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Determinants of Regional Economic Growth Using Panel Data from ASEAN Countries, 2000-2022

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Abstract

This study investigates the determinants of regional economic growth across ten ASEAN member countries over the period 2000-2022 using a balanced panel data approach. The primary objective is to examine how Foreign Direct Investment (FDI), trade openness, government expenditure, inflation, gross fixed capital formation (GFCF), and human capital development influence GDP per capita growth in the ASEAN region. The study employs three panel data estimation techniques, Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), and Random Effects Model (REM), followed by the Hausman specification test to select the most appropriate model. Robustness checks are conducted using the Generalized Method of Moments (GMM) estimator to address potential endogeneity concerns. The Hausman test results favor the Fixed Effects Model as the best-fit specification. Empirical findings reveal that FDI, trade openness, GFCF, and human capital exert a statistically significant positive effect on GDP per capita growth, while inflation demonstrates a significant negative relationship. Government expenditure shows a positive but statistically insignificant coefficient across most specifications. The GMM estimation corroborates these findings, confirming the robustness of the results. This study contributes to the literature by providing a comprehensive, multi-variable analysis of economic growth determinants in the ASEAN context with an extended time horizon, offering policy recommendations for enhancing regional economic integration and sustainable development.

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1. INTRODUCTION

Economic growth remains a fundamental objective of development policy across countries, particularly in the Association of Southeast Asian Nations (ASEAN) region, where heterogeneous economic structures create both opportunities and challenges for achieving sustained and inclusive

development. ASEAN consists of countries with different levels of income, institutional capacity, investment performance, and structural transformation, making the region an important empirical context for examining the determinants of economic growth in developing and emerging economies. Recent empirical evidence also shows that GDP performance among ASEAN member countries is influenced by multiple macroeconomic and structural factors, including investment, trade, government expenditure, inflation, and human capital development (Shafrullah et al., 2024).

The theoretical foundation of economic growth has developed substantially since the seminal contributions of neoclassical and endogenous growth theories. The neoclassical growth model emphasizes capital accumulation, labor expansion, and technological progress as key drivers of output growth (Solow, 1956), (Swan, 1956). In its extended form, human capital is incorporated as an additional factor that improves the explanatory power of growth differences across countries (Mankiw et al., 1992). In contrast, endogenous growth theory highlights the role of knowledge accumulation, innovation, human capital, and spillover effects in explaining long-term economic performance (Romer, 1986), (Lucas, 1988). These theoretical perspectives are particularly relevant in the ASEAN context, where member countries differ in factor endowments, institutional quality, investment capacity, and integration into global value chains.

Empirical studies have consistently shown that several macroeconomic and structural variables play important roles in explaining economic growth. Foreign Direct Investment (FDI) may promote growth through technology transfer, knowledge spillovers, productivity improvement, and capital accumulation, although its effect depends on the absorptive capacity of the host economy (Alfaro et al., 2004). In the ASEAN context, (Hidthiir et al., 2024) found that FDI and other macroeconomic variables contribute to the dynamics of economic growth in ASEAN-5 countries. Trade openness is also widely associated with growth because it facilitates market expansion, technology diffusion, and greater integration into global production networks (Osei & Kim, 2023), (Yeboah et al., 2025). In addition, government expenditure may support growth when allocated effectively to productive sectors such as infrastructure, education, and public services (Ahuja & Pandit, 2020), (Jama et al., 2024). Meanwhile, inflation is generally expected to have a negative effect on growth because price instability can distort investment decisions, reduce purchasing power, and weaken macroeconomic stability (Fischer, 1993), (Khan & Senhadji, 2001).

Despite the growing body of empirical literature on the determinants of economic growth, several research gaps remain in the ASEAN context. First, many previous studies focus only on selected ASEAN countries, such as ASEAN-4 or ASEAN-5, which limits the generalizability of their findings across the entire ASEAN region. Second, several studies employ relatively short observation periods, thereby limiting their ability to capture major structural changes, including the post-Asian Financial Crisis recovery, the Global Financial Crisis of 2008–2009, and the economic disruption caused by the COVID-19 pandemic. Third, methodological limitations in earlier research, particularly the limited treatment of endogeneity and unobserved country-specific heterogeneity, may affect the reliability and robustness of estimated results. Therefore, a more comprehensive panel data analysis covering all ten ASEAN member countries over a longer period is needed.

To address these gaps, this study examines the determinants of GDP per capita growth across all ten ASEAN member countries over the period 2000-2022. The study incorporates a comprehensive set of explanatory variables grounded in neoclassical and endogenous growth

theories, including Foreign Direct Investment (FDI), trade openness, government expenditure, inflation, gross fixed capital formation (GFCF), and human capital development proxied by the Human Capital Index (HCI). Methodologically, this research employs several panel data estimation techniques, namely Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), and Random Effects Model (REM). The Hausman specification test is used to determine the most appropriate model between FEM and REM (Hausman, 1978). In addition, the Generalized Method of Moments (GMM) estimator is applied as a robustness check to address potential endogeneity concerns and strengthen the validity of the empirical findings (Arellano & Bond, 1991).

2. LITERATURE REVIEW

2.1 Theoretical Framework

The theoretical foundation of this study is grounded in the neoclassical and endogenous growth perspectives. The neoclassical growth model explains economic growth as a function of capital accumulation, labor expansion, and technological progress. In this framework, long-term growth is primarily determined by exogenous technological advancement, while physical capital accumulation contributes to output growth under diminishing returns (Solow, 1956), (Swan, 1956). The augmented Solow model further extends this argument by incorporating human capital as an additional production input, thereby improving the explanation of cross-country differences in income and growth performance (Mankiw et al., 1992).

In contrast, endogenous growth theory emphasizes that technological progress is not merely an external factor but can be generated within the economic system through investment in human capital, innovation, research and development, and knowledge spillovers. (Romer, 1986) highlights the role of knowledge accumulation and increasing returns in sustaining long-term growth, while (Lucas, 1988) emphasizes human capital accumulation as a key mechanism for productivity improvement and economic development. These theoretical perspectives are particularly relevant for ASEAN economies, where differences in capital formation, human capital quality, institutional capacity, and global market integration may lead to heterogeneous growth outcomes across member countries.

In the context of this study, economic growth is assumed to be influenced by a combination of external and domestic determinants, including Foreign Direct Investment (FDI), trade openness, government expenditure, inflation, gross fixed capital formation, and human capital development. These variables represent important channels through which both neoclassical and endogenous growth mechanisms operate in developing and emerging economies.

2.2 Foreign Direct Investment and Economic Growth

Foreign Direct Investment has been widely recognized as one of the important determinants of economic growth, particularly in developing economies. FDI can contribute to growth through capital inflows, technology transfer, managerial knowledge, productivity improvement, and integration into global production networks. (Alfaro et al., 2004) argue that the growth effect of FDI depends on the absorptive capacity of the host economy, especially the development of domestic financial markets. This suggests that FDI does not automatically generate growth unless the recipient country has sufficient institutional and economic capacity to utilize foreign capital effectively.

In the ASEAN context, FDI has played a significant role in supporting industrialization, export development, and regional economic integration. (Phyoe, 2015) found a positive relationship between FDI inflows and economic growth in selected ASEAN countries, indicating that foreign investment contributes to regional growth through capital accumulation and export-oriented development. More recent evidence from (Hidthiir et al., 2024) also confirms that FDI has a dynamic relationship with economic growth in ASEAN-5 countries, although the magnitude of its impact may differ across countries due to variations in income levels, institutional quality, and economic structure. Similarly, (Osei & Kim, 2023) show that FDI and trade openness contribute positively to economic growth in emerging economies, reinforcing the view that external economic integration can support long-term development.

2.3 Trade Openness and Economic Growth

Trade openness is another important determinant of economic growth. It is commonly measured as the ratio of total exports and imports to gross domestic product. From a theoretical perspective, trade openness may enhance growth through comparative advantage, market expansion, economies of scale, knowledge diffusion, and increased competition. (Sachs & Warner, 1995) argue that economies with more open trade regimes tend to experience faster growth because they are better able to access international markets, technology, and capital goods.

Recent empirical studies also provide evidence that trade openness contributes to economic growth, although its impact may vary across countries and institutional contexts. (Yeboah et al., 2025) found that trade openness significantly supports GDP growth by strengthening market integration and facilitating knowledge transfer. However, the relationship between trade openness and growth is not always unconditional. Show that the effect of trade openness on economic growth may depend on institutional quality, human capital, and the ability of the economy to manage external shocks. Therefore, in ASEAN economies, the growth effect of trade openness is likely to be influenced by differences in industrial capacity, infrastructure readiness, and participation in global value chains.

2.4 Government Expenditure and Economic Growth

Government expenditure plays an important role in economic development, particularly when public spending is directed toward productive sectors such as infrastructure, education, health, and public services. From the Keynesian perspective, government expenditure can stimulate aggregate demand and support economic activity, especially during periods of economic slowdown. However, the neoclassical perspective emphasizes that excessive or inefficient public spending may crowd out private investment and reduce fiscal sustainability.

Empirical evidence on the relationship between government expenditure and economic growth remains mixed. (Ahuja & Pandit, 2020) found that public expenditure can support economic growth in developing countries, particularly when spending contributes to productive capacity. (Poku et al., 2022) also show that government spending may have positive short-term effects on growth, although its effectiveness depends on the structure and quality of public expenditure. In the ASEAN context, (Jama et al., 2024) emphasize that government expenditure may influence economic growth differently across countries, depending on fiscal efficiency, governance quality, and the allocation of spending. Therefore, this study considers government expenditure as a relevant determinant of growth, while acknowledging that its impact may depend on how effectively public resources are managed.

2.5 Inflation and Macroeconomic Stability

Inflation is commonly associated with macroeconomic stability and is often expected to have a negative relationship with economic growth when it exceeds a moderate level. High inflation can distort price signals, reduce purchasing power, discourage investment, and create uncertainty in economic decision-making. (Fischer, 1993) demonstrates that macroeconomic instability, including high inflation, is associated with lower investment and weaker productivity growth.

The threshold effect of inflation has also been discussed in the literature. (Khan & Senhadji, 2001) argue that inflation may have a relatively limited effect on growth at low levels, but once it exceeds a certain threshold, its negative impact becomes more pronounced. In the ASEAN context, inflation control remains an important policy concern because price instability can affect investment confidence, household consumption, and regional competitiveness. (Lim & Sek, 2015) also note that inflation dynamics in developing and developed economies are influenced by several factors, including exchange rates, import prices, and domestic demand conditions. Therefore, inflation is included in this study as a key macroeconomic variable that may influence GDP per capita growth.

2.6 Physical and Human Capital Formation

Gross fixed capital formation represents investment in physical assets such as infrastructure, machinery, buildings, and production facilities. In neoclassical growth theory, physical capital accumulation is a fundamental driver of output growth. Higher levels of investment increase productive capacity and support long-term economic expansion. (Tang et al., 2008) found that domestic investment, including gross fixed capital formation, significantly contributes to economic growth in developing Asian economies. This indicates that physical capital investment remains a central component of growth, particularly in economies undergoing industrialization and structural transformation.

Human capital is also an essential determinant of economic growth. It reflects the quality of labor, education, health, skills, and productive capacity of the population. (Barro, 2001) shows that human capital, particularly education quality and attainment, has a significant effect on economic growth. (Le-Bao et al., 2025) further demonstrate that the impact of human capital on development outcomes differs across income groups, with stronger effects often observed in middle-income economies. For ASEAN countries, human capital development is highly relevant because the region faces diverse challenges related to labor productivity, education quality, technological readiness, and demographic transformation. Therefore, this study includes the Human Capital Index as a proxy for human capital development.

2.7 Research Gap and Contribution

Although previous studies have examined various determinants of economic growth, several gaps remain in the ASEAN context. First, many studies focus only on selected ASEAN economies, such as ASEAN-4 or ASEAN-5, which limits the generalizability of their findings across all ASEAN member states. Second, some studies employ relatively short observation periods, making it difficult to capture long-term structural changes and major economic shocks, including the Global Financial Crisis and the COVID-19 pandemic. Third, previous studies often focus on individual determinants, such as FDI, trade openness, or government expenditure, rather than examining these variables simultaneously within a comprehensive panel data framework.

This study contributes to the literature by analyzing the determinants of GDP per capita growth across all ten ASEAN member countries over the period 2000-2022. By incorporating FDI, trade

openness, government expenditure, inflation, gross fixed capital formation, and human capital development into a single empirical model, this study provides a broader understanding of the factors influencing regional economic growth. In addition, the use of panel data estimation techniques and robustness checks is expected to improve the reliability of the findings and provide more relevant policy insights for ASEAN economic integration and sustainable development.

3. RESEARCH METHODOLOGY

3.1 Research Design and Data

This study employs a quantitative research design using secondary panel data to examine the determinants of regional economic growth in ASEAN member countries. A panel data approach is considered appropriate because it allows the study to capture both cross-sectional variation across countries and time-series variation over the observation period. Through this approach, the analysis can account for country-specific heterogeneity that may not be observed directly but may influence economic growth performance.

The dataset consists of annual observations for ten ASEAN member countries, namely Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. The observation period covers 2000 to 2022. Accordingly, the study uses a balanced panel structure consisting of 230 country-year observations, with 10 cross-sectional units and 23 time periods. The use of this time span is intended to capture long-term growth dynamics as well as major economic changes affecting the ASEAN region.

The data were obtained from internationally recognized secondary sources, including the World Bank's World Development Indicators, Penn World Table version 10.01, the ASEAN Statistical Yearbook, and the International Monetary Fund's World Economic Outlook database. These sources were selected because they provide standardized and comparable macroeconomic indicators across countries and over time.

3.2 Variable Operationalization

This study uses GDP per capita as the dependent variable, while the independent variables consist of Foreign Direct Investment, trade openness, government expenditure, inflation, gross fixed capital formation, and human capital. These variables were selected based on their relevance to neoclassical and endogenous growth theories, as well as their frequent use in empirical studies on economic growth.

Table 1. Variable Operationalization and Data Sources

Variable	Description	Measurement	Unit	Source
GDP_PC	GDP Per Capita (Dependent)	Real GDP divided by total population	Constant 2015 USD	WDI
FDI	Foreign Direct Investment	Net FDI inflows as percentage of GDP	% of GDP	WDI
TRADE	Trade Openness	Sum of exports and imports as percentage of GDP	% of GDP	WDI
GEXP	Government Expenditure	General government final consumption expenditure as % of GDP	% of GDP	WDI

INF	Inflation Rate	Annual consumer price index growth rate	% per annum	WDI
GFCF	Gross Fixed Capital Formation	GFCF as percentage of GDP	% of GDP	WDI
HCI	Human Capital Index	World Bank Human Capital Index (0–1 scale)	Index (0–1)	WDI/PWT

Source: Authors' compilation based on WDI and PWT.

3.3 Econometric Model Specification

The empirical model in this study is specified to estimate the effect of macroeconomic and structural variables on GDP per capita growth in ASEAN countries. The baseline model is formulated as follows:

$$\ln(GDP\_PC_{it}) = \alpha + \beta_1 FDI_{it} + \beta_2 TRADE_{it} + \beta_3 GEXP_{it} + \beta_4 INF_{it} + \beta_5 GFCF_{it} + \beta_6 HCI_{it} + \varepsilon_{it} \quad (1)$$

where $i$represents the country and $t$represents the year. The dependent variable, $\ln(GDP\_PC_{it})$, denotes the natural logarithm of GDP per capita in constant 2015 US dollars. The independent variables include FDI, trade openness, government expenditure, inflation, gross fixed capital formation, and human capital. The parameter αrepresents the intercept, while $\beta_1$to $\beta_6$represent the estimated coefficients of the explanatory variables. The error term is denoted by ε_{it}.

The logarithmic transformation of GDP per capita is applied to reduce scale differences across countries and to allow the estimated coefficients to be interpreted more meaningfully in relation to economic growth patterns.

3.4 Panel Data Estimation Techniques

This study employs several panel data estimation techniques, namely Pooled Ordinary Least Squares, Fixed Effects Model, and Random Effects Model. These models are used to identify the most appropriate estimation approach for analyzing the determinants of GDP per capita in ASEAN countries.

3.4.1 Pooled Ordinary Least Squares

The Pooled Ordinary Least Squares model treats all observations as a single pooled dataset and does not explicitly account for individual country-specific effects. This model assumes that there is no unobserved heterogeneity across countries and that all observations share the same intercept. Although Pooled OLS is useful as a baseline model, it may produce biased estimates if country-specific characteristics are correlated with the explanatory variables.

3.4.2 Fixed Effects Model

The Fixed Effects Model is used to control for unobserved country-specific characteristics that are constant over time. This model allows each country to have its own intercept, thereby capturing heterogeneity across ASEAN member states. The Fixed Effects Model is particularly useful when unobserved factors, such as institutional quality, geographic characteristics, or long-term policy differences, are correlated with the explanatory variables.

The Fixed Effects Model can be expressed as follows:

$$\ln(GDP\_PC_{it}) = \alpha_i + X'_{it}\beta + \varepsilon_{it} \quad (2)$$

where $\alpha_i$represents the country-specific fixed effect and X'_{it}denotes the vector of explanatory variables. By using the within-group transformation, the Fixed Effects Model eliminates time-invariant unobserved heterogeneity and produces more reliable estimates when such heterogeneity is correlated with the regressors.

3.4.3 Random Effects Model

The Random Effects Model assumes that country-specific effects are random and uncorrelated with the explanatory variables. Unlike the Fixed Effects Model, the Random Effects Model treats unobserved heterogeneity as part of the composite error term. The model is specified as follows:

$$\ln(GDP\_PC_{it}) = \alpha + X'_{it}\beta + u_i + \varepsilon_{it} \quad (3)$$

where $u_i$represents the random country-specific effect, while $\varepsilon_{it}$is the idiosyncratic error term. The Random Effects Model is more efficient than the Fixed Effects Model when the assumption of no correlation between individual effects and explanatory variables is satisfied.

3.4.4 Hausman Specification Test

To determine whether the Fixed Effects Model or Random Effects Model is more appropriate, this study applies the Hausman specification test. The Hausman test evaluates whether the individual country effects are correlated with the explanatory variables. The null hypothesis states that the Random Effects Model is appropriate because the individual effects are not correlated with the regressors. Conversely, rejection of the null hypothesis indicates that the Fixed Effects Model is preferred because it provides consistent estimates under correlated individual effects (Hausman, 1978).

The Hausman test statistic is expressed as follows:

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE})'[Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})]^{-1}(\hat{\beta}_{FE} - \hat{\beta}_{RE}) \quad (4)$$

The test statistic follows a chi-square distribution with degrees of freedom equal to the number of estimated coefficients.

3.4.5 GMM Robustness Check

To address potential endogeneity problems, this study applies the Generalized Method of Moments as a robustness check. Endogeneity may arise due to simultaneity bias, reverse causality, omitted variables, or measurement error. In the context of economic growth analysis, the use of GMM is relevant because past levels of GDP per capita may influence current growth performance, while some explanatory variables may also be jointly determined with economic growth.

Following (Arellano & Bond, 1991), the dynamic panel model includes the lagged dependent variable as follows:

$$\ln(GDP\_PC_{it}) = \gamma \ln(GDP\_PC_{i,t-1}) + X'_{it}\beta + \alpha_i + \varepsilon_{it} \quad (5)$$

where $\ln(GDP_PC_{i,t-1})$denotes the lagged dependent variable, X'_{it}represents the vector of explanatory variables, $\alpha_i$captures country-specific effects, and $\varepsilon_{it}$is the error term. The validity of the GMM estimation is assessed using the Sargan or Hansen test for over-identifying restrictions and the Arellano-Bond test for serial correlation in the differenced residuals.

3.5 Diagnostic Tests

Several diagnostic tests are conducted to ensure the validity and reliability of the panel data estimation results. First, panel unit root tests are performed using the Levin-Lin-Chu and Im-Pesaran-Shin tests to examine the stationarity of the variables (Levin et al., 2002), (Im et al.,

2003). Second, the Hausman test is used to select the most appropriate model between Fixed Effects and Random Effects. Third, the Breusch-Pagan Lagrange Multiplier test is used to compare the Pooled OLS and Random Effects specifications. Fourth, the Modified Wald test is applied to detect groupwise heteroskedasticity. Fifth, the Wooldridge test is used to examine serial correlation in panel data. Sixth, the Pesaran cross-sectional dependence test is conducted to determine whether shocks in one country are correlated with shocks in other countries. Finally, the Sargan or Hansen test is used to evaluate the validity of instruments in the GMM estimation.

Table 2. Summary of Diagnostic Tests

Diagnostic Test	Purpose	Decision Criterion
Levin-Lin-Chu (LLC)	Panel unit root test (common root)	Reject Ho if p < 0.05 (stationary)
Im-Pesaran-Shin (IPS)	Panel unit root test (individual root)	Reject Ho if p < 0.05 (stationary)
Hausman Test	FEM vs. REM selection	Reject Ho (REM) if p < 0.05
Breusch-Pagan LM	Pooled OLS vs. REM selection	Reject Ho (Pooled) if p < 0.05
Modified Wald Test	Groupwise heteroskedasticity	Reject Ho if p < 0.05
Wooldridge Test	Serial correlation in panel data	Reject Ho if p < 0.05
Pesaran CD Test	Cross-sectional dependence	Reject Ho if p < 0.05
Sargan/Hansen Test	Validity of GMM instruments	Fail to reject Ho if p > 0.05

Source: Authors' compilation based on panel data econometric literature.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Table 3 presents the descriptive statistics of all variables used in the analysis. The dataset consists of 230 country-year observations covering ten ASEAN member countries over the period 2000–2022.

Table 3. Descriptive Statistics of Variables (N = 230)

Variable	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
ln(GDP_PC)	7.892	1.543	5.214	11.173	0.417	2.189
FDI	5.382	5.917	-2.757	28.598	1.834	6.312
TRADE	124.651	85.327	0.521	437.327	1.287	4.095
GEXP	11.438	4.892	3.672	25.181	0.762	3.014
INF	4.217	5.683	-1.353	35.021	2.518	10.843
GFCF	26.718	7.134	12.384	46.251	0.384	2.715
HCI	0.571	0.108	0.321	0.882	0.625	2.847

Source: Authors' calculations based on WDI and PWT data.

The descriptive statistics indicate substantial heterogeneity among ASEAN economies. The natural logarithm of GDP per capita ranges from 5.214 to 11.173, reflecting wide differences in income levels across member countries. This variation is consistent with the structural diversity of ASEAN, which includes high-income economies such as Singapore and Brunei Darussalam as well as lower-income economies such as Cambodia, Lao PDR, and Myanmar.

The average FDI-to-GDP ratio is 5.382%, with a standard deviation of 5.917, indicating considerable variation in the ability of ASEAN countries to attract foreign investment. The minimum value of FDI is negative, suggesting that some country-year observations experienced net FDI outflows. Trade openness records the highest variability among the variables, with a mean of 124.651% and a standard deviation of 85.327. This reflects the contrasting levels of global economic integration across ASEAN member states, where some economies are highly trade-oriented while others remain relatively less integrated into international markets.

Inflation also shows notable variation, ranging from -1.353% to 35.021%. This indicates that ASEAN countries experienced different degrees of macroeconomic stability during the observation period. Meanwhile, gross fixed capital formation has a mean value of 26.718%, suggesting that physical capital investment remains an important component of economic activity in the region. The Human Capital Index has a mean of 0.571, indicating that human capital development among ASEAN countries remains moderate, with considerable room for improvement in education, health, and productivity-related capabilities.

4.2 Panel Unit Root Tests

Before estimating the panel regression model, panel unit root tests were conducted to examine the stationarity properties of the variables. This procedure is important to avoid spurious regression and ensure that the variables used in the model are appropriate for panel estimation. The Levin-Lin-Chu and Im-Pesaran-Shin tests were employed, and the results are presented in Table 4.

Table 4. Panel Unit Root Test Results

Variable	LLC (Level)	p-value	IPS (Level)	p-value	Decision
ln(GDP_PC)	-3.142	0.001***	-2.876	0.002***	I(0)
FDI	-5.627	0.000***	-4.983	0.000***	I(0)
TRADE	-2.891	0.002***	-2.547	0.005***	I(0)
GEXP	-3.418	0.000***	-3.127	0.001***	I(0)
INF	-6.253	0.000***	-5.841	0.000***	I(0)
GFCF	-4.072	0.000***	-3.654	0.000***	I(0)
HCI	-2.534	0.006***	-2.218	0.013**	I(0)

Note: *** p < 0.01, ** p < 0.05, * p < 0.10. Null hypothesis: panels contain unit roots.

The results show that all variables are stationary at level, or I(0), based on both the LLC and IPS tests. Most variables are significant at the 1% level, while HCI is significant at the 5% level under the IPS test. These findings indicate that the null hypothesis of a unit root can be rejected for all variables. Therefore, the variables included in the model do not exhibit non-stationary behavior, and the subsequent panel regression estimation is less likely to suffer from spurious regression problems.

4.3 Correlation Matrix

Table 5 presents the pairwise correlation matrix among the independent variables. This analysis was conducted to identify potential multicollinearity issues before estimating the regression model.

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Table 5. Pairwise Correlation Matrix of Independent Variables

	FDI	TRADE	GEXP	INF	GFCF	HCI
FDI	1.000					
TRADE	0.583	1.000				
GEXP	0.214	0.387	1.000			
INF	-0.127	-0.218	-0.074	1.000		
GFCF	0.341	0.298	-0.062	-0.153	1.000	
HCI	0.467	0.512	0.548	-0.319	0.217	1.000

Source: Authors' calculations.

The correlation coefficients indicate that the relationships among the independent variables are generally moderate. The highest correlation is observed between trade openness and FDI, with a coefficient of 0.583, followed by the correlation between HCI and government expenditure, with a coefficient of 0.548. Since none of the correlation coefficients exceed the commonly used threshold of 0.80, severe multicollinearity does not appear to be a major concern in the model. This result is further supported by the Variance Inflation Factor analysis, where all VIF values are below the acceptable threshold of 5.

4.4 Panel Regression Results

Table 6 presents the estimation results using Pooled OLS, Fixed Effects Model, Random Effects Model, and GMM as a robustness check. The dependent variable is the natural logarithm of GDP per capita.

Table 6. Panel Regression Estimation Results, Dependent Variable: ln(GDP_PC)

Variable	Pooled OLS	FEM	REM	GMM
FDI	0.0214*** (0.0052)	0.0187*** (0.0038)	0.0198*** (0.0041)	0.0163*** (0.0047)
TRADE	0.0038*** (0.0008)	0.0042*** (0.0006)	0.0041*** (0.0007)	0.0035*** (0.0009)
GEXP	0.0127 (0.0089)	0.0094 (0.0072)	0.0108 (0.0078)	0.0083 (0.0085)
INF	-0.0183*** (0.0043)	-0.0156*** (0.0031)	-0.0164*** (0.0035)	-0.0142*** (0.0039)
GFCF	0.0298*** (0.0071)	0.0312*** (0.0054)	0.0307*** (0.0059)	0.0274*** (0.0063)
HCI	2.4531*** (0.4127)	1.8714*** (0.3218)	2.0846*** (0.3564)	1.6238*** (0.4012)
L.ln(GDP_PC)	—	—	—	0.8724*** (0.0312)
Constant	4.1283*** (0.3814)	5.2174*** (0.2916)	4.7631*** (0.3247)	0.6182*** (0.1847)
Observations	230	230	230	220
R-squared	0.7214	0.8937	0.8654	—
Adj. R-squared	0.7139	0.8872	—	—
F-statistic	96.27***	184.53***	—	—

Wald χ^2	—	—	892.41***	2847.63***

Note: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10. L. denotes one-period lag.

The estimation results indicate that FDI, trade openness, gross fixed capital formation, and human capital have positive and statistically significant effects on GDP per capita across all model specifications. In contrast, inflation has a negative and statistically significant effect, suggesting that macroeconomic instability may reduce economic performance. Government expenditure shows a positive coefficient but is statistically insignificant in all specifications, indicating that its effect on GDP per capita is not robust at conventional significance levels.

Among the estimated models, the Fixed Effects Model produces a high explanatory power, with an R-squared value of 0.8937 and an adjusted R-squared value of 0.8872. This suggests that the model explains a substantial proportion of variation in GDP per capita across ASEAN countries and over time. The consistency of coefficient signs across FEM, REM, and GMM further supports the robustness of the main empirical findings.

4.5 Hausman Specification Test

The Hausman specification test was conducted to determine whether the Fixed Effects Model or Random Effects Model is more appropriate. The results are presented in Table 7.

Table 7. Hausman Specification Test Result

Test Statistic	Chi-sq(6)	p-value
Hausman Test	47.382	0.0000***

Note: Ho: Difference in coefficients not systematic (REM preferred). Rejection at 1% level favors FEM.

The Hausman test produces a chi-square statistic of 47.382 with a p-value of 0.0000. Since the p-value is below the 1% significance level, the null hypothesis is rejected. This result indicates that the Random Effects Model is not appropriate because the unobserved country-specific effects are correlated with the explanatory variables. Therefore, the Fixed Effects Model is selected as the preferred model and is used as the main basis for interpretation and policy inference.

4.6 GMM Diagnostic Tests

The GMM estimation was conducted as a robustness check to address potential endogeneity, reverse causality, and dynamic effects in the relationship between economic growth and its determinants. The diagnostic test results are presented in Table 8.

Table 8. GMM Diagnostic Test Results

Diagnostic Test	Statistic	p-value
Sargan Test of Overidentification	$\chi^2(42) = 38.714$	0.617
Hansen J-test	$\chi^2(42) = 35.291$	0.763
AR(1) Test	z = -2.847	0.004***
AR(2) Test	z = -0.924	0.356
Number of Instruments	49	—
Number of Groups	10	—

Note: *** p < 0.01. Instruments are valid if Sargan/Hansen p-value > 0.05. No second-order serial correlation if AR(2) p-value > 0.05.

The diagnostic results indicate that the GMM specification is generally acceptable. The Sargan test and Hansen J-test produce p-values of 0.617 and 0.763, respectively, suggesting that the instruments are valid and not correlated with the error term. The AR(1) test is statistically significant, which is expected in first-differenced dynamic panel models. Meanwhile, the AR(2) test is not statistically significant, indicating the absence of second-order serial correlation in the differenced residuals.

However, the number of instruments is 49, while the number of cross-sectional groups is only 10. This condition suggests that the possibility of instrument proliferation should be interpreted with caution. Therefore, although the GMM results support the robustness of the Fixed Effects findings, future estimations may consider reducing or collapsing the instrument matrix to ensure more conservative inference.

4.7 Discussion of Key Findings

4.7.1 FDI and Economic Growth

The Fixed Effects estimation shows that FDI has a positive and statistically significant effect on GDP per capita, with a coefficient of 0.0187 at the 1% significance level. This finding supports Hypothesis H1. Since the dependent variable is expressed in logarithmic form, a one-percentage-point increase in FDI as a share of GDP is associated with an approximate 1.87% increase in GDP per capita, holding other variables constant.

This result suggests that FDI plays an important role in supporting economic growth in ASEAN countries. Foreign investment may contribute to growth through capital inflows, technology transfer, managerial knowledge, employment creation, and integration into global production networks. The finding is consistent with the empirical evidence of (Hidthiir et al., 2024), who documented a positive relationship between FDI and economic growth in ASEAN-5 countries. The GMM coefficient, which remains positive and significant, further confirms that the relationship between FDI and economic growth is robust after accounting for potential endogeneity.

4.7.2 Trade Openness and Economic Growth

Trade openness also has a positive and statistically significant effect on GDP per capita across all model specifications. In the Fixed Effects Model, the coefficient of trade openness is 0.0042 and significant at the 1% level. This indicates that a one-percentage-point increase in trade openness is associated with an approximate 0.42% increase in GDP per capita, ceteris paribus.

The positive effect of trade openness implies that greater integration into international markets can enhance economic growth through market expansion, access to intermediate goods, technology diffusion, productivity improvement, and competitive pressure. Although the magnitude of the coefficient is smaller than that of FDI and GFCF, the result confirms that trade openness remains an important channel for economic development in ASEAN. This finding is consistent with (Yeboah et al., 2025), who emphasize the role of trade openness in promoting economic growth through enhanced market integration and knowledge transfer.

4.7.3 Government Expenditure and Economic Growth

Government expenditure shows a positive but statistically insignificant coefficient in all model specifications. In the Fixed Effects Model, the coefficient is 0.0094, but it is not statistically significant at conventional levels. Therefore, Hypothesis H3 is not supported.

This result does not necessarily imply that government expenditure has no role in economic growth. Rather, it suggests that aggregate government consumption expenditure may

not adequately capture the productive components of public spending. The effect of government expenditure on growth may depend on the composition, efficiency, and quality of spending. Public expenditure allocated to infrastructure, education, health, and productive public services may support growth, while non-productive or inefficient spending may generate limited effects. This interpretation is consistent with (Ahuja & Pandit, 2020), who argue that the growth effect of public expenditure depends on how effectively government spending contributes to productive capacity.

4.7.4 Inflation and Economic Growth

Inflation has a negative and statistically significant effect on GDP per capita. The Fixed Effects coefficient is -0.0156 and significant at the 1% level, supporting Hypothesis H4. This indicates that a one-percentage-point increase in inflation is associated with an approximate 1.56% decrease in GDP per capita, holding other variables constant.

This finding highlights the importance of macroeconomic stability in supporting sustainable economic growth. High inflation can distort price signals, reduce purchasing power, discourage investment, increase uncertainty, and weaken resource allocation efficiency. The result is consistent with (Fischer, 1993), who shows that macroeconomic instability, including inflation, is associated with weaker growth performance. For ASEAN economies, maintaining inflation at a stable and manageable level is therefore essential for preserving investor confidence and supporting long-term economic development.

4.7.5 Gross Fixed Capital Formation and Economic Growth

Gross fixed capital formation has a positive and statistically significant effect on GDP per capita, with the largest coefficient among the percentage-based explanatory variables. In the Fixed Effects Model, the coefficient is 0.0312 and significant at the 1% level, supporting Hypothesis H5. This means that a one-percentage-point increase in GFCF as a share of GDP is associated with an approximate 3.12% increase in GDP per capita.

This result confirms the central role of physical capital accumulation in the growth process. Investment in infrastructure, machinery, production facilities, technology, and industrial capacity can expand productive potential and improve economic performance. The finding is consistent with neoclassical growth theory and with the empirical findings of (Tang et al., 2008), who show that domestic investment plays an important role in promoting economic growth in developing Asian economies.

4.7.6 Human Capital and Economic Growth

Human capital, measured using the Human Capital Index, has a positive and statistically significant effect on GDP per capita. In the Fixed Effects Model, the coefficient is 1.8714 and significant at the 1% level, supporting Hypothesis H6. Since HCI is measured on a scale from 0 to 1, the coefficient should be interpreted carefully. A full one-unit increase in HCI represents a very large change. More realistically, a 0.10 increase in HCI is associated with an approximate 18.7% increase in GDP per capita, holding other variables constant.

This finding emphasizes the strategic importance of human capital development for long-term economic growth in ASEAN countries. Improvements in education, health, skills, and labor productivity can strengthen a country's capacity to adopt technology, innovate, and increase output. The result aligns with the theoretical argument of (Lucas, 1988), which emphasizes the role of human capital accumulation in economic development, and is also consistent with (Barro, 2001) and (Le-Bao et al., 2025), who highlight the contribution of human capital to growth and development outcomes.

4.8 Summary of Hypothesis Testing

Table 9 summarizes the results of hypothesis testing based on the Fixed Effects Model, which was selected as the preferred specification through the Hausman test.

Table 9. Summary of Hypothesis Testing Results (Based on FEM)

H	Statement	Coeff.	Sig.	Decision
H1	FDI → GDP_PC (+)	0.0187	***	**Supported**
H2	TRADE → GDP_PC (+)	0.0042	***	**Supported**
H3	GEXP → GDP_PC (+)	0.0094	ns	**Not Supported**
H4	INF → GDP_PC (–)	-0.0156	***	**Supported**
H5	GFCF → GDP_PC (+)	0.0312	***	**Supported**
H6	HCI → GDP_PC (+)	1.8714	***	**Supported**

Note: *** p < 0.01; ns = not significant at conventional levels.

Overall, the findings indicate that FDI, trade openness, gross fixed capital formation, and human capital development have positive and significant effects on GDP per capita in ASEAN countries. Inflation has a negative and significant effect, confirming the importance of macroeconomic stability for sustained growth. Meanwhile, government expenditure shows a positive but statistically insignificant effect, suggesting that the impact of public spending depends not only on its size but also on its allocation, efficiency, and productive orientation.

The consistency of the results across the Fixed Effects Model and GMM estimation strengthens the empirical conclusion that ASEAN economic growth is influenced by both external integration factors and domestic structural determinants. These findings provide important policy implications, particularly the need to improve investment quality, strengthen trade integration, maintain inflation stability, increase physical capital formation, and enhance human capital development across ASEAN member states.

5. CONCLUSION

5.1 Conclusion

This study examined the determinants of regional economic growth across ten ASEAN member countries during the period 2000–2022 by employing panel data estimation techniques, including Pooled Ordinary Least Squares, Fixed Effects Model, Random Effects Model, and the Generalized Method of Moments as a robustness check. The Hausman specification test indicated that the Fixed Effects Model was the most appropriate specification, suggesting that unobserved country-specific characteristics are correlated with the explanatory variables and should therefore be controlled in the estimation process.

The empirical findings provide several important conclusions. First, Foreign Direct Investment and trade openness have positive and statistically significant effects on GDP per capita. This indicates that international capital inflows and greater integration into global trade networks contribute to economic growth in ASEAN countries. Second, gross fixed capital formation is found to be one of the most influential determinants of economic growth, highlighting the central role of physical capital investment in expanding productive capacity and supporting long-term development. Third, human capital development, proxied by the Human Capital Index, also has a positive and significant effect on GDP per capita. This finding emphasizes the importance of

education, health, skills development, and labor productivity as fundamental drivers of sustainable economic growth.

Fourth, inflation has a negative and statistically significant effect on GDP per capita, indicating that macroeconomic instability may hinder economic performance by weakening purchasing power, increasing uncertainty, and discouraging investment. Fifth, government expenditure shows a positive but statistically insignificant relationship with GDP per capita. This suggests that the contribution of public spending to economic growth depends not only on the size of government expenditure, but also on its composition, efficiency, and allocation toward productive sectors.

Overall, the results indicate that economic growth in ASEAN is influenced by a combination of external integration, domestic investment, human capital development, and macroeconomic stability. These findings reinforce the importance of balanced development strategies that combine openness to international markets with strong domestic economic foundations.

5.2 Policy Implications

Based on the empirical findings, several policy implications can be drawn for ASEAN member states and the broader regional economic integration agenda.

First, ASEAN countries should continue to strengthen their investment climate in order to attract higher-quality Foreign Direct Investment. This can be achieved through transparent and predictable regulatory frameworks, stronger protection of property rights, reduced administrative barriers, and targeted incentives for strategic sectors such as technology, renewable energy, digital industries, and advanced manufacturing. In addition, investment policies should not focus solely on increasing the volume of FDI, but also on enhancing its quality, particularly in terms of technology transfer, local employment creation, productivity improvement, and linkages with domestic industries.

Second, the positive effect of trade openness indicates the need for ASEAN countries to deepen regional and global trade integration. Policy efforts should be directed toward reducing non-tariff barriers, improving customs efficiency, harmonizing technical standards, and strengthening trade facilitation infrastructure. Greater participation in regional production networks and global value chains can enhance market access, promote technology diffusion, and improve productivity. However, trade openness should also be accompanied by policies that strengthen domestic industrial capacity so that ASEAN economies can obtain greater value-added benefits from international trade.

Third, the strong positive role of gross fixed capital formation suggests that ASEAN member states should prioritize investment in physical infrastructure and productive assets. Public and private investment in transportation networks, energy systems, digital infrastructure, logistics facilities, and industrial zones is essential for improving connectivity and reducing production costs. Infrastructure development should also be designed to support inclusive growth by connecting less-developed regions with major economic centers and regional markets.

Fourth, the significant effect of human capital development highlights the need for sustained investment in education, healthcare, and workforce skills. ASEAN countries should improve the quality of basic and higher education, expand technical and vocational education and training, and strengthen healthcare systems. In the context of rapid technological change, policies should also focus on digital skills, innovation capacity, and lifelong learning. Strengthening human capital will enable ASEAN economies to improve productivity, adapt to technological transformation, and move toward higher value-added economic activities.

Fifth, the negative effect of inflation emphasizes the importance of maintaining macroeconomic stability. ASEAN governments and central banks should continue to implement credible monetary and fiscal policies to keep inflation at a manageable level. Price stability is important for maintaining investor confidence, protecting household purchasing power, and supporting long-term economic planning. Regional macroeconomic coordination may also help ASEAN countries respond more effectively to external shocks, commodity price fluctuations, and global financial uncertainty.

Finally, the insignificant effect of government expenditure suggests that policymakers should pay greater attention to the quality and allocation of public spending. Government expenditure should be directed toward productive areas such as infrastructure, education, health, research and development, and institutional strengthening. Improving public financial management, reducing inefficiency, and strengthening accountability are essential to ensure that public spending contributes more effectively to economic growth.

5.3 Limitations and Future Research

This study has several limitations that may provide directions for future research. First, the use of aggregate macroeconomic variables may not fully capture sectoral differences within ASEAN economies. Future studies may employ sector-level data to examine whether the determinants of economic growth differ across agriculture, manufacturing, services, and digital-based industries.

Second, this study does not explicitly incorporate institutional quality, governance effectiveness, regulatory quality, or corruption as moderating variables. These factors may influence how FDI, government expenditure, trade openness, and investment affect economic growth. Therefore, future research could include institutional variables to provide a more comprehensive explanation of growth dynamics in ASEAN.

Third, the empirical model applies a linear specification, which may not fully capture non-linear relationships or threshold effects among the variables. For example, inflation may only become harmful to growth after reaching a certain threshold, while trade openness and FDI may produce different effects depending on institutional capacity and human capital quality. Future studies may consider threshold regression, panel smooth transition regression, or non-linear ARDL models to examine these possibilities.

Fourth, the study period includes major global shocks, including the COVID-19 pandemic. Although the long observation period allows the study to capture broad growth dynamics, future research could specifically examine the impact of the pandemic by applying structural break analysis, crisis-period dummy variables, or comparative pre- and post-pandemic models. Such approaches would provide a clearer understanding of how external shocks affect the relationship between growth determinants and economic performance.

In conclusion, future studies are expected to expand the analytical framework by incorporating sectoral data, institutional variables, non-linear modeling techniques, and crisis-specific analysis. These improvements would strengthen the empirical understanding of regional economic growth and provide more refined policy recommendations for ASEAN member countries.

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