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Short-Run Gains, Long-Run Trade-Offs: Revisiting FDI, Trade Openness, and Renewable Energy in ASEAN Economic Growth

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ABSTRACT
ASEAN economies have undergone significant structural transformation, driven by increasing foreign direct investment (FDI), trade openness, and renewable energy adoption. This study investigates the long-run relationship among these variables and their effects on economic growth across ten ASEAN countries from 1998 to 2022. Using panel data and an Autoregressive Distributed Lag (ARDL) approach, this research examines both short-run and long-run dynamics. The long-run estimation reveals that FDI negatively affects economic growth with a coefficient of -0.486, indicating crowding-out effects and institutional inefficiencies. Similarly, trade openness shows a significant negative impact (-0.010), reflecting vulnerabilities related to external shocks and structural imbalance. In contrast, renewable energy consumption exerts a positive and significant influence (0.224), supporting the green growth hypothesis. Short-run results differ, with both FDI and trade openness positively influencing growth, while renewable energy remains statistically insignificant. The model confirms long-run cointegration among variables, validating their interdependence in shaping growth trajectories. These findings highlight that while FDI and trade liberalization may yield short-term gains, their long-term benefits depend on institutional quality and policy design. The study contributes to policy discourse by emphasizing the strategic importance of investing in renewable energy infrastructure and enhancing domestic absorptive capacity to sustain inclusive and resilient economic growth in ASEAN.

1. Introduction

The ASEAN region has undergone significant economic transformation over the past few decades, marked by increasing flows of foreign direct investment (FDI), trade liberalization, and the adoption of renewable energy (M. Rahman et al., 2024). These three trends are often viewed as engines of economic growth (Asri, 2025); however, growing empirical evidence suggests that the long-term implications of these strategies are far more complex and nuanced (Rafiuddin et al., 2024)(Rafiuddin et al., 2024). While FDI and trade openness can drive short-term GDP growth, concerns have emerged regarding sectoral dependency, regulatory asymmetries, and environmental degradation that may undermine the sustainability of that growth (Sitthivanh & Srithilat, 2022).

Specifically, Foreign Direct Investment (FDI)—which has long been associated with capital inflows, technology transfer, and industrial modernization—has demonstrated mixed effects on long-term development in ASEAN (Asri, 2025). In institutional environments characterized by policy uncertainty and weak domestic absorptive capacity, FDI may in fact exacerbate inequality and displace local investment (Rafiuddin et al., 2024). Poorly managed FDI may lead to resource dependence and the repatriation of profits to the home countries (Udoinyang et al., 2024). Structural barriers, such as inconsistent regulations, further hinder the realization of long-term economic benefits (Rastiati & Khoirudin, 2025). In general, FDI, trade openness, and renewable energy contribute to economic growth by enhancing technological advancement and productivity (Amin et al., 2023; M. M. Rahman, 2021).

However, excessive trade openness can expose economies to external shocks. Openness without an adequate domestic policy framework may impede sustainable growth, as evidenced by current account imbalances, vulnerability to external volatility, and the weakening of domestic industrial sectors (Lanhui & Ibrahim, 2024; van Hek et al., 2024). Concurrently, with growing awareness of the importance of sustainable development, renewable energy has emerged as a central focus in the green economic agenda across the ASEAN region (Yusoff et al., 2024).

This study aims to re-examine the relationship between foreign direct investment (FDI), trade openness, and renewable energy consumption in the context of long-term economic growth in ASEAN countries. The research is grounded in the assumption that, although these three variables may offer short-term economic gains, their long-term impacts are highly contingent upon the quality of institutions, the design of public policy, and domestic absorptive capacity. Furthermore, this study seeks to investigate whether these external factors can foster a sustainable growth trajectory—or, conversely, generate a series of trade-offs that challenge the prevailing development paradigm of the region.

Hypothesis Development

a) Foreign direct investment (FDI) and long-term economic growth

Foreign direct investment (FDI) inflows into ASEAN countries have frequently been associated with economic growth; however, empirical evidence suggests that the long-term effects of FDI are not uniformly beneficial, particularly due to sectoral dependency and policy asymmetries (Asri, 2025). In institutional contexts marked by instability, FDI may worsen income inequality and displace domestic industries, ultimately undermining the structural foundation required for sustained economic development (Rafiuddin et al., 2024). Although FDI initially contributes to GDP growth, its capacity to generate long-term productivity gains remains limited in settings with low domestic absorptive capacity (Haini et al., 2024). A reliance on foreign capital without parallel reforms in domestic investment frameworks risks triggering premature deindustrialization, particularly in economies that lack technological upgrading and local value creation mechanisms (Tan et al., 2022).

Moreover, FDI channeled into extractive or low-tech sectors tends to deliver minimal benefits in terms of innovation and job creation. In many cases, such investments exacerbate environmental degradation, further challenging the sustainability of economic progress (Sitthivanh & Srithilat, 2022). When geopolitical motives—such as those driving FDI from China—dominate investment flows, the resulting economic outcomes often fail to align with the host country's long-term development goals (Ping et al., 2021). Policy uncertainty and regulatory complexity in recipient countries additionally deter long-term reinvestment, thereby limiting the compounding growth effects typically associated with sustained FDI inflows (Rastiati & Khoirudin, 2025). Longitudinal analyses indicate that the crowding-out effect of FDI on domestic investment is particularly pronounced in developing regions like ASEAN (Ridzuan et al., 2018). Furthermore, environmental costs associated with FDI-led industrial expansion—especially in the fossil energy sector—pose significant threats to long-term economic resilience (Nguyen & Bui, 2021). Collectively, these findings highlight the urgent need for context-sensitive and strategically coherent policy frameworks aimed at reducing dependence on volatile foreign capital. Strengthening domestic growth drivers and aligning FDI with national development priorities are essential for fostering inclusive and sustainable economic outcomes (Fazira & Cahyadin, 2018). Based on this rationale, the following hypothesis is proposed:

H1: Foreign direct investment (FDI) has a negative impact on long-term economic growth

b) Trade Openness and Long-Term Economic Growth

Trade openness has long been regarded as a primary driver of economic growth; however, recent empirical evidence from the ASEAN region suggests that its long-term effects are far more complex. A study on ASEAN-6 countries reveals a nonlinear relationship, wherein trade openness initially contributes positively but eventually leads to diminishing, and even negative, returns beyond a certain threshold (Nguyen & Bui, 2021). Similarly, long-run analyses in ASEAN-5 countries conclude that trade openness does not exert a significant impact on economic growth and, in some cases, yields counterproductive outcomes.

In several developing ASEAN economies, the import component of trade openness demonstrates an insignificant or even negative correlation with growth, particularly under high inflationary conditions (Yaqin & Sulistyono, 2024). The case of the Philippines, for example, statistically confirms the adverse long-term impact of trade openness on economic performance (Arifin, 2023). This phenomenon reflects the broader structural vulnerability of ASEAN economies, which remain heavily reliant on external markets. The absence of adequate domestic safeguards in liberalized trade regimes further amplifies exposure to external shocks (Nam et al., 2023). While export activities can contribute to short-term economic expansion, the predominance of low value-added sectors limits the long-term developmental potential of free trade (Lestari et al., 2024). Moreover, indicators of human development suggest that trade openness, in the absence of robust public governance reforms, may undermine long-term societal welfare (Nam et al., 2023). Without an inclusive policy framework, trade liberalization tends to exacerbate income inequality and environmental degradation—two critical factors that constrain sustainable economic growth (Azwardi & Bashir, 2023). Political instability across several ASEAN member states further compounds these challenges by deterring long-term investments that would otherwise be catalyzed by open trade regimes (Wardani, 2024). Additional findings highlight a significant negative correlation between trade openness and capital formation in environments characterized by unstable economic policy. These insights collectively underscore a key argument: in the absence of strong domestic capabilities and coherent institutional development strategies, trade openness may hinder rather than promote long-term economic growth. Based on this rationale, the following hypothesis is proposed:

H2: Trade openness has a negative effect on long-term economic growth

c) Renewable Energy Consumption and Long-Term Economic Growth

Renewable energy consumption is increasingly recognized as a key determinant of long-term economic growth in ASEAN countries. Recent studies consistently highlight a positive and significant cointegration relationship between renewable energy usage and GDP growth across the region (Wahyudi & Palupi, 2023). For instance, empirical evidence from Indonesia, Malaysia, and Singapore demonstrates that renewable energy consumption directly drives economic expansion, lending support to the growth hypothesis in the context of energy economics (M. Rahman et al., 2024). Panel cointegration analyses and long-run regression models further confirm that the consumption of biomass and other clean energy sources makes a substantial contribution to sustainable economic expansion (Ali et al., 2018). Simultaneously, renewable energy plays a vital role in reducing the economic pressures associated with carbon emissions, thereby enhancing its value within the broader framework of long-term green development (Hanif et al., 2022). While short-term effects of renewable energy consumption may vary across ASEAN member states, the long-term impact remains consistently positive and substantial (M. Rahman et al., 2024).

Cross-country studies involving six ASEAN nations reinforce the conclusion that renewable energy systematically contributes to economic growth by improving energy efficiency and diversifying energy sources (Yusoff et al., 2024). Moreover, the increasing consumption of renewable energy reflects a strong commitment to sustainable development, which in turn enhances macroeconomic stability over the long run (Kumaran et al., 2020). Nonetheless, structural constraints and insufficient investment in clean energy infrastructure continue to hinder the full potential of renewable energy's contribution to growth, highlighting the urgent need for comprehensive policy reforms (Yusoff et al., 2024). These findings indicate that promoting renewable energy adoption is not merely an environmental imperative but also a strategic necessity

for driving sustained economic growth. Based on this rationale, the following hypothesis is proposed:

H3: Renewable energy consumption has a positive impact on long-term economic growth

d) Long-Run Cointegration among Foreign Direct Investment, Trade Openness, Renewable Energy, and Economic Growth

In the pursuit of sustainable economic growth across the ASEAN region, a comprehensive understanding of the interrelationship among foreign direct investment (FDI), trade openness, renewable energy, and economic performance is essential. Prior research demonstrates that FDI contributes positively to growth by facilitating technology transfer and enhancing domestic industrial productivity (Ridzuan et al., 2018). Trade openness promotes economic efficiency and encourages the adoption of new technologies, although it may pose environmental risks when not accompanied by adequate safeguards (Hu et al., 2021).

Panel data covering the period from 2018 to 2022 reinforces the argument that FDI consistently plays a significant role in fostering long-term growth, whereas the effects of trade openness appear to be more context-dependent, influenced by the structural characteristics of individual countries (Lestari et al., 2024). Renewable energy—both in terms of consumption and production—is increasingly shaped by FDI and trade flows, positioning it as a critical component of green economic policy frameworks (Voumik et al., 2023). When FDI is directed toward sectors that support energy transition, the resulting outcomes include not only economic expansion but also environmental improvement (Sitthivanh & Srithilat, 2022). The dynamic interplay among energy consumption, international trade, and investment reflects a mutually reinforcing relationship that sustains long-term growth trajectories (M. M. Rahman, 2021). Moreover, policy incentives promoting clean energy adoption and economic openness have been found to increase the attractiveness of host countries to foreign investors (Yusoff et al., 2024).

In the long run, countries equipped with green energy infrastructure and effective governance structures are more likely to attract sustained international investment (Huang et al., 2022). The combined effect of FDI, trade, and renewable energy has also been shown to accelerate post-pandemic economic recovery, further emphasizing their strategic interdependence (Azmin et al., 2022). Given these empirical findings, it is reasonable to hypothesize the existence of a long-run cointegration relationship among foreign direct investment, trade openness, renewable energy, and economic growth.

H4: There is a long-run cointegration relationship among foreign direct investment (FDI), trade openness, renewable energy consumption, and economic growth

2. Method

This study used a quantitative research design utilizing secondary data obtained from the World Bank. The data comprise a panel dataset, which integrates both time series and cross-sectional dimensions, covering the period from 1998 to 2022. The study focuses on countries within the Association of Southeast Asian Nations (ASEAN), a regional intergovernmental organization established in 1967, consisting of ten member states. Given the relatively small population, the sampling technique adopted is total sampling, meaning that the entire population was used as the sample. Accordingly, the ten ASEAN countries included in the analysis are Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. The selection of variables in this study is grounded in theoretical and empirical considerations concerning their relevance to long-term economic development, particularly within emerging economies. The model includes one dependent variable and three independent variables, each of which captures a distinct but interrelated dimension of macroeconomic performance.

The dependent variable is economic growth, measured by the annual growth rate of gross domestic product (GDP). This indicator reflects the aggregate performance of an economy and is commonly used to assess a country's level of development and productive capacity over time.

The independent variables are as follows:

1. Foreign Direct Investment (FDI): FDI is included due to its widely acknowledged role in facilitating capital formation, technological transfer, and productivity enhancement in host countries. Numerous studies have documented FDI’s contribution to industrial upgrading and

export diversification in developing regions (Ridzuan et al., 2018). Its inclusion allows for an empirical examination of how external capital inflows influence long-term growth trajectories.

2. Trade Openness (TO): Trade openness is incorporated as it represents a country's integration into the global economy through the exchange of goods and services. As emphasized by Arabiyat et al. (2020), trade openness can drive economic growth by enabling access to larger markets, encouraging competition, and facilitating the diffusion of innovation. However, the impact of trade openness may vary depending on structural and policy conditions in each country, which makes it a variable of interest in the ASEAN context.
3. Renewable Energy Consumption (REN): The inclusion of renewable energy consumption reflects the growing importance of sustainable energy practices in economic development strategies. With global emphasis on climate-resilient growth, renewable energy not only contributes to environmental sustainability but also reduces energy dependence and enhances energy security. Prior empirical work (e.g., Voumik et al., 2023; M.M. Rahman, 2021) suggests that increased use of renewable energy is positively associated with long-term economic growth, especially when supported by appropriate infrastructure and institutional quality.

Data Analysis Method

This study employs the Autoregressive Distributed Lag (ARDL) modeling approach to examine both short-run and long-run relationships among the selected variables. The ARDL model is particularly suitable for analyzing dynamic interactions when the underlying data series are integrated of different orders. Its flexibility in accommodating small sample sizes and mixed integration orders makes it an appropriate tool for empirical investigations involving macroeconomic variables in developing economies.

In this context, the ARDL model is utilized to investigate the dynamic linkages between Foreign Direct Investment (FDI), Trade Openness (TO), Renewable Energy Consumption (REN), and economic growth in ASEAN countries. The model allows for the estimation of both the immediate (short-run) adjustments and the equilibrium (long-run) relationships among these variables within a unified framework. This methodological choice aligns with the objective of the study to capture not only the transient effects of shocks but also the long-term equilibrium paths that shape sustainable economic development in the region.:

$$GDP_{it} = a_0 + a_1 FDI_{it} + a_2 TO_{it} + a_3 REN_{it} + e_{it} \quad (1)$$

where:

GDP*it* denotes economic growth; FDI*it* represents foreign direct investment; TO*it* refers to trade openness; REN*it* indicates renewable energy consumption; i denotes *cross section*; t denotes *time series.* Meanwhile, the ARDL model from Equation (1) is reformulated and presented in Equation (2) as follows:

$$\Delta GDP_{it} = \gamma_0 + \alpha_0 GDP_{it-1} + a_1 FDI_{it} + a_2 TO_{it} + a_3 ET_{it} + \sum_{i=1}^{n} \beta_0 \Delta PE_{it-1} + \sum_{i=1}^{n} \beta_1 \Delta FDI_{it-1} + \sum_{i=1}^{n} \beta_2 \Delta TO_{it-1} + \sum_{i=1}^{n} \beta_3 \Delta REN_{it-1} + e_{it} + \delta ect_{it} \quad (2)$$

In the ARDL model specified in Equation (2), t represents the time period capturing both short-run and long-run dynamics, α, e denote the error term. The coefficients $\beta_0\beta_1,\beta_2,\beta_3$ …. represent the long-run relationships among the variables, while $\alpha_0, \alpha_1, \alpha_2$…. denote the short-run coefficients. ECT-1 is the error correction term that measures the extent of deviation from the long-run equilibrium in the previous period *t-1*.

3. Results

Descriptive Statistical Analysis

The descriptive statistics in Table 1 provide a summary of the distributional characteristics of the four variables used in this study: economic growth (GDP), foreign direct investment (FDI), trade openness (TO), and renewable energy consumption (REN), each with 250 observations.

1. Economic Growth (GDP)
   The mean value of GDP growth is 5.78%, with a standard deviation of 2.90, indicating moderate variation in economic performance across ASEAN countries over the study period. The minimum

GDP growth rate is 0.00%, while the maximum reaches 14.52%, suggesting a wide range in growth experiences. The distribution of GDP is moderately positively skewed (0.47) and exhibits kurtosis close to normal (3.52), implying that the distribution is nearly symmetric with slightly heavy tails. The Jarque-Bera statistic of 12.15 with a p-value of 0.0023 indicates that GDP growth is not normally distributed at the 1% level of significance.

2. Foreign Direct Investment (FDI)
   The average FDI inflow is 5.54% of GDP, with a substantial standard deviation of 6.10, reflecting high variability in FDI across countries and time. The minimum value is as low as 0.06%, and the maximum reaches 31.62%, indicating large disparities in FDI dependency among countries. The FDI variable is highly positively skewed (2.23) and leptokurtic (7.69), suggesting a right-tailed distribution with extreme outliers. The Jarque-Bera test confirms strong non-normality (JB = 437.23, $p < 0.01$).
3. Trade Openness (TO)
   Trade openness has a relatively high mean value of 127.27%, indicating that, on average, the ASEAN countries have trade volumes exceeding their GDP. The data show high variability (std. dev. = 86.97), with values ranging from 32.97% to 437.33%. This large spread reflects structural differences in trade intensity across countries. The distribution is positively skewed (1.89) and leptokurtic (5.98), again indicating the presence of outliers. The Jarque-Bera test strongly rejects the null hypothesis of normality (JB = 242.21, $p < 0.01$).
4. Renewable Energy Consumption (REN)
   The average renewable energy consumption is 38.05%, with a standard deviation of 29.34, highlighting substantial differences in the adoption of renewable energy across countries. The range is wide, from 0.30% to 91.10%, suggesting some countries are heavily reliant on renewables while others are not. The distribution is nearly symmetric (skewness = 0.27) but platykurtic (1.73), indicating a flatter distribution with lighter tails than the normal distribution. Despite a more normal-looking shape, the Jarque-Bera test still indicates non-normality (JB = 19.85, $p < 0.01$).

Table 1. Descriptive Statistics

	GDP	FDI	TO	REN
Mean	5.776640	5.543200	127.2686	38.05320
Median	5.735000	3.415000	108.1950	33.45000
Maximum	14.52000	31.62000	437.3300	91.10000
Minimum	0.000000	0.060000	32.97000	0.300000
Std. Dev.	2.897339	6.100698	86.96679	29.33818
Skewness	0.474196	2.232962	1.893670	0.269610
Kurtosis	3.516448	7.693588	5.984667	1.729394
Jarque-Bera	12.14756	437.2317	242.2103	19.84581
Probability	0.002302	0.000000	0.000000	0.000049
Sum	1444.160	1385.800	31817.15	9513.300
Sum Sq. Dev.	2090.249	9267.411	1883242.	214321.5
Observations	250	250	250	250

Source: Author analysis by Eviews

Cointegration Test

The cointegration test results presented in Table 2 indicate a significant cointegration relationship among the variables under investigation. Under the null hypothesis of no cointegration, the Fisher statistic from the trace test is 127.0 and from the max-eigenvalue test is 91.32, both with a probability of 0.000, leading to the rejection of the null hypothesis at the 1% significance level. This suggests the existence of at least one cointegrating relationship among the variables. Under the hypothesis of "at most one" cointegrating vector, the Fisher trace statistic is 54.75 and the max-eigen statistic is 46.67, with corresponding probabilities of 0.000 and 0.007, respectively. These results also reject the null hypothesis, confirming the presence of more than one cointegrating relationship.

Table 2. Cointegration Test

Hypothesized No. of CE (s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	127.0	0.000	91.32	0.000
At most 1	54.75	0.000	46.67	0.007
At most 2	25.60	0.179	21.51	0.367
At most 3	27.88	0.112	27.88	0.112

Source: Author analysis by Eviews

The hypothesis of "at most 2" cointegrating relationships yields a Fisher trace statistic of 25.60 and a max-eigen statistic of 21.51, with corresponding probabilities of 0.179 and 0.367, respectively. These values do not lead to rejection at the 5% significance level, indicating that there are only two cointegrating relationships. Finally, under the hypothesis of "at most 3," both the Fisher trace and max-eigen statistics are 27.88, with a probability value of 0.112, suggesting that the null hypothesis cannot be rejected at conventional significance levels. Taken together, these results confirm the presence of a significant long-run cointegration relationship among the variables in the model, with evidence supporting up to two cointegrating vectors in the system.

Table 3. Correlation Matrix Test

	GDP	FDI	TO	REN
GDP	1.000	0.058	-0.085	0.529
FDI	0.058	1.000	0.756	-0.252
TO	-0.085	0.756	1.000	-0.546
REN	0.529	-0.252	-0.546	1.000

Source: Author analysis by Eviews

Table 3 presents the correlation matrix used to test for multicollinearity among the variables: foreign direct investment, trade openness, renewable energy, and economic growth. The correlation coefficients obtained do not indicate serious multicollinearity, as all values are below the threshold of 0.8.

Table 4. Unit Root Test

Variabel	Augmented Dickey Fuller		Philips-Perron	
	Level	1st difference	Level	1st difference
FDI	73.465***	134.746***	107.561***	346.974***
TO	24.872**	86.207***	33.719**	166.834***
REN	16.218	66.969***	15.728	119.471***
GDP	71.121***	159.656***	137.773***	973.612***

Source: Author analysis by Eviews

Based on the results of the unit root tests in Table 4. conducted using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods, it can be concluded that most of the variables are non-stationary at level but become stationary after first differencing. Consistent results were also obtained from the PP test, which supports this finding. The outcomes of the four unit root tests indicate that foreign direct investment, trade openness, renewable energy, and economic growth are stationary at the first difference level, or I (1). This is confirmed by the p-values, which are less than 0.05, indicating stationarity after first differencing.

Heteroscedasticity Test

Table 5 presents the results of the heteroskedasticity test, which aims to examine whether the regression model exhibits constant residual variance.

Table 5. Heteroscedasticity Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.811	0.684	5.569	0.000
FDI	-0.023	0.061	-0.378	0.705
TO	0.005	0.004	1.257	0.209
REN	0.106	0.084	1.266	0.206

Source: Author analysis by Eviews

Based on the probability values, it is evident that most variables are not statistically significant at the 5% confidence level, indicating no serious heteroskedasticity problems. This suggests that the regression model satisfies the assumption of homoskedasticity, where the variance of the error terms remains constant and there is no indication that the errors are dependent on the independent variables. The probability value for foreign direct investment (FDI) is 0.705 > 0.05, for trade openness (TO) is 0.209 > 0.05, and for economic growth (GDP) is 0.206 > 0.05. These results imply that the residual variance is homogeneous. Therefore, it can be concluded that there is no evidence of heteroskedasticity, and the model successfully passes the heteroskedasticity test.

Cross-Dependence Test

The Cross-Section Dependence (CD) test is a statistical procedure used in panel data analysis to determine whether there is cross-sectional dependence among units—such as countries, firms, or regions—within the dataset. Cross-sectional dependence implies that there is a correlation among cross-sectional units, meaning that an event in one unit may influence other units. The results of the Cross-Section Dependence test indicate significant dependence across the cross-sectional units in the model. The null hypothesis, which states that there is no cross-sectional dependence, is strongly rejected based on the very small p-values obtained from all tests.

Table 6. Cross-Dependence Test

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	70.52189	45	0.0089
Pesaran scaled LM	2.690243		0.0071
Bias-corrected scaled LM	2.481910		0.0131
Pesaran CD	2.426266		0.0153

Source: Author analysis by Eviews

In the Breusch-Pagan LM test, the test statistic of 70.52189 with a p-value of 0.0089 indicates the presence of significant cross-sectional dependence. Similarly, the Pesaran scaled LM and bias-corrected scaled LM tests yield consistent results, with test statistics of 2.690243 and 2.481910, and corresponding p-values of 0.0071 and 0.0131, respectively, both indicating cross-sectional correlation among units. The findings are further supported by the Pesaran CD test, which produces a test statistic of 2.426266 and a p-value of 0.0153, confirming the existence of significant cross-sectional dependence among the units in the panel.

Selection of Model Criteria

In selecting the appropriate Autoregressive Distributed Lag (ARDL) model, several criteria are employed to evaluate and identify the most suitable specification. Table 8 presents the ARDL model selection criteria based on multiple indicators, including LogL (Log Likelihood), AIC (Akaike Information Criterion), BIC (Bayesian Information Criterion), and HQ (Hannan-Quinn Criterion). Among these, the model with the lowest AIC value is considered the most optimal, as it offers the best trade-off between model fit and complexity. According to the table, the ARDL (4, 3, 3, 3) specification yields the lowest AIC value of 3.701, making it the most appropriate model for the analysis.

Table 8. Selection of Model Criteria

Model	LogL	AIC*	BIC	HQ	Specification
12	-245.653934	3.701466	5.980687	4.622871	ARDL(4, 3, 3, 3)
9	-258.420564	3.727815	5.847650	4.584786	ARDL(3, 3, 3, 3)
6	-276.506591	3.804825	5.765273	4.597361	ARDL(2, 3, 3, 3)
11	-289.303016	3.831457	5.632520	4.559560	ARDL(4, 2, 2, 2)
3	-294.170013	3.877810	5.678872	4.605913	ARDL(1, 3, 3, 3)
5	-322.593124	3.958030	5.440320	4.557265	ARDL(2, 2, 2, 2)

Source: Author analysis by Eviews

The ARDL (4, 3, 3, 3) model indicates that for each independent variable included in the model, one or more lags are considered—both for the dependent variable (economic growth) and the independent variables (foreign direct investment, trade openness, and renewable energy consumption). Specifically, the model incorporates up to four lags for the dependent variable and three lags for each independent variable. Economically, this implies that changes in the

independent variables do not affect economic growth solely in the current period but may also exert delayed effects that influence economic growth in subsequent years. This lag structure allows the model to capture both immediate and dynamic long-term interactions among the variables.

Estimation Results of the ARDL (Autoregressive Distributed Lag) Model

The long-run estimation results using the ARDL (Autoregressive Distributed Lag) method indicate that the constant term (C) is positive and statistically significant. This suggests that when all independent variables in the model are held constant or equal to zero, economic growth is expected to remain at a positive level, as represented by the value of the constant. In other words, even in the absence of changes in foreign direct investment, trade openness, or renewable energy consumption, the baseline value of economic growth is projected to be positive.

In the long run, foreign direct investment (FDI) exhibits a negative sign and a significant effect, indicating that a 1 percent increase in FDI is associated with a 0.486 percent decrease in economic growth. A similar result is observed for trade openness, which also shows a negative and significant impact on economic growth, implying that a 1 percent increase in trade openness could reduce economic growth by 0.010 percent. In contrast, the renewable energy consumption variable displays a positive and significant effect on economic growth. This implies that a 1 percent increase in renewable energy use would lead to a 0.224 percent increase in economic growth, assuming all other variables remain constant.

In the short run, the ARDL model estimation also shows that the constant term (C) is positive and statistically significant, with a value of 3.275. This indicates that, in the absence of any changes in foreign direct investment, trade openness, or renewable energy consumption, the baseline level of economic growth still experiences an upward trend, reflecting underlying positive momentum in the economy.

Table 9. Estimation Results of the ARDL (Autoregressive Distributed Lag) Model

Dependent variable = GDP Selected Model: ARDL (4, 3, 3, 3)				
Variable	**Coef.**	**Std. Error**	**t-Stat.**	**Prob**
Long run				
FDI	-0.486	0.133	-3.642	0.000
TO	-0.010	0.003	-2.557	0.012
REN	0.224	0.065	3.411	0.000
Short run				
Constant	3.275	2.390	1.370	0.173
Δ (FDI)	0.458	0.132	3.463	0.000
Δ (TO)	0.083	0.020	3.982	0.000
Δ (REN)	2.392	2.830	0.845	0.399
ECT	-0.710	0.221	-3.201	0.001

Source: Author analysis by Eviews

Foreign direct investment (FDI) exhibits a positive sign and a statistically significant effect. This indicates that a 1 percent increase in FDI is associated with an approximate 0.458 percent increase in economic growth. A similar result is found for trade openness, which also shows a positive and significant impact on economic growth, suggesting that each 1 percent increase in trade openness leads to a 0.083 percent increase in economic growth. Meanwhile, the renewable energy variable also displays a positive sign, but its effect is not statistically significant. This implies that while the increase in renewable energy consumption is positively associated with economic growth, its influence is not strong or consistent enough to be considered statistically meaningful.

The error correction term (ECT) has a negative value of -0.710 and is highly significant at the 1 percent level. This indicates the presence of a valid error correction mechanism in the model, whereby approximately 71.0 percent of the deviation from the long-run equilibrium is corrected in each period. In other words, the model has the capacity to gradually return to long-run equilibrium following a short-term shock.

Foreign direct investment (FDI) has a positive short-run effect but a negative long-run impact, suggesting that foreign investment policies need to be complemented by the development of domestic industrial capacity in order to ensure more sustainable outcomes. Likewise, trade

openness shows a positive effect in the short run but a negative effect in the long run, implying that trade strategies should focus more on enhancing export competitiveness rather than pursuing liberalization alone.

Renewable energy consumption demonstrates a positive and significant effect in the long run, but its impact in the short run is not statistically significant. This finding underscores the importance of strategic planning and sustained investment by both the government and private sector. The deployment of renewable energy often faces challenges such as high initial costs, limited infrastructure, and dependence on technologies still in development. However, over time, the long-term benefits—including the creation of green jobs, increased energy independence, and economic stability through reduced reliance on fossil fuel prices—become more evident.

Therefore, while the economic impact of renewable energy may not be immediately observable, the transition toward renewable energy remains a crucial step in ensuring sustainable economic growth and resilience to future environmental crises. These findings suggest that excessive reliance on foreign direct investment and international trade, without strengthening the domestic sector, may result in negative long-term effects. Conversely, investment in renewable energy, although slower to yield immediate returns, offers promising prospects for sustainable growth.

4. Discussion

The Relationship between Foreign Direct Investment (X1) and Economic Growth (Y)

The results of the study indicate that Foreign Direct Investment (FDI) has a negative impact on long-term economic growth in ASEAN countries. This finding is consistent with previous studies stating that FDI can create economic dependency in certain sectors and hinder the development of domestic industries (Asri, 2025). Although FDI is often associated with increased productivity and technology transfer, in reality, not all ASEAN countries have sufficient absorptive capacity to fully utilize these benefits (Haini et al., 2024). Excessive reliance on FDI can also lead to premature deindustrialization if not accompanied by policies that strengthen domestic sectors (Lestari et al., 2024). Some forms of foreign investment are directed at extractive sectors that do not generate long-term value and may even harm the environment (Sitthivanh & Srithilat, 2022). Furthermore, if FDI inflows are not aligned with national development strategies, their impact on economic growth can be counterproductive (Azwardi & Bashir, 2023). In the short run, FDI may increase growth through job creation and capital formation, but its long-term effects depend on the structure of the recipient economy (Rastiati & Khoirudin, 2025).

It is important to note that institutional quality and fiscal policy also influence the effectiveness of FDI on growth (Rafiuddin et al., 2024). Countries with weak governance are more likely to fail in directing FDI towards strategic sectors that support sustainable development (Wardani, 2024). Other studies have highlighted that FDI from specific sources—such as China—often carries geopolitical agendas that may not align with local priorities (Ping et al., 2021). This reinforces the argument that not all FDI is productive or politically neutral. Moreover, the presence of FDI does not always lead to increased public welfare, especially when there is no knowledge transfer or capacity building for local industries (Udoinyang et al., 2024). In the ASEAN context, investments driven primarily by short-term profit motives can hinder local innovation and exacerbate social inequality (Tan et al., 2022). Therefore, ASEAN countries need to adopt selective policies regarding FDI, taking into account sustainability and development inclusiveness (Fazira & Cahyadin, 2018).

These findings affirm that FDI is not a standalone determinant of economic growth, but rather a variable whose impact depends greatly on domestic structures and development policy direction (Ridzuan et al., 2018). Hence, ASEAN's future economic strategy should emphasize the synergy between FDI and local capacity building to ensure sustainable and equitable growth.

The Relationship between Trade Openness (X2) and Economic Growth (Y)

The long-run estimation results indicate that trade openness negatively affects economic growth in ASEAN countries. This finding supports previous studies which argue that trade liberalization without adequate domestic structural readiness may undermine local industrial sectors (Lestari et al., 2024). In the ASEAN context, trade liberalization is often accompanied by dependence on primary commodity exports with low added value (Yaqin & Sulistyono, 2024). Such dependency creates vulnerability to external shocks such as global price fluctuations and geopolitical crises

(Azwardi & Bashir, 2023). Moreover, countries with weak institutional capacities tend to fail in maximizing the benefits of free trade (Nam et al., 2023). Without inclusive regulations and effective governance, international trade can exacerbate social and regional inequalities (Wardani, 2024). The negative impact of trade openness on economic growth may also arise when imports surpass exports, leading to current account deficits and pressure on the exchange rate (Nguyen & Bui, 2021).

Empirically, this result aligns with the Environmental Kuznets Curve (EKC) hypothesis, where trade openness in ASEAN has driven environmental degradation more than it has supported sustainable economic growth (Hu et al., 2021; Lanhui & Ibrahim, 2024). On the other hand, in the short run, the findings show that trade openness still contributes positively to growth, in line with Arifin (2023), who emphasized the role of trade as an early catalyst for economic expansion. However, these short-term gains are not sufficient to guarantee sustainability without improved competitiveness in domestic industries and technological innovation (Voumik et al., 2023). When liberalization is not accompanied by fiscal policies that enhance domestic production capacity, countries may lose bargaining power in international trade (Amin et al., 2023). This highlights the need to strengthen investment in strategic sectors so that trade openness does not become a source of long-term structural vulnerability (Ridzuan et al., 2018).

Overall, these findings indicate that trade openness is not a neutral strategy but highly dependent on institutional readiness, policy quality, and a country's investment direction. Therefore, ASEAN countries need to design trade strategies that are not only quantitatively open but also selective and contextualized according to national development priorities (Hanif et al., 2022). Without adequate policy synergy, trade openness can become a trap of dependency rather than a driver of long-term growth (Azmin et al., 2022). A more integrated and environmentally friendly approach should be considered to maximize the benefits of trade while minimizing its negative impacts (Huang et al., 2022).

The Relationship between Renewable Energy (X3) and Economic Growth (Y)

The empirical results indicate that renewable energy consumption exerts a positive and significant long-term impact on economic growth in ASEAN countries. This finding aligns with Rahman et al. (2024), who assert that renewable energy plays a catalytic role in sustaining GDP growth by enhancing energy efficiency and reducing reliance on fossil fuels. The study confirms that as ASEAN nations invest more in renewable sources, such as solar, wind, and biomass, their economies gain greater stability and resilience. According to Wahyudi and Palupi (2023), such investments stimulate industrial diversification and create green jobs, which are essential for inclusive growth. Although the short-term effect of renewable energy on growth was not statistically significant, this result reflects common challenges such as infrastructure constraints and delayed returns on green investments (Yusoff et al., 2024). Infrastructural bottlenecks and limited financial capacity often hamper the immediate effectiveness of clean energy adoption. However, over time, these barriers tend to diminish as countries integrate sustainability into their economic strategies (Kumaran et al., 2020).

Moreover, renewable energy supports long-term growth by lowering carbon intensity and mitigating the environmental costs associated with traditional energy use (Hanif et al., 2022). This transition not only benefits public health but also fosters investor confidence in stable, forward-looking economies. Ali et al. (2018) also provide evidence that biomass energy consumption contributes to economic development in ASEAN, reinforcing the role of renewable sources in driving regional progress. From a macroeconomic standpoint, renewable energy reduces energy import dependence, thereby improving trade balances and enhancing national energy security (Azmin et al., 2022). The positive linkage between renewable energy and economic expansion also reflects structural shifts in global energy markets, where clean technologies are becoming more cost-effective (Huang et al., 2022).

Furthermore, Yusoff et al. (2024) emphasize that renewable energy consumption in ASEAN is influenced not only by environmental imperatives but also by economic modernization. These results underscore the need for comprehensive policy reforms, including fiscal incentives and institutional strengthening, to maximize the developmental benefits of clean energy. Thus,

policymakers are encouraged to frame renewable energy not just as an environmental necessity but as a strategic economic asset for sustainable growth in the region.

Long-run cointegration relationship among foreign direct investment (FDI), trade openness, renewable energy consumption, and economic growth

The finding of a long-run cointegration relationship among FDI, trade openness, renewable energy consumption, and economic growth reinforces the structural interconnectedness of these macroeconomic variables in ASEAN countries. This result indicates that, over time, the dynamics among these factors converge toward a stable equilibrium that shapes the region's development trajectory (Voumik et al., 2023). The negative long-run impact of FDI on economic growth, as revealed in the model, may reflect concerns regarding sectoral dependency and inadequate technology spillovers (Asri, 2025). In several ASEAN nations, FDI is concentrated in extractive and low-value-added sectors, which offer limited contributions to long-term productivity and innovation (Sitthivanh & Srithilat, 2022).

However, in the short term, FDI positively influences economic growth, implying that it provides temporary capital inflows and employment opportunities (Tan et al., 2022). These findings suggest that the developmental impact of FDI is highly conditional on the absorptive capacity and industrial maturity of host countries (Haini et al., 2024). Trade openness also shows a similar duality: while beneficial in the short run, it exerts a negative effect in the long run, possibly due to premature deindustrialization and increased vulnerability to external shocks (Lestari et al., 2024). This aligns with the argument that trade liberalization without institutional readiness can impede sustainable development (Nguyen & Bui, 2021).

The positive and significant long-run relationship between renewable energy consumption and economic growth confirms the strategic importance of clean energy for long-term prosperity (Rahman et al., 2024). ASEAN countries with consistent investment in biomass and renewable technologies tend to achieve better environmental and economic outcomes (Ali et al., 2018). Moreover, renewable energy reduces external energy dependence and stabilizes macroeconomic conditions amid volatile fossil fuel markets (Hanif et al., 2022). The cointegration result also supports the environmental Kuznets curve hypothesis, where economic growth becomes more sustainable as clean energy adoption increases (Huang et al., 2022).

In a broader sense, the interplay among FDI, trade, and renewable energy reflects a synergistic mechanism that influences the quality of growth, not merely its magnitude (Yusoff et al., 2024). Policies promoting environmental governance and technological upgrading enhance the ability of economies to maximize long-run benefits from these variables (Hu et al., 2021). Nevertheless, institutional quality and policy coherence remain crucial in channeling FDI and trade toward green sectors (Azwardi & Bashir, 2023). In conclusion, the observed cointegration underscores the need for integrated policy frameworks that align investment and trade strategies with renewable energy goals to achieve inclusive and sustainable economic growth in ASEAN (Wahyudi & Palupi, 2023).

5. Conclusion

This study examined the short-run and long-run relationships among Foreign Direct Investment (FDI), Trade Openness (TO), Renewable Energy Consumption (REN), and Economic Growth (GDP) in ASEAN countries over the period 1998–2022. Employing a panel ARDL approach, the findings confirmed the existence of a long-run cointegration relationship among the four variables. Both FDI and trade openness were found to exert positive effects in the short run but negative impacts on economic growth in the long run. In contrast, renewable energy consumption had a positive and significant influence on long-term economic growth, although its short-run effect was statistically insignificant. These results highlight the limitations of relying solely on foreign investment and trade liberalization as long-term growth strategies. Dependence on FDI and trade, without strengthening domestic sectors, may undermine economic resilience over time.

The policy implications suggest that ASEAN countries need to adopt long-term development strategies, including strengthening domestic industrial capacity, enhancing absorptive capability, and channeling FDI into productive and sustainable sectors. Renewable energy has been shown to be a sustainable and environmentally friendly engine of economic growth. Thus, governments in the region must accelerate the clean energy transition through fiscal incentives, infrastructure development, and institutional support. In addition, regulatory frameworks that facilitate investment in renewable energy will amplify its positive effects on economic performance. The

findings also emphasize the importance of policy integration across investment, trade, and energy to achieve sustainable growth. Within the ASEAN context, structural differences among member states call for adaptive and context-specific policy approaches.

For future research, scholars are encouraged to incorporate institutional variables such as regulatory quality and political stability to examine their mediating or moderating effects on the FDI-growth nexus. Expanding the model to include green technology adoption or energy efficiency indicators could further enrich the analysis. Moreover, employing a mixed-methods approach would offer deeper insights into the social and political mechanisms influencing policy effectiveness. Spatial analysis across ASEAN countries could also strengthen the findings by exploring cross-border policy effects. In conclusion, this study provides both theoretical contributions and practical relevance in supporting the formulation of sustainable economic development strategies in the ASEAN region.

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