Tourism spatial structure of urban agglomeration in the middle reaches of the Yangtze River based on social network analysis

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Abstract. Based on a revised gravity model, this paper establishes an evaluating indicator and model of the spatial structure of tourism economic linkages in urban agglomeration by using social network theory and method. Tourism spatial economic data of 56 urban in the urban agglomeration of the middle reaches of the Yangtze River were collected. With the help of Ucinet software, we discuss the tourism spatial structure features in the urban agglomeration of the middle reaches of the Yangtze River, and the tourism spatial structure of urban agglomeration is optimized by network density, centrality degree, structural holes, core-periphery structure and condensing subgroup model.

1. Introduction
In August 2012, Opinions on Vigorously Implementing the Strategy of Promoting the Rise of the Central Region enacted by the State Council mentioned that the three sub-urban agglomerations in the middle reaches of the Yangtze River (Wuhan Metropolitan Area, Changsha-Zhuzhou-Xiangtan Urban Agglomeration and the Urban Agglomerations around the Poyang Lake) need to collaborate to promote the integrated development of the Urban Agglomerations in the middle reaches of the Yangtze River (State Council of the PRC, 2012). In April 2015, the State Council approved the Development Plan of Urban Agglomerations in the Middle Reaches of the Yangtze River, pointing out that the innovative modes and paths should be created and developed to build an International Urban Agglomeration which would be an important backbone of the Yangtze River Economic Zone and a new growth pole of China. (the State Council of the PRC, 2015).

Under the guidance of the national policy, the regional tourism cooperation of the urban agglomeration in the middle reaches of the Yangtze River has been carried out step by step and developed extremely well. Since 2013, the provincial capitals of the urban agglomerations in the middle reaches of the Yangtze River have jointly signed the Wuhan Consensus, the Changsha Declaration, the Hefei Outline, the Nanchang Action and the Action Plan, and established the Urban tourism development cooperation organization and the Tourism Enterprise Alliance of the Urban Agglomeration in the middle reaches of the Yangtze River to build a barrier-free tourist area with multi-industry integration and low carbon. This area would be an important backbone of the Yangtze River Economic Zone and have impact on the world. The construction of the barrier-free tourist area based on the integrated development of the Urban Agglomeration in the middle reaches of the Yangtze River, so the optimization of tourism spatial structure of this area is an important measure to build a world-famous tourist destination.

2. Literature analysis on tourism spatial structure of urban agglomeration in the middle reaches of the Yangtze River
Everything is related to everything else but things nearby are more relevant than things far away (Tobler, W. R., 1979). According to this theory, no region is isolated, and each region is developing on the basis of its correlation with other regions. The evaluation index system of overall and individual tourist route network was established to discuss the network and spatial structure characteristics of tourism destinations of Yunnan Province (SUN Y., et al., 2016). The tourism spatial cooperation pattern of the main node cities in China along the “The Belt and Road” is recommended on the basis of the analysis on the network spatial
structure of tourism economic connection of those node cities. (ZOU Y.-G., 2017). WANG L.-J., et al. (2019) criticized the spatial differences and spatial clustering of Chinese mainland tourism economy by adopting 2001-2014 panel data of 31 provinces and Tobit mode. WANG X. & GUAN W.-H. (2018) studied the spatial structures of 13 tourist cities with economic connection in Jiang Su Province and analyzes the dynamic mechanism of spatial structure formation.

Theoretical reflections about the transformation of urban spaces under the impact of tourist traffic can also be found in works by the Polish social geographer Liszewski, S. (1999). The impact of tourism on HSR demand is usually related to the difficulties of estimating HSR induced demand in the modelling stage (Guirao, B., & Campa, J.L., 2015). However, Albalate, D. (2016) comes to a statistically significant negative impact on tourism outcomes by adopting the method based on differential panel data and the strategy of double fixation. WANG D. G., & NIU Y., et al. (2018) demonstrates that the High-speed rail has strengthened tourism economic relations among cities through studying the relationship among 338 cities, with using economic-relation model and spatial analysis method from ArcGIS, and a "corridor" effect of the spatial distribution of the change rates of tourism external economic relationships has presented.

As a tourist geography concept with a spatial attribute, tourist flow represents both the nerve center and the links of the tourism system (WU J.-F., &BAO H.-S., 2002). A spatial model of tourist flow mainly contains a hierarchical model of tourist flow (Marrocu, E., &Paci, R., 2013), a city tourist flow model (ZHANG Y., XU J. & ZHUANG P., 2011), the core-edge space model of tourist flow (Asero, V., & Gozzo, S., et al., 2016) and the circle and layer structure model of tourist flow (PENG H., et al., 2016). JIN C., & CHENG J., et al. (2017) analyzed the relationship between the tourists’ movement networks and the lengths of their trip, and later found the time heterogeneity in the movements.

Capone, F. & Boix, R. (2008) analyzed the spatial dynamics related to the sources of tourism competitiveness within a small scale. Weidenfeld, A., &Williams, A. M., et al. (2014) provided theoretical and empirical contributions to the understanding of space competition by examining the tourist attractions of two different business clusters (low and high) in Cornwall, England, and found that the competition between local tourist attractions is related to the differences among the levels of agglomeration, spatial proximity and thematic products when compared to the regional scale. João, R., & Nijkamp, P. (2017) analyses whether and how regional systems of innovation influence the competitiveness of tourism destinations in Europe. HUANG T., & XI J.-C., et al. (2017) constructed the gravity model of tourism space competition under the interaction of multi-destination and multi-tourist. Furthermore, they used GIS and spatial econometric methods to observe the structure changes of tourism competition system of the Yangtze River Delta Urban Agglomeration under the situation of whether there is the Ningbo-Hangzhou high-speed railway.

Romão, J., &Saito, H. (2017) applied an exploratory spatial analysis and a spatial econometric model to identify the specific spatial characteristics prevailing in Japanese regional tourism dynamics, and determined the spatial heterogeneity and agglomeration processes. More recently, tourism researchers explore and investigate tourism economy and tourists’ spatial behavior by applying techniques and methods that were not part of traditional tools for tourism research, such as GIS and GPS. (Zoltan, J., & McKercher, B., 2015). Similarly, there are also a lot of literatures using moderate centrality, intermediary centrality and close centrality of SNA to analyze the structure of tourist attractions. (Asero, V., & Gozzo, S., et al., 2016; Jin, C., & Cheng, J., et al., 2017.). WANG Q.-L., &TANU Y.-Y., et al. (2017) used the neighboring index, geographical concentration index, the gini coefficient, Lorentz curve and hotspot analysis to explore the evolution characteristics of spatial distribution, the degree of concentration and Equilibrium level of A-class tourist attractions in Anhui Province. SONG L., & LI Y., et al. (2016) analyzed the spatial structure of tourism in the Circum-Bohai-Sea theoretically by using the point-axis theory, the location entropy and the city flow. DUAN B. (2015) developed the data model of regional tourism center’s scale and spatial structure, because the research results vary with different regions, scales, time series and methods. The research object of this paper will cover 16 urban of Wuhan urban agglomeration, 22 urban of Changsha-Zhuzhou-Xiangtan urban agglomeration, and 18 urban of Poyang Lake urban agglomeration in the middle reaches of the Yangtze River. This paper will apply the social network analysis method to measure and compare the network density, centrality, and network cohesion of the tourism spatial structure of urban agglomeration in the middle reaches of the Yangtze River to identify the characteristics of tourism spatial structure of Urban Agglomeration in the middle reaches of the Yangtze River, and finally propose the optimal layout of tourism.
3. Spatial structure analysis model of urban tourism economy in urban agglomeration in the middle reaches of the Yangtze River.

3.1. Urban tourism economic linkage model
Normally, "attribute data" is used in economic research, while social network analysis adopts "relational data", which is some quantitative value of the "relationship" between things. Referring to the classical gravity correction model in econometric geography, the "attribute data" can be transferred into "relational data". The formulas are as follows:

\[ R_{ij} = k_{ij} \frac{P_i P_j}{d_{ij}} \]

\[ k_{ij} = \frac{q_i}{q_i + q_j} \]

(1)

In the formula (1), \( R_{ij} \) is the index of urban tourism economic linkages between city i and city j. \( k_{ij} \) is the contribution rate of city i to \( R_{ij} \). \( P_i \) and \( P_j \) are respectively the total number of tourists in city i and city j (unit: 10,000 person-time). \( q_i \) and \( q_j \) are respectively the gross tourism revenue in city i and city j (unit: RMB 100 million). \( d_{ij} \) is the distance between city i and city j, with adopting the shortest length of highway between cities in urban agglomerations (unit: km).

3.2. Network density
Network density refers to the closeness degree of the connection between cities in the network, obtained by the ratio of the actual number of relationships between cities and the possible number of relationships in theory. The more connections between urban systems, the greater the density of the network, the greater the overall openness of the network and the ability to access resources. The calculation expression of urban agglomeration network density is:

\[ D = \frac{\sum_{i=1}^{n} d_{cc} \cdot d(c_i, c)}{n(n-1)} = \frac{\sum_{i=1}^{n} d(c_i, c)}{\sum_{i=1}^{n} d_{cc}} \]

(2)

In the formula (2), \( n \) stands for the urban scale of urban agglomerations in the middle reaches of the Yangtze River, namely the number of cities. If there is a correlation between city i and city j, \( d(c_i, c_j) \) is equal to 1; if not, 0.

3.3. Centrality degree
Centrality is one of the focuses of the social network analysis methods, which can be divided into the network centralization and the node centrality degree. In general, the node centrality degree can be divided into two types: relative centrality degree and absolute centrality degree. In this study, relative centrality degree is adopted to measure the centrality degree of each node in the network.

3.3.1 Node centrality degree
It is used to measure the ability of a city to communicate with other cities in the network diagram. It indicates the association strength between one city and the others. The calculation formula is as follows:

\[ C_{wD}(i) = \frac{C_{wD}(i)}{n-1} \]

(3)

In the expression (3), \( C_{wD}(i) \) is the relative centrality degree of city i, which refers to the ratio of absolute centrality degree of city i to the maximum possible degree of any node in the topological graph of urban system connection network. \( C_{wD}(i) \) is the absolute centrality degree of city i, indicating the number of the other nodes connected to city i in the network.

3.3.2 Closeness centrality
It can be used to measure the degree that one city in the network is not controlled by the others, representing the sum of the shortest traffic distance between one city and the others. The smaller the closeness centrality value, the stronger the closeness centrality degree, which suggests that the better the traffic accessibility, the tighter the connection between this city and the others, and the closer the city is to the network center. The calculation formula is as follows:
In the expression (4), $C_{RP}^{-1}$ and $C_{AP}^{-1}$ are respectively the relative closeness centrality and the absolute closeness centrality of city $i$. $d_{ij}$ indicates the shortcut distance between city $i$ and city $j$.

3.3.3 Betweeness centrality

Betweenness centrality measures the spatial intermediary position of one city between the other cities in the topological graph of urban system connection network, used as an index of "control ability" macroscopically measuring the control and dependence on the other cities in the urban system connection network. The greater the center centrality, the stronger the control power to the urban agglomeration, the more advantages in the network structure system, the higher the dependence of the other cities on this city. The calculation formula is as follows:

$$C_{BB} = \frac{2\sum_{i,j,k} b_{jk}(i)}{(n-1)(n-2)} = \frac{2\sum_{i,j,k} g_{jk}(i) / g_{jk}}{(n-1)(n-2)}$$

In the expression (5), $C_{BB}$ is called the relative betweeness centrality of city $i$. $C_{BB}$ is called the absolute betweeness centrality of city $i$. $b_{jk}(i)$ is the ability of city $i$ to control the communication between city $j$ and $k$. $g_{jk}$ is the number of shortcuts between city $j$ and $k$. $g_{jk}(i)$ represents the number of shortcuts through city $i$ existing between city $j$ and $k$. here, $b_{jk}(i) = g_{jk}(i) / g_{jk}$.

4. Overview of study area and sources of data

4.1 Overview of the study area

In this paper, the research object is urban agglomeration in the middle reach of Yangtze river, consisting of 56 cities in Wuhan Urban Agglomeration, Changsha-Zhuzhou-Xiangtan Urban Agglomeration and the Urban Agglomerations around the Poyang Lake. Specifically, Urban Agglomeration in the middle reach of Yangtze river covers 16 cities in Wuhan Urban Agglomeration, including Wuhan, E’zhou, Daye, Huangshi, Hanchuan, Xiaogan, Yingcheng, Xiantao, Xianning, Tianmen, Wuxue, Huanggang, Anlu, Qianjiang, Chibi and Macheng; 22 cities in Changsha-Zhuzhou-Xiangtan Urban Agglomeration including Changsha, Xiangtan, Zhuzhou, Yueyang, Hengyang, Yiyang, Liuyang, Leiyang, Changde, Loudi, Chenzhou, Yuanjiang, Xiangxiang, Miluo, Shaoshan, Liling, Zixing, Lianyuan, Changning, Lengshuijiang, Linxiang and Jinshi; also including 18 cities-- Nanchang, Xinyu, Fengcheng, Gao’an, Zhangshu, Jiujiang, Jingdezhen, Guixi, Yingtan, Ji’an, Leping, Yichun, Gongqingcheng, Ruijiang, Shangrao, Fuzhou, Dexing and Jinggangshan within the Urban Agglomerations around the Poyang Lake (Fig.1). the spatial pattern of tourism economy of urban agglomeration in the middle reach of Yangtze River will be analyzed by observing the tourism economic relationship among those 56 cities.
4.2. Sources of data
In this study, the initial data including total number of urban tourists (unit: 10,000 person-times) and total tourism revenue (unit: RMB 100 million) are from Hubei Statistical Yearbook (2017), Hunan Statistical Yearbook (2017) and Jiangxi Statistical Yearbook (2017). In addition, referring to the Statistical Bulletins for national economic and social development of 56 cities the above mentioned in the urban agglomeration in the middle reach of Yangtze River in 2017. The shortest traffic distances (unit: km) between the cities in the urban agglomerations are collated according to the shortest highway distance between the cities in Baidu maps to reflect the latest tourism economic spatial structure of the urban system of the middle reaches of the Yangtze River.

5. Social network analysis of tourism spatial structure of urban agglomeration in the middle reaches of the Yangtze River

5.1. Analysis of spatial relationship of tourism economy in urban agglomeration of the middle reaches of the Yangtze River
This study uses the tourism economic relationship model to calculate the tourism linkage degree among 56 cities in urban agglomeration in the middle reaches of the Yangtze River. Based on this, Ucinet-netdraw method is adopted to form the basic form of tourism economic connection network of urban agglomeration in the middle reaches of the Yangtze River (Fig.2). The arrow line in the figure represents the tourism economic connection from one city to another.

By analyzing the structure chart of tourism economic connection network of urban agglomeration in the middle reaches of the Yangtze River, we can more intuitively judge the connection strength, tourism radiation and cooperative behavior among cities. From Figure 2, it is obvious that the intensity of tourism connection nodes of Wuhan, Changsha, Zhuzhou, Xiangtan and Nanchang in urban agglomeration in the middle reaches of the Yangtze River is at the highest level, which shows that the clustering and radiation ability of these five cities are the strongest in tourism economics, followed by that of Yueyang, Jiujiang and Xianning. All these are inseparable from the city's overall economic strength and administrative division status, and the traffic location in the urban agglomeration in the middle reaches of the Yangtze River.

Ucinet-Density method is used to calculate the overall tourism economy spatial network density of the urban agglomeration in the middle reaches of the Yangtze River in 2016 (Tab.1). The overall density is 0.3344, which shows that the level of network density is low, indicates that the tourism economic links between cities are weak and in a loose state. The tourism economy spatial network density of Changsha-Zhuzhou-Tan urban agglomeration and the urban agglomeration around Poyang Lake is respectively 0.5758 and 0.5451. The network density is higher, which indicates that the tourism economic links between cities in the urban agglomeration are strong. Furthermore, urban agglomerations are in a strong state of tourism economy connection. The tourism economy network density is 0.4250 in Wuhan urban agglomeration, suggesting the network density is not high, indicates that the tourism economic links between cities and urban are not strong, and in a weak connection state.

Table 1. Characteristics of social networks in urban agglomeration in the middle reaches of the Yangtze River (2016)

|                        | Density | Average distance | Distance-based cohesion |
|------------------------|---------|------------------|-------------------------|
| Wuhan Urban Agglomeration | 0.4250  | 1.575            | 0.713                   |
| Changsha-Zhuzhou-Xiangtan Urban Agglomeration | 0.5758  | 1.424            | 0.788                   |
| Urban Agglomerations around the Poyang Lake | 0.5451  | 1.392            | 0.812                   |
| Urban Agglomerations in the middle reaches of the Yangtze River | 0.3344  | 1.681            | 0.665                   |

Ucinet-Distance method is used to calculate the geodesic distance between any two cities in the Urban Agglomerations in the middle reaches of the Yangtze River. By applying such method, the following two indexes of distance are achieved: The average of the cumulative sum of the geodesic distances of any two cities is 1.681 in the Urban Agglomerations in the middle reaches of the Yangtze River and the Tourism distance-based cohesion is 0.665. The above-mentioned two indices indicate that the overall tourism cohesion is weak in the Urban Agglomerations in the middle reaches of the Yangtze River, and the structure of city tourism economy presents a loose form. However, the average of the geodesic distances cumulative sum of Wuhan urban agglomeration, Changsha-Zhuzhou-Tan urban agglomeration and Urban Agglomerations around the Poyang Lake included Urban Agglomerations in the middle reaches of the Yangtze River are 1.575, 1.424 and 1.392, respectively. Correspondingly, the respective tourism distance-based cohesion of the three urban agglomerations is 0.713, 0.788 and 0.812 (Tab. 1), which shows that the tourism cohesion of Urban Agglomerations around the Poyang Lake is strong and city tourism economy spatial structure is more compact. However, the tourism cohesion of Changsha-Zhuzhou-Tan urban agglomeration and Wuhan urban agglomeration is weak, which shows that the provincial administrative division is the obstacle factor of cross-regional economic activities.

With the urban agglomerations in the middle reaches of the Yangtze River stepping into the "two-hour tourism circle" and the integration acceleration of the urban agglomerations in the middle reaches of the Yangtze River, the inter-city tourism activities and cross-regional tourism activities are increasingly frequent, the spatial tourism economic links in the urban agglomeration in the middle reaches of the Yangtze River will increase year by year, and the administrative barriers between provinces will gradually increase.
Provincial administrative barriers will gradually be eliminated and the advantages of cluster and dispersion will emerge.

5.2. Centrality degree analysis of spatial relationship of tourism economy in urban agglomeration of the middle reaches of the Yangtze River

With the help of three indexes, namely degree centrality, closeness centrality and betweenness centrality, we can determine the location of the city in tourism economic connection spatial network of urban agglomerations in the middle reaches of the Yangtze River. By adopting Ucinet-Degree method, Ucinet-Closeness method and Ucinet-Betweenness method, the network centrality of tourism economic links among 56 cities in the middle reaches of the Yangtze River is calculated. The specific location and status of each city in the tourism economic connection of urban agglomerations are shown in Table 2. We can draw the following conclusions:

Table 2. Network centrality table of urban tourism economy connection of cities in urban agglomeration in the middle reaches of the Yangtze River

| Ranking | Degree centrality | Closeness centrality | Betweenness centrality |
|---------|------------------|----------------------|------------------------|
|         | Sort             | Value                | Sort                   | Value                      | Sort             | Value                      |
| 1       | Wuhan            | 54                   | Wuhan                  | 54.5                      | Wuhan          | 404.3                      |
| 2       | Xian (n)         | 43                   | Xian (n)               | 49                        | Xi (n)         | 95.4                       |
| 3       | Changsh          | 43                   | Changsh                | 49                        | Changsh        | 77.8                       |
| 4       | Zhuzhou          | 39                   | Zhuzhou                | 47                        | Yueyang       | 57.5                       |
| 5       | Xiangtun         | 39                   | Xiangtun               | 47                        | Zhuzhou        | 46                         |
| 6       | Yueyang          | 38                   | Yueyang                | 46.5                      | Xiangtun       | 46                         |
| 7       | Liuyang          | 34                   | Liuyang                | 44.5                      | Nanchan        | 45.1                       |
| 8       | Nanchan          | 32                   | Nanchan                | 43.5                      | Xiaogan        | 42.4                       |
| 9       | Jiujiang         | 32                   | Jiujiang               | 43.5                      | Huangsh        | 35.6                       |
| 10      | Hengyuan         | 31                   | Hengyuan               | 43                        | Yingtan        | 26.8                       |
| 11      | Yichun           | 29                   | Yichun                 | 42                        | Liuyang        | 24.2                       |
| 12      | Jingdez          | 29                   | Jingdez                | 42                        | Huangsh        | 24.2                       |
| 13      | Changde          | 28                   | Changde                | 41.5                      | Ji (n)         | 21.2                       |
| 14      | Yingtang         | 27                   | Yingtang               | 41                        | Hengyuan       | 20.1                       |
| 15      | Ji (n)           | 27                   | Ji (n)                 | 41                        | Changde        | 14.3                       |
| 16      | Fuzhou           | 27                   | Fuzhou                 | 41                        | Jingdez         | 12.4                       |
| 17      | Yiyang           | 26                   | Yiyang                 | 40.5                      | Yichun         | 9.9                        |
| 18      | Xinyu            | 26                   | Xinyu                  | 40.5                      | Yiyang         | 8.5                        |
| 19      | Chenzhou         | 25                   | Chenzhou               | 40                        | Chenzhou       | 5.8                        |
| 20      | Loudi            | 24                   | Loudi                  | 39.5                      | Fuzhou         | 5                          |
| 21      | Huangsh          | 24                   | Huangsh                | 39.5                      | Ji (n)         | 4.7                        |
| 22      | Huangsh          | 24                   | Huangsh                | 39.5                      | Loudi          | 4.6                        |
| 23      | Xiaogan          | 22                   | Xiaogan                | 38.5                      | Xinyu          | 3.4                        |
| 24      | Jinggang         | 22                   | Jinggang               | 38.5                      | E’zhou         | 3.1                        |
| 25      | Shangra          | 21                   | Shangra                | 38                        | Shaosha        | 2.3                        |
| 26      | Zhangsh          | 19                   | Zhangsh                | 37                        | Shangra        | 1.4                        |
| 27      | Shaosha          | 17                   | Shaosha                | 35.8                      | Jinggang       | 1.4                        |
| 28      | Liangyu          | 15                   | Liangyu                | 35                        | Chibi          | 0.9                        |
| 29      | Gao’an           | 15                   | Gao’an                 | 35                        | Fengeche       | 0.7                        |
| 30      | Fengeche         | 15                   | Fengeche               | 34.8                      | Leiyang        | 0.7                        |
| 31      | Xixing           | 13                   | Xixing                 | 34                        | Lianyu         | 0.6                        |
| 32      | Leping           | 13                   | Leping                 | 34                        | Zhangsh        | 0.6                        |
| 33      | Xixing           | 13                   | Xixing                 | 33.8                      | Zixing         | 0.4                        |
| 34      | Lengshu          | 12                   | Lengshu                | 33.3                      | Linxiang       | 0.4                        |
| 35      | Xiangxi          | 11                   | Xiangxi                | 32.8                      | Leiyang        | 0.2                        |
| 36      | Yuanjian         | 10                   | Yuanjian               | 32.3                      | Dqing          | 0.2                        |
| 37      | Leiyang          | 10                   | Leiyang                | 32.3                      | Lengshu        | 0.1                        |
| 38      | E’zhou           | 10                   | E’zhou                 | 32.3                      | Gao’an         | 0.1                        |
| 39      | Ruichan          | 9                    | Ruichan                | 32                        | Fengeche       | 0.1                        |
| 40      | Miluo            | 9                    | Miluo                  | 31.8                      | Yuanjian       | 0                          |
| 41      | Chibi            | 8                    | Chibi                  | 31.3                      | Xiangxi        | 0                          |
| 42      | Linxiang         | 7                    | Linxiang               | 30.8                      | Xiantao        | 0                          |
| 43      | Liling           | 7                    | Liling                 | 30.8                      | Wuxue          | 0                          |
| 44      | Gongqin          | 6                    | Gongqin                | 30.5                      | Tianmen        | 0                          |
The urban system of the Yangtze River city group overall tourism cohesion is weak with loose structure of urban tourism economy; the tourism of Poyang Lake city group cohesion is strong; the Changsha Zhuzhou Xiangtan city group and Wuhan city circle tourism has weak cohesion.

In terms of the degree centrality, closeness centrality and betweenness centrality, Wuhan scores the maximum, indicating that Wuhan in the tourism economy network in Yangtze River city group is the most significant control over other cities in the urban agglomerations and are at the key nodes of the urban agglomerations. With the development of regional tourism integration and transportation network, central cities have an external effect on other cities in the same region through the development of tourism economy, and form a pattern of interconnected development of tourism economy in urban agglomerations.

(1) Among the 56 cities of urban agglomerations in the middle reaches of the Yangtze River, Wuhan, Xianning, Changsha, Zhuzhou, Xiangtan, Yueyang, Liuyang, Nanchang, Jiujiang and Hengyang have much higher degree centrality than other cities, especially Wuhan. With their superior tourism location and natural tourism resources, these cities are in the central position of the tourism economic connection network of the urban agglomerations in the middle reaches of the Yangtze River, while Wuhan is the core city of the diffusion radiation of traffic and tourist flow among urban agglomerations in the middle reaches of the Yangtze River. Due to the lack of tourism resources and poor accessibility of tourism, the degree centrality ranking of urban tourism economic connection network is the lowest in Xiantao, Wuxue, Jinshi, Hanchuan, Anlu, Tianmen, Guixi and Qianjiang, and they are in the periphery position in the urban tourism economic connection network of urban agglomerations in the middle reaches of the Yangtze River. With the development of regional tourism integration and transportation network, central cities have an external effect on other cities in the same region through the development of tourism economy, and form a pattern of interconnected development of tourism economy in urban agglomerations.

(2) The closeness centrality of the urban tourism economic links of urban agglomerations in the middle reaches of the Yangtze River shows that the closeness centrality of Wuhan, Xianning, Changsha, Zhuzhou, Xiangtan, Yueyang, Liuyang, Nanchang, Jiujiang and Hengyang is high, which indicates that the tourist accessibility between these cities and other cities in the urban agglomeration is better, the city connectivity is closer, also shows that these cities are in the center of the tourism economic network and less controlled by other cities. Yingcheng, Macheng, Daye, Xiantao, Wuxue, Jinshi, Hanchuan, Anlu, Tianmen, Qianjiang and Guixi have poor tourist accessibility, and loose relationship with other cities in urban agglomerations. However, in terms of the level of closeness centrality, the overall connectivity of the tourism economic network of the urban agglomeration in the middle reaches of the Yangtze River is better.

(3) The betweenness centrality of urban tourism economic links of urban agglomerations in the middle reaches of the Yangtze River (Tab. 2). The betweenness centrality of Wuhan, Xianning, Changsha, Yueyang, Zhuzhou, Xiangtan and Nanchang are the highest, these cities have strong control over other cities in the urban agglomerations, and are at the key nodes of the urban agglomerations tourism economic network. By contrast, Yuanjiang, Xianxiang, Xiantao, Wuxue, Tianmen, Ruichang, Qianjiang, Macheng, Liling, Jin, Hanchuan, Guixi, Miluo, Communist Qingcheng, Daye, Changning and Anlu all have a betweenness centrality of only 0, which explains that these cities are at the edge of tourism economic connection in urban agglomeration in the middle reaches of the Yangtze River, and the spatial tourism economic interaction with other cities in the urban agglomeration are relatively weak.

In conclusion, the network centrality of each city in the middle reaches of the Yangtze River show that Wuhan has the highest score in the three indexes of network centrality, which indicates that Wuhan has the greatest influence in the entire tourism economic connection network, the closest relationship with the other cities, and the strongest control ability to the other cities. Changning, Yingcheng, Macheng, Daye, Xiantao, Wuxue, Jinshi, Hanchuan, Anlu, Tianmen, Guixi and Qianjiang have the lowest values of the three network centrality indices. It indicates that these 12 cities have the least impact in the whole tourism economic network, the less connections with other cities and the weaker control ability of other cities, and they are in a relatively isolated position in the network.

6. Conclusion
The urban system of the Yangtze River city group overall tourism cohesion is weak with loose structure of urban tourism economy; the tourism of Poyang Lake city group cohesion is strong; the Changsha Zhuzhou Xiangtan city group and Wuhan city circle tourism has weak cohesion.

In terms of the degree centrality, closeness centrality and betweenness centrality, Wuhan scores the maximum, indicating that Wuhan in the tourism economy network in Yangtze River city group is the most
influential city. Changning, Macheng, Daye, Xiantao, Wuxue, Tianjin, Hanchuan, Anlu, Tianmen, Guixi and Qianjiang has the lowest score in the three center index, and are at a relatively isolated position in the network.

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