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SPATIAL SPILLOVER EFFECTS OF TRANSPORT INFRASTRUCTURE ON ECONOMIC GROWTH OF VIETNAM REGIONS: A SPATIAL REGRESSION APPROACH

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Abstract

This article examines the spatial spillover effects of transport infrastructure in regions of Vietnam. We apply the spatial Durbin model to estimate the regional spillover of transport infrastructure to Vietnam's economic growth from 2000-2019. The results show that positive evidence exists in each period due to the connective nature of the transport infrastructure at the national level. At the regional level, transport infrastructure spillover effects vary considerably over time among four macro-regions of Vietnam: the southern region always has a positive spillover effect; the Northern region had adverse spillover effects in the period 2000-2009 and positive in the period 2010-2019; the Central region had negative spillovers in both periods; in the case of the economic region of the Mekong Delta, negative spillovers can be observed after 2010. The analysis has shown that changes in spillover among regions are closely related to the shift of production factors in Vietnam over the past two decades.

Key words: *Spillover, Transport infrastructure, Economic growth, econometrics, Vietnam*.

JEL Classification: *C22, H54, N1, 033*.

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1. Introduction

In developing countries, there are often stages of spatial transformation through the development of transport infrastructure. Good transport infrastructure will reshape geographic connectivity, reduce transport costs, open up trade flows between countries, positively affect commodity prices and increase export competitiveness (Ramajo et al., 2008; Cohen, 2010; Saima & Inayat, 2018). The benefits of transport infrastructure are not limited to specific areas but can also have positive spillover effects on neighboring regions (Chen & Haynes, 2015b).

Many studies on the impact of the development of transport infrastructure on regional economic growth have been carried out over the past decades, mainly to examine the economic returns of investments in transport to determine those which are reasonable. The pioneering work of Aschauer et al. (1989) has inspired a series of follow-up studies. However, Aschauer et al., (1989) did not find evidence of the contribution of transport infrastructure to economic growth. Subsequent research indicates a negative association between transport infrastructure and economic growth (Holtz-Eakin & Schwartz, 1995b, 1996; Moreno & Lopez-Bazo, 2007). Other efforts show positive spillovers from transport infrastructure to economic growth (Pereira & Roca-Sagalés, 2003; Cohen, 2010). Two reasons sum up the difference between the above conclusions: firstly, the difference in the definition of public

capital in investment in transport infrastructure (Yu et al., 2013; Saima & Inayat, 2018). The remaining problem is due to studies that ignore the cross-region spillover effect to linearize the parameters (Mikelbank & Jackson, 2000; Saima & Inayat, 2018).

For Vietnam, most of the studies are published at domestic conferences, so they usually only focus on considering the low returns of investment in transport to find a reasonable investment method. Very few publications mention the spatial advantage of transport infrastructure (Tran, 2009; Truong et al., 2019; Phi et al., 2019). There are no studies to estimate spillover effects at the local level, and this is very useful for community decision-making regarding the planning of major transport projects. Accordingly, the study is structured as follows. The following section briefly describes the regional distribution of transport infrastructure in Vietnam. Section 3 introduces the methodology and database to quantify spatial spillovers of transport investment. Section 4 provides an in-depth analysis of the spatial spillover effects of transport infrastructure in key economic regions. The paper ends with conclusions and policy implications.

2. Transport infrastructure in Vietnam: an overview

Before the 2000s, investment resources in transport infrastructure were mainly focused on maintenance work to ensure traffic safety and only implemented the construction of some urgent projects. As of 2004, the transport sector has made breakthroughs, upgrading and renewing more than 16,000 km of roads, 1,400 km of railways, more than 130,000 m of road bridges, 11,000 m of railway bridges. Vietnam's transport infrastructure is particularly observed to thrive in the Socio-Economic Development Strategy 2010-2019, with the scale of the road system skyrocketing to 668,000 km, nearly three times higher than at the end of 2004. Vietnam now has more than 1,800 km of expressways, of which almost 1,500 km are in use. Table 1 describes the length and density of traffic routes in Vietnam in 2019.

Table 1

The length and density of traffic routes in Vietnam in 2019

Type Road	Year 2000			Year 2009			Year 2019		
	Length (km)	Avg speed (km/h)	Road density (km/km²)	Length (km)	Avg speed (km/h)	Road density (km/km²)	Length (km)	Avg speed (km/h)	Road density (km/km²)
Expressway							1900	100	0.003
National highways	11.068	29.54	0.031	19.068	37.67	0.045	25.875	47.61	0.060
Provincial road	17.491	23.12	0.041	24.491	28.12	0.052	37.700	38.52	0.072
Other roads	101.326	13.32	0.369	152.826	13.32	0.469	256.000	23.14	0.713

Source: World Bank's GIS work using data from Directorate for Roads of Vietnam (DRVN).

The data in Table 1 shows that Vietnam's transport network has expanded significantly since the US lifted the trade embargo. With administrative characteristics by province and economy by region, the national transport network tends to cluster by region, considering spatial factors before estimating the potential economic benefits of different modes of transport is essential. Will transport provide more economic benefits than their direct impacts on the region? How can we measure spatial spillover effects of transport infrastructure if there is evidence of the existence of spillovers? The study will examine the spatial spillover effects of transport infrastructure at the national and regional levels in the next section to answer these questions.

3. Measuring spatial spillover effects of transport infrastructure in Vietnam

3.1.Model specification

This study will use the approach commonly used in most previous studies, i.e. the Cobb-Douglas production function, to test the spatial spillover from infrastructure onto economic growth (Holtz-Eakin & Schwartz, 1995a; Del Bo & Florio, 2012). The critical variable is GDP, and the interaction

variables between GDP are labor and investment capital. The extended Cobb-Douglas production function has the following form:

$$Y = f(L, K_C, K_{CT}, K_P, K_{PT}) = AL^{\alpha_1} K_C^{\alpha_2} K_{CT}^{\alpha_3} K_P^{\alpha_4} K_{PT}^{\alpha_5} \quad (1)$$

where *Y*- output; *L*- labor, K_C , K_P- are private investments and public investment not for traffic, respectively; K_{CT} , K_{PT}– is a private investment and public investment capital for transport, respectively. Taking the logarithm of both sides of the equation (1), we get a linear regression where each estimated parameter is estimated to be each GDP elasticity coefficient:

$$LnY = \alpha_0 + \alpha_1 \ln L + \alpha_2 LnK_C + \alpha_3 LnK_{CT} + \alpha_4 LnK_P + \alpha_5 LnK_{PT} + \varepsilon \quad (2)$$

The study uses Moran's index as a measure of spatial autocorrelation. Moran's I statistics suggest a spatial correlation in the research data, so it is necessary to consider the extent of the contribution of spatial factors to regional economic growth. According to Auselin (2001), who wants to feel the spatial interaction between the dependent and independent variables, the spatial econometric model is suitable. Based on the general spatial model (LeSage et al., 2009), the study proposes to choose the spatial Durbin model (SDM) as the empirical analysis model:

$$Y = \rho W_y + X\beta + \theta WX + \alpha I_n + \varepsilon \quad (3)$$

In which, ρ is the autocorrelation coefficient in space, W is the spatial weighting matrix, X is the matrix of control variables (L, K_C , K_{CT} , K_P , K_{PT}); I_n is the level unit matrix (n x1); a, θ and β are vectors of the estimated coefficient; **ε** is the error. The SDM model will contain the spatial delay of both the dependent variable (*Wy*) and the explanatory variable (*WX*). The implication is that if there is a change in the dependent variable in a specific region, that change can affect the dependent variable in all other regions by the transport network effect. A change in the explanatory variable for one observation can affect the dependent variable in all other observations. The combination of equations (2) and (3) gives us an empirical model that estimates the spillover effects in space:

$$\begin{aligned} Ln(Y)_{it} = {} & \rho \sum_{j=1}^{n} w_{ij} Ln(Y)_{jt} + \beta_0 + \beta_1 Ln(L)_{it} + \beta_2 Ln(K_C)_{it} + \beta_3 Ln(K_{CT})_{it} \\ & + \beta_4 Ln(K_P)_{it} + \beta_5 Ln(K_{PT})_{it} + \theta_1 \sum_{j=1}^{n} w_{ij} Ln(L)_{jt} + \theta_2 \sum_{j=1}^{n} w_{ij} Ln(K_C)_{jt} \\ & + \theta_3 \sum_{j=1}^{n} w_{ij} Ln(K_{CT})_{jt} + \theta_4 \sum_{j=1}^{n} w_{ij} Ln(K_P)_{jt} + \theta_5 \sum_{j=1}^{n} w_{ij} Ln(K_{PT})_{jt} + \varepsilon_{it} \end{aligned} \quad (4)$$

Where: *Y* is real GDP; *i* and *t*correspond to the index of the ith province in year *t*; *j*represents neighboring provinces (*j* ≠*i*); *wij* is an element of the spatial matrix *W* that describes the spatial arrangement between different regions of the variables. To build the spatial weight matrix *W* = (w_{ij}), the study uses a contiguous binary matrix (wbin), assuming that adjacent provinces can influence each other. The formula determines the elements of the space matrix W:

$$w_{ij} = \begin{cases} 1, & \text{the province } i \text{ has a boder with province } j, \\ 0, & \text{otherwise.} \end{cases}$$

3.2. Data

The data used in this study was collected from various sources, including the General Statistics Office of Vietnam (GSO) from 2000-2019; Statistical yearbook of the province/city directly under it. Accurate GDP data, private sector investment, employed population (labor input), transport infrastructure investment, and public investment are available from (GSO). Particularly for investment data on transport infrastructure, the study uses data on "transport infrastructure and postal services" from statistical yearbooks of provinces and cities.

3.3. Results and discussion

Next, to determine the change in the regional spillover effect, we conducted model estimation (4)

during the following periods: 2000-2009 and 2010-2019. Table 2-4 summarizes the main results of model (4) at the national and regional levels. The results show that the table's spatial autocorrelation coefficient ρ in the tables is positive and statistically significant, implying a positive spillover effect between the regions in Vietnam.

3.3.1. The spillover effect at the national level

Table 2 summarizes the SDM model estimation results, showing that the coefficients of L, K_C, K_{CT}, K_P, K_{PT} are positive and statistically significant. At the same time, their respective spatial lag coefficients are positive and statistically significant, except the sign of labor's spatial lag is negative and not significant.

Table 2

Estimation results of the SDM model from 2000-2019 and each period

Variable	2000-2019	Period 2000-2009	Period 2010-2019
Constant	1.204(9.23)***	0.689(6.87)***	1.524(14.34)***
L	0.573(19.80)***	0.472(14.37)***	0.571(13.52)***
K_C	0.152(12.47)***	0.122 (17.05)***	0.101(13.64)***
K_{CT}	0.112(12.47)***	0.068(17.05)***	0.132(13.64)***
K_P	0.179(13.58)***	0.249(13.35)***	0.162(13.58)***
K_{PT}	0.124(15.78)***	0.256(15.63)***	0.178(15.45)***
ρ	0.231(4.25)***	0.307(3.16)***	0.279(13.01)***
WxL	-0.382(1.65)	- 0.157(0.32)	- 0.198(1.38)
WxK_C	0.073(6.38)***	0.046(2.33)**	0.063(7.58)***
WxK_{CT}	0.043(6.38)***	0.028(2.33)**	0.038(7.58)***
WxK_P	0.025(11.34)***	0.003(5.56)***	0.031(9.43)***
WxK_{PT}	0.046(7.33)***	0.019(12.52)***	0.043(7.36)***
Adj. R^2	0.797	0.521	0.878
Log likelihood	178.47	154.44	165.36

Source: The author's calculations from GIS software.

Table 3 presents the direction and extent of direct and indirect spillovers of the explanatory variables. The experiment shows that the total effect of private and public investment in transport is positive and highly significant. Moreover, the elasticity coefficients of the two types of capital as an investment are pretty close (coefficients are 0.24 and 0.22), showing that the contribution of private capital and public capital to economic growth is nearly equal. The insignificant difference in these two types of capital from a personal point of view is due to the fact that market factors have played an essential role in the Vietnamese economy. The results also show that the labor coefficient (0.45) is quite reasonable, implying that labor input growth has the most significant impact on Vietnam's real GDP growth; coefficient values are very consistent with the findings of previous studies (Le *et al.*, 2011, Pham *et al.*, 2016).

Table 3

The direct and indirect effects of explanatory variables

Variables	Effect	2000-2019	Period 2000-2009	Period 2010- 2019
Labor	Direct effect	0.577(23.24)***	0.465(14.77)***	0.538(6.38)***
	Indirect effect	- 0.124(1.28)	- 0.114(1.27	-0.146(0.38)

	Total	**0.453(9.45)*** **	**0.351(14.43)*** **	**0.392(4.75)*** **
K_{CT}	Direct effect	0.155(6.03)***	0.072(14.65)***	0.116(21.24) ***
	Indirect effect	0.081(15.36) ***	0.063(9.32) ***	0.066(4.27) ***
	Total	**0.235(22.65) *** **	**0.135(5.67) *** **	**0.182(11.23)** **
K_{PT}	Direct effect	0.190(19.24) ***	0.261(3.65) ***	0.167(11.46) ***
	Indirect effect	0.033(7.36) ***	0.003(2.27)**	0.036(8.26) ***
	Total	**0.224(13.14) *** **	**0.265(11.79) *** **	**0.203(12.55) *** **
Transport infrastructure	Direct effect	0.118(18.22) ***	0.259(13.46) ***	0.172(19.47) ***
	Indirect effect	0.055(16.37) ***	0.026(13.41) ***	0.052 (2.59)**
	Total	**0.173(15.54) *** **	**0.285(27.45) *** **	**0.224(3.36)** **

Source: The author's calculations from the model.

Considering the impact of transport infrastructure, we find that transport infrastructure has a positive effect on GDP growth (coefficient is 0.17), the aggregate effect tends to decrease over time because direct impacts show signs of decline in different periods (the coefficients are 0.26 and 0.17 in the periods 2000-2009, 2010-2019, respectively). The impact of transport infrastructure declines over time, possibly due to economic reforms, investment in transport projects continues to increase, and marginal returns begin to increase after a while. The findings of this experiment are consistent with previous domestic studies (Dang, 2021; Nguyen, 2020). Table 3 also shows that the indirect effect of transport infrastructure is highly statistically significant (coefficient is 0.06), which means that the transport volume contributes both directly and indirectly to GDP. Indirect impacts increase over time: coefficients are 0.03 for the period 2000-2009; 0.05 for the period 2010-2019. This shows that the increasing spillover effects contribute more significantly to economic growth due to the expanded transport network. Next, to analyze spillover effects at the research area level, we will consider the indirect influence of transport infrastructure.

3.3.2. The spillover effects of transport infrastructure at the regional level

Table 4 shows a significant difference in indirect influence between the key economic regions of Vietnam during the study period (μ = 0.07; - 0.04; 0.14; and - 0.06 respectively for different regions). The coefficient of indirect effects on the southern critical economic region is very high, 0.14, which means that the GDP of the critical southern region will increase by 0.14% if the proportion of transport in the vicinity increases by 1%. The spillover effects in the northern critical economic region also exhibit positive signs, although these are weaker than those in the southern critical economic region (coefficient is 0.07). However, the findings indicate that increased investment in the neighboring transport infrastructure of the two key economic regions of the Central region and the Mekong River Delta may constrain the local economy (negative coefficient).

Table 4

Estimation results of SDM model at the regional level

Regions	Variable	2000-2019	Period 2000-2009	Period 2010 - 2019
Northern critical economic region	Constant	2.503(9.32)***	2.261(6.92)***	3.521(14.24)***
	L	0.538(13.09)***	0.576(16.13) ***	0.510 (3.23)**
	K_C	0.098 (10.12)***	0.051(2.98)*	0.112 (7.82)***
	K_{CT}	0.068 (13.12)***	0.031(1.89)*	0.132 (5.75)***
	K_P	0.181(7.62)***	0.224(11.35)***	0.167(3.34)**
	K_{PT}	0.143(4.13)***	0.221(22.56)***	0.194 (22.86)*
	ρ	0.215(24.67)***	0.269(4.75)***	0.197(12.73)***
	WxL	-0.193(0.51)	-0.114(2.63)**	-0.112(0.73)
	WxK_C	0.063(14.72)***	0.074(1.87)*	0.105(0.59)
	WxK_{CT}	0.034(4.77)***	0.035(2.86)*	0.105(0.09)
	WxK_P	0.061(8.49)***	0.052 (0.93)	0.056(6.75)***

	WxK_{PT}	0.021(12.42)***	0.121(0.64)	0.074(2.37)**
	μ	0.071(9.26)***	0.206(0.47)	0.052(4.14)*
	Adj. R^2	0.780	0.831	0.667
	Log likelihood	178.57	103.25	121.12
Central critical economic region	Constant	4.503(9.32)***	2.271(6.92)***	3.571(14.24)***
	L	0.537(6.36)***	0.566(1.86)*	0.524(2.05)*
	K_C	0.144(11.22)***	0.078(2.33)**	0.113(9.73)***
	K_{CT}	0.074(12.22)***	0.045(6.33)**	0.083(11.73)***
	K_P	0.171(11.32)***	0.183(10.24)***	0.202(9.45)***
	K_{PT}	0.193(15.85)***	0.172(2.25)**	0.162(17.34)***
	ρ	0.265(5.35)***	0.315(7.15)***	0.193(15.27)***
	WxL	-0.098(1.12)	-0.116(0.75)	-0.094(1.37)
	WxK_C	0.054(16.33)***	0.063(8.32)***	0.057(15.29)***
	WxK_{CT}	-0.024(15.26)***	-0.078(6.86)***	-0.065(12.29)***
	WxK_P	0.037(6.84)***	0.071(1.04)	0.102(2.45)**
	WxK_{PT}	-0.072(16.45)***	-0.033(7.59)***	-0.134(1.98)*
	μ	-0.043(8.29)***	-0.015(6.43)***	-0.06(2.51)**
	Adj. R^2	0.705	0.636	0.464
	Log likelihood	132.63	145.89	161.27
Southern critical economic region	Constant	2.273(9.21)***	1.694(6.94)***	2.533(14.54)***
	L	0.626(16.61)***	0.495(16.12)**	0.597(11.91)**
	K_C	0.167(22.05)***	0.091(21.24)***	0.151(17.98)***
	K_{CT}	0.137(18.35)***	0.071(17.24)***	0.111(13.98)***
	K_P	0.135(16.56)***	0.137(11.42)***	0.139(18.55)***
	K_{PT}	0.093(2.35)**	0.204(3.59)**	0.105(2.34)**
	ρ	0.391(14.54)***	0.326(6.47)***	0.294(15.35)***
	WxL	-1.425(1.46)	-1.075(1.47)	-1.710(0.79)
	WxK_C	0.044(17.34)***	0.039(11.45)***	0.006(2.45)*
	WxK_{CT}	0.104(16.21)***	0.092(12.25)***	0.065(1.99)*
	WxK_P	0.033(3.45)***	0.023(1.95)*	0.023(7.37)***
	WxK_{PT}	0.128(14.56)***	0.036(16.34)***	0.154(14.44)***
	μ	0.143(16.32)***	0.063(7.87)***	0.172 (7.42)***
	Adj. R^2	0.647	0.831	0.536
	Log likelihood	149.34	137.65	114.36
Cuu Long Delta critical Economic region	Constant	4.503(8.92)***	2.471(7.85)***	3.371(13.34)***
	L	0.463(14.43)***	0.405(32.93)	0.345(2.78)**
	K_C	0.127(12.63)***	0.170(6.86)**	0.062(10.67)***
	K_{CT}	0.042(15.45)***	0.058(3.89)**	0.065(6.56)***
	K_P	0.228(13.25)***	0.194(15.37)***	0.252(2.35)**
	K_{PT}	0.074(13.12)***	0.082(2.77)**	0.086(2.06)*
	ρ	0.235(7.47)***	0.169(16.76)***	0.148(21.67)***
	WxL	-0.051(1.36)	-0.131(0.16)	-0.067(2.26)**
	WxK_C	0.038(13.65)***	0.032(7.62)***	0.055(2.39)**
	WxK_{CT}	-0.078(12.45)***	-0.123(0.87)	-0.065(1.86)**
	WxK_P	0.023(5.18)***	0.013(1.98)*	0.044(2.14)*
	WxK_{PT}	-0.084(4.25)***	-0.117(0.16)	-0.135(8.57)***
	μ	-0.063 (2.22)**	-0.071(0.98)	-0.062(12.15)***
	Adj. R^2	0.548	0.496	0.522
	Log likelihood	162.56	181.46	166.52

Source: The author's calculations from GIS software.

Table 4 shows that there are significant differences in the extent of spillovers across regions in each

period. For the southern region, the spillover in the surrounding areas had a positive impact the entire time covered by the research. The regression results illustrate that the output elasticity of neighboring transport infrastructures for the two sub-periods are significant and positive (the coefficients are 0.06, 0.17). For the Northern region, no spillovers were noted in the period 2000-2009, but there was a positive spillover in 2010-2019 (coefficient of 0.05). In the central critical economic region, the estimated coefficients of spillover effects are -0.02 and -0.06 for the period 2000-2009, and 2010-2019 respectively, which means that the growth of transport investment in the surrounding areas harms economic growth in the Central region during the period. For the critical economic region of the Mekong River Delta, a negative spillover effect in the period 2010-2019 was observed (coefficient is -0.06). In the first period, the coefficient is insignificant, showing no spillover effects in the first period (1).

The findings of the study partially support those of previous studies (Tran, 2009; Tran et al., 2019; Phi et al., 2019) at the national level, but also point to some contradictory results compared with others at the regional level. This can be explained by applying the advanced spatial Durbin model, which considers the lagging factor of both dependent and independent variables and measures spatial spillovers from all possible regions, which makes the estimates of the present study more convincing. For an in-depth analysis of the differences between the macroeconomic regions, we will next study how the spillover of transport infrastructure works in Vietnam.

4. Spillover effect arising from transport network characteristics

According to Banister & Berechman (2001), an increase in transport investment in an area will upgrade the transport network of that region and thus enlarge the market size. An expanding market size means attracting a more specialized workforce, which allows the economy to expand more. Therefore, it can be argued that the expansion of the transport network can stimulate the economy in both the investment area and the surrounding areas.

For the case of Vietnam, Pham et al., (2016) conclude that both economic openness and regional integration have a clear positive impact on Vietnam's regional TFP; Le et al., (2011) found that expanding market size has a positive effect on economic growth. Therefore, the rapid expansion of market size due to improved transportation brings along many economic benefits. Based on the analysis, we can explain that the existence of positive spillover effects of Vietnam's transport network at the national level in both the research period and the change in each period is caused by the shift from factors of production.

Although, the policy of Doi Moi - comprehensive reform covering the economy and many other aspects of social life, was initiated by the Communist Party of Vietnam in the 1980s. Vietnamese politics changed slowly, continuing to maintain the model of socialism and communism under Marxism-Leninism; as a result of this, the movement of factors of production is still limited. Since 2000, the shift to a market economy has radically changed the economy, making the exchange of production and goods much more favorable due to lower transport costs. In the North, there has been a shift in factors of production from the poor provinces, i.e. the Northwest poor region (14 provinces), the Central-Central Highlands region (10 provinces), and the Mekong River Delta region (13 provinces), to the southern region. Since the last years of 2000-2009, the southern critical economic region has witnessed a strong development that is expected to benefit other economic sectors by redistributing industry. The study will continue to examine how the movement of factors of production has changed over time between the four regions in Table 5.

Table 5

The migration of production factors among regions in various periods

Period	Northern critical economic region			Central critical economic region			Southern critical economic region			Cuu Long Delta critical region		
	K	L	trend	K	L	trend	K	L	trend	K	L	trend
2000-2009	-31	-25	-	- 367	-312	-	+1036	+ 823	+	-352	-298	-
2010-2019	+65	+78	+	+35	+53	+	-115	-156	-	+46	+46	+

Source: Author's own calculations.

Table 5 shows the net movement trend of production factors (capital and labor) between regions in different periods. There was a shift of production factors from the two regions of the Central - Central Highlands and the South West in the early years of the 2000-2009 period, contributing to a significant increase in production activities in southern areas. Particularly in the northern region, production factors are relatively stable, possibly due to the long geographical distance compared to the southern region. In the recent decade, factors of production have begun to shift from the southern region towards the less developed regions. These findings seem to be utterly consistent with the current situation of Vietnam in the current context.

5. Conclusion and policy implications

Based on the research results, transport capital is associated with increased production in the region. A convenient transportation network causes positive spillover effects at the national level affecting all of Vietnam. There is a significant difference in the degree of spillover among critical economic regions of Vietnam in the different periods. In terms of policy implications, the following conclusions can be drawn:

Firstly, identifying the transport network as the lifeblood of the economy - society, the Vietnamese Government should prioritize the development of the inter-regional transport network instead of building an intra-regional transport network. The existence of spatial externalities emerging from the contribution of transport infrastructure to regional growth should be viewed from a hyper-regional perspective.

Secondly, with the characteristics of the current Vietnamese transport network, the Government should pay special attention to the coordination of traffic construction between provinces to balance and harmonize geography, economic and regional development orientation, avoiding centralized investment methods. Therefore, the central Government needs to provide guidelines and constraints on local government decision-making regarding their investment models.

Third, industrial policies related to the lagging sector are needed due to adverse spillover effects. The effects of industrial accumulation from transportation development lead to an increase in industrial activities from the central region and the Mekong Delta to the southern part, especially industries that use many technologies. Since there can be negative spillovers of transport infrastructure from migration factors, local governments in less developed areas should change their industrial policies to avoid allocating economic activities. Targeted region-specific industrial policies, such as favorable tax policies and lower interest rates on loans to invest in local technology and labor-intensive industries, are needed.

6. Possible future research

To increase the significance of this study, the following opinions can be developed more comprehensively. First, it should be assessed whether transport infrastructure development is the leading cause of the "fever" observed in real estate prices in Vietnam. Second, it is necessary to consider the relationship between urban planning and the real estate market. These questions, however, extend beyond the scope of the present research and require enormous effort. They should therefore be considered in a follow-up study.

References

Aschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics, 23*(2), 177–200. https://doi.org/10.1016/0304-3932(89)90047-0

Banister, D., & Berechman, J. (2001). Transport investment and the promotion of economic growth. *Journal of Transport Geography, 9*(3), 209–218. https://doi.org/10.1016/S0966-6923(01)00013-8

Cohen, J. P. (2010). The broader effects of transportation infrastructure: Spatial econometrics and Productivity approaches. *Transportation Research Part E, Logistics and Transportation Review, 46*(3), 317–326. https://doi.org/10.1016/j.tre.2009.11.003

Del Bo, C., & Florio, M. (2012). Infrastructure and growth in a spatial framework: Evidence from the EU Regions. *European Planning Studies, 20*(8), 1393–1414. https://doi.org/10.1080/09654313.2012.680587

Holtz-Eakin, D., & Schwartz, E. A. (1995a). *Spatial productivity spillovers from public infrastructure: evidence from state highways*, National Bureau of Economic Research Working Paper. https://doi.org/10.3386/w5004

Holtz-Eakin, D., & Schwartz, A. E. (1995b). Infrastructure in a structural model of economic growth. *Regional Science and Urban Economics, 25*(2), 131–151. https://doi.org/10.1016/0166-0462(94)02080-Z

Holtz-Eakin, D., & Schwartz, A. E. (1996). Spatial productivity spillovers from public infrastructure: Evidence from state highways. *International Tax and Public Finance, 2*(3), 459–468. https://doi.org/10.1007/BF00872777

Le, H. Q., & Pomfret, R. (2011). Technology Spillovers from Foreign Direct Investment in Vietnam: Horizonta or Vertical Spillovers? *Journal of the Asia Pacific Economy, 16*(2), 183–201. https://doi.org/10.1080/13547860.2011.564746

LeSage, J. P., & Pace, R. K. (2009). Spatial econometric models. In *Handbook of Applied Spatial Analysis*. Springer, 355–376.

Mikelbank, B. A., & Jackson, R. W. (2000). The role of space in public capital research. *International Regional Science Review, 23*(3), 235–258. https://doi.org/10.1177/016001700761012774

Moreno, R., & Lopez-Bazo, E. (2007). Returns to local and transport infrastructure under regional Spillovers. *International Regional Science Review, 30*(1), 47–71. https://doi.org/10.1177/0160017606296728

Pereira, A. M., & Roca-Sagalés, O. (2003). Spillover effects of public capital formation: Evidence from the Spanish regions. *Journal of Urban Economics, 53*(2), 238–256. https://doi.org/10.1016/S0094-1190(02)00517-X

Nguyen, T. H., & Pham, T. A. (2016). Technological spillover from FDI and determinants: The case firms in Vietnam. *Journal of Asian Business and Economic Studies, 368*, 34–41.

Phi, V. T., Dang, T. B., & Nguyen, D. H. (2019). Impact of transport infrastructure on firm performance: Case study of Cuu long delta area, Vietnam. *Jounal Problems and Perspectives in Management, 17*(2), 2019.

Saima, N., & Inayat, U. M. (2018). *The Economic Geography of Infrastructure in Asia: The Role of Institutions and Regional Integration* .Conference: PSDE & AGM At: Pakistan.

Ramajo, J., Marquez, M. A., Hewings, G. J. D., & Salinas, M. M. (2008). Spatial heterogeneity and Interregional spillovers in the European Union: Do cohesion policies encourage convergence across regions? *European Economic Review, 52*(3), 551–567. https://doi.org/10.1016/j.euroecorev.2007.05.006

Yu, N., de Jong, M., Storm, S., & Mi, J. (2013). Spatial spillover effects of transport infrastructure: Evidence from Chinese regions. *Journal of Transport Geography, 28*, 56–66. https://doi.org/10.1016/j.jtrangeo.2012.10.009

Trương, C. B., & Phan, Q. V. (2019). The spatial autocorrelation analysis for volume of freight in different regions: A case of Vietnam [IJESRT]. *International Journal of Engineering Sciences & Research Technology, 8*(12), 2019.

Tran, T. Q. (2009). Sudden Surge in FDI and Infrastructure Bottlenecks: The Case in Vietnam. *ASEAN Economic Bulletin, 26*(1), 58–76. https://doi.org/10.1355/AE26-1E