EVALUATION OF REGIONAL INNOVATION CAPABILITY IN JIANGSU PROVINCE BASED ON MULTIVARIATE STATISTICS

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ABSTRACT

The article anatomizes the intension of innovative city and proposes series of indicators of innovative city. Then the article does a cross section analysis of 13 cities in China by using these indicators with the means of Principal Components Analysis and Cluster Analysis.

Keywords: Innovative capability; Principal Components Analysis; Cluster Analysis; evaluation.

INTRODUCTION

Regional innovation capability is based on the future city to participate in the competition, innovation ability and the level of reasonable evaluation of the city, the local government is conducive to grasp the dynamics of innovation ability development in the region, through the comparison of local innovation advantages and disadvantages, to find the best practice to improve the innovation ability, so as to promote the innovation ability of the city upgrade.

Objective and accurate description of regional and regional innovation ability record is the basis and prerequisite for making new development strategy. At present, qualitative analysis or analytic hierarchy process is adopted for the comprehensive evaluation of regional innovation capability. However, the most obvious defect of qualitative analysis or analytic hierarchy process is that the selection of indexes and the determination of weights depend mainly on the experience of the evaluators, and the subjectivity is strong. In this paper, principal component analysis is used to select a few typical and representative indexes from many indexes, and a comprehensive evaluation is made on the development of regional innovation capability in recent years in Jiangsu province.

LITERATURE REVIEW

Regional innovation capability represents the basic ability of innovation factors to gather, integrate and promote sustainable innovation in a certain area, and is a major global proposition to promote regional competitiveness and achieve regional coordinated development. The measurement and evaluation of regional technological innovation ability evaluation and become a main means not a regional core competitiveness, is of great significance for the correct development of technology innovation policy and improve the level of enterprise technology innovation. The western scholars study for innovative city development and the background of globalization and knowledge-based economy combination, that formed simply rely on

innovation of city competitiveness under knowledge economy, innovation ability to city competition brings the absolute advantage of. With the further development of economic globalization, knowledge economy has become a hot topic in today's era of regional innovation ability as an important feature of the knowledge-based economy, has become a business decision, one area, one of the main factors and a national level of social economic development. One of the important reasons for the research of regional innovation system is that the rise of Silicon Valley in the United States and the magic of Silicon Valley make people realize the important role of the region in the innovation system. Another source of research on regional innovation system is industrial agglomeration. Therefore, there are two theoretical sources of regional innovation system: one is the theory of national innovation system, the other is the theory of progressive economics and modern regional development. The connotation of the regional innovation system is a system innovation to promote the network organization in an area, and the area characteristics of the associated resources, and its purpose is to promote the area of new technology or new knowledge creation and flow, renewal and transformation. Jiangsu province is a big province, a region of a developed economy, advanced culture, but by geography, culture, history, economy, multiple effects of politics, the development of different regions is significantly different, especially the city innovation ability, also show significant regional differences, therefore, accurate and objective evaluation of the regional innovation ability, will provide a series of reference for Jiangsu province and other provinces.

Construction of index evaluation system

According to the previous research on the evaluation system of regional innovation capability, we find that different evaluation systems contain different emphases, and therefore the selection of indicators is also different. In order to construct the desired objective and accurate evaluation system and comprehensive measure of regional innovation ability, this article from the macro economy, education, culture, environment and so on by selecting eight evaluation index

TABLE1 evaluation index system of urban innovation capability

number	index
1	A1 Graduate number
2	A2 High and new technology industry output value (Billion yuan)
3	A3 Per capital GDP (10k yuan)
4	A4 Revenue (Billion yuan)
5	A5 Various professional and technical personnel (10000)
6	A6 R&D investment (Billion yuan)
7	A7 Funds for cultural activities (Billion yuan)
8	A8 Environmental protection input (Billion yuan)

Evaluation process

Referring to the statistical yearbook of Jiangsu and the statistical yearbook of cities, the following raw data are obtained, as shown in table 2:

TABLE2 Index data of urban cities in Jiangsu

	A1	A2 (Billion yuan)	A3 (ten thousand)	A4 (Billion yuan)	A5 (ten thousand)	A6 (Billion yuan)	A7 (Billion yuan)	A8 (Billion yuan)
NANJING	33441	5740.94	10.74	903.49	9.92	72.65	143.74	33.13
WUXI	2043	6110.66	12.62	768.01	8.72	28.78	71.50	22.53
XUZHOU	3713	4047.74	5.75	472.33	12.30	25.46	33.59	11.43
CHANGZHOU	487	4805.99	10.44	433.88	6.54	19.85	18.54	28.57
SUZHOU	3927	13644.87	12.98	1443.82	12.66	69.61	133.52	14.12
NANTONG	682	5404.03	7.75	550.00	9.52	18.55	27.75	5.46
LIANYUNGANG	53	1669.25	4.42	261.77	6.90	23.38	49.13	19.97
HUAIAN	22	1473.86	5.06	308.51	6.31	16.42	37.32	3.32
YANCHENG	0	2044.97	5.31	418.02	9.41	17.63	43.85	18.32
YANGZHOU	1976	3880.85	8.26	295.19	6.14	43.84	94.04	5.44
ZHENJAING	2761	3900.80	10.26	277.76	4.72	29.63	42.59	16.62
TAIZHOU	0	3888.13	7.27	277.95	6.63	21.02	16.60	7.94
SUQIAN	0	665.19	3.99	210.10	5.89	13.32	21.24	12.36

Data source: Jiangsu Statistical Yearbook (2015), Chinese Urban Statistical Yearbook (2015)

Principal component analysis

Principal component analysis is of multiple correlation between variables of a multivariate statistical method, study how to reveal the internal structure of multi variables through a few principal components, which is derived from the original variables a few principal components, making them as much as possible to retain the original variable information, and not related to each other. Usually the mathematical treatment is a linear combination of the original P index, as a new comprehensive index. The principal component analysis is Hotelling first proposed in 1933, it is the use of the idea of dimension reduction, the internal structural relationship on the index system, the index is transformed into a few independent and contains most of the information of the original index (80%‐ 85%) of multivariate statistical method of comprehensive index, its advantage is that it is determined by weight based on the data analysis between the index of the internal structure of the relationship, not affected by subjective factors, and the comprehensive index (principal components) are independent of each other, reduce information cross, which makes analysis and evaluation results of objectivity and certainty.

In this paper, the principal component analysis in R software is used to analyze the regional innovation capability of 13 cities in Jiangsu province. The main principle of principal component analysis method is to use the idea of dimension reduction, the internal structural relationship on the index system, the multi index is converted into a few independent and contains most of the information of the original index (80% ~ 85%) multivariate statistical methods of the comprehensive index. Its advantage is that it is based on the data analysis to determine the weights between indicators of the internal structural relationship, not affected by subjective factors, and the comprehensive index (principal components) are independent of each other, reduce information cross, which makes the result with objectivity and veracity. Finally, the correlation coefficient matrix, the variance contribution rate, the cumulative variance contribution rate, the principal component load matrix and the comprehensive score are obtained, as shown in table 3 and table 4 :

Table 3 eigenvalue and variance contribution table:

component	eigenvalue	variance contribution	Cumulative variance contribution
1	4.9486	0.6186	0.6186
2	1.3258	0.1657	0.7843
3	0.7968	0.0996	0.8839
4	0.6344	0.0793	0.9632
5	0.1750	0.0219	0.9851
6	0.0638	0.0080	0.9930
7	0.0538	0.0067	0.9998
8	0.0018	0.0002	1.0000

Table 4 Component Matrix

	F1	F2	F3
A1	−0.30	0.54	−0.35
A2	−0.38	−0.39	0.24
A3	−0.35	0.00	0.65
A4	−0.42	−0.25	0.00
A5	−0.29	−0.36	−0.49
A6	−0.42	0.11	−0.15
A7	−0.40	0.12	−0.20
A8	−0.21	0.58	0.31

Table 4 reflects the variance of each component, namely the characteristic value, the size of it said how many corresponding components can describe the information of the original, in accordance with the cumulative contribution rate reached 85% of the first three components of variance principle, the cumulative contribution rate has reached 88.39%, so just put forward three principal components can be summed up the original data most of the information. Finally, the first three components are extracted as the first principal component, the second principal component and the third principal component, respectively.
T
able 4 is the principal component load matrix. Each load in the table represents the correlation between the principal component and the corresponding variables. From table 4, we can see that the first principal component of A4 and A6, these two elements have a relatively close relationship, which is the first principal component and the city's fiscal revenue and R&D overall investment, mainly reflects the economic strength of city macro, so it can be regarded as the first component of city economy factor. The second principal components and A1, A2, A5 is closely related with the number of graduate students in each city, high-tech output value and the number of professional and technical personnel are highly correlative, mainly reflects the level of science and technology resources city, the second principal component is defined as R & D resources. The third principal components and A3, A7, A8 these three elements are closely related, namely GDP per capita, cultural activities, environmental protection investment, mainly reflecting the city culture and environment, so eventually the third principal component is defined as the living environmental factors.

After determining the principal component, the scores of principal components in 13 cities in Jiangsu province can be obtained by using R software. Table 5 calculates the scores and ranking tables of each city. The positive and negative points of the factor scores in the table represent only the relative level of the city's innovative capacity.

Table 5 scores and ranking tables of cities in Jiangsu

	F1	ranking	F2	ranking	F3	ranking	Comprehensive ranking
NANJING	−4.44	12	2.74	1	−1.00	12	2
WUXI	−1.36	11	−0.17	8	1.28	3	3
XUZHOU	0.30	9	−0.87	11	−1.36	13	4
CHANGZHOU	0.36	8	0.70	3	1.75	1	7
ZUZHOU	−5.02	13	−2.24	13	0.14	5	1
NANTONG	0.60	7	−1.36	12	−0.26	7	6
LIANYUNGANG	1.48	4	0.78	2	−0.35	8	11
HUAIAN	2.11	2	−0.33	9	−0.58	10	12
YANCHENG	1.05	5	0.07	6	−0.62	11	8
YANGZHOU	0.19	10	−0.06	7	−0.16	6	5
ZHENJIANG	0.67	6	0.69	4	1.29	2	9
TAIZHOU	1.55	3	−0.42	10	0.25	4	10
SUQIAN	2.52	1	0.46	5	−0.37	9	13

As can be seen from table 5, in the 13 cities in Jiangsu, Suzhou's innovation capability ranks first, followed by Nanjing, Wuxi, Xuzhou, Yangzhou and other cities. But Suqian, Yancheng, Lianyungang and other cities located in the north of Jiangsu are limited by their own resources, and their creativity is insufficient.

Cluster analysis

The goal of cluster analysis is to classify data on a similar basis. Clustering comes from many fields, including mathematics, computer science, statistics, biology and economics. In different applications, many clustering techniques have been developed. These techniques are used to describe data, measure the similarity between different data sources, and classify data sources into different clusters.

From the point of view of practical application, clustering analysis is one of the main tasks of data mining. Moreover, clustering can be used as an independent tool to obtain the distribution of data, to observe the characteristics of each cluster of data, and to concentrate on the analysis of specific cluster sets. Clustering analysis can also be used as a preprocessing step for other algorithms (such as classification and qualitative inductive algorithms).

In order to accurately understand the innovation ability development status between different regions, support more constructive theory for the analysis and evaluation of the final, then based on the three principal components for further research of 13 prefecture level cities in Jiangsu province by using the cluster analysis method, the distance measure using the shortest distance method, the cluster analysis dendrogram as shown in Figure 6:

Figure 6:Cluster Dendrogram
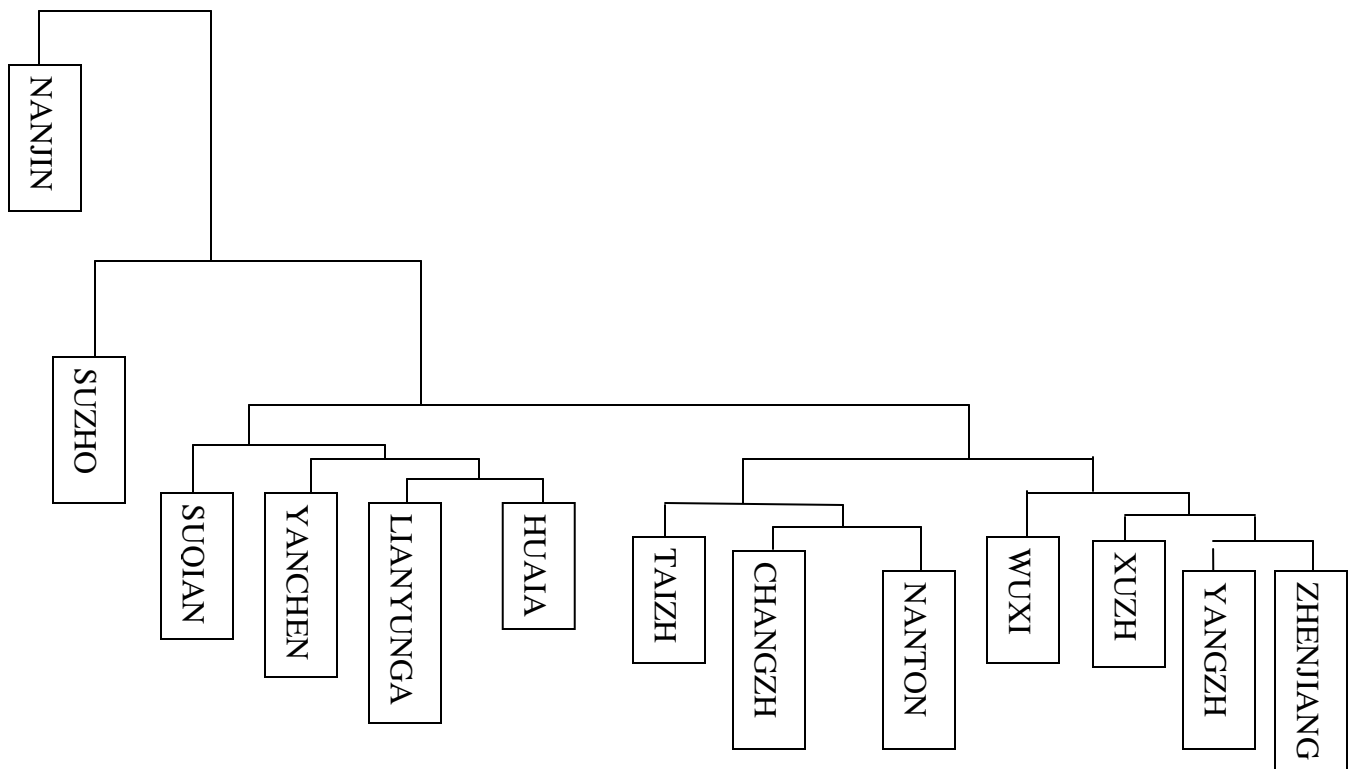
From the figure above the clustering results can be seen in Nanjing and Suzhou, with its comprehensive advantages, can be respectively into a category, and is located in Jiangsu in the north of Suqian, Yancheng, Lianyungang and Huaian is divided into a class, the rest of Changzhou, Nantong, Yangzhou, Wuxi city for a class.

Preliminary analysis of the evaluation results

According to table 3 principal component analysis results of load, the innovation ability of the city is mainly affected by their overall economic strength, with a relatively strong economic resources, can effectively promote the city's innovation ability. In addition to urban macroeconomic factors, the city's scientific and technological resources and living environment also play an important role in urban innovation. A large number of scientific research and

technical personnel, as well as external comfortable living atmosphere, can obviously enhance the opening and inclusiveness of a city, and create a suitable soil for the cultivation of urban innovative ability.

By calculating the comprehensive scores and rankings of each city, the data of table four also reflects the objective reality in reality. Suzhou and Nanjing, as the two major cities in South of Jiangsu, not only have convenient transportation, pleasant climate and environment, but also close to Shanghai, Hangzhou and other developed cities, the geographical advantages are quite obvious. At the second level of the Wuxi, Xuzhou, Yangzhou, Nantong, Xuzhou, in addition to relying on their own profound historical heritage and abundant resources and rapid development, the other city is located in the South of Jiangsu area, although their resources of science and technology is relatively backward, but rely on the superior living environment, and There is nothing comparable to this geographical advantage, in Nanjing, Suzhou, Shanghai city's radiation, its innovation ability can be improved significantly. Finally, from the data analysis results showed that Suqian, Huaian, Yancheng, Lianyungang four City, one located in Jiangsu, north of the Yangtze River Delta edge, traffic is relatively inconvenient, lacking resources, locational disadvantage is obvious, on the other hand, the economic strength of the weak, high-tech industries related it is relatively backward, coupled with high-quality scientific research personnel on local erosion to the front edge regions, the development of innovation ability is extremely limited.

Finally, based on the cluster analysis of 13 prefecture level cities in Jiangsu, we can clearly see the tremendous influence of geography, history, culture and political factors on urban innovation capability. The first and the second kind of Suzhou, Nanjing, located in the central area of South of Jiangsu, as the birthplace of Wu Yue culture, has a long history and a certain political background, so it naturally has a tolerant and innovative soil. Third Wuxi, Yangzhou, Changzhou, Nantong City, almost all located in the South of Jiangsu area, although less than Suzhou Nanjing, but the most direct advantage of location by the surrounding radiation, at a higher level of innovation ability. Fourth Suqian, Huaian, Yancheng, Lianyungang, is located in the northern Jiangsu area, due to the geographical conditions and historical natural weakness, lack of cultural heritage, Suzhou Nanjing rich and prosperous city since ancient times, the relatively poor, political influence is insufficient. Therefore, in view of the cluster analysis and the above analysis, we can clearly and intuitively see the influence of geography, history, culture and politics on the regional innovation capability.

CONCLUSIONS AND POLICY RECOMMENDATIONS

Through the evaluation of regional innovation ability of 13 prefecture level cities in Jiangsu Province, the analysis shows that the most direct impact on innovation and development of a city received a city economic situation, macro economic strength will be for the city to provide better infrastructure and resources conditions, these conditions make the city in the introduction of domestic and foreign advanced industry, absorb high-level innovative talents in other areas, has an important effect on improving the local conditions in order to improve the output of scientific research and development.

Science and technology innovation platform in Colleges and universities is an important part of the construction of the national innovation system, is the original innovation base, is a platform for training and attract high level talents, is the forefront of international cooperation in science and technology, is the carrier of the combination, in scientific research, personnel training, discipline construction and construction for economic and social services and other aspects of play an important role. From the point of view of enhancing the capability of continuous innovation, the innovation platform of system reform and mechanism as the driving force to the science and technology resources of school integration and set as the main line, to discipline concise direction, many discipline superiority, promote original innovation breakthrough as the main target, adhere to the dos and Don'ts choice has certain foundation and advantages, in line with the national and provincial key support for the research direction and goals, to concentrate on the key breakthrough, after a period of efforts to achieve domestic frontier level surgery. We should give full play to the high level of science and technology innovation platform, gathered to absorb domestic and foreign high level scientific and technical personnel, research groups to form a strong research strength, strive for more major projects in the national science and technology plans, a high level of scientific research, cultivate high-level technical personnel more.

According to the above analysis, this paper argues that in order to promote the regional innovation ability of science and technology, not only need to increase human capital investment, emphasis on science and technology funding, to strengthen human capital and improve the level of investment, more efforts should be made from the two aspects of financial development and investment in education. From the perspective of financial development, in the pursuit of economic steady and healthy development at the same time, needs the innovation of credit system, the expansion of financial scale, reasonable guide the orderly flow of funds between regions, will work closely with the coordinated development of Finance and regional economic base, enhance regional innovation capability strengthening; improving the construction of the stock market, pay attention to the development of the insurance industry the particular attention to the development in financial market, and gradually optimize the financial structure, the promotion of the regional innovation ability is the guarantee; improve financial services, innovative financial products, improve financial efficiency, increase the new industry financial support, to improve the ability of regional financial development level across the threshold, provide the conditions for the to enhance regional innovation capability.

In addition, in addition to a city's macroeconomic strength factors, the city's historical and cultural heritage, and even the overall living environment, is also an important factor in promoting urban innovation capability. The historical and cultural background of a city is the inner temperament of a city. It can embody a city's openness, tolerance and calm mind. And innovation, we need this open and inclusive city mind. And the living environment of the city is a necessary factor to meet people's daily life, and it has a certain role in attracting high-level creative talents. City culture is a city of management science, it is not only refers to a particular city public cultural facilities, the level of knowledge, education level and narrow cultural phenomenon, but also the sum of all the material culture, system culture and spiritual culture created by the city and the management system of the formation of. Urban culture is the booster of urban development. Urban culture and urban development are inseparable, supplement each

other, urban culture is the booster of urban development, and urban development is an effective carrier of urban culture. Urban culture permeates all areas of urban development.

In view of the obvious regional differences reflected in the article research, we should arouse the attention of the government departments. The gap of innovation capacity between South of Jiangsu and Northern Jiangsu is still quite large. The imbalance of regional development will hinder the overall development of Jiangsu Province in the future. In order to keep the Jiangsu province to maintain the competitiveness in regional competition in the future, while maintaining the existing foundation for the development of South of Jiangsu area, the northern Jiangsu area should increase the fiscal policy support, so as to keep pace with the developed areas of innovation and development, in order to activate the overall innovation potential of each city in Jiangsu province.

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