Evolution of Spatial Structure of Tourist Flows for a Domestic Destination: A Case Study of Zhangjiajie, China

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Abstract: Transportation facilitates the flow of tourists generating tourist flows, which produce flow effects on the spatial scale. By analyzing the evolution of tourist flows in Zhangjiajie by various modes of transportation over a long time series, the results show that the degree of development of the destination transportation network affects the dominance of the tourism node. Specifically, in the “train period”, Zhangjiajie, Changsha, Fenghuang, and Jishou core destinations become dominant with the “Matthew Effect”. In the “road period”, Jishou and Mengdonghe destinations decline, with the “Filtering Effect”. In the “high-speed railway period”, Zhangjiajie and Changsha are connected with more distant origins, and the “Diffusion Effect” occurs. It is worth noting that the development of high-speed rail has created a substitution effect for trains over long distances, and self-driving has created a substitution effect for trains over short and medium distances.

Keywords: tourist flows; network structure; evolution

1. Introduction

China’s domestic tourism market has grown rapidly over the past decade, with the total number of tourists rising from 1.71 billion in 2008 to 5.54 billion in 2018 [1]. The flow of tourism generates huge numbers of tourists and tourism revenues, and tourist flows have become one of the central issues in the current field of tourism research [2]. Broad tourism flow refers to a comprehensive tourism flow system including information flow, tourism energy flow, tourist flows, etc. [3]. In a narrow sense, the term refers to the flow of tourists from the origin to the destination [4]. The study of tourist flows has become a top priority in tourism flow research [5].

There have been many studies of tourist flows with spatial and temporal differences, such as before and after the opening of high-speed trains [1,6], before and after the holidays [7], and before and after special events [8,9]. However, the time intervals were mostly 3–5 years, and no long time series have been involved. Yet, tourist flows are dynamically changing [10]. Therefore, a comparative study of the spatial structure of tourist flow networks over long time series is necessary. The geographical scale of tourist flows can be divided into the macro-level or micro-level based on distance [11]. The micro level is the movement of tourists in the scenic area, province, and city [12]; the research results are more related to traditional tourist cities such as Beijing [13], Shanghai [14], and Xi’an [14], as well as Disney [15], Huangshan [16], and other tourist attractions. The macro level represents hundreds of kilometers of long-distance movement between cities within a city cluster [17], between cities within a country [18], and between countries [19,20]. Macro-level tourist flows can enhance the interactions and interconnections between origins and destinations. The network characteristics between the origin and the single destination have already been studied by the above scholars. However, the flow characteristics between destinations have been neglected.

Tourism transportation is the carrier of tourist flows, which helps tourists realize spatial displacement and builds the connection between tourism origins and destinations.
As transportation modes evolve, destinations are linked to increasingly distant origins, with the more distant the spatial distance the shorter the time spent. Highways, railroads, and airlines have strong competitive advantages over short, medium, and long distances, respectively [21,22]. As the earliest mode of transport, the highway is the main transport corridor for self-driving travel and plays an important role in inter-regional accessibility [23], improving the depth and breadth of travel [24], promoting the concept of “slow travel”. Trains on railroads, as the earliest means of box transportation, were undertaken to move long distances within the country. With the development of technology, high-speed rail emerged as an alternative to trains. High-speed rail originated in Japan in the 1960s and was followed by rapid development in developed countries. In the early 21st century, China began high-speed rail construction, and in 2008, China’s first high-speed rail line, the Beijing–Tianjin line, was put into operation. High-speed rail provides a faster and more comfortable travel experience and has become an important mode of transportation for travel [1]. Airplanes are an essential mode of transportation for traveling to outlying cities with poor land transportation, for outbound travel, and for inbound travel [25]. After arriving at the destination, it is often used in combination with other transportation modes.

In fact, if we accelerate tourist flows to the destination, we also increase the volume of tourists at the destination. This will put pressure on the local transportation infrastructure. The living conditions of the residents will deteriorate, and consequently, in terms of Doxey’s irritation index, there is a risk of conflict with the local population. C. Moreno advocated a type of urban layout where locals can access all their essentials at distances that would take them no more than 15 min to walk or cycle [26]. This concept was primarily about reconciling the requirements for sustainable urban functioning, but also new rhythms of life with other ways of living, working, and spending leisure time, which requires the transformation of the mono-functional central urban space into a polycentric city [27,28]. This concept helps address current issues of sustainable urban development to enhance the resilience of cities, such as Slovakia [29]. The aspect of safety plays a key role in the decision-making process when choosing a form of transport. If a particular form of transport is associated with a high risk of victimization, it will not be on the list of preferred modes for tourists. Planning for the development of transport systems should be complemented by the principles of thoughtful planning of elements of the defensive environment based on the CPTED concept, which eliminates possible negative impacts on the perception of safety in a tourist destination [30]. Under a long time sequence, a comparative evolution study of the spatial structure of tourist flows under several different transportation modes is not only a supplement to the gap in current tourist flow research but also has reference significance for rational planning of transportation, developing tourism routes, and promoting urban development.

Zhangjiajie, one of the most popular attractions in China, is recognized as a World Natural Heritage Site by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). With the rapid development of China, Zhangjiajie’s transportation network has undergone tremendous changes. Highway and railroad transportation has experienced a qualitative leap, and the transportation modes for tourists to Zhangjiajie have become increasingly diverse and convenient. Zhangjiajie is a suitable case study site to study and examine the changing characteristics of the spatial structure of the tourist flow network. This paper analyzes the tourist flows in Zhangjiajie, Hunan Province, under three different modes of transportation (“train”, “highway”, and “high-speed railway”), in order to achieve the following research objectives: (1) Based on the changes in spatial nodes in the domestic tourist flows network, we explore the functional changes of nodes in three periods. (2) Analysis of the spatial patterns based on routes and the spatial effects generated.

2. Literature Review
2.1. Tourist Flows and Transportation

Tourism refers to the choice of destinations with different attributes (attraction, setting, travel distance, etc.) by different tourists [31]. Thus, the factors influencing tourists’
choices can be broadly divided into two categories: tourist variables that affect tourists’ decisions and behaviors, and destination variables [32]. Many scholars classify different types of tourists by the criteria of socio-demographic, psychological, and behavioral characteristics [33]. Cooper found that visitors with lower income levels were more likely to travel less and stay longer [34]; Le-Klähn found that the likelihood of tourists using public transport is related to the level of education [35]. Among the destination variables, tourists’ choices are influenced by various factors such as geographical location [36] and traffic factors [37]. Connell believed that tourists’ route choice is influenced by distance decay factors and accessibility [38].

Transportation as a tool for the spatial mobility of tourists is one of the prerequisites for the existence of tourism [39]. Studies have shown that transportation is one of the most important factors affecting the movement of tourists. Law divides the factors affecting the movement of tourists into three main categories: human, traffic, and time [40]. Zeng proposed a five-factor model to influence the flow of Chinese tourists to Japan, in which the destination characteristics and transportation characteristics have a direct impact on the flow of tourists and there is an interaction between the two factors [41]. Traffic affects tourist flows, which then produce the flow effect. Tourist flow effects mainly refer to tourist flows in relation to the regional economy, society, and environmental impact [42]. The study of flow effects began with Keilly’s proposal of spatial diffusion and regional interactions; on this basis, Friedmann developed the core-edge theory [43]. These effects were confirmed in subsequent studies by scholars: Wang took the Beijing–Shanghai high-speed railway as an example and found that the high-speed railway produces the Matthew effect, the filtering effect, and the diffusion effect on regional tourist flows [44].

2.2. The Impact of Various Modes of Transport on the Destination

Transportation is not only the key to tourism development but also a major influence on destination development [45]. Transportation and tourism are interdependent, with transportation depending on the attractiveness of the destination and the destination depending on the accessibility of transportation [46]. Some scholars have linked transportation to the spatial structure of tourism destinations to explore the impact of different transportation modes on tourism destinations.

Highway transport occupies the first place in the use of transport modes in tourism, having the longest history and the greatest geographical range. Chen uses Guizhou’s highway network as empirical evidence to discover the difference between geographical advantage and the degree of destination tourist flows advantage [23]. Mokhtar studied the coupling mechanism between the road network and self-driving travel in Malaysia [47]. Sharaf’s study was on integrating the Jordanian road network with sustainable urban tourism development [48]. While the general focus on large transport modes for travel has created an imbalance in the development of transport modes within the transport system, Lumsdon turns his attention to the sustainable development of cycle transport and tourism [49].

Many scholars have studied the importance of railroads for tourism, and when some resources are linked by railroad lines, tourism may be generated, such as with the construction of the Shinkansen in Japan, which generated large tourist resorts and business centers mainly in cities along the line. Daniel highlighted the role of railroads in tourism [50]. High-speed rail has changed the spatial pattern of the origin market, improved accessibility [51], and significantly reduced the perceived distance of tourists [52], in turn changing the competitive landscape of destinations [53]. At the same time, the competition between multiple modes of transport has intensified. Concepción C analyzed the competition between high-speed rail and airlines among the various modes of tourist transport, using Barcelona as a case destination [54]. Albalate found substitution and complementary effects between high-speed rail and air transport in Spain [55].

Air travel grew rapidly during the rise of mass tourism, leading the way for transcontinental and intercontinental travel and contributing to the rapid development of many
destinations. In his study of inbound travel to Hong Kong, Oppermann summarized seven patterns of travel itineraries, including two single destination (single destination and base camp) and five multiple destination (stopover pattern/full loop/destination area loop/open jaw loop/multiple destination area loops) travel patterns [56]. Destinations can be specifically classified according to their location and characteristics in the overall travel itinerary: Single Destination, Gateway Destination, Egress Destination, Touring Destination, or Hub Destination [57]. Liu conducted an empirical analysis of the functions of tourism destinations in southern Anhui based on this classification [58]. As scholars become increasingly interested in air transport and tourism, route/service development, visitor experience, and low-cost carriers, their impact on tourism [59,60], carbon emissions, climate [61], etc., has attracted the attention of a wide range of scholars [62]. Tourism promotes the development of charter airlines and opens up new markets and destinations [63]. The interaction between air transport and tourism is mainly reflected in the development of tourist destinations that invest in local airports, develop new routes, and participate in destination planning and development [64]. At the same time, airlines use various means to stimulate tourist demand and influence destinations. A study of low-cost airlines and tourism, using Korea and Spain as case studies, found that the expansion of low-cost airlines had a significant positive impact on the tourism market [55,65]. Lohmann et al. examined how Singapore and Dubai have developed strategies between airlines, airports, tourism providers, and destinations to make themselves global destinations [66].

In general, a single mode of transportation is one-sided for the development of the destination; each mode of transportation has an indispensable role to play, and the integration of multiple modes of transportation is more comprehensive and three-dimensional for the development of the destination. The innovation of transportation modes can be regarded as the gas pedal of tourism development. The study of a single destination is also not strongly convincing, while a comparative study between destinations on a tourism route better reflects the development of the main destinations over a long time sequence and facilitates the complementary and coordinated development between regions. Therefore, based on previous studies on the impact of a single mode of transportation on destinations, we analyze the functional changes of tourist destinations under the differences of mainstream transportation modes in Zhangjiajie in three periods by integrating multiple modes of transportation under a long time sequence, focusing on the connections between destinations. The rational arrangement of tourist routes using nodal functions is of reference value to alleviate the negative impacts caused by traffic and is important for the synergistic development of multiple tourist destinations.

3. Materials and Methods
3.1. The Study Area

Zhangjiajie is located in the northwestern part of Hunan Province, at latitude 28°52′~29°48′ N and longitude 109°40′~111°20′ E. In September 1982, the Zhangjiajie National Forest Park became the first national forest park in China. In 1992, the Wulingyuan Scenic Spot, which consists of three major scenic spots including the Zhangjiajie National Forest Park, was included in the UNESCO World Natural Heritage List. In February 2004, the Zhangjiajie National Forest Park was included in the first batch of World Geoparks; in 2007, it was included in the first batch of national 5A-level tourist attractions in China; in 2017, it was awarded the honorary title of “National Forest City”. Zhangjiajie was built with tourism, and tourism has become the leading industry and pillar industry of Zhangjiajie after more than 30 years of development. By the end of 2020, the city had 26 tourism-grade zones (points), among which, 12 were 4A and above, achieving a total tourism revenue of CNY 56.90 billion and receiving 49,492 million domestic and foreign tourists [67]. Therefore, it is typical to use Zhangjiajie as a case study of tourist flows (Figure 1).
3.2. Sample Source and Handling

Ctrip (www.ctrip.com) is the largest travel service provider in China, offering travel-related elements booking and online travelogue sharing services. The “Octopus” data collector was used to retrieve travelogues with “Zhangjiajie” as the keyword and crawl a total of 1739 Zhangjiajie travelogues. The data pre-processing steps were as follows: the travelogues that were not related to the destination and duplicate travelogues, totaling 117, were deleted. From the remaining travelogues, tourist flow-related information was extracted: time, days of travel, origin, destination, and mode of transportation (to simplify the study, the origin was recorded as the capital city of the province where the tourists were located). Then the travelogues were classified using Excel to delete the missing tourist flow information, and a total of 406 pieces of tourist flow information were extracted: 105 pieces in the first period, 151 pieces in the second period, and 150 pieces in the third period. From the tourism flow information, the number of tourist flow flows was counted, e.g., for the Shanghai–Changsha–Zhangjiajie–Changsha–Shanghai travel route, Shanghai–Changsha is regarded as one flow, Changsha–Zhangjiajie as one flow, and so on, so the route contains four flows. The complete tourist flow includes the process of tourists going from the origin to the destination and then returning to the origin. Therefore, this paper identified both the origin and destination appearing in the tour route as tourist nodes to ensure the integrity of the tourist flows network. A total of 29 nodes of the Zhangjiajie tourist flow network were counted.

3.3. Research Method and Analysis

Social network analysis (SNA) provides tourism research with a set of methods and tools that allow us to comprehend the patterns and the structures of these ties [68]. SNA is a method used to study the relationships between different entities interacting in a given environment [69]. Based on graph theory, SNA can describe the structure of relations (displayed by links) between given entities (displayed by nodes) and apply quantitative...
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3.3.1. Social Network Relation Matrix Construction

The complete tourism activity of tourists from the origin to the destination and back to the origin makes them flow between different tourism destinations (i.e., tourism nodes), thus creating certain connections between different tourism destinations (i.e., interrelationships between tourism nodes), and finally forming the spatial structure system of tourist flows network. To construct the tourism flow network, we must first determine the scope and nodes of the network. This paper took Zhangjiajie as the research scope and the origin and destination as the tourism nodes. The second stage was to determine the tourist flows’ network relationship, and in this paper, the number of tourist flows between destinations was used as a value for the strength of the link between tourism nodes. The third stage was to construct a relationship matrix with the origin and destination as the nodes and the number of flows as the correlation strength value an N×N network matrix of Zhangjiajie tourist flows was constructed. Fourthly, the dichotomous matrix was calculated to determine the breakpoint value, and the connection above the breakpoint value was recorded as 1, and below the value was recorded as 0. The connection between nodes was simplified to either yes or no. In order to ensure the stability and integrity of the network, after several attempts, this paper determined 2 as the breakpoint value and calculated the dichotomous matrix.

3.3.2. Relevant Index for the Evaluation of Tourist Flow Networks

The social network analysis included two secondary indexes: the network analysis and the node analysis. Firstly, UCINET software was used to study the tourist flows network structure and node function, and GIS and other software were used to analyze the characteristics and changes of the tourist flows network structure; then, NETDRAW software was used to draw the directional network of tourist flows in different time periods. Network structure research selected network scale, network density, and the “core-edge” model as evaluation indexes to analyze the network structure of tourist flows in Zhangjiajie and its changes in different periods. Node function research selected node centrality as an index to analyze the function and status of each node in the overall tourist flows network.
structure in different periods. The specific calculation formula for the indicator is as follows (Table 1).

**Table 1. Evaluation index related to the structure of tourism networks.**

<table>
<thead>
<tr>
<th>Index</th>
<th>Function</th>
<th>Calculation Formula</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree Centrality</td>
<td>To measure which tourism nodes are central in the tourism network and to examine the cohesiveness of tourism nodes.</td>
<td>$C_{D,in}(n_i) = \sum_{j=1}^{r_{ij,in}}$ and $C_{D,out}(n_i) = \sum_{j=1}^{r_{ij,out}}$</td>
<td>$r_{ij,in}$ indicates that there is a directional connection from travel node $i'$ to $j'$, $r_{ij,out}$ indicates that there is a directional connection from travel node $i'$ to $j'$.</td>
</tr>
<tr>
<td>Closeness Centrality</td>
<td>Reflects the proximity and closeness of a node to other nodes.</td>
<td>$C_{C}(n_i) = \frac{1}{\sum_{j=1}^{d(n_i,n_j)}}$</td>
<td>$d(n_i,n_j)$ represents the shortest path distance (i.e., a path in which all nodes and all line segments are not repeated) between travel nodes $n_i$ and $n_j$.</td>
</tr>
<tr>
<td>Betweenness Centrality</td>
<td>The mediating role of a node to other nodes, whether a node is on a shortcut between the node and other nodes.</td>
<td>$C_{B}(n_i) = \sum_{j,k} g_{jk}(n_i)$, $j &lt; k$</td>
<td>$g_{jk}(n_i)$ indicates the number of geodesic lines between tourist place $j'$ and $k$. $g_{jk}(n_i)$ indicates the number of geodesic lines that must pass through tourist place $i'$. 'n' is the number of tourist places.</td>
</tr>
</tbody>
</table>

**4. Results**

4.1. Node Function Change

In the first period, Zhangjiajie, Changsha, Jishou, and Fenghuang were important nodes in Zhangjiajie’s tourist flow network. The node centrality values were in the top four of the overall network nodes due to the complementary nature of the tourism resources of the four places and their convenient transportation. Among them, Zhangjiajie’s tourism core function was the most significant, with Zhangjiajie’s “closeness centrality” and “betweenness centrality” up to 83.33 and 197.53, far ahead of Changsha in second place. In the second period, Zhangjiajie, Changsha, and Fenghuang were still important tourism nodes, but the function of the Jishou node declined. Zhangjiajie, Changsha, and Fenghuang node centrality values were one, two, and three, respectively. The development of the road transportation network made Zhangjiajie, Changsha, and Fenghuang closely connected by road transportation, and the distribution function of Jishou as a transit place weakened from being equal to Fenghuang in the first period to being overtaken by Fenghuang in the second period.; The gradual opening of the whole line of the Wuhan–Guangzhou high-speed railway made the origins closely connected with Changsha (Table 2).

**Table 2. Tourist flows network node centrality.**

<table>
<thead>
<tr>
<th>Node</th>
<th>First Period</th>
<th>Degree Centrality</th>
<th>Closeness Centrality</th>
<th>Betweenness Centrality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Out</td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Zhangjiajie</td>
<td>16</td>
<td>16</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Changsha</td>
<td>12</td>
<td>9</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Jishou</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Fenghuang</td>
<td>9</td>
<td>6</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Furongzhen</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Shaoshan</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Tongren</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Huaibei</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Wuhan</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Beijing</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
In the third period, Changsha became the strongest tourism node, Zhangjiajie remained an important tourism node, and Jishou completely lost its transit role. With the full construction of the high-speed rail network, Changsha became an important window for connecting origins with Zhangjiajie by high-speed rail, and the gradual growth of Changsha’s “degree centrality” indicated that Changsha’s ability to attract tourists increased, connecting more and more tourist destinations. The “outcloseness centrality” increased from 68.97 to 87.5, exceeding Zhang’s 73.68 in the third period; the “incloseness centrality” increased from 62.5 to 84.85, exceeding Zhang’s 80. The growth in “closeness centrality” indicated a gradual increase in Changsha’s core tourism function. The “betweenness centrality” increased from 80.9 to 408.13, far exceeding Zhangjiajie’s 204.89: a swift increase indicating Changsha’s enhanced node function. The “betweenness centrality” of Jishou gradually decreased from 20.37 in the first period to 5.34 in the third period.

### 4.2. Spatial Patterns of Tourist Flow Routes

In the first period, under the influence of transportation modes, the full loop pattern with longer travel times and without passing through repeated tourist destinations was the main choice of tourists’ travel; the destination area loop pattern with Jishou as a transit place was the second. Zhangjiajie, Jishou, and Changsha were the top three hub cities, respectively (Table 3)

### Table 3. Line space pattern statistics.

<table>
<thead>
<tr>
<th>Period</th>
<th>Single Destination Pattern</th>
<th>Stopover Pattern</th>
<th>Multiple Destination Area Loop Pattern</th>
<th>Full Loop Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Percentage</td>
<td>Quantity</td>
<td>Percentage</td>
</tr>
<tr>
<td>First period</td>
<td>0</td>
<td>0%</td>
<td>12</td>
<td>11%</td>
</tr>
<tr>
<td>Second period</td>
<td>47</td>
<td>31%</td>
<td>23</td>
<td>15%</td>
</tr>
<tr>
<td>Third period</td>
<td>54</td>
<td>36%</td>
<td>30</td>
<td>20%</td>
</tr>
</tbody>
</table>

In the second period, the “single-destination pattern” surged to 31% because of the full connectivity of Zhangjiajie’s highway network and the rapid rise of self-driving travel,
while the “stopover pattern” share increased because of the enhanced role of Changsha as a transportation hub for tourist destinations. Conversely, the share of the “destination area loop pattern” declined by 8% as the number of tour routes using Jishou as a transit point decreased and Jishou’s role as a transportation hub was weakened. Zhangjiajie remained the first hub city, while Changsha replaced Jishou as the second hub city (Table 4).

Table 4. Types of destinations and their typical representatives.

<table>
<thead>
<tr>
<th>Type and Rank</th>
<th>First Period</th>
<th>Second Period</th>
<th>Third Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Second</td>
<td>First</td>
<td>Second</td>
</tr>
<tr>
<td>Single destination</td>
<td>Zhangjiajie</td>
<td>Jishou</td>
<td>Changsha</td>
</tr>
<tr>
<td>Gateway destination</td>
<td>Jishou</td>
<td>Changsha</td>
<td>Zhangjiajie</td>
</tr>
<tr>
<td>Egress destination</td>
<td>Changsha</td>
<td>Jishou</td>
<td>Changsha</td>
</tr>
<tr>
<td>Touring destination</td>
<td>Fenghuang</td>
<td>Mengdonghe</td>
<td>Zhangjiajie</td>
</tr>
<tr>
<td>Hub destination</td>
<td>Jishou</td>
<td>Changsha</td>
<td>Zhangjiajie</td>
</tr>
</tbody>
</table>

In the third period, the “single-destination pattern” grew further thanks to the full development of the transportation network, leading to more weekend and holiday trips. The “stopover pattern” to and from Zhangjiajie and Changsha, two conveniently located cities, further increased by 5%. During this period, the role of transportation hubs in many tourist destinations was enhanced, trips were no longer limited by hub-type destinations, and the “destination area loop pattern” dependent on Jishou rapidly decreased. Zhangjiajie and Changsha maintained their status as the first and second hub cities, and Jishou lost its status as a hub city.

Overall, the share of the “single-destination pattern” increased rapidly in the second period because of the shorter travel time and more travel opportunities. As the role of the Jishou transportation hub weakened and the role of the Changsha and Zhangjiajie transportation hubs increased, the “destination area loop pattern” and “full loop pattern” decreased in the second period.

4.3. Node Aggregation Characteristics

4.3.1. Node Network Flow Characteristics

Combined with the differences in tourist flows in the sample data, the paths between scenic spots are divided into three levels, and the breakpoint values are set to 0, 5, and 10, respectively. The structure of the Zhangjiajie tourist flows network was produced via UCINET software, as shown in Figure 2, which directly reflects the spatial connection strength and network node spatial pattern between the nodes of attractions (Table 5).

Table 5. Overall tourism network characteristics.

<table>
<thead>
<tr>
<th>Period</th>
<th>Total Number of Nodes</th>
<th>Network Size</th>
<th>Network Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>First period</td>
<td>21</td>
<td>420</td>
<td>0.21</td>
</tr>
<tr>
<td>Second period</td>
<td>25</td>
<td>600</td>
<td>0.18</td>
</tr>
<tr>
<td>Third period</td>
<td>30</td>
<td>812</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Figure 2. The flow network between nodes under different flow control.
Observing Figure 2 it can be found that when the breakpoint value was $\geq 1$, the number of travel nodes in the three periods was 21, 25, and 30, respectively. As the number of nodes increased, the flow path between nodes increased, and the connections between nodes became more frequent. With the same breakpoint value, the third period had the most node paths and the highest network density. This indicates that the tourists’ tour routes were diversified and the tour was no longer a single-destination tour. The three nodes Zhangjiajie, Changsha, and Huaihua had the highest number of nodal paths and were closely linked in the three periods. When the breakpoint value was $\geq 5$, the number of nodes in the three periods rapidly decreased to 10, 9, and 10, and important nodes such as Zhangjiajie and Changsha were highlighted. The node flow paths decreased, the density decreased, and the network distribution was uneven. When the breakpoint value was $\geq 10$, the number of nodes in the three periods further decreased to 9, 8, and 7, and the network distribution was uneven, with the core nodes and major paths highlighted.

In the above changes, it can be seen that the number of participating nodes and paths decreased with the increase in breakpoint values, the core attractions and major paths were continuously highlighted in the reset transformation of breakpoint values, and the “core-edge” feature gradually became clear. During the three periods, Zhangjiajie and Changsha were the core nodes with both inflows and outflows; the number of flow paths in Fenghuang was also relatively stable. In the first period, Jishou was the second core node, and the number of tourism node paths was second only to Zhangjiajie and Changsha; in the second period, the status of Jishou declined, Fenghuang occupied the second core node status of Jishou, and Fenghuang established a direct connection with Zhangjiajie and Changsha; in the third period, when the breakpoint value was $\geq 10$, the status of Jishou declined further until the node disappeared.

4.3.2. “Core-Edge” Analysis of Nodes

Observing the density of the core and edge areas (Table 6), we can find that the density of the core areas is higher than that of the edge areas, which indicates that there is an obvious structural stratification in the Zhangjiajie tourism network, showing a “core-edge” structure. The average density of the core and edge areas was only 0.227, which is not closely connected (Table 6).

<table>
<thead>
<tr>
<th>Period</th>
<th>Core Nodes</th>
<th>Edge Nodes</th>
<th>Core Area Density</th>
<th>Edge Area Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Zhangjiajie, Changsha, Fenghuang, Jishou, Shanghai</td>
<td>Mangdonghe, Furongzhen, Shaoshan, Tongren, Huaihua, Wuhan, Beijing, Guangzhou, Nanjing, Xi’an, Chengdu, Chongqing, Nanning, Hangzhou, Jinan, Fuzhou</td>
<td>0.825</td>
<td>0.333</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.250</td>
<td>0.006</td>
</tr>
<tr>
<td>Second</td>
<td>Zhangjiajie, Changsha, Jishou, Fenghuang</td>
<td>Furong Town, Mangdonghe, Shaoshan, Tongren, Huaihua, Yueyang, Wuhan, Beijing, Shanghai, Guangzhou, Nanjing, Xi’an, Chengdu, Chongqing, Nanning, Hangzhou, Jinan, Tianjin, Shenyang, Fuzhou, Zhengzhou</td>
<td>0.705</td>
<td>0.462</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.197</td>
<td>0.027</td>
</tr>
<tr>
<td>Third</td>
<td>Zhangjiajie, Changsha, Fenghuang</td>
<td>Jishou, Furong Town, Shaoshan, Tongren, Huaihua, Yueyang, Wuhan, Beijing, Shanghai, Guangzhou, Nanjing, Xi’an, Chengdu, Chongqing, Nanning, Hangzhou, Jinan, Tianjin, Shenyang, Fuzhou, Zhengzhou, Nanchang, Harbin, Lanzhou, Changde</td>
<td>0.818</td>
<td>0.510</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.234</td>
<td>0.028</td>
</tr>
</tbody>
</table>

The number of nodes in the core area decreased, and the number of nodes in the edge area increased. Three nodes, Zhangjiajie, Changsha, and Fenghuang, were in the “core area” for a long time, which is in line with the results above. The nodes in the core area are
closely linked with each other, and Changsha relies on the transportation convenience of the provincial capital city. Nodes such as Zhangjiajie and Fenghuang rely on clusters of tourist attractions to form a clustering effect. In contrast, the edge areas are more dispersed among the nodes and less internally connected.

In general, after the three periods, the Zhangjiajie tourist flows network core area nodes continued to decrease (Figure 3). The core density was at a high level in all three periods, which indicates that the core nodes are more closely connected to each other. The core-edge density gradually increased, indicating that the core nodes have a driving effect on the edge nodes. The lower edge density indicates less connection between edge nodes, and the relatively low edge core density with less change indicates that the core nodes did not have a significant driving and promoting effect on the edge nodes. However, the edge tourism nodes in the third period increased significantly compared to the first and second periods, indicating that the number of tourist destinations connected to Zhangjiajie is increasing day by day with the integrated development of transportation modes.

Figure 3. Cont.
Dwyer divides the attractiveness of resources to destinations into two broad categories: core resources and supporting factors and resources [71]. Core resources can be endowed (inherited) or created, and the endowed resources are divided into natural resources and cultural/heritage resources. Supporting or enabling factors and resources include general infrastructure and accessibility of the destination [71]. The opening of highway lines and the development of high-speed rail have produced significant changes in the transportation function of nodes, which have produced a disappearance in the second period and a shift in the third period. The opening and perfection of the highway have enabled Zhangjiajie to establish direct links with neighboring cities, and Jishou has lost its nodal function as a transit city, arising from the advantage of a single enabling factor. The opening of high-speed rail has enabled Changsha to establish a connection with the source of tourists, and the node of transportation function has shifted from Zhangjiajie to Changsha. The development of transportation has an impact on destinations, and the centrality of nodes has changed (see Table 2), but the tourism core has not shown a shift with the change in transportation centers, and Zhangjiajie is still an important destination (see Table 4), indicating that the city with core resources has the main advantage. Changsha’s attraction for tourists is not only limited to the impact of the enabling factor (transportation), but also to its irreplaceable core resources; the superiority of cultural resources.

5.2. Spatial Patterns

The opening of the high-speed rail breaks the city-centered “circle” cooperation relationship [72]. The “Destination area loop pattern” decreased by 11% in the third period, and the “single-destination pattern” increased and became the route pattern with the largest share, proving that the opening of high-speed rail has created a “compression of time and space” [6,73]. That is, the spatial distance is objectively unchanged, and the time distance is shortened with the improvement in transportation conditions. Through the “compression of time and space”, tourists’ time distance remained the same and spatial distance increased, that is, the tourist travel radius increased [44]. In the absence of railway lines, the car is the most important means of transport [1]. The opening of the railway line and then the operation of the high-speed railway have connected Zhangjiajie to sources farther north, such as Shenyang, and the destination has been connected to...
sources farther away. Roth proposes that tourist flows within a certain region usually show a polycentric pattern consisting of multiple centers [74]. A “centrality” and “core-edge” analysis of tourist flows in Zhangjiajie reveals that a polycentric pattern consisting of three cities, Zhangjiajie, Fenghuang, and Changsha, emerged in all three periods. The spatial dispersion of multi-center nodes stimulates the flow of tourists to multiple center nodes, resulting in a dynamic tourist flow of spatial interaction [10]. Combining major attractions with secondary attractions can enhance the attractiveness of the entire area [10]. Zhang suggests that tourists prefer a combination of node tours [75]. Liu, in his analysis of the spatial distribution of tourist flows in traditional villages in western Hunan, found that a double-core multi-point spatial pattern dominated by Zhangjiajie National Forest Park and Fenghuang City was present [76]. With the main attraction, Zhangjiajie, and the secondary attraction, Fenghuang, tourists prefer to visit these two nodes in combination, and the findings of this paper verify the above scholars’ opinions.

5.3. Spatial Effect

Using Perpignan as the source and Barcelona as the destination, Masson found that the opening of the high-speed rail has led to the “Matthew Effect” and “Filtering Effect” between the origins and the destinations [53]. Wang’s study found a “Diffusion Effect” from the core area to the peripheral area [44]. The study in this paper verifies some of the above scholars’ findings, but while the “Matthew and Diffusion Effects” proposed by Masson exist between origins and destinations, this paper finds that these effects exist between destinations. There are differences in the spatial structure of tourist flows in Zhangjiajie under different transportation modes, and the “Matthew Effect”, “Filtering Effect”, and “Diffusion Effect” appear respectively. Meanwhile, high-speed rail and self-driving by road have “Substitution Effects” on trains over long distances and short-medium distances, respectively. In the first period, the four tourism nodes of Zhangjiajie, Changsha, Jishou, and Fenghuang produced the “Matthew effect”. Jishou benefited from the convenience of transportation, connecting the “before and after destinations” in Zhangjiajie. Fenghuang benefited from its unique “Cultural Resources” that complemented Zhangjiajie’s “Natural Resources”, and the strong combination generated the “Matthew Effect”. In the second period, Zhangjiajie, Changsha, and Fenghuang relied on road traffic to be closely connected, and Jishou declined in attractiveness to tourists due to traffic, and the transit and distribution functions weakened, producing a “Filtering Effect”. With the development of the “Fast-travel and Slow-travel” framework [77], scholars advocated reducing the travel frequency by extending the travel time [78]. Self-driving travel can expand and broaden the breadth and depth of tourism activities [24] to achieve door-to-door movement between destinations, so self-driving travel became an important form of “slow travel” to extend traveling time. The completion of the “Zhangjiajie-Huayuan” and “Zhangjiajie-Sangzhi” expressways and the development of self-driving travel replaced the fixed train lines that connected Zhangjiajie with the surrounding destinations during the first period. In the third period, with the rapid development of Changsha, which relied on the resources of the provincial capital city, and the improvement in Zhangjiajie’s transportation network, Zhangjiajie was connected to more distant origins, and the number of tourism nodes outside the province increased, with gradually closer ties and a “Diffusion Effect”. High-speed rail created a substitute for trains over long distances. Scholars suggest that high-speed rail is faster than conventional rail and road transport between 200–700 km and that it creates the “Substitution Effect” at this spatial distance [55]. Zhangjiajie is the furthest away from Chenzhou, a city in southeastern Hunan Province, at 635 km, so it can be assumed that the substitution of trains for high-speed rail over longer distances in the province may occur. At the same time, the “Yangtze River City Cluster” is under the development of high-speed rail; thus, Changsha, Wuhan, Guangzhou, and other places outside the province play an obvious urban effect and integration, with high-speed rail promoting tourism cooperation between Changsha and cities outside the province [52]. Changsha has established links
with long-distance origins outside the province generated by high-speed rail, creating an alternative to the links established by train in the second period.

6. Conclusions and Recommendations

6.1. Conclusions

An analysis of the structure of the tourist flow network, mainly in Zhangjiajie, was compared with the following conclusions:

(1) In terms of the tourist flows node function, there is an overall increase in the centrality of tourist nodes and an increase in radiation and cohesiveness. Overall, the province’s tourism nodes are more functional than those outside the province, and, due to the geographical proximity, traffic convenience, and concentration of attractions, the province is most closely linked to Zhangjiajie, Changsha, and Fenghuang, with obvious development advantages and greater functionality. The function of nodes such as Jishou, Furongzhen, and Mengdonghe in the less competitive position is gradually declining and the development potential is weakened.

(2) In terms of spatial distribution, the coverage of the tourist flow network has increased and the overall diffusion effect of the network is obvious. The spatial distribution of tourism nodes across the country is uneven, with a spatial distribution structure of "large dispersion and small aggregation". The development of highways has led to a clustering effect in Zhangjiajie, Changsha, and Fenghuang. Travelers tend to combine visits to neighboring nodes in a larger spatial context. The linkage density between the "core area" and the "edge area" is low, and the effect of the "core area" on the "edge area" is not obvious. As transportation modes evolved, inter-node connections became increasingly streamlined, and core cities came to the fore.

In this paper, we studied the structure of the Zhangjiajie tourist flows network over a large time span while adding the consideration of multiple traffic factors based on the previous study on the influence of a single mode of transportation. This study fills the gap in investigations of transportation and tourism over a large time span in Zhangjiajie, a typical tourist city, providing a global view of the development of tourism in Zhangjiajie, and theoretically enriching the spatial and temporal study of tourist flows in Zhangjiajie. At the same time, it provides new ideas for Zhangjiajie to take advantage of its own advantages and achieve synergistic and complementary development with neighboring cities.

However, this study also has some limitations. Due to the short time period since the opening of the high-speed railroad, the sample size of the three periods is unbalanced. Further analysis of the changes in tourist flows after the addition of high-speed railroads will be required later. Secondly, since the number of tourists using airplanes as their main mode of transportation is negligible, no specific calculations and analyses of airplanes were conducted, pending an in-depth study with a sufficient sample size. Finally, we only focused on the transportation from the source to the destination, ignoring the transportation within the tourist destination. However, in the context of transportation system development, both dimensions are equally important, especially for sustainable urban planning.

6.2. Recommendations

Based on the relevant conclusions drawn in this paper, the following recommendations are made for the development of tourism transportation in Hunan Province.

(1) First, build a comprehensive tourism transportation network system. Some scholars point out that time spent on transportation has decreased, and therefore time spent at the destination has increased [79]. Yet other empirical studies by scholars have concluded that with shorter travel times, tourists do not spend more time at their destinations, but rather move quickly along the HSR routes. Therefore, it is particularly important to build the framework of “Fast-travel and Slow-travel” under multi-mode transportation. The development of an integrated transportation network
has enhanced the coordinated use of different types of advantages of tourism nodes in the province while promoting the connection between the origin and the destination.

(2) Second, open a special line for tourism traffic in Hunan Province. This will speed up the movement of tourists between destinations and enhance the connection between tourist destinations. Moreover, it will enhance the tourism radiation of core tourism destinations, drive the development of surrounding tourism destinations, and enhance the diffusion of the whole tourist flow network.

(3) Finally, promote the intelligent management of tourism traffic. A digital traffic information network will be built using internet technology to provide services such as dynamic and real-time traffic reporting, information and data connectivity between traffic and tourism, emergency coordination of tourism traffic, and comprehensive traffic decision-making. Comprehensive, rich, and real-time traffic information should be provided to travelers through various means.

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