Empirical Research on Economical Spillover Effect of Guangdong-Hong Kong-Macao Greater Bay Area on Surrounding Cities Base on Spatial Big Data

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Abstract. Using TOPSIS evaluation method, the comprehensive strength of cities were calculated and evaluated according to some economic indicators of Guangdong-HongKong-Macao Greater Bay Area (GBA) and surrounding cities in 2021, and the social network analysis tool was used for empirical research to analyze the economic spatial connection between GBA and the surrounding cities in Guangdong. It found that the overall network connection of urban agglomeration depends on the radiation of core cities Hong Kong, Guangzhou and Shenzhen. There was a lack of reasonable gradient central cities. The surrounding cities in eastern, northern and western Guangdong were less affected by cities in GBA. There was a risk of isolation in marginal cities. The research showed that the coordinated development pattern of cities in the economic network of GBA urban agglomeration had initially taken shape. The economical spillover effect of GBA on the surrounding cities of Guangdong were beginning to show.

Keywords: Guangdong-HongKong-Macao Greater Bay (GBA) · Economical spillover effect · Economic Network Structure · Spatial Big data

1 Introduction

The economic development of urban agglomerations presents an unbalanced state, resulting in economic spillover effects. Studying the economic spillover effect of urban agglomeration can grasp the flow law of different production factors and business activities in the region, and provide a scientific basis for promoting regional economic development.

The current researches on economic spillover effect mainly focuses on the input-output of regional factors, the spillover effect and feedback effect on regional economic development, and the role of spillover effect in different spatial distances. Qin Chenglin et al. (2012) [1] found the law of convergence between spatial spillover and regional economic growth through the research on the economic spatial links between cities in the Yangtze River Delta. Yu Lu (2013) [2] found that economical spillovers are more significant to the economic growth of adjacent cities, making the economic growth of

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adjacent cities more dependent on the spatial dimension. Wang Xuehui et al. (2016) [3] found that market potential, geographical distance and other factors are closely related to the spillover effect of economic growth. Xiao Yahong and Guo Shiping (2018) [4] based on the relevant economic indicators in the statistical yearbook, used the Moran index to analyze the economic radiation effect of GBA. Xu Fangyan and Chen Kunming (2019) [5] calculated the spatial relevance and spillover effect of the economic growth of GBA urban agglomeration based on the economic data of recent 15 years, and found that capital is an input factor with strong leverage in GBA at this stage, while the impact of labor input on its economic growth is relatively limited, and concluded that the spatial spillover effect of the economic growth of the cities in GBA is strong, There is obvious economic cooperation and other conclusions.

From the perspective of research methods, many scholars have applied network analysis to the study of regional urban economic networks, such as Hou Fuhui et al. (2009) [6] by building economic links between cities in the Yangtze River Delta, they use network analysis to make accurate judgments and measure the regional economic structure. Li Jing et al. (2014) [7] used the network analysis method to describe the characteristics of the spatial correlation network of regional economic growth, used the block model to block the overall network, re deconstructed the spatial relationship of China's regional economic growth, and used the QAP method to explore the influencing factors. Liang Jingwei et al. (2015) [8] studied the spatial economic ties of the China ASEAN Free Trade Area from the perspective of urban agglomeration network, based on the analysis methods of access, core, edge and other social networks. The results showed that the cities in the free trade area were closely linked, and there was also a circle structure of core and edge, in which China occupied an important position in the network.

Although scholars have carried out more theoretical and empirical research on the bay area economy, there are few studies using spatial big data to examine the spatial interaction and coordinated development behind the construction of GBA urban agglomeration from the perspective of urban agglomeration economic spatial structure and regional integrated development. The research of urban economic space needs the data of logistics, capital flow, people flow and so on. The development of spatial big data technology makes it possible to collect urban flow data.

This paper takes the urban agglomeration of GBA and the surrounding urban agglomeration as the research object, uses the theories of economic correlation, spatial connection and spatial spillover in the new economic geography, comprehensively evaluates the urban competitiveness, constructs the economic spillover effect and spatial econometric model, studies and analyzes the spatial spillover effect of the economic growth of GBA and studies the economical spillover effect of GBA on the surrounding cities.

2 Research Methods

2.1 Evaluating City Comprehensive Strength

For the evaluation of city comprehensive strength of 21 prefecture level cities in Guangdong Province and the two special administrative regions of Hong Kong and Macao, we use the evaluation index system from Peng Fangmei (2017) [9] for reference, and select

12 indicators such as GDP (RMB 100 million), total population (10 thousand people), total import and export (US $100 million) and employment (10 thousand people) to build the evaluation index system of city comprehensive strength according to the principles of data availability and comprehensiveness.

It use TOPSIS to evaluate the comprehensive strength of 21 cities in Guangdong Province and two special administrative regions of Hong Kong and Macao. TOPSIS evaluation method is a multi-index evaluation method. By constructing the positive ideal solution and negative ideal solution of the evaluation problem (the maximum and minimum values of each index) and by calculating the relative closeness of each scheme to the ideal scheme (the degree of approaching the maximum value and far away from the minimum value), the comprehensive evaluation value is calculated to sort the schemes, so as to select the optimal scheme. The scores obtained through TOPSIS evaluation method were used as the scores of city comprehensive strength.

2.2 Economic Gravity Model

The economic connection of urban agglomeration is mainly measured by the measurement of economic spatial connection. At present, the mainstream model algorithm is quantitatively measured by gravity model. Hou Fuhui et al. (2009) [9] proposed that a variety of factors should be considered when describing the interaction between cities. It is not comprehensive to measure the interaction between cities only by three factors: population, GDP and distance. Peng Fangmei (2017) [9] in the analysis model for measuring the internal spatial network connection characteristics of GBA and the surrounding cities, 12 indicators including GDP, total population, total import and export, general fiscal expenditure and total retail sales were selected to comprehensively evaluate the influence of the city. Using this method for reference, this paper calculates the urban comprehensive strength evaluation score Vi by using 12 indicators including urban population and urban GDP to replace the two indicators Pi (Population of City i) and Gi (GDP of City i) in the original formula as the data for measuring the urban mass gravity. According to the directionality of the connection between cities, the revised calculation model is as follows:

$$R_{i\to j} = \frac{V_i}{V_i + V_j} * \frac{\sqrt{V_i V_j}}{D_{ij}^2} \tag{1}$$

Where Ri → j represents the strength of one-way economic connection between city i and city j. The effect intensity of city I on the other 22 cities is summed up to obtain Pi, which is used to express the influence degree of city i on other cities. The effect intensity of other 22 cities on city i is summed up to obtain Ni, which is used to express the influence degree of other cities on city i. To sum up, we have constructed the spatial connection analysis framework of 23 cities, including the variables {Vi, Pi, Ni} describing the city itself and the spatial connection variables {Ri → j, Rj → i} between cities.

3 Empirical Research

3.1 City Comprehensive Strength

According to the above 12 city evaluation indicators, the comprehensive quality ranking and score VI of 23 cities are calculated by using TOPSIS evaluation method. According to the directionality of city linkages, the city distance Dij is substituted into the formula, and the one-way economic linkage strength of city i to city j can be calculated. The attraction Ri → j of city interactions can be calculated, forming a two-way matrix of economic linkages of 23 cities.

By summing up the action intensity of city I on the other 22 cities, Pi is obtained, which is used to express the degree of influence of city I on other cities. The sum of its action intensity on all other cities is an important embodiment of the gravity of city I. The effect intensity of other 22 cities on city I is summed up to obtain Ni, which is used to express the influence degree of other cities on city I and reflect the ability of city I to receive radiation. The size of city characteristic value (Pi Ni) can be expressed as the position of city I in the spatial network structure. If the characteristic value is positive, it means that city I plays the role of economic spillovers. Generally, it is a developed area in the urban agglomeration. The higher the positive value, the more central the position of city I in the cluster. If the urban characteristic value (Pi Ni) is less than 0, it means that the city I has a higher radiation capacity in the central area. The lower the value, the farther away from the central area, and is located in the periphery of the whole urban agglomeration.

According to the spatial big data analysis, HK, SZ and GZ ranked among the top three, with comprehensive evaluation scores of 61.2, 53.3 and 52.9 respectively. They are the main engine of regional economic development, and play a positive role in driving the surrounding cities. Followed by DG, FS, HZ and other cities in GBA, they are adjacent to HK, SZ and GZ. From the economic connection data among cities, only three of the 23 cities have urban characteristic values (Pi Ni) greater than 0, namely GZ, HK and SZ. It can be seen that these three cities are the core cities. In addition, when the city characteristic value (Pi Ni) is less than 0, the cities with higher Ni values tend to be around the core cities and have higher radiation capacity in the central areas, such as DG, FS, MA, HZ and other cities, while the Ni values of cities in Eastern, Western and northern Guangdong are relatively low.

3.2 Network Density

The urban agglomeration network reflects the cooperation and coordination among cities. When the urban agglomeration has a considerable economic scale, it can reduce the cost and enhance the agglomeration external economy among cities. The analysis result is shown as Fig. 1. The urban agglomerations have good accessibility within and close links between cities, and each node city has a great impact on economic development, cooperation and exchange.

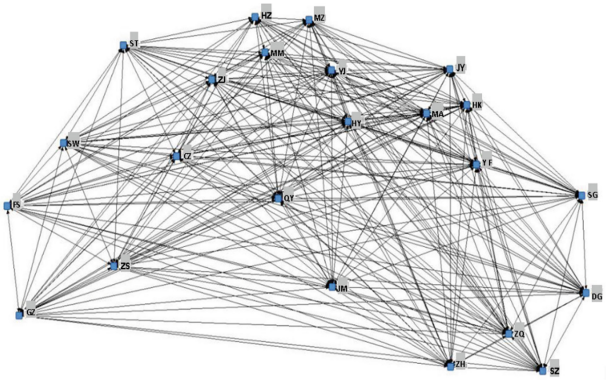

Fig. 1. The Economic Network Structure of 23 Cities.

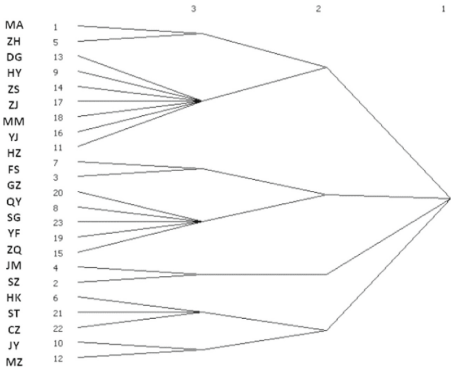

Fig. 2. Subgroup Analysis of 23 cities

3.3 Agglomerate Subgroup Analysis

The correlation convergence method in UCINET is used to cluster the spatial organization structure of urban agglomerations, to investigate the strong and weak relationships among cities, and to determine the affinity and estrangement between condensed subsets. The urban agglomerations of 23 prefecture level cities can be divided into seven cohesive subsets at three levels. The results are shown in Fig. 2.

SZ and HK belong to the same cohesive subset at the tertiary level and also belong to the same cohesive subset at the secondary level. It can be seen that the two cities are close to each other in terms of geographical location and close economic ties. One is a special administrative region and the other is a special economic zone, focusing on the development of finance, foreign trade, Internet industry, it technology, electronic equipment components and cultural and creative industries. Driven by factor aggregation and radiation, it has become the economic core of the entire region and played a leading role in the economic diffusion of the 23 cities cluster.

MA and ZH belong to the same condensed subset of the third level, while DG, HY, ZS, ZJ, MM, YJ and HZ belong to another condensed subset of the third level. These two condensed subsets together form the condensed subset of the second level. It can be seen that DG, ZS, MA, ZH and other important hub cities in GBA radiate and drive MM, ZJ, YJ and other cities in western Guangdong.

GZ and FS belong to the same condensed subset of the third level, QY, SG, YF, ZQ and JM belong to another condensed subset of the third level, and these two condensed subsets together form the condensed subset of the second level. It can be seen that GZ, FS, ZQ, JM and other cities in GBA can radiate and drive QY, YF, SG and other economically underdeveloped cities in northern Guangdong.

ST, CZ and JY belong to the same condensed subset of the third level, while MZ and SW belong to another condensed subset of the third level. These two condensed subsets together form the condensed subset of the second level. It can be seen that these five cities are economically underdeveloped cities in eastern Guangdong.

4 Conclusion

This study uses the spatial big data to conduct empirical research, and analyzes the economical spillover effect from GBA to Surrounding Cities. The following conclusions are drawn:

First, the 23 cities show certain spatial connection characteristics. The economic ties of urban agglomerations are increasingly close. The overall development level and comprehensive strength of cities in the economic network are closely related to the influence and connection degree of cities. However, the degree of urban agglomeration networking needs to be strengthened. The overall network connection depends on the radiation of core cities HK, GZ and SZ, and there is a lack of reasonable gradient central cities.

Second, HK, SZ and GZ are the core growth poles and have strong external economical spillover effect to other cities. The other cities in GBA are sub core cities. They connect with core cities and absorb advantageous resources and transmit the impact of economic radiation. Other surrounding cities in Guangdong Province are gradually affected by the GBA cities. There is a risk of isolation in the marginal cities.

Third, the pattern of coordinated development of cities in the economic network of urban agglomeration has initially taken shape, and the network coordinated economical spillover effect are gradually playing a role. The economical spillover effect from GBA to Western and northern Guangdong is beginning to show, but the radiation intensity on Eastern Guangdong is weak.

The research shows that there are obvious faults in the economic development of GBA and the eastern and northwestern Guangdong. In order to effectively promote the sustained and stable economic growth of the less developed regions in the province, we should speed up the opening of the economic channel with GBA, extend the economical spillover effect path, and create closer ties through industrial transfer, multilevel economic cooperation and exchange.

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