Research on Evaluation of Innovation and Entrepreneurship Ability of Hebei Province Based on GPCA-HCA Model in Big Data Era

Shanshan Wang[1,a], Lihong Han[1,b*]

1075728389@qq.com[a], 1070225171@qq.com[b]
[*]Corresponding Author. Email: 1070225171@qq.com

School of Economics and Management, Hebei University of Science and Technology, Shijiazhuang, China[1]

Abstract: Big data is a new supporting force and driving force for innovation and entrepreneurship, which brings new opportunities to all subjects. Innovation and entrepreneurship under the background of big data is the new engine of regional economic development. Based on the panel data from 2016 to 2020, this paper constructs the evaluation system of innovation and entrepreneurship in eastern China by using the global principal component analysis method, and obtains the regional comprehensive ranking, and uses the comprehensive score to conduct hierarchical cluster analysis by using Ward algorithm to obtain the cluster pedigree map. The dynamic evaluation of Hebei province's innovation and entrepreneurship ability during the 13th Five-Year Plan period shows that the overall innovation and entrepreneurship ability of Hebei province is on the rise from 2016 to 2020, but the comprehensive ranking has been at a low level in the eastern region, and it is in the third echelon. The overall innovation and entrepreneurship ability is poor, the investment in innovation and entrepreneurship is insufficient, the output of innovation and entrepreneurship is low, and the basic environment of innovation and entrepreneurship needs to be improved.

Keywords: Big Data, Hebei Province, The 13th Five-Year Plan, Innovative and Entrepreneurial Ability, Global Principal Component Analysis, Hierarchical Cluster Analysis.

1 INTRODUCTION

After "mass entrepreneurship and innovation" was put forward in 2014, innovation and entrepreneurship became a new driving force to promote social and economic development in China. Under the background of big data, local governments, enterprises and science and education departments also paid more and more attention to big data, and they also increased their research investment in big data in innovation and entrepreneurship, such as increasing fixed assets investment in information transmission, software and information technology services. However, the development of innovation and entrepreneurship in different regions is not balanced, and the quality of innovation and entrepreneurship varies. Influenced by factors such as history and geographical location, Hebei's regional culture has no obvious characteristics. In recent years, Hebei Province has also vigorously advocated the development

BDEDM 2023, January 06-08, Changsha, People's Republic of China

DOI 10.4108/eai.6-1-2023.2330368

of "mass entrepreneurship and innovation". For example, in 2020, Hebei Province put forward a number of policies and measures to promote the high-quality development of innovation and entrepreneurship. So, during the 13th Five-Year Plan period (2016-2020), what is the development level of innovation and entrepreneurship in Hebei Province? In this paper, the eastern region with similar geographical location and economic development level is selected as the research object. Based on the global principal component analysis and hierarchical cluster analysis, the innovation and entrepreneurship ability of eastern provinces (cities) from 2016 to 2020 is analyzed, and then the relative level of innovation and entrepreneurship ability of Hebei province and the gap between Hebei province and other eastern provinces (cities) are evaluated.

In recent years, many scholars have made research on the evaluation of regional innovation and entrepreneurship. HuangHuan and Ethan [2] sorted out the relationship between innovation and entrepreneurship, and then comprehensively evaluated the innovation and entrepreneurship ability of Sichuan Province in 2015 by using factor analysis. ParkZhefan [6] used TFP model and entropy weight -AHP model to evaluate the economic innovation and development capacity of Zhejiang Province from 2007 to 2017. HuPing [3] Using the weighted TOPSIS evaluation method to evaluate and analyze 30 provinces and cities in China in 2017, it is concluded that Zhejiang's comprehensive evaluation of innovation and entrepreneurship ranks fourth in the country.

Through combing the relevant literature, it is found that scholars have studied it from different angles and with different methods, which provides some ideas for this paper. However, most studies are based on a cross-sectional data, and data analysis cannot reflect the vertical development of innovation and entrepreneurship in a certain region. Based on this, this paper uses the collected panel data of eastern provinces (cities) in China from 2016 to 2020 to analyze the innovation and entrepreneurship capabilities of eastern provinces (cities) in China, and then evaluates the relative level of innovation and entrepreneurship capabilities in Hebei.

2 MATERIALS AND METHODS

2.1 Index Construction

Regional innovation and entrepreneurship capability is the result of the interaction of various innovation and entrepreneurship elements in a region, which can measure the efficiency of regional innovation and entrepreneurship. Based on the background of big data, this paper constructs an evaluation index system of regional innovation and entrepreneurship capability with dual input, dual output and dual environment as the main factors, as shown in Table 1.

Table 1: Evaluation index of innovation and entrepreneurship

Main type	Index name	Index code
Investment	R&D personne (human)	X1
	Full-time equivalent of R&D personnel (man-year)	X2
	Science and technology expenditure (hundred million yuan)	X3
	Internal expenditure of R&D funds (ten thousand yuan)	X4
	R&D expenditure intensity (%)	X5
Output	Number of scientific papers published by institutions of higher learning (piece)	X6

	Domestic patent application acceptance (item)	X7
	Number of domestic patent applications granted (item)	X8
	Sales revenue of new products of industrial enterprises above designated size (ten thousand yuan)	X9
	Sales revenue of new products in high-tech industries (ten thousand yuan)	X10
	Technical market turnover (hundred million yuan)	X11
Environment	Per capita GDP (Yuan/person)	X12
	educational appropriations (ten thousand yuan)	X13
	Average number of students in colleges and universities per 100,000 population (human)	X14
	Number of science and technology incubators in the enterprise system (individual)	X15
	Investment in fixed assets of information transmission, software and information technology services (hundred million yuan)	X16
	Investment in fixed assets of scientific and technological services (hundred million yuan)	X17

2.2 Research methods

2.2.1 Gpca

In order to dynamically evaluate the innovation and entrepreneurship ability of Hebei Province and the gap between Hebei Province and other provinces (cities), this paper adopts global principal component analysis as the research method, which is abbreviated as GPCA. GPCA is based on the classic principal component analysis, adding time series, constructing three-dimensional data tables with the same index data by year, and replacing the original original data with comprehensive variables to dynamically analyze and study the research object. The specific steps are as follows:

(1) Establish a global data table. Suppose there are j indicators to be evaluated, which are recorded as X_1, X_2, X_3,…,X_j. For n samples (this article refers to the provinces (cities) in the eastern part of China), there is a data table $Xt=(X_{ij})_{n\times j}$ in the t year, where $0<t\leq T$. There are t data tables in a year. Arrange all the data tables before and after the year to form an n×t×j three-dimensional time series data table, which is marked as: $X=(X_1, X_2, X_3,\ldots,X_t)^{-1}{}_{n\times t\times j}$, so that each row in the matrix represents the data of the nth sample in a certain year.

(2) Data standardization. In order to make different types of index data comparable, the original data are uniformly transformed to eliminate the influence of dimensions. In this paper, Z-Score method is adopted for standardization. In this paper, the standard data table is denoted as Z.

$$Z_{ij} = \frac{X_{ij} - \mu_j}{\sigma_j}(i = 1,2,3,\ldots,10) \quad (1)$$

Among them, Z_{ij} is the value of the jth index of the ith province (city) after dimensionless processing; X_{ij} is the original data of the j index value of the ith province (city); μ_j is the average of the 10 provinces (cities) of the jth index data;σ_j is the standard deviation of the jth index data.

(3) Data validity test. Verify the validity of the standardized data to determine whether the principal component analysis method can be used for these data. When KMO≥0.6, it means that

the data is suitable for principal component analysis; If Bartlett's spherical test conclusion rejects the original hypothesis that variables are independent of each other, it means that variables are related, which is suitable for principal component analysis of data.

(4) Determine the principal component F. Calculate the covariance matrix R of the global data table X, and calculate the eigenvalues 1,2,3,…,p>0 of r, and the corresponding eigenvectors u1, u2, u3, u_p to calculate the variance contribution rate of the principal components:

$$a_k = \frac{\lambda_i}{\sum_{i=1}^{p} \lambda_i} \tag{2}$$

The cumulative variance contribution rate is:

$$a_1 + a_2 + \cdots + a_m = \frac{\sum_{i=1}^{m} \lambda_i}{\sum_{i=1}^{p} \lambda_i} \tag{3}$$

Select the principal components F1, F2, F3, …, Fm (0<m≤p) corresponding to the first m largest eigenvalues.

(5) Calculate the comprehensive score. Calculate the comprehensive score function of the research object through the scores of each principal component, as follows:

$$ZF = \sum_{i=1}^{m} \frac{\lambda_i}{q} F_i \tag{4}$$

Where i is the characteristic root of the ith principal component; q is the sum of the characteristic roots of the principal components, Fi is the standardized score of the ith principal component, and the principal component Fi is obtained by formula (5):

$$ZF = \sum_{i=1}^{m} \frac{\lambda_i}{q} F_i \tag{5}$$

Where m is the square root of the eigenvalue corresponding to the ith principal component divided by the ith column value in the matrix; Zm is the standardized data.

2.2.2 Hca

Hierarchical cluster analysis is a statistical method to classify data based on their own information. It divides data into several groups according to the distance (or similarity), and finally ensures that the differences within a group are as small as possible, while the differences between groups are as large as possible. This paper needs to evaluate the innovation and entrepreneurship ability of the provinces and cities in eastern China from 2016 to 2020. Therefore, three dimensions, sample number (N), indicator number (P) and time (T), need to be considered in statistical analysis. Let (X1,X2,…Xp) represent the characteristics of each sample, (X_{ij}) (t),(t = 1,2,…T) represent that the j index of the ith sample is in the value of time t.

When X_{ij}>0, i=1,2,…n, j=1,2,…p, the Euclidean distance between sample m and sample n is defined as:

$$D_{mn} = \sqrt{\sum_{t=1}^{T}\sum_{j=1}^{P}[X_{mj}(t) - X_{nj}(t)]^2} \quad (6)$$

The distance function can be simplified as:

$$d_{mn} = \sqrt{\sum_{j=1}^{p}(X_{mj}^{*} - X_{nj}^{*})^2} \quad (7)$$

2.3 Data Sources

In this paper, SPSS26.0 software is used to analyze and evaluate the innovation and entrepreneurship ability of scientific and technological talents in eastern China and the relative level of scientific and technological talents in Hebei province. The relevant index data of each province (city) from 2016 to 2020 comes from China Statistical Yearbook and China Science and Technology Statistical Yearbook.

3 RESULTS & DISCUSSION

3.1 Empirical Process

The data of 10 provinces (cities) in the eastern region of China from 2016 to 2020 were arranged vertically by year to establish a time series global data table, and standardized processing was carried out.SPSS26.0 was used to measure the appropriateness of KMO sampling and Bartlett test to test the validity of the data. According to the data results in Table 2, the KMO test value is 0.825, which is greater than 0.5; Bartlett spherical test has a significance of 0.000, so the original hypothesis is rejected. (Luo,2013)

Table 2: Inspection of KMO and Bartlett

Km sampling suitability quantity.		0.825
Bartlett's sphericity test	Approximate chi-square	1671.437
	Freedom	136
	Significance	0.000

In order to transform many indexes into several comprehensive indexes and effectively reduce the dimension of data space, it is necessary to extract the principal components whose characteristic values are greater than 1, namely principal components F1, F2 and F3 (see Table 3). As can be seen from Table 3, the cumulative variance contribution rate of principal components F1, F2 and F3 reaches 84.567%. At the same time, the gravel diagram in Figure 1 shows that the characteristic values of the first three common factors change obviously, and the fourth characteristic value changes gradually. To sum up, these three principal components retain most of the information of the original data and can replace 17 original indicators [7].

Table 3: Total variance of explanation

Component part	Eigenvalue	Variance contribution rate%	Cumulative variance contribution rate%
1	9.728	57.226	57.226
2	3.157	18.571	75.797
3	1.491	8.769	84.567

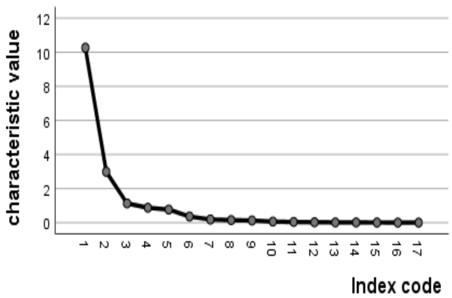

Figure 1: Gravel diagram

The maximum variance orthogonal rotation method is used to rotate the initial load matrix by factors, and the rotation component matrix in Table 4 is obtained. According to the results in Table 4, it can be seen which principal component of the 17 indexes has higher factor load [7]. The first principal component (F1) has a high factor load on X1, X2, X3, X4, X6, X7, X8, X9, X10, X13, X15, X16, and it is named as the development factor of regional twinning ability. The second principal component (F2) has higher factor loads on X5, X11 and X14, so it is named as the regional double innovation input transformation capacity factor. The third principal component (F3) has a higher factor load on X12 and X17, so this principal component is named as the regional double-innovation economic development factor [1].

Table 4: Rotation component matrix

	Ingredient		
	1	2	3
X1	0.956	0.150	0.204
X2	0.961	0.149	0.169
X3	0.917	0.284	-0.085

X4	0.857	0.406	0.247
X5	0.074	0.954	0.020
X6	0.370	0.367	0.136
X7	0.975	0.086	0.142
X8	0.960	0.090	0.068
X9	0.964	-0.059	0.176
X10	0.951	-0.002	-0.074
X11	0.204	0.902	-0.019
X12	0.085	0.246	0.611
X13	0.938	-0.040	0.216
X14	-0.173	0.941	0.023
X15	0.949	-0.010	0.209
X16	0.742	-0.081	0.375
X17	0.235	-0.190	0.817

$$F1=0.3087Z1+0.3080Z2+0.2854Z3+0.2938Z4+0.0698Z5+0.1379Z6+0.3074Z7+0.2987Z8+0.2991Z9+0.2826Z10+0.1042Z11+0.0753Z12+0.2949Z13-0.0053Z14+0.2992Z15+0.2435Z16+0.1119Z17 \quad (8)$$

$$F2=-0.0022Z1-0.0019Z2+0.0879Z3+0.1510Z4+0.5383Z5+0.1741Z6-0.0379Z7-0.00319Z8-0.1214Z9-0.0788Z10+0.4993Z11+0.1118Z12-0.1097Z13+0.5516Z14-0.0933Z15-0.1220Z16-0.15714Z17 \quad (9)$$

$$F3=0.0081Z1-0.0251Z2-0.2464Z3+0.0739Z4+0.0318Z5+0.0650Z6-0.0541Z7-0.1194Z8-0.0248Z9-0.2509Z10-0.0314Z11+0.5533Z12-0.0173Z13+0.0811Z14+0.0100Z15+0.2001Z16+0.7014Z17 \quad (10)$$

In the calculation formula of each common factor, the greater the coefficient of the index, the greater the promoting effect of the index on the common factor, and the smaller the opposite.

The comprehensive score expression is obtained from the principal component expression and the cumulative variance contribution rate of each principal component:

$$ZF=0.6767F1+0.2196F2+0.1037F3 \quad (11)$$

Table 5: Composition matrix

	Ingredient		
	1	2	3
X1	0.989	-0.004	0.009
X2	0.987	-0.003	-0.027
X3	0.914	0.152	-0.262
X4	0.941	0.261	0.079
X5	0.224	0.930	0.034
X6:	0.442	0.301	0.069
X7	0.985	-0.065	-0.058
X8	0.957	-0.055	-0.127
X9	0.958	-0.210	-0.026

X10	0.906	-0.136	-0.267
X11	0.334	0.862	-0.033
X12	0.241	0.193	0.588
X13	0.945	-0.189	0.018
X14	-0.017	0.953	0.086
X15	0.959	-0.161	0.011
X16	0.780	-0.211	0.213
X17	0.359	-0.271	0.746

According to this, the scores, comprehensive scores and rankings of each principal component of innovation and entrepreneurship ability of 10 provinces (cities) in eastern China from 2016 to 2020 are calculated. The specific results are shown in Table 6.

Table 6: Comprehensive ranking of innovation and entrepreneurship in eastern China

Ranking	2016		2017		2018		2019		2020	
1	Guangdong	2	Guangdong	2.88	Guangdong	4.12	Guangdong	4.84	Guangdong	5.79
2	Jiangsu	1.84	Jiangsu	2.08	Jiangsu	3.4	Jiangsu	3.01	Jiangsu	4.16
3	Beijing	0.15	Zhejiang	0.84	Beijing	0.86	Beijing	1.25	Zhejiang	1.76
4	Shandong	-0.18	Beijing	0.46	Zhejiang	0.56	Zhejiang	1.14	Beijing	1.58
5	Zhejiang	-0.21	Shandong	0.05	Shandong	0.18	Shandong	0.22	Shandong	0.91
6	Shanghai	-1.09	Shanghai	-0.88	Shanghai	-0.65	Shanghai	-0.44	Shanghai	-0.21
7	Tianjin	-1.43	Tianjin	-1.57	Fujian	-1.5	Hebei	-1.39	Hebei	-1.12
8	Fujian	-1.97	Fujian	-1.85	Tianjin	-1.62	Fujian	-1.43	Fujian	-1.19
9	Hebei	-2.18	Hebei	-1.97	Hebei	-1.81	Tianjin	-1.72	Tianjin	-1.52
10	Hainan	-3.28	Hainan	-3.25	Hainan	-3.27	Hainan	-3.21	Hainan	-3.12

In this paper, the comprehensive scores of provinces calculated by the global principal component analysis method are used for cluster analysis, and SPSS26.0 clustering module is used for calculation. Q-type clustering in hierarchical clustering, Euclidean distance squared calculation and "Ward method" calculation are used for clustering method to obtain the cluster pedigree diagram of systematic cluster analysis, as shown in Figure 2. Considering the actual situation of the provinces and cities in eastern China, combined with the results of Figure 2, this paper holds that the innovation and entrepreneurship capabilities of the provinces and cities in eastern China can be clearly divided into three groups, as shown in Table7.

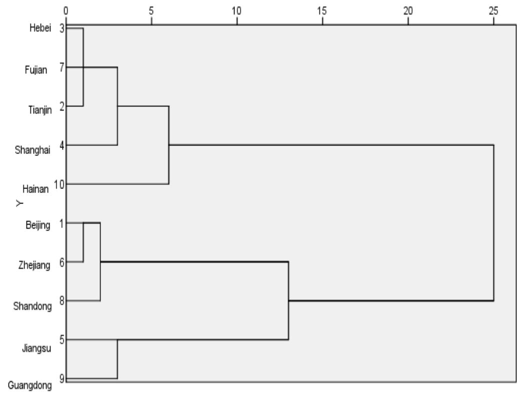

Figure 2: Cluster pedigree diagram of innovation and entrepreneurship ability of provinces and cities in eastern China

Table 7: Cluster analysis of innovation and entrepreneurship ability of provinces and cities in eastern China from 2016 to 2020

Category	Area
1	Guangdong, Jiangsu
2	Shandong, Zhejiang, Beijing
3	Hainan, Shanghai, Tianjin, Fujian, Hebei.

3.2 Analysis of Empirical Results

3.2.1 Analysis of Dynamic Characteristics of Innovation and Entrepreneurship in Eastern China

It can be seen from the comprehensive score and ranking table in Table 6 that the innovation and entrepreneurship capabilities of 10 provinces (cities) in the eastern region of China are generally on the rise from 2016 to 2020, but the innovation and entrepreneurship capabilities of different regions are quite different, and the innovation and entrepreneurship capabilities of the same region are also fluctuating in different years [9]. According to the cluster pedigree diagram obtained by cluster analysis, the innovation and entrepreneurship capabilities of the eastern provinces and cities of China can be divided into the following three categories.: the first category includes Guangdong and Jiangsu. In 2016-2020, Guangdong and Jiangsu had strong innovation and entrepreneurship ability, and their comprehensive scores were much higher than those of other provinces (cities). Among them, Guangdong ranked first in 2016-2020, and its comprehensive scores rose the fastest, from 2.00 in 2016 to 5.79 in 2020; Jiangsu ranked second in 2016-2020, rising from 1.84 in 2016 to 4.16 in 2020; The second category includes Beijing, Zhejiang and Shandong. These three provinces and cities ranked 3rd-5th, with Beijing's comprehensive score of 0.15, Shandong's comprehensive score of -0.18 and Zhejiang's comprehensive score of -0.21 in 2016. In 2017, the comprehensive scores of the three provinces and cities were all positive and developed rapidly. The third category includes Shanghai, Hebei, Fujian, Tianjin and Hainan. The comprehensive scores of the third-class provinces and cities in 2016-2020 were all negative, and compared with the first two types of provinces and cities, the development of innovation and entrepreneurship in Hainan was the slowest, ranking 10th in 2016-2020.

There is polarization in the comprehensive scores among provinces and cities in the eastern region. For example, in 2020, the average comprehensive score of innovation and entrepreneurship in 10 provinces (cities) in the eastern region was 0.704, that of Guangdong province was 5.79, and that of Hainan was -3.12, with a difference of 8.91 between them. The polarization phenomenon is serious.

3.2.2 Analysis of Dynamic Characteristics of Innovation and Entrepreneurship Ability of Scientific and Technological Talents in Hebei Province

The variance contribution rate of the development factors of regional innovation capability in first principal component reached 57.226%, which had the greatest impact on regional innovation and entrepreneurship. As can be seen from Figure 2, the development factor of regional dual-innovation capability in Hebei Province has developed fastest, rising from -2.73 in 2016 to -1.34 in 2020. It can also be seen from Table 8 that the ranking of regional dual-innovation capability development factor has risen from 9th in 2016 to 7th in 2020. The increase of R&D personnel, the full-time equivalent of R&D personnel, the expenditure of science and technology and the internal expenditure of R&D funds in Hebei Province, as well as the emphasis on supporting infrastructure of education, innovation and entrepreneurship have played a key role in the promotion of the ranking of regional innovation capability development factors in Hebei Province. From 2016 to 2020, the internal expenditure of R&D funds in Hebei Province increased from 38.343 billion yuan to 63.437 billion yuan, an increase of 65.45%; Although the number of R&D personnel, the full-time equivalent of R&D personnel and the expenditure on science and technology fluctuate slightly, the overall situation is on the rise. From 2016 to 2020, Hebei Province's education funds ranked fifth among all provinces and cities in the eastern region, which provided good educational support for innovation and entrepreneurship in Hebei Province. The number of scientific and technological enterprises in Hebei Province has also increased year by year, from 102 in 2016 to 282 in 2020, which has improved the score of regional innovation capability development factor in Hebei Province. In recent years, Hebei Province has also continuously increased its support for big data and increased its investment in fixed assets of information transmission, software and information technology services. In 2020, the fixed assets investment of information transmission, software and information technology services in Hebei Province was 56.144 billion yuan, ranking third in the eastern region of China. The backward economic output of innovation and entrepreneurship and the output of knowledge and technology in Hebei Province are the main reasons for the backward ranking of regional innovation capability development factors in Hebei Province. Compared with other provinces and cities in the east of China, Hebei has fewer coastal areas, and its market development and openness are lower than those of other coastal provinces and cities in the east. In 2016, the sales revenue of new products of industrial enterprises above designated size in Hebei reached 392.314 billion yuan, and in 2020, the sales revenue reached 719.098 billion yuan, with a rapid growth, ranking 6th-7th in 2016-2020. In the output of knowledge and technology, the number of papers published by universities in Hebei province, the number of domestic patent applications accepted and the number of domestic patent applications authorized are in a inferior position, lagging behind other provinces and cities in eastern China, ranking 8th-9th.

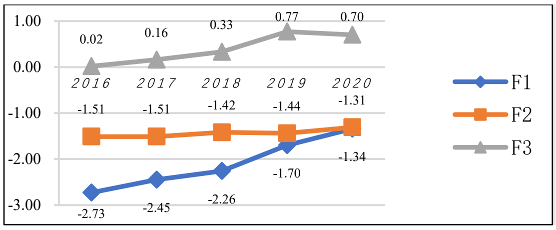

Figure 3: Chart of principal components of innovation and entrepreneurship ability in Hebei Province from 2016 to 2020

The variance contribution rate of the second principal component is 18.571%. As can be seen from Figure 3, the development of regional dual innovation transformation capacity factor in Hebei Province is relatively slow. In 2016 and 2017, the score of this component was -1.51. In 2018, the score slightly increased to -1.42, then decreased to -1.44 in 2019, and rose to -1.31 in 2020. The ranking of this factor is also at the bottom, 9-10, which is mainly due to the fact that Hebei Province's R&D investment intensity, technology market turnover and the average number of college students per 100,000 population are lower than other eastern provinces and cities. From 2016 to 2020, Hebei Province ranked 8th in terms of technology turnover, which is far from the developed cities in the east.

Table 8: Scores and rankings of main components of innovation and entrepreneurship in Hebei Province from 2016 to 2020

	2016		2017		2018		2019		2020	
	score	ranking	score	ranking	score	ranking	score	ranking	score	ranking
F1	-2.73	9	-2.45	9	-2.26	9	-1.70	8	-1.34	7
F2	-1.51	10	-1.51	9	-1.42	9	-1.44	9	-1.31	10
F3	0.02	4	0.16	8	0.33	7	0.77	9	0.70	3

The third principal component, the regional double-innovation economic development factor, was on the rise in 2016-2019, from 0.02 in 2016 to 0.77 in 2019, and declined slightly to 0.70 in 2020, but the ranking fluctuated greatly. In 2016, the per capita GDP of Hebei was 43,062 yuan, ranking 9th in the eastern region, which was relatively backward. However, in 2016, the investment in fixed assets of scientific research and technical services in Hebei was 35.18 billion yuan, ranking third, ranking first. Therefore, comprehensively speaking, the regional dual-innovation economic development factors ranked first in 2016, and the variance contribution rate of the regional dual-innovation economic development factors was 8.769%, which had a limited impact on the innovation and entrepreneurship of Hebei.

From the cluster genealogy, we can know that Hebei province is in the third group, and its comprehensive ability of innovation and entrepreneurship is weak, and the comprehensive scores of Hebei from 2016 to 2020 obtained by the global principal component analysis method are all negative, with the comprehensive score of -2.18 in 2016 and -1.12 in 2020. In terms of ranking, the comprehensive ranking of innovation and entrepreneurship in Hebei province from 2016 to 2018 ranks ninth. In 2019-2020, it ranked seventh. It can be seen that Hebei's innovation and entrepreneurship ability is gradually improving, but it is still lower than the average level in the eastern region, and the gap between Hebei and the average level in the eastern region is expanding.

4 CONCLUSIONS AND SUGGESTIONS

By comparing with other eastern provinces (cities), this paper analyzes and evaluates the innovation and entrepreneurship ability of Hebei. The empirical results show that from 2016 to 2020, the innovation and entrepreneurship capacity of Hebei is on the rise, but Hebei is located in the third echelon in the eastern region, and there is a big gap with other developed provinces (cities) in the east, which is characterized by poor innovation and entrepreneurship capacity, insufficient investment in innovation and entrepreneurship, low innovation and entrepreneurship output, and the basic environment for innovation and entrepreneurship needs to be improved. According to the above evaluation results and the present situation of innovation and entrepreneurship development in Hebei, the following suggestions are put forward.

First of all, all market players should conform to the development requirements of the era of big data, actively integrate into innovation and entrepreneurship, and improve the quality of innovation and entrepreneurship. Secondly, Hebei Province should establish an innovation and entrepreneurship data platform based on big data, and use information technology and computer technology to form an innovation and entrepreneurship atmosphere of data analysis, management and decision-making, so as to improve the efficiency of innovation and entrepreneurship. At the same time, Hebei should change from government-led to market-led in technological innovation, and constantly improve the construction of technology market system. Finally, Hebei should improve the regional coverage of new infrastructure, make rational layout, make overall planning and develop key areas and industries.

Acknowledgements: In 2021, the key research project of humanities and social sciences in colleges and universities of Hebei Province, Research on the Implementation Path of xiong'an new area Innovation and Entrepreneurship Elements Agglomeration (SD 2021021)

REFERENCES

[1] DangWei, WangHairui, LiGuojun. (2015). Evaluation of regional independent innovation capability in East China-based on grey cluster analysis and global principal component analysis. J. Industrial Technology and Economy. 34(08), 99-107.

[2] HuangHuan, Ethan, GuoYimeng, Peng Xiaohong. (2017). Evaluation of regional dual innovation comprehensive ability and analysis of its spatial structure evolution-taking Sichuan Province as an example. J. Soft Science. 31(08), 76-80.

[3] HuPing. (2019). Research on the evaluation and promotion path of "mass entrepreneurship and innovation" in Zhejiang Province .J. Journal of Hubei University of Economics (Humanities and Social Sciences Edition). 16(02), 56-60.

[4] LuoRuixue, CaiXuexiong. (2013). Dynamic Study on Comprehensive Evaluation of Urbanization Level in Fujian Province-Based on Global Principal Component Analysis. J. Fujian Forum (Humanities and Social Sciences Edition). (12), 135-139.
[5] MaYanyan, GuoJin, ZhangKailin. (2018). Evaluation of regional innovation capability in Northeast China based on global principal component analysis. J. Science and Management. 38(06), 18-26.
[6] ParkZhefan, MiaoBinbin, ZhangWeien. (2019). Research on Evaluation of Regional Economic Innovation and Development Capability-Taking Zhejiang Province as an Example. J. Journal of Hebei University of Economics and Business. 40(03), 87-93 ..
[7] WangLing. (2021). Dynamic evaluation of regional industrial competitiveness of 17 cities (prefectures, districts) in Hubei Province-calculation based on global principal component analysis J. Hubei Social Sciences. 77-83.
[8] ZhangQiang, YanKai. (2020). Research on the comprehensive competitiveness of the Yangtze River Delta port group based on global principal component analysis and cluster analysis. J. Journal of Dalian Maritime University (Social Science Edition). 19(06), 66-72.
[9] ZhuMeifeng. (2020). Quantitative analysis of Shanxi's talent attraction based on global principal component [J]. Journal of North University of China (Social Science Edition). 36(06), 71-76.