

Spatial structure analysis of tourism economy in Shaanxi province, China



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ABSTRACT

This paper uses the modified gravity model to measure the intensity of tourism economic connection in 11 prefecture-level cities in Shanxi Province from 2016 to 2020. From the perspective of the social network, the density and core-periphery area of the tourism economic network's spatial structure are explored. The research shows that: From 2016 to 2020, the overall tourism economic connection in Shanxi Province shows a growing trend, and the differentiation phenomenon between the central region and the southern and northern regions is more obvious. There is an unbalanced spatial structure of the tourism economy in all prefecture-level cities in Shanxi province. On the whole, the network density shows a growing trend. The various indexes of Taiyuan, the capital city of Shanxi Province, are obviously better than other cities' indexes. The number of core areas of the tourism economy changes little. These areas are closely connected but the strengthening trend is not obvious. The relations within the periphery region are not strong, and the connection between the periphery region and the core region is also weak. The connection of the regional tourism economy is strongly dependent on tourism resources endowment and transportation accessibility. The spatial structure of the tourism economy network is under the great influence of policy suggestions and planning. This study provides a certain theoretical basis for the formulation of tourism economic development strategy in Shanxi Province. The limitation is that the impact of COVID-19 on tourism development has not been specifically analyzed.

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1. Introduction

With the convenience of means of transportation and the development of all-for-one tourism, the interregional tourist source market, infrastructure, resource development, and other aspects get increasingly connected, promoting the formulation of the complex and steady tourism economic network. In recent years, scholars have also studied the spatially linked structure of the tourism economy precisely in terms of its spatial structure evolution, spatial variation analysis, and influencing factors. Most of the early studies were based on the geographic location theory and core-edge theory models (Majewska, 2015), and the research focused on the regional differences in tourism economic development (Cellini and Cuccia, 2015), spatial

differentiation characteristics (Guedes and Jiménez, 2015) and their external effects (Sarrión-Gavilán et al., 2015).

Social network analysis has been used in the research of social network structure and social relations for a long time since its emergence in the 1930s, and then it has been extended and developed in information science, economics, and other aspects. Since the 1990s, social network analysis has been applied to tourism economic research and has gradually gained attention. Some scholars believe that it is an excellent method to study tourism. Using social network analysis, Kim and Scott (2018) analyzed the evolution of tourism-related organizations and institutional networks in Korea.

2. Literature survey

Foreign scholars such as Kim et al. (2021) used 3D models to find tourist attractions that enrich the travel experience of tourists. Jwa (2016) proposed an intelligent tour guide service platform based on GIS and developed a mobile application to provide intelligent tour guide service. Park and Kim (2021) used SNA analysis to measure risk factors and their

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relationships, and based on this, they proposed a method to cope with risk. Lee et al. (2017) and others provided gamification tourism services for tourists by using the technology of the Rich Communication Suite. Through WPAN, Kim et al. (2019) combined the mobile client template with the basic content of digital signage to generate menus, providing various information and convenience for tourism services (Kim et al., 2019).

Tourism is the largest interpersonal activity in modern society. The state of social networks of various categories of people involved in the development of tourism specifically includes the relationships within and between residents as hosts of tourism and immigrants working in tourism, intra-traveler relationships of guests, and relationships between hosts and guests. The quality of the social network of individual residents of the destination as hosts, including network composition, density, and position in the network, is directly related to their level of tourism participation (Hwang and Stewart, 2017).

In 2017, the newly revised Regulations of Shanxi Province on Tourism clearly stipulate that tourism should be regarded as a pillar industry of the local economy and social development to promote the transformational development of the resource-reliant economy in Shanxi. Exploring the network structure of the tourism economy and its influencing factors, vigorously developing tourism, and strengthening and coordinating the relation of the tourism economy among regions is a significant way to promote the coordinated development of the regional tourism economy.

3. Research methods and data sources

3.1. Modified gravity model

The gravity model can measure the geometric relationship between the outflow and inflow in two regions in all aspects, and Newton's law of universal gravitation is introduced to study the tourism economic problems. In this paper, the gravity model is modified to measure the relation intensity of the tourism economy between cities is as follows:

$$R_{ij} = K_{ij} \frac{\sqrt{P_i V_i} \sqrt{P_j V_j}}{D_{ij}^2}, \text{ where } K_{ij} = \frac{R_i}{R_i + R_j} \quad (1)$$

where, K_{ij} is the gravity coefficient, R_{ij} is the relation intensity of tourism economy in the city i and j , P_i , P_j , and V_i , V_j respectively represents the number of visitor arrivals in city i and city j (unit: 10,000 person-times) and the total revenue from tourism (unit: 100 million yuan), D_{ij} is the traffic distance between city i and j , R_i , R_j represents the total number of A-level tourist attractions in the two prefecture-level cities in that year. C_i , the tourism economic connection of the city, is the summation of the relation of tourism economy between the city and other cities, $C_i = \sum R_{ij}$.

3.2. Social network analysis (SNA)

Social network analysis is widely applied in academic circles to study the actors and their relationships in a structural network (Hwang et al., 2016). The 11 prefecture-level cities in Shanxi Province are the nodes in the network, and the tourism and economic relations among them are the lines connecting these nodes. This paper applies Ucinet 6.0, the social network analysis software, to analyze the spatial structure features of the tourism economy in 11 prefecture-level cities of Shanxi Province from three perspectives: social network density, social network centralization, and core-periphery model, and provides policy suggestions for the coordinated development of tourism in Shanxi Province.

3.2.1. Social network density

Social network density reflects the closeness of the social network, and the value range is [0, 1]. The higher the density of the social network is, the closer the connection of the tourism economy is. Formula:

$$\Delta = \frac{L}{N(N-1)} \quad (2)$$

where, Δ is the density of the social network; L represents the number of social network connections; N is the number of social network nodes, that is, network size.

3.2.2. Social network centrality

The centrality of the social network reveals the differences in the grades and advantages of tourism in different cities in Shanxi Province's spatial structure tourism economy and reflects the important attributes of the spatial structure of the tourism economy in Shanxi Province. The centrality of the social network includes degree centrality, closeness centrality, and betweenness centrality.

(1) Degree centrality:

$$C_{D(i)} = \frac{d_i(i) + d_o(i)}{2(N-1)} \quad (3)$$

where $CD(i)$ is the relative degree of centrality of node i , $d_i(i)$ is the in-centrality corresponding to the internal nodes, and $D_o(i)$ is the out-centrality corresponding to the external nodes. N refers to the number of points connected to point i in the network.

(2) Closeness centrality: Closeness centrality reveals the close relationship among nodes in the social network. The higher the closeness centrality is, the greater the impact of other cities on the connection of the tourism economy between the city and other cities is based on the following equation:

$$C_{c(i)} = \frac{N-1}{\sum_{j=1}^n d(n_i, n_j)} \quad (4)$$

(3) Betweenness centrality: Betweenness centrality refers to the degree of the interval between a node and other points in the social network, revealing the degree of mediation at other points. The betweenness centrality of tourism economic connection indicates the probability of the route connecting the tourism economy of a city with other cities passing through the city, forming "local dependence". Formula:

$$C_B(i) = \frac{\sum_{j < k} g_{jk}(i)}{(N-1)(N-2)} \quad (5)$$

where, $C_B(i)$ is the spacing centrality, g_{jk} represents the number of short-range lines between g and k , N is the number of nodes in the social network.

3.2.3. Core-periphery model

Core-Periphery Model is an ideal structural model of social network analysis. "Core" is formed by the partitioning clustering of a series of nodes, and "Periphery" means that there is no connection among nodes. The "status" of cities in the tourism economic connection is not equal. Some of them are located in the core areas, some are located in the periphery areas.

3.3. Regional classification and data sources

Shanxi Province is briefly named Jin, with Taiyuan as its provincial seat. It is located in the central part of China, east of the Loess Plateau, west of North China, and The Taihang Mountains, and it has a temperate continental monsoon climate. With an area of 156,000 square kilometers, it has jurisdiction over 118 county-level administrative units in 11 prefecture-level cities. Shanxi Province is rich in natural tourist landscapes such as famous mountains and beautiful waters, valleys, caves, and forest parks. There are also rich and colorful cultural tourism resources with a long history such as unique courtyards, villas, temples, cave statues, monument stones, sculptures, ancient cities, passes, and cultural heritages. "Ancient Chinese civilization, good scenery in Shanxi" is an accurate description of Shanxi's tourism resources. By December 2020, there were 219 A-level tourist attractions in Shanxi Province. The structure of the spatial distribution of scenic spots is an olive-shaped structure that is "small at both ends and large in the middle". The spatial distribution of the scenic spots is relatively scattered, and the quantity of scenic spots in different cities is relatively balanced (Fig. 1).

The year from 2016 to 2020 is a golden opportunity period for the accelerating development of tourism in Shanxi Province and a key strategic phase for transformation and upgrading. It is also a crucial period for Shanxi Province to accelerate the cultivation of the tourism pillar industry and promote the construction of a strong tourism province. The data from 11 prefecture-level cities in Shanxi Province from 2016 to 2020 are selected as

research data and the data are chosen from Shanxi Statistical Yearbook and National Economic Development Statistical Bulletin in corresponding years. After a lot of work, the highway mileage among cities (Although the high-speed railway is fast and convenient in the research area, the highway belongs to a point-to-point distance which is more coherent. Therefore, the road distance is chosen as the data) is chosen in this paper and this paper takes the shortest road mileage of "Amap" as the reference data.

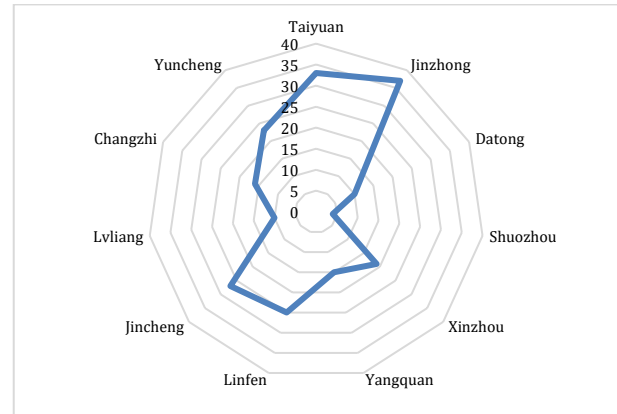


Fig. 1: Number of A-level tourist attractions in each prefecture-level city of Shanxi Province

Innovation of this paper: (1) Previous studies on the tourism economy mainly focus on coastal areas or developed provinces. Research on the overall tourism economy of Shanxi Province is not enough. This paper can provide some theoretical basis for the formulation of tourism economic development strategy in Shanxi Province. (2) The data used in previous works are generally selected from data in two or three years, with a large time span and the data are discontinuous and outdated. In this paper, the data from the latest five consecutive years are used to ensure the accuracy of the analysis results. (3) This paper finds out the impact of COVID-19 on the tourism economy which has never been encountered in previous works.

4. Empirical analysis

4.1. Total amount of tourism economic links

The data selected in this paper are from 2016 to 2020, spanning 5 years, which can scientifically and reasonably reflect the coordinated development of the tourism economy in Shanxi Province. According to the revised gravity model, the relation degree of tourism economy is measured, and the total amount of tourism economic relation in Shanxi Province from 2016 to 2020 is obtained.

4.2. Characteristics of the spatial structure of tourism economy network

Based on the data of tourism economic links in Shanxi Province, the spatial structure of the tourism economy network from 2016 to 2020 was

constructed by using Ucinet 6.0 software. Considering the scientificity, applicability, and comparability of the data, the average value is taken as the breakpoint value after several binarization experiments, and the value of tourism economic relations in Shanxi Province is transformed into a binary matrix.

Using the NetDraw, the drawing tool in Ucinet 6.0 software, to draw the figure of the spatial structure of the tourism economic network in Shanxi Province (Fig. 2), this paper makes analyses parts of the spatial structure density of the tourism economy network in Shanxi Province. Fig. 2 shows that from

2016 to 2020, the spatial structure of the tourism economic network in Shanxi Province shows the differences between the south, the north, and the central region. The networks in the south and the north are relatively sparse, while the network in the central region is relatively dense. As time goes by, the networks in the southern and northern regions gradually become dense. In 2016, four isolated islands of tourism economy were formed, namely Datong city, Shuozhou City, Yuncheng City, and Linfen City. By 2020, only two isolated islands of tourism economy were still left.

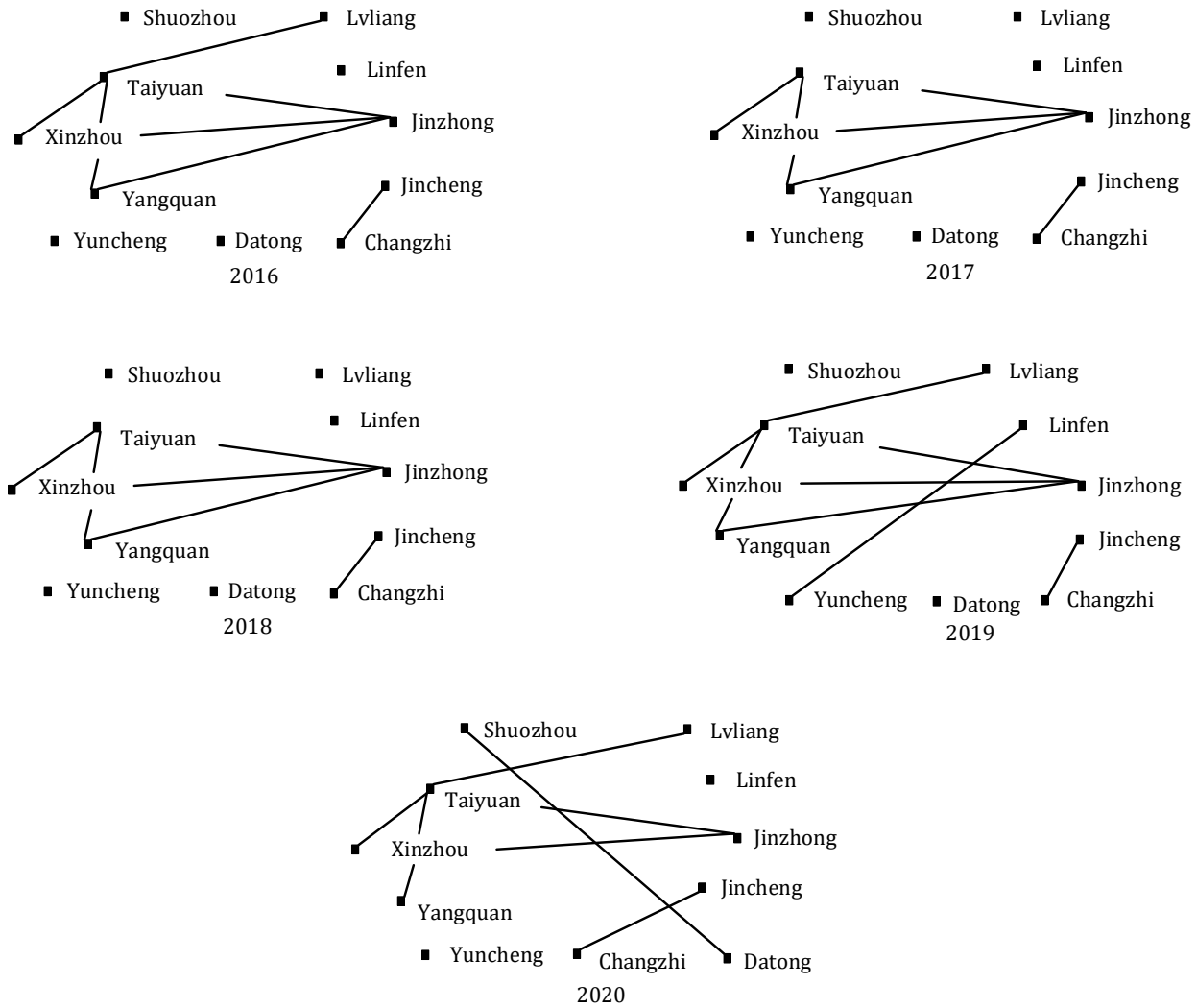


Fig. 2: Network spatial structure of tourism economic links in Shanxi Province (Years 2016-2020)

4.3. Analysis of core-periphery model

As shown in Tables 1 and 2, from 2016 to 2020, Taiyuan, Jinzhong, Yangquan, and Xinzhou had been in the core position. Datong, Changzhi, and Jincheng joined the core areas in 2017, which pulled down the density of tourism economic relations in the core areas to some extent, while the density of tourism economic connection in the peripheral areas also decreased to 0. In 2019, these three cities fell out of the core areas, and the density of tourism economic connection between the core areas and the edge areas rebounded, which indicates that the tourism

economic development power of these three cities needs to be strengthened. Because of the remote geographical location, inconvenient transportation, late start of tourism development, and other reasons, the development of the urban tourism economy in marginal areas is slow, and the tourism economic connection is weak, which is far lower than the density of tourism economic connection in core areas. Due to the impact of the epidemic, the density of tourism economic relations in the core areas decreased in 2020 to a certain extent.

Table 1: Core and edge areas of tourism economic connection network in Shanxi Province (Years 2016-2020)

Year	Core	Edge
2016	Taiyuan, Jinzhong, Yangquan, Xinzhou	Datong, Changzhi, Jincheng, Shuozhou, Lvliang, Linfen, Yuncheng
2017	Taiyuan, Datong, Yangquan, Changzhi, Jincheng, Xinzhou, Jinzhong	Shuozhou, Lvliang, Linfen, Yuncheng
2018	Taiyuan, Datong, Yangquan, Changzhi, Jincheng, Xinzhou, Jinzhong	Shuozhou, Lvliang, Linfen, Yuncheng
2019	Taiyuan, Jinzhong, Yangquan, Xinzhou	Datong, Changzhi, Jincheng, Shuozhou, Lvliang, Linfen, Yuncheng
2020	Taiyuan, Jinzhong, Yangquan, Xinzhou	Datong, Changzhi, Jincheng, Shuozhou, Lvliang, Linfen, Yuncheng

On the whole, the driving ability of the cities in the core areas is still insufficient for the tourism economy of the cities in the edge areas, and there is a serious core-periphery structure in the tourism economy network. It shows that further strengthening the construction of tourist cities in the core areas is important. At the same time, it is also necessary for the cities in the core areas to pay attention to the radiation and its driving effect on the tourism economy in the peripheral areas. The cities in edge areas should also change the concept of tourism economic development, change from passivity into the initiative, and actively integrate into the tourism economic construction of the core cities. Meanwhile, these cities can strengthen the tourism economic cooperation among them, and finally achieve the goal of optimizing the spatial structure of the tourism economy in Shanxi Province and promoting the interconnected development of the regional tourism economy.

Table 2: Density of core-edge areas of tourism economic connection network in Shanxi Province (Years 2016-2020)

Year	Core zone density	Marginal zone density
2016	0.833	0.036
2017	0.262	0
2018	0.286	0
2019	0.833	0.036
2020	0.667	0.036

5. Conclusion

Based on the social network analysis, taking Shanxi Province as the regional perspective, this paper studies the spatial structure of the tourism economy network in 11 prefecture-level cities of Shanxi Province from 2016 to 2020 from the perspectives of the degree of tourism economic relation, the density of the network's spatial structure and core-edge. The conclusions are as follows:

1. The tourism economy of 11 prefecture-level cities in Shanxi Province become increasingly closely connected, with a significant increase in the total amount of vertical and horizontal connections. Taiyuan city ranks first in the total amount of relations, and Jinzhong city ranks second. The connections among other cities are relatively less and these cities rank behind. The spatial distribution characteristic of tourism economic relation in Shanxi Province is "strong in the middle, weak in the north and the south", and the spatial development trend of tourism economic connection is unbalanced.
2. In Shanxi Province, the density of the tourism economic network shows an increasing trend.

Taiyuan always takes the first place, and there is a relatively obvious gap in other cities. The development of the cities in the core areas is closely connected, and the driving capacity is still insufficient for the tourism economy of the cities in the marginal areas, the connection among cities in the marginal areas is little, and the overall development is unbalanced. It shows an obvious characteristic that the central areas are the core and the southern and northern areas are the edges. The tourist cities are relatively scattered and the development is relatively isolated.

3. Regional tourism economic correlation is strongly dependent on tourism resource endowment and transportation accessibility. The central region ranks first in the regional economic relation with abundant tourism resources, and Taiyuan City, with relative transportation advantages, is in the first place in the connection of regional economy.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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