



THE URGENCY OF FISCAL BUFFERS IN FACING THE ENERGY TRANSITION PARADOX AND THE IMPACT OF GREEN ECONOMIC VARIABLES ON FOREIGN INVESTMENT IN ASEAN-10

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Abstract

This study aims to analyze the impact of green economy variables on Foreign Direct Investment (FDI) in 10 ASEAN member countries from 2000 to 2020. The primary issue investigated is the energy transition paradox, where sustainability policies potentially become a cost burden for foreign investors. The research methodology employs a quantitative approach using panel data regression with the Fixed Effect Method (FEM), enhanced by Clustered-Robust Standard Error to address classical assumption issues. The results indicate that Renewable Energy Consumption (REC), CO₂ emissions, and Natural Resource Depletion (NRD) simultaneously have a significant effect on FDI. Partially, only the REC variable shows a significant negative impact, where every one percent increase in renewable energy consumption decreases FDI by 0.159% of GDP. In contrast, CO₂ emissions and NRD do not exhibit statistically significant effects. These findings confirm the efficiency-seeking motives of investors who perceive the energy transition as an additional compliance cost due to the absence of adequate fiscal support. Consequently, a fiscal buffering strategy is required through the synchronization of tax incentives and the implementation of carbon taxes to maintain investment competitiveness amidst the global energy transition.

Keywords: ASEAN-10; FDI; Fiscal Buffering; Green Economy; Renewable Energy

INTRODUCTION

Global conditions have a significant impact on a country's economic development, particularly through the flow of Foreign Direct Investment (FDI), which strengthens competitiveness, drives development, creates jobs, and fosters technological advancement (Mathur, 2025). FDI also enhances economic integration among countries through an increasingly interconnected global investment network, where trade ties, geographical distance, and economic disparities are key factors influencing FDI flows (Li *et al.*, 2024), and helps countries access international capital, technology, and new markets to strengthen sustainable economic development (Milner, 2014; Zvezdanovic Lobanova, 2024). In Southeast Asia, ASEAN has emerged as one of the most attractive investment destinations amid a global shift in FDI toward digital technology, environmentally friendly sectors, and electric vehicles, as evidenced by FDI inflows reaching US\$230 billion in 2023, up from US\$224 billion in 2022 (ASEAN Secretariat, 2023). World Bank data shows that FDI trends in ASEAN have been volatile over the past five years, influenced by regulatory, institutional, macroeconomic, and business environment factors; efficient regulations and investment protection can boost FDI (Contractor *et al.*, 2020). However, the global shift toward sustainability has created a contradictory situation regarding the effectiveness of the green economy in attracting foreign investment in ASEAN. Although (Goh *et al.*, 2025) noted the strategic potential of renewable energy, the reality reveals a paradox: (Goh *et al.*, 2025) found a long-term positive relationship, yet (Chung, 2014) showed that polluting industries actually relocate to countries with lax regulations, and (Luh *et al.*, 2025) found no significant impact due to policy gaps.

Most of the literature has limitations because it tends to analyze ASEAN either in aggregate or in a fragmented manner, as seen in the study (Goh *et al.*, 2025) and (Luh *et al.*, 2025) which focus only on specific countries, meanwhile (Phung *et al.*, 2022) employed a



regional analysis that remains general in scope. Other studies, such as (Qamruzzaman, 2023), (Wahid *et al.*, 2025), and (Ulgiati *et al.*, 2022) have also not specifically captured the ASEAN context in its entirety. The importance of this geographical context is emphasized by studies outside the region, such as (Santika *et al.*, 2025), (Chung, 2014), and (Haliti & Merovci, 2020).

Although investors continue to seek operational efficiencies, the high costs of the renewable energy transition in the ASEAN region create a fiscal paradox: green investments, which are structurally expensive, require compensation in the form of lower tax burdens. The cost of generating renewable energy in developing countries, including those in the ASEAN region, remains higher than that of conventional fossil-fuel-based energy due to the significant capital investment required in infrastructure, storage technology, and transmission networks (Zin Lin *et al.*, 2026). Consequently, without adequate fiscal support, increasing the share of renewable energy in the energy mix could actually raise investors' operational costs and reduce the competitiveness of investment locations.

On the other hand, ASEAN countries actively use fiscal policies as instruments of tax competition to attract FDI amid a stringent regulatory environment. Commonly used instruments include tax holidays, tax allowances, reductions in corporate income tax rates, and investment tax credit incentives for priority sectors (Pitaloka & Slamet, 2025). However, the effectiveness of tax competition in offsetting the costs of the energy transition remains a subject of debate among academics. Tax incentives have a significant impact on FDI inflows in the ASEAN region, but their impact varies depending on policy design and the economic context of each country (Rizka & Asqolani, 2024). This raises a fundamental question: Are tax incentives and environmental taxes, such as a carbon tax, needed to mitigate the negative impacts of the high costs of the energy transition, which are currently dampening foreign investor interest in the ASEAN region? This question becomes increasingly relevant given the findings of this study, which indicate that RECs have a significant negative impact on FDI, a sign that without adequate fiscal compensation, the green energy transition agenda risks conflicting with the goal of increasing foreign investment inflows.

LITERATURE REVIEW

Pollution Haven Hypothesis and Pollution Halo Hypothesis

The uncertainty surrounding investor behavior regarding green economy policies gives rise to two theoretical hypotheses: The Pollution Haven Hypothesis (PHH), which posits that firms avoid strict regulations and the adoption of green economy practices (Mirhoseyni *et al.*, 2023; Ranocchia & Lambertini, 2021) and Pollution Halo Hypothesis (PH) which argues that strict regulations drive efficiency and attract FDI (Ranocchia & Lambertini, 2021). Empirical evidence is also varied; the Pollution Halo Hypothesis (PHH) has been confirmed in China (Shen *et al.*, 2019), OECD countries (Sadik-Zada & Ferrari, 2020), and the ASEAN-5 (Guzel & Okumus, 2020), while studies on the BRICS and MINT groups (Shao *et al.*, 2019) as well as BRICMT (Ozcelik *et al.*, 2024) support the Pollution Halo hypothesis or refute the negative impact of regulation, confirming that the national context is highly determinative.

The Pigouvian Theory of Externalities and Green Tax Incentives

The Pigouvian theory of externalities, first proposed by Arthur C. Pigou in the early 20th century, serves as the foundation for the use of fiscal instruments to correct market failures resulting from negative environmental impacts (Manta *et al.*, 2023). This theory states that economic activities that generate negative externalities, such as CO₂ emissions, should be taxed at a rate equal to the social costs they impose, so that market prices reflect the true costs to society. Conversely, activities that generate positive externalities, such as the adoption of renewable energy, should receive subsidies or tax incentives so that the market achieves a socially optimal level of production (Manta *et al.*, 2023). In the context of the green economy,



this Pigouvian framework involves two policy approaches: first, the imposition of environmental taxes (green taxes) to internalize the negative external costs of carbon emissions; and second, the provision of tax incentives to encourage positive impacts, such as increasing the share of Renewable Energy Consumption (REC) in the national energy mix. The implication for this study is that the negative coefficient of REC on FDI can be interpreted as a result of the absence of adequate Pigouvian incentives: the costs of the energy transition are fully borne by investors without fiscal compensation from the government, so investors treat renewable energy as a cost burden rather than a competitive advantage.

Tax-Induced Efficiency Seeking

The concept of tax-induced efficiency seeking refers to the behavior of multinational corporations that actively select investment locations based on tax burden optimization in order to maximize global operational cost efficiency (Wadhwa & S, 2011). This concept is an extension of the OLI (Ownership, Location, Internalization) paradigm introduced by Dunning in 1980, which asserts that location advantages, including favorable tax regimes, are key determinants in FDI location decisions. Within this framework, compliance costs which encompass environmental taxes, carbon taxes, natural resource royalties, and tax administration costs are treated as components of total operating costs that influence the competitiveness of investment locations (Wadhwa & S, 2011). The relevance of this concept to the research findings is highly significant: the efficiency-seeking motive identified by the negative REC coefficient indicates that investors in ASEAN view the costs of the renewable energy transition as additional compliance costs that reduce operational efficiency. In other words, as long as high REC costs are not offset by adequate tax incentives, efficiency-oriented investors will tend to choose investment locations with lower energy costs and tax burdens, reinforcing the argument for the need for fiscal buffering as a policy response.

To analyze the Green Economy aspect, key indicator proxies are required. Previous studies have shown that there is a relationship between green economy variables namely Renewable Energy Consumption, CO₂ Emissions, and Natural Resource Depletion and FDI. According to research conducted by Ulgiati *et al.* (2022), Renewable Energy Consumption (REC) has a positive correlation with FDI. An increase in REC makes the production of goods and services cheaper and more timely, due to the increased energy supply resulting from the " ." This aligns with research conducted by Wahid *et al.* (2025). Based on prior research, the following hypothesis can be formulated:

H1: Renewable energy consumption has a positive effect on foreign direct investment

According to research conducted by Hammad Ahmad Khan *et al.* (2025), CO₂ Emissions are negatively correlated with FDI. CO₂ emissions act as an independent variable representing low operational compliance costs, so that countries with lower environmental standards tend to attract larger investment inflows, particularly in pollution-intensive industrial sectors. This is consistent with research conducted by Gök *et al.* (2024). Based on previous research, the following hypotheses can be formulated:

H2: CO₂ emissions have a negative effect on Foreign Direct Investment

According to research conducted by Bayahya *et al.* (2025), Natural Resource Depletion is positively correlated with FDI. Findings in this paper indicate that for every one-unit increase in NRD, FDI is predicted to increase by 0.812 units. This large coefficient reflects the strong dependence of foreign investors on natural resource-based sectors, where the exploitation of natural wealth is the primary attraction for investment. Based on previous research, the following hypothesis can be formulated:

H3: Natural Resources Depletion has a positive effect on Foreign Direct Investment



METHODS

This study employs a quantitative approach using panel data regression analysis to examine how the relationship among Green Economy variables influences Foreign Direct Investment (FDI). The study covers 10 ASEAN member countries: Indonesia, Malaysia, Singapore, Thailand, the Philippines, Vietnam, Brunei Darussalam, Cambodia, Laos, and Myanmar. The observation period spans 21 years, from 2000 to 2020. All research data consists of secondary data obtained and downloaded directly from the World Bank's official website (data.worldbank.org). Data on the dependent variable, namely Foreign Direct Investment (FDI) growth, was taken from global economic indicators available in the database. Information on independent variables includes Renewable Energy Consumption, CO₂ Emissions, and Natural Resource Depletion.

Table 1. Research Variables

No	Variable	Definition	Unit
1	Foreign Direct Investment	Net long-term foreign investment inflows expressed as a percentage of Gross Domestic Product (GDP)	% of GDP
2	Renewable Energy Consumption	Share of renewable energy in total final energy consumption	% of total final energy consumption
3	CO ₂ Emissions	Carbon dioxide from cement production, gas flaring, and the combustion of fossil fuels (solid, liquid, and gas)	Metric Tons per Capita
4	Natural Resources Depletion	The sum of net deforestation, energy depletion, and mineral depletion	% of GNI

Source: Author-processed data, 2026

Based on the results of a series of tests, it was determined that the Fixed Effect Method (FEM) is the appropriate and accurate model to use in modeling the complexity of the data. To address the constraints of classical assumption tests, the Clustered-Robust Standard Error method was applied (Colin Cameron & Miller, 2015). This step was used to ensure that the estimation results still met the Best Linear Unbiased Estimator (BLUE) criteria so that the resulting regression was efficient, unbiased, and scientifically valid. Basic panel data regression model:

$$FDI_{i,t} = \alpha + \beta_1 (RE)_{i,t} + \beta_2 (CO_2)_{i,t} + \beta_3 (NRD)_{i,t} + e_{i,t}$$

Informasi:

- FDI = Foreign Direct Investment (US\$)
- α = Constant (intercept)
- RE = Renewable Energy Consumption
- CO₂ = CO₂ Emissions
- NRD = Natural Resources Depletion
- $\beta_1, \beta_2, \beta_3$ = Regression coefficients for each independent variable
- e_t = Error term (disturbance variable)
- t = Time period (2000–2020)
- i = Entity or Country



RESULTS AND DISCUSSION
Descriptive Statistics

Table 2. Descriptive Statistics

	Obs	Mean	Max	Min	Std. Dev.
FDI	210	5.11	29.67	-2.76	5.77
RE	210	33.90	85.80	0	27.84
CO ₂	210	284.80	2175.77	5.07	433.91
NRD	210	5.20	27.69	0	5.99

Source: Data processed by the author using STATA 19, 2026

Based on Table 2 of the descriptive statistics, it is evident that the Foreign Direct Investment (FDI) variable shows an average value of 5.11 percent with a range between -2.76 percent and 29.67 percent, where negative values indicate the occurrence of divestment in certain countries. In the energy sector, Renewable Energy recorded an average usage of 33.90 percent with a very wide range (0–85.80 percent), reflecting the disparity in the green energy transition among ASEAN members. Meanwhile, the average CO₂ emissions were 284.80 metric tons per capita with a high standard deviation (433.91), illustrating extreme differences in carbon footprints due to uneven industrial scales. Finally, the Natural Resource Depletion variable has an average of 5.20 percent with a maximum value of 27.69 percent, confirming that the exploitation of natural resources remains the backbone of the economy for some countries in the region.

Panel Data Model Estimation and Model Testing

Table 3. Model Selection Test

Model Selection Test Method	p-value	Results
<i>Chow</i> Test	0,0000	FEM
<i>Hausman</i> Test	0,0000	FEM

Source: Data processed by the author using STATA 19, 2026

Based on the table above, it can be seen that the p-value of the Chow test is 0.0000. This figure is lower than the 5 percent significance threshold (α), so the null hypothesis stating that the Common Effects Model (Pooled OLS) is most appropriate for describing the relationship between the research variables must be rejected. Therefore, the results of this test confirm that the Fixed Effects Model has a higher fit compared to the Common Effects Model (Pooled OLS).

To determine whether the Fixed Effects Model is indeed the most accurate model for describing the relationships among variables, the study proceeded with a Hausman test. This additional test aims to compare the fit between the Fixed Effects Model and the Random Effects Model. Referring back to the data in Table 2, the p-value obtained from the Hausman test is 0.0000. Since this value is smaller than the set significance level, it can be concluded that the Fixed Effects Model is the most appropriate model to use. Furthermore, to ensure that the estimation results meet the criteria of the Best Linear Unbiased Estimator (BLUE), the regression model must undergo a series of classical assumption tests to verify its validity.



Classical Assumption Tests

Table 4. Results of Classical Assumption Tests

Classical Assumption Tests	Test Results	Follow-up
Normality Test	Non-normal	Use of the Central Limit Theorem because $n = 210$ (Barri, 2019).
Multicollinearity Test	No signs	-
Autocorrelation Test	Significant	Use of robust standard errors (Colin Cameron & Miller, 2015).
Heteroscedasticity Test	Significant	Use of robust standard errors (Colin Cameron & Miller, 2015).

Source: Compiled by the Author

F-Test (Simultaneous)

Table 5. F-Test Results

Dependent Variable: <i>Foreign Direct Investment</i>	
variabel	b/se
R ²	0,187
F-stat	4,79
Prob (F-stat)	0,0292

Robust Standard Error

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: Data processed by the author using STATA 19, 2026

The results above indicate that the variables Renewable Energy, CO2 Emissions, and Natural Resources Depletion collectively have a significant effect on Foreign Direct Investment (FDI). This is evidenced by a significance value of 0.0292, which is below the 0.05 threshold, as well as a calculated F-value (4.79) that is greater than the table F-value (3.86). These green economy variables contribute 18.73% to the variation in Foreign Direct Investment (FDI). However, 81.27% of foreign investment decisions are still determined by institutional and macroeconomic factors, such as political stability, fiscal policy, and infrastructure quality.

Hypothesis Testing (t-Test)

Table 6. Results of the t-Test

Variable	Coefficient	Robust Std. Error	t-statistic	Prob > t	Description
Constant	10.18816	1.368711	7.44	0.000	significant
REC	-.1598789	.0437836	-3.65	0.005	significant
CO2	-0,0029283	0,0024767	-1,18	0,267	not significant
NRD	0,226217	0,1466641	1,54	0,157	not significant

Source: Data processed by the author using STATA 19, 2026

Based on the regression results above, if all independent variables (RE, CO2, and NRD) are held constant or set to zero, FDI is predicted to remain at 10.18816 percent of GDP. REC has a negative coefficient of -0.1598789, meaning that every one-percent increase in renewable energy consumption reduces FDI by 0.1598789 percent of GDP. CO2 Emissions has a negative coefficient of -0.0029283, so every one-metric-ton increase in emissions reduces the FDI rate by 0.0029283 percent of GDP. NRD has a positive coefficient of 0.226217, meaning that a one-



percent increase in the Natural Resources Depletion ratio relative to GDP increases FDI by 0.226217 percent of GDP. It was found that only Renewable Energy Consumption has a significant effect on Foreign Direct Investment (FDI) with a negative coefficient of -0.1598 and a p-value (0.005) below the 5 percent alpha level, so H_0 is rejected. Conversely, the variables CO_2 Emissions (coefficient -0.0029; $p = 0.267$) and Natural Resource Depletion (coefficient 0.2262; $p = 0.157$) showed significance levels greater than 0.05, meaning neither variable has a significant individual effect on FDI. These findings reinforce the rejection of the Pollution Halo hypothesis in ASEAN-10. The REC phenomenon confirms the efficiency-seeking motive, consistent with the argument by Hübler & Keller (2010) that inefficient energy policies can reduce investment attractiveness. Although these findings differ from those of Ulgiati *et al.* (2022) and Wahid *et al.* (2025), who state that green energy enhances investment image, these results actually reinforce the findings of the “ ” paradox from Luh *et al.* (2025) and Chung (2014), and are consistent with the perspective of Hübler & Keller (2010).

The coefficient of -0.159 for the Renewable Energy Consumption (REC) variable should not be interpreted merely as a rejection of green energy, but rather as a signal of the absence of adequate tax incentives in the ASEAN region. Without support from fiscal instruments such as tax allowances, green investment tax credits, or accelerated depreciation for renewable energy assets, the energy transition will only be perceived by investors as an additional operational burden that increases production costs (Manta *et al.*, 2023). This finding aligns with Pigou's perspective in his theory of externalities, which states that without fiscal corrections, the market cannot automatically reflect the social value of clean energy; thus, tax incentives serve as a crucial fiscal buffer in maintaining the competitiveness of green investments (Manta *et al.*, 2023). In other words, ASEAN governments need to actively design fiscal instruments capable of bridging the cost gap between renewable energy and conventional fossil fuels so that investors no longer treat the energy transition as a cost-increasing factor.

The phenomenon of CO_2 having a negative impact on FDI indicates that high carbon emissions reflect weaknesses in environmental management and sustainability risks that could potentially reduce investment appeal (Chiriluş & Costea, 2023). This finding suggests that investors are beginning to anticipate the future implementation of a carbon tax in the ASEAN region. Several ASEAN countries have moved toward the gradual implementation of carbon pricing instruments: Indonesia launched a national carbon exchange in September 2023 and is currently implementing a carbon tax for the coal-fired power plant sector, while Malaysia, Thailand, and Vietnam are studying similar carbon tax systems or emissions trading schemes (ETS) (SEAISI, 2024; Zin Lin *et al.*, 2026). Therefore, mitigation policies involving the synchronization of carbon tax implementation plans with tax incentives for low-emission investments are highly strategic for maintaining FDI flows amid this transition.

Furthermore, a positive NRD indicates that while the exploitation of natural resources offers short-term profit opportunities through access to raw materials and low costs, excessive reliance on this sector can trigger the resource curse and structural vulnerabilities that degrade investment quality (Elheddad, 2016). This NRD finding demonstrates that competitive natural resource tax rates achieved through mechanisms such as production sharing contracts, cost recovery, and resource rent taxes, remain the primary attraction for resource-seeking investors compared to stringent environmental standards (Wadhwa & S, 2011). This aligns with Dunning's OLI paradigm from 1980, which states that the availability of natural resources along with a favorable tax regime constitutes a key component of a country's location advantage (De *et al.*, 2022). However, excessive reliance on natural resource-based fiscal incentives without stringent sustainable management standards risks triggering the resource curse and long-term structural vulnerabilities. Therefore, an ideal natural resource tax policy design must balance short-term fiscal incentives with binding environmental sustainability requirements.



CONCLUSION

The dimensions of the green economy exhibit varied effects on Foreign Direct Investment (FDI) inflows in the ASEAN-10 countries during the 2000–2020 period. Simultaneously, Renewable Energy Consumption, CO₂ Emissions, and Natural Resource Depletion were found to have a significant impact on FDI; however, only REC had a negative and significant effect, indicating that an increase in the green economy's share is still associated with a decline in foreign investment, as investors are sensitive to rising operational costs and the relatively high costs of renewable energy infrastructure. On the other hand, CO₂ emissions and NRD do not show a statistically significant influence after the model was refined using Clustered-Robust Standard Error. Although CO₂ emissions tend to have a negative relationship reflecting potential investment barriers due to pollution and NRD shows a positive direction indicating investor interest in resource exploitation, neither has yet become a consistent determinant of FDI growth in ASEAN-10. In general, these findings confirm that investment decisions in the region are still driven more by conventional economic considerations and cost efficiency than by strict environmental sustainability standards.

Therefore, addressing the research question, the implementation of tax incentives and the imposition of environmental taxes (such as a carbon tax) are essential instruments as mitigation strategies. The negative impact of RECs demonstrates that without fiscal support such as tax allowances or green investment tax credits, the energy transition will continue to be perceived as a cost burden that undermines the region's competitiveness. Synchronizing the provision of incentives to bridge the cost gap for clean energy with the implementation of carbon taxes to internalize the external costs of pollution will serve as a fiscal buffer. This step will not only shift investors' motives from merely seeking short-term cost efficiency toward sustainable investment but also ensure that ASEAN remains competitive in attracting FDI flows amid the global energy transition.

Recommendations

Future research is recommended to expand the scope of independent variables such as political stability, fiscal policy, infrastructure quality, and trade openness or other macroeconomic variables, given that 81.27% of FDI variation is still influenced by factors outside this model. Additionally, a systematic comparative study is needed to identify threshold effects and unique patterns among ASEAN countries through sector-level analysis. Future researchers should also explicitly incorporate tax dimensions, such as the tax climate index, to provide more comprehensive estimates for policymakers.

Regarding policy recommendations, the governments of each of the 10 ASEAN countries need to design fiscal buffering schemes to reduce the cost of renewable energy through the expansion of tax holidays, green investment tax credits, and accelerated depreciation for green infrastructure. Additionally, the development of a roadmap that aligns the implementation of carbon taxes with aggressive tax incentives for low-emission companies is crucial. This synchronization will provide the long-term regulatory certainty that investors need when making sustainable investment decisions in the ASEAN region.

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