Journal of Hospitality and Tourism Management 47 (2021) 124–133

Contents lists available at ScienceDirect

Journal of Hospitality and Tourism Management

journal homepage: www.elsevier.com/locate/jhtm

Spatial network structure of the tourism economy in urban agglomeration: A social network analysis

Chang Gan[a], Mihai Voda[b], Kai Wang[a,*], Lijun Chen[c], Jun Ye[c]

[a] College of Tourism, Hunan Normal University, Changsha, 410081, China
[b] Faculty of Geography, Dimitrie Cantemir University, Targu Mures, 540545, Romania
[c] College of Geography and Tourism, Huanggang Normal University, Huanggang, 438000, China

ARTICLE INFO

Keywords:
Spatial network structure of the tourism economy
Urban agglomeration
Social network analysis
Urban agglomeration in the middle reaches of the yangtze river

ABSTRACT

Despite extensive and active research on network structures in tourist destinations, literature on the spatial network structure of the tourism economy in urban agglomeration is limited. Taking Urban Agglomeration in the middle reaches of the Yangtze River (UAMRYR) as the case study, this study aims to examine the characteristics associated with the spatial network structure of the tourism economy by adopting the tourism economic gravity model and social network analysis (SNA). The main conclusions are as follows. The spatial network structure of the tourism economy in UAMRYR was loose, with limited adequate tourism economic connections and collaboration among various plates. As the three core cities, Wuhan, Changsha, and Nanchang not only had more tourism economic connections among other cities but also acted as an intermediary and a bridge between the spatial network structure of the tourism economy. To sum up, the findings of this study could be applied to formulate scientific policies to promote spatial integration and tourism economic cooperation in urban agglomerations.

1. Introduction

The spatial network structure of the tourism economy in tourist destination is a complex system involving tourism economic activities as an intermediary agent, communication mediums comprising transportation infrastructure and information technologies, and geographic elements including different scale and rank cities (Leiper, 1979). Specifically, the spatial network structure of the tourism economy could hasten the flow of tourism economic factors in tourist destinations, including the capital, technology, talents, and information, through spillover effect and irradiation effect (Kim, Williams, Park, & Chen, 2021). Besides, the spatial network structure of the tourism economy could promote spatial integration and synchronized tourism industrial development among tourist destinations by consolidating tourism economic connections (Yin, Lin, & Prideaux, 2019). Consequently, examining the spatial network structure of the tourism economy in tourist destinations is a significant issue of concern to the tourism scholars.

During the last few decades, numerous network structures in tourist destinations have been investigated from the perspectives of both demand and supply (Liu, Huang, & Fu, 2017). In terms of the supply perspective, several studies primarily focused on the connections and correlations between tourism organizations in tourist destinations (Kirilenko, Stepchenkova, & Hernandez, 2019; Pavlovich, 2003). Regarding the demand perspective, most researchers were mainly interested in tourist mobility (Asero, Gozzo, & Tomaselli, 2015; D'Agata, Gozzo, & Tomaselli, 2012) and tourism flow (Liu et al., 2012; Mou et al., 2020; Seok, Barnett, & Nam, 2020). However, the research on the spatial network structure of the tourism economy in tourist destinations has been scarcely assessed and discussed, specifically in urban agglomerations. Moreover, the spatial network structure of the tourism economy in urban agglomeration can reflect the connections and correlations between different urban tourist destinations in space (Zhang et al., 2020), which plays an indispensable role in tourism industrial coordinated development of urban agglomerations (Wang, Gan, Yang, & Zhang, 2019). Hence, rigorous and comprehensive analysis of the spatial network structure of the tourism economy warrants more attention from researchers.

Urban Agglomeration in the middle reaches of the Yangtze River (UAMRYR) constitutes a critical region of growth in the Yangtze River Economic Belt, bearing the substantial target to become the fourth pole

* Corresponding author.
E-mail addresses: 1583086911@qq.com (C. Gan), mmvoda@yahoo.com (M. Voda), kingviry@163.com (K. Wang), 15271623988@163.com (L. Chen), floweryj@163.com (J. Ye).

https://doi.org/10.1016/j.jhtm.2021.03.009
Received 8 October 2020; Received in revised form 7 March 2021; Accepted 8 March 2021
Available online 17 March 2021
1447-6770/© 2021 The Authors.

for economic development in China. *The Urban Agglomeration Development Plan for the middle reaches of Yangtze River* (hereafter "Development Plan"), approved by the State Council of China in 2015, proposed the target of constructing a barrier-free tourism zone to stimulate all-ground development. Although the tourism economic collaboration among cities has progressively augmented over the last few decades, greater range and in-depth level of tourism economic interactions are still lacking among various cities.

To respond to practical call, first, taking UAMRYR as the case study, this study adopts time distance and comprehensive evaluation index system to modify the tourism economic gravity model. Second, the tourism economic gravity model is used to evaluate the strength of tourism economic connections (STEC), and construct the spatial connection matrix of the tourism economy. Third, the characteristics associated with the spatial network structure of the tourism economy are empirically explored by using the social network analysis (SNA). Overall, this study aims to provide practical implications for policymakers expecting to reinforce regional tourism economic collaboration and promote synchronized development in UAMRYR. Furthermore, the practical implications mentioned above, although explicitly articulated in a UAMRYR case study, tend to have enriched application, at least, to other urban agglomerations in the China.

The remainder of this paper is structured as follows: Section 2 presents the literature review; Section 3 introduces the study case, data source and processing, and research methodologies; Section 4 analyzes the comprehensive coefficient of the tourism economic quality, STEC, and characteristics regarding the spatial network structure of the tourism economy; Section 5 discusses the research results and demonstrates the theoretical contributions; and Section 6 provides conclusions, presents practical implications, and summarizes limitations and recommendations for future research.

2. Literature review

2.1. Spatial network structure in tourist destination

The growing significance of network has triggered the interest of researchers to conduct network exploration. In the tourist destination context, spatial network structures have been examined from both supply and demand perspectives (Liu et al., 2017). From the supply perspective, tremendous interest was stimulated in the network structure of business or non-business tourism organizations, including collaborative network of environmental governance (Erkuş-Öztürk & Eraydın, 2010), cooperation network of travel company (Jesus & Franco, 2016), inter-organizational knowledge network (Raisi, Baggio, Barratt-Pugh, & Willson, 2020), and tourism marketing network (Wang, Qu, & Yang, 2020). Together with the rapid advancement of information technology, hyperlinked network and mobile phone network have garnered considerable attention of scholars (Kim & Lee, 2019; Kubo et al., 2020). Besides examining network structure characteristics of tourist destinations, a quite few scholars have summarized the impact of network structure, including endorsing sustainable tourism development (Erkuş-Öztürk & Eraydın, 2010), enhancing tourism competence (Denicolai, Cioccarelli, & Zucchella, 2010), and prompting residents' participation (Hwang, Chi, & Lee, 2013).

From the demand perspective, the network structure analysis was conducted through tourist behavior and tourist mobility (Stienmetz & Fesenmaier, 2015). For example, Asero et al. (2015) explored the homogeneity or heterogeneity among trips-related attributes of tourists by adopting the network analysis method. With the rapid development of information technology, tourists' digital footprint was used to extract different types of data information. Mou et al. (2020) examined the spatial pattern of tourist flows and revealed that online travel diaries could more precisely reflect the spatial characteristics of tourist flows. To offer more meritorious tourism marketing information for policymakers in tourist destinations, an increasing number of researchers are focusing on the correlation between tourist flows and attractions (e. g., Kirilenko et al., 2019; Liu et al., 2017). Furthermore, studies have extended the focus on identifying latent tourism brand (Tasci, Khalilzadeh, Pizam, & Wang, 2018) and retrieving tourism image (Wang, Li, & Lai, 2018).

2.2. Impact of tourism on the spatial network structure of urban agglomeration

Urban agglomerations stem from the continuous enlargement of city or metropolitan area and the blurring of their boundaries where economic activities and production activities are linked by diverse transportation or information networks to optimize the allocation of resources (Liu, Zhang, Pan, Ma, & Tang, 2020). Urban agglomerations are novel regions units to promote regional spatial integration and harmonize various industries' development (Fang, Yu, Zhang, Fang, & Liu, 2020). With the advancement of transportation infrastructure and information technology, the correlation between cities has become increasingly intricate in urban agglomerations (Liu et al., 2020). Additionally, the leading urban agglomeration form has shifted from "space of place" (i.e., a locale where modalities, functions, and significance are included in physical boundaries) to "space of flow" (i.e., constituting pedestrian flows, logistics flows, capital flows, technology flows, and information flows, space of flow is a dynamic and continuous space), where the development of urban agglomerations does not solely depend on the static function of location, but network connections (Castells, 1996, 2005). Thus, the spatial network structure in urban agglomerations has gradually become a hot topic in academic circles (Evans-Cowley, 2010). In the tourism domain, some studies have focused more on examining the significant impact of the tourism economic development on the spatial network structure of urban agglomerations, which can be abridged into two effects (Yin et al., 2019). First, tourism spillover effect regarding a phenomenon that tourism economic activities in one city can trigger industrial agglomeration and endorse tourism productivity of surrounding cities (Bo, Bi, Hengyun, & Hailin, 2016; Kim et al., 2021). Second, tourism radiation effect denotes a phenomenon that cities with favorable development advantages can play a demonstrative role in the tourism economic development of other cities (Huang, Xi, & Ge, 2017; Wang, Niu, & Qian, 2018). However, there have been few previous studies of spatial network structure of the tourism in urban agglomerations is largely assumed and uncertain.

3. Materials and methodology

3.1. Study case

UAMRYR, with an area of 0.317 million km^2, is an enormously large state-level urban agglomeration, located in the central region of China (Fig. 1). UAMRYR encompasses the Wuhan Metropolitan Area, Metropolitan Area around Changsha–Zhuzhou–Xiangtan, and Metropolitan Area around Poyang Lake. The "Development Plan" pointed out that UAMRYR is not only a vital part of the Yangtze River Economic Belt but also a crucial region to endorse the swift growth of the central area in China. In 2018, the total GDP of UAMRYR exceeded 8.05 trillion RMB, accounting for approximately 8.9% of the total GDP of China, suggesting that UAMRYR significantly contributes to China's economic development. UAMRYR is rich in natural, cultural, and social tourism resources, such as Yangtse Gorges, Lushan Mountain, Yellow Crane Tower, etc. By 2018, UAMRYR had 550 3A tourist attractions and above [based on the standard of China, tourist attractions are rated from A (1A) to AAAAA (5A)], two times more than that for 2011. Furthermore, UAMRYR's tourism economic development amplified intensely, by nearly 4.5 times, from 408 billion RMB in 2011 to 1.84 trillion RMB in 2018. This indicates that tourism industry has unreservedly contributed to the growth and development across UAMRYR.

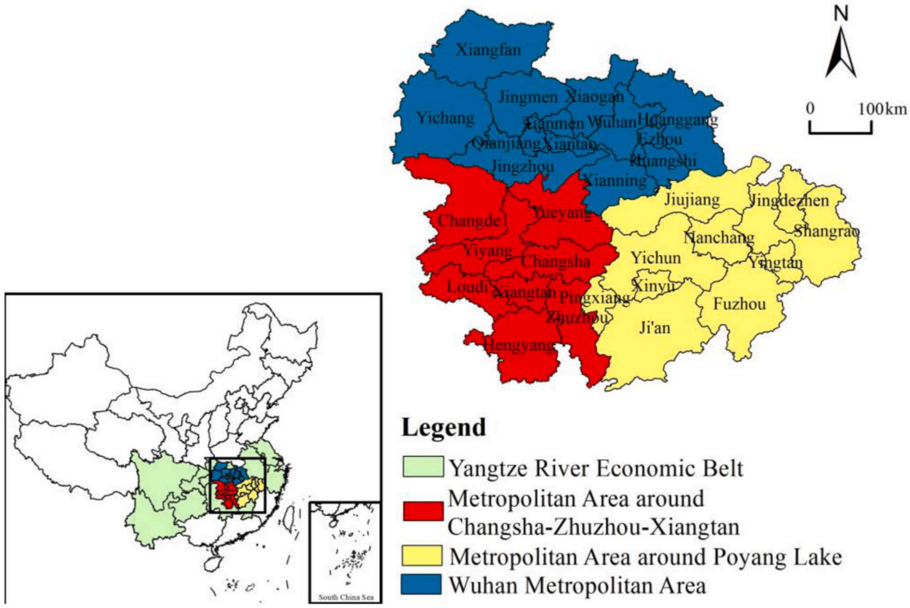

Fig. 1. Geolocation of Urban Agglomeration in the middle Reaches of the Yangtze River.

3.2. Data source and processing

In this study, we considered 28 cities in UAMRYR as the spatial units to examine the spatial network structure of the tourism economy. However, Tianmen City, Qianjiang City, and Xiantao City were excluded owing to data imperfection. The data of the tourism economic quality on the city-level in UAMRYR were obtained from the *China City Statistical Yearbook* (2019). Besides, a part of data was obtained from the *Hubei Province Statistical Yearbook* (2019), *Hunan Province Statistical Yearbook* (2019), and *Jiangxi Province Statistical Yearbook* (2019). In addition, a list of attractions was obtained from the official website of the Ministry of Culture and Tourism of China (https://www.mct.gov.cn/). For the travel time of high-speed railway (HSR) traffic and railway traffic, this study primarily referred to the *National Railway Passenger Timetable* (2019). In particular, regarding the HSR traffic, we selected "G" and "C" prefixes as the research sample (https://www.12306.cn/index/). Furthermore, the travel time of highway traffic was referred to https://www.changtu.com.

3.3. Research methods

3.3.1. Tourism economic gravity model

Like Newton's universal gravitation law, economists believe that the economic connection among cities can be explored by the law of retail gravitation (Dejean, 2019). Since Reilly (1931) first introduced this theory into economics, the economic gravity model was expansively applied to examine the economic linkage among regions. Subsequently, the economic gravity model was recurrently modified to adapt various research scenarios.

Constructing the spatial connection matrix through the tourism economic gravity model is the fundamental pillar of examining the spatial network structure of the tourism economy. Of note, the principle of the economic gravity model is that the strength of spatial linkage among two regions is directly proportional to their quality and inversely proportional to the distance (Dejean, 2019). Both the tourism economic gravity model and gravity model are similar, in which the STEC between two cities is proportional to their respective tourism economic quality but inversely proportional to the distance among them. This study used the comprehensive coefficient to evaluate the tourism economic quality of each city. Moreover, the time distance was used in this study. The tourism economic gravity model is as follows:

$$Fij = kij\frac{Pi \cdot Pj}{D_{ij}^{b}} \tag{1}$$

Where F_{ij} denotes the STEC; P_i and P_j denote the tourism economic quality of city i and city j; D_{ij} represents the distance between city i and city j; k_{ij} denotes the empirical constant; b denotes the distance attenuation coefficient, a value of 2 as used elsewhere (Zipf, 1942).

The spatial distance has been shortened with the improvement of transportation infrastructure construction; thus, straight-line distance cannot precisely reflect distance among cities (Jin, Gong, Deng, Wan, & Yang, 2018). In addition, the transportation distance is notably not comparable in regions with favorable traffic accessibility (Jin, Zheng, & Zhang, 2013). Compared with the transportation distance, time distance allows researchers to comprehensively demonstrate the changes in distance between cities (Dejean, 2019). Hence, the time distance has been widely used to modify the gravity model (e. g., Jin et al., 2013; Jin et al., 2018; Zhang et al., 2020). Besides, the "Development Plan" highlights that UAMRYR, comprising three-dimensional transportation networks, plays a strategic role in the transportation pattern of China. At present, highway traffic, railway traffic, and HSR traffic are the leading traffic modes (Jin et al., 2018). Accordingly, we used the minimum travel time of highway traffic, railway traffic, and HSR traffic to profoundly depict the actual distance between cities (Zhang & Li, 2019).

$$Dij = (hij \cdot rij \cdot gij)^{\frac{1}{s}} \tag{2}$$

Where h_{ij} denotes the minimum travel time of highway traffic between two cities; r_{ij} denotes the minimum travel time of railway traffic between two cities; g_{ij} denotes the minimum travel time of HSR traffic between two cities; and s denotes types of traffic ways between two cities.

The tourism economic quality characterizes a complex system with heterogeneity, diversity, and multidimensions of constituent factors. Besides, the tourism economic quality not only needs to reflect the industrial scale but also indicate the industry performance (Zhang, Gu, Gu, & Zhang, 2011). Based on the principle of systematisms and scientific, this study established a comprehensive index system based on the two dimensions—tourism economic scale and tourism economic performance. The tourism economic scale can represent the overall level of tourism development (Zhu, Zhu, & Zhu, 2013), including total attractions, total star-rated hotel, and the number of domestic tourists, etc. Additionally, the tourism economic performance can demonstrate the economic benefit of tourism development (Tang, 2015), including domestic tourism revenue, foreign exchange earnings from international tourism, and total tourism revenue, etc. Table 1 shows the comprehensive index system regarding the tourism economic quality.

This research applied the information entropy weight (IEW) method, developed by Shannon (1948), to calculate the weights of multi-indexes. The technique for the order of preference by similarity to ideal solution (TOPSIS), advanced by Hwang and Yoon (1981), is a numerical method to solve multi-criteria decision-making issues. In this study, we used TOPSIS to calculate the comprehensive coefficient of the tourism economic quality (CCTEQ).

The spatial connection among cities is not directional in the tourism economic development, and cities with large tourism economic quality have more attraction power than other cities (Bai, Zhou, Xia, & Feng, 2020). In addition, this research used the ratio of every city's tourism economic quality to the sum of the tourism economic quality for a pair of cities to modify the weighting factor k. Moreover, the spatial connection matrix of the tourism economy was established through the above-mentioned series of modification.

$$kij = \frac{Pi}{Pi + Pj} \tag{3}$$

Suppose that the STEC between city i and all other cities is F_i (total strength of the tourism economic connection, TSTEC). F_i can be calculated as follows:

$$Fi = \sum_{j=1}^{27} Fij \tag{4}$$

3.3.2. SNA model

In this study, SNA was applied to examine the correlation between various social individuals and analyze the structural characteristics among social groups based on the graph theory and algebra (Benítez-Andrades, García-Rodríguez, Benavides, Alaiz-Moretón, & Labra Gayo, 2020). Owing to the advantages of iconic expression and precise calculation, SNA has been extensively adopted in an army of disciplines, including economics, sociology, management, geography, and tourism (Bai et al., 2020; Li, Garces, & Daim, 2019; Liu, Tao, Yang, & Bi, 2019; Yin, Gu, & Zhang, 2020). Furthermore, SNA was applied to examine the characteristics associated with the spatial network structure of the tourism economy in UAMRYR under the auspices of UCINET (University of California at Irvine Network) software; Table 2 presents these formulas.

Table 1
Comprehensive evaluation index system of the tourism economic quality.

Dimension	Indicator (Unit)	Reference
Tourism economic scale	Total attractions (number)	Wang, Mao, Xian, and Liang (2019)
	Total star-rated hotel (number)	Tang (2015)
	Number of domestic tourists (million person-times)	Huang and Peng (2012)
	Number of international tourists (person-times)	Tang (2015)
	Total number of tourists (million person-times)	Zhu et al. (2013)
Tourism economic performance	Domestic tourism revenue (RMB Yuan 100 million)	Tang (2015)
	Foreign exchange earnings from international tourism (USD 10,000)	Huang and Peng (2012)
	Total tourism revenue (RMB Yuan 100 million)	Wang, Huang, Gong, and Cao (2020)
	Percentage of total tourism revenue in GDP (%)	Zhu et al. (2013)
	Percentage of total tourism revenue in the tertiary industry (%)	Tang (2015)
	Density of tourism revenue (10,000/km^2)	Guo, Mu, Ming, and Ding (2020)

Table 2
The formulas of indexes regarding spatial network structure characteristics of the tourism economy.

Index	Formula	Explanation of formula
Network density	$D = \frac{L}{N \times (N-1)}$	Where D is the network density; L is the number of actual connections; $N \times (N-1)$ is the number of possible connections; and N is the number of points in a network structure (Network relationship).
Network efficiency	$E = 1 - \frac{M}{\max(M)}$	Where E is the network efficiency; M is the number of redundant lines; and max (M) is the maximum number of possible redundant lines.
Degree centrality	$De = \frac{n}{N-1}$	Where De is the measure of degree centrality; n is the number of nodes connected with the city; and N is the maximum number of nodes connected with the city.
Betweenness centrality	$Cbi = 2\frac{\sum_i^n \sum_j^n bij(l)}{N^2 - 3N + 2}$, $i \neq j \neq l, i < j$	Where Cb_i is betweenness centrality; b_{ij} is the number of the shortcuts between city i and city j; and $b_{ij}(l)$ represents the number of shortcuts between city i and city j.
Closeness centrality	$C_{APi}^{-1} = \sum_{i-1}^{n} d_y$	Where C_{APi}^{-1} is closeness centrality; and d_{ij} is the shortest distance between city i and city j.

Reportedly, network density is applied to evaluate the level of closeness among different cities in a network (Bai et al., 2020). Like the network density, the network relationship is also used to measure the level of closeness between cities (Zhang & Li, 2019). Network efficiency is an indicator to examine the degree of redundant lines in a network; it can reflect the network structure's stability. Moreover, the greater the network efficiency, the more intensive the network structure's stability (Jin et al., 2018).

In addition, degree centrality is used to evaluate the degree of coagulative power of a city in the network structure (Liu et al., 2017). The higher the point centrality, the greater power in the network structure. Besides, the degree centrality comprises in-degree centrality and out-degree centrality (Jin et al., 2018). While the in-degree centrality can illustrate the number of direct relationships that a city could receive, the out-degree centrality can reflect the number of relationships that the city could send. Betweenness centrality is used to measure the degree where a city controls the tourism economic connection (Bai et al., 2020). Furthermore, the closeness centrality is applied to assess the degree where a city is not dominated by other cities (Yin et al., 2020).

Based on the relational data, cohesive subgroup analysis is widely applied to collect the actors with relatively strong, direct, close or positive connections in the network structure (Frank, 1995). Cohesive subgroup analysis consists of many models such as core-edge structure, block model analysis, component analysis method and so on. In this study, we used the block model analysis to examine the position of each city and the linkage pattern in the tourism economic network (Lv, Feng, Kelly, Zhu, & Deng, 2019). The model can illustrate the status of network structure and reflect the role of various cities in a cohesive group (Zhang & Li, 2019). As Wasserman and Faust (1994) accentuated, the scale of every block should be considered while examining the network linkage.

4. Results

4.1. The comprehensive coefficient of tourism economic quality

The average value of comprehensive coefficient of tourism economic quality (CCTEQ) was 0.126, and eight cities were above the mean value, followed by Wuhan, Changsha, Yichang, Nanchang, Jiujiang, Jingdezhen, Pingxiang, and Shangrao from high to low (Table 3). Among these

Table 3
The comprehensive coefficient of tourism economic quality.

Metropolitan area	City	CCTEQ	Rank	Metropolitan area	City	CCTEQ	Rank
Wuhan Metropolitan Area	Wuhan	0.927	1	Changsha–Zhuzhou–Xiangtan	Yueyang	0.111	11
	Huangshi	0.038	24		Changde	0.059	20
	Huanggang	0.084	15		Yiyang	0.032	25
	Ezhou	0.018	28		Loudi	0.046	23
	Yichang	0.156	3	Metropolitan Area around Poyang Lake	Nanchang	0.153	4
	Xiangyang	0.056	21		Jingdezhen	0.135	6
	Jingmen	0.025	27		Pingxiang	0.133	7
	Xiaogan	0.032	26		Jiujiang	0.138	5
	Jingzhou	0.047	22		Xinyu	0.113	10
	Xianning	0.063	19		Yingtan	0.120	9
Metropolitan Area around-	Changsha	0.392	2		Ji'an	0.108	12
	Zhuzhou	0.066	18		Yichun	0.090	14
	Xiangtan	0.104	13		Fuzhou	0.072	16
	Hengyang	0.068	17		Shangrao	0.128	8

cities, the CCTEQ of Wuhan was 0.927, which was far higher than other all cities, which suggested that Wuhan, as the absolute central city, is the crucial growth pole in UAMRYR. Additionally, from the viewpoint of metropolitan areas, the order of the spatial distribution characteristics by metropolitan areas was the Wuhan Metropolitan Area (0.145), Metropolitan Area around Poyang Lake (0.119), and Metropolitan Area

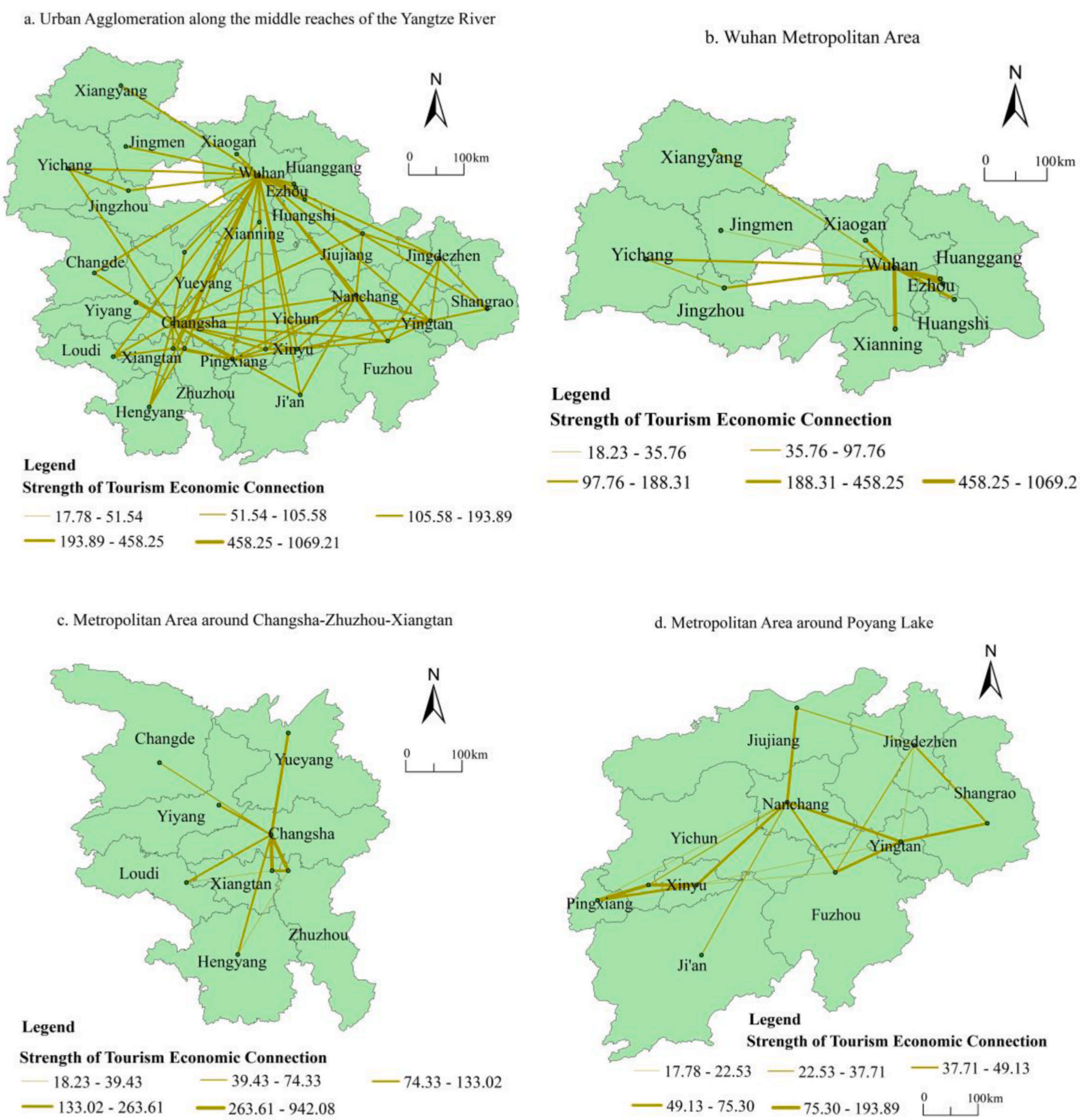

Fig. 2. The strength of the tourism economic connection.

around Changsha–Zhuzhou–Xiangtan (0.110) by calculating the total mean value of various metropolitan areas.

4.2. Strength of tourism economic connection

We applied the tourism economic gravity model to evaluate the STEC. In addition, a connection strength diagram was drawn using ArcGIS10.2 software. To elucidate the main characteristics of spatial connection, lines whose STEC value was below the mean (17.595) were shown through transparent color. Fig. 2a illustrates a three-branch connection schema in UAMRYR, namely, Wuhan, Changsha, and Nanchang had more tourism economic connections between other cities.

On the metropolitan area level, a significant core–periphery structure was found in tourism economic connections (Fig. 2b–d). Wuhan Changsha and Nanchang had more connections among other cities in their respective urban circle, demonstrating that the three cities served as predominant powers in the transmission of tourism economic factors. In addition, the strongest connection was between Wuhan and Huanggang, followed by Wuhan–Xianning, Wuhan–Xiaogan, and Wuhan–Huangshi in the Wuhan Metropolitan Area; the strongest connection was between Changsha and Xiangtan, followed by Changsha–Zhuzhou in the Metropolitan Area around Changsha–Zhuzhou–Xiangtan; the strongest connection was between Xinyu and Yichun, followed by Pingxiang–Yichun in the Metropolitan Area around Poyang Lake. Notably, the tourism economic connections are closest between the adjacent cities, consistent with the distance–decay regularity.

Regarding TSTEC, as shown in Table 4, Wuhan, Changsha, Xiangtan, Pingxiang, Xinyu, Nanchang, Yichuan, Zhuzhou, Yingtan, and Yueyang ranked in TOP10. The spatial difference was enormous in the Wuhan Metropolitan Area. For example, TSTEC of Wuhan was >500 times that of Jingmen, suggesting that the polarization effect of Wuhan was too intense in the Wuhan Metropolitan Area. On the urban circle level, the strongest of TSTEC was registered by the Wuhan Metropolitan Area, which accounted for 43.43%, followed by the Metropolitan Area around Changsha–Zhuzhou–Xiangtan and Metropolitan Area around Poyang Lake at 34.13% and 22.44%, respectively.

4.3. Structural characteristics of the overall network

The network density had a lower level of 0.133 in UAMRYR, demonstrating a sparsely connected network and little tourism economic collaboration within urban agglomeration. In particular, the number of network relationships in UAMRYR was only 101, which was far less than the maximum possible value of relationships ($N = 756$). Thus, tremendous room exists for enhancing tourism economic collaboration. With regard to the network efficiency, the value was at a relatively high level of 0.804, suggesting that the spatial network structure of the tourism economy was unstable to a certain extent. On the urban circle level, the Metropolitan Area around Poyang Lake displayed the highest network density (0.344) and network relationship (101), revealing that the spatial network structure of the tourism economy was closer and more tourism economic connections and collaboration was present in the metropolitan area. Furthermore, its network efficiency (0.555) was lower, illustrating that every city could conveniently attain the tourism economic cooperation among other cities through the overall network structure.

4.4. Structural characteristics of individual network

To facilitate the later horizontal and vertical comparison, these indicators, depicting the structural characteristics of an individual network, were standardized. The specific analysis is as follows; Table 5 shows the results. Wuhan and Changsha were primate cities with the in-degree centrality far beyond the out-degree centrality, suggesting that the siphon effect of the two cities were far from the spillover effect toward circumambient cities. In particular, Wuhan and Changsha became the growth pole of UAMRYR but failed to adequately stimulate the tourism economic development of surrounding cities. Regarding the out-degree centrality, Wuhan, Changsha, and Nanchang ranked in TOP3, suggesting that the three cities could bear the missions and generate a radiation effect toward surrounding cities to a certain extent. Notably, the in-degree centrality of some cities was 0, such as Ezhou, Xiaogan, Changde, and Loudi, demonstrating that the aforementioned cities could not receive the spillover effect from core cities. Owing to the lower level of the tourism economic development or unfavorable transportation accessibility, the aforementioned cities played a peripheral role in the tourism economic network.

Regarding the degree centrality, 10 cities were above the mean value (0.154), and the highest value was of Wuhan, followed by Changsha, Nanchang, Pingxiang, Xinyu, Yingtan, Zhuzhou, Xiangtan, Yichun, and Fuzhou, suggesting that the 10 cities had more tourism economic connections and integration between surroundings cities. Specifically, Wuhan, Changsha, and Nanchang ranked in TOP3, signifying that the three cities, as the core city, had extremely dense linkages among neighborhood cities in UAMRYR. In contrast, Jingmen, Xiaogan, Xiangyang, and Yiyang ranked in the last four, and their degree centrality value was 0, suggesting that these cities were almost unrelated to other cities.

In terms of closeness centrality, the closeness centrality of only six cities was more than the average value (0.223), followed by Wuhan, Changsha, Nanchang, Pingxiang, Xinyu, and Xingtan from high to low; this revealed that the above-mentioned cities could rapidly generate tourism economic connections between other cities in UAMRYR. In addition, Wuhan, Changsha, and Nanchang still ranked in TOP3, suggesting that the three cities had the stronger ability to gain tourism

Table 4
Total strength of the tourism economic connection.

City	Total strength of tourism economic connection	Percentage %	City	Total strength of tourism economic connection	Percentage %
Wuhan	5096.373	38.313	Yueyang	241.450	1.815
Huangshi	58.444	0.439	Changde	46.321	0.348
Huanggang	226.246	1.700	Yiyang	30.172	0.227
Ezhou	30.575	0.230	Loudi	30.925	0.232
Yichang	179.541	1.350	Nanchang	433.018	3.255
Xiangyang	24.836	0.187	Jingdezhen	174.343	1.311
Jingmen	10.688	0.080	Pingxiang	571.705	4.298
Xiaogan	30.969	0.233	Jiujiang	271.850	2.044
Jingzhou	52.100	0.392	Xinyu	453.336	3.408
Xianning	76.939	0.578	Yingtan	256.215	1.926
Changsha	3137.649	23.588	Ji'an	118.420	0.890
Zhuzhou	346.568	2.605	Yichun	402.655	3.027
Xiangtan	619.975	4.661	Fuzhou	105.708	0.795
Hengyang	87.092	0.655	Shangrao	187.701	1.411

Table 5
Network centrality of the tourism economy in UAMRYR.

Metropolitan area	City	In-degree centrality	Out-degree centrality	Degree centrality	Closeness centrality	Betweenness centrality
Wuhan Metropolitan Area	Wuhan	1.000	0.750	1.000	1.000	1.000
	Huangshi	0	0.125	0.040	0.140	0
	Huanggang	0.115	0	0.080	0.158	0.002
	Ezhou	0	0.125	0.040	0.140	0
	Yichang	0.077	0.250	0.080	0.178	0.004
	Xiangyang	0	0	0	0.122	0
	Jingmen	0	0	0	0.122	0
	Xiaogan	0	0	0	0.122	0
	Jingzhou	0.038	0.125	0.040	0.140	0
	Xianning	0.038	0.125	0.040	0.158	0
Metropolitan Area around Changsha–Zhuzhou–Xiangtan	Changsha	0.692	0.875	0.680	0.595	0.315
	Zhuzhou	0.154	0.500	0.160	0.218	0.003
	Xiangtan	0.154	0.375	0.160	0.218	0.003
	Hengyang	0.077	0.250	0.080	0.178	0
	Yueyang	0.077	0.125	0.040	0.158	0
	Changde	0	0.125	0.040	0.158	0
	Yiyang	0	0	0	0	0
	Loudi	0	0.250	0.080	0.178	0
Metropolitan Area around Poyang Lake	Nanchang	0.308	1.000	0.320	0.311	0.020
	Jingdezhen	0.115	0.250	0.120	0.178	0.003
	Pingxiang	0.231	0.625	0.240	0.263	0.009
	Jiujiang	0.115	0.375	0.120	0.198	0.004
	Xinyu	0.231	0.625	0.240	0.263	0.004
	Yingtan	0.154	0.625	0.240	0.263	0.019
	Ji'an	0.038	0.250	0.080	0.178	0
	Yichun	0.154	0.500	0.160	0.218	0
	Fuzhou	0.038	0.500	0.160	0.218	0
	Shangrao	0.077	0.250	0.080	0.158	0
Average value		0.139	0.321	0.154	0.223	0.050

economic factors than other cities. Conversely, Yiyang, Xiangyang, Jingmeng, Xiaogan, Ezhou, and Jingzhou had lower closeness centrality, demonstrating that they played the role of a fringe actor in the tourism economic cooperation.

Regarding betweenness centrality, only two cities were above the mean value (0.050), followed by Wuhan and Changsha, suggesting that the control power of Wuhan and Changsha was stronger than other cities in the flow of tourism economic factors. Alternatively, Wuhan and Changsha could not only have more tourism economic connections between other cities but also act as both an intermediary and a bridge in the spatial network of the tourism economy. Notably, 26 cities were below the average value, suggesting that these cities had weak controllability for other cities. Overall, tourism economic linkages of numerous cities were regulated by the main core cities in UAMRYR.

4.5. Cohesive group of the spatial network structure of the tourism economy

We used convergent correlation (CONCOR) to analyze cohesive subgroup of tourism economic connections in UAMRYR. To guarantee that the number of cities in each plate exceeded 3, we set the maximum segmentation depth as 2 and the convergence standard as 0.2 (Lv et al., 2019). In addition, we divided 28 cities into four plates to differentiate between the role of each plate. A total of 101 relationships were present in the spatial network structure of the tourism economy, with 42 relationships within the plate and 59 relationships outside the plate (Table 6), demonstrating a significant spillover effect and spatial connection among four plates.

Plate 1 comprised six cities, namely, Wuhan, Changsha, Zhuzhou, Xiangtan, Hengyang, and Pingxiang, which were primarily a core city or transportation center in UAMRYR. In addition, plate 1 played a main inflow role in the spatial network structure of the tourism economy, as it received 38 relationships, but solely sent out 12 contacts outside plate. Plate 2, comprising Yiyang, Xinyu, Yingtan, Nanchang Jiujiang, Fuzhou, and Yichun, played a bidirectional spillover role in the spatial network structure of the tourism economy, as the number of relationships, which plate 2 sent both inside ($n = 18$) and outside ($n = 21$), were all large. Plate 3, comprising Huangshi, Xiaogan, Xiangyang, Ezhou, Jingmen, Jingzhou, Shangrao, and Jingdezhen, played a main overflow role in the spatial network structure of the tourism economy, as the actual ratio was less than the expected ratio (it sent 2 contacts inside plate but 14 contacts with other plates). Plate 4 comprised six cities, including Huanggang, Changde, Yueyang, Yichang, Xianning, and Loudi. Moreover, Plate 4 played the main overflow role in the spatial network structure of the tourism economy because plate 4 had zero actual inter-linkages but more tourism economic connections among other plates.

Based on the previous results, the network density of the spatial network was 0.133. In this study, the network density of any plate with value over the whole value (0.133) was reassigned with "1"; else, it was assigned with "0." Based on the calculation process, we acquired the image matrix (Table 7). Plates 1 and 2 not only had own internal tourism economic connection but also received tourism economic spillover from

Table 6
The spillover effect between plates.

Plate	Receiving relationships		Sending out relationships		Expected ratio/%	Actual ratio/%	Role of plate
	Inside	Outside	Inside	Outside			
Plate 1	22	38	22	12	18	64	Main inflow
Plate 2	18	9	18	21	26	46	Bidirectional spillover
Plate 3	2	4	2	13	26	14	Main overflow
Plate 4	0	8	0	13	18	0	Main overflow

Table 7
Density matrix and image matrix of four plates.

Plate	Density matrix				Image matrix			
	Plate 1	Plate 2	Plate 3	Plate 4	Plate 1	Plate 2	Plate 3	Plate 4
Plate 1	0.733	0.146	0.000	0.139	1	1	0	1
Plate 2	0.375	0.321	0.047	0.000	1	1	0	0
Plate 3	0.167	0.031	0.036	0.063	1	0	0	0
Plate 4	0.333	0.000	0.021	0.000	1	0	0	0

other plates. For example, plate 1 received the overflow of plates 2–4, and plate 2 acquired the spillover effect of plate 1. Compared with plates 1 and 2, no internal tourism economic spillover occurred in plates 3 and 4. Owing to the weak awareness of cooperation, a dearth of abundant tourism economic collaboration and connections existed within plates 3 and 4. Unlike plate 3, however, plate 4 effectively received radiation effect from plate 1.

5. Discussion

Despite the significance of the tourism economic network of urban agglomerations, the understanding of characteristics regarding the spatial network structure of the tourism economy is limited. To overcome this omission in the extant literature, and gain more insights into the spatial network structure of urban agglomerations, this study not only measured STEC but also explored the characteristics regarding the spatial network structure of the tourism economy in UAMRYR.

The tourism economic connections were closest between adjacent cities, which is in line with the distance–decay regularity (Dejean, 2019). The higher tourism economic quality and favorable transportation accessibility can elucidate the phenomenon that Wuhan, Changsha, and Nanchang held more TSTEC. Although Yichang had the third-highest tourism economic quality, it held few tourism economic integrations between other cities owing to the unfavorable transportation network connection; this establishes that the favorable transportation accessibility can promote STEC positively (Zhang et al., 2020).

With regard to the structural characteristics of the overall network, although a series of declarations regarding tourism economic cooperation, such as *Wuhan Consensus*, *Changsha declaration*, and *Nanchang Operation*, were signed, UAMRYR offered characteristics like a loose and unstable spatial network connection. Moreover, the rationale for this finding is, perhaps, that most tourism economic collaborations among cities were driven by government interventions rather than the market mechanism. Alternatively, the market mechanism did not play a dominant role in the tourism economic activities, thereby corroborating Wang, Mao, et al. (2019).

With respect to the structural characteristics of an individual network, Wuhan, Changsha, and Nanchang presented the characteristics of strong centrality. The values of degree centrality, betweenness degree, and closeness centrality exceeded those of other cities in UAMRYR, illustrating a structural characteristic of three-branch in UAMRYR, corroborating Liu, Mu, Hu, Li, and Wang (2018). Additionally, this structural characteristic accords with the results of tourism economic connections, namely, Wuhan, Changsha, and Nanchang had more tourism economic linkages among other cities.

Regarding the cohesive subgroup analysis, the spatial network structure of the tourism economy in UAMRYR was at the initial stage of block formation. Besides, there was a dearth of more tourism economic connections among different plates due to the restrictions of administrative mechanism. Moreover, cities where tourism resources are concentrated and favorable transportation service are provided, such as Wuhan, Changsha, Nanchang, Zhuzhou, and Pingxiang, benefited more from the growth of other cities located in plates 3 or 4. To promote tourism economic integrations and connections, thus, it is imperative to break the barrier of administration division among various plates; this finding supports Sun, Tang, and Tang (2015).

This study contributes to the following broad literature. First, previous studies primarily focused on the correlation among tourism organizations or tourism flows in tourist destinations; this study can complement the literature on the tourism spatial network, which also responds to the call for more empirical studies on the flow of space in tourist destinations. Second, this study constructed the tourism economic gravity model to assess STEC and established the spatial connection matrix of the tourism economy; this is an applicable and innovative methodology that adopts the time distance and comprehensive evaluation index system to alter the conventional gravity model. Although the empirical analysis is based on the UAMRYR sample, the methodology and theoretical analyses are generic and applicable across the world. Thirdly, this study identifies the position and role of various cities within the spatial network structure of the tourism economy deduced from new urban economic geography. Furthermore, this study illustrates the significant impact of favorable transportation accessibility on tourism economic integration and connection of urban agglomerations.

6. Conclusion

Taking the UAMRYR as a case study, this study investigated the spatial network structure of the tourism economy based on the SNA. The main results of this study are as follows. First, owing to the higher tourism economic quality and better transportation accessibility, Wuhan, Changsha, and Nanchang have more tourism economic connections among other cities. Second, the spatial network structure of the tourism economy is loose and unstable to some extent in UAMRYR. Third, the results of degree centrality, closeness centrality, and betweenness centrality demonstrated that the spatial network structure of the tourism economy reflected a significant three-branch structure distribution pattern, namely, Wuhan, Changsha, and Nanchang are the core cities in the spatial network structure. Finally, there exists a lack of tourism economic integrations among various plates owing to the restrictions of administrative mechanism.

Accordingly, practical implications about tourism economic collaboration and synchronized tourism industrial development of UAMRYR are provided for policymakers. First, the core cities, such as Wuhan, Changsha, and Nanchang, should create more spillover effect and radiation effect across other cities, which is potentially advantageous for the spatial integration and coordinated development of the tourism industry in UAMRYR. Meanwhile, some sub-core cities, such as Yichang, Zhuzhou, and Pingxiang, should be developed to disperse tourist flows to avoid “big city disease”, thereby promoting the stability of the spatial network structure of the tourism economy and attaining holistic tourism economic development of urban agglomeration. Second, to break the limits of administrative barriers and enhance tourism economic cooperation among cities, it is essential to create an inter-district extensive cooperation mechanism by completely using HSR or Yangtze River Golden Waterway to hasten the flows of tourism economic factors like talents, technologies, capital, and information. In addition, an open sharing mechanism for tourists flow within UAMRYR to alleviate the imbalance of the tourism economic development. Third, based on the cohesive group analysis, numerous cities, located in plates 3 and 4, actively promote transportation infrastructure and information technologies to receive more material and non-material tourism factors from plates 1 and 2 to augment tourism economic connection among cities. Furthermore, the widespread tourism economic connections within plates should be enhanced by collectively exploiting tourism resources and designing tourist routes.

Inevitably, this study faces some limitations, which need further investigation. First, owing to the data unavailability, this study could not take into account some factors (e.g., traffic cost) to modify the time distance. Thus, future research should consider external factors when the sophisticated database is provided. Second, the case was limited to UAMRYR, which could hinder the universality and wider applicability of empirical results. Therefore, it is essential to investigate the spatial network structure of the tourism economy across other urban agglomerations in the world. Furthermore, the evolution characteristics regarding the spatial network structure of the tourism economy warrant further investigation based on the panel data.

Acknowledgments

This paper was mainly supported by the National Social Science Foundation of China (No. 18BJY191). It also supported by Anhui Province University Natural Science Foundation (No. KJ2019A0632) and Hubei Provincial Department of Education Philosophy and Social Science Prosperity Plan Key Project (No.20D097). Meanwhile, we would like to thank the editor and the two anonymous referees for their constructive comments and critical suggestions, which have significantly improved the manuscript. Furthermore, we thank Miss Qingfang Liu for map drawing.

References

Asero, V., Gozzo, S., & Tomaselli, V. (2015). Building tourism networks through tourist mobility. *Journal of Travel Research, 55*(6), 751–763. https://doi.org/10.1177/0047287515569777.

Bai, C., Zhou, L., Xia, M., & Feng, C. (2020). Analysis of the spatial association network structure of China's transportation carbon emissions and its driving factors. *Journal of Environmental Management, 253*, 109765. https://doi.org/10.1016/j.jenvman.2019.109765.

Benítez-Andrades, J. A., García-Rodríguez, I., Benavides, C., Alaiz-Moretón, H., & Labra Gayo, J. E. (2020). An ontology-based multi-domain model in social network analysis: Experimental validation and case study. *Information Sciences, 540*, 390–413. https://doi.org/10.1016/j.ins.2020.06.008.

Bo, Z., Bi, Y., Hengyun, L., & Hailin, Q. (2016). The spillover effect of attractions. *Tourism Economics, 23*(4), 731–743. https://doi.org/10.5367/te.2016.0541.

Castells, M. (1996). *The rise of the network society*. Oxford: Black well Publishers.

Castells, M. (2005). Space of flows, space of places: Materials for a theory of urbanism in the information age. *Comparative Planning Cultures*, 45–63.

Dejean, S. (2019). The role of distance and social networks in the geography of crowdfunding: Evidence from France. *Regional Studies, 54*(3), 329–339. https://doi.org/10.1080/00343404.2019.1619924.

Denicolai, S., Cioccarelli, G., & Zucchella, A. (2010). Resource-based local development and networked core-competencies for tourism excellence. *Tourism Management, 31*(2), 260–266. https://doi.org/10.1016/j.tourman.2009.03.002.

D'Agata, R., Gozzo, S., & Tomaselli, V. (2012). Network analysis approach to map tourism mobility. *Quality and Quantity, 47*(6), 3167–3184. https://doi.org/10.1007/s11135-012-9710-7.

Erkuş-Öztürk, H., & Eraydın, A. (2010). Environmental governance for sustainable tourism development: Collaborative networks and organisation building in the Antalya tourism region. *Tourism Management, 31*(1), 113–124. https://doi.org/10.1016/j.tourman.2009.01.002.

Evans-Cowley, J. S. (2010). Planning in the age of Facebook: The role of social networking in planning processes. *Geojournal, 75*(5), 407–420.

Fang, C., Yu, X., Zhang, X., Fang, J., & Liu, H. (2020). Big data analysis on the spatial networks of urban agglomeration. *Cities, 102*. https://doi.org/10.1016/j.cities.2020.102735.

Frank, K. A. (1995). Identifying cohesive subgroups. *Social Networks, 17*(1), 27–56.

Guo, X., Mu, X., Ming, Q., & Ding, Z. (2020). Spatial and temporal differentiation characteristics of transportation service function and tourism intensity coordination: A case study of Yunnan Province. *Journal of Natural Resources, 35*(6), 1425–1444. https://doi.org/10.31497/zrzyxb.20200615 (in Chinese).

Huang, J.-H., & Peng, K.-H. (2012). Fuzzy rasch model in TOPSIS: A new approach for generating fuzzy numbers to assess the competitiveness of the tourism industries in asian countries. *Tourism Management, 33*(2), 456–465. https://doi.org/10.1016/j.tourman.2011.05.006.

Huang, T., Xi, J.-C., & Ge, Q.-S. (2017). Spatial differentiation and integration optimization of an urban agglomeration tourism system under the influence of high-speed railway network evolution. *Applied Spatial Analysis and Policy, 12*(2), 349–376. https://doi.org/10.1007/s12061-017-9245-3.

Hwang, D., Chi, S.-H., & Lee, B. (2013). Collective action that influences tourism. *Journal of Hospitality & Tourism Research, 40*(4), 497–515. https://doi.org/10.1177/1096348013503999.

Hwang, C. L., & Yoon, K. (1981). *Multiple attribute decision making: Method and application*. New York: Spring-verlag.

Jesus, C., & Franco, M. (2016). Cooperation networks in tourism: A study of hotels and rural tourism establishments in an inland region of Portugal. *Journal of Hospitality and Tourism Management, 29*, 165–175. https://doi.org/10.1016/j.jhtm.2016.07.005.

Jin, R., Gong, J., Deng, M., Wan, Y., & Yang, X. (2018). A Framework for spatiotemporal analysis of regional economic agglomeration patterns. *Sustainability, 10*(8). https://doi.org/10.3390/su10082800.

Jin, H., Zheng, L., & Zhang, J. (2013). Network analysis of economic contacts variability in Poyang Lake Ecological Economic Zone based on travel time cost. *Economic Geography, 33*(6), 148–154. https://doi.org/10.15957/j.cnki.jjdl.2013.06.009 (in Chinese).

Kim, S., & Lee, W. S. (2019). Network text analysis of medical tourism in newspapers using text mining: The South Korea case. *Tourism Management Perspectives, 31*, 332–339. https://doi.org/10.1016/j.tmp.2019.05.010.

Kim, Y. R., Williams, A. M., Park, S., & Chen, J. L. (2021). Spatial spillovers of agglomeration economies and productivity in the tourism industry: The case of the UK. *Tourism Management, 82*. https://doi.org/10.1016/j.tourman.2020.104201.

Kirilenko, A. P., Stepchenkova, S. O., & Hernandez, J. M. (2019). Comparative clustering of destination attractions for different origin markets with network and spatial analyses of online reviews. *Tourism Management, 72*, 400–410. https://doi.org/10.1016/j.tourman.2019.01.001.

Kubo, T., Uryu, S., Yamano, H., Tsuge, T., Yamakita, T., & Shirayama, Y. (2020). Mobile phone network data reveal nationwide economic value of coastal tourism under climate change. *Tourism Management, 77*. https://doi.org/10.1016/j.tourman.2019.104010.

Leiper, N. (1979). The framework of tourism: Towards a definition of tourism, tourist, and the tourist industry. *Annals of Tourism Research, 6*(4), 390–407.

Li, S., Garces, E., & Daim, T. (2019). Technology forecasting by analogy-based on social network analysis: The case of autonomous vehicles. *Technological Forecasting and Social Change, 148*. https://doi.org/10.1016/j.techfore.2019.119731.

Liu, B., Huang, S., & Fu, H. (2017). An application of network analysis on tourist attractions: The case of Xinjiang, China. *Tourism Management, 58*, 132–141. https://doi.org/10.1016/j.tourman.2016.10.009.

Liu, Z., Mu, R., Hu, S., Li, M., & Wang, L. (2018). The method and application of graphic recognition of the social network structure of urban agglomeration. *Wireless Personal Communications, 103*(1), 447–480. https://doi.org/10.1007/s11277-018-5454-6.

Liu, W., Tao, Y., Yang, Z., & Bi, K. (2019). Exploring and visualizing the patent collaboration network: A case study of smart grid field in China. *Sustainability, 11*(2). https://doi.org/10.3390/su11020465.

Liu, Y., Zhang, X., Pan, X., Ma, X., & Tang, M. (2020). The spatial integration and coordinated industrial development of urban agglomerations in the Yangtze River Economic Belt, China. *Cities, 104*. https://doi.org/10.1016/j.cities.2020.102801.

Liu, F., Zhang, J., Zhang, J., Chen, D., Liu, Z., & Lu, S. (2012). Roles and functions of tourism destinations in tourism region of south anhui: A tourist flow network perspective. *Chinese Geographical Science, 22*(6), 755–764. https://doi.org/10.1007/s11769-012-0557-6.

Lv, K., Feng, X., Kelly, S., Zhu, L., & Deng, M. (2019). A study on embodied carbon transfer at the provincial level of China from a social network perspective. *Journal of Cleaner Production, 225*, 1089–1104. https://doi.org/10.1016/j.jclepro.2019.03.233.

Mou, N., Zheng, Y., Makkonen, T., Yang, T., Tang, J., & Song, Y. (2020). Tourists' digital footprint: The spatial patterns of tourist flows in Qingdao, China. *Tourism Management, 81*. https://doi.org/10.1016/j.tourman.2020.104151.

Pavlovich, K. (2003). The evolution and transformation of a tourism destination network: The waitomo caves, New Zealand. *Tourism Management, 24*(2), 203–216. https://doi.org/10.1016/s0261-5177(02)00056-0.

Raisi, H., Baggio, R., Barratt-Pugh, L., & Willson, G. (2020). A network perspective of knowledge transfer in tourism. *Annals of Tourism Research, 80*. https://doi.org/10.1016/j.annals.2019.102817.

Reilly, W. J. (1931). *The law of retail gravitation*. Texas: University of Texas.

Seok, H., Barnett, G. A., & Nam, Y. (2020). A social network analysis of international tourism flow. *Quality and Quantity*. https://doi.org/10.1007/s11135-020-01011-8.

Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal, 27*, 379e423–623e656.

Stienmetz, J. L., & Fesenmaier, D. R. (2015). Estimating value in Baltimore, Maryland: An attractions network analysis. *Tourism Management, 50*, 238–252. https://doi.org/10.1016/j.tourman.2015.01.031.

Sun, Q., Tang, F., & Tang, Y. (2015). An economic tie network-structure analysis of urban agglomeration in the middle reaches of Changjiang River based on SNA. *Journal of Geographical Sciences, 25*(6), 739–755. https://doi.org/10.1007/s11442-015-1199-2.

Tang, Z. (2015). An integrated approach to evaluating the coupling coordination between tourism and the environment. *Tourism Management, 46*, 11–19. https://doi.org/10.1016/j.tourman.2014.06.001.

Tasci, A. D. A., Khalilzadeh, J., Pizam, A., & Wang, Y. (2018). Network analysis of the sensory capital of a destination brand. *Journal of Destination Marketing & Management, 9*, 112–125. https://doi.org/10.1016/j.jdmm.2017.11.007.

Wang, K., Gan, C., Yang, Y., & Zhang, S. (2019a). Evolution and driving factors of urban tourism economic network structure in Urban Agglomeration in the Middle Reaches of the Yangtze River. *Geography and Geo-Information Science, 35*(5), 118–125 (in Chinese).

Wang, Q., Mao, Z., Xian, L., & Liang, Z. (2019b). A study on the coupling coordination between tourism and the low-carbon city. *Asia Pacific Journal of Tourism Research, 24*(6), 550–562. https://doi.org/10.1080/10941665.2019.1610002.

Wang, D.-g., Niu, Y., & Qian, J. (2018a). Evolution and optimization of China's urban tourism spatial structure: A high speed rail perspective. *Tourism Management, 64*, 218–232. https://doi.org/10.1016/j.tourman.2017.08.010.

Wang, Y., Li, X. R., & Lai, K. (2018b). A meeting of the minds: Exploring the core–periphery structure and retrieval paths of destination image using social network analysis. *Journal of Travel Research, 57*(5), 612–626.

Wang, Y.-C., Qu, H., & Yang, J. (2020a). Love spillover from a hotel sub-brand to its corporate brand: An associative network theory perspective. *Journal of Hospitality and Tourism Management, 44*, 263–271. https://doi.org/10.1016/j.jhtm.2020.07.006.

Wang, J., Huang, X., Gong, Z., & Cao, K. (2020). Dynamic assessment of tourism carrying capacity and its impacts on tourism economic growth in urban tourism destinations in China. *Journal of Destination Marketing & Management, 15*. https://doi.org/10.1016/j.jdmm.2019.100383.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge, UK: Cambridge University Press.

Yin, C., Gu, H., & Zhang, S. (2020). Measuring technological collaborations on carbon capture and storage based on patents: A social network analysis approach. *Journal of Cleaner Production, 274*. https://doi.org/10.1016/j.jclepro.2020.122867.

Yin, P., Lin, Z., & Prideaux, B. (2019). The impact of high-speed railway on tourism spatial structures between two adjoining metropolitan cities in China: Beijing and Tianjin. *Journal of Transport Geography, 80*, 102495. https://doi.org/10.1016/j.jtrangeo.2019.102495.

Zhang, H., Gu, C.-l., Gu, L.-w., & Zhang, Y. (2011). The evaluation of tourism destination competitiveness by TOPSIS & information entropy–A case in the Yangtze River Delta of China. *Tourism Management, 32*(2), 443–451. https://doi.org/10.1016/j.tourman.2010.02.007.

Zhang, Y., & Li, Z. (2019). Research on spatial correlation network structure of inter-provincial electronic information manufacturing industry in China. *Sustainability, 11*(13). https://doi.org/10.3390/su11133534.

Zhang, P., Zhao, Y., Zhu, X., Cai, Z., Xu, J., & Shi, S. (2020). Spatial structure of urban agglomeration under the impact of high-speed railway construction: Based on the social network analysis. *Sustainable Cities and Society, 62*. https://doi.org/10.1016/j.scs.2020.102404.

Zhu, Y., Zhu, Q., & Zhu, Z. (2013). Modeling, evaluation and analysis of tourism destination competitiveness: A case study of the Yangtze River Delta of China. *Asia Pacific Journal of Tourism Research, 19*(8), 932–949. https://doi.org/10.1080/10941665.2013.833122.

Zipf, G. K. (1942). The unity of nature, least-action, and natural social science. *Sociometry, 5*(1), 48–62.