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The causal relationship between government investment and economic development in ASEAN countries

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Abstract

The purpose of this article is to evaluate the impact of public investment on economic growth. The data was used from the annual data of the Asian Development Bank (ADB) for 6 countries in ASEAN during 2000-2022. The methodology used in the project is to apply the unit root test to the stationarity properties of individual time series and establish the cointegration relationship between non-stationary variables using methods related to cointegration testing in the long-run. The error correction model (ECM) considers the impact of the variables public investment, public expenditure and budget revenue from taxes on short-term economic growth and long-term growth thereby calculating the adjustment speed and adjustment time of the model and using the Granger causality test with fixed effects for analysis of unbalanced panel data to comprehensively analyze the relationship between public investment and economic growth. Data analysis and processing were performed using Stata software version 17. The findings that public investment has a long-term impact on economic growth and has a two-way causal relationship in all countries. The authors provide policy implications to make public investment more effective contributing to promoting the country's socio-economic development, reviewing and improving the legal system on public investment, restructuring public investment while strongly enhancing the efficiency and quality of public investment, inviting and attracting foreign direct investment (FDI) capital, diversifying capital sources and creating more motivation for the private economic sector to develop and promulgate solutions to develop high-quality human resources.

Keywords: ASEAN, Economic growth, Error correction model, Granger causality test, Public investment, Unit root test.

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1. Introduction

Public investment includes investment in programs and projects to develop socio-economic infrastructure, investment to serve the activities of government organizations, political and socio-political organizations at home and abroad and investment to support the provision of public services and goods. The question here is how to effectively restructure public investment when the medium-term plan is still being implemented. The high growth of Southeast Asia's economy shows that the economy of the entire East Asia region is undergoing structural changes. Therefore, relying on infrastructure investment to promote economic growth is almost a priority consideration for most ASEAN countries. However, along with innovation, public investment policy and public investment capital are facing many conflicting opinions due to differences in assessment and analysis results of its impact on various economic variables. In addition, when the government tries to increase public investment they must reduce their investment for the sake of other spending. The relationship between economic growth and public investment has been studied quite widely and there have been many debates. In the world, there are two opposing schools of thought: public investment promotes economic development and vice versa has no or little impact or even has a negative impact on economic growth. Besides, a permanent increase in public investment will cause a temporary effect or the effectiveness of public investment on economic growth depends on increased spending from donor sources. Moreover, many previous studies only conducted largely in developed countries [1-3]. There is a lack of empirical research in ASEAN countries. In this article, using empirical research, we evaluate the impact of public investment on economic growth and the causal relationship between economic growth and public investment. The results of this research will be summarized and serve as a basis for policy suggestions related to public investment of the government in ASEAN countries to make public investment activities more effective contributing to promote the country's socio-economic development.

The article proceeds as follows: part two presents a literature review, part three provides data, methods and research model. The empirical findings are discussed in part four and part five summarizes the conclusions and recommendations.

2. Literature Review

2.1. Theory

The relationship in national product between factor inputs and output growth is explained by the production function. The total product (Y) is effected by investment (K) and labor (L) [4]. The Solow model focuses on four variables: Output (Y), capital (K), labor (L) and knowledge or labor efficiency (A) [5]. Over time the products (capital, labor and knowledge) come from the key assumptions of the Solow model regarding the three inputs and the characteristics of the production function.

Public expenditure is expenditure made by the state and its agencies in the provision of public goods [6]. Public spending is an economic category that is objectively associated with the existence of the state. Through periods of socio-economic development, views on public spending have also changed to a certain extent. In the era of free competitive capitalism, according to classical economists, public spending is the spending of public legal entities. From an economist's point of view, public spending is conceptualized entirely based on the concept of socio-economics which is the power and influence of the state and public agencies for socio-economic fields [7].

Abdullah [8] and Al-Yousif [9] argue that increased public investment in socioeconomic infrastructure will encourage economic growth and increased public investment in health and education will increase labor productivity leading to increase national output. At the same time, public investment in infrastructure such as roads, communications and electricity will reduce production costs and increase company profits, promoting growth [10]. Debt financing for public investment enhances economic growth if an economy is dynamically inefficient and if public capital has a sufficiently large productivity effect [11]. Expanding government spending will contribute positively to economic growth [12, 13] and economic growth plays a significant role in reducing poverty [14]. However, some authors such as Barro [15], Laudau [16], Fölster and Henrekson [17] and Engen and Skinner [18] do not support the view that increased public investment will promote economic growth. Instead, they argue that increasing government public investment can reduce economic efficiency because the government will increase tax revenue or borrow to finance investments.

2.2. Previous Empirical Studies

In the period of 1970 to 1990 with a sample of 95 developing economies both private and public investment are important for economic growth with private investment having a higher impact [19].

Mittnik and Neumann [20] estimated the impact of public investment on economic growth of six industrialized economies including the United States. They concluded that public investment is important for economic growth and reducing spending could harm development.

Ruch and Geyer [14] examined the relationship between public-sector capital investment, economic growth and poverty reduction at a municipal level in South Africa between 2001 and 2011. It is unclear how much this investment has contributed to the improvement in the living conditions and poverty status of households despite tremendous spending in capital investment programmes over the last decade. Panel regression was used to analyse this relationship and the results support the hypothesis that there is a strong and positive relationship between economic growth and poverty reduction.

Kamiguchi and Tamai [11] show that debt financing for public investment enhances economic growth if an economy is dynamically inefficient and if public capital has a sufficiently large productivity effect. Moreover, it reduces economic growth rates in a dynamically efficient economy.

Meka'a et al. [10] evaluated the impact of investing in fundamental public infrastructure on economic growth in Cameroon. The study compares the elasticities of various infrastructure types on growth and private investment. With data from WDI [21] a generalized method of moments is used revealing that the energy sector has the highest contribution. Therefore, the impacts of investments actually allocated do not have the same effects on the growth and behaviour of private investments. Macroeconomic performance in Cameroon is positively influenced by investment in road and telecommunications infrastructure.

3. Methodology

3.1. Research Data

Key indicators for Asia and the Pacific annual data table of the Asian Development Bank (ADB) for six ASEAN countries (Malaysia, Thailand, Indonesia, Vietnam, Cambodia and the Philippines) from 2000 to 2022 because the data of the remaining member countries such as Singapore, Brunei, Timo Leste, Laos and Myanmar are incomplete. They were not included in the survey.

3.2. Research Methods

In this procedure, we use unit root tests to test the stationarity properties of individual time series Phillips and Perron [22]. It is necessary to test and establish the cointegration relationship between non-stationary variables using methods related to cointegration testing to find the long-run impact. We use the proposals of Pedroni [23] and Pedroni [24] the Fisher co-integration test [25] to ensure the reliability of the cointegration nature of the combination of variables.

The error correction model (ECM) considered the impact of the variables public investment, public expenditure and budget revenue from taxes on economic growth, thereby calculating the adjustment speed and adjustment time of the model. This method has advantages over most previous studies on the same topic (estimation of static ordinary least squares (OLS) equations). The vector error correction model (VECM) model includes all dynamic interrelationships over time between variables while estimating single static equations often requires strong assumptions about the model form and causal relationships between variables. Accordingly, the short-term impact is analyzed as well as the adjustment process to a stable long-term relationship. In addition, the time series analysis method also avoids some weaknesses of the pure OLS method such as spurious regression or autocorrelation. The authors use the Granger causality test with fixed effects to analyze unbalanced panel data [26, 27] to comprehensively analyze the relationship between economic growth and public investment. Data analysis and processing were performed using Stata software version 17.

3.3. Research Models

The authors suggest a framework for study after providing an overview of previous studies.

3.3.1. Error Correction Model

- Long-term equilibrium impact

$$lnRGDP_{it} = \alpha_{it} + \alpha_1 lnRGI_{it} + \alpha_2 lnRGC_{it} + \alpha_3 lnRTR_{it} + \varepsilon_{it}$$

With

α_{it} = Coefficient

α_1, α_2, α_3: Regression coefficient (estimated) and original coefficient of variables.

ε_{it} = The residuals are assumed to be normally distributed and independent of $E(\varepsilon_{it}) = 0$ and uniform error variance $E(\varepsilon^2_{it}) = \sigma^2_\varepsilon$, $t = 1,\dots,T$.

i = Table order ($i = 1,\dots,N$)

t = Observation time ($t = 0,\dots,T$)

- Short-term equilibrium impact

$$\Delta lnRGDP_{it} = \alpha_{it} + \alpha_1 \Delta lnRGI_{it} + \alpha_2 \Delta lnRGC_{it} + \alpha_3 \Delta lnRTR_{it} + \beta\varepsilon_{it-1} + v_{it}$$

With

α_{it} = Coefficient

α_1, α_2, α_3: Regression coefficient (estimated) and original coefficient of variables.

β: the model's adjustment speed to adjust the impacts of short-run variables on long-run equilibrium.

ε_{it-1}: First-order lag of residuals in regression of long-run equilibrium effects.

v_{it} = The residuals are assumed to be normally distributed and independent with $E(v_{it}) = 0$ and uniform error variance $E(v^2_{it}) = \sigma^2_v$, $t = 1,\dots,T$.

i = Table order ($i = 1,\dots,N$).

t = Observation time ($t = 0,\dots,T$).

3.3.2. Granger Causality Test

$$lnRGDP_{it} = \alpha_{it} + \alpha_1 lnRGI_{it} + \alpha_2 lnRGC_{it-1} + \alpha_3 lnRTR_{it-2} + \varepsilon_{it}$$

$$lnRGI_{it} = \beta_{it} + \beta_1 lnRGDP_{it} + \beta_2 lnRGDP_{it-1} + \beta_3 lnRGDP_{it-2} + v_{it}$$

α_{it} *và* β_{it} = Coefficient

α_1, α_2, α_3: Regression coefficient (estimated) and original coefficient of variables.

β_1, β_2, β_3: Regression coefficient (estimated) and original coefficient of variables.

ε_{it} *và* v_{it} = The residuals are assumed to be normally distributed, independent with $E(\varepsilon_{it}) = 0; E(v_{it}) = 0$ uniform error variance $E(\varepsilon^2_{it}) = \sigma^2_\varepsilon; E(v^2_{it}) = \sigma^2_v; t = 1,\ldots,T$.

i = Table order ($i = 1,\ldots,N$).

t = Observation time ($t = 0,\ldots,T$).

The main research variables of the model are as follows: Real gross domestic product (RGDP), real government investment (RGI), real government consumption (RGC) and real tax revenue (RTR). The transformation values of variables are performed as follows:

From the annual data set of Key Development Indicators in the Asia Pacific region (ADB), we choose nominal data of Gross domestic product (GDP), public investment, public expenditure and tax revenue. These data in each country are calculated in local currency. We must convert the variables to real values in USD. This means we choose the implicit deflator and the exchange rate between the local currency and USD (exchanger rate). Thus, by multiplying the nominal value by 100 divided by the deflation coefficient and dividing by the exchange rate, we will get the value of real variables in USD. It is worth noting that each country in the table has different base years for calculating real values (implicit deflator = 100). From the real values of the variables RGDP, RGI, RGC, RTR, we take the natural logarithm and multiply by 100. We will get the corresponding variables in the model as lnRGDP, lnRGI, lnRGC and lnRTR. Taking the natural logarithm and multiplying by 100 of the variables so that when considering the partial impact of each independent variable on the dependent variable in the regression model, we get the estimated coefficients as a percentage.

In addition, the topic also analyzes possible heterogeneity between countries through the values of R^2 achieved. According to Wooldridge [28] the applied panel data analysis method can compare the values achieved for R^2 "overall", R^2 "between" and R^2 "within".

R^2 "overall" characterizes the level of explanation of the change in the dependent variable in the entire model.

R^2 "between" characterize the differences between different tables.

units (countries).

R^2 "within" measures the differences in the panels themselves (per country) over the survey period.

Through different values of R^2 "overall", R^2 "between" R^2 "within", the study will show the heterogeneity in the relationship between public investment and economic growth. This is due to the characteristics and circumstances of each country and also shows that ASEAN countries can be divided into 3 separate groups in terms of economic development level: low, medium and high levels.

4. Research Results

4.1. Table Unit Root Eigenvalue Tests

The number of observations for each country in the table is different, so it is not possible to apply unit root eigenvalue tests to the time series for each country. Therefore, the topic uses unbalanced panel unit root eigenvalue tests common to all countries which are considered appropriate in this case. These tests not only increase the power of unit root eigenvalue tests due to the observation period but also minimize the risk of breaking the structure of the data. Among the table unit root eigenvalue tests Levin-Lin-Chu, Harris-Tzaivalis, Breitung, Im-Perasan-Shin, Fisher type test and Hadri, there are only two types of tests: Im-Perasan-Shin and Fisher type test can be applied to unbalanced data tables. Accordingly, the topic applies Fisher's test to the variables in the model.

Table 1.
Fisher stationarity test of Phillips-Perron property without lag 6 trend (Original variable).

Variables	Statistic	Value	p-value	N	T
lnRGDP	Inverse chi-squared (12) p	11.217	0.510	6	22.3
	Inverse normal z	-0.181	0.428		
	Inverse logit t (34) L*	-0.163	0.435		
	Modified inv. chi-squared Pm	-0.159	0.563		
lnRGI	Inverse chi-squared (12) p	18.367	0.105	6	22.3
	Inverse normal z	-0.890	0.186		
	Inverse logit t (34) L*	-0.888	0.190		
	Modified inv. chi-squared Pm	1.299	0.096		
lnRGC	Inverse chi-squared (12) p	7.768	0.803	6	22.3
	Inverse normal z	1.548	0.939		
	Inverse logit t (34) L*	1.754	0.955		
	Modified inv. chi-squared Pm	-0.863	0.806		
lnRTR	Inverse chi-squared (12) p	21.905	0.038	6	22.3
	Inverse normal z	-0.941	0.173		
	Inverse logit t (34) L*	-1.219	0.115		
	Modified inv. chi-squared Pm	2.021	0.021		
Significance at 1%					

Note: L* = lag 6.

Source: Processing results from investigation data.

Table 2.
Fisher stationarity test of Phillips-Perron property with trend, lag 6 (Original variable).

Variables	Statistic	Value	p-value	N	T
lnRGDP	Inverse chi-squared (12) p	1.949	0.999	6	22.3
	Inverse normal z	3.789	0.999		
	Inverse logit t (34) L*	4.097	0.999		
	Modified inv. chi-squared Pm	-2.051	0.979		
lnRGI	Inverse chi-squared (12) p	28.927	0.004	6	22.3
	Inverse normal z	-0.938	0.174		
	Inverse logit t (34) L*	-1.441	0.079		
	Modified inv. chi-squared Pm	3.455	0.000		
lnRGC	Inverse chi-squared (12) p	11.844	0.458	6	22.3
	Inverse normal z	2.285	0.988		
	Inverse logit t(34) L*	2.219	0.983		
	Modified inv. chi-squared Pm	-0.031	0.512		
lnRTR	Inverse chi-squared (12) p	20.903	0.051	6	22.3
	Inverse normal z	0.098	0.539		
	Inverse logit t(34) L*	-0.403	0.344		
	Modified inv. chi-squared Pm	1.817	0.034		
Significance at 1%					

Note: L* = lag 6.
Source: Processing results from investigation data.

Looking at the table of results of testing the stationarity of the variables in the model, we see that at lag 6, the test without trend (see Table 1), the test with time trend (see Table 2) is almost all factors that are non-stationary. But at the initial variance degree also equal to the Fisher test with the Phillips-Perron property, whether there is a trend (see Table 3) or no trend (see Table 4) and the variables in the model all stop at the 1% significance level for both four inspection standards.

Table 3
Fisher stationarity test of Phillips-Perron property without lag 6 trend (Difference variable).

Variables	Statistic	Value	p-value	N	T
lnRGDP	Inverse chi-squared (12) p	83.399	0.000	6	22.3
	Inverse normal z	-7.421	0.000		
	Inverse logit t (34) L*	-9.516	0.000		
	Modified inv. chi-squared Pm	14.574	0.000		
lnRGI	Inverse chi-squared (12) p	161.115	0.000	6	22.3
	Inverse normal z	-10.145	0.000		
	Inverse logit t (34) L*	-18.312	0.000		
	Modified inv. chi-squared Pm	30.438	0.000		
lnRGC	Inverse chi-squared (12) p	63.972	0.000	6	22.3
	Inverse normal z	-6.171	0.000		
	Inverse logit t (34) L*	-7.290	0.000		
	Modified inv. chi-squared Pm	10.608	0.000		
lnRTR	Inverse chi-squared (12) p	149.457	0.000	6	22.3
	Inverse normal z	-10.032	0.000		
	Inverse logit t (34) L*	-17.079	0.000		
	Modified inv. chi-squared Pm	28.058	0.000		
Significance at 1%					

Note: L* = lag 6.
Source: Processing results from investigation data.

Table 4.
Fisher stationarity test of Phillips-Perron property with trend, lag 6 (Difference variable).

Variables	Statistic	Value	p-value	N	T
lnRGDP	Inverse chi-squared (12) p	113.065	0.000	6	22.3
	Inverse normal z	-8.879	0.000		
	Inverse logit t (34) L*	-12.908	0.000		
	Modified inv. chi-squared Pm	20.630	0.000		
lnRGI	Inverse chi-squared (12) p	155.478	0.000	6	22.3
	Inverse normal z	-9.210	0.000		
	Inverse logit t (34) L*	-17.404	0.000		
	Modified inv. chi-squared Pm	29.287	0.000		
lnRGC	Inverse chi-squared (12) p	65.313	0.000	6	22.3
	Inverse normal z	-5.727	0.000		
	Inverse logit t (34) L*	-7.325	0.000		
	Modified inv. chi-squared Pm	10.882	0.000		
lnRTR	Inverse chi-squared (12) p	135.227	0.000	6	22.3
	Inverse normal z	-9.182	0.000		
	Inverse logit t (34) L*	-15.449	0.000		
	Modified inv. chi-squared Pm	25.153	0.000		
Significance at 1%					

Note: L* = lag 6.
Source: Processing results from investigation data.

In this model, using the Fisher test, the Phillips-Perron property has both trend and non-trend for unbalanced panel data. We can get variables with the following characteristics: lnRGDP, lnRGI, lnRGC and lnRTR stop at the difference level, the integration level is I (1), giving us an assertion that in the survey model, the variables have co-integration characteristics. There is a linear combination between the variables so that the quantity that characterizes the additive mixture of the variables is the residual which will have the characteristic of stopping at the level of significance, the order of integration being I (1). Therefore, the most appropriate model for regression of variables is the error correction model (ECM).

Table 5.
Long-run equilibrium model (ECM) regression results with robustness analysis.

Dependent variable	Independent variables	Estimated coefficient	P > |t|	F-test	R^2
lnRGDP	lnRGI	0.056	0.547	F(3.5) = 230.04	Within= 0.952
	lnRGC	0.722	0.001	Prob > F = 0.000	Between = 0.990
	lnRTR	0.064	0.429		Overall = 0.981
	Intercept coefficient	361.595	0.000		
Significance at 5%					

Source: Processing results from investigation data.

4.2. Error Correction Model (ECM)

4.2.1. Regression Equation for Variables in the Long- Run

The long-term equilibrium model regression results with strength analysis in Table 5 give us the following: The simultaneous impact of the three variables lnRGI, lnRGC, lnRTR on the variable lnRGDP is statistically significant through the F test (Wald test) at the 5% level. In addition, from a partial perspective, the impact of lnRGC on lnRGDP is statistically significant at the 5% level. The intercept coefficient which is the starting quantity for each country in the data table is also statistically significant at the 5% level. Moreover, the level of explanation for changes in economic growth variables through the explanatory variables of public investment, public expenditure and tax revenue is quite high as shown by the values R^2 (R^2 “overall” = 0.981; R^2 “between” = 0.990 R^2 “within” = 0.952).

We can calculate the residual, linear combination of all variables from the regression equation that long-term balances the variables. The descriptive statistical value of the residual variable (Res) is as follows:

Table 6.
Descriptive statistics of Res residuals of the long-run equilibrium model (ECM) with robustness analysis.

Variable	Medium		Standard deviation	Min.	Max.	Number of observations
Res	Overall	4.63e-08	39.336	-75.487	297.986	N = 134
	Between	-46.803	27.338	-46.803	26.175	n = 6
	Within	-41.001	30.828	-41.001	282.665	T-bar = 22.33

Source: Processing results from investigation data.

According to Table 6, we see that the residuals have an average value close to zero which shows that the values of the residuals revolve around a fixed value of zero. The findings are shown below using the Phillip-Perron attribute Fisher test, lag equal to 6 and both trend and no trend for the residual variable.

Table 7.
Fisher stationarity test of Phillips-Perron property without trend, lag 6 (Residual variable).

Variable	Statistic	Value	p-value	N	T
Res	Inverse chi-squared (10) p	24.335	0.018	6	22.33
	Inverse normal z	-0.558	0.288		
	Inverse logit t (29) L*	-1.208	0.117		
	Modified inv. chi-squared Pm	2.517	0.005		
Significance at 5%					

Source: Processing results from investigation data.
Note: L* = lag 6.

Table 8.
Fisher stationarity test of Phillips-Perron property with trend, lag 6 (Residual variable).

Variable	Statistic	Value	p-value	N	T
Res	Inverse chi-squared(10) p	56.007	0.000	6	22.33
	Inverse normal z	-4.612	0.000		
	Inverse logit t(29) L*	-6.094	0.000		
	Modified inv. chi-squared Pm	8.982	0.000		
Significance at 1%					

Note: L* = lag 6.
Source: Processing results from investigation data.

We can determine that the residuals are stationary at the 1% significance level for all four criteria based on Tables 7 and 8 which evaluate the residual variable's stationarity in the two situations with and without trend. This indicates that the degree of integration for the variable Res is I(0). Therefore, we can conclude that ECM applied to the analysis of the unbalanced panel data under investigation is appropriate. The next step in the ECM analysis model is to consider how the equation regresses the factors in the short run and calculates the correction rate.

4.2.2. Regression Equation for Variables in the Short Run

The final step in ECM is the determination of the model's correction coefficient. The adjustment coefficient is the combined adjustment speed of short-term variables so that the impact of long-term variables is balanced. Therefore, the project performs unbalanced panel data regression with fixed effects for all difference variables and first-order lag of the residuals; we have the impact equation of the variables in the short- run. The regression results are presented below.

Table 9.
Short-run impact ECM regression results with robustness analysis.

Dependent variable	Independent variables	Estimated coefficient	P > |t|	F-test	R^2
DlnRGDP	DlnRGI	0.110	0.001	F(4,123) = 105.05 Prob > F = 0.000	0.773
	DlnRGC	0.714	0.000		
	DlnRTR	0.015	0.302		
	Lres	0.446	0.046		
	Shear coefficient	-0.018	0.982		
Calibrated speed β = 0.4464 = 44.64%/year Significance at 5%.					

Source: Processing results from investigation data.

The simultaneous effect of four explanatory variables DlnRGI, DlnRGC, DlnRTR and Lres on the dependent variable DlnRGDP is significant at 5% as shown by F statistical value (Wald test) and p-value = 0.000. The partial impact of the two variables DlnRGI and DlnRGC is statistically significant at 1%. The adjustment coefficient (estimated coefficient of the variable LRes) is statistically significant at 5%. Accordingly, the model's adjustment speed is $\beta = 0.446 = 44.6\%$/year. With this value, the time needed for the model to reach long-term equilibrium is $\eta = 100/44.6 = 2.24$ years.

In a nutshell, the ECM applied to the project's model gives the following results: All explanatory variables in the model (lnRGI, lnRGC and lnRTR) have a positive effect on economic growth (lnRGDP variable) in which estimated coefficients of lnRGI and lnRGC are statistically significant at level 1%. The level of explanation of explanatory variables for economic growth is quite high R2 "overall" = 0.981 (see Table 5). The speed and adjustment time of the model are $\beta = 0.446 = 44.6\%$/year and $\eta = 100/44.64 = 2.24$ years respectively (see Table 9).

Thus, public spending, public investment and budget revenue contribute to the development of the economies of ASEAN countries. This study supports the findings of Ramirez and Nazmi [1], Bukhari, et al. [3], Kamiguchi and Tamai

[11], Glass [13], Ruch and Geyer [14], Khan and Kumar [19], Mittnik and Neumann [20], Haque [29], Sahoo, et al. [30] and Mallick [31] concerning the contribution of public investment to economic development. It differs from Phetsavong and Ichihashi [32] regarding the role of private investment in fostering economic development. It is also different from the research results of Kumo [33].

With a 1% increase in public spending, the economic growth rate is 0.72%. However, the level shown in public investment and budget revenue is quite low specifically with an increase of 1% in public investment and budget revenue; economic growth only reaches 0.56% and 0.64% (see Table 5). This clearly shows the economic characteristics of ASEAN countries. Like other developing countries, public investment is not highly effective. In ASEAN countries, public investment is often spread out not strategic, project implementation time is long and project acceptance assessment often shows quite poor quality. This shows that the amount of capital invested is quite large but the benefits are not as expected, so the payback period is long making the profit level very low. Most of the private sectors in the remaining three countries, Indonesia, Vietnam and Cambodia are not strong making the public sector the dominant force in the economy except for Malaysia, Thailand and the Philippines. The role of the public sector in these countries is clearly shown. The government increases investment and contributes to economic development quite significantly. This is also consistent with the Keynes model of economics emphasizes that the government must accept "sacrifice" and increase public spending and investment to promote economic growth and contribute to solving unemployment.

4.3. Testing the Granger Causality Relationship between Public Investment and Economic Growth

The authors tested the Granger causality relationship between the two variables lnRGDP and lnRGI using a constraint model with strength analysis to consider the interaction between economic growth and public investment.

Table 10.
Regression results for the constrained model with strength analysis for Granger causality.

Dependent variables	Independent variables	Estimated coefficient	F-tests	R^2
lnRGDP	lnRGI	0.818	F (1, 5) = 52.05 Prob > F = 0.000	Within = 0.715 Between = 0.898 Overall = 0.856
lnRGI	lnRGDP	0.874	F (1, 5) = 69.34 Prob > F = 0.000	Within = 0.715 Between = 0.898 Overall = 0.856
Significance at 5%				

Source: Processing results from investigation data.

Table 10 presents a two-way relationship between public investment and economic growth. The regression results for the constrained model with strength analysis by adjusting for error variance show that the values of the F test (Wald test) are quite large and significant statistics at 5%. The partial impact of the public investment variable on the economic growth variable and the economic growth variable on the public investment variable are statistically significant at 5%. This confirms that there is a positive two-way relationship.

5. Conclusion and Policy Implications

5.1. Conclusion

The project applied the error correction model (ECM) to analyze the impact of public investment, public expenditure and tax revenue variables on short-term and long-term economic growth. Moreover, the topic also confirms the Granger cause-and-effect relationship between public investment and economic growth. The approach of the project is to apply unbalanced panel data for six ASEAN countries (2000 - 2022).

The Gragner model shows that the relationship between public investment and economic growth is positive and statistically significant while in the ECM model, the adjustment speed is 44.6% per year and the time to the unbalanced effects of variables in the short run reaches equilibrium in the long run at about 2.2 years. The contribution of the public expenditure variable to economic growth is the highest followed by budget revenue from taxes and finally the public investment variable. Although it also has a positive impact on economic growth, government investment contributes quite little to economic development in ASEAN countries. The low contribution of government investment is because in ASEAN countries, like other developing countries public investment projects often have low efficiency, large investment capital, the payback period is long and the majority of people are not satisfied. In addition, using unbalanced panel data analysis techniques, the project discovered heterogeneity in most of the six ASEAN countries surveyed. Countries not only face initial conditions due to different socioeconomic characteristics but also different relationships between public investment, public spending, public budget revenue and economic growth. The results of data analysis and processing show significance in terms of public policy for 6 ASEAN countries through the error correction model and testing the Granger cause-and-effect relationship. An increase in public investment has the effect of promoting economic growth and vice versa. Overall, our results are consistent with the views of Abdullah [8], Al-Yousif [9] and Cooray [12] previous studies. However, public investment is quite low compared to the contribution of public spending and budget revenue from taxes to economic growth. This can be explained by the relatively low investment efficiency of public projects in ASEAN countries.

5.2. Policy Implications

First, promoting economic growth in ASEAN countries through increased public investment requires careful calculation by governments when promulgating policies during the current crisis period.

Second, there needs to be a strategic long-term investment plan to minimize the uncertainty of public investment, making public investment stable and an important factor promoting economic growth.

Third, restructure public investment in the direction of gradually reducing the proportion of public investment in total social investment capital while strongly enhancing the efficiency and quality of public investment.

Fourth, strictly manage the mobilization and improve the efficiency of capital use in public investment (including state budget capital, government bond capital, state investment credit capital and capital of state-owned enterprises).

Fifth, review and improve the legal system on public investment, minimizing overlap and inconsistency between laws related to public investment and clarifying the responsibilities and authority of relevant agencies. Continue administrative reform in a substantive way to invite and attract FDI capital and diversify capital sources to promote economic development.

Sixth, create more motivation for the private economic sector to develop not only giving priority to foreign invested enterprises or state-owned enterprises because domestic private investment is the country's internal strength and plays an important role in stimulating and maintaining economic growth.

Seventh, promulgate solutions to develop high-quality human resources in attracting, managing and using investment capital to bring economic efficiency.

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