

# A Comparative Analysis of the Characteristics of High-Speed Railway Network in China's Metropolitan Areas

Qingmu Su<sup>1\*</sup> & Hsueh-Sheng Chang<sup>1</sup>

<sup>1</sup> National Chengkung University, Department of Urban Planning, Tainan, Taiwan

\* Qingmu Su, E-mail: 865921044@qq.com

Received: October 8, 2017 Accepted: October 28, 2017 Online Published: November 2, 2017

doi:10.22158/wjssr.v4n4p318

URL: <http://dx.doi.org/10.22158/wjssr.v4n4p318>

## **Abstract**

*The role of high-speed rail network in the metropolitan areas is becoming more and more important, which has become one of the main ways of the city personnel contacts. This paper mainly uses the social network analysis method to revamp the six national metropolitan areas: metropolitan area of the middle reaches of the Yangtze River, metropolitan area of Hachang, metropolitan area of Chengyu, metropolitan area of Yangtze River Delta, metropolitan area of Zhongyuan, metropolitan area of Beibu Gulf make a comparative analysis. The macroscopic and microscopic angles are used to calculate and compare the overall network characteristics, centrality, core-periphery structure and cohesion subgroups. It is mainly due to the fact that the high-speed rail network structure of the six major metropolitan areas needs to be improved. Metropolitan area of the middle reaches of the Yangtze River and metropolitan area of Zhongyuan are relatively good the integrity and the connectivity. Metropolitan area of Yangtze River Delta is the highest utilization rate of resources. Metropolitan area of Hachang is the highest network density. Metropolitan area of Chengyu is outstanding between core and periphery. Metropolitan area of Beibu Gulf network of organizations is broken. Therefore, when layout of high-speed rail infrastructure, we should consider the high-speed rail network resource utilization, balance high-speed rail traffic within the metropolitan areas, thus enhancing the city's high-speed rail accessibility and convenience.*

## **Keywords**

*Spatial Characteristics of High-speed Railways, analysis of social network, metropolitan areas, comparative analysis*

## **1. Introduction**

With the intensive construction of high-speed railways and railway stations in mainland China, high-speed railways have quickly become important modes of transportation between major cities in mainland China. Especially in the formation of metropolitan areas, high-speed rail play an irreplaceable role. The metropolitan areas have become the main force of regional development and the main place

of regional comprehensive strength and comprehensive competitiveness at home and abroad. Then the “National New Urbanization Plan (2014-2020)” is required to restart in 2017 Compile 12 metropolitan areas’ development plan. As of the end of March 2017, mainland China has formed the metropolitan area of Yangtze River Delta, metropolitan area of the Pearl River Delta, metropolitan area of Beijing-Tianjin-Hebei, metropolitan area of Zhongyuan, metropolitan area of the middle reaches of the Yangtze River, metropolitan area of Chengyu, metropolitan area of Hachang, metropolitan area of Liaozhongnan, metropolitan area of Shandong Peninsula, metropolitan area of West coast of the strait, Metropolitan area of Beibu Gulf, Metropolitan area of Guanzhong a total of 12 state-level Metropolitan areas, and the State Council has approved a total of six state-level Metropolitan areas, namely: metropolitan area of the middle reaches of the Yangtze River, metropolitan area of Hachang, metropolitan area of Chengyu, metropolitan area of Yangtze River Delta, metropolitan area of Zhongyuan, metropolitan area of Beibu Gulf. We can see that the metropolitan area has become the strategic focus of local and national conditions. The competition between regions is no longer limited to the competition between cities and cities, instead, the formation of the central city as the representative and other cities the common division of labor and cooperation between the metropolitan areas of mutual attraction and exclusion. In order to promote the development of metropolitan area, and better play high-speed rail fast, convenient, large transport characteristics, it is necessary to study the structural characteristics of high-speed rail network of metropolitan areas. Friedmann and Miller (1965) first began to study the metropolitan areas of network and the main research direction is the relationship between urban and urban hierarchy networks. At present, the research on the spatial structure of metropolitan area mainly focuses on four aspects: First, Zhu (2006) and Bai (2014) study the mechanism and the causes of the metropolitan area; second, explored the structural characteristics of metropolitan areas from a city’s properties, such as Nie et al. (2017) explored the agglomeration economic structure of the metropolitan area from the attributes of logistics. Yu et al. (2014) explored the spatial development pattern of metropolitan area from the characteristics of urban tourism; third, Han et al. (2010) explored the spatial pattern of metropolitan area from spatial structure optimization. Fourth, Wang and Wu (2013) explored the relationship between metropolitan areas from spatial structure measure. In the aspect of high-speed rail, Vickerman (1995), Levinson (2012) and Kim (2000) have studied the influence of the reachability of high-speed rail in Europe and South Korea on regional spatial structure. Jiang et al. (2010) studied the impact and change of the reachability of metropolitan areas from the specific line; FANG Da-chun and SUN Ming-yue (2015) Using the social network analysis method from the perspective of network density, centrality and cohesion subgroup, analyzed the spatial structure characteristics of metropolitan areas in the Yangtze River Delta from the high-iron age. It can be seen that the metropolitan area research is still at the theoretical stage both theoretical and empirical, mainly focused on the specific impact of spatial structure, rarely from the network point of view to explore, so the network of metropolitan areas have further in-depth to study. And from the

perspective of high-speed rail to analyze the metropolitan area is very few, and most of the high-iron research focused on the relationship within the city group or from a single specific line to explore, and the comparison between metropolitan area is picky.

Therefore, the social network analysis has a wide range of prospects in the study between metropolitan areas. However, the current urban planning mainly research from the direction of spatial, and less from the perspective of social networks. Urban space design can cause human activities to make more meaningful human environment and the natural environment in order to improve the quality of human space environment, thus changing the quality of human life, but to reveal the interconnection between the space is empty. The social network analysis, it is based on things and things between the integrity, differences, the degree of analysis, so it is a favourable complement to the spatial analysis. This paper analyses the spatial characteristics of the metropolitan area in the mainland by the spatial structure of high-speed rail, and can compare the differences among metropolitan areas, and try to describe the characteristics of the existing urban high-speed rail network in mainland China from different aspects, and provide valuable reference for the future construction of high-speed rail and the operation of metropolitan area.

## **2. Research Objects and Methods**

### *2.1 Research Objects*

Metropolitan area, as a gathering place of population, capital and technology, has become a universal form of the spatial form of human social and economic development. In this paper, the State Council approved six national metropolitan areas as the object of this study (metropolitan area of the middle reaches of the Yangtze River, metropolitan area of Hachang, metropolitan area of Chengyu, metropolitan area of Yangtze River Delta, metropolitan area of Zhongyuan, metropolitan area of Beibu Gulf), and to high-speed rail data as their analysis of the bridge. The population of the six metropolitan areas accounts for 53% of the total population and the proportion of GDP accounts for 49%. Therefore, the six major metropolitan areas are highly representative. The development and distribution of the six major national metropolitan areas is shown in Figure 1 and Table 1.

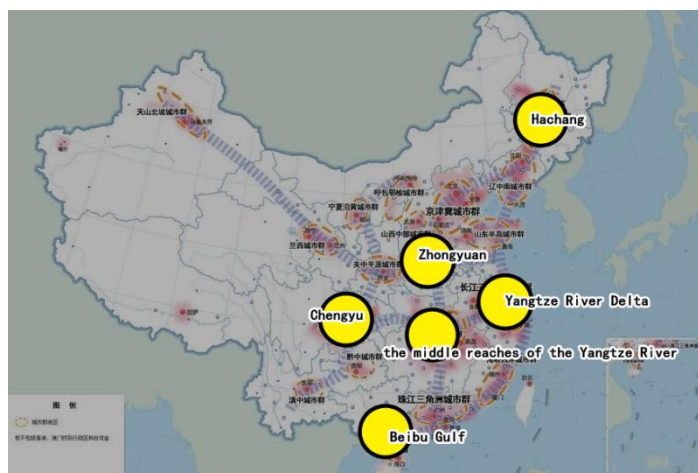


Figure 1. Distribution of the Six Major National Metropolitan Areas

Table 1. Overview of the Development of Six Major National Metropolitan Areas

<i>metropolitan area</i>	<i>City list</i>	<i>Population/billion people</i>	<i>Area/million square kilometers</i>	<i>main city</i>	<i>GDP/trillion</i>	<i>proportion of GDP</i>
The middle reaches of the Yangtze River	Wuhan, Huangzhou, Huanggang, Xiaoning, Xianning, Xiantao, Tianjiang, Xiangyang, Yichang, Jingzhou, Jingmen, Changsha, Zhuzhou, Xiangtan, Yueyang, Yiyang, Changde, Hengyang, Loudi, Nanchang, Jiujiang, Jingdezhen, Yingtan, Xinyu, Yichun, Pingxiang, Shangrao, Fuzhou, Ji'an	2.4	31.7	Wuhan, Changsha, Nanchang, Hefei	4.5	7.08
Hachang	Harbin, Daqing, Qiqihar, Suihua, Mudanjiang, Changchun, Jilin, Siping, Liaoyuan, Matsubara, Yanbian	0.39	26.4	Harbin, Changchun	2.16	3.40
Chengyu	Chengdu, Chongqing, Zigong, Luzhou, Deyang, Mianyang, Suining, Neijiang, Leshan, Nanchong, Meishan, Yibin, Guang'an, Dazhou, Yaan, Ziyang	0.91	18.5	Chongqing, Chengdu	4.76	7.48
Yangtze River Delta	Shanghai, Nanjing, Wuxi, Changzhou, Suzhou, Nantong,	1.5	21.17	Shanghai, Nanjing,	12.67	19.92

	Yancheng, Zhenjiang, Taizhou, Hangzhou, Ningbo, Jiaxing, Huzhou, Shaoxing, Jinhua, Zhoushan, Taizhou, Hefei, Wuhu, Maanshan, Tongling, Anqing, Chuzhou, Xuancheng				Hangzhou, Hefei, Suzhou		
Zhongyuan	Ziyuan, Jincheng, Yuncheng, Liaocheng, Heze, Suzhou, Huaibei, Zhaoyuan, Luoyang, Luoyang, Sanmenxia, Jiyuan, Changzhi, Jincheng, Yuncheng, Liaocheng, Heze, Fuyang, Bengbu, Bozhou, Xingtai, Handan	1.58	28.7		Zhengzhou, Luoyang	5.56	8.74
Beibu Gulf	Nanning, Beihai, Qinzhou, Fangchenggang, Yulin, Chongzuo, Zhanjiang, Maoming, Yangjiang, Haikou, Danzhou, East, Chengmai, Lin Gao, Changjiang	0.44	11.66		Nanning, Zhanjiang, Haikou	1.62	2.55

*Source:* Encyclopedia of Baidu.

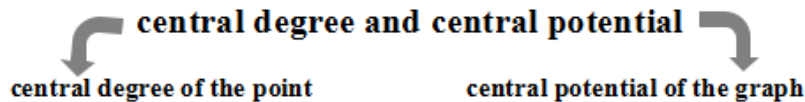
## 2.2 Research Methods

Social network analysis is a method to study the structural relationship between social networks, and to study the actors and actors, actors and the Internet and the network and the interaction between the network and the overall structure by the use of graph theory and mathematical model. The theory of the network regards the “relationship” as an analytical unit, and regards the structure as a model of the relationship between the actors, where the structure can be either a structure of action, a political structure, a social structure, and an economic structure (Stanley Wasserman, 1994). The social network method provides a visual analysis tool for studying the network structure of the metropolitan area, and scientifically quantitatively analyzes the network structure relationship of the metropolitan area. This paper mainly investigates the differences between the central and the equivalence of different nodes in the metropolitan area of Chinese mainland based on high-iron space, the consistency of the whole network and the regional pattern of regional cities through the Overall Density Analysis, Centrality, Core/Periphery Structures and Subgroup Cohesion.

(1) Overall density analysis. The network density reflects an indicator of the degree of closeness

between individuals in the network. The metropolitan area of cities is defined as the ratio of the number of connection relationships between cities that are actually owned and the maximum number of theoretical relationships that may be owned. The greater the network density, the closer the relationship between the network nodes.

(2) Centrality analysis. Network centrality measures the degree to which nodes are centralized throughout the network. Network Centrality can be divided into central degree and central potential.



The central degree measures the index of the center of power of the individual in the whole network, including the central degree of degree, the central degree of betweenness and the central degree of closeness. The central degree of degree is the number of other points directly connected to this point. Measure the fulcrum of their own trading capacity, did not take into account the ability to control other fulcrum. The central degree of betweenness measures the extent to which the fulcrum controls the degree of resources. That is to say, the extent to which a point is the intermediary of the other members of the network, and thus a control capability index. The central degree of closeness refers to the more the point is closer to the other, the easier it is to convey the information, considering how much the actor is not being controlled by the other actors.

The central potential measures how much of a map is built around one or some special points. That is to say that the points of the different center of the standardization, and finally get the figure in the overall center of the target. The measurement is the overall network integration or consistency. Central potential of the indicators are generally divided into the central potential of degree, the central potential of betweenness and the central potential of closeness.

(3) Subgroup cohesion analysis. Subgroup cohesion refer to the fact that some nodes in the network are so closely related that they are combined into a subgroup. Subgroup cohesions can be obtained to analysis of small groups in the network phenomenon of seriousness from the reciprocity of relationships, the proximity or accessibility among subgroups, the frequency of relationships among subgroups, the relationship between the density of internal members of subgroups contrast to and the relationship between internal and external members Density and so on, and then look at the overall development of the network as a whole. There may be a whole very loose, but the core of small groups are very high cohesion.

(4) Core-peripheral structure analysis. Core-Peripheral structure refers to the whole network in which the city is at the core position, which cities are marginalized. With a quantitative way to scientifically determine which cities are in a more important position, which nodes are in a relatively minor position.

### 3. Construction of High-Speed Railway Network in Metropolitan Area

#### 3.1 Node Selection

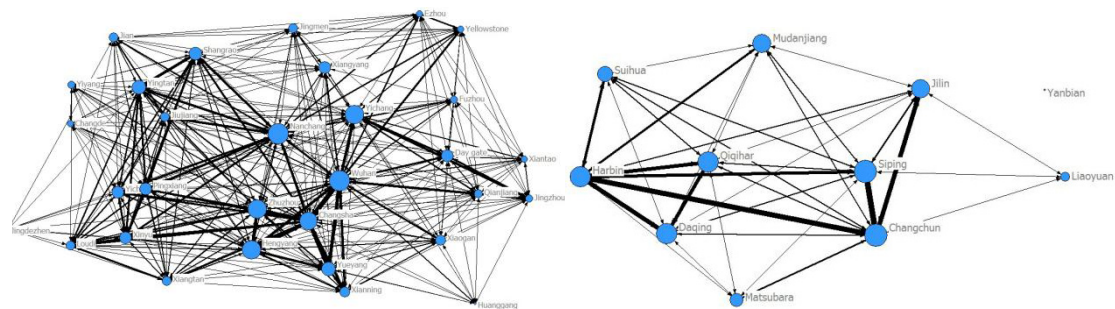
The choice of nodes is based on the prefecture-level administrative units in the metropolitan area. The nodes do not indicate the size of the administrative units, but only the stations where the trains arrive. The size of the nodes indicates the relative importance of the nodes in the metropolitan areas. The larger the node, the more cities that connect the city to the metropolitan area.

#### 3.2 Edge and Edge Rights

This article based on the 12306 railway website query results. If the two nodes in the train, we say that the existence of the two nodes edge. The determination of the edge rights to the basis of the number of trains per day as a basis. The more rough, the more the number of trips. While considering the train is round-trip, so the train came out with the train is not equal.

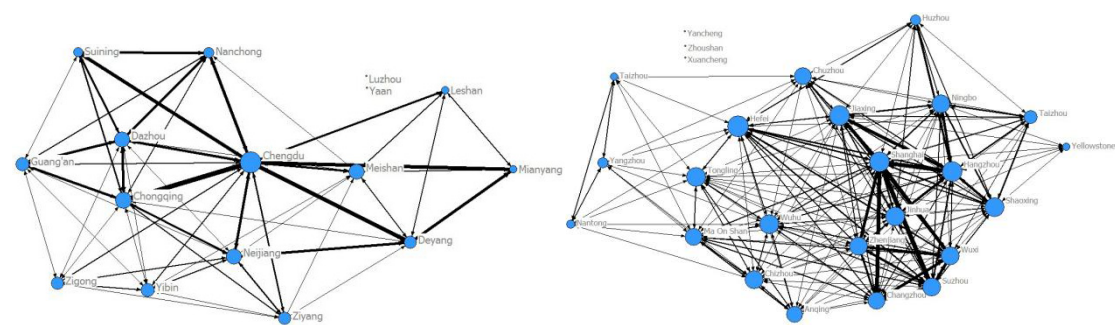
#### 3.3 Urban Agglomeration Network Structure

This paper uses UCINET.6 to construct the social network structure of six national metropolitan areas. The data are from 12306 website (August 20, 2017-August 14, 2017). The weight value is the average of the number of passes within 25 days (number of passes including GC-high-speed rail/intercity, D-car, Z-direct, T-Express, K-Express train). And it analyzes the degree of high-speed rail travel between cities within the metropolitan area. Figure 1 for the six major metropolitan areas of high-speed rail network model.



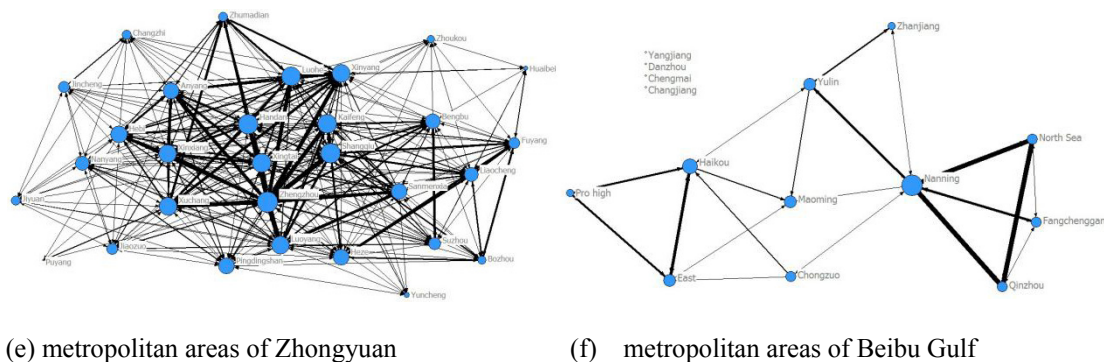
(a) the middle reaches of the Yangtze River

(b) metropolitan areas of Hachang



(c) metropolitan areas of Chengyu

(d) metropolitan areas of Yangtze River Delta



**Figure 2. The six major metropolitan areas of high-speed rail network mode**

**4. A Comparative Analysis of High-Speed Railway Network**

*4.1 The Overall Characteristics of Comparative Analysis*

According to the results of Table 2 and the high-speed network model of the six major metropolitan areas constructed in Figure 2, the overall characteristics of the major metropolitan areas can be clearly demonstrated. From the high-speed network model, we can be initially seen that the metropolitan area of the middle reaches of the Yangtze River, the metropolitan area of Yangtze River Delta, metropolitan area of Zhongyuan have complex network intertwined, and have more intensive in the network visual structure. However, metropolitan area of Hachang, metropolitan area of Chengyu, metropolitan area of Beibu Gulf is relatively sparse, the network visual structure is relatively simple. This can also be further analyzed from the specific data of the number of nodes, the average degree, the average path length, the network density, and the average point weight.

**Table 2. Network Structure Eigen Values of the Six Major Metropolitan Areas**

index	the middle reaches of the Yangtze River	Hachang	Chengyu	Yangtze River Delta	Zhongyuan	Beibu Gulf
Number of nodes	31	11	16	27	30	15
Average degree	18.61	6.36	6.43	13.12	17.33	2.2
Average path length	1.38	1.22	1.43	1.34	1.4	2.08
Network density	0.62	0.64	0.43	0.53	0.60	0.16
Average point strength	307	124	80	328	219	21

From the number of nodes, the number of nodes were 31, 27, 30 respectively in the metropolitan area, the metropolitan area of the Yangtze River Delta and the metropolitan area of Zhongyuan, the



metropolitan area of the middle reaches of the Yangtze River, about 2 times or more of the other three metropolitan areas. The more the number of nodes will inevitably lead to increased contact between them, the network will show more complex. But only the number of nodes cannot see the network connection is good or bad. The average and the average point of right power is a good indicator. The average number of each node is connected to other nodes of the line, the more lines, the higher the accessibility of the travel network. The average point of strength is the average daily number of cars issued by each city. In metropolitan area of the middle reaches of the Yangtze River travel network, with the highest average, the average city can be directly by train to reach 18.61 cities in the metropolitan area, and the average point of strength is also higher, ranked second, that is to say, each city's high-speed rail station is sent daily to other cities in the metropolitan area to reach 307 trains. Followed by the metropolitan area of Zhongyuan, although the average number of metropolitan area is similar to the middle reaches of the Yangtze River, shifts a day is fewer. While the metropolitan area of Yangtze River Delta, although the average is only 13.12, it has the highest average point strength, we can see the metropolitan area of urban high-speed rail frequent, urban network is more active. metropolitan area of Hachang and metropolitan area of Chengyu is relatively general, to be further improved. Finally, metropolitan area of Beibu Gulf with other cities there is a big gap, and between the metropolitan area in each city only with 2.2 cities connected to each city issued the number of trains only 21 shifts. From the average shortest path, the average shortest path of the six metropolitan areas did not exceed 2, except the metropolitan area of Beibu Gulf. The average shortest path of the high-speed rail network is the smallest, which is 1.22, while the average shortest path of the other metropolitan area is between 1.34 and 1.43. It can be seen that the six metropolitan areas can reach the other cities in two cities, The network presents the characteristics of a small world. Six metropolitan area of the network density is not high, indicating that the network is not intensive, network connectivity and integrity to be improved (When the network density is 0, it means that each city in the city group does not intersect and the network density is 1, then the network has the highest degree of connectivity). Metropolitan area of Hachang of the network density is the most prominent, which is 0.64. While the metropolitan area of Beibu Gulf of network density is only 0.16, is still in the initial level of construction.

In general, the network structure of metropolitan area of the middle reaches of the Yangtze River and metropolitan area of Zhongyuan is the most reasonable. The metropolitan area of Yangtze River Delta is the most frequent network communication. Metropolitan area of Hachang has the highest network density, but other performance in general, that the transaction costs and expenses of the high-speed rail travel will affect the efficiency of resource use. The most bad of network is the metropolitan area of Beibu Gulf, there is still a long way to go in high-speed rail network construction.

#### 4.2 The Network Centrality of Comparative Analysis

The comparative analysis of the overall characteristics of the metropolitan area mainly discusses the characteristics of the whole network from the macroscopic point of view, and the centrally comparative analysis of the metropolitan area is to explore the structural characteristics of the network from the microscopic point of view. As the high-speed rail is a two-way, so the centrality points of out degree and in degree separate the statistics, the purpose is to determine the high-iron network absorption and exclusion benefits. The size of the network centrality can not only reflect the concentration of resources, but also reflect the uneven distribution of resources. The greater the centrality, the more high-iron network focused on several large cities. Table 3 is a comparative analysis of the centrality structure of the six metropolitan areas.

**Table 3. A comparative Analysis of the Centrality Structure of the Six Metropolitan Areas**

Centrality		the middle reaches of the Yangtze River	Hachang	Chengyu	Yangtze River Delta	Zhongyuan	Beibu Gulf
central potential degree (%)	Out of degree	15.62	22.84	29.22	17.8	27.84	16.5
central potential closeness (%)	In degree	16.28	22.69	29.1	17.15	29.04	10.37
central potential betweenness (%)	Out of degree	36.63	40.11	60.3	40.34	35.26	69.17
	In degree	36.63	40.11	60.3	40.34	35.26	49.63
	of3.3		5.36	16.15	4.15	5.28	25.69

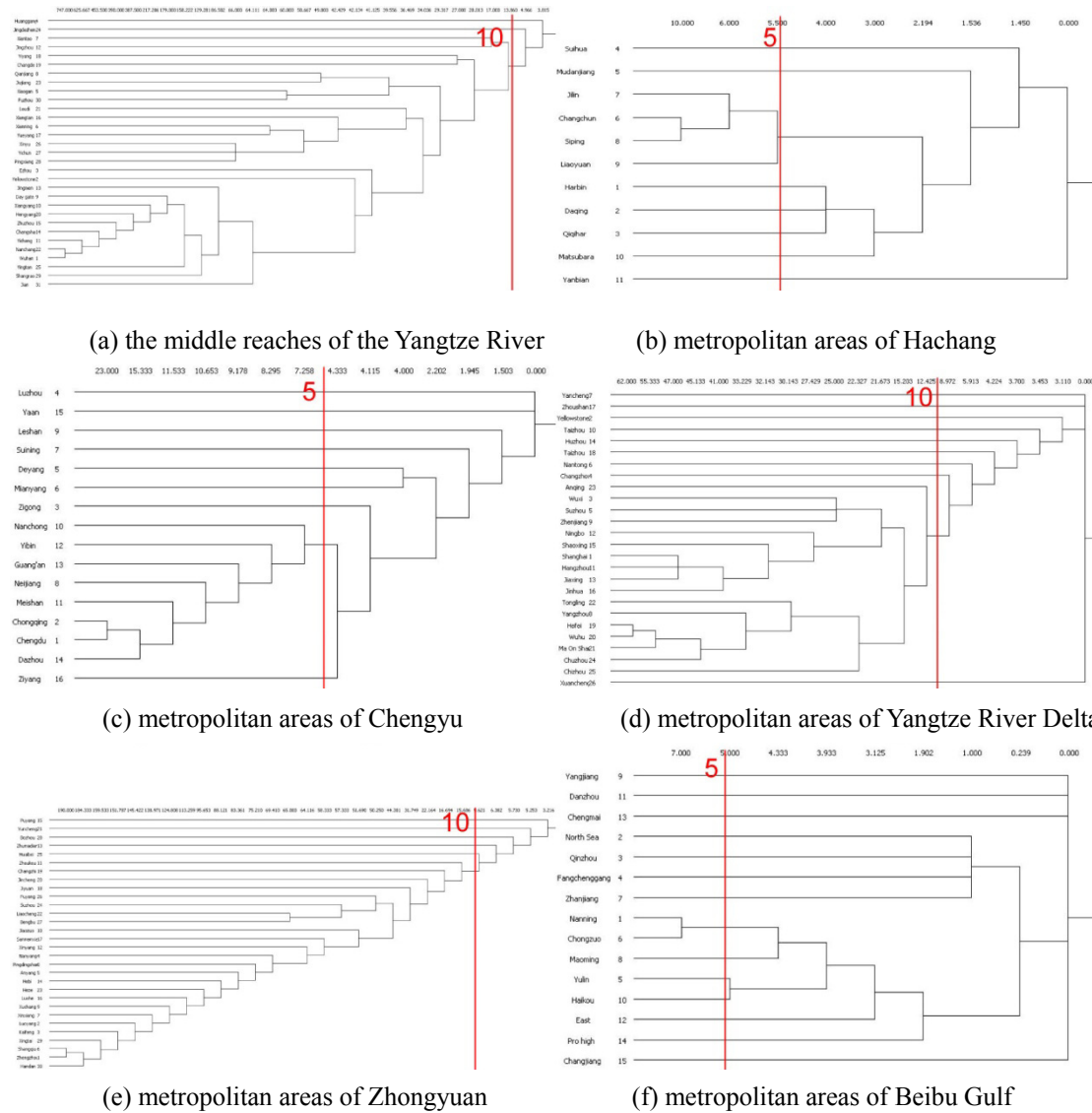
From the central potential of degree point of view, the six metropolitan areas in the central potential of degree are below 30%, are under the level of partial. The metropolitan area of the middle reaches of the Yangtze River, the metropolitan area of Yangtze River Delta and the metropolitan area of Beibu Gulf are all about 15%, indicating that the resources of the high-speed rail station are evenly distributed, and the route arrangement makes the cities within the city group have good accessibility. Out degree is greater than the in degree the potential in the metropolitan area of Hachang, metropolitan area of Chengyu, the metropolitan area of Yangtze River Delta, metropolitan area of Beibu Gulf, Indicating that these metropolitan areas have shrunk, or the phenomenon of resource flight, or metropolitan area to the surrounding expansion. The out degree is less than the in degree the potential in the metropolitan area of The middle reaches of the Yangtze River, metropolitan area of Zhongyuan. Indicating that the high-speed rail will be the introduction of external resources to promote the local economy to further

enhance. From the central potential point of closeness of view, central potential of closeness reflects the metropolitan area within the overall accessibility of the degree. As the high-speed rail lines are in and out of the same track to carry out, so out degree and in degree of central potential points of closeness is the same. The higher of central potential of closeness is the metropolitan area of Chengyu and metropolitan area of Beibu Gulf, which is 60.3% and 69%. Indicating that there are several more concentrated nodes in the distribution of resources. The core nodes are highly accessible but weaken the other cities of accessibility. The central potential of closeness score of metropolitan area of the middle of Yangtze River Delta, metropolitan area of Yangtze River Delta, metropolitan area of Hachang, metropolitan area of Zhongyuan is about 40%, the density is not very high, the core city resources are not too concentrated, the whole network access is more balanced. From the central potential of betweenness point of view, mainly reflects the core cities of the control of resources. The central potential of betweenness of the six metropolitan areas is very low, in addition to metropolitan area Chengyu and metropolitan area of Beibu Gulf about 20%, the other in the 5% up and down. It can be seen that metropolitan area within the two cities can be almost between the direct travel, and the role of “intermediary” in other cities in the metropolitan area is not obvious, and the high-speed rail network is closely linked.

In general, the centrality of the six major metropolitan area is not very obvious, high-speed rail site resources distribution is more uniform, but there are also individual city center prominent phenomenon. In the distribution of high-speed rail resources, metropolitan area of Chengyu and metropolitan area of Beibu Gulf need to control the excessive concentration of resources, to strengthen the protection of important sites. High-speed rail network is more balanced in the metropolitan area of the middle of the Yangtze River, metropolitan area of Hachang, metropolitan area of the Yangtze River Delta, metropolitan area of Zhongyu. It is necessary to improve the efficiency of resources to prevent excessive balance caused by resources.

#### *4.3 Subgroup Cohesion and Core-Peripheral of Comparative Analysis*

Using the K-plex algorithm, when the Minimum size and K values are 3 and 2, the urban aggregates based on the high-iron space are shown in Figure 3. Better of network connectivity is metropolitan area of Zhongyuan, metropolitan area of the Yangtze River and metropolitan area of the Yangtze River Delta, when the network connection strength to  $\geq 10$ , most cities are still in this period, indicating that the network connectivity is high. Especially in the metropolitan area of Zhongyuan, 31 cities have 4 less than 10 network connection strength, the entire network of high-speed rail distribution is the most balanced, the whole network accessibility is better. And metropolitan area of Chengyu, metropolitan area of Hachang, metropolitan area of Beibu Gulf, when the network connection strength of 5, there are more cohesive subgroups. Especially in the metropolitan area of Beibu Gulf, when the network connection strength is 1, still divided into several cohesive subgroups, but the cluster subgroups are mostly single city, the whole network is more dispersed, the overall network connectivity is blocked.



**Figure 3. High-Speed Rail Network K-Plex Cohesion Subgroup**

From the core-peripheral structure point of view (Table 4), correlation is greater than 50%, indicating that the core cities in the high-speed rail network plays a more important role. Metropolitan area of the middle reaches of the Yangtze River, metropolitan area of Chengyu, metropolitan area of Zhongyuan of the core cities are more, the relative proportion of the core city and the edge of the city is small. The core area and the edge of the joint density is not high, which also reflects the high-speed rail network in the city group is more balanced. However, the correlation between the metropolitan area of Hachang, metropolitan area of of the Yangtze River Delta and metropolitan area of the Beibu Gulf is more than 70%. The core cities are less important, which highlights the importance of the core cities in the metropolitan area. High-speed rail site resources are relatively concentrated, then the overall network will be more like a pyramid-type structure.

**Table 4. Core-Peripheral Structure Statistics Table**

index	the middle reaches of the Hachang Yangtze River	Chengyu	Yangtze River Delta	Zhongyuan	Beibu Gulf	
Correlation	0.6076	0.7065	0.5962	0.7304	0.6054	0.8076
Core	Wuhan, Zhuzhou, Yueyang, Loudi, Yingtan, Pingxiang, Shangrao	Changsha, Harbin, Xiangtan, Changchun, Hengyang, n, Siping, Nanchang,	Chengdu, Chongqing, Suining, Nanchong, Dazhou	Shanghai, Changzhou, Zhenjiang	Wuxi, Zhengzhou, Suzhou, Luoyang, Anyang, Sea, Qinzhou, Shangqiu, Xinxiang, Xuchang, Xinyang, Hebi, Luohe, Sanmenxia, Xingtai, Handan	Nanning, North
Periphery	Yellowstone, Huanggang, Xianning, Qianjiang, Xiangyang, Jingzhou, Yiyang, Jiujiang, Fuzhou, Ji'an	Ezhou, Daqing, Xiaoning, Qiqihar, Xiantao, Suihua, Tianmen, Mudanjiang, Yichang, g, Jilin, Neijiang, Jingmen, Liaoyuan, Changde, Matsubara, Meishan, Jingdezhen, Yanbian	Zigong, Luzhou, Deyang, Mianyang, Jilin, Neijiang, Leshan, Yibin, Guang'an, Ya'an, Ziyang	Huangshan, Hefei, Maanshan, Anqing, Chizhou, Xuancheng, Puyang, and so on.	Taizhou, Kaiqing, Nanyang, Fangchenggang, Wuhu, Pingdingshan, Yulin, Chongzuo, Tongling, Jiaozuo, Zhoukou, Zhanjiang, Chuzhou, Zhumadian, Maoming, Jiyuan, Yangjiang, Changzhi, Haikou, Jincheng, Danzhou, East, Yuncheng, Chengmai, Pro Liaocheng, Heze, high, Changjiang, Suzhou, Huaibei, Fuyang, Bengbu, Bozhou	

## 5. Conclusion

This paper introduces the social network analysis method, attempts to explore the spatial characteristics of metropolitan area from the high-speed network structure. The comparative analysis of the network structure of the six major metropolitan areas can clearly understand the real relationship between the metropolitan areas overall network. In general, the six major metropolitan areas of high-speed rail network structure are still in the middle and the initial level. The network structure of metropolitan area of the middle reaches of the Yangtze River and metropolitan area of Zhongyuan is the most reasonable, the network fragmentation is low, the high-iron resources are not too concentrated, too scattered, and the overall network accessibility is good. Metropolitan area of Yangtze River Delta of high-speed rail network is the most busy system, high-speed rail network resource utilization is higher, but in the

internal resource allocation on the core city of the surrounding control is obvious, which may cause the overall network blocked. Metropolitan area of Chengyu has a little network of broken organization, but the core city is over control resources. Although the core city can be rapid development, once the core city problems, the network structure will be greatly impeded. Metropolitan area of Hachang has the highest network density, but the overall network utilization is not high, through other channels to strengthen the link within the city group to improve the network level to expand. Metropolitan area of Beibu Gulf is a new Metropolitan area, the organization of the network broken, high-speed rail site construction backward, whether it is macro or micro-structure are poor performance, the overall network accessibility to be improved. In short, in the construction of high-speed rail not only need to consider the rationality of resource distribution, but also need to improve the high-speed rail network resource utilization, optimize and expand the coordination function of urban networks, improve the network structure, improve the accessibility and convenience of high-speed rail network between cities.

## References

- Chun, F. D., & Yue, S. M. (2015). The Reconstruction of the Spatial Structure of the Yangtze River Delta City Group in the High-speed Rail Era-Based on the Social Network Analysis. *Economic geography*, 35(10), 50-56.
- Friedmann, J., & Miller, J. (1965). Journal of the American Institute of Planners. *The urban field*, 33(4), 312-319.
- Gang, H. Y., Fu, J. H., & Feng, L. J. (2010). Research on Anhui Jianghuai Urban Agglomeration apation structure optimization according to the promotion the City-level. *Economic geography*, 30(7), 1101-1106.
- Haibing, J., Jiangang, X., & Yi, Q. (2010). The Influence of Beijing-Shanghai High-speed Railways on Land Accessibility of Regional Center Cities. *Acta Geographica Sinica*, 65(10), 1287-1298.
- Hu, Y., Tian, C., Lin, L., Kaiyong, W., & Dongfang, Z. (2014). Structure of tourist economy network and its spatial development pattern in Jianghuai Urban Agglomeration. *Progress in Geography*, 33(2), 169-180.
- Kim, K. S. (2000). High-speed Rrail Developments and Spatial Restructuring: A Case Study of the Capital Region in South Korea. *Cities*, 17(4), 251-262. [https://doi.org/10.1016/S0264-2751\(00\)00021-4](https://doi.org/10.1016/S0264-2751(00)00021-4)
- Levinson, D. M. (2012). Accessibility Impacts of High-speed Rail. *Journal of Transport Geography*, 22, 288-291. <https://doi.org/10.1016/j.jtrangeo.2012.01.029>
- Ming, Z. Y. (2006). A research on Spatial Industrial Structure and Industrial Regional Growth-Based on Urban Cluster of Yangtse River Delta. *Economic geography*, 26(3), 387-390.
- Nie, J. X., Huang, Y. P., & Chen, P. (2017). Research on Urban Network of Wuhan Metropolitan Area in China Based on Social Network Analysis. *International Journal of Culture and History*, 3(1), 1-5.

- Vickerman, R. W. (1995). The Regional Impacts of Trans—European Networks. *The Annals of Regional Science*, 29, 237-254. <https://doi.org/10.1007/BF01581809>
- Wasserman, S., & Faust, K. (1994). *Social Network Analysis*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511815478>
- Wei, W., & Zhi, Q. W. (2013). The Measure and Comparative Research on Spatial Structure's Integrated Efficiency of Yangtze River Delta, Pearl River Delta and Beijing-Tianjin-Hebei Urban Agglomeration in China. *Urban Development Studies*, 20(7), 63-71.
- Yong, L. B., & Yan, L. D. (2014). Study on Spatial Mechanism and Spatial Structure of Urban Agglomeration in the Middle Reaches of Yangtze River. *Macroeconomic research*, 11, 47-58.