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Evaluation of Creative Space Efficiency in China' Provinces Based on AHP Method

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Abstract

The AHP method was used in 30 provinces of China to construct the index system of creative space efficiency evaluation and determine the weight of each index. The fuzzy comprehensive evaluation method was further used to score the indexes at all levels, and then the total efficiency score was sorted. The purpose of this study is to adjust the regional layout of creative space reasonably and implement financial policies accurately through the evaluation of the efficiency of creative space. The results is ranking top in weight of several indicators, which include the number of incubated Startups, the number of innovation and entrepreneurship mentors, the survival rate of incubator, the innovative training activities, etc. It was also found that Beijing, Shanghai, Jiangsu, Guangdong and Zhejiang ranked first in the score of creative space efficiency. This study is meaningful in that it was In order to effectively solve the problem of the imbalance of the creative space efficiency in China's province, by coordinating the regional pattern, establishing a sound service system and improving the efficiency evaluation system.

Keywords: *Creative space; efficiency evaluation; AHP method; Fuzzy comprehensive evaluation; Entrepreneurial innovation*

1. Introduction

In 2014, China's central government proposed "mass entrepreneurship, mass innovation ", and the whole country began to systematically deploy entrepreneurial innovation. In 2015, the central government also proposed: "norms guide the construction and development creative space, and increase moving of mass entrepreneurship and innovation work," which was also the first time that the concept of creative space had emerged. The emergence of creative space' concept also marked the entry of China into the era of innovation 2.0. Grassroots people had become the main force of entrepreneurship, promoted the development of innovation in China. In 2016, the Ministry of Science and Technology of China issued documents calling for the development of creative space to remove obstacles and shorten the approval process. In 2017, the proposal of "innovation and entrepreneurship demonstration base" promoted the construction process of mass

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innovation space base, and land, capital and other elements entered the arena. In November 2018, the Ministry of Finance, the Ministry of Education, the Ministry of Science and Technology and the State Administration of Taxation of China jointly issued a letter, which aimed at further opening up a new situation in the economy and improving the efficiency of creative space, such as science and technology business incubators and university science and technology parks. Under the guidance of the joint policies of the central and local governments, a large number of creative spaces had emerged.

As of 2019, the number of technology incubators reached 4500, the number of creative space was more than 6000, the number of enterprise incubator platform team was more than 540,000. As mass entrepreneurship and innovation's policy weight grows, more and more companies and teams were attracted, but then problems arising. For example, the layout of regional space was uneven, and creative space mainly concentrated in Beijing, Shanghai, Guangzhou and Shenzhen, such as the first-tier cities, these areas of space applications were extremely fierce. At present, China's mass entrepreneurship economy still relies on policy support, and other important phenomena still exist, mostly relying on policy subsidies. To evaluate the efficiency of creative space in the province of China is beneficial to the government departments to have an objective understanding of it, to adjust the regional layout of public creation space reasonably, and to adopt accurate financial policy to carry out targeted support.

2. Prior study

Different countries have different references to creative space, and Western countries mainly used Fablab, Sharing platform, Techshop and other words to describe it. Sarfraz pointed out that the science and technology business incubator is a kind of assistance project to adjust the various talents and resources needed by the entrepreneurial entrepreneurs in the entrepreneurial activities in the identity of the deployment center, and provide various suggestions and guidance for the entrepreneurial entrepreneurs [1]. Tod believed that through the use of shared platforms for creators and users, the implementation of processes and production and other links, so that creativity can be converted into productivity in it, this platform is mass creation space [2]. Sidaway and Anna studied mass creation space and business incubators in terms of service content, arguing that they mainly provide secretarial services, business planning, team building, market development and financial guidance specialized business services and consulting services [3,4]. Arlotto explored the relationship between mass creation space and technology enterprises, and found that the two have the co-promotion of development [5]. Schwartz put forward the best practice analysis framework of space creation, which has become a universal phenomenon in many parts of the world [6]. Low studied the operating performance of incubators in Silicon Valley, arguing that the sharing of information resources and the mobility of incubators are important factors to improve the performance of incubators [7]. Liden studied the key factors influencing the operation of local business incubators in the United States, and the results showed that business skills, incubation training, brand image, financing channels directly affected the performance of incubators [8]. According to the service demand of different types of enterprises, Singh pointed out that the factors of market and management are more important in nonlinear innovation and entrepreneurship based on the difference between linear innovation and nonlinear innovation [9]. Shen has carried on the research on the influence factors such as hardware facilities, service quality, cooperation and so on in the Chinese colleges and universities [10].

In recent years, some scholars have explored the theory of entrepreneurship. liu analyzed the general and special principles of constructing the evaluation index system of college students' employment entrepreneurship education by AHP [11]. Xiong synthesized the basic DEA efficiency evaluation model and improved the competitive DEA cross-efficiency model, taking the important operation index of several high-

tech enterprises such as technological innovation, advertising input and brand value as the evaluation index, evaluated the operational efficiency of high-tech entrepreneurial enterprises in different regions of China, and analyzed the input redundancy and output deficiencies of non-DEA effective high-tech entrepreneurial enterprises in various regions [12]. Zhou constructed a comprehensive evaluation model of the combination of the two to evaluate the scientific and technological entrepreneurial talent ecosystem, according to the characteristics of analytic hierarchy process and data envelopment analysis [13].

In summary, a series of qualitative research results have been produced, quantitative research results are rare. But many scholars have begun to explore the mathematical methods and tools of entrepreneurship, and formed a solid foundation. To this end, this study adopts AHP method to evaluate the efficiency of China creative space in order to provide more accurate financial targeting support.

3. Empirical analysis & construction of evaluation index system of creative space efficiency

3.1 AHP method for construction of evaluation index system of creative space efficiency

3.1.1 Calculation Process

This study analyzed the relationship between each index of maker space, and established a hierarchical rating index system. After the system was established, the important relationship between the two variables is determined, and its relative importance can be expressed by 1-9 scale method. The meaning of the indicators is shown in table 1:

Table 1. Meaning of scale

Scale	Definition	Meaning
1	Equally important	The two elements are equally important
3	Slightly important	The former is slightly important than the latter
5	Obviously important	The former is obviously important than the latter
7	Strongly important	The former is Strongly important than the latter
9	Absolutely important	The former is absolutely important than the latter
2,4,6,8	Intermediate value of adjacent scale	Intermediate value of the above judgment

For the n index of the same level, the judgment matrix of pairwise comparison can be $A = (b_{ij})$, which should be satisfied, $b_{ij} > 0, b_{ij} = 1/b_{ij}$

Calculate the product M_i of each row of the judgment matrix A:

$$M_i = \prod_{j=1}^{n} b_{ij} \qquad i = 0,1,2,\cdots,n$$

Calculate the m-th root of each row M_i: $\alpha_i = \sqrt[n]{M_i}$

Normalize vector $\alpha = (\alpha_1, \alpha_2 \cdots \alpha_n)^T$: $W = \frac{\alpha_i}{\sum_{i=1}^{n} \alpha_i}$, and W is the index weight.

Get the maximum eigenvalue: First, there is

$$\omega = AW = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{12} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix} \begin{pmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{pmatrix} = \begin{pmatrix} \omega_1 \\ \omega_2 \\ \\ \omega_n \end{pmatrix}$$

Then, the maximum eigenvalue is

$$\lambda_{max} = \sum_{i=1}^{n} \frac{\omega_i}{W_i}$$

In order to prove the rationality of the calculated weights, the consistency test should be carried out, and the maximum eigenvalue is used to calculate the consistency index: $\mathrm{CI} = \frac{\lambda_{max}-m}{m-1}$, Than relative consistency index is : $\mathrm{CR} = \frac{CI}{RI}$ (For *RI* is the average random consistency index, which is an empirical value. Size of *RI* is related to the order, can be obtained by looking up the table). The smaller the value of *CR*, the better the consistency of the judgment matrix will be. When *CR* less than 0.1, the better the consistency satisfaction is considered.

Table 2. Average random consistency index

Order	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

CITE:The evaluation index system of overall planning urban and rural economic and social development and its application, Fu Zhaogang (2006)

3.1.2 Determination weight of index system of creative space efficiency

Evaluation of creative space efficiency requires a comprehensive and complex system, with the total index (expressed in A), mainly reflected in the 5 secondary indicators (expressed in B), including manpower input, financial input, material input, service output and incubation output. The 5 secondary indicators include 20 tertiary indicators (expressed in C). The manpower input B1 consists of 4 three levels: the number of managers, the number of technicians, the number of service personnel and the number of innovative and entrepreneurial mentors. The financial input B2 contains 3 three levels: the R & D investment, the public equipment investment and the total investment. The material input B3 includes the total area, the public space area, the number of public equipment sets and the network coverage. And the service output B4 includes developing innovative services, innovative training activities, attracting teams and the number of participants Incubation output B5 includes 5 three levels: the number of incubators, the survival rate of the incubators, the turnover of the technology market, the number of patents granted, and the number of scientific papers. As shown in table 4.

We asked 20 experts about the relative importance of the indicators at all levels of index system of creative space efficiency through questionnaires, and first constructed the judgment matrix, then carried on the calculation and consistency test. The secondary indicators are used as examples to illustrate the example, which include manpower input, financial input, material input, service output and incubation output.

Table 3. Level 2 indicator judgment matrix for expert ratings

A	B1	B2	B3	B4	B5
B1	1	3	4	2	0.5
B2	0.33333	1	2	0.5	0.25
B3	0.25	0.5	1	0.33333	0.2
B4	0.5	2	3	1	0.25
B5	2	4	5	4	1

It calculated the eigenvector of Table 3' matrix, $W = (0.259, 0.096, 0.061, 0.149, 0.435)^T$, then calculated the maximum eigenvalue $\lambda_{max} = 5.095$, $CI = 0.024$, and finally calculated the consistency coefficient value $CR = 0.0238$. This can be found that 0.0238 is less than 0.1, passed the test of consistency coefficient.

In the same way, the weights of other third-level indicators can be calculated. In addition, *CR* value of the secondary index B1 is 0.048, the value of B2 is 0.092, the value of B3 is 0.010, the value of B4 is 0.005, and the value of B5 is 0.007, all of which are also less than 0.1. There is Table 4 for specific secondary index weight, tertiary index weight, composite weight and sorting.

Table 4. Evaluation index system and weight of space efficiency

Level 1 indicators	Level 2 indicators	Level 2 Weight	Level 3 indicators	Level 3 Weight	Composite weights	Sorting
Total indicators	Manpower input B1	0.257	Number of managers C1	0.157	0.04	9
			Number of technicians C2	0.272	0.07	5
			Number of service staff C3	0.088	0.024	12
			Number of innovative entrepreneurship mentors C4	0.483	0.124	2
	Financial input B2	0.094	R &D Investment C5	0.626	0.059	7
			Public utility input C6	0.238	0.022	15
			Total investment C7	0.136	0.013	17
	Material input B3	0.06	Total Area C8	0.059	0.004	20
			Public Space Area C9	0.195	0.012	19
			Public equipment sets C10	0.468	0.028	11
			Network coverage C11	0.278	0.017	16
	Service output B4	0.149	Special innovation services C12	0.088	0.013	17
			Innovative training activities C13	0.483	0.072	4
			Attracting Entry Team C14	0.157	0.023	13
			Attracting Admissions C15	0.272	0.041	8
	Incubation output B5	0.441	Number of Incubated Startups C16	0.445	0.196	1
			Survival Rate of Incubator C17	0.262	0.116	3
			Technical market turnover C18	0.152	0.067	6
			Number of patents C19	0.088	0.039	10
			Number of scientific papers C20	0.052	0.023	13

3.2 Empirical Analysis

3.2.1 Example of fuzzy comprehensive evaluation

After determining the weight of the evaluation index system of creative space efficiency by AHP method, this paper evaluated the efficiency of creative space in various provinces of China. For each index, the fuzzy comprehensive evaluation method was adopted to score, then the rating grade gained 5 grades: very good, relatively good, general, relatively poor, very poor. And the set of fields is expressed as. $V = \{V_1 V_2 V_3 V_4 V_5\}$. The fuzzy relation matrix R can be obtained by selecting 20 experts from the Department of Education, university teachers and entrepreneurs to evaluate the efficiency of creative space in some provinces. Taking the second-level index B1 in Guangdong province as an example, this paper explained the calculation process of the results of the efficiency evaluation of creative space:

$$R_1 = \begin{bmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \end{bmatrix} = \begin{bmatrix} 0.3 & 0.5 & 0.1 & 0.1 & 0 \\ 0.5 & 0.3 & 0.1 & 0.1 & 0 \\ 0.5 & 0.3 & 0.1 & 0.1 & 0 \\ 0.4 & 0.3 & 0.2 & 0.1 & 0 \end{bmatrix}$$

$W_1 = [0.157 \quad 0.272 \quad 0.088 \quad 0.483]$ The single-layer fuzzy evaluation results can be calculated according to the formula $B_1 = R_1 W_1$. And $W_1 = [0.157 \quad 0.272 \quad 0.088 \quad 0.483]$ also can be described the weight of 4 third level indicators under B1 second level indicators. It can be calculated that:

$$B_1 = [0.421 \quad 0.331 \quad 0.148 \quad 0.100 \quad 0]$$

The results show that 42.1% of the experts think Guangdong province is doing very good on the manpower input B1 index, 33.1% think that the manpower input is relatively good, 14.8% think that the level of manpower input is general, and 10% think it is relatively poor, none think it is very poor.

In the same way, we can get the results of single-layer fuzzy evaluation of other secondary indexes of creative space efficiency in Guangdong province. Just as:

$$B_2 = [0.623 \quad 0.319 \quad 0.033 \quad 0.025 \quad 0]$$
$$B_3 = [0.611 \quad 0.248 \quad 0.095 \quad 0.046 \quad 0]$$
$$B_4 = [0.617 \quad 0.257 \quad 0.126 \quad 0.000 \quad 0]$$
$$B_5 = [0.703 \quad 0.266 \quad 0.031 \quad 0.000 \quad 0]$$

After calculating the second level index B layer, the fuzzy evaluation results of the total index A layer can be calculated according to the weight summary. Then calculated:

$$A = RW = \begin{bmatrix} 0.421 & 0.311 & 0.148 & 0.100 & 0 \\ 0.623 & 0.319 & 0.033 & 0.025 & 0 \\ 0.611 & 0.248 & 0.095 & 0.046 & 0 \\ 0.617 & 0.257 & 0.126 & 0 & 0 \\ 0.703 & 0.266 & 0.031 & 0 & 0 \end{bmatrix} [0.257 \quad 0.094 \quad 0.060 \quad 0.149 \quad 0.441]$$

It can be calculated that:

$$A = [0.605 \quad 0.286 \quad 0.078 \quad 0.031 \quad 0]$$

The principle of maximum membership refers to the highest proportion of all grades as the final evaluation conclusion. It can be found that 60.5% of the expert opinion thinks that the total index is very good, and 98.9% of the opinions give very good and relatively good. This can get the conclusion that efficiency of creative space in Guangdong Province is very high.

3.2.2 Empirical Analysis of China's Provinces

Due to the serious lack of statistical data in Tibet, which is not conducive to the scientific analysis, the statistical samples of Tibet was removed. In addition, an empirical analysis was made on the other 30 provinces excluding Taiwan, Hong Kong and Macao.

The index scores of the analysis included total index A of creative space efficiency and manpower input B1, financial input B2, material input B3, service output B4, incubation output B5. Table 5 can be obtained by taking the very good and relatively good proportion of opinions in fuzzy comprehensive evaluation algorithm as the score of evaluation index of creative space efficiency.

Table 5. Scores of Creative Space Efficiency Evaluation in China's 30 Provinces

	Beijing	Shanghai	Jiangsu	Guangdong	Zhejiang	Chongqing	Tianjin	Shandong	Fujian	Hubei
B1	0.798	0.795	0.755	0.707	0.756	0.805	0.697	0.694	0.717	0.718
B2	0.901	0.913	0.923	0.909	0.64	0.897	0.877	0.875	0.81	0.859
B3	0.992	0.998	0.924	0.897	0.913	0.8	0.812	0.831	0.845	0.764
B4	0.987	0.989	0.92	0.903	0.92	0.897	0.903	0.892	0.887	0.917
B5	0.989	0.991	0.989	0.989	0.987	0.909	0.917	0.915	0.913	0.902
A	0.994	0.982	0.931	0.891	0.89	0.873	0.849	0.847	0.846	0.845
	Liaoning	Hunan	Henan	Hubei	Anhui	Sichuan	Jilin	Shaanxi	Shanxi	Heilongjiang
B1	0.817	0.704	0.729	0.689	0.683	0.499	0.478	0.416	0.314	0.325
B2	0.859	0.753	0.695	0.707	0.703	0.6	0.594	0.551	0.514	0.487
B3	0.764	0.762	0.728	0.668	0.688	0.613	0.704	0.623	0.539	0.495
B4	0.917	0.89	0.9	0.893	0.884	0.799	0.781	0.624	0.591	0.463
B5	0.902	0.85	0.847	0.853	0.85	0.835	0.697	0.617	0.547	0.429
A	0.845	0.805	0.804	0.793	0.789	0.682	0.656	0.561	0.491	0.417
	Jiangxi	Yunnan	Guizhou	Inner Mongolia	Guangxi	Hainan	Gansu	Xinjiang	Ningxia	Qinghai
B1	0.314	0.296	0.354	0.264	0.251	0.217	0.187	0.067	0.013	0
B2	0.419	0.364	0.324	0.257	0.242	0.219	0.196	0.039	0.021	0
B3	0.436	0.392	0.367	0.261	0.219	0.196	0.175	0.045	0.021	0
B4	0.405	0.386	0.379	0.318	0.215	0.185	0.167	0.067	0.037	0
B5	0.418	0.404	0.368	0.307	0.295	0.267	0.195	0.124	0.048	0.013
A	0.391	0.369	0.362	0.291	0.262	0.233	0.188	0.088	0.033	0.006

From Table 5 and Figure 1, it can be found that the scores of the first echelon include Beijing, Shanghai, Jiangsu, Guangdong, Zhejiang and Chongqing, with a score of more than 0.85. Especially in the first three regions exceed 0.9, and the efficiency of comprehensive innovation is extremely high. The second echelon

include Tianjin, Shandong, Fujian, Hubei, Liaoning, Hunan, Henan, Anhui, Sichuan, Jilin, Shaanxi, with a score of 0.5-0.85. And the third echelon consist of Shanxi, Heilongjiang, Jiangxi, Yunnan, Guizhou, Inner Mongolia, Guangxi, Hainan, Gansu, with a score of between 0.15-0.5. And the fourth echelon consist of Xinjiang, Niingxia, Qinghai, with a score 0-0.15. The highest score is 0.994 points in Beijing, and the lowest score is 0.006 points in Qinghai, and the overall score of the provinces is very large. Among the provinces that rank before Anhui, the score change is relatively smooth, the score from Sichuan began to show a sharp decline. This trend continues to the following provinces, reflecting the imbalance of input and output of creative space resources in China.

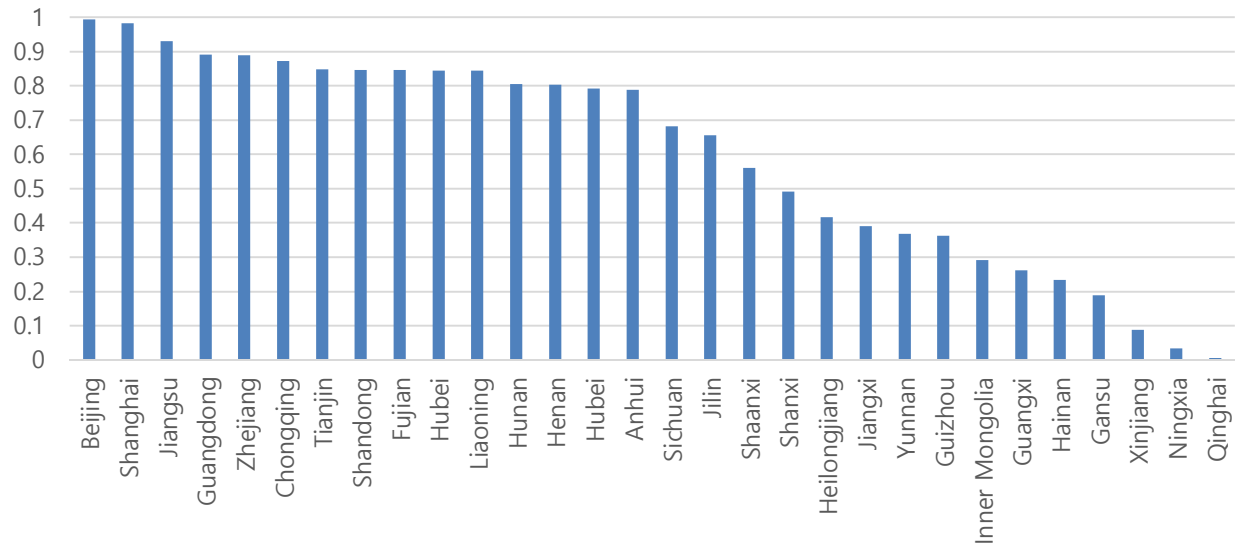

Figure 1. Ranking Chart of Total Indicators in 30 Provinces of China

4. Suggestions

4.1 Coordinating regional pattern of creative space

We should formulate the policy of coordinating the development of regional creative space from the national level. The government should give priority to the mass creative resources in backward areas, improve the occupancy rate of creative space enterprises, promote talent exchange and attract financing. In addition to balance the backward areas, we should also pay attention to strengthen the management of the superior areas. For example, beijing, shanghai, jiangsu, guangdong, zhejiang and other places have developed economies, with a large number and scale of creative space. However, the homogenization development effect of these regions is also relatively obvious, so it is necessary to change the mode of quantitative growth and the mode of qualitative growth for these regions. We should continue to increase the support for the creative space in the Yangtze River Delta, Pearl River Delta and Beijing-Tianjin-Hebei region, form the spear advantage, and bring the agglomeration effect of innovation.

4.2 Establishment of service system

The lack of funds and overall service level of creative space in many regions has constrained the actual achievement transformation ability of maker space. From the point of capital, government should constantly

enrich the financing mode, strengthen the guidance of the public creation of financial funds, but also reduce the threshold of capital entry for innovative start-ups, and do a good job of fund protection. We should constantly improve the financing environment of angel investment, venture capital and private investment, cultivate angel investors and public investment institutions, and gradually standardize the financing mechanism for the construction of public creation space. In terms of relevant services, we should reasonably reduce the procedures and procedures for entering the maker space, and promote cooperation among governments, enterprises, universities, research institutes and other organizations. It is necessary to provide consulting services in intellectual property, law, accounting and finance for mass entrepreneurship and innovation enterprises, and allow the teams to register enterprises according to their work positions. Relevant government departments should give great support to administrative examination and approval.

4.3 Further Improving the Efficiency Evaluation System

In this paper, the evaluation indicators of creative space are divided into 5 secondary indicators and 20 tertiary indicators. We need to consult more experts to determine whether to add some indicators to ensure the scientific of the evaluation system of maker space efficiency. Not only should be evaluated according to the capital investment, investment and construction scale, the number of entrepreneurial mentors and so on, but also should be measured through some indicators that reflect the operation quality of creative space. The establishment of a reasonable efficiency evaluation system is conducive to the government departments to make scientific judgment, improve the efficiency of the use of funds, achieve the rational allocation of resources, input and output than achieve greater results.

5. Conclusions

Index system for evaluating the creative space efficiency was established, through a questionnaire survey of experts from the Department of education, universities and enterprises in innovation and entrepreneurship. The weight of each index is determined by AHP. Among them, the top 10 indicators are the number of incubated Startups, the number of innovation and entrepreneurship mentors, the survival rate of incubator, innovative training activities, the number of technicians, the technical market turnover, the R & D investment, the attracting admissions, the number of managers, and the number of patents. The fuzzy comprehensive evaluation method is used to evaluate 30 provinces in China, which get the scores of each index of the evaluation of maker space efficiency, and rank the total efficiency index. The efficiency of creative space in China's 30 provinces is divided into four echelons, among which Beijing, Shanghai, Jiangsu, Guangdong, Zhejiang and other regions have high efficiency level, while Gansu, Xinjiang, Ningxia and Qinghai have low efficiency level. There are great differences in the provincial evaluation scores of creative space efficiency among different echelons.

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