Study on Spatial Evolution and Influencing Factors of High-quality Development of Logistics Industry in Yangtze River Economic Belt

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Abstract. The Yangtze River Economic Belt is not only an important hub for interaction and cooperation between the Middle East and the west, but also has a high-standard and efficient transportation network based on the Yellow River waterway construction. It is of great significance to study how its logistics industry can achieve high-quality development. Based on the panel data of 11 provinces and cities in the Yangtze River Economic Belt from 2011 to 2020, this paper uses spatial autocorrelation model to determine the regional differences of high-quality logistics development, and explores the three major influencing factors of regional imbalance through geographically weighted regression analysis. It is found that there is a significant spatial positive correlation between the high-quality development of logistics in various provinces in the region, and the gap between upstream and downstream is obvious; At the same time, for economic factors, enterprise factors and population factors, the upstream region is more sensitive to population size, while the downstream region pays more attention to economic level, which reflects the different development stages of logistics industry in different regions. Therefore, it is the only way to grasp the different characteristics of different regions and realize overall coordination and high-quality industrial development according to local conditions.

Keywords: Logistics industry; High quality development; Regional differences; geographically weighted regression.

1. Introduction

The 14th Five-Year Plan for People's Republic of China (PRC)'s National Economic and Social Development and the Outline of the Long-term Goals in 2035, which was voted by the Fourth Session of the 13th National People's Congress in March, 2021, pointed out that it is necessary to "comprehensively promote the development of the Yangtze River Economic Belt and give full play to the overall advantages of industrial synergy". Since then, the 14th Five-Year Plan for Modern Logistics Development issued by the General Office of the State Council has shown a "new blueprint" for the high-quality development of modern logistics, in which it is mentioned that "the modern logistics system should be adapted to supply and demand. However, there are still some problems in China's logistics industry, such as regional information sharing and unbalanced resource allocation. Take the Yangtze River Economic Belt as an important strategic development economic belt in China, the industrial development between its upstream and downstream is extremely unbalanced, and the "Matthew effect" is remarkable. Therefore, it is of great significance for the industry to realize high-quality development to explore the reasons, development status and influencing factors of regional synergy.

2. Research methods

2.1 Index system construction.

After the 14th Five-Year Plan of Modern Logistics was issued by the State Council in May, 2022, relevant scholars pointed out that "building a modern logistics system is of great significance for building a new development pattern and promoting high-quality development", and at the same time indicated that the development of modern logistics needs to start from five power points, namely "building a system, optimizing configuration, strengthening service, promoting innovation and optimizing environment". By referring to relevant literature[1][2], the sample span is from 2011 to 2020.

Table 1 Comprehensive Evaluation System of High-quality Development of Logistics Industry

System layer	Decision-making level	Index layer	Attribute
System construction	Logistics infrastructure construction	Highway density	Positive
		Railway density	Positive
		Postal path density	Positive
	Logistics industry scale	Number of employees in transportation industry	Positive
		Added value of transportation industry	Positive
	Network construction	Optical cable line length	Positive
		Internet broadband access port	Positive
Configuration optimization	Transport structure	Proportion of railway transportation	Positive
		Specific gravity of waterway transportation	Positive
	Transportation equipment	Number of trucks owned by highway operation	Positive
		Number of civil motor carriers	Positive
Service coordination	Industrial synergy	The GDP proportion of transportation industry in the tertiary industry	Positive
		Total retail sales of social consumer goods	Positive
	Business stock	Rotation volume of goods	Positive
		Total postal service	Positive
		Express delivery volume	Positive
	Urban-rural synergy	Rural delivery route	Positive
Innovation and opening up	Science and technology investment	Number of patent applications for industrial enterprises above designated size	Positive
		R&D funds of industrial enterprises above designated size	Positive
		Full-time equivalent of R&D personnel in industrial enterprises above designated size	Positive
	Opening up to the outside world	Total export-import volume	Positive
		Actual utilization of foreign capital	Positive
Improvement of environment	Environmental protection	Green coverage rate	Positive
	energy consumption	Total coal consumption	Negative
		Total oil consumption	Negative

Data sources: China Energy Statistical Yearbook, National Bureau of Statistics and statistical yearbooks of provinces.

2.2 Entropy weight method

First of all, data processing, which is divided into positive index processing and negative index processing.

Positive index：

$$x'_{ij} = \frac{X_{ij}-min(X_{1j},X_{2j},...,X_{nj})}{max(X_{1j},X_{2j},...,X_{nj})-min(X_{1j},X_{2j},...,X_{nj})} \quad (1)$$

Negative index：

$$x'_{ij} = \frac{max(X_{1j},X_{2j},...,X_{nj})-X_{ij}}{max(X_{1j},X_{2j},...,X_{nj})-min(X_{1j},X_{2j},...,X_{nj})} \quad (2)$$

Where i represents indicator, j represents object, which is the initialized data value of the j object of the i indicator, and x'_{ij} is the normalized data value of the j object of the i indicator.

Secondly, calculate the information entropy.

$$E_j = -\frac{1}{\ln n}\sum_{i=1}^{n}\frac{x_{ij}}{\sum_{i=1}^{n}x_{ij}}\ln\frac{x_{ij}}{\sum_{i=1}^{n}x_{ij}} \quad (3)$$

Again,determine the weight.

$$w_j = \frac{D_j}{\sum_{j=1}^{n} D_j} \tag{4}$$

$$D_j = 1 - E_j \tag{5}$$

Finally, the comprehensive score of the high-quality development level of logistics in each province is calculated.

$$Z_j = \sum_{j=1}^{n} w_j x_j \tag{6}$$

2.3 Spatial autocorrelation model

Global Moran index[3][4]:

$$\mathrm{I} = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{7}$$

Where w_{ij} is the spatial weight matrix, which is taken from the 0-1 matrix, that is, the value is 1 when they are adjacent, and 0 when they are not adjacent; $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$; x_i and x_j represent the comprehensive scores of cities i and j.

Local Moran index:

$$I_i = \frac{n(x_i-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sum_{j=1}^{n} w_{ij}(x_j - \bar{x}) \tag{8}$$

2.4 Geographically weighted regression analysis

In this paper, GWR analysis method is used to study the variable correlation between regions[5][6].

$$y_i = \beta_0(u_i, v_i) + \sum_{m=1}^{p} \beta_m (u_i, v_i) x_{im} + \epsilon_i \tag{9}$$

Among them, y_i represents the comprehensive score of logistics quality of province i, (u_i, v_i) represents the geographical coordinates of province i, x_{im} represents the m-th influencing factor of province i, and ϵ_i represents random error.

3. Empirical research and analysis

3.1 Comprehensive score analysis

The comprehensive score level of logistics high quality in the Yangtze River Economic Belt increased from 0.2756 in 2011 to 0.3034 in 2013, and the promotion rate reached 10.09%. After 2013, it dropped sharply, and the decline rate reached 29.53% in 2017. After 2017, it rose slowly, but the overall level in 2020 still did not reach the level in 2011. Observing Figure 1, we can see that among the 11 provinces in the Yangtze River Economic Belt, all provinces except Anhui declined to varying degrees after 2015, and then rose again after 2017, especially Jiangsu Province, which has been ranked first in comprehensive score during the sample period, was surpassed by Anhui Province in 2016. The reason is that the growth rate of China's logistics industry continued to decline in 2015, with the first negative growth since the financial crisis in 2009. However, 2015 is the year when China put forward the strategy of building a "the belt and road initiative" in an all-round way. With the leap-forward promotion of the closing year of China's "Twelfth Five-Year Plan", the domestic environment began to pick up after a short trough.

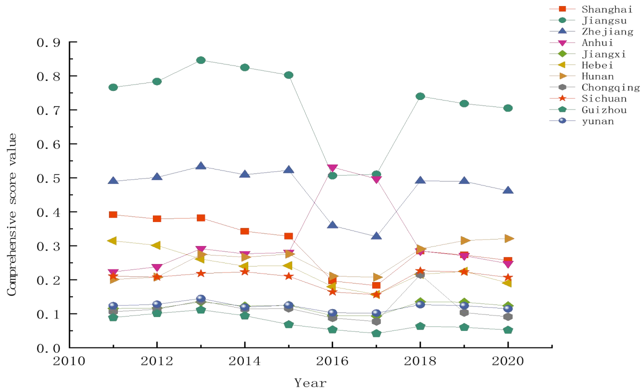


Fig. 1 Comprehensive scoring chart of logistics high-quality development level

3.2 Spatial autocorrelation result analysis

3.2.1 Analysis of global spatial autocorrelation results

Observing the change trend of the overall Moran value of high-quality logistics development, as shown in Figure 2, the overall Moran value of high-quality logistics development in the Yangtze River Economic Belt showed a downward trend during the sample period. The reason is that even though the country has gradually increased its economic investment in the logistics industry in the Yangtze River Economic Belt in recent years, in 2018, the Economic Information Daily stated that "there is a serious problem of information separatism in the Yangtze River Economic Belt, and the phenomenon of information hardening across administrative regions and means of transport is prominent, which has seriously affected the logistics efficiency". The current situation of "fragmentation" between the upper and lower reaches has separated the intensive development of the logistics industry in the Yangtze River Economic Belt and increased the development differences between different regions.

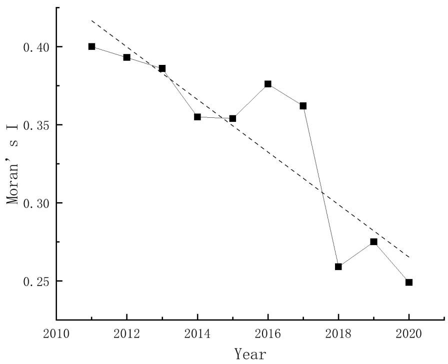


Fig. 2 Global moran value trend diagram

3.2.2 Analysis of local spatial autocorrelation results

In this paper, the local Moran index is used to explore the agglomeration of 11 provinces. The areas in the first quadrant (HH) all have similar high development levels. The area in the second quadrant (LH) represents that the development level of this area is lower than that of the adjacent areas; The areas in the third quadrant (LL) all have similar low scores. The area in the fourth quadrant (HL) represents that the development level of this area is higher than that of the surrounding areas.

As can be seen from Figure 3, in 2015, there were 3 regions in the first quadrant of HH, and 6 regions in the third quadrant of LL, accounting for 81.8% of the total. In 2020, there are 3 regions in the first quadrant of HH and 5 regions in the third quadrant of LL, and the regions with positive spatial correlation account for 72.7% of the total. Among them, Shanghai, Jiangsu and Zhejiang were in the first quadrant of HH in 2015; Hubei, Hunan, Chongqing, Sichuan, Guizhou and Yunnan are in the third quadrant of LL. On the whole, the upstream of the Yangtze River Economic Belt is in the third quadrant of LL, and the downstream is in the first quadrant of HH. By 2020, Hunan Province will be transformed from LL area to the fourth quadrant of HL, which shows that the development speed of high-quality logistics in Hunan Province is significantly faster than that in surrounding cities. Generally speaking, there is obvious polarization in the high-quality development of logistics. The backward economic development in the upper reaches and the unbalanced development of logistics industry seriously restrict the high-quality and intensive development of logistics. The economy of the downstream region is relatively developed, and the phenomenon of logistics industry agglomeration is obvious. The regions develop synergistically and promote each other, which widens the development distance from the middle and upper reaches and intensifies the development differentiation.

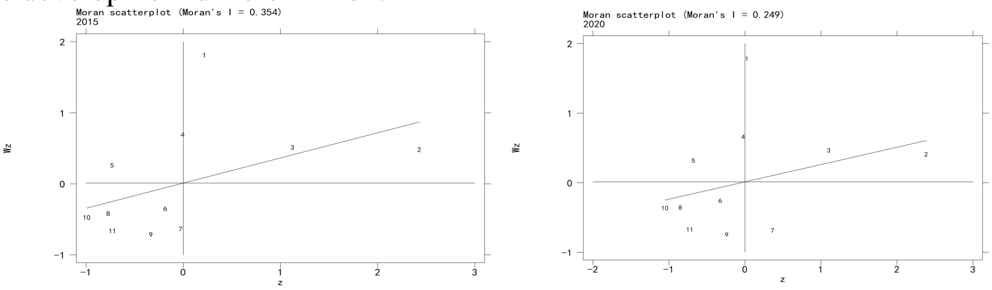


Fig. 3 Local Moran Scatter Map of Yangtze River Economic Belt in 2015 and 2020

3.3 Geographically weighted regression result analysis

As shown in Table 4, the bandwidth of the model is calculated by AICc, and the goodness of fit is 0.583.

Table 4 GWR model parameter results

model parameter	Bandwidth	Residual Squares	Effective Number	Sigma	AICc	R2	R2 Adjusted
numerical value	208.779386	0.150843	4.006807	0.146867	6.063099	0.582667	0.403229

Influencing factor 1: per capita GDP

On the whole, the influence of GDP per capita on the high-quality development of logistics in the Yangtze River Economic Belt is in a positive spatial correlation, and Moran index is positive. As shown in Figure 4, the regression coefficient from west to east is gradually strengthened. Chongqing, Yunnan and Sichuan in the west have the lowest but still positive regression coefficients, while Zhejiang, Shanghai and Jiangxi in the east have the highest regression coefficients. This shows that the economic development of the Yangtze River Economic Belt will support the logistics industry to achieve high-quality development to a certain extent. In addition, from the perspective of the degree of influence, the high-quality development of logistics in the economically developed downstream areas is more sensitive to the impact of economic factors.

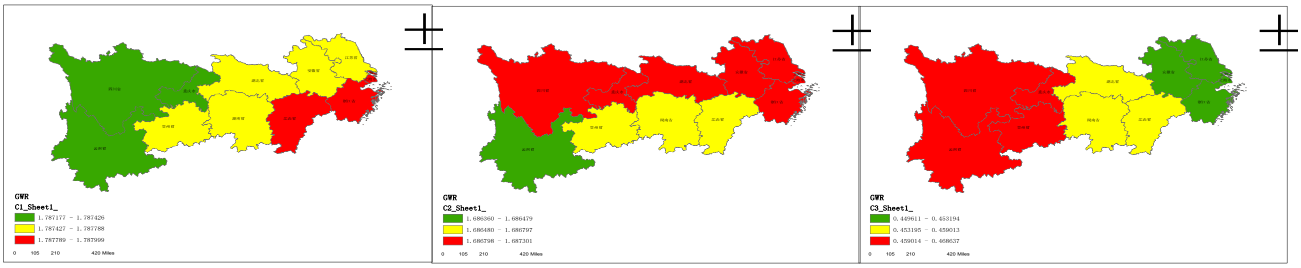
Influencing factor 2: the number of transportation enterprises

The number of enterprises in the transportation industry in the Yangtze River Economic Belt has a positive impact on the high-quality development of logistics, and gradually decreases from north to south. As shown in Figure 5, among the eleven provinces and cities, six provinces and cities in the north are all high-impact areas, and the regression coefficients of Guizhou, Hunan, Jiangxi and Zhejiang provinces in the south are low, while the regression coefficient of Yunnan Province is the lowest but still positive. This shows that the scale of logistics enterprises in the Yangtze River Economic Belt has a positive impact on the high-quality development of logistics in different degrees, and it has a greater impact on the northern region.

Influencing factor 3: population density of provinces

The influence of population size on the high-quality development of logistics in the Yangtze River Economic Belt is positive in all regions, showing obvious positive correlation. As shown in

Figure 6, the urban population size gradually decreases from west to east in the Yangtze River Economic Belt, with the highest regression coefficient in the upper reaches of the west, followed by the middle provinces and cities, and the lowest regression coefficient in the lower reaches, but still positive. This shows that the population size of the Yangtze River Economic Belt has a positive role in promoting the high-quality development of logistics. In addition, compared with the downstream areas, the logistics enterprises in the upstream areas are more inclined to labor-intensive industries, so they are more sensitive to the influencing factor of urban population size.



A. Spatial heterogeneity difference map of per capita GDP; B. Spatial heterogeneity difference map of the number of transportation enterprises; C. Spatial heterogeneity difference map of population density

Fig. 4 Analysis diagram of influencing factors of GWR

4. Summary

The agglomeration phenomenon of high-quality logistics development in the Yangtze River Economic Belt is remarkable, and there is room for optimization. At the same time, the spatial difference is obvious and the polarization phenomenon is serious, which hinders the interconnection between regions. It is particularly important to explore the key influencing factors in different regions so as to manage the Yangtze River Economic Belt in different regions. In the exploration of the factors affecting the high-quality development of logistics in the region, this paper only selects three macro-level factors, and finds that the logistics industry in the upstream region is more labor-intensive, while the logistics development in the downstream region is more sensitive to economic factors. When formulating policies, for the upstream region, the economic development is relatively backward, so accelerating the level of regional scientific and technological innovation and promoting the upgrading of logistics industry are the top priority; For the downstream areas, the economic situation is relatively developed and the level of informatization is relatively high, so it is particularly important to give full play to the advantages of regional resources and promote the coordinated development of surrounding areas.

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