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Measurement and Evaluation on Tourism Economic Network Characteristics of China Four Major Urban Agglomerations

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Abstract: Studying the characteristics and driving mechanisms of tourism economic development in urban agglomerations is significant for promoting high-quality development of the tourism industry. This article explores the spatial structure and differences of the tourism economy within the Yangtze River Delta, the Guangdong-Hong Kong-Macao Greater Bay Area, the Beijing-Tianjin-Hebei urban agglomeration, and the Chengdu-Chongqing economic circle by using the tourism-modified gravity model and social network analysis methods. Meanwhile, the tourism economic index and tourism supply capacity index are constructed to explore the dislocation of supply and demand in the central cities of each urban agglomeration. Finally, from the perspective of regional economic integration development, suggestions are put forward for further improving the tourism economic network.

Keywords: four major urban agglomerations, tourism-modified gravity model, social network analysis, tourism economy, supply-demand dislocation

1. Introduction

The tourism industry is a strategic pillar of the national economy. Against the backdrop of economic globalization and regional economic integration, regional economic cooperation and development have become the main themes of China's tourism economy. In China's regional development landscape, the Yangtze River Delta urban agglomeration, the Guangdong-Hong Kong-Macao Greater Bay Area, the Beijing-Tianjin-Hebei urban agglomeration, and the Chengdu-Chongqing economic circle are the four main growth poles driving China's economic development. These regions, which together account for half of the nation's GDP, boast rich tourism resources, strong industrial bases, vast consumer markets, advantageous geographical locations, and convenient transportation. This provides a solid foundation for tourism development. However, with the continuous evolution of the interaction between regional economies and tourism, the integration process within urban agglomerations is uneven, and the development of the tourism economy shows a complex spatial correlation structure.

In recent years, scholars at home and abroad have mostly used social network analysis to study the spatial correlation structure of the tourism economy, focusing on aspects such as the evolution of the

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spatial structure of the tourism economy, spatial differences, and influencing factors. From a research perspective, the focus is generally on urban agglomerations, comprehensive urban belts, and provincial tourism spatial structures. For instance, researchers like Guangming Xiao et al. [1-4] have studied the evolution of the tourism spatial pattern in the Pearl River Delta, Yangtze River Delta, the middle reaches of the Yangtze River urban agglomeration, and the 12 provinces in the western region. In terms of research content, there is a focus on the dynamic evolution of the tourism spatial structure [5], the characteristics of the spatial correlation network of tourism economic development between Chinese provinces [6], and the mechanisms of spatio-temporal evolution of tourism economic connection patterns [7]. Regarding theoretical models, structural hole theory, core-periphery theory, gravity models, two-dimensional combined matrix methods, and spatial misalignment evaluation models are primarily used. Researchers like Deguang Liu et al. [8-10] have analyzed issues such as the evolution of the urban economic development and tourism economic structure, the intensity of regional tourism economic connections, and the influencing factors of tourism space.

Existing studies have paid more attention to the models themselves and have not fully integrated the new requirements proposed by the country in recent years for optimizing the overall spatial layout of the tourism industry or the new plans proposed by regions for economic development strategies and industrial layout structures. They have not adequately considered the basic conditions, development levels, and functional positioning of different cities to propose strategic paths for promoting the coordinated development of the tourism industry. This paper draws on the research results and experiences of many scholars, combines the issues of tourism economic development discovered through comparisons between and within urban agglomerations, and proposes ideas for promoting tourism economic development at various levels of cities and optimizing the structure of the tourism spatial network based on the requirements of regional integration development patterns. This provides a reference for promoting coordinated development of the regional tourism economy.

2. Research Approach and Data Sources

This paper applies the gravity model to measure and analyze the spatial correlation network layout characteristics of tourism economic development in the four major urban agglomerations. It calculates the intensity of tourism economic connections among 81 cities, uses UCINET software to judge the network structure by calculating network degree, network density, and network efficiency of urban agglomerations; and calculates the degree centrality and betweenness centrality to identify central cities. It also draws the topological structure map of the tourism economic connection social network to observe and compare the relationships of various nodes in the network. Additionally, core-periphery analysis is used to identify core and peripheral cities and to compare the similarities and differences between core cities and central cities. Cohesion subgroup analysis is used to subdivide the subsets of each urban agglomeration to determine the degree of coordinated tourism economic development within the urban agglomerations.

Considering the characteristics of tourism economic development, the focus is on central cities. The tourism economic index and tourism supply capacity index are constructed and calculated to rank the tourism economic development capacity of cities and analyze the degree of misalignment between tourism economic development levels and tourism resources and carrying capacity, thereby determining their development driving capabilities.

To exclude the impact of the pandemic, data on total tourism income, number of tourists, GDP, number of travel agencies, number of star-rated hotels, number of airports, and number of train stations are taken from the 2019 Statistical Yearbook of each city. Data on the number of terminals is sourced from the official websites of various airports. Road network density is referenced from OpenStreetMap data, and distance data is collected from Baidu Maps.

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3. Empirical Measurement

3.1. Tourism Economic Network Analysis

3.1.1. Overall Network Construction

Analyzing the topological structure map of the tourism economic network of the four major urban agglomerations reveals that, with the exception of Huizhou and Hengshui, there are generally spatial correlations between cities within the urban agglomerations. The number of tourism economic relationships in the Yangtze River Delta urban agglomeration, Chengdu-Chongqing economic circle, Guangdong-Hong Kong-Macao Greater Bay Area, and Beijing-Tianjin-Hebei urban agglomeration are 240, 38, and 22, respectively. Meanwhile, the sub-networks of different nodes exhibit two characteristics: one is a radial network, such as the network between Hefei and cities within Anhui Province, which is relatively unstable; the other is a clustered network where almost every node is connected, forming a denser sub-network with higher density than the overall network. For instance, Chengdu and Chongqing, as well as Beijing and Tianjin, serve as both sources and destinations of tourists, resulting in a more stable network structure.

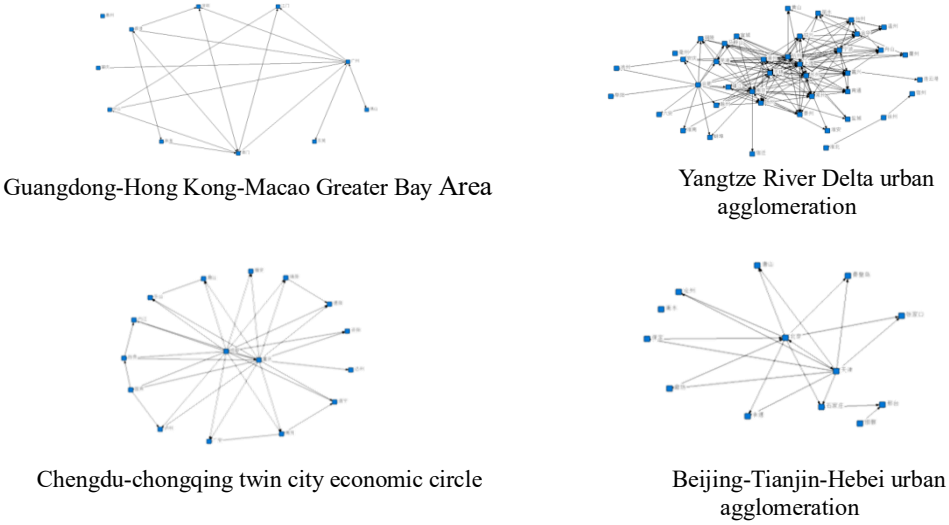

Figure 1: Structure chart of tourism economic connection network of four urban agglomerations

3.1.2. Network Characteristics Analysis

The overall network connections among the four urban agglomerations are more numerous but less frequent compared to connections within each urban agglomeration, resulting in less robustness than the internal networks of the urban agglomerations. The cross-urban agglomeration connections of central cities exhibit a significant clustering effect. Among these, the Yangtze River Delta urban agglomeration demonstrates good network accessibility, strong network stability and coordination, and a pronounced spatial spillover effect. The cities in the Guangdong-Hong Kong-Macao Greater Bay Area have the closest network connections. In the Chengdu-Chongqing economic circle, the network connections between cities generally revolve around a few key points. The Beijing-Tianjin-Hebei urban agglomeration has lower network redundancy and a relatively loose network structure, with most cities only showing single-line connections to Beijing, Tianjin, and Shijiazhuang, indicating a lack of intra-provincial network connections and placing most cities in a subordinate position.

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Using degree centrality and betweenness centrality functions to measure individual network characteristics, it was found that most of the connections are based on central cities such as Shanghai, Nanjing, Hefei, Hangzhou, Suzhou, Chengdu, Chongqing, Guangzhou, Macau, Hong Kong, Shenzhen, and Beijing. Cities like Jinhua, Tangshan, Meishan, and Wuhu also play certain intermediary and dominant roles in the network. Macau, Guangzhou, Shanghai, and Hangzhou exhibit strong regional resource dominance, whereas Beijing, Chengdu, and Chongqing lack sufficient resource allocation capacity for their respective urban agglomerations.

Applying the core-periphery analysis function to measure the network structure of the four major urban agglomerations reveals that the Guangdong-Hong Kong-Macao Greater Bay Area and the Yangtze River Delta urban agglomeration have a dumbbell-shaped core-periphery structure, while the Chengdu-Chongqing economic circle and the Beijing-Tianjin-Hebei urban agglomeration have a pyramid structure. In each urban agglomeration, central cities serve as the core cities. However, cities with high centrality such as Huzhou, Jiaxing, Changzhou, Shaoxing, Deyang, and Tianjin, although located in the core areas, do not exhibit strong resource control. Peripheral cities are those with relatively low centrality.

Table 1: Comparative table of structural characteristics of tourism economic network in four major urban agglomerations

Indicator type(+/−)	Ranking of completeness of tourism economic network from high to low				Overall indicator value
Network relevance	Yangtze River Delta urban agglomeration	Chengdu Chongqing Dual City Economic Circle	Guangdong-Hong Kong-Macao Greater Bay Area	Beijing-Tianjin-Hebei city cluster	0.6
Network relevance Indicator value(+)	1	0.85	0.82	0.78	
Network level Indicator value(−)	0.63	0.89	0.53	0.83	0.5
Network density Indicator value(+)	0.16	0.13	0.2	0.11	0.09
Network efficiency Indicator value(−)	0.79	0.81	0.83	0.85	0.79
Core City	Shanghai, Hangzhou, Suzhou, Wuxi, Huzhou, Nanjing, Ningbo, Jiaxing, Changzhou, Shaoxing	Chengdu, Chongqing, Deyang	Macau, Guangzhou, Hong Kong, Shenzhen	Beijing and Tianjin	
Edge cities	5 cities in Jiangsu, and 12 cities in Anhui	10 cities in Sichuan	Huizhou, Dongguan, Zhongshan, Zhaoqing, and Jiangmen	six cities in Hebei Province	

An analysis of cohesive subgroups within the four major urban agglomerations reveals distinct hierarchical characteristics in network structures, closely associated with the distribution of central cities. In the Guangdong-Hong Kong-Macao Greater Bay Area, the 11 cities are divided into four relatively tightly-knit subgroups. The tourism economic network connections are relatively balanced, with Hong Kong, Shenzhen, Guangzhou, and Macau belonging to the first subgroup, and Zhuhai and

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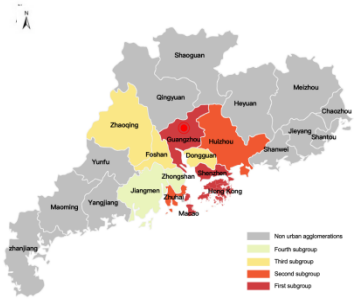
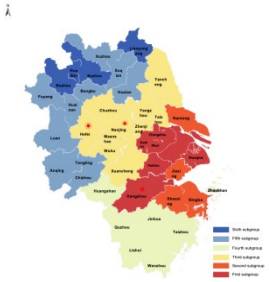
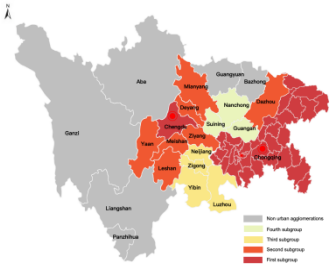
Huizhou to the second subgroup. These subgroups form the core area of the overall network in the Greater Bay Area. The Yangtze River Delta Urban Agglomeration's 41 cities are divided into six relatively tightly-knit subgroups. Shanghai, Changzhou, Wuxi, Huzhou, Hangzhou, and Suzhou belong to the first subgroup, constituting the core area of the overall network in the Yangtze River Delta urban agglomeration. In the Chengdu-Chongqing Economic Circle, the 16 cities are divided into four relatively tightly-knit subgroups. Chengdu and Chongqing form the first subgroup, which serves as the core area within the overall network of the Chengdu-Chongqing economic circle. The Beijing-Tianjin-Hebei Urban Agglomeration's 13 cities are divided into four relatively tightly-knit subgroups. Beijing and Tianjin form the first subgroup, acting as the core area within the overall network of the Beijing-Tianjin-Hebei urban agglomeration.



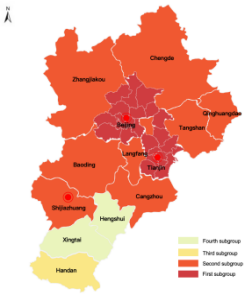
Guangdong-Hong Kong-Macao Greater Bay Area



Yangtze River Delta urban agglomeration



Chengdu-chongqing twin city economic circle



Beijing-Tianjin-Hebei urban agglomeration

Figure 2: Four major urban agglomerations condenses subgroup distribution

3.2. Analysis of Synchronization and Misalignment between Central Cities' Tourism Economy and Tourism Supply Capacity

Using the Analytic Hierarchy Process (AHP), the weights of the tourism economic indicators were calculated separately, resulting in the Tourism Supply Capacity Index $R = 0.41 \times N_1 + 0.21 \times N_2 + 0.38 \times N_3$.

Table 2: Index system and weight of tourism supply capacity index

	Primary indicators	weight	Secondary indicators	weight
Tourism supply capacity index	Convenience of transportation(N_1)	0.41	Highway network density	0.13
			The shortest distance between the center of each administrative district where the scenic spot is located and the airport	0.12
			The shortest distance between the center of each administrative district where the scenic spot is located and the train station (including the high-speed rail station)	0.16

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Table 2: (continued)

Tourism infrastructure(N_2)	0.21	Number of travel agencies	0.04
		Number of star rated hotels	0.05
		Number of airports (including urban terminals)	0.06
		Number of train stations (including high-speed rail stations)	0.06
Number of 4A level or above scenic spots(N_3)	0.38	Number of 4A level scenic spots	0.13
		Number of 5A level scenic spots	0.25

Substituting the values of various indicators of central cities into the index formula, it was found that the top ten cities in terms of the Tourism Economy Index and Tourism Supply Capacity Index are: Chongqing, Shanghai, Beijing, Chengdu, Tianjin, Hangzhou, Nanjing, Guangzhou, Suzhou, and Ningbo. The Misalignment Index shows that Hangzhou and Suzhou have relatively balanced supply and demand capabilities in tourism economics. The Tourism Economy Index of Beijing and Guangzhou is lower than their Tourism Supply Capacity, with Guangzhou having the most severe negative misalignment. The remaining cities are in a state of synchronous high values, with Chongqing and Tianjin having higher positive misalignment indexes.

Table 3: Tourism economy index, tourism supply capacity index and dislocation index of TOP10 cities

City name	Tourism Economic Index	Tourism supply capacity index	Dislocation index
Chongqing	1	0.62	0.38
Shanghai	0.56	0.41	0.15
Beijing	0.49	0.56	-0.07
Chengdu	0.42	0.29	0.13
Tianjin	0.36	0.13	0.24
Hangzhou	0.31	0.27	0.03
Nanjing	0.21	0.10	0.11
Guangzhou	0.20	0.33	-0.14
Suzhou	0.20	0.21	-0.01
Ningbo	0.20	0.13	0.07

4. Conclusions and Implications

4.1. Conclusions

4.1.1. Characteristics of Tourism Economic Networks in Urban Agglomerations

For the overall tourism economy network, firstly, the network connectivity, hierarchy, density, and efficiency among urban agglomerations are generally low, with cities within different agglomerations interacting to some extent, and the connection networks among central cities being highly concentrated. Secondly, the network structures of all urban agglomerations exhibit more radiative networks than clustered networks. Thirdly, the degree of perfection of the tourism economy network among urban agglomerations ranks from high to low as follows: Yangtze River Delta, Guangdong-Hong Kong-Macao, Chengdu-Chongqing, Beijing-Tianjin-Hebei.

Regarding the tourism economy networks of various urban agglomerations, the Yangtze River Delta urban agglomeration has relatively close tourism economic connections between cities, a rich hierarchical spatial network, strong stability, and the most subgroups. The cities have extensive

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connections, strong synergy, tourism resources are concentrated in multiple points, the central city network has high concentration and resource control, and there are few peripheral cities. The Guangdong-Hong Kong-Macao Greater Bay Area has a relatively stable tourism economy network, with relatively close tourism economic connections between cities, concentrated tourism economic forms, fewer subgroups, clear hierarchies, and significant differences in network connections between cities, characterized by "two large ends" between core and peripheral cities. The Chengdu-Chongqing twin-city economic circle has weak accessibility in the tourism network, poor stability, lack of hierarchy, the smallest proportion of core cities and the largest proportion of peripheral cities, with relatively little tourism economic exchange. The Beijing-Tianjin-Hebei urban agglomeration has not yet formed a complete tourism economy network between cities, with unbalanced tourism economic development, and weak driving effect of the central cities' tourism economy.

4.1.2. Characteristics of Internal Tourism Economic Development in Urban Agglomerations

Firstly, the external connectivity of China's tourism economy is more pronounced than its internal connectivity, and the network structure's clustering is uneven. Secondly, central cities occupy core positions in the network; however, not all core cities are the central cities of their respective urban agglomerations, such as Huzhou, Changzhou, and Deyang. Additionally, central cities generally have a high degree of tourism economic connections but a weaker capability for resource allocation within the urban agglomeration. Thirdly, the clustering of subgroups spatially presents a concentric pattern, with central cities as the origin, showing strong spatial self-organization capabilities. Core cluster cities are mainly concentrated in Beijing, Shanghai, and Jiangsu Province, while most cities in Hebei, Sichuan, and Anhui Provinces are in peripheral areas, with fewer tourism economic connections between cities. Fourthly, cities with a high tourism economy index also have high tourism supply capacity indexes, and these are all core cities. The tourism supply and demand levels in Chongqing, Beijing, and Shanghai are far higher than those in other cities, while there is still significant potential for the development of the tourism industry in Guangzhou.

4.2. Implications

1. Economic development levels are a crucial driving force for tourism economic development. It is necessary to establish cultural and tourism economic belts according to urban agglomeration development plans and local policies, improve collaborative tourism development mechanisms, and promote the aggregation and circulation of resources, information, and related talents. This can enhance the regional driving force and improve the tourism supply capabilities of positively misaligned cities and the market expansion capabilities of negatively misaligned cities.

2. Under the trend of regional economic integration, future urban agglomeration tourism should focus on both local integration and the spatial spillover effects of integration. Sub-central cities can be considered as regional tourism centers, utilizing the resources of central cities to develop local tourism. For underdeveloped tourism areas, it is essential to deeply explore potential, strengthen cultural construction investment, create a good market business environment, and absorb the spatial spillover from core cities.

3. Improving traffic accessibility and convenience is a crucial engine for urban tourism development. The integration of tourism with high-speed rail, aviation, and road transportation should be emphasized. It is necessary to enhance transportation infrastructure and supporting service functions, strengthen tourism distribution functions, and build a "comprehensive transportation network + tourism" service system. This includes innovatively launching special tourist trains for well-known scenic spots, opening direct flight routes between popular cities, and developing multi-

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city joint self-driving tour routes to promote the spread of tourism flows from core to peripheral areas and improve the regional tourism pattern.

4. Digitalization is an essential support for the high-quality development of the cultural and tourism industry and a vital tool for promoting the deep integration of the "five-in-one" digital China. Leveraging "Internet+", big data, and establishing regional tourism cooperation trading platforms can innovate tourism products, develop IP operation chains, extend the service and consumption chains of tourism operations, and optimize the efficiency of tourism economic network structures and the spatial sub-organization capabilities of urban agglomerations. This will better achieve differentiated coordinated development and deep cooperation in the tourism economy.

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