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Macroeconomic and Environmental Determinants of FDI in 6-ASEAN Countries: A Panel Analysis

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Abstract
Foreign Direct Investment (FDI) plays an important role in promoting economic growth, technology transfer, employment creation, and regional economic integration in developing countries, particularly in ASEAN economies. However, despite the growing literature on FDI determinants, previous studies have generally examined macroeconomic, environmental, financial, and technological factors separately, resulting in limited understanding of their combined effects on FDI inflows, especially in the ASEAN context. This study offers a more integrated perspective by simultaneously incorporating economic growth, carbon emissions, domestic credit, technology, and energy consumption into a unified empirical framework using the Seemingly Unrelated Regression–Panel Corrected Standard Errors (SUR-PCSE) approach. The study analyzes panel data from six ASEAN countries: Cambodia, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. The results indicate that economic growth, domestic credit, and energy consumption have significant positive effects on FDI inflows, while carbon emissions negatively affect FDI. In contrast, technology does not have a statistically significant effect on FDI in the observed countries. These findings suggest that ASEAN economies still rely heavily on macroeconomic stability, financial development, and infrastructure readiness in attracting foreign investment, while environmental sustainability is becoming increasingly important in shaping investment decisions. This study contributes to the literature by providing a more comprehensive framework for analyzing FDI determinants in ASEAN countries and offers policy insights for strengthening sustainable investment competitiveness in developing economies.

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Introduction

In the era of increasing globalization, Foreign Direct Investment (FDI) has become an important driver of economic growth in developing countries, particularly in Southeast Asia, including Cambodia, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. FDI not only provides external financing but also contributes to technology transfer, productivity improvement, employment creation, and regional economic integration (Sapuan & Roly, 2021). In the ASEAN region, FDI inflows have continued to increase alongside regional economic integration and the implementation of the ASEAN Economic Community (AEC), which facilitates cross-border capital mobility (ASEAN Secretariat, 2023). However, FDI inflows are influenced by various macroeconomic and structural factors, including domestic credit, economic growth, carbon emissions, energy consumption, and technological development (Berliyani et al., 2024).

FDI has become an essential component of economic development in ASEAN countries because it supports industrial expansion, enhances productivity, and strengthens international economic connectivity. According to Hema & Osathanunkul (2021), FDI contributes significantly to the development of industrial, trade, and service sectors in developing economies. Beyond capital inflows, FDI also facilitates technology transfer, managerial knowledge, technical expertise, and workforce skill development, thereby improving economic efficiency and competitiveness (Anwar et al., 2023).

Various studies have shown a positive relationship between technological progress and FDI inflows. Dua & Verma (2023) show that increasing domestic economic capacity, digital transformation, and the quality of the business environment are important factors that attract foreign direct investment flows to developing countries in Asia.. At the ASEAN level, countries that increase research and development (R&D) spending and strengthen technological infrastructure have shown greater success in attracting foreign investment, particularly Malaysia and Vietnam, which have implemented pro-technology policies to support high-technology manufacturing sectors (World Bank, 2023). However, the level of technological readiness and innovation capacity remains uneven across ASEAN countries, potentially creating differences in their ability to attract high-quality foreign investment.

Foreign investors also consider stable and sustainable economic growth as an important indicator in assessing the profitability and attractiveness of a host country. Gross Domestic Product (GDP) positively affects FDI inflows into ASEAN countries, as shown by Aslam & Rudatin (2023), who argue that increasing economic output strengthens investment attractiveness. However, while economic growth may stimulate investment inflows, rapid industrial expansion may also generate environmental consequences, particularly through increasing carbon emissions and energy consumption. Adrian (2023) finds that GDP growth and energy consumption significantly contributed to higher CO_2 emissions in several ASEAN countries, including Indonesia, Malaysia, Thailand, and Vietnam. This situation highlights the trade-off between economic growth and environmental sustainability. Environmental quality has therefore become an increasingly important issue, not only for developed countries but also for developing economies, because pollution from industrial production, transportation, and other economic activities can contribute to environmental degradation and climate-related challenges.

Figure 1 illustrates the movement of FDI inflows in six ASEAN countries during the period 2011–2022. Overall, FDI trends in ASEAN countries fluctuate due to both internal and external factors, including economic conditions, political stability, government policies, infrastructure quality, and global crises such as the COVID-19 pandemic. Cambodia recorded relatively high and stable FDI inflows, reflecting the country's open economic policies and focus on industrial development. In contrast, Thailand experienced negative FDI inflows in 2020, indicating capital outflows during the pandemic period and reflecting the impact of economic uncertainty and domestic political instability. Indonesia showed fluctuating FDI performance, suggesting that despite its large market potential,

investment inflows remain sensitive to regulatory and bureaucratic challenges. Meanwhile, Malaysia, the Philippines, and Vietnam demonstrated relatively strong investment growth supported by industrial expansion, export-oriented development, and investment incentive policies. These patterns indicate that ASEAN countries exhibit different levels of investment competitiveness and structural readiness in attracting foreign investors.

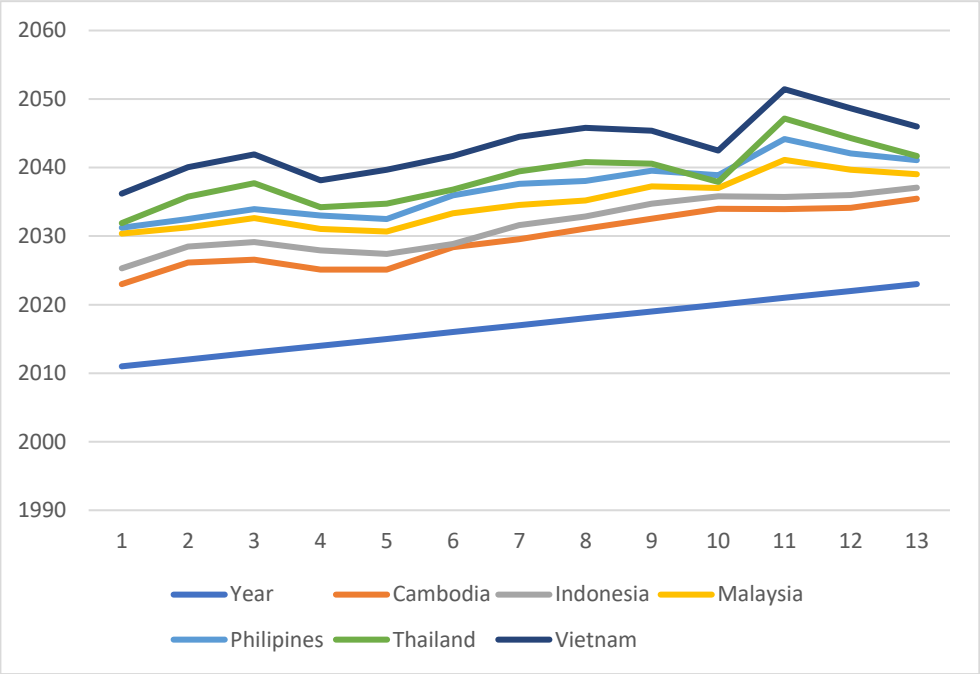

Fig 1. Foreign Direct Investment of 6 ASEAN Countries (2011 – 2022)
Source: World Bank Data, 2025

Understanding the relationship between FDI and structural factors in ASEAN economies is important because the region continues to experience economic transformation alongside increasing global competition. In particular, the role of technology transfer through FDI remains an important issue in supporting long-term economic development and industrial upgrading. Nevertheless, an important question remains regarding the extent to which ASEAN countries have fully benefited from technology transfer and whether technological progress alone is sufficient to attract foreign investment under current regional conditions. Therefore, integrating macroeconomic, environmental, financial, and technological factors into a unified analytical framework becomes increasingly relevant for understanding the dynamics of FDI inflows in ASEAN countries.

Despite the growing importance of FDI in ASEAN economies, previous studies have generally examined the determinants of FDI separately by focusing only on selected aspects such as economic growth, financial development, environmental quality, or technology. As a result, limited attention has been given to the combined interaction between macroeconomic, environmental, financial, and technological factors within a unified empirical framework, particularly in the context of ASEAN countries. Furthermore, many previous studies rely on conventional panel approaches that may not fully capture cross-sectional dependence and structural heterogeneity among countries. This limitation may reduce the ability of previous studies to explain the complex dynamics of FDI inflows within an increasingly integrated regional economy.

Based on these gaps, this study seeks to answer of how do economic growth, carbon emissions, domestic credit, technology, and energy consumption affect FDI inflows in six ASEAN countries

during the period 2011–2023. Therefore, this study aims to examine the multidimensional determinants of FDI by integrating macroeconomic, environmental, financial, and technological variables within a panel-data framework using the SUR-PCSE estimation approach. This study is expected to provide a more comprehensive understanding of the structural factors influencing FDI inflows and offer policy insights for strengthening sustainable investment competitiveness in ASEAN economies.

Literature Review

Foreign Direct Investment (FDI) plays a crucial role in promoting economic growth, particularly in developing countries, as it contributes to productivity improvement, employment creation, and technology transfer. According to the Eclectic Paradigm or OLI Framework proposed by Dunning (1980) and further developed by Narula & Dunning (2000), multinational enterprises invest in foreign countries when they possess ownership advantages, benefit from location advantages, and prefer internalization over external licensing. Among these components, location advantages are particularly relevant in explaining FDI inflows because foreign investors tend to prefer countries with stable economic conditions, efficient infrastructure, and supportive business environments. Therefore, factors such as economic growth, technological advancement, environmental quality, and energy availability become important determinants influencing investment decisions. The OLI framework remains highly relevant in explaining contemporary FDI patterns, especially in the era of globalization and increasing sustainability concerns, where environmental and technological considerations are increasingly integrated into multinational investment strategies (Narula & Dunning, 2010).

Economic growth is widely recognized as one of the primary determinants of FDI. Countries experiencing stable and sustained economic expansion tend to attract higher levels of foreign investment because economic growth reflects larger market potential, stronger purchasing power, and lower macroeconomic risk. Ghazalian (2024) argues that economic growth increases investor confidence and enhances the profitability prospects of host countries. Similarly, Anwar et al. (2023) find that GDP growth has a positive and significant effect on FDI inflows in ASEAN countries. Kurniawan & A'yun (2022) further demonstrate that economic growth and FDI exhibit a mutually reinforcing relationship, suggesting that sustained economic expansion enhances the attractiveness of host countries to foreign investors. Similar evidence is provided by Ariyani & Firmansyah (2023) and Nabila et al. (2026), who identify economic development as an important determinant of foreign investment inflows in emerging Asian economies. Anita & Udjianto (2024) also demonstrate, using a Fixed Effect Model approach across Indonesian provinces, that the rate of regional economic growth has a positive and significant effect on inclusive economic development, confirming that stronger economic performance serves as a foundational driver of broader development outcomes. Within the OLI framework, economic growth strengthens location advantages by signaling economic stability and long-term investment opportunities.

Financial development also plays an important role in supporting FDI inflows. More recent studies also support the role of financial development in attracting FDI. Osei & Kim (2023) show that financial development strengthens the growth-enhancing effects of FDI, while Ansari & Sensarma (2022) find that institutional and financial conditions significantly influence the FDI-growth nexus in ASEAN economies. Likewise, Sahu & Dash (2021) identify financial sector quality as an important determinant of FDI inflows across ASEAN countries. Wen et al. (2025) provide empirical evidence from Asian economies that financial development, mediated through bank lending, has a positive and statistically significant effect on national technological innovation, suggesting that the quality of financial systems plays a critical role in enabling innovation capacity across the region.

Environmental quality has also become an increasingly important factor in determining FDI. Two major theories explain the relationship between environmental conditions and foreign investment,

namely the Pollution Haven Hypothesis (PHH) and the Pollution Halo Hypothesis. The PHH states that multinational firms tend to relocate pollution-intensive production activities to countries with weaker environmental regulations in order to minimize production costs. In contrast, the Pollution Halo Hypothesis suggests that FDI may improve environmental quality through the transfer of cleaner technologies and more efficient production methods. Recent studies indicate that environmental degradation may reduce investment attractiveness because investors are increasingly concerned about sustainability issues and future regulatory risks. Zhu et al. (2021) demonstrate that stricter environmental considerations influence FDI decisions in developing countries. Therefore, carbon emissions may either attract or discourage FDI depending on the environmental policies and institutional conditions of host countries. Recent evidence suggests that environmental sustainability is becoming increasingly relevant in investment decisions. Tsoy & Heshmati (2024) find no consistent support for the Pollution Haven Hypothesis across countries with different income levels, while Gök et al. (2024) demonstrate that carbon emissions can negatively affect FDI under stricter environmental standards. Furthermore, Febriyanto et al. (2024) show that environmental pressures associated with investment activities have become increasingly important in ASEAN countries, highlighting the growing role of sustainability considerations in attracting foreign investors. One possible explanation is that multinational enterprises are increasingly required to comply with environmental, social, and governance (ESG) standards imposed by investors, consumers, and international supply chains. Consequently, countries characterized by high carbon emissions may be perceived as having greater environmental risks, stricter future regulatory adjustments, or higher compliance costs. This trend suggests that the traditional pollution-based competitive advantage may be gradually losing relevance, particularly as global investment increasingly shifts toward sustainable and low-carbon production systems.

Energy availability is another important determinant of FDI because industrial production and business operations rely heavily on stable energy infrastructure. Countries with reliable and affordable energy supplies tend to be more attractive to foreign investors due to lower operational costs and greater production efficiency. Recent studies provide further evidence regarding the relationship between energy and FDI. Edeh et al. (2024) argue that foreign investment and energy demand are strongly interconnected in emerging economies. Similarly, Fang et al. (2024) show that FDI significantly influences the structure and intensity of energy consumption in host countries. Moreover, Jinapor et al. (2025) find that FDI can interact with energy consumption in shaping economic development outcomes, indicating the strategic role of energy availability in attracting foreign investment.

Technological development is also considered an important determinant of long-term competitiveness and investment attractiveness. Countries with stronger technological capabilities, innovation systems, and research and development (R&D) capacity are generally expected to attract more foreign investment because they offer higher productivity and efficiency. More recently, Wang et al. (2024) demonstrate that digital transformation significantly promotes outward investment activities by improving firm efficiency, information accessibility, and international competitiveness. These findings suggest that technological advancement and digital readiness may increasingly influence investment decisions in the modern economy. However, the impact of technology on FDI depends not only on technological availability itself but also on the absorptive capacity of the host country, including human capital quality, institutional support, and industrial readiness (Narula & Dunning, 2010).

Although previous studies have examined various determinants of FDI, most research tends to focus only on selected dimensions such as economic growth, financial development, environmental quality, or technology separately. As a result, there remains limited synthesis regarding how macroeconomic, environmental, financial, technological, and energy-related factors interact simultaneously in influencing FDI inflows, particularly in ASEAN countries. Furthermore, many

previous studies employ cross-sectional or time-series approaches that may not fully capture country heterogeneity and dynamic structural changes over time. Therefore, this study attempts to provide a more integrated analytical framework by examining the combined effects of economic growth, carbon emissions, domestic credit, technology, and energy consumption on FDI inflows in six ASEAN countries during the period 2011–2023. This integrated approach is expected to provide a more comprehensive understanding of the structural determinants of FDI within the ASEAN region.

Method

This study focuses on six ASEAN member countries, namely Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Vietnam, during period 2011 to 2023. The analysis employs panel data regression to examine the relationship between the independent variables, economic growth, carbon emissions, domestic credit, technology, and energy consumption and the dependent variable, FDI. Panel data are used because they allow the analysis to capture both cross-sectional variations across countries and time-series dynamics over the observation period. The econometric model used in this study is specified as follows:

$$FDI_{it} = \alpha + \beta_1 EG_{it} + \beta_2 EM_{it} + \beta_3 CD_{it} + \beta_4 T_{it} + \beta_5 EC_{it} + \varepsilon_{it} \quad (1)$$

where i represents the country and t denotes the time period. FDI is the dependent variable, while EG (economic growth), EM (carbon emissions), CD (domestic credit), T (technology), and EC (energy consumption) are the independent variables.

The use of panel data offers several advantages, including an increased number of observations, greater variability, reduced multicollinearity, and improved estimation efficiency. It also enables the model to account for unobserved heterogeneity across countries, which is particularly relevant when analyzing multiple economies with different structural characteristics.

The estimation procedure begins with the application of three standard panel data models: the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The selection of the most appropriate model is determined using the Chow test, Hausman test, and Lagrange Multiplier test. The results of these tests indicate that the FEM is the most suitable specification, suggesting that country-specific characteristics play a significant role in explaining variations in FDI across ASEAN countries.

However, panel data involving multiple countries are likely to exhibit cross-sectional dependence, where economic shocks in one country may affect others due to regional economic integration. In addition, macro-panel data commonly contain heteroscedasticity and autocorrelation, which may lead to inefficient standard errors if conventional FEM estimation is applied without correction.

Therefore, this study employs the Fixed Effect Model (FEM) as the baseline regression model, with standard errors corrected using the Seemingly Unrelated Regression–Panel Corrected Standard Errors (SUR-PCSE) approach. This correction allows the model to account for heteroscedasticity, autocorrelation, and contemporaneous correlation across panels, thereby producing more reliable and efficient statistical inference.

This approach ensures that the estimated coefficients remain consistent under the FEM specification, while the inference is improved through robust error correction that reflects the interconnected nature of ASEAN economies.

Result and Discussion

The following analysis evaluates the impact of various economic and environmental factors on Foreign Direct Investment (FDI) across selected ASEAN economies. Table 1 illustrates the descriptive statistics for all variables, highlighting significant disparities in economic growth, emissions, and energy consumption among the member nations from 2011 to 2023. It is encompassing a total of 78 observations. Foreign Direct Investment (FDI) as the dependent variable recorded an average value

of 4.37 with a standard deviation of 3.94, and its values fluctuated within a range of -0.98 to 14.14, indicating significant disparities in investment attraction across the region. Economic Growth showed a mean of 4.66%, where the lowest mark of -9.51% indicates a period of economic crisis and the highest peak of 8.65% reflects rapid growth in developing nations. Regarding environmental and infrastructure factors, carbon emissions averaged 13.10, tending to be higher in industrialized countries, while Domestic Credit showed a wide variation with an average of 87.13, reflecting different levels of banking activity. Furthermore, the average for Technology stood at 134.80, signaling strong progress in certain member states, and Energy Consumption recorded a mean of 27.59, with higher usage typically found in the more industrial economies. These findings highlight the diverse structural influences that characterize the intervariable relationships in the subsequent analysis.

Table 1. Analysis Statistics Descriptive

Variables	Obs	Mean	Std. Dev	Min	Max
FDI	78	4.369	3.941	-0.988	14.14
Economic Growth	78	4.663	3.192	-9.518	8.650
Emission	78	13.09	9.631	0.237	33.60
Domestic Credit	78	87.12	43.84	22.60	164,0
Technology	78	134,8	18.96	94.39	181,9
Energy Consumption	78	27.58	16.30	2.2	65

The wide variation in FDI values suggests that investment inflows are not evenly distributed across ASEAN countries, but rather concentrated in economies with more favorable investment environments. This reflects differences in market size, policy consistency, and industrial development among member states. Countries with stronger economic performance and stable growth conditions tend to attract more investment, as they offer better prospects for profitability and lower macroeconomic risks (Maibetly & Idris, 2021; Phommouny et al., 2024).

In addition, the variation in domestic credit indicates differing levels of financial sector development, where countries with more advanced banking systems are better able to support investment activities through access to financing. Higher levels of energy consumption and carbon emissions are generally associated with more intensive industrial activity, which can attract efficiency-seeking FDI (Tran-Nam & Tran, 2026). However, this may also raise concerns related to environmental sustainability, especially as global investors increasingly consider environmental standards. Overall, these patterns reflect the heterogeneous economic structure of ASEAN countries and support the relevance of including these variables in explaining FDI inflows in the subsequent regression analysis.

Table 2. Chow Test

F 5.67 = 66.30
Prob > F = 0.0000

The selection of the most appropriate panel data regression model was conducted through two essential diagnostic tests: the Chow Test and the Hausman Test. According to the results of the Chow Test presented in Table 2, the probability value is 0.0000, which is significantly lower than the alpha level of 0.05. Consequently, the null hypothesis (H0) is rejected, suggesting that the Fixed Effect Model (FEM) is more suitable than the Pooled Least Square (PLS) approach.

To further validate this selection, the Hausman Test was performed as shown in Table 3, yielding a Chi-square value of 504.72 with a probability of 0.0000. Since the resulting probability is also less than 0.05, the null hypothesis is again rejected, confirming that the Fixed Effect Model (FEM) is the most statistically appropriate model for this research. This indicates that country-specific

characteristics play a significant role in influencing Foreign Direct Investment within the observed ASEAN economies.

Table 3. Hausman Test

Chi 2 (5) = 504.72
Prob > Chi2 = 0.0000

The robustness of the regression model is further evaluated through diagnostic tests for multicollinearity and heteroscedasticity. Based on the Multicollinearity Test results in Table 4, the Variance Inflation Factor (VIF) for all independent variables Economic Growth, Emission, Domestic Credit, Technology, and Energy Consumption is well below the threshold of 10. Domestic Credit exhibits the highest VIF at 2.18, while the mean VIF for the entire model is 1.59. These values indicate that there is no significant multicollinearity between the independent variables, fulfilling the classical assumption required for a reliable regression model.

Table 4. Multicollinearity Test

Independent Variables	VIF	1/VIF
Growth Economy	1.16	0.865348
Emission	1.47	0.681478
Credit Domestic	2.18	0.459325
Technology	1.56	0.639839
Consumption Energy	1.57	0.636015

Additionally, the Heteroscedasticity Test presented in Table 5 yields a Chi-square (Chi2) value of 0.00 with a probability (Prob > Chi2) of 1.0000. This exceptionally high probability value means the study fails to reject the null hypothesis (H0), confirming that there is no significant influence of heteroscedasticity within the model. Consequently, the variance of the error terms is constant (homoscedastic), ensuring that the estimated coefficients are efficient and the statistical inferences are valid.

Table 5. Heteroscedasticity Test

Chi2 (1) = 0.00
Prob > Chi2 = 1.0000

The regression analysis results presented in Table 6. It is using the Seemingly Unrelated Regression (SUR) approach to examine the determinants of Foreign Direct Investment (FDI) in six ASEAN countries. The SUR method is employed because it allows the simultaneous estimation of multiple equations while accounting for potential correlations among the error terms, thereby producing more efficient and consistent estimates compared to separate OLS estimations.

Table 6. Panel Data Regression Results using SUR Estimation Method

Variables	Coefficient	Standard Error	z	P>|Z|	Information
Economic Growth	0.1786014	0.0684847	2.61	0.009	Significant
Emission	-0.1146934	0.0166431	-6.89	0.000	Significant
Domestic Credit	0.0230556	0.0076106	3.03	0.002	Significant
Technology	-2.6884	2.8228	-0.95	0.341	Not Significant
Energy Consumption	0.1687313	0.0113277	14.90	0.000	Significant

The regression results provide important insights into the determinants of Foreign Direct Investment (FDI) in six ASEAN countries. Overall, the findings indicate that economic growth, domestic credit, and energy consumption significantly encourage FDI inflows, while carbon emissions reduce investment attractiveness. Meanwhile, technology does not show a statistically significant direct effect on FDI. These results suggest that FDI inflows in ASEAN are still largely influenced by macroeconomic conditions, financial system development, and infrastructure readiness rather than by technological sophistication. This reflects the current structure of many ASEAN economies, where foreign investment remains concentrated in labor-intensive manufacturing and resource-based sectors. As a result, ASEAN countries continue to compete mainly through production efficiency and market potential rather than innovation-driven competitiveness.

Economic growth shows a positive and significant relationship with FDI, indicating that countries with stronger economic performance tend to attract more foreign investment. This finding is consistent with Ghazalian (2024), who explains that economic expansion improves investor confidence by increasing market opportunities and profitability prospects. Similarly, Anwar et al. (2023) find that GDP growth positively influences FDI inflows in ASEAN economies. This finding is further supported by Kurniawan & A'yun (2022), who document a mutually reinforcing relationship between economic growth and FDI, and by Ariyani & Firmansyah (2023), who identify economic development as a key determinant of FDI inflows in emerging Asian economies. From the perspective of the OLI framework proposed by Dunning (1980) and Narula & Dunning (2000), stable economic growth strengthens location advantages because investors are generally more interested in countries with predictable economic conditions and lower macroeconomic risk. This finding also implies that ASEAN economies may still rely too heavily on growth-based strategies to attract foreign investors. Such dependence may become problematic in the long run, particularly when countries face external economic shocks, rising labor costs, or weakening growth performance.

Carbon emissions have a negative and highly significant effect on FDI, indicating that environmental degradation reduces the attractiveness of ASEAN countries to foreign investors. The findings suggest that environmental sustainability is becoming increasingly important in investment decisions. This result supports Zhu et al. (2021), who argue that investors are becoming more concerned about environmental quality and future regulatory risks. Similarly, Tsoy & Heshmati (2024) find no consistent empirical support for the Pollution Haven Hypothesis, while Gök et al. (2024) demonstrate that carbon emissions may discourage FDI under stricter environmental standards. Furthermore, Febriyanto et al. (2024) show that environmental pressures associated with investment activities have become increasingly important in ASEAN economies, highlighting the growing relevance of sustainability considerations in attracting foreign investors. This relationship is further evidenced by A'yun & Khasanah (2022), who demonstrate that FDI inflows in ASEAN countries are associated with higher CO_2 emissions, suggesting a reciprocal dynamic in which investment-driven environmental degradation may, over time, discourage further foreign investment as global sustainability standards become more stringent.

Domestic credit positively affects FDI inflows, showing that financial sector development plays an important role in attracting foreign investment. This finding is consistent with Noviyanti et al. (2023), who show that financial development positively influences FDI inflows by improving financial intermediation, reducing investment uncertainty, and creating a more favorable investment climate for foreign investors. In the ASEAN context, stronger domestic credit availability may also signal institutional stability and business confidence, both of which are important considerations for foreign investors. Similarly, Sahu & Dash (2021) identify financial sector development as one of the most significant determinants of FDI inflows in ASEAN countries, suggesting that well-developed financial systems facilitate capital allocation and reduce financing constraints for multinational firms. This result is further supported by Osei & Kim (2023), who demonstrate that financial development enhances the growth benefits associated with FDI by improving capital allocation efficiency and

strengthening investment absorption capacity. However, countries with underdeveloped financial systems may face difficulties in fully benefiting from FDI because weak financial institutions can limit investment expansion and industrial upgrading.

Wang et al. (2024) argue that digital transformation improves firms' international investment capabilities by reducing transaction costs, enhancing information accessibility, and increasing operational efficiency. These findings suggest that technological readiness should theoretically enhance a country's attractiveness to foreign investors. However, the insignificant result in this study suggests that technological advancement alone may not yet be sufficient to attract foreign investors in ASEAN countries. One possible reason is that FDI in the region is still largely concentrated in sectors that prioritize lower production costs and market access over advanced technological capability. In addition, technological development across ASEAN countries remains uneven. While several countries have made progress in digitalization and industrial upgrading, others still face limitations related to research and development (R&D), innovation systems, digital infrastructure, and human capital quality. As argued by Narula & Dunning (2010), the impact of technology depends not only on technological availability itself but also on the absorptive capacity and institutional readiness of the host country. Therefore, ASEAN countries may still face challenges in transforming from efficiency-seeking investment destinations into innovation-driven economies.

Energy consumption has a positive and highly significant effect on FDI, indicating that energy availability remains an essential requirement for industrial activity and investment expansion. This finding is consistent with Edeh et al. (2024), who emphasize the strong interconnection between FDI and energy demand in emerging economies. Similarly, Fang et al. (2024) argue that foreign investment is closely associated with changes in energy consumption structures and energy requirements within host economies. In addition, Jinapor et al. (2025) find that FDI interacts with energy consumption in promoting inclusive growth and economic development. This finding is also consistent with A'yun et al. (2026), who show that non-renewable energy consumption remains closely linked to economic development processes, indicating that energy availability continues to serve as an important foundation for production activities and investment expansion. In ASEAN countries, higher energy consumption often reflects stronger industrial capacity, infrastructure readiness, and production expansion, which are attractive to multinational firms. However, this result also highlights an important challenge for ASEAN economies. Although greater energy consumption may support industrial development, excessive dependence on non-renewable energy sources may simultaneously increase carbon emissions and environmental pressure. As a result, ASEAN countries need to balance industrial expansion with environmental sustainability by improving renewable energy infrastructure and promoting cleaner energy policies.

Overall, the findings suggest that FDI inflows in ASEAN are still mainly driven by economic growth, financial development, and infrastructure capacity rather than by technological sophistication. At the same time, environmental sustainability is becoming increasingly important in shaping investor decisions. These results imply that ASEAN countries may need to gradually shift from growth-oriented investment strategies toward more sustainable and innovation-based competitiveness. Without improvements in environmental governance, technological readiness, and institutional quality, ASEAN economies may continue to attract FDI in quantity but may struggle to attract higher-quality investment capable of supporting long-term technological upgrading and sustainable economic transformation.

Conclusion

This study concludes that economic growth, domestic credit, and energy consumption are significant drivers of FDI in six ASEAN countries, while carbon emissions act as a structural deterrent and technology does not yet exert a statistically significant direct effect. Strong economic growth signals market potential and macroeconomic stability, thereby enhancing investor confidence, while

adequate domestic credit reflects financial sector maturity that supports business expansion and reduces operational constraints. Similarly, reliable energy availability indicates industrial readiness and production capacity, making host countries more attractive for investment. In contrast, rising carbon emissions diminish investment appeal amid increasing global emphasis on sustainability and environmental standards, and the insignificant role of technology suggests that technological advancement in ASEAN has not yet fully translated into a competitive location advantage. These findings imply that ASEAN economies still rely heavily on growth-oriented and infrastructure-based competitiveness in attracting foreign investment. Therefore, policymakers should strengthen macroeconomic stability, improve financial systems, expand sustainable energy infrastructure, enhance environmental governance, and promote innovation capacity to attract higher-quality and more sustainable FDI in the future. Despite its contributions, this study has several limitations, including its focus on only six ASEAN countries, the exclusion of several institutional and structural factors, and the use of annual panel data that may not fully capture short-term investment dynamics. In addition, although the SUR-PCSE approach addresses heteroscedasticity, autocorrelation, and cross-sectional dependence, potential endogeneity issues may still remain. Future research may provide broader perspectives by incorporating additional variables, expanding the country coverage, and applying alternative econometric approaches to better capture the complexity of FDI determinants in developing economies.

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Declarations

Author contribution	:	Silvia Maura Madrim was responsible for the conceptualization, research design, data analysis, and overall coordination of the study. She also led the preparation of the manuscript. Muhammad Fathur Reza contributed to data collection, data processing, and manuscript revision. Indanazulfa Qurrota A'yun as the third author contributed to data analysis, interpretation of results, and critical revision of the manuscript. All authors reviewed and approved the final version of the manuscript.
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Additional information		No additional information is available for this paper.

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