Big Data Analysis of the Tourism Linkage of the Yangtze River Delta Using Stata Calculation and Improved Gravity Model

Shengming Liu
Huaqiao University, Quanzhou, Fujian 362000
15750999597@163.com

Abstract. In this study, the top 11 prefecture-level cities with GDP ranking in 2020 in the Yangtze River Delta are selected as the basic research units. Based on the basic gravity model, the data selection of some variables is adjusted, and the intensity, total amount and membership degree of tourism economic links of major cities in the Yangtze River Delta are calculated by USING Stata. The study found that the tourism economic linkages of the Yangtze River Delta urban agglomeration show an evident core-edge structure, with Shanghai, Suzhou, and Hangzhou as the key linkage triangle; the peripheral cities present weaker tourism economic linkages with other cities. In the whole urban agglomeration, tourism economic linkages should be strengthened, and the synergy and integration of tourism development in the Yangtze River Delta need to be further enhanced. Therefore, it is proposed that transport facilities should be improved, innovative cooperation should be enhanced, and tourism resources should be integrated, so as to promote the deep integration and win-win development of tourism in the Yangtze River Delta region.

Keywords: Yangtze River Delta, Tourism Economic Linkage, Gravity Model, Stata.

1. Introduction

Under the background of booming global trade in services, China also prioritizes the development of trade in services. Since the 1980s, with the development of China’s reform and opening up, its deepening participation in economic globalization after joining the WTO, and the rapid rise in per capita GDP, the service industry has played an increasingly important role in the national economy, and people have begun to view its importance at an unprecedented height. In recent years, China’s trade in services has grown at a fast pace. The added value of China’s service industry rose from 39.8% to 54.5% of GDP, an increase of nearly 15% in 20 years, and the share of service industry employees rose from 27.5% to 47.7%, an increase of 20% in 20 years, indicating that the service industry has a clear radiating and driving effect on the national economy. Since 2012, the Chinese government has issued the 12th Five-Year Plan for Service Industry Development (2011-2015), the Outline for Innovative Development of Service Industry (2017-2025), and the 14th Five-Year Plan for the Development of Trade in Services, contributing to the gradual formation of a systematic, comprehensive, open and scientific planning system for the development of trade in services in China.

The development of the service industry is one of the important signs reflecting the economic growth of an economy. The service industry is defined as an industry that renders or produces service products in connotation, and externally includes service sectors, such as distribution services, education services, and financial services. As one of the most powerful and largest industries in global economic development, tourism increasingly highlights its important position in the national economy. With the advent of the post-epidemic era, the domestic tourism economy is gradually recovering. In 2020, China received a total of 637 million domestic tourists, recovering 79.0% year-on-year on a comparable basis, and achieved domestic tourism revenue of 466.56 billion yuan, recovering 69.9% year-on-year on a comparable basis. According to the calculations of the China Tourism Academy, with the further improvement of living standards and the change of the consumers and consumption concept, the demand for tourism will continue to increase with promising development prospects. By 2025, the number of domestic tourists will exceed 8.3 billion, with tourism revenue approaching 10 trillion yuan.
The gravity model is a classic model to explore the structure of tourism networks in urban agglomerations. After years of research and continuous improvement, the gravity model has alienated distance from a spatial concept to a combination of monetary and temporal concepts. Taking the Yangtze River Delta in 2020 as the analysis object, this study attempts to measure the tourism economic linkage of the Yangtze River Delta urban agglomeration using the gravity model, examine the closeness of tourism economic ties in the Yangtze River Delta urban agglomeration, and explore the radiation effect of the central cities on other cities. This study aims to provide a theoretical reference for the spatial organization of regional tourism and intra-regional tourism integration.

In this study, the first part begins with a review of the literature on the gravity model as well as the contribution of this study; the second part presents the estimation methods, models, and data used; the third part discusses the results of the empirical analysis; the fourth part renders the conclusions and recommendations.

2. Literature Review

2.1. Origin and Development of the Gravity Model

The gravity model is a model that applies economic, social and political interactions in geographic space. It originated with Newton’s Law of Universal Gravitation. The law states that any particle of matter in the universe attracts another one with a force varying directly as the product of the masses and inversely as the square of the distance between them. In economic dynamics, the theory of economic gravitation argues that “the Law of Universal Gravitation also applies to economic problems, i.e., there is also a law of gravitation for regional economic links.” The gravity model was first developed by Tinbergen and Poyhonen in international trade in the 1960s. According to $F_{ij} = \frac{Q_i Q_j}{d_{ij}^2}$, they concluded that the volume of trade between two countries is proportional to their GDP and inversely proportional to the distance between them [1]. Linnemann introduced the population variable to the trade gravity model, suggesting that the population size is positively related to the size of trade [2]. Berstrand used per capita income instead of population size [3]. Francois chose GDP per capita and absolute distance between trading parties as explanatory variables [4]. So, Loaga and Winters adjusted the physical distance to economic distance in the gravity model [5]. The gravity model has a broader application scope, and it has gradually become the main empirical research tool for international trade flows.

2.2. Application of Gravity Model in Tourism Industry

In 1966, Crampon proposed a potential model of tourism attractiveness, which identified the population size in the source area, the destination capacity and the distance between the two places as factors affecting the number of tours [6]. However, the model still has shortcomings in predicting tourism demand; based on its shortcomings, many scholars have made further improvements to this model, such as Wolfe, Edwards and Dennis’ correction to the distance variable [7] as well as Cesario and Knetsc’s improvement of the equation constraints [8].

In the 1980s, Chinese scholar Zhang Lingyun first applied the gravity model architecture to the study of tourism network structure of urban agglomerations [9]. In recent years, some domestic scholars began to study the economic linkage of regional tourism and spatial structure of tourism from the perspective of tourism traffic integration. Xuan Guofu et al. applied the tourism gravity model from the perspective of the source place, and empirically studied the model by analyzing the economic income, the population size in the source place, and the spatial distance difference to the tourist place [10]. Guo Wei et al. examined the factors affecting inbound tourism in China based on the international trade gravity model, and concluded that absolute distance and the level of economic development were the main influencing factors [11].

The literature review suggests that existing research focuses on the development of services trade internationally and across the country as a whole, while there are fewer domestic studies that
quantitatively measure specific sectors of services trade in the Yangtze River Delta region. In the Yangtze River Delta region, the resident population exceeds 220 million and the per capita income level is moving into the stage of leisure and holiday tourism consumption. Strong economic strength, favorable policy support and abundant tourism resources have combined to promote tourism in the Yangtze River Delta, making it a large domestic tourism market. Considering tourism as a typical service trade sector and closely related to service sectors such as transportation, catering, and accommodation and based on the characteristics of the Yangtze River Delta region and the applicability of the gravity model in the field of services trade, this study adopts the gravity model to quantitatively simulate the strength of tourism linkages between cities, and proposes suggestions for the high-quality development of the Yangtze River Delta integration, expecting to provide a reference for the coordinated development of regional tourism service trade.

3. Research Methods and Research Data

3.1. Modeling

The gravity model is a common method for measuring economic linkages between regional cities. Using the shortest highway distance between cities at different levels in the Yangtze River Delta region, and Stata measures the intensity, total amount and membership degree of tourism economic connection among 11 cities in the region.

Its calculation formula is:

\[ R_{ij} = \sqrt{G_i R_i} \times \frac{R_j}{S_d^2} \]  

(1)

\[ R_i = \sum_{j=1}^{n} R_{ij} \]  

(2)

\[ F_{ij} = \frac{R_{ij}}{\sum_{j=1}^{n} R_{ij}} \]  

(3)

where, \( R_{ij} \) denotes the tourism economic linkage between city i and city j; \( R_i \) represents the total amount of tourism economic connection; \( F_{ij} \) stands for economic affiliation degree; \( G_i \) denotes the tourism revenue of city i (billion yuan); \( R_i \) is the number of tourists in city i (billion trips); \( C \) is the average monetary cost of railway transportation (yuan/person-km); \( S \) is the average speed of railway transportation (km/hour); \( d \) represents the shortest transportation distance between city i and city j (km).

3.2. Data Explanation

In order to measure the tourism integration in the Yangtze River Delta region, the top 11 prefecture-level cities with GDP ranking in the Yangtze River Delta region in 2020 were selected for the study, including Shanghai, Suzhou, Nanjing, Nantong, Changzhou, and Xuzhou in Jiangsu Province, Hangzhou, Ningbo, Wuxi, and Wenzhou in Zhejiang Province, and Hefei City in Anhui Province.

In total, there are five indicators: number of domestic tourists, domestic tourism revenue, average railway cost, railway passenger speed and shortest transport distance. By the end of 2020, 6,008 km of high-speed railways were in operation in the Yangtze River Delta, creating the densest network of high-speed railways in China. The three provinces and one city have formed a high-speed rail metropolitan circle, with Shanghai as the center and a distance of 0.5 to 3 hours. Therefore, this study chooses to use railways as the main mode of travel for tourism in the Yangtze River Delta region. In this study, all data for the empirical analysis sources from the website of the National Bureau of Statistics, the 2021 statistical bulletin and statistical yearbook of each city, the website of the Ministry
of Transport of China and the website of 12306. For the shortest transportation distance, the preferred recommended route distance under the driving mode of the Gaode Map is uniformly used in this study.

4. A Study of Tourism Economic Linkage in the Yangtze River Delta

Table 1. Tourism Economic Linkages between Cities in the Yangtze River Delta in 2020

<table>
<thead>
<tr>
<th>Shanghai</th>
<th>Suzhou</th>
<th>Hangzhou</th>
<th>Nanjing</th>
<th>Ningbo</th>
<th>Wuxi</th>
<th>Hefei</th>
<th>Nantong</th>
<th>Changzhou</th>
<th>Xuzhou</th>
<th>Wenzhou</th>
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<tbody>
<tr>
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<td>28.28</td>
<td>43.33</td>
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<td>20.46</td>
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<tr>
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<td>14.98</td>
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<td>0.43</td>
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<td>0.5</td>
<td>0.55</td>
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<tr>
<td>Average</td>
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<td>40.86</td>
<td>22.87</td>
<td>10.01</td>
<td>12.16</td>
<td>27.35</td>
<td>3.38</td>
<td>3.54</td>
<td>15.41</td>
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</tbody>
</table>

* Average tourism economic linkage

According to Table 1, the largest tourism economic linkage within the Yangtze River Delta urban agglomeration in 2020 is between Suzhou and Wuxi, at 146.80; the smallest tourism economic linkage is between Nantong and Xuzhou, at 0.1. The distance between Suzhou and Wuxi is 49 km, which is significantly smaller than that between Nantong and Xuzhou. Based on the city tourism economic linkage model, the distance between cities has a greater impact on the tourism economic linkage between cities. The cities with closer tourism economic linkage with Shanghai, the central city in the Yangtze River Delta region, are the neighboring Suzhou and Hangzhou, at 135.74 and 95.77, respectively. The cities with closer tourism economic linkage to Nanjing, one of the sub-central cities in the Yangtze River Delta region, are Changzhou at 21.91, and Guangzhou and Suzhou at 16.02 and 14.98, respectively. The cities with closer tourism economic linkage to Guangzhou, one of the four cities is less than 5% of the total amount in the Beijing-Tianjin-Hebei region. The gap between regions is too large and extremely unbalanced. In summary, these data further support this study that distance between cities has a greater impact on inter-city tourism economic linkage.

Table 2. Total amount of tourism economic connection of cities in Yangtze River Delta in 2020

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>339.74</td>
<td>408.55</td>
<td>228.65</td>
<td>100.08</td>
<td>121.58</td>
<td>273.51</td>
<td>33.78</td>
<td>35.37</td>
<td>154.09</td>
<td>7.61</td>
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As shown in Table 2, among the 11 cities in the Yangtze River Delta, Shanghai and Suzhou have the highest total tourism economic connection, while Hefei and Xuzhou have the lowest, which are below 35. Shanghai, Suzhou, Wuxi and Hangzhou account for 19.52%, 23.47%, 15.71% and 13.14% of the total tourism economic ties in the Yangtze River Delta. The total amount of regional economic links in the other seven cities is relatively low in the Yangtze River Delta, and the total amount of tourism economic links in the four cities is less than 5% of the total amount in the Beijing-Tianjin-Hebei region. The gap between regions is too large and extremely unbalanced.


As shown in Table 3, taking 5% of tourism economy membership as the boundary, the main directions of tourism economy connection of each city are as follows: Shanghai-Suzhou-Hangzhou-Wuxi-Ningbo; Suzhou-Wuxi-Shanghai-Changzhou-Hangzhou; Hangzhou-Shanghai-Ningbo-Suzhou-Nanjing-Wuxi; Nanjing-Changzhou-Hangzhou-Suzhou-Shanghai-Hefei-Wuxi; Ningbo-Hangzhou-Shanghai-Suzhou-Wenzhou; Wuxi-Suzhou-Shanghai-Changzhou-Hangzhou; Hefei-Nanjing-Shanghai-Hangzhou-Changzhou-Hefei-Shanghai-Suzhou-Wuxi; Nantong-Shanghai-Suzhou-Hangzhou-Wuxi-Changzhou; Changzhou-Suzhou-Wuxi-Nanjing-Shanghai-Hangzhou; Xuzhou-Hefei-Nanjing-Hangzhou-Shanghai-Suzhou-Changzhou-Wuxi; Wenzhou-Ningbo-Hangzhou-Shanghai-Suzhou. The cities in the Yangtze River Delta are closely connected with other cities with Shanghai, Suzhou and Hangzhou as the center.

In the Yangtze River Delta region, the urban tourism economy shows a triangular development pattern, with Shanghai as the core and Suzhou and Hangzhou as sub-centers; other cities show a gradual decline as the distance from the main node cities increases. On the one hand, tourism economic linkages between neighboring provinces and cities in the Yangtze River Delta region are generally stronger than those between non-neighboring provinces and cities. The more distant the two provinces and cities are, the weaker their tourism economic linkages are. This is basically in line with the law of distance decay. On the other hand, there is strong tourism economic linkage between Shanghai Municipality and Zhejiang and Jiangsu provinces in the Yangtze River Delta region, while Anhui Province has no tourism economic linkage with Shanghai, Zhejiang and Jiangsu. This reflects, to some extent, the constraints on the free flow of production factors such as material, human and information flows across the region, further illustrates the importance of breaking the stereotyped mentality, and achieves a synergistic and win-win situation of regional tourism driven by the government.

5. Conclusion and Suggestions

5.1. Conclusions

Based on the regional traffic conditions, this study uses the gravity model to establish a regional tourism economic linkage model. The tourism economic linkage between the cities in the Yangtze River Delta urban agglomeration is measured, and an empirical analysis of the tourism economic linkage among major cities in the Yangtze River Delta urban agglomeration is conducted. The following conclusions are made:

(1) The tourism economic linkage between cities is closely related to their tourism resources. As for Shanghai and Suzhou, which have a strong tourism economy, their average tourism economic linkage reaches the highest at 33.97 and 40.86, respectively, with a strong radiation capacity. As for Xuzhou and Hefei, which have a weak tourism economy, their average tourism economic linkage is only 0.76 and 3.38, ranking the last two.
The inter-city tourism economic linkage follows the law of distance decay. The tourism economic linkage extends along the main traffic arteries and decreases with distance. Transport conditions are the support system for regional tourism linkages. The construction and improvement of transport infrastructure will affect the scope and intensity of tourism economic linkage.

In the Yangtze River Delta region, the urban tourism economy shows a triangular development pattern. Changzhou and Suzhou, Nanjing and Wuxi have more linkages than Changzhou and Shanghai; Ningbo and Hangzhou have more linkages than Ningbo and Shanghai. Tourism development is not entirely centered on Shanghai. With the development of tourism in the Yangtze River Delta urban agglomeration, the Shanghai-centered structure might evolve into a triangular structure of Shanghai, Suzhou, and Hangzhou.

5.2. Policy Suggestion

Based on the empirical research results of this study, the following countermeasures and suggestions are proposed for the tourism development in the Yangtze River Delta urban agglomeration:

(1) Improving rail transport in the Yangtze River Delta and enhancing accessibility to the city

Transport is an important factor affecting the flow and effectiveness of regional tourism. Currently, transport integration in the Yangtze River Delta promotes tourism and economic linkage between Shanghai and neighboring cities, but peripheral cities still lack transportation infrastructure. The Yangtze River Delta should further strengthen the transport integration, promote the construction of a modern rail transport system with a rational layout, a clear network hierarchy, and an integrated efficient connection, support the regional integration, and strive to create a “Yangtze River Delta on rails,” with the aim of effectively strengthening the tourism economic linkage between cities, realizing the radiating effect of core cities on the surrounding cities, and opening up fast lanes for the smooth flow of factors between cities.

(2) Promoting tourism cooperation among major node cities and increasing Shanghai’s “radiating power” to the Yangtze River Delta region

At present, taking Shanghai, Suzhou and Hangzhou as the main nodes, the integrated tourism development of the Yangtze River Delta promotes the integration of tourism resources in the node cities and drives the development of the surrounding area. In this way, the advantages of Shanghai, Suzhou and Hangzhou in terms of tourism resources and transportation are given full play. In addition, it is necessary to establish a regional tourism cooperation mechanism around the Yangtze River Delta region and build a platform to enable the lower-order gradient areas of tourism development, so as to directly receive the cutting-edge tourism radiation from the higher-order areas and to promote the integrated development of the Yangtze River Delta region.

(3) Integrating and innovating the tourism resources of the Yangtze River Delta and promoting the formation of a sub-center with a strong radiation capacity

It is necessary to promote the tourism development in Hefei and the surrounding cities to form a sub-center with a strong radiation capacity in the northwestern part of the Yangtze River Delta urban agglomeration. Anhui Province may take advantage of its industrial development, use industrial tourism and technology tourism as breakthroughs, and complement with other regional tourism, thereby expanding the wider tourism industry coupling and enhancing the development of tourism in the Yangtze River Delta.

References


