Spatial Impact of Public Investment on Province's Economic Growth in Vietnam

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ABSTRACT

This study considers the spatial impact of public investment on provinces' economic growth in Vietnam using a spatial econometric model with province-level data. The context of the Vietnamese economy shows that it has reached a lot of success in the period 2010-2020 with an essential role in public investment. The empirical results show that there is a positive impact of public investment on economic growth and there exists a spillover effect of public investment from one province to the economic growth of another province. Besides, the estimated results also indicate that private investment, foreign direct investment, and the province's policies have a positive impact on economic growth

Keywords: Growth, provinces of Vietnam, public investment, spatial econometric model.

1. INTRODUCTION

Many opinions exist about the returns of public investment for the economic development regions. Accordingly, the first point of view is that people tend to consider public investment as a driving force for economic growth and as the source of economic development (Solow, 1956; Barro, 1990). Aschauer (1989a, 1989b) has suggested that there is a difference between the sources of physical capital and so, public infrastructure is the basic factor that explains the differences in production levels and development by territory. In addition, Aschauer (1989a, 1989b) emphasizes that good public infrastructure contributes significantly to productivity growth in the private sector and economic growth. This view has been supported by many studies (Munnell 1990a, 1990b; Berndt and Hansson 1992; Nadiri and Mamuneas 1994). The second view argues that the positive effect of public investment on output is unclear and indicates that the impact of public infrastructure investment is negative or insignificant. (Sturm and de Haan 1995; Pereira and Sagalés 2003). The debate between the two views suggests that other factors such as data sources, estimation methods, geographical features, and especially the spillover effects on the benefits of public investment can cause these different results from the previous researchers.

In recent years, in spillover effect of public investment has been considered in terms of geographic, or spatial impact, which has partly reduced the errors in assessing the impact of public investment on economic growth. In general, studies with spatial impacts tend to emphasize that public investment plays a role in the geographical distribution of economic activities and spillover effects between geographic regions (Kamps 2005; Välilä et al. 2005; Rodríguez-Pose and Crescenzi 2008; Kemmerling and Stephan 2008; Ottaviano 2008). Välilä et al. (2005) and the European Commission

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N. D. Nguyen and P. T. T. Hong (eds.), *Proceedings of the 11th International Conference on Emerging Challenges: Smart Business and Digital Economy 2023 (ICECH 2023)*, Advances in Economics, Business and Management Research 274,
https://doi.org/10.2991/978-94-6463-348-1_8

(2007) shows that public investment in the European Union (EU) plays an indispensable role as a determinant of output across Europe. Similarly, some studies analyzing the impact of investments by the European Restructuring Fund have found a positive relationship in terms of linkages between countries/regions with different levels of impact (Cappelen et al. 2003; Rodríguez-Pose and Fratesi 2004; Puigcerver-Peñalver 2007).

Peracchi and Meliciani (2001) confirmed a strong correlation in economic growth between neighboring localities and neighboring countries. Anderson and Van Wincoop (2001) also argue that localities within the same country are often closely linked because they follow key government policies, and neighboring localities are often more favorable when carrying out commercial transactions with geographically distant provinces. Dall'erba and Le Gallo (2008) show that with funds being allocated at the regional level, it seems more relevant to focus on their impact at the same level of spatial desegregation.

This study focuses on analyzing the impact of public investment on provinces' economic growth in Vietnam using a spatial econometric model with province-level data in the period 2010-2020. The contribution of this research spatial correlation between public investment and economic growth is positive. Moreover, the research uses different matrices to robustness check for the model. The test results show that there is not much difference in the estimated coefficients in the model when using different spatial matrices.

In addition to the introduction, this study is presented in three sections. Section 1 is a brief description of the context of economic growth and public investment in Vietnam's provinces. Section 2 explains the model and data sources. Section 3 presents the estimation results and discussion. Section 4 provides conclusions and policy implications to promote economic growth in Vietnam's provinces.

2. CONTEXT OF ECONOMIC GROWTH AND PUBLIC INVESTMENT

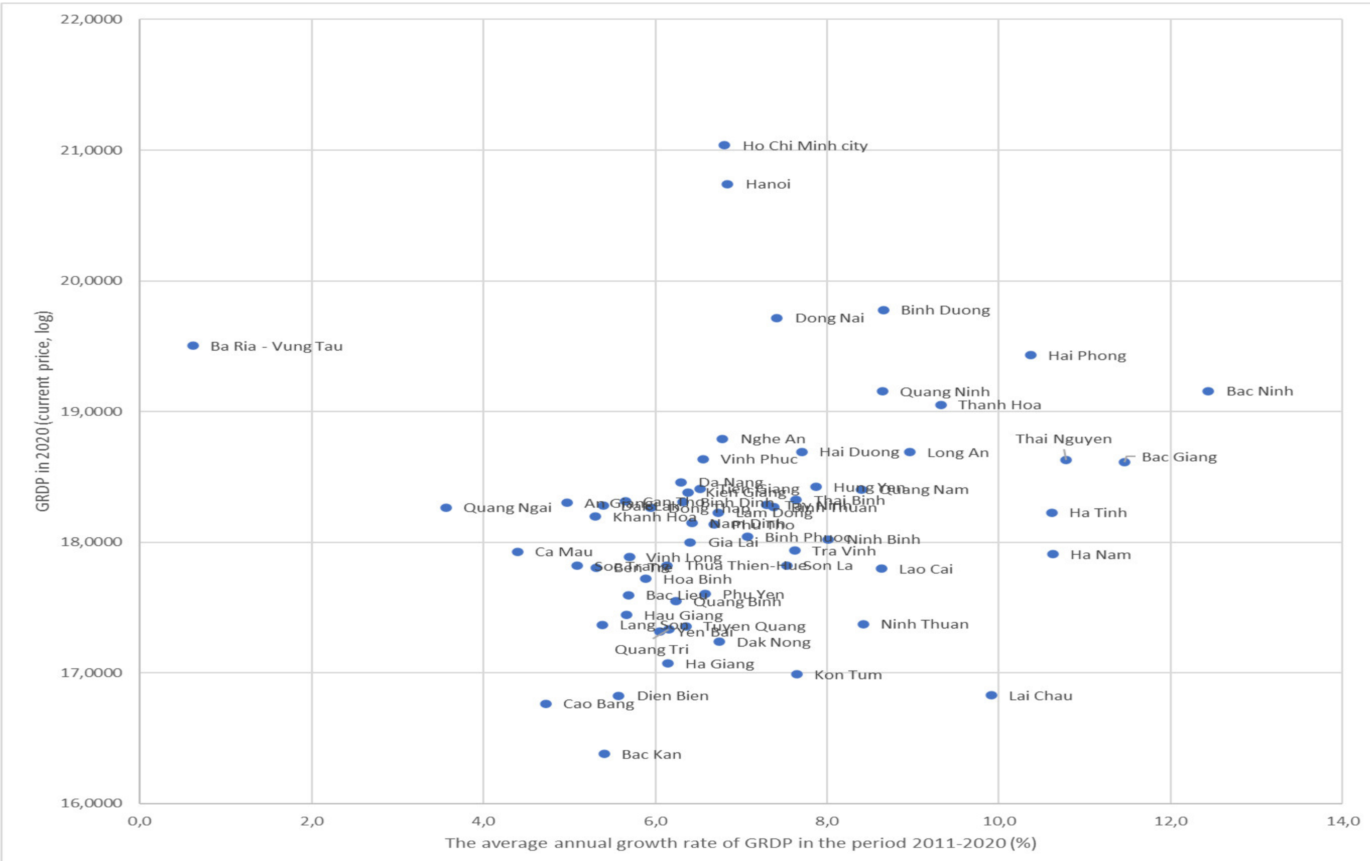
2.1. Context of Economic Growth

In the period 2011-2020, the Vietnamese economy saw a remarkable recovery after being negatively affected by the financial crisis and the world economic recession in 2008-2009. The economic scale of Vietnam by 2020 reached VND (Vietnamese Dong) 6,293.1 trillion, and the Gross Domestic Product (GDP) per capita reached VND 64.4 million/person. The average economic growth of the whole period 2011-2020 reached 6%/year, lower than the planned target of 6.5-7%, but these are still positive results in the context of the world economy facing many difficulties and being affected by the epidemic.

Some provinces maintained high growth rates from 2011 to 2020 such as Thai Nguyen, Bac Ninh, Hai Phong, and Bac Giang ... in part due to the large concentration of industrial parks. Although big cities such as Hanoi and Ho Chi Minh City have a very large-scale economic base compared to the rest of the provinces, the growth rate is only average. In addition, some provinces with low economic scale have a relatively slow rate, mainly seen in the provinces of the Northwest Northern Mountainous region such as Bac Kan, Cao Bang, Dien Bien, Ha Giang, and Lang Son all have growth rates below the national average of 6% / year.

Unequal economic growth across regions leads to many inadequacies. The uneven concentration of export processing zones can pose challenges for enterprises in terms of labor recruitment, logistics, and supply; at the same time led to an unexpected increase in immigration in some provinces and localities, creating a great challenge for local authorities to provide basic public services to immigrants. This indirectly puts pressure on public investment policy.

Figure 1. Province's average economic growth rate in the period 2011-2020



Source: Calculation from Vietnam Statistical Yearbook of provinces/cities

2.2. Public Investment Policies

*** Before the year 2003**

Before the year 2003, Vietnam did not have a specific law on public investment management. The adjustment of public investment activities was mainly carried out by sub-law documents, the highest being the Government's Decree, including Decree No. 43/1999/ND-CP of the Government dated June 29, 1999, on the State's development investment credit; Decree No. 52/1999/ND-CP of the Government dated July 8, 1999, promulgating regulations on investment and construction management; and Decree No. 12/2000/ND-CP of the Government dated May 5, 2000 on amendments and supplements to several articles of the Regulation on investment and construction management promulgated together with the Government's Decree No. 52/1999/ND-CP of July 8, 1999.

*** From year 2003 to 2014**

During this period, Vietnam still did not have a law on public investment. The adjustment of public investment activities is mainly carried out through several laws such as the Law on Construction, the Law on Budget, the Law on Bidding, and sub-law documents including Decree 16/2005/ND-CP of the Government. Government dated February 7, 2005, on Management of construction investment projects; Decree 112/2006/ND-CP on amendments and supplements to several articles of Decree 16/2005/ND-CP on Management of construction investment projects; Decree No. 12/2009/ND-CP dated February 12, 2009, of the Government on Construction Investment Project Management (replacing Decree No. 16/2005/ND-CP dated February 7, 2005, of Government on construction investment project management, Decree No. 112/2006/ND-CP dated September 29, 2006, of the Government amending and supplementing some articles of Decree No. 16/2005/ Decree-CP on the management of construction investment projects); and the Government's Decree No. 83/2009/ND-CP dated October 15, 2009, amending and supplementing several articles of the Government's Decree No. 12/2009/ND-CP on Investment Project Management construct. Decree No. 12/2000/ND-CP amending and supplementing some articles of the regulations on investment management and construction promulgated together with the Government's Decree No. 52/1999/ND-CP of July 8, 1999.

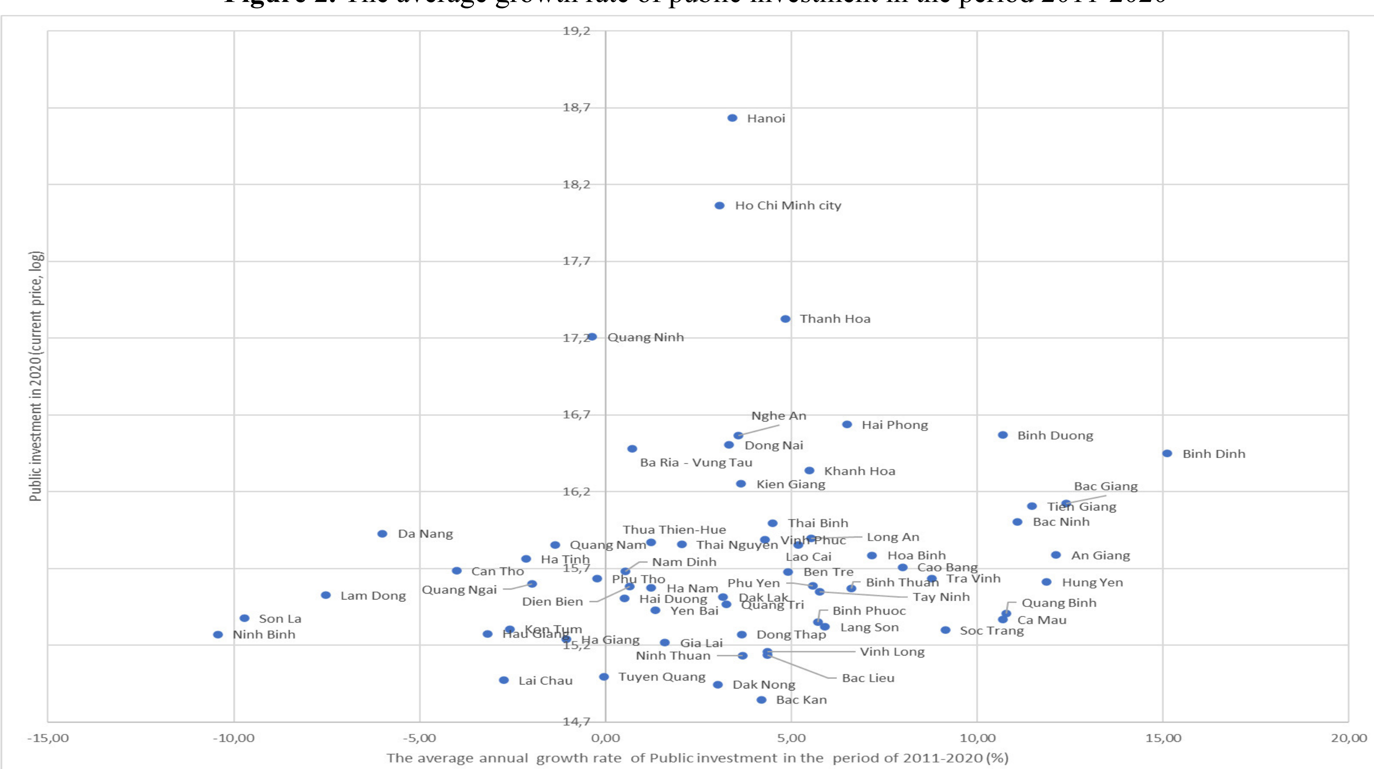
*** From the year 2014 to the present**

From year 2014 to now, Vietnam has made significant progress in public investment implementation and management. Law on Public Investment in 2014 takes effect to implement regulations on the management and use of public investment capital and state management of public investment. The National Assembly approved the law on Public Investment in 2019 on June 13, 2019. The President signed the Order announced on June 27, 2019. The law takes effect on January 1, 2020. The Public Investment Law 2019 has many innovative contents compared to the Law on Public Investment 2014 which was revised in 2018, to complete the legal basis system and improve the efficiency of public investment activities for public investment. with institutions and units.

2.3. Context of Public Investment

Total social development investment capital reached VND 2.16 trillion in 2020 and achieved an average growth rate of 6.5% per year in the 2011-2020 period. 33.68% was capital from the State economic sector, reaching VND 728.9 trillion. The proportion of investment in the state economic sector has decreased from 38.1% in 2010 to 31.1% in 2019. In the investment structure of the state economic sector, investment from the state budget and loans account for the main proportion, according to Vietnamese law, this is the source of public investment. By 2020, this investment reached VND 631.26 trillion, accounting for 86.6% of the total state capital, of which 64% is mainly from the state budget and 22.6% is the loan capital.

Figure 2. The average growth rate of public investment in the period 2011-2020



Source: Calculation from Statistical Yearbook of provinces/cities

Investment in the state economic sector grows relatively slowly compared to other sectors. In the 2011-2020 period, the growth rate of investment's state economic sector was only 5.1 %/year, lower than the average rate of 6.5 %/year of the total investment of Vietnam. In the period 2011-2020, the average growth rate of public investment from the state budget reached 8.89%/year, much higher than the average growth rate of investment in the state economic sector of 5.11%/year. Meanwhile, loan capital grew by 0.21% and the capital of state-owned enterprises only increased by 1.79 %/year.

Public investment is concentrated mainly in big cities such as Hanoi; Ho Chi Minh City; Quang Ninh; and Hai Phong... Hanoi accounted for 34.2% in 2020, an increase of 15.68 percentage points compared to 2010. Followed by Ho Chi Minh City, public investment capital Using 19.4% of the country's total public investment, an increase of 9.28 percentage points compared to 2010. It is noteworthy that some other cities are experiencing rapid public investment growth in recent years such as Thanh Hoa, accounting for 9.27%, which increased by 5.34 percentage points compared to 2010.

3. RESEARCH METHODOLOGY

3.1. Model

Suppose the Cobb-Douglass production function for a province has the following form:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} \tag{1}$$

In which,

t is the time of year t and i is province i;

Y – output

K – capital stock

L – labor

Because K capital is formed from public investment (Ig), private investment (Ip), and FDI (foreign direct investment). Equation (1) can be written as:

$$Y_{it} = A_{it} Ig_{it}^{\alpha_1} Ip_{it}^{\alpha_2} fdi_{it}^{\alpha_3} L_{it}^{\beta} \tag{2}$$

Taking the Loga on both sides of equation (2) and replacing the capital K with the components, the research gets the estimated model as follows:

$$lnY_{it} = A_{it} + \alpha_1 lnIg_{it} + \alpha_2 lnIp_{it} + \alpha_3 lnfdi_{it} + \beta lnL_{it} + u_{it} \tag{3}$$

The characteristics of provincial policies can affect the output of the province. The research team is considering adding the Provincial Competitiveness Index (PCI) which affects the province's output. Therefore, model (3) is rewritten as follows:

$$lnY_{it} = A_{it} + \alpha_1 lnIg_{it} + \alpha_2 lnIp_{it} + \alpha_3 lnfdi_{it} + \beta lnL_{it} + \gamma lnPCI_{it} + u_{it} \tag{4}$$

To simple, model (4) can be written as follows:

$$Y_{it} = c + \beta X_{it} + u_{it} \tag{5}$$

In which, X is a set of independent variables of the model (5) including Ig, Ip, FDI, L, and PCI.

Considering the spatial impact in the model (5), it gets:

the $Y_{it} = a + \rho \sum_{j=1}^{n} w_{ij}\, y_{it} + \sum_{j=1}^{n} X_{ij}\, \beta_k + \sum_{k=1}^{K} \sum_{j=1}^{n} w_{ij}\, X_{ijt} \theta_k + \tau_i + \xi_t + v_{it}$ (6)

$v_{it} = \lambda \sum_{j=1}^{n} m_{ij}\, v_k + \varepsilon_{it}$ (6')

$\varepsilon \sim (0, \sigma^2 I)$

i=1,2,…, n; t=1,2,…,T

In which,

Y and X are denoted above.

w is the spatial weight matrix.

a is constant.

The parameters ρ, β and θ are the coefficients that represent the impact of the independent variables on the dependent variable, respectively.

The form of spatial econometric models:

From models (6) and (6') it performs tests to obtain a suitable spatial econometric model based on the following criteria

If $the\ \theta = 0$ model is the Spatial Autoregressive Model with Autoregressive disturbances (SAC).

If $the\ \lambda = 0$ model is the Spatial Durbin Model (SDM).

If$\theta = 0$ and $\lambda = 0$ model is the Spatial Autoregressive Regressive (SAR).

If$\rho = 0$ and $\theta = 0$ model is the Spatial Error Model (SEM).

If$\rho = 0$ and $\theta = 0$ and $\tau_i = \psi \sum_{j=1}^{n} w_{ij}\, \tau_i + \zeta_i$ model is Generalized Spatial Panel Random Effects Model (GSPRE).

Building weight matrix

The most common tool to measure the spatial correlation between objects is Moran's I index according to Moran's (1950) test. In Vietnam, there are 63 provinces/cities with the characteristics of stretching and therefore, the topic is selected as a spatial unit with the administrative unit at the provincial headquarters being the geographical location. In this paper, the first-order contiguous matrix with a contiguous scale will be used for calculations in this model. This is a common form of spatial matrix applied by many studies. Accordingly, assuming province ith is adjacent to two other provinces, the value in the matrix calculated on average for each province is ½.

Spatial dependence and spatial lag testing

To test for the existence of spatial lag dependence and spatial lag independence in the panel model, the research is using the null hypothesis $H_0 : \rho = 0$ (no existence of spatial dependence) and $H_0 : \theta = 0$ (no existence of spatial lag). Accordingly, the Lagrange multiplier method (LM) is used to test the model estimation for the null hypothesis to avoid complicated problems related to the maximum likelihood (ML) estimate. In which the tests for the spatial effect and the error component of the model are based on the studies of Anselin (1988); and Baltagi et al (2003, 2006, 2007).

3.2. Data Resources

The research uses Gross Regional Domestic Product (GDP) as a proxy for output and it is collected in the Statistical Yearbook in GSO and the Statistics Office in Vietnam's provinces. Similarly, the research also collects capital (such as Public investment, Private investment, and Foreign Direct Investment) and labor data from the above source.

The research collects PCI data from the Vietnam Chamber of Commerce and Industry (VCCI).

Table 1. Descriptive statistics

Variable	Obs	Average	Standard deviation	Min. value	Max. value
Gross Regional Domestic Product at constant price 2010	693	59328	109500	4711	762830
Public investment	693	7749	13229	1626	83159
Private investment	693	9190	13475	1706	94163
Foreign Direct Investment	693	5499	10057	0	51534
Provincial Competitiveness Index - PCI	693	67	2	62	75
Labor	693	946	759	250	4747

Source: Authors' calculations

4. RESULT

4.1. Testing Models

**** Hausman test for SDM model***

Firstly, the research estimates the SDM model with fixed and random effects. Secondly, the research uses the Hausman test for these models. The test result shows that Prob>chi2=0.0001, the research rejects the null hypothesis as a spatial Durbin model with random effect. So, Durbin's spatial economic model with fixed effect is chosen in this case.

Ho: difference in coefficients not systematic chi2(3) = 22.13 Prob>=chi2 = 0.0001

Source: Authors' calculations

**** Test for the spatial lag of the independent variable***

The result shows that chi2(1) = 35,12 and Prob>chi2=0.0000<0.05, so it can be rejected null – hypothesis Ho: model does not have a lag of independent variable. Therefore, the model has a spatial lag of the dependent variable.

(1) [Wx]FDI = -[Spatial]rho[Main]FDI* *chi2(1) = 35.12* *Prob > chi2 = 0.0000*

Source: Authors calculations

**** Test for SAR model or SDM model***

The result indicated that chi2(2) =16,96 and Prob > chi2=0.0000<0.01, it can be rejected null-hypothesis Ho: model is SAR model. So, SDM is the chosen model in this case.

(1) [Wx]i_gdp - [Wx]FDI = 0 *(2) [Wx]i_gdp = 0*

chi2(2) = 15.96
Prob > chi2 = 0.0000

Source: Authors' calculations

**** Test for SEM model or SDM model***

The result indicated that chi2(10) =43,51 and Prob>chi2=0.0000<0.01, it can be rejected null-hypothesis Ho: model is SEM model. So, SDM is the chosen model in this case.

(1) [Wx]i_gdp = -[Spatial]rho[Main]i_gdp*
(2) [Wx]FDI = -[Spatial]rho[Main]FDI*
chi2(2) = 43.51
Prob > chi2 = 0.0000

Source: Authors' calculations

**** Test for SAC model, GSPRE model, and SDM model***

To test the appropriate model selection among SAC, GSPRE, and SDM models, the research relies on the statistics of BIC and AIC (Belotti et al., 2016). Accordingly, if any model has smaller BIC and AIC values, it will be the chosen model. [see Akaike, 1974; Stone, 1979; Raftery, 1995; Sakamoto et al., 1986; and Schwarz, 1978].

The result shows that the SDM model is a model that has the smallest value of AIC and BIC. So, SDM is the chosen model in this case.

SDM Model		**SAC Model**		**GSPRE Model**	
AIC	**BIC**	**AIC**	**BIC**	**AIC**	**BIC**
-18.015	-15.21	-56.775	-54.87	-58.71	-72.855

Source: Authors' calculations

4.2. Estimated Result

In this section, the team uses the Quasi-Maximum likelihood econometric model to assess the impact of public investment on economic growth.

Table 2. Estimation results of SDM spatial econometric model

VARIABLES	**SDM - FE**
Public investment	0.073***
	(0.00)
Non-State-invested sector	0.581***
	(0.11)
Foreign-invested sector	0.012*
	(0.00)
Labor	0.324***
	(0.01)
PCI	0.131*
	(0.09)
Rho	0.193**
	(0.11)
lgt_theta	-2.32***

	(0.31)
sigma2_e	0.00***
	(0.00)
Constant	2.34***
	(0.71)
Observations	693
R-squared	0.85
Number of mun	63

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Authors' calculations

Table 2 result above shows that the estimated SDM model with fixed effects and does not have the effect of LeSage and Pace (2009). The coefficient of public investment is positive and significant, so public investment has a positive impact on the province's economic growth. Besides, the coefficient of PCI is also positive and significant, meaning that provinces' policies can promote more provincial economic growth in Vietnam. Specifically, the model results may be given when other factors remain unchanged, an increase of 1% in public investment, private investment, FDI, PCI, and labor can increase the GRDP of countries. provinces are 0.073%, 0.581%, 0.012%, 0.131% and 0.324% respectively.

Considering the spatial coefficient Rho = 0.2 is positive and statistically significant, it shows that when considering the spatial impact between provinces, it shows a positive spillover from economic growth from one province to another. However, the coefficient lgt_theta = -2.32 is negative and statistically significant, showing some factors affecting growth (here, including public investment, private investment, FDI, labor, and PCI) across provinces showed a negative effect indicating that an increase in inputs for one province may decrease outputs for another province. This is true when input resources are limited, and it is necessary to have policy solutions to balance and optimize the input resources of the provinces to achieve the highest growth.

4.3. Direct, Indirect, and Total Spillover Effects

In the econometric model, it is permissible to consider the complex structure of the variable that depends on the explanatory variables, and the change of the explanatory variable can affect itself, directly to other variables or also indirectly to other variables. Therefore, in the spatial econometric model, there will exist direct, indirect, and total influences between variables. LeSage and Pace (2009) show that direct effects exist in spatial econometric model regression, and they are used to measure the average changing of independent variables on dependent variables. Accordingly, the mechanism of direct marginal effect is expressed through the effects from the diagonal elements of the spatial matrix and its neighbors. Meanwhile, the indirect marginal effect measures the effect of the non-diagonal elements of these matrices. Total effects are combined the direct effects and indirect effects. The decomposition results of spillover effects for the SDM model are as follows:

Table 3. Direct, indirect, and total spillover effect

LR_Direct	
Public investment	0.0612***
Non–state investment	0.4913***
FDI	0.0245***
Labor	0.3149***
PCI	0.1231***
LR_Indirect	

Public Investment	0.0231***
Private Investment	0.2124***
FDI	-0.0119***
Labor	0.2814***
PCI	0.5144
LR_Total	
Public Investment	0.0783***
Private Investment	0.5876***
FDI	0.0103***
Labor	0.3821***
PCI	0.1214***

*** *p<0.01*

Source: Authors' calculations

The table above presents the direct, indirect, and overall spillover effects of the spatial econometric model assessing the impact of public investment on economic growth in Vietnam's provinces. The estimation results show that the coefficients of public investment in the direct, indirect, and total spillover effects are positive and statistically significant. This implies that public investment not only positively affects the economic growth of this province, but also positively affects the economic growth of other provinces.

4.4. Robustness Check

The research uses different matrices to robustness check for the model. Which, the spatial matrices are built specifically as follows:

- MW1 is a first-order contiguous matrix with a contiguous scale that is defined above.

- First-order contiguous matrix (MW2): This is a simple matrix with only values of 0 and 1. In which, 1 is contiguous to neighboring provinces and 0 is non-contiguous.

- Marginal contiguous matrix (MW3): This matrix is built based on the contiguous boundary distances between provinces. The value in the matrix is the contiguous value (in km or miles) of two contiguous provinces and vice versa is 0.

- Distance matrix to three central provinces (MW4): This matrix is built based on three central provinces: Hanoi, Da Nang, and Ho Chi Minh City. The value in the matrix is measured by calculating the distance from the provinces to the central province. In which, the distance is taken as the smallest value of a province to one of the three central provinces above.

- Coordinate space matrix (MW5): This matrix is built based on the coordinates of a province according to Google Maps including Longitude and Latitude.

Table 4. Results of Robustness check

Index	**MW1**	**MW2**	**MW3**	**MW4**	**MW5**
Public investment	0.0731	0.07439	0.07522	0.07811	0.07357
Non–state investment	0.5814	0.57110	0.57803	0.58477	0.57325
FDI	0.0122	0.01362	0.01528	0.01812	0.01481
Labor	0.3241	0.32635	0.33110	0.33163	0.32740
PCI	0.1313	0.12610	0.12600	0.13240	0.11350

Spatial					
Rho	0.1930	0.19332	0.19682	0.21907	0.19364
Variance					
sigma2_e	0.0034	0.0035	0.0038	0.0040	0.0039

Source: Authors' calculations

The table above presents the results of estimating the SDM spatial econometric model for the 05 spatial matrices mentioned above to verify the stability of the model. The results showed that there appeared to be no difference between the estimation results of the matrices. Accordingly, the choice of matrix does not seem to affect the study results, but not by much. For example, the variation of rho is only from 0.19 to 0.22, and sigma2_e is only from 0.0034 to 0.004 between models. Besides, the sign of the variables and the degree of statistical significance of the variables do not change. Therefore, the results of the model are solid and can be used to analyze the impact of FDI on economic growth.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The results of the current situation analysis show that public investment and economic growth have improved in the period 2010-2020, especially since the economy affected by the COVID-19 pandemic has hurt the economy in 2020. However, the results of economic development in the past period show that economic growth has improved significantly, and the role of public investment is relatively important in the process of economic development in Vietnam's provinces. Empirically, the modeling results show that the spatial impact of public investment on economic growth is positive. Besides, the spillover effects of public investment not only have a positive impact on the economic growth of these provinces but also have a positive impact on the economic growth of other provinces.

In terms of limitations, due to the characteristics of Vietnam's data, especially national public investment programs, the project has only synthesized public investment data in provinces. Besides, the limitation of the spatial econometric model is about the relativity of the spatial matrix, and it is difficult to determine the right model. In addition, modeling channels for spreading public investment from one province to another is relatively difficult due to the complexity of quantifying variables and the inability to describe these diffusion channels. For example, public investment programs and projects such as highways that can run through many provinces in Vietnam, the benefits of this public investment in the provinces, and the ability to transport goods in the provinces thanks to this road are difficult to calculate.

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