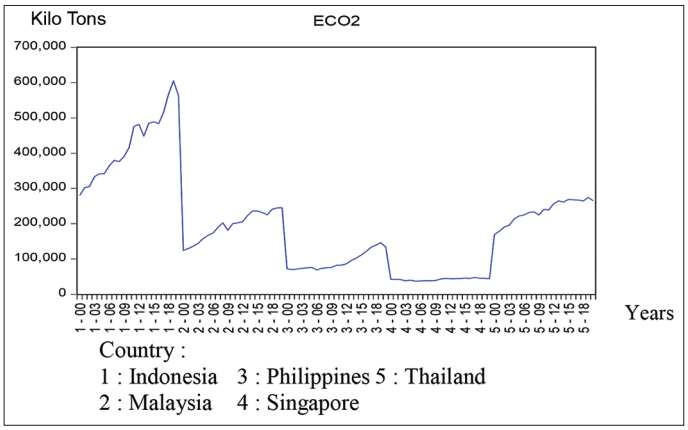
The governments of ASEAN-5 countries are trying to implement various efforts to reduce CO_2 emission levels because the higher the CO_2 emissions, the greater the impact on both the environment and the economy. For the environment, CO_2 emissions have the potential to increase the earth's surface temperature, triggering climate change and natural disasters. Meanwhile, for the economy, it resulted in disruption of economic activities both nationally and internationally. Renewable energy has the advantage of low emission capacity, which plays an important role in reducing CO_2 emissions by up to 50% by 2050 (Charfeddine and Kahia, 2019). This resource has the potential to reduce greenhouse gas emissions while providing sustainable electricity generation at lower costs compared to traditional sources (Chel and Kaushik, 2018).

In Graph 2 it can be seen that data on the development of CO_2 emissions from the five founding ASEAN countries. The highest level of CO_2 emissions is Indonesia. Then followed by Thailand, Malaysia, the Philippines, and finally Singapore. According to this data, it is proven that Indonesia has the worst environmental quality compared to the other 4 ASEAN countries, which is reflected in the highest level of CO_2 emissions. This also has an impact on Indonesia's lowest FDI inflow which is also proven in previous data. This also applies to other countries. Where FDI triggers increased CO_2 emissions (Pao and Tsal, 2011; Van Khanh and Le Phuong, 2023).

2. LITERATURE REVIEW

The relationship between energy, economy and environment is an important factor in a country's development process (Mai, 2023; Satrianto, 2024). There needs to be a balance between these three important factors in order to obtain maximum results for the

Graph 2: CO_2 emissions in Association of Southeast Asian Nations-5 countries 2000-2020



Source: World Bank, 2023 (data processed)

country's development. Where energy use plays an important role in a country's socio-economic development and living standards (Tripathi et al., 2016).

2.1. Foreign Direct Investment (FDI) and Emission CO_2

Comfortable environmental standards in developing countries with predictable tests, it is recommended that FDI triggers increased CO_2 emissions (Pao and Tsai, 2011). Every country definitely wants to obtain a healthy environment as well as a smooth flow of FDI for the purpose of economic growth. Foreign direct investment in ASEAN-5 countries is an important topic to research, an increase or decrease in foreign direct investment flows raises important questions regarding the environmental impacts (Zeng and Eastin, 2012). Zeng and Eastin (2012) state that overall FDI flows in developing countries encourage increased environmental awareness. In pollution-intensive sectors, foreign direct investment flows can be associated with increased CO_2 emissions, but in other sectors the same relationship does not apply to foreign direct investment. So, the benefits of this research can benefit policy makers (Amin et al., 2022). Pao and Tsai (2011) found that FDI triggers increased CO_2 emissions which is supported by the Pollution Haven Hypothesis theory. Besides that, Xu et al. (2023) found that CO_2 emissions had a negative effect on foreign direct investment for the E7 and G7 group of countries.

2.2. Economic Growth, International Trade, Renewable Energy Consumption, FDI

Satrianto (2024) state that economic growth is significantly influenced by macroeconomic factors including population and foreign direct investment. From the supply side, direct foreign investment acts as a spur to finance economic activity, while from the demand side, its contribution is predicated on its potential to stimulate the economy. Therefore, the ability to grow economically becomes a negotiating tool that is inextricably linked to a nation's advancement, making foreign direct investment one of the key factors in achieving this objective.

Trade and FDI can be seen as complementary because FDI will trigger increased competitiveness in international markets (Jin, 2022; Husnain et al., 2024). Gökmenoğlu and Taspinar (2016) stated that a country that adheres to an open economic system will be a great opportunity for foreign investors to invest or invest their capital in that country. The more open a country is to international trade, the more FDI will enter that country. According to Kayani et al. (2024) found that international trade and FDI have a positive influence, where to encourage FDI, trade also provides access to natural resources because the free flow of raw materials and semi-finished goods is supported by initiatives related to FDI promotion, made possible through international trade.

Studies show that FDI inflows to certain countries tend to increase after those countries engage in renewable energy initiatives or make commitments to build renewable energy-related infrastructure (Jin, 2022; Namahoro et al., 2021). Bakhsh et al. (2017) show that foreign direct investment is positively related to CO_2 emissions.

2.3. Renewable Energy Consumption, Population, Energy Intensity, CO2 Emissions

Akbar et al. (2023) stated that consumption of non-renewable energy increases CO_2 emissions, while consumption of renewable energy reduces CO_2 emissions. Therefore, increasing renewable energy consumption and raising awareness through higher education can help SAARCH countries reduce CO_2 emissions. Zoundi (2017) found that renewable energy consumption has an impact on CO_2 emissions. Increasing the use of renewable energy will reduce CO_2 emissions. This will improve the quality of previously polluted air. To reduce the impact of environmental degradation or environmental pollution, switch to the use of renewable energy which is more environmentally friendly. Renewable energy is natural energy that comes from nature and will not run out because it is formed from sustainable natural processes. The higher the use of renewable energy, the lower the CO_2 emissions. According to Dilanchiev (2024), they stated that the use of renewable energy has the potential to improve environmental quality because of its ability to reduce CO_2 emissions. In the long term and short term, renewable energy consumption can reduce CO_2 emissions (Shaari et al., 2020). According to Akbulaev (2023) states that the use of renewable energy sources is a driving factor in reducing CO_2 emissions in France, while in Italy, emissions are the result of FDI.

Aye and Edoja (2017) researched 31 developing countries showing that renewable energy consumption and population also have a positive and significant influence on CO_2 emissions. According to Aminata et al. (2022) found that GDP and population in the short and long term have a positive effect on CO_2 emissions, and recommend policies regarding willingness to pay for industry and willingness to accept for society. Furthermore, population is also proven to be statistically significant in causing CO_2 emissions, because population growth has a direct impact on CO_2 emissions. As the population increases, demand for energy, food, transportation, and other goods and services that contribute to greenhouse gas emissions also increases (Lalon et al., 2023; Dong et al., 2018).

In general, energy intensity is used to explain the level of energy efficiency or is used as a parameter and measure in assessing energy efficiency in a country, and is the amount of energy consumption

per GDP. Where energy intensity is different from energy efficiency, namely the less energy needed to produce one output, the more efficient the use of energy. This measure of energy intensity does not reflect overall energy efficiency, but it can be an illustration that using a small ratio explains that a country is getting better at using energy in the production process. Therefore, energy intensity is a proxy for measuring the level of energy efficiency, the more efficient the energy, the less the impact of CO_2 emissions on the environment (Ahmadi, 2023). Energy intensity and economic growth cause higher CO_2 emissions, while renewable energy contributes greatly to reducing emissions within 10 years (Aye and Edoja, 2017). Namahoro et al. (2021) conclude that energy intensity and economic growth cause higher CO_2 emissions, while renewable energy contributes greatly to reducing emissions within 10 years.

3. METHODOLOGY

3.1. Data, and Variable

This type of research is descriptive and associative. This research uses secondary data, namely panel data with a time series period from 2000 to 2020, and the cross sections studied are the 5 founding countries of the Association of South East Asian Nations (ASEAN-5), namely Indonesia, Malaysia, the Philippines, Singapore and Thailand. In this research there are endogenous variables and exogenous variables. Endogenous variables are foreign direct investment (FDI) as Y_1 and CO_2 emissions as Y2. The exogenous variables in this research are economic growth (X_1), international trade (X_2), renewable energy consumption (X_3), population (X_4), and energy intensity (X_5). Data obtained from the official World Bank website. An explanation of variable indicators, data sources and data units can be seen in table 1.

3.2. Analysis Method

This research uses a simultaneous equation model. Simultaneous equations are statistical models where the endogenous variable is a function of other endogenous variables. This means that endogenous variables can act as exogenous variables in other equations. Figure 1 shows the framework for this research. FDI, economic growth, international trade affect CO_2 emissions. Meanwhile, CO_2 emissions, renewable energy consumption, population and energy intensity influence FDI.

3.2.1. Structural model

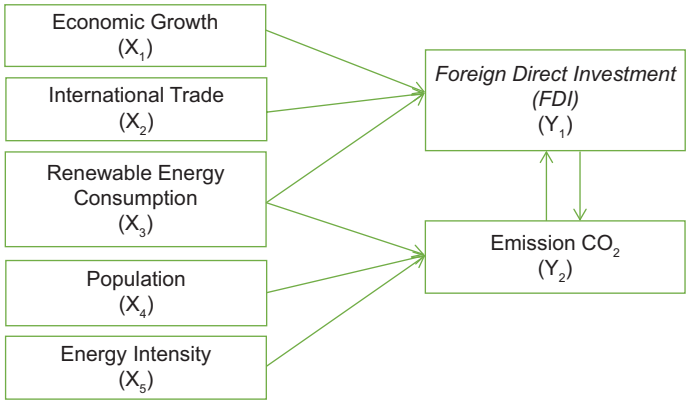
In general, the form of the structural equation of the simultaneous equation model in this research can be seen in equations (1) and (2) as follows:

$$Y_{1it} = \alpha_0 + \alpha_1 Y_{2it} + \alpha_2 X_{1it} + \alpha_3 X_{2it} + \alpha_4 X_{3it} + \varepsilon_{1it} \quad (1)$$

$$Y_{2it} = \beta_0 + \beta_1 Y_{1it} + \beta_2 X_{3it} + \beta_3 X_{4it} + \beta_4 X_{5it} + \varepsilon_{2it} \quad (2)$$

Information:
Y_{1it} = FDI
Y_{2it} = Emission CO_2
X_{1it} = Economic growth
X_{2it} = International trade
X_{3it} = Renewable energy consumption
X_{4it} = Population
X_{5it} = Energy intensity

Figure 1: Conceptual framework



α,β = Coeficient estimation
i = cross section
t = time series
ε = error term

3.2.2. Identify simultaneous equations

An equation is said to be identifiable if the equation meets the following conditions (Gujarati, 2021):

$$K - k = \text{or} > m - 1 \quad (3)$$

Information:
K = number of predetermined variables in the model
k = number of predetermined variables in the estimated equation
m = number of endogenous variables in the estimated equation

Then you can see the provisions for identifying an equation model as follows:
K – k > m – 1 is called overidentified, so TSLS is used
K – k = m – 1 is called just/exactly identified, so ILS is used
K – k < m – 1 is called under identified

Based on the previous provisions, the results obtained in equations 1 and 2 are as follows:

Equation 1:
K = Economic Growth, International trade, Renewable energy consumption, Population, Energy intensity.
k = Renewable energy consumption, Economic Growth, International trade.
m = FDI, Emission CO_2
K – k = or > m – 1

$$5 - 3 > 2 - 1 = 2 > 1 \text{ (overidentified)} \quad (4)$$

Equation 2:
K = Economic Growth, International trade, Renewable energy consumption, Population, Energy intensity.
k = Renewable energy consumption, Population, Energy intensity.
m = FDI, Emission CO_2
K – k = or > m – 1

$$5 - 3 > 2 - 1 = 2 > 1 \text{ (overidentified)} \quad (5)$$

After carrying out this test, it can be concluded that this research is over identified because the value of K – k > m – 1, therefore the simultaneous equation analysis uses the Two Stage Least Square (TSLS/2SLS) approach.

4. RESULTS AND DISCUSSION

4.1. Research Result

4.1.1. Simultaneous equation analysis FDI

Based on the results of the analysis in equation 6, we obtain a simultaneous equation for the endogenous variable FDI (Y1) along with the exogenous variables that influence it, namely CO_2 emissions (Y2), Economic Growth (X1), international trade (X2), and renewable energy consumption (X3).

$$Y_{1it} = 26.2092 - 2.3936 \text{ Log } Y_{2it}^{**} + 0.1071\ X_{1it} + 0.0459\ X_{2it}^{**} - 0.0188\ X_{3it} \quad (6)$$

***significant on $\alpha = 1\%$,
**significant on $\alpha = 5\%$

Equation 6 shows the influence of exogenous variables on endogenous variables. If there are no exogenous variables, the FDI value is 26.2092%. The influence of the CO_2 emission, Economic Growth, international trade and renewable energy consumption variables can be seen from the R-squared value of 0.7382. This figure shows that the contribution of exogenous variables to endogenous variables is 73.82% and the rest is explained by other variables outside the model of 36.18%.

CO_2 emissions have a significant and negative effect on FDI in ASEAN-5 countries. This is indicated by the probability value of 0.01 which is smaller than the alpha level value of 0.05. The estimated CO_2 emission coefficient is 2.3936. This means that if CO_2 emissions increase by one unit, FDI will decrease by 2,3937 units. On the other hand, reducing CO_2 emissions by one unit will increase FDI by 2,3937 units.

Economic growth (X1) has a positive and insignificant effect on FDI. This is because the probability value of 0.38 is greater than the alpha level value of 0.05. The estimated coefficient of economic growth on FDI is 0.1071. This means that an increase in economic growth by one unit will increase FDI in ASEAN-5 countries by 0.1071 one unit. On the other hand, a decrease in economic growth by one unit will reduce FDI by 0.1071 per unit.

The influence of international trade (X2) has a significant and positive effect on FDI because the probability value of 0.00 is smaller than the alpha level value of 0.05. The estimated coefficient for international trade is 0.0459. With the meaning of the words, an increase in international trade by one unit will increase FDI in ASEAN-5 countries by 0.0459 per unit. On the other hand, a one-unit reduction in international trade activity can reduce FDI by 0.0459 one-unit in ASEAN-5 countries.

The influence of renewable energy consumption (X3) has a negative effect and does not have a significant effect on FDI because the probability value of 0.70 is greater than the alpha level value of 0.05. The estimated coefficient for renewable energy consumption on FDI is 0.0188 units. In other words, increasing renewable energy consumption by one unit will reduce FDI by 0.0188 units. On the other hand, reducing renewable energy consumption by one unit will increase FDI by 0.0188 units in ASEAN-5 countries.

4.1.2. Simultaneous equation analysis emission CO_2

Equation 7 shows the simultaneous equation of the endogenous variable CO_2 emissions (Y2) along with the exogenous variables that influence it, namely FDI (Y1), renewable energy consumption (X3), population (X4), and energy intensity (X5),

$$Y_{2it} = -12.0892 + 0.0819\ Y_{1it}^{**} - 0.0508\ X_{3it}^{**} + 1.3055\ X_{4it}^{**} + 0.3426\ X_{5it}^{**} \quad (7)$$

***significant on α=1%,
**significant on α=5%

Based on the estimation results in equation 7, it can be seen that there is an influence of exogenous variables on endogenous variables. However, if there are no exogenous variables, then FDI will have a constant value of −12.0892 units. The contribution of the FDI, renewable energy consumption, population and energy intensity variables can be seen from the R-squared value of 0.8633. This shows that the exogenous variables are able to explain variations in the endogenous variables of 86.33%, while the rest is explained by other factors outside the model, with a standard error of 0.3104 units.

FDI has a significant and positive influence on CO_2 emissions as evidenced by the probability value (0.00) which is smaller than the alpha level value (0.05). The estimated coefficient of FDI on CO_2 emissions is 0.0819. With the meaning of the words that if FDI increases by one unit, CO_2 emissions will increase by 0.0819 one unit. On the other hand, if FDI decreases by one unit, CO_2 emissions will also decrease by 0.0819 unit in ASEAN-5 countries.

The influence of renewable energy consumption (X3) has a significant and negative effect on CO_2 emissions because the probability value of 0.00 is smaller than the alpha level value of 0.05, with a renewable energy consumption coefficient value of 0.0508. This means that when there is an increase in renewable energy consumption by one unit, CO_2 emissions will decrease by 0.0508 per unit. On the other hand, reducing renewable energy consumption by one unit will increase CO_2 emissions by 0.0508 units in ASEAN-5 countries.

Furthermore, the influence of population (X4) has a significant and positive effect on CO_2 emissions because the probability value of 0.00 is smaller than the alpha level value of 0.05 with a population coefficient value of 1.3055 units. It can be said that when there is an increase in population by one unit, it will cause an increase in CO_2 emission levels by 1.3055 units. On the other hand, when there is a decrease in population by one unit, the level of CO_2 emissions will decrease by 1.3055 units in ASEAN-5 countries.

The influence of energy intensity (X5) has a significant and positive effect on CO_2 emissions because the probability value of

0.00 is smaller than the alpha level value of 0.05, with an energy intensity coefficient value of 0.3426 units. It can be said that when there is an increase in energy intensity by one unit, it will cause an increase in CO_2 emissions by 0.3426 units. On the other hand, when there is a decrease in energy intensity by one unit, it will cause a decrease in CO_2 emissions by 0.3426 units.

4.2. Discussion

4.2.1. The influence of CO_2 emissions, economic growth, international trade, and renewable energy consumption simultaneously have a significant effect on FDI in ASEAN-5 countries

From the test results, it was found that CO_2 emissions, economic growth, international trade, and renewable energy consumption simultaneously had a significant effect on FDI in ASEAN-5 countries. This simultaneous effect was obtained with a value of 0.7382 or 73.82%. This means that exogenous variables, namely CO_2 emissions, economic growth, international trade, and renewable energy consumption simultaneously influence FDI in ASEAN-5 countries, while 26.18% is influenced by other variables outside the model or outside this research. So the first hypothesis in this research Ha is accepted and H0 is rejected. This means that every change in CO_2 emissions, economic growth, international trade and renewable energy consumption causes changes in FDI in ASEAN-5 countries.

First, CO_2 emissions have a negative effect on FDI in ASEAN-5 countries. This is caused by high environmental awareness in investor countries, because they will not want to invest in countries that have a bad environment as evidenced by high CO_2 emissions which will be detrimental. If CO_2 emissions are high then economic activities cannot run smoothly because there are environmental activities that are not good. Besides that, investors do not want to invest in countries with high CO_2 emissions because of the risk of environmental damage and climate change. This can cause natural disasters, disrupt supply chains, and increase operating costs. Companies and investors are increasingly concerned about their public image and want to be seen as part of the solution, not part of the problem. Investing in countries with high CO_2 emissions can damage their reputation and make them unattractive to environmentally conscious consumers and partners. The results of this research are in line with research conducted by Xu et al. (2023) and Khan et al. (2023) showing that CO_2 emissions have a negative effect on FDI for both groups of countries.

Second, economic growth has no significant effect on FDI in ASEAN-5 countries. This means that when there is an increase in the rate of economic growth it does not have a significant impact on the increase or decrease in FDI in ASEAN-5. On the other hand, if there is a decrease in the rate of economic growth it will not have a significant impact on FDI flows. The reason is that economic growth is not the only factor that influences FDI in ASEAN-5. Many investors do not depend on just one focus but many other factors are considered. In the context of FDI in ASEAN-5, economic growth is not always the sole factor that determines the entry of foreign direct investment. FDI is influenced by a number of complex and interrelated factors, such as political stability, infrastructure, investment policies, market regulations, income levels and macroeconomic stability. While economic growth can be an important indicator for investors in assessing market potential and long-term profits, the decision to undertake FDI is also influenced by other considerations, such as political and security risks, government policies regarding foreign investment, as well as microeconomic factors such as labor costs and market access. Therefore, the results showing that economic growth has no significant effect on FDI are not surprising and are consistent with the understanding that FDI is influenced by many factors other than economic growth. In further analysis, it is important to consider various variables that may influence FDI flows into the ASEAN-5 region. There are several important factors that influence the entry of FDI into a country, namely: market size, availability of Natural Resources and Human Resources, infrastructure, and international trade policies (Gökmenoğlu and Taspinar, 2016; Shaari et al., 2020; Van Khanh and Le Phuong, 2023; Mai, 2023). Apart from that, this research is also in line with research conducted by Charfeddine and Kahia (2019) regarding economic growth, corruption and FDI. The method used is the Panel Vector Auto Regression (PVAR) processing technique. The results of this research show that there is no relationship or influence between economic growth and FDI.

Third, international trade has a significant and positive effect on FDI. Where if there is an increase in the international trade ratio, it indicates an increase in cooperative relations between countries, which means there is economic openness of a country. Economic openness indicates economic integration between these countries. In other words, the higher the level of international trade, the greater the possibility of FDI entering a country. Economic openness allows the freer flow of goods, services and capital between countries. This creates opportunities for foreign investors to explore new markets, utilize different production factors, and establish partnerships with local companies. As a result, FDI tends to increase along with the growth of international trade. Apart from that, increasing international trade can also bring significant economic benefits to host countries, such as technology transfer, job creation, increased productivity, and development of local industry. This condition can strengthen international trade relations and become an effective strategy for promoting economic growth and development at the global level. In accordance with the theory put forward by Gökmenoğlu and Taspinar (2016), a country that adheres to an open economic system will be a great opportunity for foreign investors to invest or invest their capital in that country. The more open a country is to international trade, the more FDI will enter that country.

Fourth, renewable energy consumption does not have a significant or negative effect on FDI. This is encouraged because many countries still depend on conventional energy sources such as oil, gas and coal. Renewable energy technologies such as solar panels and wind turbines are still relatively expensive to install and purchase compared to traditional power plants. Renewable energy such as solar and wind energy is not always consistently available. This requires expensive energy storage technology so that it can be used when needed. Apart from that, there are many other factors that are more dominant in the entry of FDI into a country, namely: Market size, availability of Natural Resources (SDA) and Human Resources (HR), infrastructure, and international trade

Table 1: Variable indicators and data sources

Variable	Indicator	Source	Unit
Foreign direct investment/(Y_1)	FDI growth	World Bank	%
Emission CO_2 (Y_2)	Emission CO_2	World Bank	Kilo Tons
Economic growth (X_1)	GDP growth	World Bank	%
International trade (X_2)	Ratio of exports and imports to GDP multiplied by 100%	World Bank	%
Renewable energy consumption (X_3)	Renewable energy consumption growth	World Bank	%
Population (X_4)	Total population	World Bank	Person
Energy intensity (X_5)	Ratio of primary energy use to total energy consumption multiplied by 100%	World Bank	%

FDI: Foreign direct investment, GDP: Gross domestic product

policies (Gökmenoğlu and Taspinar, 2016; Shaari et al., 2020; Van Khanh and Le Phuong, 2023; Azam et al., 2015; The results of this research are supported by research conducted by Amin et al. (2022) showing that there is no significant relationship between renewable energy and FDI in the low-income country group.

4.2.2. The influence of FDI, renewable energy consumption, population, and energy intensity simultaneously have a significant effect on CO_2 emissions in ASEAN-5 countries

From the test results it was found that FDI, renewable energy consumption, population and energy intensity simultaneously had a significant effect on CO_2 emissions in ASEAN-5 countries. This simultaneous effect was obtained with a result of 0.8633 or 86.33%. This means that exogenous variables, namely FDI, renewable energy consumption, population and energy intensity, contribute to CO_2 emissions in ASEAN-5 countries, while the remaining 13.67% is influenced by other variables outside the model or outside this research.

First, FDI has a significant and partially positive effect on CO_2 emissions in ASEAN-5 countries. FDI can encourage increased energy consumption, both directly and indirectly. For example, increased investment in the manufacturing sector can increase energy demand to run machines and equipment. This increase in energy consumption can cause an increase in CO_2 emissions if the energy source comes from fossil fuels. Then ASEAN-5 countries have weaker environmental requirements to attract FDI. This can cause companies to invest in these countries without having to implement environmentally friendly practices, thereby increasing CO_2 emissions. The results of this research are in line with research conducted by Pao and Tsai (2011) which states that FDI triggers increased CO_2 emissions which is supported by the Pollution Haven Hypothesis theory. The results of this research are the same as research conducted by Zeng and Eastin (2012) which concluded that the overall flow of FDI in developing countries reduces environmental quality. In pollution-intensive sectors, FDI flows can be associated with increased CO_2 emissions. The results of this research are supported by research conducted by Bakhsh et al. (2017) which found that FDI was positively related to CO_2 emissions.

Second, renewable energy consumption has a significant and negative effect on CO_2 emissions in ASEAN-5 countries. Renewable energy such as solar, wind, water, geothermal energy and bioenergy does not produce CO_2 emissions or other dangerous pollutants when producing energy. This is different from fossil fuels such as coal, petroleum and natural gas, which produce large amounts of CO_2 emissions when burned. The more renewable energy used, the less need there is for fossil fuels. This has reduced overall CO_2 emissions, because fossil fuel power plants are one of the largest sources of CO_2 emissions in the world. The results of this research are the same as research conducted by Zoundi (2017), namely that renewable energy consumption or REC has an impact on CO_2 emissions. Increasing the use of renewable energy will reduce CO_2 emissions. The results of this research are also in line with research conducted by Aye and Edoja (2017) using panel data analysis of 31 developing countries. The research results show that renewable energy consumption and population also have a positive and significant influence on CO_2 emissions. The results of this research are supported by research conducted by Namahoro showing that energy intensity and economic growth cause higher CO_2 emissions, while renewable energy contributes greatly to reducing emissions within 10 years.

Third, population has a significant and positive effect on CO_2 emissions in ASEAN-5 countries. The population in ASEAN-5 countries can be categorized as dense. The denser the population of the ASEAN-5 countries, the higher the demand for energy to meet their needs, such as for housing, transportation, industry and agriculture. This increased demand is often met by burning fossil fuels, such as coal, oil and natural gas, which are the main sources of CO_2 emissions. As the population increases, consumption of goods and services also increases. This leads to increased production of goods and services, which requires energy and produces CO_2 emissions. Then the increasing population growth in this area has caused deforestation, because the population needs more land for housing, agriculture and other development. Forests absorb CO_2 from the atmosphere, and deforestation means the loss of these CO_2 sinks, which can lead to increased CO_2 emissions. The results of this research are the same as research conducted by Aye and Edoja (2017) which shows that renewable energy consumption and population also have a positive and significant influence on CO_2 emissions.

Fourth, energy intensity has a significant and positive effect on CO_2 emissions in ASEAN-5 countries. Higher energy intensity in ASEAN-5 has increased the greater use of fossil fuels or the use of less efficient technology. Fossil fuels such as coal, petroleum, and natural gas are the main sources of carbon dioxide (CO_2) emissions when they are burned to produce energy. When energy intensity increases, fossil fuel consumption also tends to increase, which in turn increases CO_2 emissions into the atmosphere. In

addition, technology that is less efficient in converting energy from fossil fuels to useful energy (such as heat or electricity) can also increase CO_2 emissions. For example, if a power plant uses outdated technology, it may require more fuel to produce the same amount of energy compared to a more efficient power plant. This will result in greater CO_2 emissions per unit of energy produced. Therefore, increasing energy intensity often contributes to increasing CO_2 emissions, especially if energy use is not accompanied by steps to increase energy efficiency or switch to cleaner and more sustainable energy sources. The results of this research are in line with research conducted by Namahoro et al. (2021) who shows that energy intensity and economic growth cause higher CO_2 emissions, while renewable energy contributes greatly to reducing emissions within 10 years.

5. CONCLUSION

Based on the research results obtained from the discussion regarding the analysis of the influence of economic variables, energy variables and population on FDI and CO_2 emissions in ASEAN-5 countries, the following conclusions can be drawn:

1. CO_2 emissions, economic growth, international trade, and renewable energy consumption simultaneously have a significant influence on FDI in ASEAN-5 countries. This means that every change in CO_2 emissions, economic growth, international trade and renewable energy consumption causes changes in FDI in ASEAN-5 countries. Partially, economic growth and renewable energy consumption do not have a significant effect on FDI, while CO_2 emissions and international trade have a significant effect on FDI in ASEAN-5 countries.
2. FDI, renewable energy consumption, population, and energy intensity simultaneously have a significant effect on CO_2 emissions in ASEAN-5 countries. This means that every change in FDI, renewable energy consumption, population and energy intensity causes changes in CO_2 emissions in ASEAN-5 countries. Partially, all FDI, renewable energy consumption, population and energy intensity variables have a significant effect on CO_2 emissions in ASEAN-5 countries.

Based on these conclusions, ASEAN-5 countries can implement energy policies to reduce CO_2 emission levels, prevent continued environmental damage, and support the smooth running of economic activities. High levels of foreign direct investment (FDI) can have positive impacts on the economy, such as reducing unemployment rates, increasing economic activity, and increasing production. However, a decrease in FDI can result in a decrease in GDP growth and disruption to economic activity, both at the national and international levels. Therefore, it is recommended that ASEAN-5 countries also adopt policies in the economic sector to encourage smooth FDI flows by paying attention to CO_2 emission levels.

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