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Tourism, Foreign Direct Investment, and Energy Consumption: Evidence from Causality Analysis in ASEAN

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ABSTRACT

ASEAN's rapid economic expansion has been increasingly supported by tourism growth and foreign direct investment (FDI), both of which contribute significantly to regional development while simultaneously intensifying energy demand. This study examines the dynamic relationships among tourism, FDI, and energy consumption in ASEAN using a panel Vector Error Correction Model (VECM) and Wald causality tests. The results confirm the existence of both short-run and long-run interdependencies among the variables. In the short run, tourism significantly stimulates FDI inflows by expanding market opportunities and demand for tourism-related industries. Conversely, energy consumption negatively affects tourism, indicating that environmental pressure and intensive energy use may reduce tourism competitiveness. In the long run, the strongest relationship occurs between FDI and energy consumption, suggesting that ASEAN's economic growth remains highly dependent on energy-intensive industrialization and infrastructure development. The findings imply that although ASEAN economies are gradually diversifying through tourism-led service expansion, regional growth continues to rely heavily on industrial and energy-driven activities. Therefore, ASEAN countries need integrated policies that combine tourism development, investment expansion, and sustainable energy management to support long-term economic competitiveness and environmental sustainability.

Keywords: Energy Consumption, Foreign Direct Investment, Tourism, VECM

JEL Classification: O13, O19, O47

INTRODUCTION

Tourism has emerged as one of the most strategic sectors in the global economy during the twenty-first century, contributing significantly to economic growth, employment generation, foreign exchange earnings, and regional development. According to the World Tourism Organization, international tourist arrivals are projected to reach 1.8 billion by 2030, reflecting the increasing importance of tourism as a driver of global economic integration and service-sector expansion (UNWTO, 2024). Beyond its direct contribution to gross domestic product (GDP), tourism stimulates trade activities, promotes infrastructure development, supports small and medium enterprises, and generates multiplier effects across transportation, hospitality, and related service industries (Blake et al., 2023). In developing economies, tourism is also increasingly recognized as a catalyst for structural transformation by enhancing labor absorption, improving regional connectivity, and accelerating urban and infrastructure development (Sheng Yin & Hussain, 2021). Consequently, tourism is no longer viewed solely as a consumption-oriented activity but rather as a strategic component of long-term economic development and international competitiveness.

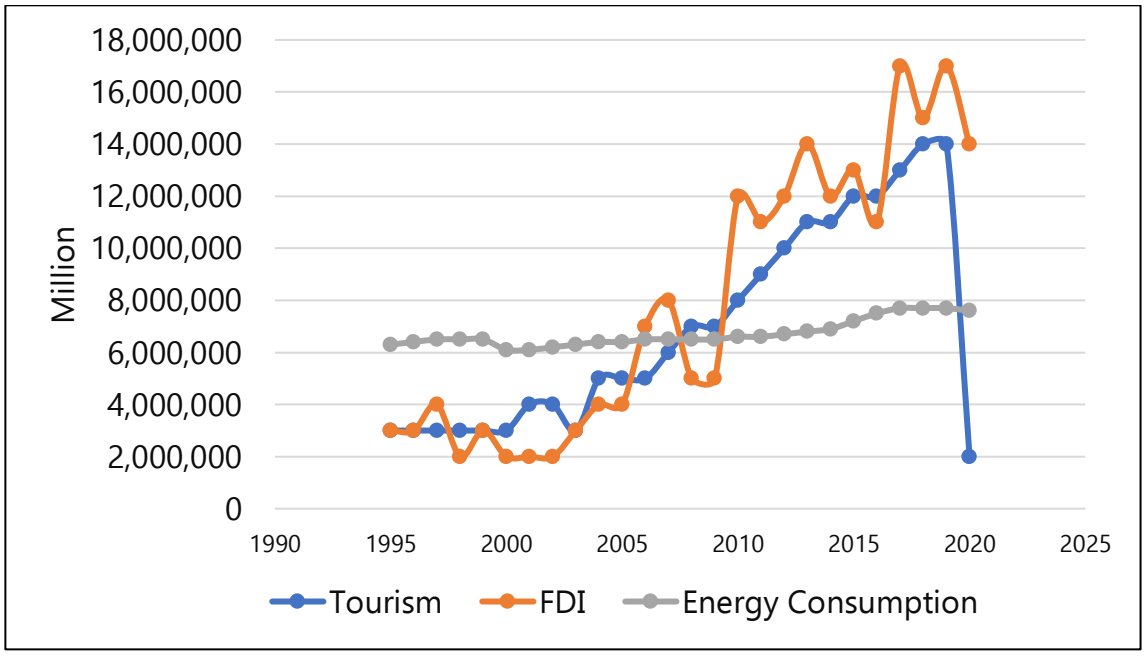

Figure 1. Trends in Tourism, Foreign Direct Investment, and Energy Consumption (1995–2020)
Source: Author's processing based on International Energy Agency and World Bank Data (1995-2020)

Figure 1 illustrates the dynamic trends in tourism, foreign direct investment (FDI), and energy consumption in ASEAN during the period 1995–2020. The figure demonstrates a substantial increase in international tourist arrivals alongside rising FDI inflows and

energy demand across the region. This pattern reflects the broader transformation of ASEAN economies toward deeper integration into global production networks and international service markets. Since the late 1990s, ASEAN countries have experienced rapid urbanization, industrial expansion, and service-sector growth, all of which have strengthened the role of tourism and investment as major contributors to regional economic performance. The expansion of tourism activities in ASEAN has been supported by rising income levels, improvements in transportation infrastructure, digital connectivity, and regional economic integration through initiatives such as the ASEAN Economic Community (AEC) (ASEAN, 2020). Empirical evidence suggests that higher income levels and macroeconomic stability significantly increase tourism demand, particularly in emerging economies undergoing rapid middle-class expansion (World Bank, 2023; UNWTO, 2024).

The figure further indicates that tourism and FDI experienced relatively strong upward trends after the mid-2000s, reflecting ASEAN's increasing attractiveness as both a tourism destination and an investment hub. At the same time, energy consumption also exhibited a consistent increase, suggesting that economic expansion in the region remains closely associated with rising energy demand. This relationship highlights an important development challenge for ASEAN economies: while tourism and foreign investment contribute positively to economic growth, they simultaneously increase pressure on energy infrastructure and environmental sustainability. The sharp decline in tourism activity in 2020, as shown in Figure 1, also reflects the significant impact of external shocks such as the COVID-19 pandemic on the tourism sector, while FDI and energy consumption remained relatively more resilient. This indicates that the interaction among tourism, investment, and energy demand may vary across periods of economic expansion and crisis, thereby requiring a dynamic analytical framework capable of capturing both short-run and long-run adjustments.

At the same time, ASEAN has become one of the world's most attractive destinations for foreign direct investment due to its large market size, strategic geographic location, abundant labor force, and increasing openness to international trade. ASEAN is currently recognized as the world's sixth-largest economy and is projected to become one of the major global growth centers over the coming decades (UNWTO, 2024). Foreign direct investment inflows into ASEAN reached approximately US$230 billion in 2023, driven by strong investment in manufacturing, digital industries, infrastructure, renewable energy, and financial services (UNWTO, 2024). The growing inflow of foreign investment has contributed significantly to industrial upgrading, technology transfer, productivity improvement, and employment creation throughout the region (Shah et al., 2025). Simultaneously, tourism development has increasingly contributed to infrastructure expansion, regional connectivity, and urban development, thereby reinforcing ASEAN's attractiveness as both an investment destination and a tourism hub (Blanco et al., 2024).

Despite the rapid expansion of tourism and FDI in ASEAN, the relationship between these variables and their interaction with energy consumption remains theoretically

and empirically ambiguous. Existing studies provide conflicting conclusions regarding the direction of causality between tourism and FDI. On the one hand, tourism growth may attract foreign investment by increasing demand for hotels, transportation systems, entertainment facilities, and tourism-related infrastructure. On the other hand, FDI may itself stimulate tourism development through improvements in infrastructure quality, service standards, technological advancement, and destination competitiveness (Davidson & Sahli, 2015; Sheng Yin & Hussain, 2021). Similarly, the relationship between FDI and energy consumption remains inconclusive in the literature. Investment inflows directed toward manufacturing and infrastructure sectors are generally associated with rising energy demand, whereas investments in technology-intensive and environmentally sustainable sectors may improve energy efficiency and reduce resource intensity (Bekun et al., 2019; Chen et al., 2016). These contrasting findings suggest that tourism, FDI, and energy consumption may interact through complex and dynamic transmission mechanisms that differ across countries and over time.

The ambiguity surrounding these relationships becomes more pronounced in the ASEAN context due to the substantial heterogeneity among member countries in terms of economic structure, institutional quality, industrial capacity, energy systems, and stages of development. Economies such as Singapore and Malaysia possess relatively advanced infrastructure, stronger institutions, and diversified industrial structures, whereas lower-income ASEAN countries continue to face structural limitations related to infrastructure gaps, energy availability, and institutional capacity. Consequently, the interaction between tourism, FDI, and energy consumption is unlikely to follow a uniform pattern across the region. Furthermore, most previous studies have examined these relationships separately by focusing only on tourism-growth, FDI-growth, or energy-growth linkages, resulting in a fragmented understanding of the broader development process (Hasan et al., 2026). Existing empirical studies also predominantly employ static or semi-dynamic econometric approaches that are limited in capturing feedback effects, long-run equilibrium adjustments, and bidirectional causality simultaneously. As a result, the dynamic interdependence among tourism, FDI, and energy consumption remains insufficiently explored, particularly within the ASEAN region.

To address these gaps, this study investigates the dynamic causal relationships among tourism, foreign direct investment, and energy consumption in ASEAN using a panel Vector Error Correction Model (VECM) combined with joint Wald tests. The VECM framework is particularly appropriate because it enables the analysis to distinguish between short-run adjustments and long-run equilibrium relationships while simultaneously capturing bidirectional causal interactions among variables (Gao et al., 2025). By integrating tourism, FDI, and energy consumption within a unified analytical framework, this study provides a more comprehensive understanding of how demand-side expansion, external capital inflows, and energy utilization jointly shape the development trajectory of ASEAN economies.

The contribution of this study is twofold. First, from a theoretical perspective, the study extends the development economics literature by integrating tourism, FDI, and energy consumption into a single dynamic framework, thereby clarifying whether these variables function as complementary growth drivers or operate independently within ASEAN economies. Second, from a policy perspective, the findings provide important implications for designing integrated development strategies that balance economic expansion with energy sustainability. Understanding the causal structure among tourism, investment, and energy demand is essential for policymakers seeking to strengthen regional competitiveness while ensuring environmentally sustainable growth. Accordingly, this study aims to examine the dynamic interrelationships among tourism, FDI, and energy consumption in ASEAN, with particular emphasis on identifying the short-run and long-run causal mechanisms that jointly influence regional growth and energy demand dynamics.

METHOD

This study employs a quantitative approach using panel data analysis to investigate the dynamic relationships among tourism, foreign direct investment (FDI), and energy consumption in ASEAN countries. The analytical framework is designed to capture both short-run adjustments and long-run equilibrium relationships among variables within an integrated system. The study focuses on ASEAN member countries over the observation period 1995–2020 using annual data obtained from the World Bank and the International Energy Agency.

The relationship among tourism, FDI, and energy consumption is grounded in the development economics perspective, which emphasizes the interdependence between external capital inflows, service-sector expansion, and resource utilization. Tourism development is expected to stimulate investment inflows by increasing demand for infrastructure, hospitality services, transportation, and supporting industries. Conversely, foreign direct investment may contribute to tourism growth through infrastructure improvement, technology transfer, and destination development. At the same time, both tourism expansion and investment activity are closely associated with rising energy demand due to increased transportation activities, industrial production, and urban development (Shah et al., 2025). Following the framework developed by Raifu and Afolabi (2024), the functional relationships among variables are specified as follows:

$$Tourism = f(FDI, Energy\ Consumption) \quad (1)$$
$$FDI = f(Tourism, Energy\ Consumption) \quad (2)$$
$$Energy\ Consumption = f(Tourism, FDI) \quad (3)$$

These equations indicate that tourism, foreign direct investment, and energy consumption are treated as endogenous variables within a simultaneous dynamic system. Economically, the framework assumes that shocks occurring in one variable

may transmit to other variables through both direct and indirect channels over time. Therefore, the relationships among variables are expected to exhibit feedback effects and dynamic adjustments rather than simple one-directional interactions.

Table 1. presents the operational definition of variables used in this study

Variable	Symbol	Measurement	Unit	Source	Expected Relationship
International Tourism	TOUR	International tourist arrivals	Number of persons	World Bank	Positive toward FDI and EC
Foreign Direct Investment	FDI	Net inflows of foreign direct investment	Million US$	World Bank	Positive toward TOUR and EC
Energy Consumption	EC	Total energy consumption	Billion Btu	International Energy Agency	Positive toward FDI; potentially negative toward TOUR due to environmental pressure

Source: Author's compilation

To estimate the dynamic interactions among variables, this study applies the panel Vector Error Correction Model (VECM). The VECM approach is appropriate because it enables simultaneous estimation of short-run dynamics and long-run equilibrium relationships among cointegrated variables. Compared with conventional static panel regression, the VECM framework captures intertemporal adjustments and bidirectional causality, making it particularly suitable for examining complex macroeconomic relationships in heterogeneous regional contexts such as ASEAN (Gao et al., 2025). The panel VECM model is formulated as follows:

$$\begin{bmatrix} \Delta LTOUR_{it} \\ \Delta LFDI_{it} \\ \Delta LEC_{it} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \sum_{k=1}^{p} \begin{bmatrix} \beta_{11k} & \beta_{12k} & \beta_{13k} \\ \beta_{21k} & \beta_{22k} & \beta_{23k} \\ \beta_{31k} & \beta_{32k} & \beta_{33k} \end{bmatrix} \begin{bmatrix} \Delta LTOUR_{it-k} \\ \Delta LFDI_{it-k} \\ \Delta LEC_{it-k} \end{bmatrix} + \begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \end{bmatrix} ECT_{it-1} + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \end{bmatrix} \ldots (4)$$

where i represents cross-sectional units (countries), $t$denotes time periods, and $p$indicates the optimal lag length. The term ECT_{it-1}refers to the error correction term derived from the long-run cointegration equation, while ε_{it}denotes the white-noise disturbance term. The coefficient of the error correction term reflects the speed of adjustment toward long-run equilibrium following short-run disequilibrium shocks.

The use of panel VECM in this study provides several methodological advantages. First, the approach integrates both cross-sectional and time-series dimensions, thereby improving estimation efficiency and allowing the analysis to account for heterogeneity across ASEAN countries. Second, the framework captures both short-run and long-run causal mechanisms simultaneously. Third, the model accommodates feedback effects among variables, which are particularly relevant in examining the interaction between tourism, investment, and energy demand. Economically, this approach allows the study to identify whether tourism expansion stimulates investment inflows, whether FDI

contributes to higher energy demand, and whether energy consumption affects long-term tourism sustainability.

Prior to estimating the VECM, several preliminary econometric procedures are conducted. The first step involves stationarity testing using the Augmented Dickey-Fuller (ADF) unit root test. Stationarity testing is necessary to avoid spurious regression results that may arise from non-stationary time-series data. The ADF test equation is expressed as follows:

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta Y_{t-1} + \varepsilon_t \quad (5)$$

where ΔY_t denotes the first difference of the variable, α_0 represents the intercept term, p is the lag length, and ε_t is the error term. The null hypothesis of the ADF test indicates the presence of a unit root, implying non-stationarity. If the probability value is lower than the selected significance level (1%, 5%, or 10%), the null hypothesis is rejected, indicating that the variable is stationary.

After confirming stationarity properties, the optimal lag length is determined using several information criteria, including the Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ). Selecting an appropriate lag length is essential because insufficient lag structures may omit important dynamic information, whereas excessive lag structures may reduce estimation efficiency and create over-parameterization problems (Doytch et al., 2024).

The next stage involves panel cointegration testing to determine whether a long-run equilibrium relationship exists among tourism, FDI, and energy consumption. If cointegration is confirmed, the VECM specification becomes appropriate because it incorporates both short-run adjustments and long-run equilibrium dynamics. Subsequently, Granger causality tests and joint Wald tests are employed to identify the direction and strength of causal relationships among variables. The Granger causality framework is particularly useful for examining predictive causality by evaluating whether past values of one variable contain information that helps explain future movements in another variable.

To ensure the robustness and reliability of the estimated model, several diagnostic and stability tests are conducted following model estimation. These procedures include residual diagnostics, stability analysis, and supplementary Box–Jenkins identification procedures for evaluating residual behavior and forecasting consistency. Although the Box–Jenkins framework is not employed as the primary analytical model, it serves as an additional procedure to improve model reliability and specification accuracy.

From a policy perspective, identifying the causal structure among tourism, FDI, and energy consumption is essential for designing integrated development strategies in ASEAN. If tourism is found to stimulate FDI inflows, governments may prioritize tourism infrastructure and destination development policies to attract foreign

investment. Conversely, if FDI significantly increases energy consumption, investment policies should be accompanied by energy-efficiency regulations and clean energy transition strategies to ensure long-term sustainability. Therefore, the panel VECM framework not only provides econometric advantages but also generates important policy implications for balancing economic growth, investment expansion, and sustainable energy management in ASEAN economies.

RESULT

Descriptive statistical analysis is conducted to provide an initial overview of the characteristics and distribution of the variables used in this study. The analysis focuses on three main variables, namely international tourism, foreign direct investment (FDI), and energy consumption across ASEAN countries during the observation period. Descriptive statistics are essential in panel-data analysis because they provide preliminary insights into data dispersion, central tendencies, and cross-country heterogeneity before conducting further econometric estimation (Gujarati, 2021).

Table 2. Results of Descriptive Statistics

Variable	Observation	Mean	Std.Deviation	Minimum	Maximum
Tourism (number of persons)	10	14.488	14.479	12.756	15.826
FDI (Million US$)	10	20.823	15.747	18.370	23.203
Energy Consumption (Btu)	10	29.265	19.159	0.798	44.500

Source: Primary Data Processing, 2025

Table 2 presents the descriptive statistics of the variables employed in this study. Overall, the results indicate substantial variation among ASEAN countries in terms of tourism activity, foreign direct investment inflows, and energy consumption. Tourism, measured by international tourist arrivals, records an average value of 14.488 with a relatively moderate standard deviation, suggesting that tourism activity has expanded steadily across ASEAN economies, although differences among countries remain evident. The relatively narrow gap between the minimum and maximum values also indicates that tourism development has become increasingly widespread within the region.

Foreign direct investment (FDI) exhibits a mean value of 20.823 million US dollars with a relatively high standard deviation of 15.747, reflecting considerable disparities in investment inflows among ASEAN member countries. The large dispersion between minimum and maximum values indicates that FDI inflows tend to be concentrated in several economies with stronger industrial capacity, institutional quality, and investment attractiveness, such as Singapore, Malaysia, and Thailand. Economically, this finding implies that ASEAN's investment integration remains asymmetric, where certain countries dominate regional capital inflows due to superior infrastructure, regulatory efficiency, and market size advantages.

Meanwhile, energy consumption demonstrates the highest level of variability among all variables, with an average value of 29.265 Btu and a standard deviation of 19.159. The significant difference between minimum and maximum values suggests substantial heterogeneity in industrial activity, urbanization, and energy utilization across ASEAN countries. Countries with more advanced industrial structures and larger manufacturing sectors tend to exhibit considerably higher energy consumption compared to less industrialized economies. This finding indicates that regional economic expansion in ASEAN remains closely associated with rising energy demand and energy-intensive production systems.

From a broader development economics perspective, the descriptive results reveal that ASEAN economies exhibit heterogeneous patterns of tourism development, investment attraction, and energy utilization. The observed disparities imply that the transmission mechanisms linking tourism, FDI, and energy consumption may differ substantially across countries. This heterogeneity further justifies the use of a dynamic panel framework, as static estimation techniques may fail to adequately capture the complex interdependence and adjustment processes among variables over time. Therefore, the descriptive analysis provides an important preliminary indication that the relationship among tourism, FDI, and energy consumption in ASEAN is dynamic rather than uniform across economies.

Prior to estimating the panel Vector Error Correction Model (VECM), stationarity testing is conducted to determine the integration properties of the variables. Stationarity is a fundamental requirement in time-series and panel-data econometrics because non-stationary variables may produce spurious regression results and misleading statistical inferences. In this study, panel unit root tests are performed using four complementary approaches: Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests. Employing multiple tests improves robustness because each procedure possesses different assumptions regarding cross-sectional heterogeneity and autoregressive structures (Baltagi, 2021).

Table 3. Stationarity Test Level Results

Var	LLC t-Stat	Prob	IPS t-Stat	Prob	ADF t-Stat	Prob	PP t-Stat	Prob	Note
Tourism	1.40701	0.9203	1.73492	0.9586	13.6487	0.8479	23.8273	0.2500	Non-Stationer
FDI	2.96840	0.9985	0.73670	0.7693	23.4351	0.2679	16.1685	0.7061	Non-Stationer
EC	0.50811	0.6943	4.27940	1.0000	6.17906	0.9986	6.78635	0.9973	Non-Stationer

Source: Primary Data Processing, 2025

The results presented in Table 3 indicate that all variables are non-stationary at the level form. This conclusion is confirmed by the probability values of the LLC, IPS, ADF, and PP tests, which are consistently greater than the 5% significance level. For example, the ADF probability value for tourism is 0.8479, while the PP probability value reaches 0.2500, both indicating the presence of a unit root. Similarly, FDI and energy

consumption also fail to reject the null hypothesis of non-stationarity across all testing procedures.

Economically, the existence of non-stationarity suggests that tourism, FDI, and energy consumption exhibit strong long-term trends during the observation period. This finding is consistent with the structural transformation experienced by ASEAN economies since the 1990s, characterized by sustained tourism expansion, increasing foreign capital inflows, and rising industrial energy demand. However, the presence of unit roots implies that shocks affecting these variables may have permanent effects rather than temporary fluctuations. Consequently, estimating the relationships using variables in level form could generate biased and spurious regression estimates.

The non-stationarity of the variables further indicates that ASEAN economies experienced persistent growth trajectories during the study period, reflecting deeper economic integration, industrialization, and infrastructure expansion across the region. Therefore, transforming the variables into stationary form becomes necessary before proceeding to dynamic model estimation.

To address the non-stationarity problem, all variables are transformed into first differences. The first-difference procedure removes stochastic trends and allows the variables to fluctuate around a constant mean and variance over time. The results of the stationarity tests after first differencing are presented in Table 4.

Table 4. Stationarity Test First Difference Level

Var	LLC t-Stat	Prob	IPS t-Stat	Prob	ADF t-Stat	Prob	PP t-Stat	Prob	Note
Tourism	-8.6297	0.0000	-9.3275	0.0000	112.5770	0.0000	202.356	0.0000	Stationer
FDI	-4.5733	0.0000	-	-	55.8452	0.0000	75.0775	0.0000	Stationer
EC	2.56770	0.0051	-4.8203	0.0000	61.0708	0.0000	81.1586	0.0000	Stationer

Source: Primary Data Processing, (2025)

The results in Table 4 demonstrate that all variables become stationary after first differencing. The probability values of the LLC, IPS, ADF, and PP tests are all below the 5% significance level, indicating rejection of the null hypothesis of unit roots. Tourism records highly significant statistics across all tests, while FDI and energy consumption also achieve stationarity after differencing. These findings confirm that the variables are integrated of order one, I(1), thereby satisfying the preliminary requirement for cointegration and VECM estimation.

The stationarity results provide important economic implications. Since tourism, FDI, and energy consumption become stationary only after differencing, the findings suggest that the variables are driven by long-run structural trends rather than short-term cyclical fluctuations alone. This reflects the persistent nature of ASEAN's economic transformation process, where changes in tourism activity, foreign investment, and energy demand evolve gradually over time through cumulative development effects.

The confirmation of first-order integration also indicates the potential existence of long-run equilibrium relationships among variables. In other words, although tourism, FDI, and energy consumption may deviate temporarily in the short run, they are likely to move together over time due to underlying economic linkages. Therefore, the findings strongly support the use of a panel Vector Error Correction Model (VECM), which is specifically designed to capture both short-run adjustments and long-run equilibrium dynamics among cointegrated variables.

Following the confirmation that all variables are integrated of order one, I(1), and stationary at first difference, the next stage of the analysis examines whether a long-run equilibrium relationship exists among tourism, foreign direct investment (FDI), and energy consumption in ASEAN countries. Establishing cointegration is essential because the Vector Error Correction Model (VECM) framework is only appropriate when variables share common long-run stochastic trends. Accordingly, this section presents the core empirical findings of the study, including the cointegration test, short-run causality, long-run causality, strong causality analysis, and the joint significance test. Together, these findings provide a comprehensive understanding of the dynamic interactions among tourism, FDI, and energy consumption within the ASEAN economic system.

Cointegration analysis is employed to determine whether tourism, foreign direct investment (FDI), and energy consumption move together in the long run despite short-run fluctuations. In econometric terms, the existence of cointegration indicates that variables share a stable equilibrium relationship over time, implying that deviations from equilibrium are temporary and will eventually converge back to the long-run path.

Table 5. Cointegration Test Results

Hypothesis	Eigenvalue	Trace Statistic	Critical Value	Probability
None	0.066012	31.80178**	29.79707	0.0385
At most 1	0.01523	22.1727	15.49471	0.0923
At most 2	6.22E-05	5.008765**	3.841466	0.025

Notes: ** significant at the 5% level.
Source: Primary Data Processing, 2025

The results presented in Table 5 indicate the existence of at least one cointegrating relationship among tourism, FDI, and energy consumption at the 5% significance level. The trace statistic for the "None" hypothesis (31.80178) exceeds the corresponding critical value (29.79707), with a probability value of 0.0385, leading to rejection of the null hypothesis of no cointegration. Similarly, the "At most 2" hypothesis is also statistically significant at the 5% level. These findings confirm that the variables are cointegrated and therefore exhibit long-run equilibrium relationships despite being individually non-stationary in level form.

Economically, the cointegration results suggest that tourism development, foreign investment inflows, and energy consumption in ASEAN are structurally interconnected

over time. Although short-run shocks may temporarily disrupt the relationships among these variables, market adjustments and economic mechanisms gradually restore equilibrium in the long run. This finding reflects the integrated nature of ASEAN's economic transformation process, where tourism expansion, investment activities, and energy demand evolve simultaneously as part of broader regional development dynamics.

The presence of cointegration also implies that changes in one variable are likely to have long-term implications for the others. For instance, sustained tourism expansion may stimulate infrastructure investment and increase energy demand, while persistent increases in energy consumption may influence both industrial productivity and tourism competitiveness. From a policy perspective, the findings indicate that tourism, FDI, and energy consumption should not be treated as isolated sectors but rather as interconnected components of ASEAN's development strategy.

Since the variables are cointegrated, the panel Vector Error Correction Model (VECM) becomes the appropriate econometric framework for analyzing both short-run adjustments and long-run causal dynamics among the variables.

After confirming the existence of long-run equilibrium relationships, the next stage examines the short-run causal dynamics among tourism, FDI, and energy consumption using the Granger causality framework within the VECM specification. Short-run causality analysis identifies whether past movements in one variable significantly affect another variable within a relatively limited adjustment period.

Table 6. Short-Run Causality Results

Dependent Variable	Tourism	FDI	Energy Consumption
Tourism	–	-0.4461	-0.000013**
FDI	7.6331**	–	1.3619
Energy Consumption	94.9504	-1.4683***	–

Notes: ** and *** denote significance at the 5% and 10% levels, respectively.

Source: Primary Data Processing (2025)

The short-run causality results reveal several important dynamic relationships among the variables. First, tourism significantly and positively affects FDI in the short run, as indicated by the coefficient value of 7.6331 at the 5% significance level. This finding suggests that increasing tourist arrivals contribute to improving investor confidence and expanding market opportunities, particularly in tourism-related sectors such as hospitality, transportation, retail services, and entertainment industries. In other words, tourism functions as a demand-side signal that encourages foreign investors to allocate capital into ASEAN economies.

However, the reverse relationship is not statistically significant, implying that FDI does not immediately stimulate tourism growth in the short run. This result may reflect the time lag typically associated with investment projects, especially those involving infrastructure construction, transportation systems, or tourism facilities, which require substantial implementation periods before influencing tourist arrivals.

The results further show that energy consumption negatively affects tourism in the short run, with a statistically significant coefficient of -0.000013 at the 5% significance level. Economically, this finding may indicate that excessive energy consumption often associated with industrial expansion, pollution, and environmental degradation reduces tourism attractiveness and environmental quality. Tourism destinations that experience deteriorating environmental conditions may become less competitive in attracting international visitors.

Meanwhile, FDI negatively influences energy consumption at the 10% significance level, as reflected by the coefficient value of -1.4683. This finding suggests that foreign investment in ASEAN may increasingly flow into relatively energy-efficient sectors such as tourism services, digital industries, and environmentally sustainable activities rather than exclusively into energy-intensive manufacturing industries. Consequently, FDI may contribute to improving energy efficiency in the short run.

Overall, the short-run causality results indicate that tourism plays a more active role in influencing investment inflows than vice versa. The findings also highlight the importance of environmental sustainability in maintaining tourism competitiveness within ASEAN economies.

While the previous analysis focuses on short-run dynamics, the long-run causality results provide insights into the structural relationships among tourism, FDI, and energy consumption over extended periods of economic adjustment.

Table 7. Long-Run Causality Results

Dependent Variable	Tourism	FDI	Energy Consumption
Tourism	–	0.00012	-5614.246
FDI	-0.4809	–	2795.659***
Energy Consumption	-5323.352**	-1.7958***	–

Notes: ** and *** denote significance at the 5% and 10% levels, respectively.
Source: Primary Data Processing, 2025

The long-run estimation results demonstrate that tourism and FDI do not exhibit statistically significant bidirectional causality over the long term. This finding implies that tourism growth alone is insufficient to sustain long-run foreign investment inflows in ASEAN countries, while FDI expansion does not necessarily guarantee long-term tourism development. Investment decisions in ASEAN appear to depend more heavily on structural determinants such as institutional quality, infrastructure readiness, regulatory stability, and energy availability rather than tourism activity alone.

In contrast, energy consumption exhibits a significant long-run relationship with both tourism and FDI. The negative effect of energy consumption on tourism indicates that excessive energy use may undermine tourism sustainability through environmental deterioration, increased pollution, and declining ecological quality. This finding reinforces the argument that environmental sustainability has become increasingly important for maintaining long-term tourism competitiveness in ASEAN economies.

The results also reveal a strong long-run interaction between FDI and energy consumption. Rising investment activity tends to increase energy demand due to industrial expansion, infrastructure development, and production activities. Conversely, inefficient or inadequate energy systems may reduce investment attractiveness because high operational costs and unreliable energy supply increase business uncertainty. This bidirectional relationship highlights the strategic importance of energy infrastructure in sustaining ASEAN's long-term economic competitiveness.

Furthermore, the error correction terms indicate that FDI and energy consumption exhibit relatively strong adjustment mechanisms toward long-run equilibrium, whereas tourism demonstrates weaker long-run responsiveness to disequilibrium shocks. This suggests that tourism dynamics are more sensitive to short-term fluctuations and external shocks compared to investment and energy systems, which tend to adjust more systematically over time.

To further examine the dynamic interactions among variables, strong causality tests are conducted by combining both short-run and long-run adjustment mechanisms within the VECM framework.

Table 8. Strong Causality Results

Dependent Variable	Tourism	FDI	Energy Consumption
Tourism	–	1.92515	1.36719
FDI	2.83513**	–	2.47765**
Energy Consumption	1.79660*	1.56831	–

Notes: * and ** denote significance at the 1% and 5% levels, respectively.

Source: Primary Data Processing, 2025

The strong causality results indicate that both tourism and energy consumption significantly influence FDI. International tourist arrivals Granger-cause FDI at the 5% significance level, suggesting that tourism expansion enhances investment attractiveness by signaling stronger market demand and broader business opportunities. Similarly, energy consumption significantly affects FDI, indicating that energy availability and industrial infrastructure remain critical determinants of foreign investment decisions in ASEAN economies.

Interestingly, no reverse causality is observed from FDI toward tourism or energy consumption. This finding implies that foreign investment inflows in ASEAN are not primarily concentrated in tourism-related industries but are more likely directed toward manufacturing, trade, logistics, and broader industrial sectors. As a result, tourism and energy systems appear to function as foundational drivers of investment attractiveness rather than merely outcomes of investment expansion.

From a broader economic perspective, the strong causality results highlight the importance of maintaining both tourism competitiveness and energy reliability to sustain foreign investment inflows. ASEAN countries with stronger tourism sectors and more reliable energy infrastructure are likely to attract greater levels of foreign capital compared to economies with weaker service sectors and energy constraints.

To evaluate whether tourism, FDI, and energy consumption jointly influence the ASEAN economic system, a joint Wald test is conducted. The Wald test examines the simultaneous significance of all variables within the estimated model.

Table 9. Strong Causality Results

Hypothesis	Chi-Square	Probability
All variables exhibit a significant simultaneous relationship	25.38013**	0.0313

Notes: ** significant at the 5% level.

Source: Primary Data Processing, 2025

The Wald test results indicate that the null hypothesis of joint insignificance is rejected at the 5% significance level. The chi-square statistic of 25.38013 with a probability value of 0.0313 confirms that tourism, FDI, and energy consumption are simultaneously interconnected within the ASEAN economic system.

This finding suggests that changes in one variable are systematically associated with adjustments in the other variables, reinforcing the existence of dynamic interdependence among tourism development, foreign investment inflows, and energy demand. Economically, the results imply that ASEAN's growth process cannot be explained through isolated sectoral analysis because tourism, investment, and energy systems evolve interactively within the broader development framework.

The empirical findings overall demonstrate that tourism primarily functions as a short-run driver of investment attractiveness, whereas the long-run dynamics of ASEAN economies are more strongly associated with the interaction between FDI and energy consumption. These results provide an important foundation for the subsequent discussion section, which interprets the broader economic implications of the findings in relation to regional development, sustainability, and policy formulation in ASEAN countries.

DISCUSSION

The empirical findings of this study indicate that the relationships among tourism, foreign direct investment (FDI), and energy consumption in ASEAN reflect broader structural transformations occurring within the regional economy. ASEAN economies have historically relied on export-oriented industrialization as the primary engine of growth; however, the results suggest that tourism increasingly functions as an additional pillar of economic expansion alongside investment-led industrial development. In this context, tourism contributes to demand-side growth through the expansion of service-sector activities, while FDI continues to support capital accumulation, industrial upgrading, and infrastructure development. Consequently, the interaction among tourism, FDI, and energy consumption illustrates that ASEAN's development trajectory is becoming more multidimensional, combining industrial expansion with service-sector transformation.

The findings demonstrate that the dynamics among tourism, FDI, and energy consumption differ substantially between the short run and the long run. In the short

run, tourism exerts a significant positive influence on FDI inflows, indicating that increasing tourist arrivals strengthen investor confidence and create broader market opportunities, particularly in tourism-related industries such as hospitality, transportation, retail trade, and supporting infrastructure. This result supports the tourism-led investment hypothesis, which argues that tourism expansion enhances a destination's attractiveness for foreign investors because growing tourism demand signals higher economic potential and stronger consumption markets (Dogru et al., 2020; Sokhanvar et al,. 2018).

Within the ASEAN context, this relationship is highly relevant because tourism has become one of the region's most strategic sectors for generating employment, infrastructure development, and foreign exchange earnings. Countries such as Thailand, Indonesia, Malaysia, and Singapore have experienced substantial investment inflows into tourism-supporting industries, including airports, hotels, urban transportation, and digital tourism platforms. The findings are also consistent with Hamijaya and Suryaman (2023), who emphasized that tourism competitiveness plays a critical role in strengthening regional economic development through improvements in infrastructure quality, destination attractiveness, and supporting economic activities. Their study highlights that sustainable tourism development not only enhances regional competitiveness but also stimulates broader economic spillover effects through investment and service-sector expansion.

However, the findings reveal that FDI does not significantly affect tourism growth in the short run. This result differs from studies arguing that foreign investment directly improves tourism performance through infrastructure modernization and service-quality enhancement (Antonakakis et al., 2015). One possible explanation is that the structure of FDI inflows in ASEAN remains heavily concentrated in manufacturing, industrial production, logistics, and export-oriented sectors rather than tourism-specific industries. Economies such as Vietnam, Malaysia, and Thailand continue to attract substantial manufacturing-based investment, particularly in electronics, automotive industries, and industrial processing sectors. As a result, the immediate transmission effect of FDI toward tourism development remains relatively limited. Moreover, tourism-related investment projects generally require longer implementation periods before generating measurable effects on international tourist arrivals.

Another important finding is the negative short-run effect of energy consumption on tourism. This suggests that rising energy consumption, often associated with industrial activity, environmental degradation, and urban congestion, may reduce the attractiveness of tourism destinations. The result supports previous studies showing that excessive energy use and environmental deterioration negatively affect tourism sustainability and destination competitiveness (Paramati et al,. 2017; Azam et al., 2018). In the ASEAN context, rapid urbanization and industrialization have increasingly generated environmental pressures, particularly in major tourism destinations. Coastal

degradation, pollution, excessive traffic congestion, and environmental stress have become major challenges in countries such as Indonesia, Thailand, and the Philippines.

This finding is also closely related to the study by Lismiyah et al. (2024), which found a strong causal relationship between energy consumption and environmental pressure in Indonesia. Their findings imply that rising energy use contributes significantly to carbon emissions and environmental degradation, thereby potentially reducing environmental sustainability and tourism attractiveness in the long term. In the context of ASEAN, where tourism competitiveness strongly depends on environmental quality, the transition toward sustainable energy systems becomes increasingly important not only for environmental protection but also for maintaining tourism resilience and long-term destination competitiveness.

The long-run results provide deeper insights into the structural characteristics of ASEAN's economic development model. The absence of a significant long-run causal relationship between tourism and FDI indicates that tourism growth alone is insufficient to sustain long-term foreign investment inflows. This suggests that investors consider broader structural determinants such as institutional quality, infrastructure readiness, governance effectiveness, macroeconomic stability, and energy reliability rather than tourism activity alone. This finding aligns with recent empirical studies emphasizing that institutional quality and infrastructure development remain the primary determinants of investment attractiveness in emerging economies (Nguyen & Su, 2021; Balsalobre-Lorente et al., 2020).

In ASEAN, structural heterogeneity among member countries strongly influences the ability to transform tourism growth into sustainable investment inflows. Economies such as Singapore and Malaysia possess stronger institutional quality, more advanced infrastructure systems, and better regulatory environments, enabling tourism growth to generate larger investment spillovers. Conversely, lower-income ASEAN economies often face infrastructure limitations, weaker governance structures, and insufficient energy capacity, limiting their ability to fully capitalize on tourism expansion. This finding also complements Kartowisastro and Trihadmini (2024), who emphasized that macroeconomic stability and policy conditions significantly shape economic performance and investment dynamics across ASEAN countries. Their findings suggest that macroeconomic and monetary conditions remain fundamental in determining the attractiveness and sustainability of investment inflows within the region.

One of the most important findings of this study is the strong bidirectional relationship between FDI and energy consumption in the long run. This result confirms that ASEAN's economic growth remains highly dependent on energy-intensive industrialization. Foreign investment inflows are strongly associated with manufacturing expansion, infrastructure construction, logistics development, and urbanization processes, all of which require substantial energy inputs. This finding is consistent with recent studies showing that industrial FDI significantly increases energy demand and environmental pressure in developing and emerging economies (Acheampong et al., 2025; Danish & Wang, 2018).

At the same time, energy systems also significantly influence investment attractiveness in ASEAN. Countries with more reliable energy infrastructure, stable electricity supply, and stronger energy efficiency systems tend to attract larger and more sustainable investment inflows. Reliable energy availability reduces operational uncertainty, production interruptions, and industrial costs, thereby strengthening investor confidence. In contrast, inadequate energy systems may discourage investment because energy shortages and high operational costs reduce industrial competitiveness. The findings therefore reinforce the importance of sustainable infrastructure and cleaner energy systems as strategic components of long-run economic competitiveness in ASEAN.

An important implication of these results is that ASEAN economies remain structurally dependent on energy-intensive growth patterns despite the increasing contribution of tourism and services. Although tourism contributes to service-sector expansion and demand-side growth, the strong long-run interaction between FDI and energy consumption suggests that ASEAN has not yet fully transitioned toward low-carbon or knowledge-based development structures. Industrial production, transportation systems, logistics networks, and infrastructure development continue to dominate regional growth patterns, thereby sustaining high energy demand across the region.

The strong causality results further reinforce the strategic role of tourism and energy systems in attracting foreign investment. Tourism and energy consumption significantly influence FDI, whereas reverse causality from FDI to tourism is not observed. This implies that tourism acts more as a signaling mechanism for economic opportunity rather than merely as an outcome of investment expansion. Countries capable of maintaining strong tourism competitiveness, environmental sustainability, and reliable infrastructure are therefore more likely to attract long-term foreign capital inflows. In ASEAN, this pattern is particularly visible in economies that combine strong tourism sectors with advanced infrastructure and institutional stability, such as Singapore, Thailand, and Malaysia.

The findings also highlight substantial structural and institutional heterogeneity across ASEAN member countries. ASEAN should not be viewed as a homogeneous economic region because member countries differ significantly in institutional quality, industrial capacity, tourism competitiveness, infrastructure readiness, and energy availability. Singapore possesses highly advanced financial systems, strong institutions, and efficient infrastructure, allowing tourism and investment to generate stronger spillover effects. Meanwhile, emerging ASEAN economies may face difficulties translating tourism potential into sustained investment and economic expansion because of weaker infrastructure systems and limited energy capacity. Consequently, the relationships identified in this study are shaped not only by economic variables but also by broader institutional and structural differences across countries.

From a policy perspective, the findings imply that ASEAN countries need to adopt integrated development strategies that simultaneously strengthen tourism competitiveness, investment attractiveness, and sustainable energy systems. Tourism

policies should focus not only on increasing visitor arrivals but also on improving environmental sustainability, destination quality, infrastructure connectivity, and long-term resilience. Likewise, investment policies should prioritize energy-efficient industries, renewable energy expansion, and sustainable infrastructure development to reduce excessive dependence on energy-intensive growth patterns.

In addition, the findings suggest that cleaner energy transitions are no longer solely environmental objectives but have become strategic economic requirements for sustaining long-term competitiveness in ASEAN. Countries capable of integrating tourism development, investment expansion, and sustainable energy systems are likely to achieve stronger and more resilient economic growth in the future. Therefore, ASEAN's long-run development strategy should emphasize balanced economic transformation that combines industrial upgrading, sustainable tourism, and environmentally responsible energy policies within an integrated regional framework.

CONCLUSION

This study examines the dynamic relationships among tourism, foreign direct investment (FDI), and energy consumption in ASEAN using a panel Vector Error Correction Model (VECM). The findings confirm the existence of both short-run and long-run interdependencies among the variables, indicating that tourism, investment inflows, and energy demand are structurally interconnected within ASEAN's economic development process.

In the short run, tourism significantly stimulates FDI inflows by expanding market opportunities and increasing demand for tourism-related industries such as transportation, hospitality, and supporting infrastructure. However, FDI does not immediately influence tourism growth, suggesting that investment projects require longer adjustment periods before generating measurable impacts on tourist arrivals. The results also show that rising energy consumption negatively affects tourism, indicating that environmental pressures and intensive energy use may reduce tourism competitiveness in ASEAN countries.

In the long run, the strongest relationship occurs between FDI and energy consumption, reflecting ASEAN's continued dependence on energy-intensive industrialization and infrastructure development. Foreign investment increases energy demand through industrial expansion and urban development, while reliable energy systems remain essential for maintaining long-term investment attractiveness. These findings imply that although ASEAN economies are increasingly supported by tourism and service-sector growth, regional development still relies heavily on energy-intensive economic activities.

From a policy perspective, the study highlights the importance of integrating tourism development, investment policy, and sustainable energy management within a unified regional growth strategy. ASEAN governments should prioritize infrastructure

improvement, institutional strengthening, renewable energy adoption, and environmentally sustainable tourism policies to maintain long-term competitiveness while reducing environmental pressures. Sustainable energy transition is therefore not only an environmental objective but also a strategic requirement for supporting investment attractiveness and tourism resilience in ASEAN.

This study contributes to the literature by integrating tourism, FDI, and energy consumption into a single dynamic framework in the ASEAN context. Nevertheless, the study remains limited to causality analysis and does not fully incorporate broader institutional, environmental, or socio-economic factors. Future research may therefore include variables such as renewable energy, carbon emissions, institutional quality, or technological innovation to provide a more comprehensive understanding of sustainable development dynamics in ASEAN countries.

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