

A Study on Economic Spatial Structure of Urban Agglomerations in Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract

Based on the multi-index data of 11 cities in Guangdong-Hong Kong-Macao Greater Bay in 2016, the urban economic quality was calculated by TOPSIS method. Applying the modified gravitational model, the economy spatial linkage characteristics of core city-to-periphery city and periphery city-to-periphery city were analyzed. In addition, based on the method of network density analysis, centrality measures, core-periphery structure analysis to make a further verification about facts carried out from spatial connection analysis. This study shows that the Guangdong-Hong Kong-Macao Bay has an obvious core-periphery structure, and the overall economic network connection of Greater Bay is not strong. Guangdong-Shenzhen-Hong Kong is the core urban agglomeration in the Greater Bay Area. Dongguan and Foshan are transforming from marginal cities to semi-marginal cities. The marginal cities are limited by geographical distance or the economic environment, which leads to their development far behind the overall development of the Greater Bay Area. Finally, combined with the new wooden barrel theory and location advantage analysis method, advices were carried out to build a higher-level of the Greater Bay Area in future by dividing the Greater Bay Area into three major urban agglomerations. Urban agglomerations were proposed to meet the resources and industrial demands of the core urban imperfections and drive the economic development of the marginal cities at the same time.

Keywords: Guangdong-Hong Kong-Macao Greater Bay Area, improved gravity model, social network analysis, new barrel theory, location advantage analysis

1. Introduction

At the end of the 20th century, the concept of “Bay Area Economy” was born. The Bay Area has become the growth pole that promotes technological innovation and drives the development of the global economy. “Bay Area” refers to the coastal geographical area with three sides forming land and one side recessed into the sea. If the port group and town group are formed in the area, the economic activities generated by them will be called “Bay Area Economy”. This kind of economic form has the characteristics of high economic development, efficient allocation of resources, efficient aggregation of elements, and highly developed contact networks. This kind of economic form is formed through the economic development and cooperation of cities and towns in the region. Therefore, under the background of the trend of regional economic integration, China has gradually transformed the Guangdong-Hong Kong-Macao the Greater Bay Area from the regional economic cooperation hypothesis into an actual national strategy to accelerate the rapid development of the regional economy and the efficient utilization of resources. It will to make China have the ability to face the new round of industrial structure transformation and reform and opening to the outside world. It is an important method for Guangdong-Hong Kong-Macao the Greater Bay Area to establish and deal with the global market by exploring the regional urban agglomeration. For China, the construction of Guangdong-Hong Kong-Macao the Greater Bay Area needs to integrate the complex, pluralistic economic form and social system—the integration of nine cities in the mainland with Hong Kong and Macao, and the economic communication with the world market on the spot.

2. Literature Review

Foreign scholars' research on the Bay Area and urban agglomeration mainly focuses on the overall development and spatial structure of the Bay Area and the urban agglomeration. TAYLOR (2000) derived the model through multivariate analysis of theoretical knowledge, and concluded that under the condition of globalization, there is a spatial order in European cities, but it is impossible to exist "urban Europe". PAIN (2007) examined the interrelations between London and the southeastern United Kingdom through core-periphery theory and confirmed the functional relationship between cities. Cowell (2009) analyzed how the multi-centralism strategy can achieve complementarity in the industrial composition and economy of the cities in the region, and proposed the relationship between regional complementarity and related political governance. Volberding (2010) analyzed the rise of the San Francisco Bay area regional participants, and their growing economic partnership with China. He found that active policies by regional actors have produced tangible local benefits for the relationship between the Bay Area and China, including job creation and expansion of the tax base. Jiao (2017) analyzed the urban expansion of the Yangtze River Delta Urban Agglomeration (YRD) in each period through the accessibility and spatial interaction intensity of the core cities and the accessibility of the road network. The result shows that spatial connection plays an important role in urban expansion within urban agglomerations. Liu (2018) used social network analysis theory to study the economic membership level and centrality of urban agglomerations in the middle reaches of the Yangtze River and the social network structure intensity of urban agglomeration. It is concluded that the structural characteristics of social network - "weak center traction and discrete clusters".

Ma and Wu (2016) analyzed the economic openness of the Bay area by the factors of human capital level, cultural tolerance, economic growth speed and infrastructure convenience. Zhang (2017) explored the successful experience of its system and division of labor and coordination mechanism from the construction of the World Bay Area economy, and got enlightenment from combining with the unique agglomeration spillover effect of natural ecology and industrial accumulation and land resources of Guangdong-Hong Kong-Macao Greater Bay Area. Peng (2017) showed that the spatial structure of Guangdong-Hong Kong-Macao Greater Bay Area was characterized by three layers by measuring the comprehensive quality of cities and the interaction between cities. Her study shows that the Greater Bay Area lacks a reasonable division of level. And the Greater Bay Area should strengthen spatial connections, focus on the construction of a gradient hierarchical urban system, and expand the bay area space and hinterland depth. Qin and Pan (2018) concluded that adjusting the industrial structure and promoting the industrial division and cooperation among cities are the important ways to strengthen the competitiveness of the Greater Bay Area through the analysis of the convergence and consensus of the industries of the urban agglomeration.

At present, most domestic and foreign scholars focus on the economic development of Guangdong-Hong Kong-Macao the Greater Bay Area, the comparative research with the world's four major Bay Areas, the economic development factors, and on the economic correlation analysis. While few analyses the gradient construction of urban agglomerations in Guangdong-Hong Kong-Macao the Greater Bay Area, or the advantages and characteristics of each city, the influence of industrial division and cooperation and the establishment of the Greater Bay Area on the economic development of the Pearl River Delta region. This paper attempts to start from this perspective, through the gravity model and spatial network structure analysis method to study the economic space of Guangdong-Hong Kong-Macao Greater Bay Area. Based on the theory of "core-half periphery-periphery", this paper constructs the gradient of the urban agglomeration of the Greater Bay Area, explores each city's status and value. From the perspective of the new barrel theory, the economic relations and development advantages of the Greater Bay Area are analyzed. And the economic development strategies of marginal cities in urban agglomeration are studied by using location advantage analysis.

3. Theoretical Basis and Research Design

3.1 Theoretical Basis

3.1.1 Guangdong-Hong Kong-Macao Greater Bay and Economic Spatial Structure

Guangdong-Hong Kong Macao the Greater Bay Area refers to the urban agglomeration, which include two special administrative regions of Hong Kong and Macao, and Guangzhou, Shenzhen, Zhuhai, Foshan, Zhongshan, Dongguan, Zhaoqing, Jiangmen and Huizhou in Guangdong Province. It is an important space carrier for China to build world-class urban agglomeration and participate in global competition. The construction of the Greater Bay Area has been written into the report at the 19th National Congress of the CPC and the government work report, and it has been promoted to the national development strategy level. The study of the economic spatial structure of the urban agglomeration of Guangdong-Hong Kong-Macao the Greater Bay

Area will help to clarify the status of each city in the urban agglomeration, improve the cooperative innovation mechanism, and promote a good relationship with mutual benefit. Two important characteristics of contemporary urban development are the urban scale and urban alliance and integration. Under the impetus of rapid urbanization and urban regionalization, urban agglomeration has become the basic regional unit for China to participate in global competition and international division of labor. The economic spatial structure of urban agglomeration is a part of the spatial structure of urban agglomeration, which reflects the mutual economic relations and mutual economic interreaction between cities in a specific region, and shows the economic development level of urban agglomeration and the economic relevance of the urban agglomeration.

3.1.2 Social Network Analysis

Social network analysis (SNA) research methods have been widely used in network organization structure analysis in recent years. Tang (2013) used social network analysis to construct an urban cluster economic network structure model, which bases on economic linkage strength and economic network structure characteristics. He empirically analyzed the network density of urban agglomeration economic network in the middle reaches of the Yangtze River, and revealed its economic network structure features. Fang (2013) used 16 cities in the Yangtze River Delta as an example to construct a tourism economic connection network by modifying the gravity model, and analyzed the correlation between tourism spatial aggregation and network characteristics among cities. Zhang (2012) used the centrality and core degree to measure the change of China's role in the international trade system, and proposed corresponding countermeasures and suggestions. Therefore, network density analysis and centrality analysis were used to study the economic spatial organization structure of the urban agglomeration of Guangdong-Hong Kong-Macao Greater Bay Area.

3.1.3 New Barrel Theory

The new barrel theory is based on the theory of Laurence J. Peter's barrel theory, which highlights the integrity and integration of the whole. Song (2009) analyzed the spatial distribution of the urban agglomeration in the Central Plains with the help of the new barrel theory, and put forward the idea of integrating the resources of the urban agglomeration, giving play to the common advantages and highlighting the strengths of all sides. Tang (2008) put forward the concept of urban strategic alliance based on the new barrel theory, which highlights the regionality of urban agglomerations, and draws the conclusion that geo-spatial link and strategic spatial link of urban agglomeration are both important. Based on this, this paper will use the new barrel theory to analyze the relative advantages and resources of the marginal cities in Guangdong-Hong Kong-Macao the Greater Bay Area, and to study the development direction of those cities.

3.1.4 Location Advantages Analysis

Location analysis is also an analytical method commonly used in urban agglomerations. Lu (2008) used the urban location and accessibility to analyze the location advantages of the Wuhan Urban Circle, and proposed that the Wuhan Urban Circle should develop in the "one core and several strong cities" type rather than the "one strong and several weak cities" type. Lu (2009) used the method of economic geographic location analysis to explore the location advantage of Guanhekou area in Jiangsu Province. According to the local industrial development, geographical trend and policy direction, it was analyzed that Guanhekou should be controlled by sediment, and the inland waterway should be developed. This paper analyzes the location of the urban agglomerations in Guangdong-Hong Kong-Macao the Greater Bay Area, finds out the location advantages and disadvantages of the urban agglomeration, and puts forward some corresponding suggestions.

3.2 Research Ideas and Steps

This paper uses the improved gravity model to analyze the economic structure of urban agglomeration, and study the economic characteristics of each city and the mutual economic force between cities. UCIENT and NetDraw software are used to analyze the economic spatial structure of urban agglomeration and obtain corresponding characteristics of the economic spatial structure. According to the economic spatial structure characteristics of urban agglomeration, the new barrel theory and location advantage analysis are used to analyze the advantages and disadvantages of each city's own development, and corresponding countermeasures are made. Instead of putting aside the development of the core cities of urban agglomeration or the overall planning and development of urban agglomeration that have been focused on in the past, the innovation of this paper is to refine the development strategy of each city. Finally, the development planning strategy of each city in Guangdong-Hong Kong-Macao the Greater Bay Area is defined, and the advantages are integrated into the overall development of the Greater Bay Area.

3.3 Research Scope and Overview

At present, although the planning rules for the urban agglomeration of Guangdong-Hong Kong-Macao the Greater Bay Area has not yet been introduced, scholars have fully discussed the spatial scope of the urban agglomeration of the Greater Bay Area. Tang (2017) proposed that the spatial scope of Guangdong-Hong Kong-Macao the Greater Bay Area should not be limited to the “9+2” pattern of the Pearl River Delta and Hong Kong and Macao, but cover the whole of Guangdong Province. However, based on fact that the Guangdong-Hong Kong-Macao the Greater Bay Area is the historical basis for the development of the Pan-Pearl River Delta region, this study still uses tradition and national planning—the "9+2" urban pattern of the Grand Bay. Therefore, the spatial scope of this study is the Guangdong- Hong Kong-Macao the Greater Bay Area urban agglomeration of Guangzhou, Shenzhen, Foshan, Dongguan, Huizhou, Jiangmen, Zhaoqing, Zhuhai and Zhongshan in Guangdong Province and Hong Kong and Macao Special Administrative Region. Such a spatial scope is in line with national policies, and also makes research more focused.

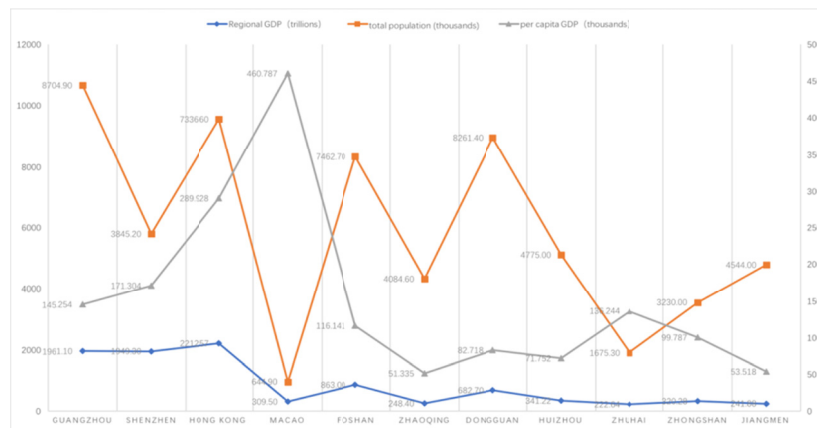


Figure 1. The GDP, Total Population and Per Capita GDP of the Greater Bay Area in 2016

The subjects of this study are 9 cities in Guangdong Province, and 2 special administrative regions, Hong Kong and Macao. The total population of the urban agglomeration is 54.5646 million, with a total area of 56,500 square kilometers. First of all, the basic economic situation of Guangdong-Hong Kong-Macao the Greater Bay Area is shown from the point of view of Economic Aggregate, total population and per capita GDP. As shown in Figure 1, the economic aggregate is highly concentrated in the three places of Guangzhou, Shenzhen and Hong Kong, and then decreases by other cities in the Greater Bay Area. The study of spatial distribution and structure of urban economy in urban agglomeration will be the basis of rest of this paper.

3.4 Research Methods

3.4.1 Gravity Model

In the past studies, the measurement of economic spatial connection is an important part of the study of economic spatial structure. The time-point study of regional economic spatial connection can determine the core and marginal regions, single-core center or double-cores center or even multi-cores center space in the region. Therefore, this paper studies the spatial structure of urban economy in the Greater Bay Area through the spatial linkage analysis method. The traditional gravity model is widely used in the fields of geographic distance attenuation or spatial interaction strength. It is a classic model in spatial connection analysis. This paper bases on the spatial structure relation strength formula of the related documents, defines the strength of inter-city economic interaction FE_{ij} as a function of the quality of urban economic development and the highways distance between cities. The intensity of economic connection between cities attenuates exponentially with the distance of highway. And the attenuation function is defined as $e^{-\beta_{ij}d_{ij}}$, then the expression of the inter-city economic spatial interaction force FE_{ij} in the Guangdong-Hong Kong-Macao Greater Bay is:

$$FE_{ij} = GMe_iMe_je^{-\beta_{ij}d_{ij}} \tag{1}$$

$$TFE_i = \sum_j FE_{ij} = \sum_j GMe_iMe_je^{-\beta_{ij}d_{ij}} \tag{2}$$

In the expression: FE_{ij} is the economic spatial interaction force between city i and city j; TFE_i is the total economic space force of city i; G is the gravitational constant, which is usually 1 according to the gravity model; Me_i and Me_j are the economic development quality of city i and city j; d_{ij} is the highways distance between cities

i and j ; β_{ij} is the attenuation factor the spatial interaction force between cities i and j , shows the decay rate of the interaction, according to the classical gravity model, take 2 here.

The economic development quality of 11 cities in Guangdong-Hong Kong-Macao the Greater Bay Area are measured by using 13 indicators, which are selected based on the data availability, reliability, comprehensiveness, including GDP and the total population and general fiscal expenditure. The TOPSIS evaluation method is used to measure the selected evaluation index system (see Table 1). In order to analyze the economic spatial connection data of the interaction, there is a certain directionality in the calculation of the force. Therefore, the calculation of the economic spatial connection force of a single city is modified as follows:

$$R_{(i \rightarrow j)} = \frac{Me_i}{Me_i + Me_j} Me_i Me_j e^{-\beta_{ij} d_{ij}}; R_{(j \rightarrow i)} = \frac{Me_j}{Me_i + Me_j} Me_i Me_j e^{-\beta_{ij} d_{ij}} \tag{3}$$

$$P_i = \sum_j R_{(i \rightarrow j)} = \sum_j \frac{Me_i}{Me_i + Me_j} Me_i Me_j e^{-\beta_{ij} d_{ij}} \tag{4}$$

$$N_i = \sum R_{(j \rightarrow i)} = \sum \frac{Me_j}{Me_i + Me_j} Me_i Me_j e^{-\beta_{ij} d_{ij}}$$

In the expression: $R_{(i \rightarrow j)}$ is the economic space force of city i to city j ; $R_{(j \rightarrow i)}$ is the economic space force of city j to city i ; P_i is the sum of the external economic space force of city i , the actual meaning is the influence of the city i on the economic development of other cities in the internal network structure; N_i is the sum of the economic spatial connection forces of all other cities to the city i , the actual meaning is the influence of other cities in the internal network structure on the economic development of city i .

In summary, the analysis of the economic spatial connection in Guangdong- Hong Kong-Macao the Greater Bay Area is built on the city’s own economic variables $\{Me_i, TFE_i, P_i, N_i\}$ and economic spatial connection variables $\{FE_{ij}, R_{(i \rightarrow j)}, R_{(j \rightarrow i)}\}$.

3.4.2 Data Source

The raw data used to analyze economic spatial structure of the Guangdong-Hong Kong-Macao the Greater Bay Area is the statistical data of 11 cities in 2016. The data are all from the corresponding year’s “Guangzhou Statistical Yearbook”, “Macao Statistical Yearbook”, “Hong Kong Statistical Yearbook”, “Shenzhen Statistical Yearbook”, “Foshan Statistical Yearbook”, “Dongguan Statistical Yearbook”, “Huizhou Statistical Yearbook”, “Zhongshan Statistical Yearbook”, “Zhuhai Statistics Yearbook”, “Zhaoqing City Statistical Yearbook” and “Jiangmen City Statistical Yearbook”.

Table 1. Urban economic development quality evaluation indicators

Evaluation object	Numbering	Indicator (unit)	Indicator meaning
Urban Economic Development Quality Me	1	Gross Regional Product (100 million yuan)	economic level
	2	Total population (10,000 people)	Population size
	3	Employment population (10,000 people)	Employment scale
	4	Fixed assets investment (100 million yuan)	Investment level
	5	Total import and export (100 million yuan)	Foreign trade level
	6	Tourism income (100 million yuan)	Travel strength
	7	General fiscal expenditure (100 million yuan)	Financial strength
	8	Total retail consumption (100 million yuan)	Spending power
	9	Port cargo throughput (10,000 tons)	Port freight level
	10	Financial industry employees (persons)	Financial strength
	11	Manufacturing employees	Manufacturing strength
	12	Ratio of secondary industry to tertiary industry (%)	Industrial structure
	13	Actual use of foreign capital (100 million US dollars)	Foreign investment attraction

4. Spatial Linkage and Spatial Network Structure Analysis of Guangdong-Hong Kong-Macao Urban Agglomeration

4.1 Analysis of Economic Spatial Connection Characteristics

4.1.1 Analysis of Urban Characteristics

According to the TOPSIS evaluation analysis method and equation 2, the economic development quality of Me_i and the total economic space force $TFE_i = P_i + N_i$ of each city in Guangdong-Hong Kong-Macao Greater Bay

Area. It can be concluded that Shenzhen, Guangzhou and Hong Kong have the top three economic space forces. The economic qualities of the three cities are more than five times that of Zhaoqing, and the total amount of economic space forces are about 30 times that of Zhaoqing. At the same time, it can be seen in Table 2 that the economic quality and economic spatial forces of cities have obvious ladder-type.

Table 2. Urban self-characteristics in 2016 (Sorted by The Sum of Economic Space Forces)

No.	City	Me	P _i	N _i	P _i -N _i	P _i +N _i
1	Shenzhen	45.22	1207.07	975.29	231.78	2182.36
2	Guangzhou	52.27	1154.68	901.99	252.69	2056.67
3	Hong Kong	64.91	996	635.27	360.73	1631.27
4	Foshan	22.79	467.98	688.95	-220.97	1156.93
5	Dongguan	27.73	444.51	585.58	-141.07	1030.09
6	Macao	24.89	328.43	331.2	-2.77	659.63
7	Zhongshan	10.31	315.82	310.81	5.01	626.63
8	Jiangmen	13.38	146.04	268.19	-122.15	414.23
9	Zhuhai	11.12	133.22	289.99	-156.77	423.21
10	Huizhou	13.94	69.42	194.93	-125.51	264.35
11	Zhaoqing	9.51	35.8	123.76	-87.96	159.56

From the analysis of economic quality, the economic quality of first echelon, including Hong Kong, Guangzhou and Shenzhen, is 2-3 times of that of second echelon, including Foshan, Dongguan and Macao. In addition, the quality of second echelon is 3 times of that of the third echelon, including Zhongshan, Jiangmen, Zhuhai, Huizhou and Zhaoqing. In the economic quality index, there is an obvious gradient classification in the urban agglomeration of Guangdong-Hong Kong-Macao Greater Bay Area. It is not difficult to analyze similar phenomenon in economic space force index. Guangzhou, Shenzhen and Hong Kong, which have the leading economic quality and economic space force, are the core cities in the Greater Bay Area. The second group includes Foshan, Dongguan and Macao, which surrounds Guangzhou, Shenzhen and Hong Kong. And those have smallest economic space force are Zhongshan and Jiangmen, marginal cities on the edge of the Greater Bay Area. It indicates that there is a certain relationship between the economic spatial linkages between the geographical location of the city and the economic development of the city. In particular, a city with higher level of economic connection with the surrounding cities, and closer to the core city often shows a better level of economic development, while a city with weaker economic links with the surrounding cities tend to an opposite result.

The causes of the stepwise segmentation of economic quality in the Greater Bay Area can be divided into objective reasons and subjective reasons. From the analysis of subjective reasons: there is a certain deviation during the index selection of this paper, it has certain deviations. The Greater Bay Area itself faces the land and sea, and the port freight level is an important index to measure economic development. However, Zhaoqing does not have developed port and shipping location, that has become a weak point in economic quality calculation of Zhaoqing. From the analysis of objective reasons: Guangzhou, Shenzhen, and Hong Kong have their own economic volume and regional status. But cities such as Dongguan and Foshan, which rely on the development of Guangzhou, Shenzhen and Hong Kong to drive their economic development. This approach has hysteresis and finiteness.

4.1.2 Core-Periphery Structure of the Greater Bay Area

Based on the equation (3) and the equation (4), the P_i and N_i values of the 11 cities are calculated and shown in Table 2. According to the definitions of P_i and N_i, the P_i value of city i reflects the sum of the economic spaces forces to all other cities, and that is an important expression of the influence of urban economic space; while N_i of urban i reflects the sum of the economic spaces forces of other cities to the city i, reflecting its ability to receive forces. Therefore, the value of (P_i-N_i) can be expressed as the status characteristic of the economic space network structure of the city to a certain extent.

Therefore, it is reasonable to follow that: first, the city is generally a developed area in the urban agglomeration if its (P_i-N_i) value is positive; secondly, the higher (P_i-N_i) value of the city i, the higher the economic status of the city is in the urban agglomeration, while the city with the highest value of (P_i-N_i) must be the economic core of the urban agglomeration. In Table 2, Hong Kong (360.73) is the city with highest (P_i-N_i) value. Given the

actual economic volume and development, Hong Kong is indeed the economy core of the Greater Bay Area; then Guangzhou (252.69) and Shenzhen (231.78) are also core cities. At the same time, Guangzhou, Shenzhen and Hong Kong are also the core urban agglomeration of the Greater Bay Area. It can be explained by the quality effect of gravity model, that is, the greater the economic quality of the city, the higher the value of (P_i-N_i) . In addition, when the (P_i-N_i) value of the city i is less than 0, the cities with larger N_i value tends to be around or among the core cities, and the ability to receive economic space force from the core cities is stronger. On the contrary, the (P_i-N_i) value is negative and the city with a small N_i value is at the edge of the Greater Bay Area. Because of the geopolitical position, its ability to accept economic space forces and its own economic space are both weak. That also can be explained through the gravity model, which says that the force between cities decays with the increase of distance.

4.1.3 Core-to-Periphery Economic Spatial Force Analysis

Taking Guangzhou, Shenzhen and Hong Kong as the core, and calculating their economic spatial forces to the marginal cities, which is shown in Table 3. According to Table 3, Guangzhou's economic space force to the marginal cities in the Greater Bay Area far exceeds that of Shenzhen and Hong Kong. It can be seen that the economic space force between Shenzhen and Hong Kong is very strong and the economic relationship is very close. In contrast, the economic links between these two cities and marginal cities in the Greater Bay Area are relatively weak. Dongguan and Foshan are the most affected by the core cities in the marginal cities. The N_i values of these cities are after to the three core cities. Based on this, the economic relationships of Foshan and Dongguan in the Greater Bay Area are mainly from the core cities.

From the perspective of the core cities, for Hong Kong, there is no strong economic relationship with any marginal cities in the Greater Bay Area. Its main economic space forces are to the other two core cities of Shenzhen and Guangzhou, and the overall relationship with the Greater Bay Area is not tight enough. And the overall driving force and lifting power of Hong Kong are not strong. Secondly, Guangzhou's P_i is slightly weaker than that of Shenzhen, while Guangzhou has close economic ties with the marginal cities in the Greater Bay Area. For most of the marginal cities, economic space force from Guangzhou is the strongest. In particular, Guangzhou's economic space force to Foshan and Dongguan is 15.9 times and 1.6 times that of Shenzhen to Foshan and Dongguan, that establishes a central role for Guangzhou in marginal cities. The reason is related to the economic status of Guangzhou its geographical location. As a whole, the forces from Shenzhen to marginal cities are not as good as that of Guangzhou. But Shenzhen has a strong economic connection with Dongguan, that does make Shenzhen more influential than Hong Kong on the edge of the city.

Table 3. Data table of core cities' economic spatial forces to periphery cities

Core City to Other City	Core City	Hong Kong	Guangzhou	Shenzhen	Sum of Space Force from
Periphery City	↓Me	64.91	52.27	45.22	Core Cities
Dongguan	27.73	96.04	229.80	141.12	494.69
Foshan	22.79	23.01	495.72	31.18	572.69
Huizhou	13.94	48.30	26.18	67.63	156.04
Jiangmen	13.38	17.22	70.99	25.77	127.37
Zhuhai	11.12	13.37	35.34	18.36	78.19
Zhongshan	10.31	26.29	81.78	36.23	154.61
Zhaoqing	9.51	2.84	32.54	3.73	48.61
Macao	24.89	22.29	59.02	44.70	126.00
Sum of Space Force (Core to periphery)		227.07	972.33	324.02	—

From the perspective of marginal cities, Dongguan is located between Guangzhou and Shenzhen. It has a good geographical advantage and is strongly influenced by the economic space forces from the core cities. Moreover, Dongguan's own manufacturing is strong, and foreign trade is frequent. It is an ideal economic hinterland for deepening development, which is closely related to the development of Guangzhou, Shenzhen and Hong Kong. Huizhou is far from the core urban agglomeration and is not as good as Dongguan in terms of geographical advantages. But as another hinterland of Shenzhen, Huizhou still has strong development potential in the Greater Bay Area by relying on Shenzhen's development. Shenzhen, Dongguan and Huizhou establish economic circle, and establish a cooperative pilot zone to further form a more potential economic urban agglomeration. As a second-tier city in Guangdong Province, Foshan is adjacent to Guangzhou. It relies on the economic help of Guangzhou, and has a steady development ability. Foshan's economic growth rate in 2017 is second only to

Shenzhen in Guangdong Province. Zhaoqing is on the edge of Guangdong-Hong Kong-Macao the Greater Bay Area, which has weak economic spatial connection with the core cities. At the same time, its traditional industry occupies a large proportion of its GDP, and the industry transformation is difficult. But as the gateway between Guangzhou and western Guangdong Province, Guangzhou has space dependence on Zhaoqing. Building the economic circle of Guangzhou and Foshan and Zhaoqing makes sense to deepen the reform of Guangzhou's industry, the industrial transformation of Foshan and the economic development of Zhaoqing.

4.1.4 Periphery-to-Periphery Economic Spatial Force Analysis

According to the calculation of the economic spatial forces in marginal cities, the matrix table of forces is shown in Table 4. Based on the data in the matrix table, it can be concluded that Macao (286.48), Foshan (209.32) and Dongguan (171.48) are the three cities with the highest economic spatial forces to the other marginal cities. While Macao (205.20), Foshan (118.57) and Zhongshan (116.42) are the three cities in the marginal cities that are most affected by the economic space forces from other marginal cities. After removing each top three cities, the economic space forces of the remaining marginal cities are less than 100 and the overall economic connections between the marginal cities are weak.

From the point of view of a single city, the basic reasons why Macao becomes the first ranking force of both types of forces in marginal cities are due to the following points. Firstly, Macao's own economy depends on the gaming industry and tourism, and its development is as strong as that of Guangzhou and Shenzhen and Hong Kong. Secondly, Due to the geographical location of Macao, which is far away from the three cities of Guangzhou, Shenzhen and Hong Kong, the economic relationship with the Greater Bay Area is weak. Thirdly, the geographical location of Macao and Zhuhai is very close, which causes Macao's economic space forces received mainly from Zhuhai. In the force matrix, only Macao's economic spatial force (154.66) to Zhuhai reaches more than 100. It can be seen that the intensity of economic connection between Macao and Zhuhai exceeds that of between the other marginal cities.

Foshan's position in the marginal cities is similar to that of Guangzhou in the core cities, and its economic space forces with other marginal cities are high. The bidirectional economic spatial force between Dongguan and Foshan is relatively high. The economic relationship between these two marginal cities is higher than that of between the other marginal cities, and at the same time it is slightly lower than the economic relationships between the core cities, which shows the stratification of the half- marginal city. It is not difficult to see from table 3 and table 4 that the economic spatial structure of Guangdong-Hong Kong-Macao the Greater Bay Area is changing from the core-periphery structure to the core-semi periphery-periphery structure. It is an important measure to improve the development of the Greater Bay Area to use the semi- marginal city to drive the development of the marginal city

Table 4. Matrix of Periphery Cities' Economic Spatial Forces to Periphery Cities

Periphery City to Periphery City	Dongguan	Foshan	Huizhou	Jiangmen	Zhuhai	Zhongshan	Zhaoqing	Macao	Sum of Space	
City	↓Me	27.73	22.79	13.94	13.38	11.12	10.31	9.51	24.89	Force Received
Dongguan	27.73	—	45.52	19.99	10.95	7.17	11.23	1.89	21.86	96.76
Foshan	22.79	55.39	—	3.85	29.18	6.33	13.29	10.52	20.47	118.57
Huizhou	13.94	39.77	6.30	—	0.95	1.45	2.29	0.35	1.72	51.10
Jiangmen	13.38	22.71	49.72	0.99	—	12.26	23.61	6.96	37.97	116.24
Zhuhai	11.12	17.87	12.97	1.81	14.75	—	19.69	1.17	154.66	68.26
Zhongshan	10.31	30.22	29.39	3.10	30.64	21.24	—	1.82	50.09	116.42
Zhaoqing	9.51	5.51	65.43	0.52	9.79	1.36	1.98	—	0.06	84.59
Macao	24.89	23.58	18.75	0.97	20.42	69.08	70.85	1.56	—	205.20
Sum of Space Force to Periphery	195.06	228.07	31.23	116.69	118.89	142.94	24.28	286.84	—	

The economic quality of Jiangmen (13.38), Zhuhai (11.12) and Zhongshan (10.31) is at the tail position of that of Guangdong-Hong Kong-Macao the Greater Bay Area urban agglomeration. Locating in the southwest of the Greater Bay Area, Jiangmen, Zhuhai and Zhongshan are farther away from the core cities than other marginal cities. Zhongshan and Zhuhai are limited by the size of the city. Jiangmen is rich in land resources, but far from the core of the Greater Bay Area. Lack of funds makes it unable to develop rapidly. Based on this, building economic circle of Jiangmen and Zhongshan and Zhuhai can effectively alleviate the shortage of land in Zhongshan and Zhuhai, and at the same time, bring enough funds for Jiangmen. Building an economic circle

composed of marginal cities in the Greater Bay Area can realize mutual benefit and win-win between marginal cities.

4.1.5 Economic Spatial Structure Characteristics of Urban Agglomerations

Figure 2 shows the economic spatial connection between cities calculated by the modified gravity model spatial relationship measured by the modified gravity model. By observing the distribution of economic spatial connections under different levels, it can be identified and analyzed that the overall economic spatial structure of the Greater Bay Area urban agglomeration still has significant hierarchical characteristics. But it is divided into a core urban agglomeration and a marginal urban agglomeration. Further analysis shows that strongest economic links are the Shenzhen-Hong Kong line and Foshan-Guangzhou line, followed by Huizhou-Shenzhen line and Shenzhen-Dongguan line, and finally the links between the core cities and the marginal cities. Therefore, the core urban agglomeration is the first level, and the marginal urban agglomeration, which is led by Foshan and Dongguan, is the second level. The strength of economic connection in the first level is high, while the connections between first level and second level mainly rely on Foshan and Dongguan to Guangzhou and Shenzhen to maintain contact. Therefore, it is imperative to strengthen the relationship between the core cities in the first level and the coordinated development of the urban agglomeration of the first and second levels.

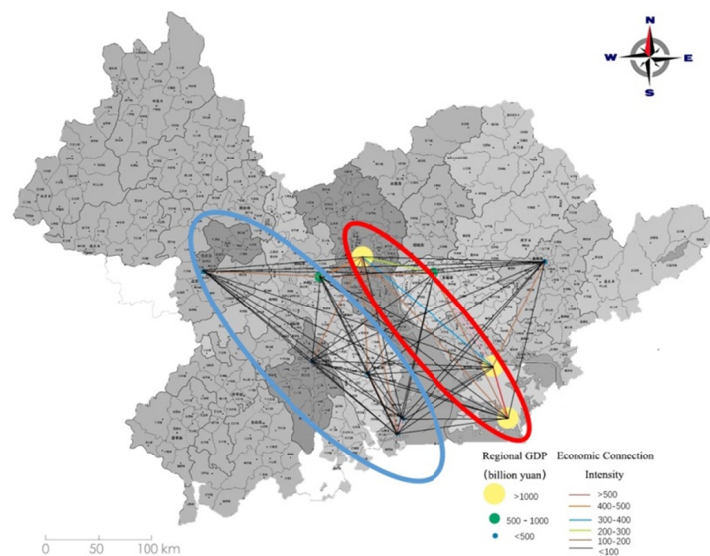


Figure 2. 2016 Guangdong-Hong Kong-Macao Greater Bay Area Space Map

4.2 Social Network Analysis

4.2.1 Network Density Analysis

The actual spatial network density measured by UCIENT under different connectivity thresholds for the urban agglomeration of Guangdong-Hong Kong-Macao the Greater Bay Area is shown in Table 5. When the connection threshold is set to 1, the network density is 0.9273, which is very close to 1, indicating that the network density is high. But when the connection threshold is continuously increased to 20, the network density rapidly drops to 0.5000. And the network density drops to 0.2727 when the threshold reaches to 40. It can be analyzed that the overall economic space network of the Greater Bay Area is basically formed. The stability of economic connection is relatively low. The relationship between cities in urban agglomeration is not so close and the hierarchy is significant.

Table 5. Network Density (Under Different Threshold value)

Connection threshold	≥1	≥3	≥20	≥40
network density	0.9273	0.8182	0.5000	0.2727

4.2.2 Center Degree and Core-Periphery Structure Analysis

The centrality analysis is an important index to measure the status of nodes in the network structure. By measuring the node cities' corresponding Degree Centrality and Closeness Centrality, it can be judged which status of the node city is in the whole network. Also, it can effectively verify the relevant conclusions in the analysis of urban characteristics.

Guangzhou, the city with the highest degree and closeness centrality in the network (all with a maximum of 100), not only has an absolute core position, but also plays a role as bridges with Shenzhen and Hong Kong (both values are close to 100) in the Greater Bay Area. The above analysis proves once again the status of Guangzhou, Hong Kong and Shenzhen as the core cities of the entire urban agglomeration. From the perspective of the overall degree centrality distribution, it can be seen that there is a core-periphery structure among cities, which is basically consistent with the above spatial relationship analysis. Besides the three core cities, Dongguan and Foshan have the most outstanding performance.

Table 6. Centrality measures

City	Degree Centrality	Closeness Centrality
Guangzhou	100.000	100.000
Hong Kong	90.000	90.909
Shenzhen	90.000	90.909
Dongguan	90.000	90.909
Foshan	90.000	83.333
Zhongshan	80.000	83.333
Macao	80.000	76.923
Jiangmen	80.000	71.429
Huizhou	40.000	55.556
Zhaoqin	20.000	55.556
Zhuhai	80.000	52.632
std.Dev	18.982	13.879

The degree centrality and closeness centrality of Zhongshan, Macao and Jiangmen are at a medium level. Huizhou and Zhaoqing are on the edge of the Greater Bay Area, and the economic relationships with the core cities and other marginal cities are weak, which results in a low degree centrality and closeness centrality. Zhuhai has good economic relations with the surrounding cities, but it is farther away from the core urban agglomeration, which leads to the low degree centrality.

Table 7. Core-Periphery structure

No.	City
1	Hong Kong, Shenzhen, Guangzhou
2	Macao, Dongguan, Foshan, Huizhou, Jiangmen, Zhuhai, Zhongshan, Zhaoqin

In this paper, the core-periphery structure analysis in SNA is used to verify the urban network of Guangdong-Hong Kong-Macao Greater Bay Area. Through the core-periphery absolute model, which is seen in Table 7, the fit degree of the core-periphery structure of the whole network is 0.787. The core cities are Guangzhou, Hong Kong, Shenzhen, and the marginal cities are 8 cities, such as Macao, Dongguan, Foshan and Huizhou and so on. The core-periphery continuous model is used to measure the core degree of each city to modify the results of the absolute model. The result is shown in Table 8. It can be basically divided into three levels according to the value of the core degree, namely, the first level (core degree is above 0.4) includes Guangzhou, Hong Kong and Shenzhen, which are the core cities; the second level (core degree is 0.1-0.4) includes Foshan, Dongguan and Zhongshan; the third level is the remaining five cities with a core of less than 0.1. The overall network structure presents a "core-half periphery-periphery" spatial structure, and the hierarchy is clearly divided.

Table 8. Sorted city core degree

No.	City	Coreness degree
1	Guangzhou	0.62
2	Hong Kong	0.462
3	Shenzhen	0.425
4	Foshan	0.318
5	Dongguan	0.283
6	Zhongshan	0.101
7	Macao	0.093
8	Huizhou	0.091
9	Jiangmen	0.088
10	Zhuhai	0.062
11	Zhaoqing	0.043

5. Spatial Correlation and Coping Strategies of Urban Agglomerations in Guangdong-Hong Kong-Macao Greater Bay Area

In the many research and analysis of Guangdong-Hong Kong-Macao Greater Bay, there are many articles focusing on the three core cities in the Greater Bay Area. At the same time, most of the articles on the overall development of the Greater Bay Area are focusing on the strategic development instead of the cities in Bay Area individually or the economic circle formed by several cities in detail. Therefore, this article divides the Greater Bay Area into three major economic circles to analyze and explore the relationship between them.

5.1 New Barrel Theory and Spatial Integration of the Greater Bay Area

The traditional barrel theory believes that the water content of the barrel depends on the shortest board. Then, it develops into the theory of tilting the barrel. That is, the water filling capacity of the barrel depends on the longest board, and the barrel can be tilted to the longest board to enlarge the loading. However, with the growth of longboard, the marginal effect of the amount of water is diminishing, and the overall damage of longboard damage is prone to occur. The new barrel theory came into being. That is to say, instead of adding a long board, a larger barrel is made by the long board of each barrel to realize the overall resource integration, area collaboration and efficient operation.

The urban agglomeration of Guangdong-Hong Kong-Macao Greater Bay as a whole should not be limited to the accelerated development of the three central cities of Guangzhou, Shenzhen and Hong Kong, and then to stimulate the marginal cities in the Greater Bay Area but to consider the strategic planning as a whole. A regional overall thinking should be shifted from a single isolated urban thinking to strengthen the cooperation of the Greater Bay Area. In addition, this is also the goal of cooperation in the Pan-Pearl River Delta since 2004. The integration of Guangdong-Hong Kong-Macao the Greater Bay Area is to be realized by the economic circles built by the marginal cities and the core cities.

5.2 Analysis of Economic Geography Location of Guangzhou-Foshan-Zhaoqing urban agglomeration

5.2.1 Analysis of the spatial structure of the Guangzhou-Foshan-Zhaoqing urban agglomeration

Guangzhou is close to the South China sea which is China's gateway to the world. Its unique geographical location and comprehensive transportation infrastructure have provided important support for Guangzhou Port, Pearl River Delta and even South China in many aspects, such as to material distribution center and international trade. Currently, it has traded with over 500 ports in over 170 countries and regions around the world. There are four ports and terminals that have opened passengers and freighters to and from Hong Kong. Its inland river can communicate with all parts of both Guangdong Province and Guangxi Province, and is connected to more than 100 rivers. Foshan is located in the hinterland of the Pearl River Delta, with Hong Kong and Macao in the south and Guangzhou in the east. It has similar history and culture to that of Guangzhou. The downtown area of Foshan is accessible within an hour of Guangzhou's three major transportation hubs, Guangzhou New Baiyun Airport, Guangzhou Nansha Port and Guangzhou Railway Station. It is also an important entrance to Guangzhou for Guangdong province. Zhaoqing is located in the northwest of the Greater Bay Area. It is located to Guangxi province. It relies on its advanced manufacturing industry. It is on the way to increase the geographical depth of the urban agglomeration and to utilize regional resources for development.

The Guangzhou-Foshan-Zhaoqing urban agglomeration is relatively inland in the Greater Bay Area, and therefore its shipping industry will be limited to a certain extent. By reaching cooperation with other cities in the Greater Bay

Area, it can improve the urban transportation hub structure around the Greater Bay Area, which will greatly benefit the connectivity and carrying capacity of the urban agglomeration as a whole.

5.2.2 Analysis of the Economic Industry of Guangzhou-Foshan-Zhaoqing urban agglomeration

Guangzhou has a relatively complete manufacturing industry and tertiary industry and a reasonable industrial structure is relatively while it is still weak in the innovation. In 2015, R&D expenditure in Guangzhou accounted for 2.1% of GDP, while corporate R&D expenditure accounted for 1.26% of the main operating income. In contrast, R&D expenditure in Shenzhen accounted for 4.5% of GDP. The low input onto scientific research and experimental development in Guangzhou leads to a weak social innovation atmosphere and corporate R&D awareness. In addition, during the industrial transformation period, the emerging industry in Guangzhou are not strong enough. In 2017, GDP in Guangzhou reached 2,105.513 billion yuan, which saw an increase of 7% while the secondary industry grew by 4.7%. The three traditional industries of automobile, petrochemical and electronic products are still the pillar industries of Guangzhou, accounting for 52.1% of the total output while emerging industries accounting for 9.2%.

Foshan is based on its import and export trade to achieve good economic returns. In addition, it actively introduces foreign capital and further enhances economic and trade cooperation to eliminate outmoded small and medium-sized enterprises in village-level in industrial zones. Through the way to transform enterprises with backward production capacity into new-type industries, in 2017, Foshan achieved a regional GDP of 954.96 billion yuan, which saw an increase of 8.5%. The primary, secondary and tertiary industries increased by 1.9%, 8.2% and 9.1% respectively. The service industry is the pillar industry of Foshan. However, the flaw in Foshan is that the content involved in the tertiary industry is complex and numerous, making it hard to identify and divide. At the same time, the technical threshold of the service industry and the innovation industry needs to be raised. The economy with the service industry as the mainstay in Foshan is essentially a low-end economic form which is dominated by the sales of labor. Therefore, the key to Foshan's completion of this industrial restructuring is the accumulation of core technologies.

Zhaoqing City is weak in the industrial production, foreign trade and private investment. Regional GDP in Zhaoqing in the first three quarters of 2017 was 155.976 billion yuan, which saw an increase of 4.8%. The growth rate of the secondary industry was low and there was a downward trend, which was 1% point lower than that of the same period of last year. Import and export decreased by 11.3% year-on-year, and the city's investment fell by 67% year-on-year as a whole.

5.2.3 Coping Strategies for the Economic Development of Guangzhou-Foshan-Zhaoqing Urban Agglomeration

First, given that Guangzhou itself is lack of innovation capacity and weak in emerging industries, Guangzhou should continue to introduce international high-tech and high-end industries. The introduction of research and development of high technology is a top priority. Through institutional design and policy support, local enterprises should be encouraged to increase R&D investment and enhance the independent innovation capabilities. For the traditional pillar industries, it is necessary to speed up the industrial structure rectification and refine the scale of the industry to improve the production efficiency. For some heavy industries, their location can be transferred to Zhaoqing, which can stimulate the re-development of Zhaoqing's manufacturing industry and save space for Guangzhou as well. At the same time, to promote the smooth transformation of the industries in the two cities, Guangzhou should consider to exchange innovative thinking and activities with Foshan.

Second, given that the service industry in Foshan is complex and the threshold of industrial technology is low, Foshan should carry out certain reconstruction of the service industry system, separate different types of service industries and improve the service industry service standards to transform into a modern historical city. In terms of technical conditions, Foshan is advised to encourage and support the joint ventures or mergers of peer companies in the city, increase investment in research and development, rapidly upgrade products and structures, and actively participate in the acquisition of important international industrial technologies. Relying on the Belt and Road, Foshan can be an important hub between western Guangdong and eastern Guangdong Province by improving the transportation system between Zhaoqing and Guangzhou. It can be connected with Guangxi province throughout the western Guangdong and Zhaoqing.

Third, given that the manufacturing industry in Zhaoqing is slowing down and foreign trade is weak. Zhaoqing should consider actively introducing manufacturing enterprises that have transferred locations from Guangzhou and Foshan due to space limitation, and providing some subsidies for the development of local manufacturing. Since Zhaoqing is situated in the west of Guangdong province and has no good base for Hong Kong transportation, it should consider constructing a developed land transportation system which can improve the connection both with Foshan and with Guangxi province. In the face of the stagnant economy, Zhaoqing is suggested to break the barrier of entrepreneurship and improve the opening degree, which makes it easier for new ventures to enter new markets.

The obstacles of the Guangzhou-Foshan-Zhaoqing urban agglomeration are mainly as follow. First, the economy target is not clear enough for industrial chain division. Second, there are administrative barriers resulting from excessive intervention from the government. Given that there are differences in the industrial structure of the three cities, active adjustment and industrial precision should be achieved. Guangzhou should make concessions when making strategic plan with Foshan and Zhaoqing to establish a equal environment within the Guangzhou-Foshan-Zhaoqing urban agglomeration. Let Guangzhou lead the Guangzhou-Foshan Economic Circle and learn from the development experience of the service industry in Hong Kong and Macao by enhancing economic and industrial communication with them. Therefore, the Guangzhou-Foshan-Zhaoqing urban agglomeration is advised to improve the attractiveness of investment by international capital, provide industrial benefits of the service industry, and take advantage of Zhaoqing's land resources to promote its own economic development.

5.3 Economic and Geographical Location Analysis of Shenzhen-Dongguan-Huizhou Urban Agglomeration

5.3.1 Analysis of the Spatial Structure of Shenzhen-Dongguan-Huizhou Urban Agglomeration

Shenzhen, located on the southern coast of China and adjacent to Hong Kong, is a bridge and hub for trade between China's mainland and overseas. That is, mainland provide s huge labor and financial resources for it. In addition, the Shenzhen River is connected to both Hong Kong in south and to Dongguan and Huizhou in south. It is located in the geographical center of the Greater Bay Area. Dongguan is located in the south-central part of Guangdong Province, northeast of the Pearl River Delta. It is 70 kilometers away from Guangzhou, 85 kilometers away from Shenzhen, 47 nautical miles from Hong Kong, and 48 nautical miles from Macao. Dongguan is an essential place from Guangzhou to Hong Kong and is situated at the juncture of core urban cities, which provides great geographical convenience. Huizhou is located in the southeast of Guangdong Province, adjacent to Daya Bay in the south and bordering by Shenzhen, with a sea area of 4,520 square kilometers and a coastline of 223.6 kilometers. What's more, Huizhou owns nine high-speed rail stations on three high-speed rail lines.

5.3.2 Analysis of Economic Industry of Shenzhen-Dongguan-Huizhou Urban Agglomeration

Shenzhen enjoys preferential policies as a special economic zone, which provides a large economy scale and a reasonable industrial structure. In addition, it is adjacent to Hong Kong and has a strong international trade system. In 2017, GDP in Shenzhen was 2.243 trillion yuan, which saw an increase of 8.8% over the previous year. The per capita GDP amounted to 183,100 yuan. However, in the process of rapid development, Shenzhen has exposed its own shortcomings. The rapid increase in the cost of production leads to constraints on industrial transformation. With the improvement human resources year by year. In 2017, the monthly salary per capita in Shenzhen reached 8,666 yuan, ranking third in the country. As a special zone, Shenzhen's district structure is gradually difficult to adapt to the rapid development of its own economy. Though with the same GDP as Guangzhou, Shenzhen has an area of 1997 square kilometers, which is 27% of Guangzhou. Due to the attraction of Shenzhen's economic "special zone speed", a large amount of capital poured into the Shenzhen financial industry, resulting in the continued overheating of the financial industry in Shenzhen and the accumulation of risks.

Dongguan is mainly based on its huge manufacturing industry and the unique Dongguan Port location. In 2017, the total production value of Dongguan City was 758.212 billion yuan. In terms of industries, the added value of the primary industry was 2.336 billion yuan, down 0.3%; the added value of the secondary industry was 359.384 billion yuan, up 9.2%; the added value of the tertiary industry was 396.465 billion yuan. It witnessed a growth of 7.2% and the economic structure continues to improve. The manufacturing industry provides a strong support for economic growth. In the first half of 2017, the cargo throughput in Dongguan Port was 74.745 million tons, which saw an increase of 9.51% and far surpassed other marginal cities. The unbalanced expansion of towns in Dongguan also imposes constraints on its development. The supply and demand of land and other resources are in an equilibrium state. It is difficult for the leading industries and pillar industries to go a step further. Given that the annual throughput of Dongguan Port is large and the shoreline of the terminal is long, there are many small shipping agency companies, which has caused shipping chaos and restricted the pace of Dongguan Port to move towards world-class ports. In addition, *The Port Cooperation Development Agreement of the Dongguan Port Authority of Dongguan Port* published at the end of 2017, will integrate and rectify the ports of Guangzhou and Dongguan, which will increase import and export trade of Dongguan by a certain extent.

The economic operation of Huizhou City showed a steady trend both in quantity and quality. In 2017, GDP in Huizhou reached 383.158 billion yuan, while the transformation of industrial structure needs to be improved. The per capita GDP amounted to 80,200 yuan, which saw an increase of 7.4%. The main dilemma Huizhou faced is that the urban position and urban development do not completely match. Huizhou wants to build a livable city, while its tertiary industry in the economic structure is relatively weak. Despite that Huizhou owns vast land resources, the

development intensity is low, which is 11% compared with that of more than 50% in Shenzhen and nearly 50% in Dongguan. The large amount of idleness of the land reduces the efficiency of production factors.

5.3.3 Coping Strategies for the Economic Development of the Shenzhen-Dongguan-Huizhou Urban Agglomeration

First, with the increase of the cost of production and the influx of capital into the financial industry, the administrative region of Shenzhen cannot meet the rapid economic growth and consumer demand. Shenzhen is advised to deepen the supply-side structural reforms, reduce the output of unnecessary industries, provide accurate supply on the demand side, and weaken dependence on production factors such as labor and land. For heavy industry with large land demand, it is required to improve production efficiency, or rectify environmental protection requirements and move to Huizhou to promote the continued development of local manufacturing. At the same time, based on Shenzhen's own policy of establishing a high-tech industry, it will vigorously develop strategic emerging industries and concentrate on key common technologies of the Internet, biology, new energy, new materials, cultural creativity, and new generation information technology. It will benefit Shenzhen and the two fringe cities of Dongguan and Huizhou to strengthen the construction of economic cooperation zones. By Strengthening the governance of capital entering Shenzhen's financial industry, improving the relevant investment system of the financial industry, and attracting capital to promote the development of the financial industry and even the Shenzhen economy in a healthy and effective manner, the Shenzhen-Dongguan-Huizhou Urban Agglomeration will realize transformation from the economic cooperation zone to the metropolitan area goal.

Second, for problems faced by Dongguan, such as the unbalanced development of its internal towns and streets, bottleneck met by industrial optimization, and the interaction of ports. The government of Dongguan is responsible for the assistance of different towns and streets, and the guide to investing social funds. Through the way to explore Hong Kong's development model and improve the deepening and development of the tertiary industry, Dongguan is suggested to clarify the basic industries and advantages of each town street, refine the division of labor and cooperation, and enlarge the manufacturing industry. Facing the problem of industrial optimization, it should speed up the adjustment of the economic structure, take the initiative to abandon the extensive production mode, turn to the research on the growth mode with core competitiveness, and transform to an intensive economy. In the face of port integration issues, Dongguan should actively seek cooperation with Guangzhou to take the opportunity to rectify the chaos of the Dongguan Port Small Terminal Transportation Agency, reducing the competition consumption with Guangzhou Port, and meeting the needs of Guangzhou Port and China Merchants Port as well. In addition, the integration of Guangzhou and Dongguan can help build a world-class hub port, which provides a more convenient platform for foreign trade, and share the shipping pressure of Hong Kong Freeport at the same time.

Third, in view of the Huizhou's mismatching of urban position and urban development, Huizhou government should carry out detailed short-, medium- and long-term urban planning under the full understanding of the development of Huizhou City. Urban development is a process in which rational planning and forecasting can be carried out according to the current urban conditions. In view of the low development intensity of land resources, Huizhou should increase the GDP output of the unit construction land. Under the premise of protecting cultivated land, the land use layout along the Yangtze River will be used to build the coastal economic zone of Daya Bay. Considering the problem of insufficient utilization of marine shipping resources, Huizhou can build Huizhou Freeport by the planned Daya Bay Economic Belt, and establish a modern port of logistics organization, specialization and informationization. In addition, Huizhou is advised to connect with the Beijing-Kowloon Railway to realize the sea-rail combined transport so as to cover the provinces of Jiangxi, Hubei, Anhui and other provinces along the eastern part of Guangdong and along the Beijing-Kowloon Railway.

The main problems of the Shenzhen-Dongguan-Huizhou urban agglomeration are: 1. The gap between the three cities' economy is wide. The city with the largest economic scale is likely to control the strategic plan of the urban agglomeration. 2. Shenzhen and Dongguan will be limited due to the size of administrative divisions, although, geographically, Dongguan and Guangzhou is in the center of the Greater Bay Area, with unique economic development conditions. Therefore, during the development of urban agglomerations, Shenzhen should fully consider the actual situation of Dongguan and Huizhou, assist Dongguan to complete industrial transformation and upgrading, and promote the development of Huizhou infrastructure and manufacturing. In the coastal areas, the coastal economic belt and the free trade port will be established, the port division of labor will be clearly defined, and the eastern Guangdong and Guangdong provinces will be closely linked to bring the shipping benefits into the inland areas of the urban agglomeration. In terms of port cargo, Hong Kong set a good example in this aspect. Shenzhen-Dongguan-Huizhou urban agglomeration should enhance economic cooperation and establish a pilot zone to accept and retain Shenzhen's spilled industries and expand the radiation capacity of core cities, which not only solves the problem of administrative division restrictions in Shenzhen and Dongguan, but also enables Dongguan

and Huizhou to enjoy the industrial spillover effect of Shenzhen, improving the industrial structure and optimizing the economic development mode.

5.4 Analysis of Economic Geographical Location of Jiangmen-Zhongshan-Zhuhai Urban Agglomeration

5.4.1 Analysis of the Spatial Structure of Jiangmen-Zhongshan-Zhuhai Urban Agglomeration

Jiangmen is located in the southwest of the Greater Bay Area with a coastline of 414.8 kilometers long which is the longest in Guangdong Province. Therefore, the convenient water transportation and unique location bring convenience for large ships to park. However, Jiangmen's location is far away from the centre of the Greater Bay Area and its traffic is relatively backward. It is not easy for Jiangmen to establish strong economic ties with other cities in the Greater Bay Area. Zhongshan is connected to Guangzhou in the north and to Macao in the south. It is close to the core urban agglomeration in the Greater Bay Area. Zhuhai is adjacent to Hong Kong in the east, and Macau is in the south with a vast sea area which has 6 first-class ports and 7 second-level ports. It is an important port city in China.

5.4.2 Analysis of Economic Industry of Jiangmen-Zhongshan-Zhuhai Urban Agglomeration

The economy in Jiangmen is developing steadily as a whole. In 2017, the economy grew by 8.1%. The growth of the primary, secondary and tertiary was 3.5% 9.3% and 7.5% respectively. The industry is dominated by heavy industry and manufacturing. The industrial transformation of Jiangmen is gradually carried out. The high-tech industry has grown by 24.1% and the advanced manufacturing industry has increased by 13%. However, the growth rate of traditional manufacturing has slowed down, and so as the growth of high-energy-consuming industries. Jiangmen's own problems lie in regional integration and the underdeveloped trade economy. In 2002, the Xinhui District was relocated to Jiangmen, and the people of the two places still had a gap in cultural and social aspects. The cooperation between Jiangmen city and Xinhui district was weak. Jiangmen focuses economic development on the manufacturing industry instead of its own shipping trade. In 2017, the average industrial growth rate was 10%, while the export volume increased by only 8.3%.

Zhongshan works as a world-class advanced manufacturing base in the Greater Bay Area, with a clear strategy for economic development. In 2017, Zhongshan had saw an increase of 11.2% in high-tech manufacturing industry, which accounted for 18.5% of industrial added value, and saw an increase of 8.3% in the equipment manufacturing industry, which accounted for one-third of the added value of industrial enterprises above designated size. In addition, the degree of industrial cluster in Zhongshan is high, which provides Zhongshan great advantages in industry development. Zhongshan currently has three 100 billion-level industrial clusters and 10 super-billion-level industrial clusters. However, the small population limits labor resources in Zhongshan and constraint its manufacturing industry expansion. In 2016, the total population of Zhongshan in the Greater Bay Area was 3.23 million, which was only higher than that of Zhuhai. Despite of the superior geographical location, Zhongshan's inability to form an effective connection with others in the economy, it cannot promote the economy as a whole.

Zhuhai focus on the secondary industry, with a booming innovation industry. In 2017, the primary, secondary and tertiary industry increased by 4.1%, 11.6% and 6.9% respectively. Advanced manufacturing, equipment manufacturing and technology manufacturing saw an increase of 15.2%, 13.4% and 17.8% respectively. Meanwhile, the import and export of high-tech products grew by 12.9%, accounting for 31.1% of total imports and exports, which indicated that high-tech products in Zhuhai was high competitive. However, Zhuhai is limited by its own land area and poor transportation conditions. Before the opening of the Guangzhou-Zhuhai city railroad in 2011, the core areas of Zhuhai and the Pearl River Delta could only be contacted by roads. In addition, there is no effective economic driving point around Zhuhai. Despite the fact that Zhuhai is connected to Macao on land, in the past few decades, Macao has developed into a tourism city dominated by entertainment and gaming, and therefore it is difficult for Zhuhai to obtain economic development assistance and support from Macao. As a financial and trade center, Hong Kong has shifted a large part of its industry to Shenzhen and Dongguan instead of Zhuhai, which widened the gap between Zhuhai and Shenzhen or Dongguan.

5.4.3 Coping Strategies for Economic Development of Jiangmen-Zhongshan-Zhuhai Urban Agglomeration

First, the issue of regional integration of Jiangmen and the underdevelopment of the trade economy is caused by different regional cultural forms and changed customs. It is imperative to resolve the isolation within population in Jiangmen by adjusting the direction of economic development and achieving and steady economic growth. Jiangmen is advised to encourage local business and shipping by subsidies and benefits, set up a sound port terminal system, establish an economic free trade zone, and promote foreign trade so as to stimulate shipping throughput throughout the city.

Second, in the face of the lack of population and economic connection with other cities, Zhongshan is suggested to attract talents by certain subsidies and policies. In economic relations, Zhongshan can connect to Zhuhai in the south and Jiangmen in the west to establish a new urban agglomeration. This will not only ease Zhuhai's reliance on Macao's embarrassment, but also actively develop the secondary industry and research innovative technologies based on Jiangmen's vast land resources.

Third, Zhuhai can establish economic ties with Zhongshan and Jiangmen. The three cities all focus on innovative manufacturing industries which can be used as the cornerstone to promote communication between the three cities. Zhuhai provides channels for import and export of high-tech products. Jiangmen offers land resources and developed shipping systems for the three, and Zhongshan supplies the technology and talents of high-tech manufacturing. With the construction of the Greater Bay Area, Zhuhai gains an excellent opportunity to advance the transportation system by both land and water, and to build economic relationship with the core cities of Guangzhou, Shenzhen and Hong Kong.

The main problems of the Zhuhai-Zhongshan-Jiangmen urban agglomeration are: First, lack of core cities leads to lack of driving force in economic development. Second, it too far from the core of the Greater Bay Area to obtain economic growth benefits. Given that cities in the Zhuhai-Zhongshan-Jiangmen urban agglomeration have common grounds such as focusing on manufacturing industries and concerning over the high-tech manufacturing industry. Jiangmen, Zhongshan and Zhuhai can achieve regional development advantage after they unite and exchange resources with each other. At the same time, strong transportation links between cities should be built so as to Improve competitiveness within the Greater Bay Area, especially on high-tech manufacturing aspect.

5.5 Three Urban Agglomerations Cooperate with Hong Kong and Macao

The Guangzhou-Foshan-Zhaoqing urban agglomeration develops and improves its own advantageous industrial service industry, consolidates the foundations of the primary and secondary industries, and strengthens exchanges and learning with the service industries in Hong Kong and Macao. The Shenzhen-Dongguan-Huizhou urban agglomeration relies on Shenzhen's high-tech industry to vigorously develop strategic emerging industries. Constructing a free port group along the coast, sharing the pressure of Hong Kong shipping and improving the convenience of shipping in Guangdong-Hong Kong-Macao the Greater Bay Area are primary measures. The Jiangmen-Zhongshan-Zhuhai urban agglomeration goes deep into the high-tech manufacturing industry. Relying on the advantages of Zhuhai Special Zone, the advantages of Zhongshan talent resources, and the advantages of Jiangmen's coastline, the urban agglomeration can strengthen the manufacturing industry and foreign trade. Based on the population attracted by Macao's tourism and gaming industry to stimulate the growth of production and consumption in these three regions. In the end, the core cities and marginal cities in the Greater Bay Area will develop together, complete the integration of economic development, and build a harmonious coexistence between the nine cities in the Mainland and Hong Kong and Macao.

6. Conclusions and Revelations

This study analyzes the spatial connection characteristics and spatial structure of the urban agglomerations of Guangdong-Hong Kong-Macao the Greater Bay Area through the modified gravity model and SNA method, and draws the following conclusions:

First, the urban agglomeration of Guangdong-Hong Kong-Macao the Greater Bay Area has shown certain spatial connection characteristics. It has formed the network structure, and the economic quality and economic space between cities have a gradient. The structure is transforming from "core-periphery" to "core-half periphery-periphery". The overall development of the region is uneven, with three cities of Guangzhou, Hong Kong and Shenzhen as the core to drive the development of other cities. Connecting the core cities and deepening the coordinated development of the first and second tier cities will provide a new impetus for the development of the Greater Bay Area.

Second, the overall network density and intensity in the Greater Bay Area are low. According to the core degree, the three urban agglomerations can be constructed, and the marginal cities in the urban agglomeration can rely on the driving force of the core cities for economic development. Giving full play to the connecting role of Dongguan and Foshan and developing the hinterland resources will provide the support for promoting the overall economic development.

Through the analysis of the above conclusions, this paper divides the nine inland cities into three urban agglomerations: Guangzhou-Foshan-Zhaoqing, Shenzhen-Dongguan-Huizhou, Jiangmen-Zhongshan-Zhuhai. Based on the new barrel theory and the analysis of the location advantage of the urban agglomeration, the following suggestions are put forward:

First, the Guangzhou-Foshan-Zhaoqing urban agglomeration will give full play to the advantages of Guangzhou's and Foshan's service industry, and Zhaoqing's land resource advantages. The urban agglomeration should define the division of labor in the industrial chain, realize industrial precision and promote the upgrading of industrial structure. Guangzhou should make concessions when makes the economic strategic plan with Foshan and Zhaoqing. The urban agglomeration should strengthen the industrial and technical communication with Hong Kong and Macao, learn the development experience from Hong Kong and Macao service industry. For Guangzhou and Foshan, Zhaoqing should strengthen the development of manufacturing industry to establish a solid foundation.

Second, the development of Shenzhen-Dongguan-Huizhou urban agglomeration should take full use of the industrial spillover effect of Shenzhen. The establishment of the pilot zone will share Shenzhen's development dividend to Dongguan, Huizhou, so that both Dongguan and Huizhou can enjoy the economic growth brought by the high-tech industries in Shenzhen. Building the coastal economic belt and free trade ports in coastal area, strengthening the link between east Guangdong and north Guangdong can bring shipping dividend into inland urban agglomeration. Shenzhen-Dongguan-Huizhou urban agglomeration can also learn about Hong Kong's shipping trade experience in port freight.

Thirdly, the core advantage of Jiangmen-Zhongshan-Zhuhai urban agglomeration is that the development goal of urban industry is the same. The cities can carry on close industrial cooperation, expand the industrial cluster of high-tech manufacturing industry, and form regional development advantage. Building a developed trade harbor will create good condition for manufacturing industry export.

The three urban agglomerations should make clear their own strengths and defects and pay attention to the building of urban agglomerations. By solving the problems of lack of resources and imperfect industry in core cities, the economic development of marginal cities can be promoted. Through the study of Hong Kong and Macao advantage industries, marginal cities can take advantage of geographical location, enjoy the dividends of cooperation in the Greater Bay Area. Using Hong Kong and Macao to promote the development of the coastal cities in the Greater Bay Area and to continuously promote the process of economic integration of the Guangdong-Hong Kong-Macao Greater Bay Area. It will eventually develop into a world-class bay area economy, giving the southern part of China positive economic benefits.

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