Monocentric Growth and Productivity Spillovers in Vietnam : A Spatial Regression Approach

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Abstract

After more than 30 reforms (1986 – 2018), although Vietnam's economic growth has had inevitable fluctuations, it remained higher than the regional and world average with an average increase throughout nearly 7%/year. However, if we consider the spatial dimension alone, the growth is not proportional. The productivity growth has been mainly concentrated within the major urban areas and their neighboring provinces. With this evidence, the purpose of this study was to verify whether there existed an extreme productivity growth and a spillover effect in Vietnam by spatial econometric tests to survey data and remote sensing data. The I-Moran test results showed a close relationship between the light density at night, industrial density, enterprise efficiency, and labor quality. Furthermore, the I-Moran test provided evidence that productivity spills existed among several firms. The research results suggested that attracting and expanding production in target areas, infrastructure, and incentives must ensure positive spillovers at levels higher than those obtained from experimental research.

Keywords : **urbanization, Vietnam, trade, and investment**

JEL Classification Codes : C21, O1, O18

Paper Submission Date : April 23, 2021 ; Paper sent back for Revision : June 6, 2021 ; Paper Acceptance Date : December 6, 2021; Paper Published Online : March 15, 2022

After the "Doi Moi" period in 1986, the Vietnamese economy gained many significant achievements. From being considered the most impoverished country globally, Vietnam has become a middle-income country in the world. In particular, after more than 30 years of implementing the foreign direct investment (FDI) policy, from purely agricultural land to a country with high GDP per capita in the region, FDI has become a vital resource to promote socioeconomic development. Although the macro indicators have shown that Vietnam's economy is developing stably, many shortcomings affect its sustainable development, including income inequality, labor productivity, investment effects, and environmental pollution. One of the reasons affecting the economic growth rate is the disproportionate urban expansion, giving rise to uneven development between regions. After the 6th Congress (1986) with reform policy, the Vietnamese Communist Party established three economic triangles, including the North (Hanoi - Hai Phong - Quang Ninh), Central (Hue - Quang Nam Da Nang - Quang Ngai), and the South (Ho Chi Minh City - Dong Nai - Ba Ria-Vung Tau). In particular, the Ho Chi

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DOI : https://doi.org/10.17010/ijf/2022/v16i3/168704

Minh urban area (HCM) is the core city, with the periphery having a tremendous urbanization rate in Vietnam, with a high density of industrial parks and many investment projects. According to Dean Cira (2011), the expansion of Ho Chi Minh City's peripheral areas includes 29 large cities concentrated in eight adjacent provinces and cities [1], with a total area of 30,404 km². The radius of influence from 150 – 200 km is divided into four regions of open economic space as follows :

(1) Central Development Region. Including the center of Ho Chi Minh City, an area of 2,061 km² with Ho Chi Minh City is the central city of the region, and is administratively recognized as a city under the Central government. Duc Hoa district, Can Giuoc district (Long An); Thu Dau Mot City, Di An, Thuan An, Ben Cat Town, Tan Uyen (Binh Duong Province); Bien Hoa city, Nhon Trach district, Trang Bom, Long Thanh, and a part of Vinh Cuu district (Dong Nai province) with Ho Chi Minh City is the central nuclear city of the region. Binh Duong City is the driving force for development in the North. Bien Hoa city - Long Thanh - Nhon Trach is the driving force of development in the region's East.

(2) Eastern Development Region. Including Long Khanh urban area and districts Thong Nhat, Cam My, Xuan Loc, Dinh Quan, Tan Phu, a part of Vinh Cuu district (Dong Nai province), and the whole province of Ba Ria - Vung Tau. In which, Vung Tau city is the critical center of development in the Southeast region. Long Khanh city is the critical center of development in the East of the region.

↳ ***Strategies.*** To develop Phu My and Cai Mep-Thi Vai urban areas in specialized industrial zones, supporting industries, multidisciplinary industries, oil and gas exploitation industries, port industries; to develop international logistics services associated with Trans-Asia corridor and hub of international transshipment seaports of Cai Mep, Sao Mai - Ben Dinh, and Long Thanh international airport.

(3) Northern Development Region. Bau Bang, Dau Tieng, Phu Giao, Bac Tan Uyen (Binh Duong province), and the entire province of Tay Ninh, Binh Phuoc province. Chon Thanh urban center is the most important center of development in the North of the region. Trang Bang - Go Dau (Tay Ninh) is the most important development center in the region's Northwest.

↳ ***Strategy.*** Developing multi-sector industrial zones associated with urban areas, non-tariff zones of border gate economic zones.

(4) Southwest Development Region. Including Long An province (except for Duc Hoa and Can Giuoc districts) and the whole province of Tien Giang. My Tho City and Tan An City are the central urban centers of the southwestern region.

↳ ***Strategy.*** Developing high-tech agriculture, specialized agriculture (growing rice, fruit trees), fishing, and aquaculture; to develop eco-tourism, river landscape, orchards.

Table 1 presents the population in the four open-space regions around the HCMC metropolitan area. The statistics indicate that an exciting aspect is the high population density in the Northeastern port area and not the

[1] Binh Duong, Binh Phuoc, Tay Ninh, Long An, Dong Nai, Ba Ria-Vung Tau, Tien Giang with Ho Chi Minh City is the central city.

Table 1. ***Current Situation of Ho Chi Minh Urban Area with Eight Adjacent Provinces and Cities (29 Major Cities)***

STT	City Name	City Role	Administration	Class	Population (,000)
1	Ho Chi Minh city	Municipality : under the command of the Central government	Central Government	Multicipality	8,993
2	Bien Hoa	Provincial city	Dong Nai	1	1,251
3	Vung Tau	Provincial city	Ba Ria- Vung Tau	1	527
4	Thu Dau Mot	Provincial city	Binh Duong	1	417
5	My Tho	Provincial city	Tien Giang	1	270,7
6	Ba Ria	Provincial city	Ba Ria- Vung Tau	2	205,1
7	Tan An	Provincial city	Long An	2	215,2
8	Tay Ninh	Provincial city	Tay Ninh	3	1,169
9	Đong Xoai	Provincial city	Binh Phuoc	3	150,05
10	Long Khanh	Provincial city	Đong Nai	3	245
11	Thuan An	Provincial city	Binh Duong	3	603
12	Di An	Provincial city	Binh Duong	3	415,3
13	Go Cong	District-level town	Tien Giang	3	107,7
14	Ben Cat	District-level town	Binh Duong	3	224,34
15	Tan Uyen	District-level town	Binh Duong	3	204,4
16	Phu My	District-level town	Ba Ria-Vung Tau	4	221,03
17	Binh Long	District-level town	Binh Phuoc	4	105,5
18	Phuoc Long	District-level town	Binh Phuoc	4	81,2
19	Cai Lay	District-level town	Tien Giang	3	242,76
20	Kien Tuong	District-level town	Long An	4	145,12
21	Hoa Thanh	District-level town	Tay Ninh	4	146,66
22	Trang Bang	District-level town	Tay Ninh	4	183,38
23	Long Thanh	Commune-level town	Dong Nai	4	27,08
24	Trang Bom	Commune-level town	Dong Nai	4	666,43
25	Ben Luc	Commune-level town	Long An	4	195
26	Hau Nghia	Commune-level town	Long An	4	13,07
27	Duc Hoa	Commune-level town	Long An	4	345,817
28	Can Giuoc	Commune-level town	Long An	4	192,33
29	Can Duoc	Commune-level town	Long An	4	218,2

Source : Southern Institute for Spatial Planning of Vietnam (SISP).

balance in the South West region. In which, HCM is the urban area with the highest population growth. This evidence shows that the growth pattern corresponds to disproportionate development according to the socioeconomic structure of the region. Therefore, this study will experimentally integrate with remote sensing data and ground survey data along with spatial econometric methods. Specifically, we use night light data, survey data, and spatial statistical techniques to determine the geographic pattern of the growth pole using spatial regression to examine the relationship between growth poles and productivity spillovers among firms in Vietnam.

Theoretical Overview

Cluster Cities and Economic Growth

The relationship between growth, efficiency, and convergence was proposed by Marshall (1890). The research results have shown that increasing profits according to the intermediate supply source's size, attracting labor, and spreading knowledge are the main factors leading to growth and convergence. Based on previous studies, Duranton (2004) built an integrated model of variables affecting economic size, labor force, and knowledge spillover. This theoretical model allows for quantitative testing in terms of convergence and economic growth. Next, McCann (2008), integrating the fundamentals of Marshall and Jacobs, combined with industry networks, the concept of transaction costs, and concluded that the relationship between income convergence and economic growth is based on integrating these factors.

Spatial Spillover and Productivity of Enterprises

There has been a large amount of experimental research on the spatial characterization of yield diffusion. In particular, many studies have shown that geographic proximity between enterprises can increase productivity through the spillover of technology and knowledge. Jaffe et al. (1993), Awadhesh (2016), Aprajita and Pattanayak (2018), and Verma and Kaur (2018) showed that these spillovers were localized and decreased over time. Also, the proximity of local firms to multinational corporations (MNCs) can create absorbent technology and knowledge through labor mobility (Crespo et al., 2009; Dhamija & Singh, 2018; Halpern & Muraközy, 2007; Moreno & Trehan, 1997; Lychagin et al., 2016). With the recent development of geographic information system (GIS) and spatial econometric method, Mariotti et al. (2015) and Himanshu and Anand (2019) applied data and techniques to quantify spatial spillovers of productivity. Expressly, these studies confirmed the existence of FDI-initiated spatial externality and that the operations of multinational corporations (MNCs) have affected the productivity of local firms.

Methodology and Data

Model Specification

This study applies the approach commonly used in previous studies (Blalock & Gertler 2008; Javorcik, 2004; Kohpaiboon, 2006; Yu et al., 2013), which is the Cobb-Douglas production function to test the spillover of productivity. The locally owned sector growth is indicated in the following form :

$$Y_{ijt} = A_{ijt} (K_{ijt})^{\alpha} (L_{ijt})^{\beta} e^{\varepsilon_{it}} \quad (1)$$

where, Y_{ijt}, K_{ijt}, L_{ijt} - output (value-added), capital accumulation and labor accumulation of the *i* local firm in industry *j* at time *t* ; A_{ijt} is the total factor productivity (TFP) of the *i*th local firm in industry *j* at time *t*, which depends on the following factors: Export activity *(EX)*, import *(IM)*, FDI activity *(FDI)*, quality number of employees *(QL)*, age of enterprises *(Age)*, provincial minimum wage *(MW)*, and local government spending *(GE)*. As A_{ijt}'s functional form is unknown, the study uses a simple function form to represent :

$$\text{Ln}A_{it} = \alpha_1 \text{Ln}Ex_{it} + \alpha_2 \text{Ln}IM_{it} + \alpha_3 \text{Ln}FDI_{it} + \alpha_4 \text{Ln}QL_{it} + \alpha_5 \text{Ln}Age_{it} + \alpha_6 \text{Ln}GE_{it} \quad (2)$$

By taking the logarithm of both sides of equation (1), replace A_{ijt} from equation (2). Taking back the parameters, we get the model describing the relationship between output and input of an enterprise rewritten as follows :

$$\text{Ln}Y_{it} = \beta_0 + \beta_1 \text{Ln}L_{it} + \beta_2 \text{Ln}K_{it} + \beta_3 \text{Ln}EX_{it} + \beta_4 \text{Ln}IM_{it} + \beta_5 \text{Ln}FDI_{it} + \beta_6 \text{Ln}QL_{it} + \beta_7 \text{Ln}Age_{it} + \beta_8 \text{Ln}MW_{it} + \beta_9 \text{Ln}GE_{it} + \varepsilon_{it} \quad (3)$$

In further considering whether spatial factors have a spillover effect on productivity, the study uses Moran's I index to measure the spatial autocorrelation. Moran's I statistics suggest a spatial correlation in the research data, so it is necessary to add spatial factors to the model. According to Anselin and Rey (2014), who want to consider the spatial interactions between dependent and independent variables, the spatial econometric model is suitable. This section presents the general form of two types of spatial models as the basis of empirical models.

Spatial Lag Model (SLM)

The spatial lag model (SLM) is a spatially self-regressive model in which the dependent variable in each locality is correlated with the dependent variable in other localities. The model (SLM) has the following general form :

$$Y = \rho W_y + X\beta + u \quad (4)$$

where, the variable X explains the change of the dependent variable Y, u random error; $W y$ - is the weight matrix based on the distances between localities. The variable Y combines the effects of the independent variables located in the host region with the spillover from neighboring regions. The empirical model of SLM below is estimated according to provincial data obtained from the industry survey (VCCI) conducted in 2018. The level and statistical significance of the coefficient ρ is an indicator for productivity spillovers across provinces :

$$\text{Ln}Y = \beta_0 + \rho W\text{Ln}Y + \beta_1 \text{Ln}L + \beta_2 \text{Ln}K + \beta_3 \text{Ln}EX + \beta_4 \text{Ln}IM + \beta_5 \text{Ln}FDI + \beta_6 \text{Ln}QL + \beta_7 \text{Ln}Age + \beta_8 \text{Ln}MW + \beta_9 \text{Ln}GE + \varepsilon \quad (5)$$

Spatial Error Model (SEM)

The second specification of the spatial econometric approach is the spatial error model (SEM). This approach assumes that the model is defective and correlated for spatial error. Equation (6) shows the mathematical form of SEM as follows :

$$Y = X\beta + u \;\; ; \;\; u = \lambda Wu + \varepsilon \quad (6)$$

The above representation shows the role of the spatial weight matrix in connecting the cross-position effect through the errors. Specifically, the magnitude and statistical significance of λ are critical factors for the existence of a mechanism to influence spillover effects through spatial errors.

$$\text{Ln}Y = \beta_0 + \beta_1 \text{Ln}L + \beta_2 \text{Ln}K + \beta_3 \text{Ln}EX + \beta_4 \text{Ln}IM + \beta_5 \text{Ln}FDI + \beta_6 \text{Ln}QL + \beta_7 \text{Ln}Age + \beta_8 \text{Ln}MW + \beta_9 \text{Ln}GE + u \quad (7)$$

$$u = \lambda Wu + \varepsilon$$

Table 2. ***Define and Measure the Variables in the Model***

Variable	Proxy	Unit of Measure	Data Sources
Value- added	*Y*	USD	GSO
Capital	*K*	USD	GSO
Labor	*L*	1,000 people	GSO, Ministry of Labor
Import value	*IM*	USD	GSO
Export activities	*EX*	USD	Gs0
FDI activities	*FDI*	USD/năm	GSO
The quality of labor	*QL*	1,000 people	GSO, Ministry of Labor
The age of firms	*Age*	year	GSO
Provincial minimum wage level	*MW*	VND/month	GSO, Ministry of Labor.
Provincial government expenditure	*GE*	VND	Ministry of Finance

Data

↳ ***Ground Data.*** The primary data for this study were collected from nationwide surveys of all information related to the 2018 production activities of 138,122 enterprises conducted by the Vietnam Chamber of Commerce and Industry (VCCI). After removing duplicate observations and missing information, the data was sorted using STATA 19 and GIS in GIS format. Table 2 summarizes the analytical model's variables and units of measurement and data sources and measurements.

↳ ***Night Time Light (NTL) Data.*** This study used the Night-Time light (NTL) data for 2018, managed by the United States Air Force (USAF). This global data collects the Earth's surface nocturnal light between 8:30 and 10:00 pm. Raw data are cleaned and processed by the Central National Geophysical Data (NGDC) under the National Oceanic and Atmospheric Administration (NOAA) regulator, which has been publicly available since 1992. Each pixel of this global data represents an area of 0.86 km^2, with a light intensity value on a scale of 0-64. According to Henderson et al. (2012) and Pinkovskiy and Sala-i-Martin (2016), NTL's illumination intensity can represent urban density and economic activity. Both studies noted a statistically significant relationship between the NTL index and GDP. This study converted the NTL data to a provincial indicator, as shown in Figure 1.

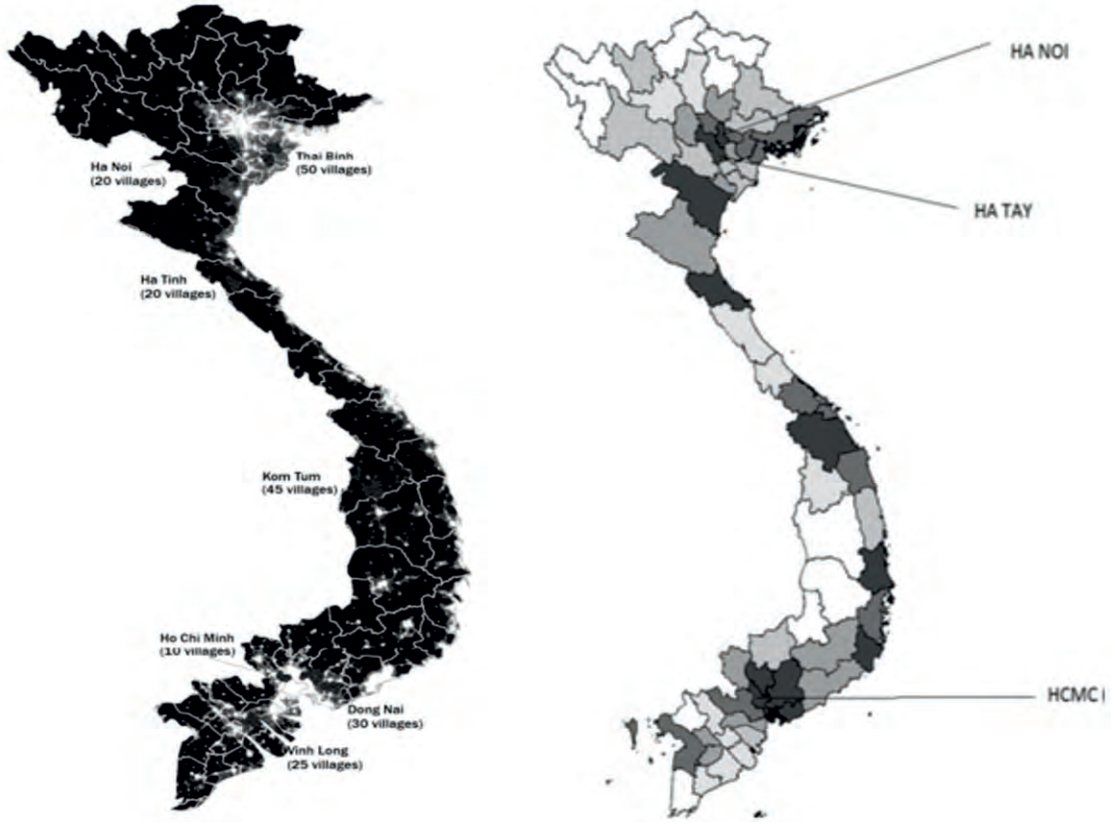
Analysis and Results

Geographic Model of Central Monopole Growth Pole

As mentioned in the introduction, Vietnam's economic growth rate has been spatially disproportionately distributed. The growth is mainly concentrated in the HCMC metropolitan area and the periphery, and this characteristic leads to different urban classifications of the HCMC metro area. Therefore, this study aims to test this single-central growth pole's boundary by integrating the spatial statistical method with NTL density and survey data. Furthermore, this computation also quantifies the relationship between physical indicators (i.e., the size of the NTL indicates urban density) and socioeconomic characteristics obtained from the official public survey.

In addition to the NTL density, three spatial data from the industrial survey were used in this analysis: industrial density, firm productivity, and labor quality. All collected data were be converted to GIS format. Each pair of

Figure 1. ***Data Converted from NTL Data (DMSP/OLS)***



Source : Min and Gaba (2014).

Table 3. ***I-Moran Test of Spatial Autocorrelation Between NTL and Control Variables***

Moran's Test	Industrial Density	Firm's Productivity	Labour Quality
NTL	0.4465	0.4778	0.505
(Night Time Light)	(0.0007)	(0.002)	(0.000)

spatial and NTL data was then examined using the Local Moran-I test. Table 3 presents the I-Moran test results showing that there is a spatial correlation in the data.

Table 3 presents the results of testing the spatial relationship between NTL and variables. Moran's I coefficients with (IS) are positive and statistically significant, showing a positive spatial correlation between NTL and the local industrial density. This result confirms that NTL and industrial density data in the region are positively correlated. Similarly, the results also show a spatial relationship between NTL and firm productivity (PF). It also consolidates that the high productivity firms are located in the vicinity of major economic centers. Finally, Moran's I test results reveal a local relationship between NTL and labor quality, classified based on average schooling years. Similar to the previous cases, the test results show a spatial correlation between NTL and labor quality (QL) in the localities. It indicates a link between high urban density and high labor quality in the expanded central areas. In contrast, a link exists between low urban density and low labor rates in some sectors.

All of the main findings from Moran's I test have shown a single-central growth geographic model. The spatial

analysis results are consistent with Vietnam's current situation, and this confirms that the physical evidence obtained from the coverage of NTL density is consistent with the magnitude of the socioeconomic indicators. This feature affirms that convergence occurs in neighboring areas in major economic centers, which significantly attracts economic activities and creates a significant share of Vietnam's GDP.

Spillover Productivity and Convergence on the Urban Periphery of HCMC

The results obtained from the spatial test further reinforce the claim that Ho Chi Minh City (HCM) has the highest economic efficiency. Although spatial testing has answered the question related to geospatial, there are still other questions related to the spillover mechanism and the degree of influence that remain unanswered. Therefore, we applied spatial econometric techniques to the nationwide industrial survey based on the theory presented in the Methodology section.

Table 4 presents the results obtained from three models by the method: linear model (OLS), space lag model (SLM), and spatial error model (SEM). The starting point of the research model in this study is the Cobb-Douglas production function in expanding the spatial factor. The first column of Table 4 presents the results obtained from the OLS regression. For the most part, the results are consistent with previous studies in this area. Labor (L) and capital (K) contribute positively and statistically in creating added value. Export (EX) activities positively affect firm productivity, while import (IM) is not statistically significant.

The research results show that the quality of labor (management) positively affects the firm's productivity.

Table 4. ***Experimental Results of Spatial Regression Model with Distance Weighting Values***

Dependent Variable Ln*Y*	**OLS**	**SLM**	**SEM**
Constant	12.793	11.703*	11.822**
t-value	(0.769)	(6.77)	(6.93)
Ln (*L*)	0.393**	0.384***	0.423***
t-value	(3.023)	(3.490)	(3.525)
Ln (*K*)	0.287***	0.252***	0.311***
t-value	(3.188)	(2.810)	(3.887)
Ln (*EX*)	0.119***	0.131***	0.112***
t-value	(3.966)	(4.366)	(3.733)
Ln (*IM*)	–0.011	–0.011	–0.013
t-value	(–0.55)	(–1.11)	(–1.30)
Ln (*Age*)	–0.662	–0.831*	–0.664
t-value	(–1.408)	(–1.932)	(–1.580)
Ln (*QL*)	0.493***	0.392***	0.457***
t-value	(3.286)	(2.801)	(3.515)
Ln (*FDI*)	0.271***	0.243***	0.229***
t-value	(3.857)	(3.471)	(3.816)
Ln (*MW*)	0.817	–0.459	0.167
t-value	(0.675)	(–0.406)	(0.150)
Ln (*GE*)	–0.162	0.042	–0.091
t-value	(–0.623)	(0.175)	(–0.395)

*W**ln *Y*		0.153***	
t-value		(5.101)	
λ			0.344**
t-value			(0.13)
	Statistical Detail		
R-squared	0.671		
F-stat	117.35		
Pseudo-*R*-squared	0.684	0.931	
Log likelihood	–50.617	–47.64	–49.44
AIC	121.38	117.36	118.99
Moran's *I* test	1.751*		
LMlag	5.178**		
LMerr	1.342		
Robust LM lag	3.974**		
Robust LMerr	0.078		
Observation	63	63	63

Note. *t* - values are in parentheses. ***, **,* denotes 0.01, 0.05, 0.10 significance level, respectively.

However, the firm's age (AGE) does not affect the firm's operations. Foreign direct investment (FDI), considered as the source of technological and managerial spillovers, positively affects productivity. Minimum wages Ln(MW) and management expenditure Ln(GE) per province are the regression model's control variables. However, both of these control variables are not statistically significant. In addition, to consider whether there is a spatial element in the data, the I-Moran test is included. Moran's test results of residuals show that there exists cointegration in space. Therefore, the spatial econometric approach will give more consistent results than the OLS regression method. Furthermore, the SLM (LMlag) LM test results and the Robust LM test have indicated that the SLM model is the most suitable.

Columns two and three in Table 4 present the estimated results from the following models: SLM and SEM. The LM and Robust LM test results show that the SLM model is more suitable than the SEM model. Still, the estimation results obtained from the SLM and SEM models share the same statement that there is a positive contribution from factors: labor, capital, exports, firm age, FDI, and labor's education level for firm productivity. However, the minimum amount and level of expenditure of the provincial budget are not statistically significant. Simultaneously, the SLM model results show that the coefficient $\rho = 0.15 > 0$ and statistically substantially confirms that spillovers are one of the crucial factors that increase the speed convergence direction of HCMC's extraordinary urban area expansion. In other words, spillovers from high-productivity firms accelerate productivity convergence. As a result, the industrial sectors and the highly qualified workforce are becoming more and more closely interlinked in the developed industrial clusters surrounding the HCMC, particularly urban areas.

Conclusions and Policy Recommendations

In this study, we are interested in growth poles in Vietnam by experimentally using a spatial regression model applied with combined night light (NTL) and industrial survey data. As shown by night light, the results indicate that urban density has a spatial correlation with industrial density, enterprise productivity, and high labor skills.

This relationship is highly significant in the expanded Ho Chi Minh area. It confirms the existence of a growth pole in Vietnam, where the physical evidence observed by satellite is consistent with the socioeconomic characteristics of the specific urban area of HCMC.

Secondly, the experimental results prove that the estimates from the OLS method will be biased because of spatial error. Therefore, it is more reasonable to improve the traditional method by applying spatial econometric techniques to industrial surveys nationwide. The results of the experiment confirm a positive diffusion of productivity. This result also shows that this positive external environment is one of the factors creating convergence, leading to the formation of a central growth pole in Vietnam.

Third, Vietnam has maintained a decent growth rate for more than 20 years and is a developed country with an excellent middle-income level in the region, with its economy mainly concentrated around the Ho Chi Minh special zone. This growth pole leads to two significant concerns that are related to Vietnam's future development. First, will policies to promote economic growth based on export activities sustain economic expansion in the long run? Second, will the one-center model allow Vietnam to maintain growth in the future? If the government wants long-term growth by establishing a second growth pole, this study would suggest that infrastructure development coupled with supportive policies create a spillover effect like the HCMC urban area. In contrast, the expansion of production and other economic activities will be concentrated around the expanded HCMC metropolitan area.

Limitations of the Study and Scope for Further Research

The study results show that the relationship between light at night and economic activity is strongly correlated. We also find a relatively weak relationship between economic activity and light (especially wages) in rural areas or small and medium-sized cities, but strong in areas with high urban density. The light at night has a relatively close relationship with population density, suggesting that it is a good proxy for studying urbanization across regions of the world. Therefore, this study can be extended in several directions as follows. Firstly, NTL data can be used to study the urbanization rate among vital economic regions of Vietnam. Second, NTL data can be used to study population density variability and population change between urban and rural areas. However, it is beyond the scope of this study and requires significant effort and can be taken up by researchers in future studies.

Authors' Contribution

Dr. Hai Minh Nguyen conceived the idea and developed qualitative and quantitative designs to undertake the empirical study. Dr. Hai Minh Nguyen extracted highly reputed research papers, filtered these based on keywords, and generated concepts and codes relevant to the study design. Both authors verified the analytical methods. The numerical computations were done by Dr. Hai Minh Nguyen using GIS and STATA 19.0.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

Funding Acknowledgment

The authors received no financial support for the research, authorship, and publication of this article.

References

Anselin, L., & Rey, S. J. (2014). *Modern spatial econometrics in practice: A guide to Geoda, Geodaspace and Pysal.* GeoDa Press LLC. https://doi vi&as_sdt=0,5&cluster=5312664891934702193

Aprajita, P., & Pattanayak, J. K. (2018). Impact of firm specific and macro-economic factors on the level of underpricing of initial public offerings (IPOs): Evidence from the Indian market. *Indian Journal of Finance, 12*(2), 7–25. https://doi.org/10.17010/ijf/2018/v12i2/121367

Awadhesh, P. S. (2016). Does technology spillover and productivity growth connection exist? Firm level evidence from the Indian manufacturing industry. *Indian Economic Journal, 63*(4), 561–588. https://doi.org/10.1177/0019466220160401

Blalock, G., & Gertler, P. J. (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics, 74*(2), 402–421. https://doi.org/10.1016/j.jinteco.2007.05.011

Crespo, N., Fontoura, M. P., & Proença, I. (2009). FDI spillovers at regional level: Evidence from Portugal. *Papers in Regional Science, 88*(3), 591– 607. https://ideas.repec.org/e/pcr163.html

Dean Cira. (2011). *Assessment of urbanization in Vietnam*. World Bank (WB). https://kienviet.net/2012/04/16/dean-cira-do-thi-hoa-o-viet-nam-dang-dien-ra-theo-chieu-

Dhamija, R., & Singh, K. (2018). A study on impact of FDI flows on poverty reduction in India. *Prabandhan: Indian Journal of Management, 11*(7), 49 – 62. https://doi.org/10.17010/pijom/2018/v11i7/129942

Duranton, G. P. (2004) Micro-foundations of urban agglomeration economies. In, J. V. Henderson & J. F. Thisse (eds.), *Handbook of regional and urban economics* (pp. 2063–2118). North-Holland, Amsterdam. http://www.science/article/B7P64-4FFPH88/2/4a62facec6b03e872c19df4ff38993f5

Halpern, L., & Muraközy, B. (2007). Does distance matter in spillover? *Economics of Transition,15*(4), 781– 805.

Henderson, J. V., Storeygard, A., & Weil, D. N. (2012). Measuring economic growth from outer space. *American Economic Review, 102*(2), 994 –1028. https://doi.org/10.1257/aer.102.2.994

Himanshu & Anand, D. (2019). Impact of agglomeration economies on productivity firms of pharmaceutical firms of Himachal Pradesh. *Arthshastra Indian Journal of Economics & Research, 8*(6), 17–28. https://doi.org/10.17010/aijer/2019/v8i6/150841

Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. *The Quarterly Journal of Economics, 108*(3), 577–598. https://doi.org/10.2307/2118401

Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review, 94*(3), 605–627. https://doi.org/10.1257/0002828041464605

Kohpaiboon, A. (2006). Foreign direct investment and technology spillover: A cross-industry analysis of Thai manufacturing. *World Development, 34*(3), 541–556. https://www.semanticscholar.org/paper/Foreign-direct-investment-and-technology-

Lychagin, S., Pinkse, J., Slade, M. E., & Reenen, J. V. (2016). Spillovers in space: Does geography matter ? *The Journal of Industrial Economics, 64*(2), 295 – 335. https://doi.org/10.1111/joie.12103

Mariotti, S., Mutinelli, M., Nicolini, M., & Piscitello, L. (2015). Productivity spillovers from foreign multinational enterprises to domestic manufacturing firms: To what extent does spatial proximity matter? *Regional Studies, 49*(10), 1639 –1653. https://doi.org/10.1080/00343404.2013.867428

Marshall, A. (1890). *Principles of economics*. Macmillan.

McCann, P. (2008). Agglomeration economics. In, C. Karlsson (ed.), *Handbook of research on cluster theory* (pp. 22–39). Edward Elgar.

Min, B., & Gaba, K. M. (2014). Tracking electrification in Vietnam using nighttime lights. *Remote Sensing, 6*(10), 9511– 9529. https://doi.org/10.3390/rs6109511

Moreno, R., & Trehan, B. (1997). Location and the growth of nations. *Journal of Economic Growth, 2*(4), 399 – 418. https://doi.org/10.1023/A:1009741426524

Pinkovskiy, M., & Sala-i-Martin, X. (2016). Lights, camera,....income! Illuminating the national accounts-household surveys debate. *The Quarterly Journal of Economics, 131*(2), 579–631. https://doi.org/10.1093/qje/qjw003

Verma, S., & Kaur, G. (2018). Total factor productivity growth of manufacturing sector in Punjab: An analysis. *The Indian Economic Journal, 65*(1– 4), 91–106. https://doi.org/10.1177%2F0019466217727848

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

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