A Study on the Gravity Model of the Interaction between Tourism Spaces and Its Application

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Abstract

Tourists are the body of the interaction of tourism spaces. In order to ensure the sustainable development of tourist attractions, the interaction between tourism-generating regions and tourist attractions should always be long lasting, which has a great significance for the sustainable development of tourism. Therefore, it is necessary to conduct a thorough study on the interaction mechanism between tourism spaces by constructing a gravity model, so as to build a theoretical framework for the long-term development of tourist attractions and to achieve the core objective of promoting the development of tourism industry in China. To this end, a tourism spatial interaction model is established first in this paper, and an analysis for the tourism spatial interaction by the gravity model is conducted to present the application ideas of the tourism spatial interaction, which is of great significance in enhancing the level of China's tourism development.

Keywords: Tourism Spaces; Interaction and Gravity Model.

1. RESEARCH OVERVIEW

1.1 Research background

1.1.1 Background of spatial interaction

Spatial interaction theory was first proposed by the famous geographer Ullman, that is, a process in which between different regions, some elements in the regions, such as personnel, material, etc., need to be exchanged so as to ensure the normal operation in ecology, culture and other aspects. Ullman presents in this theory that the interaction between different regions must meet three conditions: first of all, resources of both sides must be complementary, which is a prerequisite for spatial interaction. Secondly, both resources must be mobile, as spatial complementation is difficult to be realized for fixed resources. Finally, there must be intervening opportunities between different regions so that the communication among elements can be guaranteed.

1.1.2 Background of tourism development

With the development of Chinese society, China's faster economic development, and its increasing economic level, people's pursuit of quality of life is on the increase. Tourism can not only make visitors appreciate all kinds of exotic natural landscapes and broaden their minds, but also allow them to experience the diversity of cultures; it has become one of the most popular consuming styles. Therefore, China's tourism industry has been developing rapidly, and there are more and more developed tourism resources; with great economic benefits generated along with the prosperity of tourism, it has become a new economic growth point in China. It is thus important to make in-depth research of the tourism industry and study the interaction between tourism spaces to promote the development of tourist attractions.

1.2 Literature review

Tourism spatial interaction is restricted by the tourist traffic level, and the improvement of the traffic level and the construction of tourist information service system and its tourism development axis can effectively promote the development level of tourist attractions. Within a certain range of tourist area, a three-pole driven, three-zone collaborated and three-belt linked integrated tourist attraction development pattern can be established, which is of vital significance for the optimal allocation and the comprehensive development of tourist attractions. (Li et
al., 2012) The elements of tourism space interaction mainly include tourists, tourist funds and scenic spot goods, etc., which together form the tourism space interaction system. There exist some competition and cooperation relationships among different tourist attractions, by which they can complement each other in resources, commodities, spiritual civilization, image of the attraction, traffic system, etc., so as to achieve the purpose of promoting the overall development of the spot. (Yang et al., 2012) The interaction between tourism spaces has three characteristics. First, the development of some tourist attractions focus on the natural scenery, while that of some others on the high urban economic development level, and still others on the particular cultural characteristics of countryside; if these features of the different tourist attractions can be integrated, an all-around and high-standard tourist region can be formed. Second, there are characteristics of transferability between tourism spaces; on the one hand, tourism attractions must construct an advanced three-dimensional transportation of land, sea and air so that visitors can arrive the scenic spots faster and enjoy their journey; on the other hand, they must develop perfect logistics network to ensure that commodities and goods within the scenic spots can be conveyed as fast as they, so as to realize mutual cooperation between the scenic spot. Finally, perfect intermediary opportunity system must be established among tourism spaces. Intermediary opportunity can effectively expand the tourist routes of scenic spots and constantly enrich the tourism network, which makes the interaction between the tourism spaces possible. (Bi et al., 2012)

2. CONSTRUCTION OF THE INTERACTION GRAVITY MODEL FOR TOURISM SPACES

2.1 Development of the gravity model formula

In the 19th century, the law of universal gravitation discovered by Newton was widely applied in the urban construction, and the initial spatial interaction gravity model formula for the universal gravitation model was established, as shown below:

\[ T_{ij} = K P_i^\alpha P_j^\beta r_{ij}^{-(\alpha+\beta)} \]  \hspace{1cm} (1)

Where \( T_{ij} \) represents the spatial interaction gravity strength between spaces i and j, \( P_i \) represents the size of the metrics of space i, \( P_j \) represents the size of the metrics of space j, \( r_{ij} \) represents the distance from i to j, \( \alpha \), \( \beta \) represents the scale parameters of the two spaces, \( \beta \) represents the local damping coefficient, and K represents the normalization factor. The spatial interaction gravity model formula plays a certain role in practical application, but it also has some disadvantages (Zhu and Lu, 2012). First of all, the spatial interaction gravity model formula was obtained mainly through experience, and experience does not serve as a scientific theory, which causes the deficiency of scientific theory basis of the formula (Liu, 2012). Secondly, there is an unsolved problem of faulted point in the formula. These two problems lead to the huge disadvantages of the spatial interaction gravity model formula. Through in-depth study, some experts and scholars have proposed a new formula for spatial interaction gravity model to solve the problems mentioned above:

\[ T_{ij} = A_i O_j B_j D_j \exp(-\beta C_{ij}) \] \hspace{1cm} (2)

Compared with the initial spatial interaction gravity model formula, the new formula firstly changes the performance content of \( T_{ij} \), emphasizing the gravity coefficient from space i to space j, with a clear direction. \( O_i \) represents the output metrics of space i to space j, \( D_i \) represents the input metrics of space i to space j, and \( A_i \), \( B_j \) is the balancing factor whose calculation must rely on \( O_i \) and \( D_i \). At the same time, in a certain degree, \( A_i \), \( B_j \) can replace the function of normalization factor in the original spatial interaction gravity model formula. The new formula effectively solves the problems of the original formula. It was named the Wilson Model as it was proposed by Wilson.

2.2 Tourism space interaction model

Compared to other areas, scenic spots have certain particularity in that its tourism space interaction gravity is of high complexity; to study the tourism spatial interaction, it is needed to build a new gravity model on the basis of the Wilson Model, as shown below:

\[ T_{jk} = K A_k P_j C_k \exp(-\beta r_{jk}) \] \hspace{1cm} (3)

where, \( T_{jk} \) can be expressed by concrete contents, such as the number of tourists from the tourism-generating
region j to the scenic spot k, expenses, and the time spent, etc. $A_k$ represents the development level of the tourism scenic area as a whole, or the degree of attraction of the scenic spot for tourists, which is affected by many factors, such as the degree of novelty of tourism resources, infrastructure construction and service level of the scenic area, the influence level of the scenic spot, etc. $P_j C_j^\alpha$ represent the population and per capita income of the tourism-generating region j respectively, and $\alpha$ reflects the income parameter of the tourism-generating region j; the combination of the two stands for the level of tourism consumption of the tourism-generating region j. If $G_j$ is taken as the GDP per capita of space j, then we can obtain $G_j = \frac{G_j}{P_j}$; substitute it into the above formula and adjust it, and the adjusted formula is as follows:

$$T_{jk} = KA_k P_j^{1-\alpha} C_j^\alpha \exp(-\beta r_{jk})$$  \hspace{1cm} (4)

The above formula can not only express the mechanism of the interaction between the tourism spaces more effectively, but also reflect an important feature, that is, as to a particular tourism-generating region, when its GDP per capita rises and people's income has a greater improvement, its consumption demand will also increase, leading to the increase of people's tourism consumption level (Xiao, 2008).

### 2.3 Determination of $\alpha$ and $\beta$

Affected by the lack of systematic statistical and scientific theory, it is difficult to use the above formula to deduce the values of $\alpha$ and $\beta$, and the calculation cannot be proceeded to draw the conclusion; therefore, it is needed to take other methods to determine the values of $\alpha$ and $\beta$.

#### 2.3.1 Value of $\alpha$

If $E_j$ is used to represent the overall tourism consumption ability of tourism-generating region j, we may know that $E_j$ is mainly influenced by two factors. One is the total population of j, and the other is the economic development level of it, namely, the per capita income level (Wang, 2017). Therefore, we may obtain $E_j \propto P_j C_j^\alpha$, and it can be concluded through calculation that the average per capita tourist expenditure in j is:

$$E_j = k C_j^\alpha$$  \hspace{1cm} (5)

This formula, combined with the per capita GDP, annual tourism rate, average traveling expenses, per capita tourism spending, and other data of every major tourist city in China, leads to the regression equation as shown below:

$$E_j = 0.874 C_j^{0.641}$$  \hspace{1cm} (6)

It is hence known that $\alpha \approx 0.64$. As can be seen from the analysis of the values of $\alpha$, tourism expenditure has become a part of the overall cost of the Chinese people as well as an important way of life. It shows that the quality of life of our people has been greatly improved and that the development level of tourism has been marked by a qualitative leap (Li, 2015).

#### 2.3.2 Value of $\beta$

Some experts and scholars have put forward the formula of damping coefficient by conducting in-depth research, as shown below:

$$\beta = \frac{2T}{\sqrt{t_{\max} D}}$$  \hspace{1cm} (7)

In the field of tourism, T refers to the interval between two travels of tourists or the tourism cycle, $t_{\max}$ refers to the age group of tourists who travel the most, and D refers to the distance between the tourism-generating region and the tourist attraction.

First, T will change accordingly with the level of social and economic development. In the absence of
large-scale social problems, such as epidemic diseases and other factors, the higher the level of socio-economic development, the smaller $T$ is; therefore, the trend of $T$ has been falling in recent years.

Second, $t_{\text{max}}$ and $t_{\text{min}}$ should be determined based on the statistics of major tourist attractions in recent years. The tourist age distribution is shown in Table 1:

<table>
<thead>
<tr>
<th>Particular year</th>
<th>0-18year (%)</th>
<th>19-39year (%)</th>
<th>39-59year (%)</th>
<th>59-79year (%)</th>
<th>79years old (%)</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>6</td>
<td>37</td>
<td>25</td>
<td>18</td>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>2013</td>
<td>8</td>
<td>35</td>
<td>24</td>
<td>17</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>2014</td>
<td>7</td>
<td>40</td>
<td>21</td>
<td>22</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>2015</td>
<td>10</td>
<td>38</td>
<td>19</td>
<td>26</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>2016</td>
<td>9</td>
<td>41</td>
<td>21</td>
<td>17</td>
<td>12</td>
<td>41</td>
</tr>
</tbody>
</table>

The analysis of the table shows that the majority of tourists are aged 19 to 39, with the least number of people aged between 0 and 18 and over 79. The main reasons are that the majority of the 0-18 age group are students, who spend less time in tourism, that travelling is hard for the elderly over the age of 79 as they do not feel easy to travel very far to the tourist attractions, and that young people aged 19-39 have the most interests in travelling as they take it as the major way of relieving work stress; that is way most of the tourists are aged 19-39. The analysis of the median in the table finds that although there is a certain fluctuation of the age, the overall age of tourists is around 38 in that people in this age group have relatively stable career and family status and are willing to spend more money into travelling; meanwhile, this group of people feel more curious about fresh things, which is another reason why they are more interested in outdoor tourism. Therefore, the value of $t_{\text{max}}$ should be around 38 years old.

3. ACTUAL APPLICATION OF THE INTERACTION OF TOURISM SPACES

3.1 Strengthen the construction of transport facilities in tourist areas

Scenic spots have the largest highway passenger quantity, and many of them have the problem of insufficient highway construction, leading to the fact that many tourists cannot enter the scenic spots, which is not conducive to the development of the scenic spots. Therefore, the first step is to strengthen the construction of road traffic facilities in tourist attractions. By establishing the perfect tourism scenic spot highway traffic system, on the one hand, more foreign tourists will be attracted, and on the other hand, excellent scenic spot goods or products in the scenic areas can be conveyed to all over the country, reflecting the transferability of tourism spatial interaction. Therefore, scenic spots should, taking the scenic areas as the center, cooperate with the local government to establish expressways, direct highway, automobile camp, etc., and build a special line from the city to the scenic spot, so as to enhance the construction of highways in tourism scenic areas. (Hou et al., 2015).

3.2 Establish perfect scenic spot collecting and distributing center system

In the perspective of tourism spatial interaction, in-depth cooperation can be carried out between tourism scenic spots, by which they can establish travelling collecting and distributing centers to achieve the purpose of complementary advantages between them (Xue and Weng, 2010). The idea of optimal construction of collecting and distributing centers in tourist attractions is shown in Figure 1:
Tourism scenic spots can be divided into three or more components, which mainly include natural ecological tourism scenic spots, urban tourism scenic spots, rural tourism scenic spots, etc. A special passenger line starting from the local airport or railway station to the scenic spot may be constructed to ensure that the tourists who have just got off the plane or train will be able to come to the scenic spot in the first time (Zhu and Lu, 2010). At the same time, a direct line can be established between the cooperative tourist attractions to connect various tourist attractions to become a whole, reflecting the complementarity between different scenic spots. In addition, it is necessary to perfect the construction of tourist distributing centers in scenic spots and improve the services of the centers, to enable the distributing center to bear a variety of functions, such as ticket booking, shopping, waiting, catering, etc., so as to save visitors’ waiting time as far as possible, improve tourists’ travelling experience, and enhance the service level of scenic spots.

3.3 Establish the cloud service platform of tourist scenic spots

With the development of information technology, the Internet has been playing a more and more important role in traditional fields and providing a broad space for the development of them. In the field of tourism, the cloud service platform can be established to enhance the overall development level of tourism scenic spots. The system of cloud service platform of tourist scenic spots is shown in Figure 2:

4. CONCLUSION

The cloud service platform mainly includes the following aspects:

First, the tourism marketing system. The tourism marketing system's main job is to spread the tourism resources, characteristics and advantages of the scenic spots outward, so that tourists in the outside world can understand
the them in a more intuitive way and their interests in travelling can be stimulated; in addition, it will also help to set up the brand images of tourism scenic spots to promote the sustainable development of the scenic spots (Lu, 2013).

Second, the tourism information management system. The tourism information management system will release related information of the scenic spots, such as traffic conditions of the direct highway, number of tourist in the scenic spots, weather conditions, parking spaces of the parking lots, and available rooms of hotels and restaurants on that day and in the following days, so as to provide important reference for tourists' traveling (Mao et al., 2013).

Third, the tourism scenic spot enterprise management system. The cloud platform can integrate many enterprises within the tourist scenic areas, enhance the cooperation among enterprises, and promote the development of tourism scenic spots in the direction of integration. On this basis, the enterprise alliance can be made to supervise the industry to check such problems as corporate infractions, so as to guarantee the healthy development of tourist attractions.

Next, it is necessary to establish a tourism e-commerce system, so that the e-commerce enterprises within the tourist attractions can form an alliance and jointly promote the development of tourist scenic spots while the cooperation is developing.

Finally, it is necessary to establish an e-government system. The development of tourism scenic areas inevitably requires the participation of the government. The establishment of e-government system can not only provide a communication channel between the related departments of the government and the scenic spots to promote the sharing of data information between the two sides, but also better deal with the unexpected situations and tourists' complaints in tourist attractions to improve the development level of tourist attractions (Tang and Li, 2016).

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