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Impact of metropolises' competitiveness characteristics on structural transformation of provinces in Vietnam: A spatial approach

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Abstract

The uneven development between geographical areas has long been analysed in detail, especially in regard to the relationship between urban and rural areas. However, studies on the impact of the advantages in competitive characteristics of urban areas on rural areas seem to be overlooked. This study, therefore, analyses the effects of metropolises on the structural transformation of provinces based on specific metropolises' competitiveness characteristics. Firstly, Moran's I is used on the share of non-agricultural sectors in the economic structure in order to measure the spatial autocorrelation between provinces in Vietnam as a typical developing country. Furthermore, the relationship between metropolises and the change in the economic structure of provinces is analysed quantitatively using spatial panel data models based on data from the statistics yearbook of all 63 areas in the period 2010 to 2019. The research results confirm the role of metropolises' competitiveness characteristics in the provinces' structural transformation process. Provinces with a high proportion of non-agricultural sectors in their economic structure are concentrated around metropolises. With advantages in competitiveness characteristics, the metropolis is the destination for migration, the origin of remittance, and the market for neighbouring provinces. These roles are seen as driving forces for off-farm activity through changes in the incomes of neighbouring provinces. Accordingly, focusing on specific metropolises' competitiveness characteristics and enhancing regional connectivity will promote effective provincial structural transformation.

Keywords: *competitiveness characteristics, structural transformation, Moran's I, spatial panel data model, Vietnam.*

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1. INTRODUCTION

Structural transformation, which refers to the reallocation of economic activities across the agricultural, manufacturing, and service sectors (Kuznets, 1973), is one of the primary concerns in the development economics literature. This process is critical to the development of any economy, but especially those in developing countries that rely almost entirely on low-productivity agriculture. It is also well known that countries with rapid growth have also experienced significant changes in their economic structure (Rodrik, 2016; de Vries et al., 2015). Structural transformation aids in the efficient allocation of resources and the sustainable increase of productivity (McMillan & Heady, 2014), as well as the creation of opportunities for workers to gain access to better technologies and accumulate capabilities (McMillan et al., 2014; Mujeri & Mujeri, 2021). Moreover, structural transformation helps shape the modern world not just in economic terms. It contributes to the creation of classes, social organisations, social habits, and political movements, while also promoting urbanisation and the forming of new social habits (Rodrik, 2016). Regarding policy, meanwhile, structural transformation is an

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important tool for improving the economy's resilience following shocks and disruptions across various disciplines (van Aswegen & Retief, 2020). As a result, structural transformation determinants have long been studied, and countries' governments have sought to influence these factors in order to develop their economies. However, these determinants have tended to be examined across the entire economy of countries, even though every country has different regions with distinct characteristics and levels of development. This raises the question of whether the competitiveness characteristics of areas with high-level development matter for the structural transformation of areas with lower development. The answer to this question is critical to the literature but will also have key policy implications. Assessing the structural transformation in smaller areas aids in determining the natural origins of this process and provides a comprehensive view of structural transformation determinants so that policymakers can apply more appropriate policies in specific regions.

With more than 35 years of Doi Moi reform implementation, Vietnam is one of the countries that has undergone the fastest structural transformation. The agricultural sector's share in GDP in 1986 was 38.06%, but by 2019, this number was only 13.96%, while the share of agricultural employment decreased from 70.88% in 1991 to 37.22% in 2019. This transformation plays a core role in the impressive development of Vietnam's economy. Once listed as the poorest country in the world in 1990 with a GNP of less than $500 per year, it has become a lower-middle-income country with a GNP of around $1,900 per year (at 2010 constant prices) in 2019. This process is still ongoing, especially at the provincial level, where each locality has unique characteristics. With characteristics similar to most other developing countries, the case study of Vietnam will serve as an excellent example to help provide a comprehensive picture of the ongoing robust transformation process in the economic structure of such countries so that appropriate policies can be applied to them.

The main goal of this study is to explore the effects of the metropolis's competitiveness characteristics on the provinces' structural transformation process. We use the fundamental theories of structural transformation and regional linkages to develop hypotheses regarding the impact of metropolises' competitive characteristics on the structural change in neighbouring provinces. After that, a spatial panel data model is employed to determine whether the structural transformation of provinces originated from metropolises' competitiveness following the spatial approach. The rest of the study is structured as follows. The second section outlines our theoretical framework and develops many hypotheses to help answer the research question. The third section characterises the data and methods, and the fourth section presents the results. The fifth section provides a discussion, and the final section draws a conclusion.

2. THEORETICAL BACKGROUND

2.1. Structural transformation

The factors influencing structural transformation have been investigated in relation to both closed and open economies for a long time. For a closed economy, structural transformation is driven by two mechanisms: changes in income and changes in productivity. The first of these – changes in income – involves differences in the income elasticity of goods, known as non-homothetic preferences. Agricultural products have lower income elasticity than non-farm products (Kongsamut et al., 2001). Therefore, a higher income will increase demand for non-agricultural products, leading to a shift of labor to the non-agricultural sector (Foellmi & Zweimüller, 2008). By analysing data from nearly 40 countries in the post-war period, Comin et al. (2021) indicate that the impact of income plays a key role in most of the reallocation of sectors in the economic structure. The second mechanism – changes in productivity – involves unequal technological progress across industries. Assuming that in an economy with two sectors with different productivity where the output shares of the two sectors are kept constant, an increasing proportion of the labour force will move to the non-progressive sector (Baumol, 1967). According to Gollin et al. (2002), increased agricultural productivity can accelerate industrialisation. In support of this, Ngai and Pissarides (2007) argue that the difference in growth rates of total factor productivity (TFP) in various sectors will shift employment away from sectors with a high rate of technological progress toward low-growth sectors. Sharing the same results, Bustos et al. (2019) indicate that increases in agricultural productivity can shift labour to the industrial sector. However, increased agricultural productivity has only been beneficial in the short run due to increased specialisation in less innovative industries, but this negatively affects manufacturing productivity in the long run. Herrendorf et al. (2014) construct a multi-sector model that incorporates the major existing theories to account for many important aspects of structural transformation and then demonstrates the importance of both mechanisms. Alongside the effects of income and productivity, the role of external factors from outside the country is investigated in the open economy. McMillan et al. (2014) examine the role of globalisation in providing opportunities for countries to encourage investment and achieve structural transformation. According to Teignier (2018), international trade has accelerated the structural transformation of certain countries. Van Neuss (2019) emphasises that outsourcing plays an important role in structural change in both developed and developing countries.

2.2. Metropolises' competitiveness and regional linkages

There have been numerous debates regarding regional competitiveness, mostly centring around the fundamental question of whether different types of areas (cities, regions, or states) can compete with one another. Real life, however, demonstrates that competition occurs at the level of individual regions, for example, in the retention, attraction, and support of companies and individuals who can generate new job opportunities and increase an area's wealth (Jirásková, 2013). It can be seen that urban areas always have outstanding characteristics in development capacity compared to rural areas (Truong Cong, 2021) and that these characteristics play not only a competitive role but also a supporting role in the development of rural areas. Through the growth pole theory, Perroux (1955) argues that the development of geographical regions is unbalanced. This development first occurred at growth points or poles and extended through various channels, affecting the entire economy. Based on the growth pole theory, the core-periphery model of Friedman (1966) detailed the spatial distribution of economic, political, and cultural power in specific regions, including core or dominant regions and the surrounding peripheral and semi-peripheral regions. In such cases, the core region is the centre, typically the metropolis, which holds the dominant power in the economy, a high growth rate, and a strong innovation potential. Meanwhile, the peripheral regions with a lower level of development often depend on the core region.

The effects from the growth pole to neighbouring regions are commonly divided into two types: trickling down and polarisation (Hirschman, 1958; Myrdal, 1957). Trickling down (or spreading effects) will have a positive impact on the surrounding area, including the spillover of investment, innovation, and the ability to absorb the disguised unemployed workforce. By contrast, polarisation (or backwash effects) will negatively affect the development of the neighbourhood, leading to the selective migration of young, skilled, knowledgeable people's expertise and the attraction of capital movement from neighbouring areas to the centre. According to Myrdal (1957), spreading effects tend to be weaker than backwash effects, while Hirschman (1958) argues that spreading effects will eventually exceed backwash effects when

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the centre of a region depends on products from the periphery to expand. In addition, studies by Douglass (1998) and Tacoli (2003) show that, from the spatial perspective, the relationship between the two urban and rural areas is shown through flows with different directions. These include people, goods, production, capital, information, waste, and pollution.

2.3. Hypothesis developments

According to the theories of structural transformation discussed above, the determinants of economic structural transformation include improved productivity and income in the area. Meanwhile, the aforementioned regional linkage theories promote diverse local development, and their interaction results in variation within each region. This indicates that there is a clear connection between the structural transformation of a locality and the link between that locality and other localities. In particular, the effects of regional linkages on local incomes and productivity and boosting non-agricultural activity are likely to spur structural transformation. In this study, the neighbouring provinces of the metropolises have a lower level of development, so they will be considered rural areas, and related hypotheses will be mentioned below.

Remittances and migration always coexist; however, their directions are diametrically opposed. Flows of migration from provinces to cities will create a flow of remittances back to where migrants originated (Mobrand, 2012; Gray, 2009). Furthermore, labour migration from provinces to metropolises is a primary driver of provincial change, particularly transformation in traditional agricultural areas (Ge et al., 2020; Caulfield et al., 2019). The impact of migration on structural change, on the one hand, is reflected in lower agricultural productivity due to a decrease in labour (Taylor & Castelhano, 2016; Shi, 2018; Hussain et al., 2018). Having said this, migration will increase household income through remittances (Nguyen et al., 2017; Samaratunge et al., 2020). These remittances then help to increase agricultural productivity by financing the more significant application of new technologies, pesticides, and chemical fertilisers (Caulfield et al., 2019), thereby reducing the value of labour and causing the gradual elimination of labour in agricultural activities (Bhandari & Ghimire, 2016). The previous literature suggests that the reduction in agricultural labour is offset by remittances from migration (Taylor & Castelhano, 2016; McCarthy et al., 2006). Expenditures of remittances are highly dependent on household characteristics (Adams & Cuecuecha, 2013; Garip, 2014); however, most remittances are used by families for food purchases, clothing, and spending on health care and education. The demand for food is inelastic according to income, while the remaining expenditures are elastic according to income. Hence, higher income creates opportunities for developing local production and service activities (Nguyen et al., 2017). Obviously, the determinants of migration will also determine the effects of remittances. Therefore, separating the effects of migration and remittances is very complex (Taylor & Castelhano, 2016). There will be no remittance if there is no migration. This study aims to understand the impact of metropolises' competitive advantages on the structural transformation of neighbouring provinces, so it only focuses on the determinants of migration and remittances in general rather than disaggregating specific impacts. Meanwhile, the driving force behind migration is often considered in relation to the push-pull theory (Nguyen et al., 2015; Ge et al., 2020). From a metropolis's perspective, job opportunities and higher income levels are the main drivers of migration (Hoffmann et al., 2019; Becic et al., 2019; Yu et al., 2019; Pitoski et al., 2021; Otterstrom et al., 2021). Based on the arguments presented above, the following hypotheses are proposed:

H1: Average income in metropolises positively affects the provinces' structural transformation.

H2: Metropolises' underemployment rate positively affects the provinces' structural transformation.

As metropolises grow in size, so does the demand for surrounding provincial land (Diao et al., 2019), putting pressure on land prices and increasing the opportunity costs of participating in agricultural sectors (Cali & Menon, 2013), in turn moving labour to non-agricultural activities (Cobbinah et al., 2015). Land in metropolises is primarily used for housing and manufacturing (Aguilar et al., 2003); however, some research suggests that migration between provinces and metropolises affects farmland usage in provinces (Qin & Liao, 2016; Caulfield et al., 2019; Ge et al., 2020), so using housing-related factors may result in endogeneity with migration. As a result, we hypothesise that metropolis land-use expansion influences provincial structural transformation as stated below:

H3: The land used for non-agricultural production and business ratio in metropolises positively affects provinces' structural transformation.

Metropolises with a large population serve as a thriving market for goods and services from nearby areas (Otsuka, 2007). Demand for provincial production not only raises provincial household incomes, resulting in the development of the non-farm economy in provinces (Christiaensen & Todo, 2014; Haggblade et al., 1989) but also expands the market for processed foods (Reardon et al., 2016). Thus, the following market effects hypothesis is proposed:

H4: Metropolises' large populations positively affect provinces' structural transformation.

Metropolises are information centres that provide weather information, price volatility, consumer preferences, knowledge, and technology information (Wattenbach et al., 2005). This information assists farmers in increasing their productivity, crop production, and profitability by managing market risk and limiting damage from natural hazards (Ajani, 2014; Ajani & Agwu, 2012). Greater access to information has played a crucial role in the shift away from farming and toward more modern types of work in services and manufacturing (Tacoli, 2003). Hence, the following hypothesis on information effects is proposed:

H5: Metropolises' internet subscribers ratio positively affects provinces' structural transformation.

The manufacturing industry is one of the key non-agricultural sectors. It is typical of urban areas (Monarca et al., 2019) in that it has a high number of linkages with non-agricultural sectors in other localities (Kaur et al., 2009; Chifamba & Odhiambo, 2015). Therefore, manufacturing in a metropolis creates connections and promotes the development and expansion of non-agricultural sectors in neighbouring provinces, ultimately leading to structural transformation. Thus, we formulate the following hypothesis on sectoral linkages:

H6: The gross product of metropolises' manufacturing industries positively affects provinces' structural transformation.

Based on previous studies and empirical evidence, our research framework assumes that the effects of metropolises on structural transformation in provinces are determined by the outstanding competitiveness of metropolises' characteristics (Figure 1).

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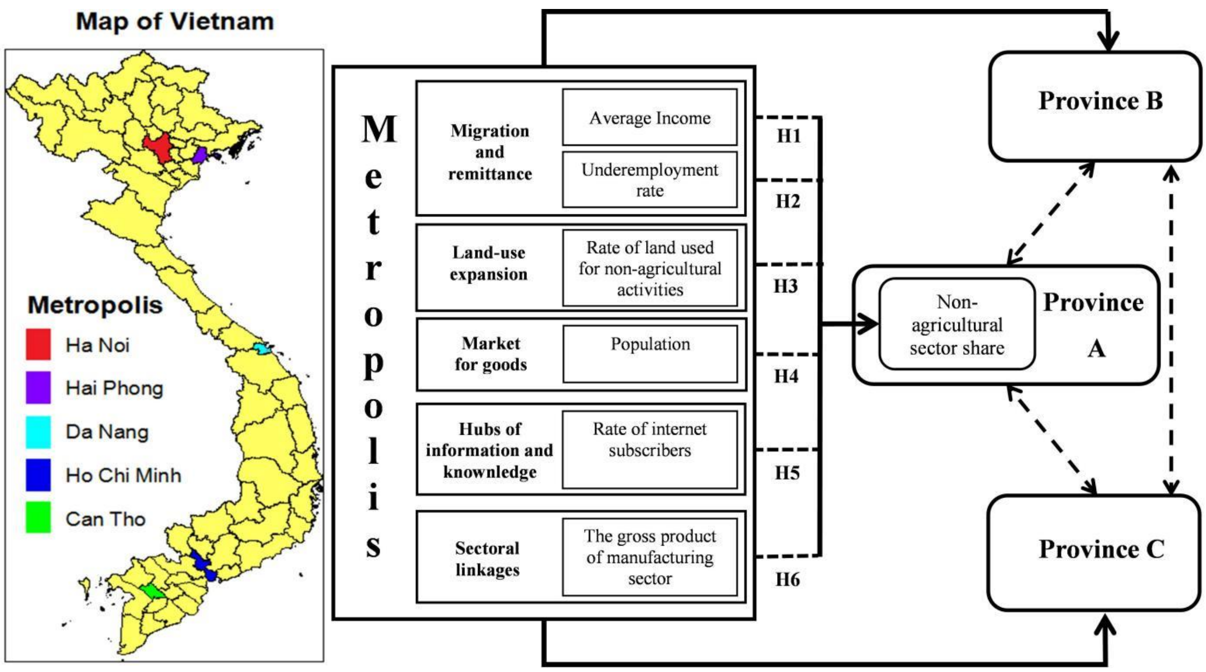

Fig. 1 – Location of metropolises and conceptual framework. Source: Truong Cong (2021)

3. RESEARCH OBJECTIVE, METHODOLOGY, AND DATA

3.1. Methodology

Spatial autocorrelation – defined as the correlation of a variable in one area with itself in nearby territories – is used to measure the degree of dependency between the variables. The spatial autocorrelation can either be positive or negative. It will be positive when the same values of the variable appear geographically together and negative when different values of the variable appear geographically together. Moran's I, which is commonly used to measure and test spatial autocorrelation (Getis, 2008), was first formulated by Moran (1950) as follows:

$$\mathrm{I} = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n}\left[w_{ij}(Y_i-\bar{Y})(Y_j-\bar{Y})\right]}{\left(\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}\right)\sum_{i=1}^{n}(Y_i-\bar{Y})^2} \tag{1}$$

where n denotes the number of provinces; Y_i and Y_j are the non-agricultural sector shares at province i and j, respectively; $\bar{Y}$ is the mean value of the non-agricultural sector shares; and w_{ij} is a weight index of province i relative to j in spatial weights matrix. Spatial weights matrix W=(w_{ij}: i,j =1,…n) describes spatial relations between n provinces. According to normal practice, self-influence was ruled out by assuming that w_{ij} = 0 (when i = j) for all i =1,..,n (so spatial weights matrix W has a zero diagonal). Moran's I values range from +1 to -1, with +1 corresponding to strong positive spatial autocorrelation or clustering, -1 corresponding to high negative spatial autocorrelation or dispersion, and 0 corresponding to no spatial autocorrelation.

Neglecting spatial dependency and spatial heterogeneity while examining geographic regions might lead to bias in regression analysis due to breaches of common assumptions (Anselin, 1988). Endogenous interaction effects, exogenous interaction effects, and correlated effects are three forms of interaction effects that might explain the dependency of an observation in one specific location on observations in another location (Manski, 1993). The Manski model is as follows:

$$Y = \lambda WY + \alpha\tau_N + X\beta + WX\delta + \mu \quad (2)$$
$$\mu = \rho W\mu + \varepsilon$$
$$\varepsilon \overset{\text{i.i.d}}{\sim} N(0, \sigma^2 I_n)$$

where Y is a (N x 1) vector of non-agricultural sector share of provinces; X is a (N x k) matrix of competitiveness characteristics of metropolises; μ is an (N x 1) vector of the error term; WY reflects the endogenous interaction effects; WX reflects the exogenous interaction effects; $W\mu$ reflects the correlated effects; λ is a spatial autoregressive coefficient; ρ is a spatial autocorrelation coefficient; and ι_N is an associated (N x 1) vector with the constant term parameter α, while β and δ are associated (k x 1) vectors with unknown parameter. Various models are obtained by imposing constraints on one or more parameters in this model (Elhorst, 2014). The competitiveness characteristics of metropolises are used as explanatory variables in this research to study the effects of metropolises on provincial structure transformation. At the same time, some provinces receive impacts from the same metropolis; hence, there will be no exogenous interaction effects (WX) in this study. The models we use for analysis include SAC, SAR, and SEM. The model with both endogenous interaction effects (WY) and correlated effects ($W\mu$) is the spatial autoregressive confused model (SAC) (Kelejian & Prucha, 2010). The model with only endogenous interaction effects is the spatial autoregressive model (SAR), which enables us to describe the specific spillover effects of the dependent variable between geographical regions but cannot describe the spillover effects from potential unobservable factors. In contrast, the model with only correlated effects is the spatial error model (SEM), which allows us to determine the spillover effects of unobservable factors between localities but cannot describe the specific spillover effect of the dependent variable. The statistical approach we adopted to determine the optimum regression model relied on the Hausman specification and Lagrange multiplier tests. More specifically, to compare the random effects to the fixed effects, we used Hausman specification tests; to test the absence of each spatial component without having to estimate the unconstrained model, we used Lagrange multiplier (LM) tests.

3.2. Data

Metropolises and provinces: According to Vietnam’s regulations on local administrative units, metropolises are localities with a population size of 1,500,000 people or more and a natural area of 1,500 square kilometres or more. Based on this definition, Vietnam has five metropolises: Hanoi, Ho Chi Minh, Da Nang, Can Tho, and Hai Phong. The remaining areas are provinces.

Spatial data: This data includes geographical information on the localities of Vietnam extracted from the Global Administrative Area Database (GADM). It will provide information regarding the area and location of the localities and can be used to define the spatial weights matrix in spatial autocorrelation and spatial regression analysis of panel data.

Socio-economic data: This data will provide information on the competitiveness characteristics of the metropolises and the proportion of non-agricultural sectors in provinces. The data is taken from 630 observations from the provincial statistical yearbooks of all provinces and metropolises in Vietnam over the ten years from 2010 to 2019. It includes the following: (1) non-agricultural sector share: the ratio of total value-added of industries and services to all economic activities' total value-added; (2) metropolis per capita income: average monthly income per capita in the metropolis; (3) the underemployment rate in the metropolis: the ratio of underemployed people to the total number of people working in the metropolis economy (underemployed people are those who work under 35 hours and are willing and ready to work additional hours in the reference period. They include those who (i) want to do an extra job(s) to increase their overtime; (ii) those who want to replace one of their current job(s) with another job to enable them to work overtime; (iii) those who want to increase the hours of one of their current jobs; and (iv) those who fit a combination of the three criteria above. Someone who is ready to work additional hours if there is a chance to work overtime means that they are ready to do it immediately); (4) the rate of land area used for non-agricultural production and business: the ratio of the land area used for non-agricultural production and business to the total land area of a metropolis; (5) metropolis population: the number of people in the metropolis; (6) the rate of internet subscribers: the ratio of the number of internet subscribers to the total population of the metropolis (an internet subscriber is the registration number entitled to access the Internet. Each Internet subscriber has an account to access the network provided by an Internet service provider (ISP). Internet subscribers include indirect Internet subscribers (dial-up), broadband Internet (xDSL) subscribers, and direct Internet subscribers.); and (7) the gross product of the manufacturing sector: the total value-added of the manufacturing sector.

4. RESULTS AND DISCUSSION

4.1. The descriptive statistics

Table 1 presents descriptive statistics for the variables used in this study. For metropolises' competitiveness characteristics, the monthly per capita income of metropolises in Vietnam (Inc) is approximately VND 4.206 million. However, this value differs significantly between metropolises, with the largest difference being as much as 4.467 million VND. Metropolises' underemployment rate (UDEm) ranges from 0.2 to 4.410%, with an average value of 0.785%. The average percentage of land area used for non-agricultural production and business (Land) in metropolises is 3.406%, while the average percentage of internet subscribers (Inter) in metropolises is 38.073%. The average population of metropolises (Pop) is 4.604 million people, with the population in the largest metropolis being 7.740 million people (17.3 times greater than the population in the smallest metropolis). The total manufacturing industrial product of the metropolises fluctuates between 9.238 and 207.718 trillion VND, with an average value of 84.265 trillion VND. Regarding the economic structure of the provinces, the share of the non-agricultural sector (SnA) averaged 72.341%; however, there was a large disparity between localities. The proportion of non-agricultural sectors in the economic structure is highest in the localities, reaching as high as 93.420%, while the lowest value is only 41.521%.

Tab. 1 – Descriptive statistics of variables. Source: own research

Variables	Description	Mean	SD	Min	Max
Independent variables					
Inc	Average monthly income per capita in the metropolis (million VND)	4.206	1.321	2.243	6.710
UDEm	The underemployment rate in the metropolis (%)	0.821	0.785	0.200	4.410
Land	The rate of land area used for non-agricultural production and business (%)	3.406	1.143	0.578	8.320
Inter	The rate of internet subscribers (%)	38.073	24.247	7.862	72.167

Pop	Metropolis population (million people)	4.604	2.631	0.447	7.740
GPMan	The gross product of the manufacturing sector (trillion VND)	84.265	68.205	9.238	207.718
Dependent variable					
SnA	Non-agricultural sector share (%)	72.341	12.143	41.521	93.420

4.2. Spatial autocorrelation

In the Moran scatter plot (Figure 2), each point represents each observation's value compared with the value of neighbouring observations. The horizontal axis of the scatter graph represents the share of the non-agricultural sector of each province, while the vertical axis indicates the weighted average (averaged values received in neighbouring provinces). The slope of a least-squares regression line through the points is the value of Moran's I. It can be seen that most of the observations are distributed in the upper right and the bottom left (states that the value for the non-agricultural sector share in the area and the value of its neighbourhoods are similar – positive spatial autocorrelation). Therefore, the slope of regression lines is an upward slope. In other words, the almost non-agriculture share of provinces in Vietnam is clustering. Areas located near each other have a similar value to the non-agriculture share in economic structure.

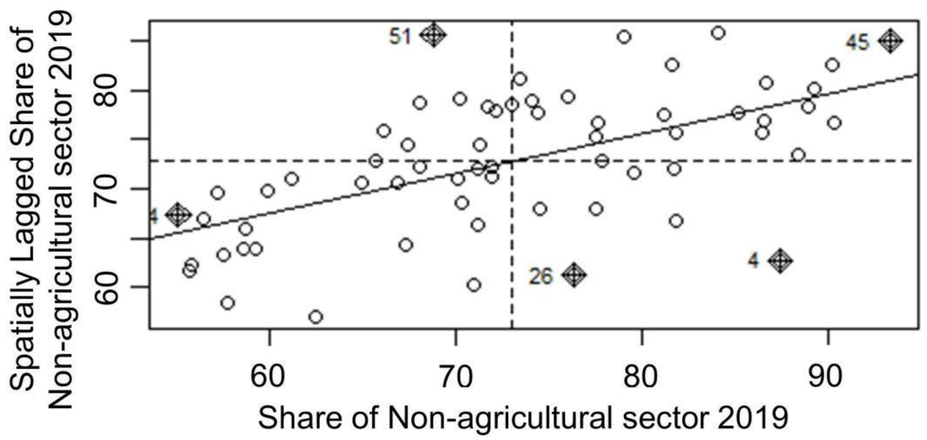

Fig. 2 – Moran scatter plot of non-agriculture share in provinces of Vietnam 2019

Statistically, Moran's I (as shown in Table 2) proves that the non-agriculture share in the economic structure of provinces is not independently distributed over space. The values of this index fluctuate within a small range, with the lowest value being 0.3680 and the highest value being 0.4022 in the period from 2010 to 2019, indicating a strong positive spatial autocorrelation and the clustering phenomenon. In addition, the test results of Moran's I show that the p-value is always smaller than 0.01 over the course of 11 years, which means the hypothesis H_0 (no spatial autocorrelation) can be rejected with significance.

Tab. 2 – Moran's test of the spatial autocorrelation. Source: own research

Year	2010	2013	2016	2019
Moran's I	0.3680	0.3695	0.3734	0.4022
Standard deviate	4.6524	4.6625	4.4698	4.793
Variance	0.0075	0.0076	0.0076	0.0076
P-value	1.641e-06	2.82e-06	3.91E-06	8.215e-07

4.3. Spatial panel data models

According to the results of Moran's I statistics shown above, there is a spatial clustering in non-agriculture share in the economic structure in Vietnam. Therefore, spatial economic models are employed to analyse the relationship between provinces and metropolises. Moreover, to control more effectively for individual heterogeneity or change over time but not across entities, this study collects panel data and analyses the effects of metropolises and provinces.

Tab. 3 – Lagrange multiplier and robust Lagrange multiplier tests. Source: own research

Test	**Null hypothesis**	**Value of Test**	**P-value**
Lagrange multiplier tests (LM)			
LM-Lag	No spatial autocorrelation (λ=0) assuming no random effects (σ_μ^2=0)	13.0651	0.0004
LM-Error	No random effects (σ_μ^2=0) assuming no spatial correlation (λ=0)	15.7762	0.0001
Robust Lagrange multiplier tests (RLM)			
RLM-Lag	No spatial autocorrelation (λ=0) assuming the possible existence of random effects (σ_μ^2>=0)	0.3560	0.5823
RLM-Error	No random effects (σ_μ^2=0) assuming the possible existence of spatial autocorrelation (λ>=0)	3.0141	0.0886

The results of the Lagrange multiplier tests (LM), as presented in Table 3, suggest that it is impossible to conclude that the appropriate spatial effect will be used in the model when both LM-Lag and LM-Error tests give a P-value < 0.01. Furthermore, the results of the robust Lagrange multiplier tests (RLM) show that both the RLM-Lag and RLM-Error tests are not significant at the 5% level even though the RLM-Lag test has P-value = 0.5823 is higher than the P-value = 0.0886 of the RLM-Error test. From here, it is possible to eliminate the possibility of there being a combination of both spatial effects in the model or the SAC model. However, it is not possible to choose between SAR and SEM models, so both SAR and SEM models are considered.

Tab. 4 – Spatial panel data models. Source: own research

Variables	**Spatial autoregressive model (SAR)**		**Spatial error model (SEM)**	
	Fixed effects	Random effects	Fixed effects	Random effects
Constant		37.0231*** (11.4217)		53.2876*** (16.7721)
Inc	0.7120*** (3.7321)	0.7305*** (4.1032)	1.0629*** (4.6801)	1.3271*** (4.9206)
UDEm	-0.4781* (-1.7981)	-0.3947 (-1.2736)	-0.4840* (-1.7121)	-0.3329 (-1.1886)
Land	2.5443 (0.5861)	1.7208 (1.0891)	4.0156 (0.9831)	1.5417 (0.9328)
Inter	0.1265 (1.2171)	0.1624** (2.5531)	0.1157 (1.3126)	0.1901*** (3.2361)
Pop	0.4371** (2.1225)	0.3898* (1.7216)	0.5218** (2.3056)	0.4104 (1.3551)
GPMan	0.0166	0.0047	0.0192	-0.0014

	(0.8012)	(0.1541)	(0.7428)	(-0.2604)
Spatial lag for the dep. variable (λ) Lambda	0.2447*** (4.5605)	0.3021*** (4.9930)		
Spatial lag for error components (ρ) Rho			0.3237*** (3.6002)	0.3775*** (3.8966)
Robust Hausman test	66.2142***		97.5063***	
Log-likelihood	-622.6701	-754.428	-1120.6723	-809.6623
AIC	1206.5523		2206.7612	
BIC	1543.7760		2517.0069	

Notes: Standard deviations are shown in brackets. Significance: *p < 0.1, ** p < 0.05, *** p < 0.01.

The robust Hausman test was used to compare random effects and fixed effects models for spatial panel data (Arbia, 2014; Elhorst, 2014). The test results shown in Table 4 indicate that the strong Hausman test for both the spatial lag of the dependent variable and the spatial lag error has a p-value < 0.01. This result means we must reject the null hypothesis regarding the absence of correlation between individual effects and explanatory variables (significant at the 0.01 level). Therefore, fixed effects will be considered in the selected spatial econometric models. The Akaike criterion of specifications (AIC) is used for model selection. With these criteria, the model with the lowest AIC value is selected, which is biased towards the SAR model (AIC = 1206.5523). In other words, the most suitable model for simulating the structural transformation at the provincial level in Vietnam is the endogenous interaction effect (SAR) model. Based on the results from Table 4, it can be seen that the variables Inc, UDEm, and Pop are all statistically significant. More specifically, the variables Inc and Pop positively impact the proportion of non-agricultural sectors in the economic structure, while the variable UDEm has a negative impact. This helps to strengthen hypotheses H1, H2, and H4. In contrast, the variables Land, Inter, and GPMan are not statistically significant at the 5% level, meaning that hypotheses H3, H5, and H6 are not supported.

From the results of the spatial model analysis with panel data, it can be seen that the impact of metropolises on the economic structure of neighbouring provinces is most clearly evident in the process of migration and remittance. As a destination for labour from neighbouring localities and as a source of funds through remittance (Mobrand, 2012; Gray, 2009), metropolises contribute to raising the income of households in provinces, promoting the development of non-agricultural activities, thereby helping to transform the economic structure. This is consistent with the findings of Truong Cong (2021), Ge et al. (2020), and Nguyen et al. (2017). More specifically, metropolises are characterised by high per capita income and the provision of a wide range of jobs and job characteristics, thus attracting a large number of workers across multiple areas who want to increase their income and find suitable work (Pitoski et al., 2021; Hoffmann et al., 2019). After leaving the locality to work in metropolises, workers will send money back to their families in their place of origin. The amount of money received from migrants will increase the consumption of non-agricultural goods, thereby promoting the development of non-agricultural activities (Nguyen et al., 2017). Interestingly, the impact of metropolises' income characteristics on structural change in localities is spillover. In other words, the increase in income in metropolises not only increases the proportion of non-agricultural industries in one locality but also spreads to other localities. However, the reduction in the metropolises' underemployment rate only directly impacts the economic structure of specific localities while not having an indirect effect on neighbouring localities.

As a consumption market for products from the neighbourhoods, metropolises with the characteristics of a large population and large consumer demand for goods will help to solve the output issues for products as well as raise the income of the people who live in the regions (Christiaensen & Todo, 2014; Haggblade et al., 1989). In addition, the demand for products in metropolises is very diverse, especially the need for processed foods. This promotes the development of non-farm activities in neighbouring provinces to integrate into production processes serving metropolises' markets (Jayne et al., 2018; Reardon, 2015). However, the increase in population in metropolises also directly impacts the rise in the share of non-agricultural sectors in the economic structure of a particular locality while not having an indirect effect on the economy of neighbouring localities.

The need for metropolises' land expansion has been shown to impact structural change in neighbouring localities in previous studies (Cobbinah et al., 2015; Thuo, 2013). These studies use residential land as a proxy for metropolises' land-expanding effects, which is acceptable when analysing the single impact of metropolises' land expansion on neighbouring provinces because land use expansion in metropolises is done for multiple purposes, including residential development and service production activities. However, when considering the overall impact of metropolises on provincial structure transformation, if residential land is used as an explanatory variable, it will likely violate the phenomenon of correlation with another characteristic of the metropolises, population. Therefore, in this study, the proportion of land used for non-agricultural production and business – instead of residential land – is employed as a proxy for metropolises' land expansion. The research results indicate that the expansion of land use in metropolises may affect the economic structure of neighbouring localities; however, this impact may be primarily caused by pressure on residential land demand, while there is no evidence that the increase in land use for non-agricultural production and business purposes in metropolis areas will affect the structural transformation in neighbouring provinces.

The manufacturing industry, which is among the industries most typically found in metropolises, is considered to be highly connected (Monarca et al., 2019; Kaur et al., 2009). Therefore, the development of this industry in metropolises is expected to promote the development of non-agricultural activities and structural transformation in neighbouring provinces. However, the results suggest that this impact is not significant in the case of Vietnam. The main reason is that the linkages between industries are still very weak (Cong, 2022; Demont & Rutsaert, 2017). Such a lack of connectivity between sectors will limit the ability to integrate production activities in the value chain, leading to inefficient production support and the inability to promote non-agricultural activities.

It has also been shown by previous studies that the role of the information and knowledge hub of metropolises will make a significant contribution to the process of structural change in neighbouring provinces (Truong Cong, 2021; Tacoli, 2003). However, even though the effect was positive, the results in this study were not statistically significant. This difference stems from the addition of spatial factors to the model, which previous studies have overlooked. In fact, the role of metropolises as information and knowledge centres cannot be denied, but in the case of Vietnam, the contribution of this role may be insignificant when the system of communication used to transmit such information remains limited.

From the above analysis, it can be seen that metropolises play an essential role in the structural changes that take place in neighbouring provinces through particular functions. Based on these functions, policymakers can effectively develop options to promote the structural transformation of localities. With limited resources, policymakers can focus on specific competitiveness characteristics in metropolises instead of spreading their investments across all localities. Policies related to income and employment opportunities are remarkably suggested when the impact from income is spillover to the whole region. In addition, the development of commodity markets for neighbouring localities should also be considered. Using the available infrastructure, metropolises must develop distribution systems in their markets and more fully exploit both domestic markets and international markets. In addition, it is crucial to invest in and upgrade infrastructure and communication systems between provinces and metropolises. This will help people access information and knowledge in a timely manner, thereby making it easier to make adjustments to production and business activities. In particular, it should be noted that any local development policy needs to be placed in regional linkages linked with metropolises to bring into full play the resources that are available.

5. CONCLUSION

This study analyses the effects of metropolises' competitiveness characteristics on the structural transformation of neighbouring provinces in Vietnam using a spatial regression model with panel data. Our results indicate that there is spatial autocorrelation in the proportion of non-agricultural sectors between localities, with a high proportion of non-agricultural sectors in the economic structure being concentrated around metropolises. Metropolises contribute to provincial structural change based on specific competitiveness characteristics. In particular, they play a clear role in attracting migrant workers and providing remittances. In addition, the metropolises market provides opportunities for the development of non-agricultural activities while also promoting structural transformation in neighbouring provinces. Based on our findings, we propose several policies to promote the structural transformation of the provinces in Vietnam through metropolises, such as the policy of allowing liberal migration, supporting labourers looking for suitable jobs in metropolises, and offering budget packages to help build a network connecting product consumption markets in which the metropolises' markets will play the central role. Furthermore, the provinces themselves also focus on creating an environment designed to diversify economic activities for labourers in which they can access suitable jobs, which in turn boosts overall income and expands the market for local products. In general, this study has extended the scope for understanding the structural transformation of geographic regions. The factors promoting structural change not only appear within an individual locality but also include impacts from neighbouring localities, especially areas with a greater level of development. Our results also reinforce the necessity of integrating spatial factors in the analysis of the change in the structural transformation of specific geographical areas, which has often been overlooked in other studies before. The addition of a spatial element to studies related to geographical areas will thus become necessary. Moreover, this study uses the adjacency weight matrix in the correlation analysis between localities while also simplifying the relationship when assuming the provinces will be affected by the nearest metropolises. In the case of using another type of matrix, such as a distance matrix, the estimation result will produce the same result if it is assumed that the localities interact within a radius of fewer than 75km, and results will vary with different distance threshold assumptions. Therefore, to improve the validity of the research, we propose that a deeper examination of the effect of distance on specific metropolises impacts be undertaken. It should also be noted that, because this study focuses on the impact of specific competitive characteristics of metropolises on the structural transformation of provinces, the factors affecting the linkages between localities, such as transport systems, type of terrain, or public policies regulated by the government, have been simplified. However, in reality, these factors have specific vital effects, especially in socialist countries like Vietnam, where public policies always play a significant role in economic activities. These limitations can be addressed in future studies.

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