

Analysis on the Spatial Characteristics of Comprehensive Innovation Competitiveness of the Yangtze River Economic Belt

Manlin Xu

School of Management Science and Engineering, Anhui University of Finance and Economics,
Bengbu 233000, China

Abstract

The Yangtze River Economic Belt and comprehensive innovation competitiveness are important strategic development regions and important driving forces of China's economic development. Once combined efficiently, they are the core forces to promote the high-quality development of China's economy. Based on the measurement data of innovation competitiveness of 11 provinces and cities in the Yangtze River Economic Belt, this paper constructs a comprehensive innovation competitiveness evaluation model by Factor Analysis, obtains the scores of provincial and municipal technological innovation capability factors and innovation sustainable development factors, and reveals the spatial correlation characteristics of regional innovation competitiveness in the Yangtze River Economic Belt by using global and local Moran's I. The research finds that: (1) with the implementation of the Yangtze River Economic Belt strategy, the upstream and downstream regions realize a new situation of "double radiation" of innovation; (2) Provinces with low comprehensive innovation competitiveness have considerable innovation and sustainable development ability and have a good development trend; (3) There has always been a spatial correlation between the comprehensive innovation competitiveness of provinces and cities, and the imbalance and disharmony of innovation competitiveness remain prominent in the past five years. Based on the research conclusions, put forward relevant policy suggestions.

Keywords

The Yangtze River Economic Belt; Comprehensive Innovation Competitiveness; Factor Analysis; Spatial Features.

1. Introduction

In the process of economic globalization, competition at home and abroad has become more intense, which has greatly challenged the traditional economic development model. Only innovation is the inexhaustible driving force to promote the prosperity of cities, nations and even countries. As a major national strategic development area in China, the Yangtze River Economic Belt is a major strategy related to the overall situation of national development. Natural and convenient resources and transportation, high-quality labor resources, considerable demand market and perfect innovation system have injected a lot of vitality into the regional innovation of the Yangtze River Economic Belt and greatly improved the innovation competitiveness. However, there are great differences in innovation background and innovation ability among provinces and cities in the Yangtze River Economic Belt. The economic development among provinces and cities is uneven. Administrative segmentation and market barriers hinder the circulation of innovation resources and innovation elements to a great extent. There are great differences in basic development conditions such as resources, environment and industry in the upstream, middle and downstream, and the allocation efficiency of elements between provinces and cities is low. These factors hinder the further improvement of the innovation competitiveness of the Yangtze River Economic Belt. Therefore,

exploring the level of comprehensive innovation competitiveness of provinces and cities in the Yangtze River Economic Belt and analyzing the spatial characteristics of innovation competitiveness are of great significance to balance the economic development among provinces and cities, promote the efficient allocation of innovation resources and innovation elements, narrow the gap of innovation ability and promote innovation cooperation among provinces and cities.

In the late 1990s, scholars and research institutions at home and abroad began to pay attention to urban competitiveness, and have achieved fruitful results so far. Landry explored the connotation of innovative cities and believed that cities should focus on input-output ratio or cost and profit management to think about how to take creative actions to protect future interests [1]. Urban competitiveness is an important indicator of innovative cities. To a certain extent, it is equivalent to economic performance. Because it is related to competition, innovative cities must seize the market first and make capital appreciate. In the large area of urban development, it has a strong ability to optimize the allocation of resources, absorb and use various methods and means to promote economic development, actively innovate, and finally show a more sustainable development ability and development trend [2]. The consideration of competitiveness can start from the national competitiveness at the macro level, the urban competitiveness at the meso level and the enterprise competitiveness at the micro level. The three interact and are inseparable. The core is the enterprise competitiveness, which directly affects the competitiveness of the whole city. The result of urban competitiveness is to make the city join the international trend, and stimulate the ability of the city to optimize the allocation of resources in its region from both internal and external aspects [3]. Jiang et al. compare the investment status of basic research between China and seven countries such as the United States and Japan in the past 20 years. It is found that there are some problems in China's basic research investment, such as low proportion, single source and unbalanced executive structure. China should adjust these problems to further enhance China's competitiveness [4]. Wang et al. based on the urban panel data, and studies the impact of technological innovation on the high-quality development of urban economy, and finds that although technological innovation has heterogeneity on the high-quality development of urban economy, they all have a certain promotion effect. Under the action of urban integration, the promotion effect between them has been improved to a certain extent [5]. Deng based on the micro perspective of enterprises, and explores the role of enterprise innovation culture in improving enterprise competitiveness, and finds that enterprise innovation culture plays a certain role in improving management system reform and technological capability innovation, and finally improves enterprise competitiveness [6]. In recent years, the academic research on urban competitiveness has been more detailed and in-depth both horizontally and vertically. Horizontally, the research based on macro perspectives such as country and urban agglomeration has been gradually enriched. Wang based on the international consumption center cities, it is analyzed that the urban competitiveness across the country has obvious spatial differentiation and gradient gap, and the eastern cities have more prominent international competitiveness in the consumption field than the central and western cities [7]. Huo investigated the economic radiation effect of Guangdong Hong Kong Macao Bay area on the surrounding cities [8]. Vertically, scholars dig out many detailed connotations of urban competitiveness, including urban cultural competitiveness, urban tourism competitiveness and urban innovation competitiveness [9-11]. In terms of research methods, most of the relevant research on the early urban competitiveness evaluation model is the expansion and extension of Porter's national competitiveness evaluation theory. With the increase of evaluation indicators and the complexity of the system, the main methods used at present include fuzzy consistency matrix, entropy weight TOPSIS method, principal component analysis, gem-anp model and AHP method [12]. In terms of the selection of the index system, most of the research

on urban competitiveness is from the comprehensive perspective of urban development, selecting the local economy, infrastructure, government policies, education and other aspects for comprehensive analysis[13].The index system of innovation competitiveness research is relatively messy and there is no unified standard. This paper selects three secondary indicators of innovation ability, innovation potential and innovation sustainable development, a total of 8 factors to build a comprehensive innovation competitiveness index system.

With the increasingly close relationship between provinces and cities, their innovation activities are not independent of each other. The communication of R&D elements determines the spatial relevance of sample data of provinces and cities. In terms of spatial feature analysis, it is mainly realized through global Moran's I. Based on the spatial statistical analysis method, Liu et al. revealed the dynamic changes and overall spatial distribution characteristics of China's tourism economic growth [14]. Liu et al. explored the spatial distribution characteristics of innovative enterprises at the provincial scale, and concluded that innovative enterprises show the characteristics of agglomeration distribution in space, and the spatial distribution of various types of enterprises is significantly different. In many studies, if different research variables or different research methods are selected, the conclusions are very different. In other words, the current China's sustained economic growth and urban comprehensive innovation competitiveness, the data of previous studies have changed over time, and the persuasiveness and applicability of the conclusion in the current situation need to be discussed.

Through the above review, it can be found that the research on the comprehensive innovation competitiveness of cities mainly focuses on the macro perspectives such as the state and urban agglomeration, and pays less attention to the provincial level under the urban agglomeration area. However, the comprehensive innovation competitiveness of provincial cities is not only an important embodiment of the comprehensive innovation competitiveness of enterprises at the micro level, but also an important hub to improve the comprehensive innovation competitiveness of countries at the macro level. Therefore, this paper will focus on the research based on the data of 11 provinces and cities in the Yangtze River Economic Belt, calculate their comprehensive innovation competitiveness with factor analysis method, select the timeliness index data, and use the global Moran's I and local Moran's I to reveal the spatial distribution of regional innovation competitiveness and the spatial agglomeration types of provinces and cities in the Yangtze River Economic Belt.

2. Definition and Research Data Source

The research scope of this paper is 11 provinces and cities in the Yangtze River Economic Belt, including Shanghai, Jiangsu Province, Zhejiang Province, Anhui Province, Jiangxi Province, Hubei Province, Hunan Province, Chongqing City, Sichuan Province, Yunnan Province and Guizhou Province. The data is mainly the measurement data of urban comprehensive innovation competitiveness, which comes from the statistical yearbooks of 11 provinces and cities, China Statistical Yearbook, China economic network database and EPS global statistical database. Considering the integrity and availability of the data, this paper selects the data with a time span of 5 years from 2014 to 2018 as the research object, and specifically selects the number of patents (items), the export volume of high-tech industry (part) (RMB 100 million), the regional GDP (RMB 100 million), R&D expenditure (RMB 100 million), the total amount of foreign investment (RMB 100 million), the number of mobile Internet users (10000), the number of colleges and universities and education funds (100 million yuan) are eight indicators that comprehensively reflect the innovation ability, innovation potential and innovation sustainable development ability of provinces and cities, and then characterize the comprehensive innovation competitiveness of provinces and cities, see Table 1.

Table 1. Index system of urban comprehensive innovation competitiveness

Primary index	Secondary index	Tertiary indicators
Innovation competitiveness	innovation ability	number of patents (items)X1
		the export volume of high-tech industry (part) (RMB 100 million)X2
	Innovation potential	the regional GDP (RMB 100 million)X3
		R&D expenditure (RMB 100 million)X4
		the total amount of foreign investment (RMB 100 million)X5
		the number of mobile Internet users (10000)X6
	Innovation and sustainable development	the number of colleges and universities X7
		education funds (100 million yuan)X8

3. Research Methods

3.1. Calculation of Urban Comprehensive Innovation Competitiveness

For the calculation of comprehensive innovation competitiveness among cities, the factor analysis method is selected to obtain the score and ranking of each main factor, and on this basis, the comprehensive score of each provincial and municipal factor is calculated and graded. The specific steps of factor analysis are as follows:

Step1: standardize the Z-value of the original 8 indicators of innovation competitiveness, and conduct kmo and Bartlett applicability test on the standardized indicators. If the kmo statistic is greater than 0.5 and the significance of Bartlett's sphericity test is less than 0.05, you can enter the next step of factor analysis, otherwise this method is not suitable for application;

Step 2: conduct factor analysis on the 8 standardized indexes that have passed the applicability test. The extraction method is the main component method. Based on the eigenvalue greater than 1, the rotation method is the maximum variance method;

Step 3: analyze the factor load matrix after rotation, which reflects the correlation between the original index and each extracted factor. According to the factor load matrix after rotation, analyze which indexes of each principal component factor have a large load rate, and name each principal factor analysis on this basis;

Step4: calculate the factor score of each main factor and calculate the comprehensive factor score of each city. The weight is the variance contribution rate after the rotation of the extracted factor. The calculation formula of the comprehensive factor score is shown in formula (1), where s is the comprehensive factor score of each city; $Y_1, Y_2, Y_3, \dots, Y_n$ are the scores of the extracted principal factors; $F_1, F_2, F_3, \dots, F_n$ are the variance contribution rate of each main factor after rotation.

$$S = \frac{F_1 Y_1 + F_2 Y_2 + F_3 Y_3 + \dots + F_n Y_n}{F_1 + F_2 + F_3 + \dots + F_n} \quad (1)$$

3.2. Spatial Correlation Analysis

Spatial correlation analysis is a method to measure spatial correlation based on sample data with spatial dependence. It mainly includes global spatial autocorrelation and local spatial autocorrelation, which respectively describe the spatial characteristics of the research samples in the "global" and the correlation of spatial elements in the "local". Based on factor analysis, this paper makes a global Moran's I test on the comprehensive score of innovation competitiveness of provinces and cities in the Yangtze River Economic Belt from 2014 to 2018 to determine whether the spatial distribution of innovation competitiveness of different

provinces and cities is similar (spatial positive correlation), different (spatial negative correlation) or independent of each other. The formula is:

$$I = \frac{N \sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\left(\sum_i \sum_j w_{ij} \right) \sum_i (x_i - \bar{x})^2} \quad (2)$$

Where N is the number of spatial units; x_i and x_j are the attributes of spatial units i and j, W_{ij} is the spatial weight. If the spatial unit i is adjacent to the spatial unit j, $W_{ij} = 1$, otherwise it is 0. Moran's I was statistically tested with P value and Z score.

Based on the global spatial autocorrelation test, further study the local spatial autocorrelation of the comprehensive innovation competitiveness of provinces and cities, to observe the spatial agglomeration types of spatial units and their adjacent regions. Based on this, observe the changes of the spatial correlation mode of the comprehensive innovation competitiveness in different periods. According to local Moran's I, the comprehensive innovation competitiveness of the Yangtze River Economic Belt can be divided into four agglomeration areas: radiation effect area (H-H type), transition area (L-H type), low-speed growth area (L-L type) and polarization effect area (H-L type). The change modes of spatial correlation mode of comprehensive innovation competitiveness mainly include four kinds: adjacent region transition, alternating region transition, region without transition but negatively correlated with surrounding regions, and region without transition but positively correlated with surrounding regions.

4. Calculation and Analysis of Comprehensive Innovation Competitiveness

4.1. Calculation of Comprehensive Innovation Competitiveness

This paper makes factor analysis on the eight indicators of the comprehensive innovation competitiveness of provinces and cities in the Yangtze River Economic Belt from 2014 to 2018. After calculating the main factor scores of provinces and cities, the comprehensive innovation competitiveness scores of provinces and cities are obtained. The following is an example of the calculation process in 2018. First, standardize each index, and then conduct applicability test. The results are shown in Table 2. The kmo statistic is 0.810, and the significance of Bartlett sphericity test is less than 0.05, which is very suitable for factor analysis.

Table 2. Applicability test results

KMO sampling suitability quantity		0.810
Bartlett sphericity test	Approximate chi square	107.583
	Freedom	28
	Significance	0.000

Then factor analysis was carried out on the eight standardized indicators. After processing, it can be seen from table 3 that two eigenvalues of the correlation coefficient matrix were greater than 1, which were 6.3 and 1.096 respectively. The cumulative variance contribution rate of the two principal components reached 92.457%. According to the principle of extracting principal components by principal component analysis, it means that the extracted two principal components cover 92.457% of the information in the original data, It can better replace the original eight indicators to analyze 11 cities in the Yangtze River Economic Belt. Then, the factor

load matrix after rotation is analyzed. After the maximum variance rotation, the weight of the first main factor is 78.752%, which has a large load rate in the indicators such as the number of patent authorizations (items), the export volume of high-tech industries (part), R&D expenditure (100 million yuan), and the total foreign investment (100 million yuan). It mainly explains the level of innovation input and output, so it is named technological innovation capability factor; The weight of the second main factor is 13.705%, which has a large load rate in the regional GDP (100 million yuan), the number of mobile Internet users (10000 households), the number of colleges and universities, education funds (100 million yuan) and other indicators. It mainly explains the regional economic level and the sustainable development force of technological innovation, so it is named the innovation sustainable development ability factor.

Table 3. Eigenvalue and variance contribution rate of each principal component

Component	Initial eigenvalue			Extract the sum of squares of loads			Sum of squares of rotating loads		
	Total	Variance %	Accumulate %	Total	Variance %	Accumulate %	Total	Variance %	Accumulate %
1	6.3	78.752	78.752	6.3	78.752	78.752	3.789	47.359	47.359
2	1.096	13.705	92.457	1.096	13.705	92.457	3.608	45.098	92.457
3	0.324	4.045	96.503						
4	0.155	1.94	98.443						
5	0.08	1.001	99.444						
6	0.023	0.285	99.729						
7	0.015	0.184	99.913						
8	0.007	0.087	100						

Extraction method: principal component analysis.

Finally, the factor score is calculated, including the factor score of the main factor and the comprehensive innovation competitiveness score. The comprehensive innovation competitiveness score shows that the ranking of 11 provinces and cities in the Yangtze River Economic Belt has basically not changed from 2014 to 2018. The ranking and score are as follows: the average score of comprehensive factors has increased year by year in the past five years, and Jiangsu, Shanghai and Zhejiang rank first, second and third respectively. The comprehensive innovation competitiveness is strong. The comprehensive score has been above the average score in the past five years, so it can be listed as the first grade; Chongqing and Sichuan rank fourth and fifth. In the past five years, the comprehensive score has increased from below the average score to above the average score, which can be listed as the second grade; The comprehensive scores of Hunan, Anhui, Jiangxi, Yunnan, Guizhou and Hubei have always been below the average score and are listed as the third grade.

In order to more intuitively see the scores of technological innovation ability factors and innovation sustainable development ability factors of 11 provinces and cities in the Yangtze River Economic Belt from 2014 to 2018, Tables 4 and 5 show the scores and rankings of these two factors in the past five years.

As can be seen from table 4 and 5, since the weight of technological innovation capability factor is as high as 90%, the ranking of comprehensive factor scores is basically the same as that of technological innovation capability factor scores, while the ranking of innovation sustainable development capability factor scores is very different. Especially since 2016, Anhui, Sichuan, Hubei, Hunan, Guizhou and other middle and upper reaches cities have ranked in the forefront of innovation sustainable development capability factor scores, With the implementation of the strategy of "integrated innovation in the upper reaches and lower reaches of the Yangtze River" in the past 11 years, the comprehensive competitiveness of the two cities of Jiangsu and

Shanghai has not only broken the situation of "integrated innovation in the upper reaches and lower reaches of the Yangtze River", but also emerged with the implementation of the strategy of "integrated innovation in the Yangtze River". Cities with high comprehensive innovation competitiveness have emerged in the upstream and downstream respectively, which has achieved a qualitative breakthrough in the driving role of "double radiation" of upstream and downstream innovation in the future. Moreover, from the factor score of innovative sustainable development ability, the cities in the middle and upper reaches are in the "thick accumulation" stage, and the innovative sustainable development ability has a trend to catch up with and surpass the cities in the lower reaches of the Yangtze River. With the implementation of the strategy, "thin hair" is just around the corner.

Table 4. 2014-2018 technological innovation capability factor score and ranking

Score Region	Factor score of technological innovation ability(S1)									
	2014	Ranking	2015	Ranking	2016	Ranking	2017	Ranking	2018	Ranking
Anhui	-0.62	9	-0.57	8	-0.54	8	-0.55	9	0.15	7
Shanghai	1.46	2	1.62	2	1.82	2	1.53	2	1.22	2
Jiangsu	2.19	1	2.08	1	2.25	1	2.18	1	1.51	1
Zhejiang	0.57	3	0.56	3	1.21	3	1.30	3	1.00	4
Jiangxi	-0.61	8	-0.59	9	-0.58	9	-0.68	10	-0.36	8
Hubei	-1.02	11	-1.00	11	-1.12	11	-1.17	11	-1.09	11
Hunan	-0.72	10	-0.70	10	-0.65	10	-0.43	8	0.29	6
Chongqing	-0.13	4	-0.12	4	0.12	4	0.10	4	0.41	5
Sichuang	-0.45	7	-0.50	7	-0.22	6	-0.12	5	1.09	3
Yunnan	-0.42	6	-0.45	6	-0.29	7	-0.36	7	-0.48	9
Guizhou	-0.25	5	-0.32	5	-0.17	5	-0.27	6	-0.74	10

Table 5. 2014-2018 innovation sustainable development capability factor score and ranking

Score Region	Factor score of innovation sustainable development ability(S2)									
	2014	Ranking	2015	Ranking	2016	Ranking	2017	Ranking	2018	Ranking
Anhui	0.35	7	0.32	7	0.43	6	0.41	5	-0.57	8
Shanghai	0.98	2	1.06	2	0.54	5	0.32	6	1.79	2
Jiangsu	1.25	1	1.36	1	0.81	3	0.91	2	1.92	1
Zhejiang	0.89	4	0.94	4	0.04	7	-0.15	8	0.64	3
Jiangxi	-0.26	8	-0.31	8	-0.20	8	-0.04	7	-0.56	7
Hubei	0.78	5	0.70	5	1.32	1	1.50	1	-0.04	4
Hunan	0.58	6	0.48	6	0.63	4	0.49	4	-0.56	6
Chongqing	-1.09	10	-1.05	10	-1.57	11	-1.68	11	-0.81	11
Sichuang	0.97	3	0.96	3	0.85	2	0.64	3	-0.66	10
Yunnan	-0.69	9	-0.68	19	-0.92	9	-0.82	9	-0.63	9
Guizhou	-1.22	11	-1.10	11	-1.40	10	-1.25	10	-0.52	5

From the perspective of dynamic development, Jiangsu Province's score in terms of technological innovation capability factors is significantly ahead of other provinces and cities. This is due to the vigorous implementation of the innovation driven development strategy in Jiangsu Province in recent years, the continuous and significant increase of the whole society's R&D investment and the output value of high-tech industries over the years, national innovative pilot cities, national high-tech zones, National Science and technology business incubators The

number of innovation platform carriers such as national key laboratories rank first in China. In contrast, the remaining two first tier cities, Shanghai and Zhejiang Province, showed a downward trend as a whole. In 2018, the factor scores of technological innovation ability of Zhejiang Province even fell to the fourth. This is because when its comprehensive innovation competitiveness is at a high level, the acceptable spillover effect of innovation competitiveness of other provinces is not obvious, and the economic environment is depressed in recent years, and the real estate, stock and other markets are depressed. This has brought certain negative effects to Shanghai as a financial center and Zhejiang Province dominated by the tertiary industry. Although the distance between provinces and cities has been shortened with the development of transportation, and the professional and technical personnel in Shanghai and Zhejiang Province have been greatly improved, the growth rate of high-tech industry exports has slowed down significantly, and the result still shows a downward trend. The ranking of technological innovation capability factors in Sichuan Province and Hunan Province shows an upward trend, which is mainly due to the gradual weakening of the blocking force of the Yangtze River with the rapid development of transportation and communication, the more convenient circulation of innovation factors among provinces and cities, the gradual reduction of the cost of accepting innovation Spillovers from other provinces and cities, and the promotion of the development of high-tech industries, the increase of regional GDP and the availability of innovation resources and innovation factors, Located in the middle of the Yangtze River, Hunan is the "dragon waist" of the Yangtze River Economic Belt. After integrating into the Yangtze River Economic Belt, Hunan has built an efficient and convenient comprehensive transportation system, strengthened the improvement of the ecological environment, accelerated the development of advantageous industries and the going out of advantageous production capacity, strengthened the development and opening-up platform, and achieved remarkable innovation results. In terms of innovative sustainable development factors, it is worth mentioning that although Hubei Province is at the bottom of the comprehensive factor score, the innovative sustainable development factors of Hubei Province have been in the forefront for nearly five years, ranking first among 11 provinces and cities in the Yangtze River Delta economic belt in 2017 and 2018, which shows that although Hubei Province's current comprehensive innovation competitiveness is not strong, it has a good development trend, It will show a good development trend in the next few years.

4.2. Analysis on Spatial Characteristics of Comprehensive Innovation Competitiveness

Table 6. Global Moran's I situation from 2014 to 2018

Project	2014	2015	2016	2017	2018
Moran's I	0.480	0.518	0.568	0.555	0.333
P value	0.002	0.003	0.001	0.002	0.031
Z score	3.465	3.578	3.589	3.516	2.223

Based on the measurement of the comprehensive innovation competitiveness of 11 provinces and cities in the Yangtze River Economic Belt from 2014 to 2018, further calculate the overall Moran's I among these 11 provinces and cities in the past five years, and explore the spatial distribution characteristics of the comprehensive competitive innovation competitiveness among them. The results are shown in table 6. It can be seen that the global Moran's I is positive, the p value is less than 0.05, and the Z score is greater than 1.65. There is a spatial positive correlation between the comprehensive innovation competitiveness of provinces and cities. The overall Moran's I in 2014 and 2018 decreased from 0.480 to 0.333, indicating that although there has been spatial correlation between the comprehensive innovation competitiveness of provinces and cities in five years, the spatial correlation in 2018 is weaker than that in 2014.

Therefore, it can be found that the spatial correlation of the comprehensive innovation competitiveness of 11 provinces and cities in the Yangtze River Economic Belt tends to weaken. Based on the global spatial autocorrelation analysis, this paper further makes a local spatial autocorrelation study on the comprehensive innovation competitiveness of 11 provinces and cities in the Yangtze River Economic Belt, in order to observe the spatial agglomeration types of spatial units and their adjacent regions. In order to more intuitively see the regional distribution of Moran's I in 11 provinces and cities of the Yangtze River Economic Belt in 2014 and 2018, table 7 presents the research results in 2014 and 2018 respectively, which can be seen from the table, there is a significant spatial correlation between the comprehensive innovation competitiveness of 11 provinces and cities in the Yangtze River Economic Belt, that is, the provinces and cities with strong comprehensive innovation competitiveness and adjacent regions show the characteristics of spatial agglomeration, which is specifically reflected in the diffusion effect area of "high-high" agglomeration in the lower reaches of the Yangtze River, The diffusion effect areas of "low low" agglomeration are all in the middle and upper reaches of the Yangtze River, which is consistent with the global Moran's I research results, showing a significant spatial positive correlation; During the study period, many regions have no transition and have high spatial stability, and the regions without transition are mainly concentrated in the low-speed growth region, showing a spatial positive correlation effect with the surrounding areas; The region of transition in the study period is consistent with the conclusion of factor analysis, and Sichuan Province and Chongqing jumped to adjacent regions; There are significant differences in the comprehensive innovation competitiveness of the Yangtze River Economic Belt. Anhui and other middle reaches of the Yangtze River are distributed in the transition zone of "low-high" agglomeration, and Sichuan, Chongqing and other upper reaches of the Yangtze River are distributed in the polarization effect zone of "high-low" agglomeration. In addition, most provinces and cities in the Yangtze River Economic Belt are still in the low-speed growth zone of "low-low" agglomeration, so it is urgent to narrow the regional development gap.

Table 7. Regional distribution of Moran's I in 2014-2018

Year	Radiation effect area	Transition region	Low growth area	Polarization effect region
2014	Shanghai,Jiangsu,Zhejiang	Anhui	Jiangxi,Hubei,Hunan,Chongqing, Sichuan,Yunnan,Guizhou	
2015	Shanghai,Jiangsu,Zhejiang	Anhui	Jiangxi,Hubei,Hunan,Chongqing, Sichuan,Yunnan,Guizhou	
2016	Shanghai,Jiangsu,Zhejiang	Anhui	Jiangxi,Hubei,Hunan,Chongqing, Sichuan,Yunnan,Guizhou	
2017	Shanghai,Jiangsu,Zhejiang	Anhui	Jiangxi,Hubei,Hunan,Chongqing, Sichuan,Yunnan,Guizhou	
2018	Shanghai,Jiangsu,Zhejiang	Anhui	Jiangxi,Hubei,Hunan,Chongqing, Sichuan,Yunnan,Guizhou	Sichuan, Chongqing

5. Conclusion

To sum up, this paper uses the measurement data of the comprehensive innovation competitiveness of the Yangtze River Economic Belt from 2014 to 2018, combined with factor

analysis and spatial correlation analysis to measure the comprehensive innovation competitiveness of the Yangtze River Economic Belt, explore the spatial characteristics of 11 provinces and cities in the region, and draw the following conclusions:

(1) From 2014 to 2018, the ranking of the comprehensive innovation competitiveness of 11 provinces and cities in the Yangtze River Economic Belt has hardly changed, and the comprehensive innovation competitiveness is on the rise. Overall, Jiangsu, Zhejiang, Shanghai and Hunan rank first, with strong comprehensive innovation competitiveness; Chongqing and Sichuan are the second grade, and the comprehensive score of comprehensive innovation competitiveness has jumped above the average score; Hunan, Anhui, Jiangxi, Hubei, Yunnan and Guizhou are the third grade, and the innovation score is far lower than the average score. With the implementation of the Yangtze River Economic Belt strategy, a series of macro-control has led to the emergence of regions with comprehensive innovation competitiveness higher than the average in the upper reaches of the Yangtze River, and a new situation of "double radiation" of innovation with the lower reaches of the Yangtze River.

(2) The third level provinces and cities with low comprehensive innovation competitiveness rank among the top in the innovation sustainable development ability. In particular, the innovation sustainable development ability factor of Hubei Province has been ahead of other provinces and cities in the Yangtze River Economic Belt in the past five years, which shows that although its comprehensive innovation competitiveness is not strong at present, it will have a good development trend in the future, and the comprehensive innovation competitiveness has a trend of "accumulation and thin development".

(3) From the perspective of spatial distribution characteristics, there has been spatial correlation between the comprehensive innovation competitiveness of provinces and cities in the past five years. The lower reaches of the Yangtze River with "high-high" agglomeration and the middle and upper reaches of the Yangtze River with "low-low" agglomeration show the agglomeration characteristics of spatial positive correlation. Although the comprehensive innovation competitiveness of the Yangtze River Economic Belt has made effective progress, the imbalance and disharmony of innovation competitiveness are still prominent. Coordinated development and narrowing the development gap between the upper, middle and lower reaches of the Yangtze River are urgent problems to be solved.

For the current situation of innovation and development of the Yangtze River Economic Belt, in addition to giving play to the independent regulation and control ability of the market based on following the national macro-control, government departments should issue specific incentive policies and formulate practical action measures according to the different innovation and development conditions of the upper, middle and lower reaches of the Yangtze River. Based on the summary and analysis of the previous research contents, combined with the strategic and natural advantages of the Yangtze River Economic Belt, this paper believes that relevant measures and schemes can be formulated from the following aspects:

(1) Give full play to the economic advantages of the river basin and build a modern comprehensive three-dimensional transportation system

The Yangtze River Economic Belt has a vast drainage area, traversing the hinterland of China. Relying on the Yangtze River, it has obvious river transportation advantages. Build a transportation hub center, solve the waterway restrictions, realize water land combined transportation, sea rail combined transportation and river sea combined transportation, improve the function of golden waterway, enhance the geographical proximity of the upper, middle and lower reaches of the Yangtze River, reduce the transportation cost of resources, so as to realize the efficient and large-scale transmission of people flow, information flow and logistics between cities, strengthen the innovative links between cities in the upper reaches and cities in the middle and lower reaches, and constantly optimize the comprehensive

transportation organization structure, Enhance transportation capacity and quality, build a three-dimensional transportation network that supports the organic integration and joint force of the Yangtze River Economic Belt, and promote regional coordinated development.

(2) Adjust measures to local conditions, take the adjustment of industrial structure as the core, and enhance the radiation of regional innovation

As the largest natural economic corridor and the most important industrial corridor in China, the Yangtze River Economic Belt connects the East, middle and west of China and is extremely rich in natural and industrial resources. The adjustment of industrial structure is a systematic project. In terms of the development of industrial structure in the Yangtze River Economic Belt, first, make an overall plan for industrial planning in different regions, clarify the development direction of industrial optimization and adjustment, reasonably distribute industries, resources and markets, and promote the organic and coordinated development of industries and urban space; Second, vigorously cultivate modern industries, strive to upgrade and transform traditional industries, and change the industrial pattern to the third, second and first industries; Third, encourage new industries and new drivers, take high-tech industries represented by information technology, bioengineering and new materials as the main development focus, and cultivate strategic emerging industries.

(3) Resource sharing and give full play to the spatial spillover effect of talents

The Yangtze River Basin is full of talents and the undertakings of science, technology and education are developed. However, there is a serious imbalance in the talent resources of the Yangtze River Economic Belt, and the barriers hindering the flow of talents still exist between regions. Promoting the sharing of talent resources is an important breakthrough point to promote the all-round development of the Yangtze River Economic Belt. On the one hand, focus on the regional resources and Industrial Differentiation of the upper, middle and lower reaches of the Yangtze River, scientifically guide the regional talent strategy and plan the differentiated development; On the other hand, with the construction of three-dimensional transportation network system, the links between regions are becoming closer and the flow of talents is becoming more convenient. Encourage the upper and middle reaches of the Yangtze River to improve the preferential conditions for attracting investment and attracting high-end talents, actively attract the settlement of emerging high-tech industries, improve their innovation competitiveness and narrow the gap with the lower reaches.

(4) deepen one's international exchanges and one's cooperation with the one belt, one road

The development of the Yangtze River Economic Belt must be integrated into the national and even international development pattern, promote greater regional economic cooperation, and encourage enterprises along the belt to "go global" in various ways. One belt, one road, is to promote economic cooperation and promote economic and economic growth. The economic belt is constantly driving the economic growth momentum. We should actively promote economic diplomacy, promote overseas transfer of manufacturing industry, improve economic and trade cooperation, enhance risk management and control capabilities, and promote the Yangtze River Economic Belt as the breakthrough point for the effective implementation of the "one belt and one road" initiative.

References

- [1] L. Charles: The Creative City:A Toolkit for Urban Innovators(Taylor and Francis, England 2012).
- [2] I. Begg:Cities and Competitiveness, Urban Studies, Vol. 36(1999),795-809.
- [3] Y. T. Miu,C. L. Gu,B. Y. Lin: New urban competitiveness model: analytic hierarchy process, Economic Geography,Vol. 01(2004),39-42.
- [4] G. X. Jiang,R. Y. Cheng: A comparative study on basic research investment between China and major innovative countries, World Sci-Tech R & D, Vol. 40(2018),537-548.

- [5] R. Q. Wang, S. Y. Yu, X. H. Hu: Technological innovation, urban agglomeration integration and high-quality economic development, *Finance and Economy*, Vol. 07(2020), 59-66.
- [6] X. Y. Deng: Research on enterprise culture and enterprise competitiveness from the perspective of value realization, *Modern management science*, Vol. 08(2021), 91-99.
- [7] J. Wang: Evaluation of competitiveness of international consumption center cities based on entropy weight method, *Journal of Commercial Economics*, Vol. 21(2020), 189-192.
- [8] Q. Huo: Study on the measurement of economic radiation of Guangdong Hong Kong Macao Dawan district to surrounding cities--a case study of three cities in western Guangdong, *China Business & Trade*, Vol. 08(2020), 7-8.
- [9] W. S. Jia, J. Shi: Construction of evaluation system of urban cultural competitiveness in China -- Also on the development of cultural value in Xi'an, *Journal of Xi'an Jiaotong University(Social Sciences)*, Vol. 05(2019), 139-145.
- [10] D. J. Yang, Y. H. Shi, P. Y. Chen: Study on the evaluation and promotion path of tourism competitiveness of marine cities in China, *Ocean Development and Management*, Vol. 04(2022), 1-10.
- [11] J. J. Li, H. J. Zhu: Connotation and evaluation index system of urban innovation competitiveness in China, *Review of Economic Research*, Vol. 45(2018), 52-59.
- [12] G. B. Li, Y. P. Tian: Validity analysis of tourism resource competitiveness and tourism development level in the Pearl River Delta, *Economic Geography*, Vol. 39(2019), 218-224.
- [13] F. Z. Wang, J. R. Lv: Evaluation and temporal and spatial evolution of urban competitiveness of Central Plains urban agglomeration, *Geographical Research*, Vol. 30(2011), 49-60.
- [14] J. Liu, J. Wang, Y. D. Xi: Spatial pattern evolution of tourism economic growth quality in China, *Economic Management*, Vol. 38(2016), 160-173.
- [15] K. K. Liu, X. L. Feng, M. L. Zhou: Spatial distribution characteristics and influencing factors of innovative enterprises in Zhejiang Province, *Resource Development & Market*, Vol. 36(2020), 1389-1394.