Analysis on the Competitiveness of Industrial Manufacturing Level in Various Regions of China

Xianke LI [1, 2, a] ,Chongyan LI [2, b*]

lixianke1987@163.com[a], lichongyan123@163.com[b]

Macao Polytech University, Macau, China[1]

Guangzhou College of Applied Science and Technology, Guangzhou, China[2]

Abstract: Industrial competitiveness is an important performance of regional industrial manufacturing level. This paper constructs a three-level index system from four aspects: economic creativity, scientific and technological innovation, energy utilization and environmental protection, and evaluates the industrial competitiveness of various regions in China. Firstly, the paper makes a statistical description and analysis of the three-level indicators, then calculates their respective weights by using the entropy weight method, and finally calculates the comprehensive score of the industrial competitiveness of various regions in China. The results show that scientific and technological innovation ability is the main factor affecting the industrial competitiveness of a region, with a weight contribution of 48.04%; The impact of economic creativity is second, and the weight contribution is 26.68%. Secondly, through k-mean cluster analysis, the industrial competitiveness of 31 regions in China is divided into three levels: leading, catching up and lagging. By improving the transaction cost of innovation activities of enterprises in the region, reducing the uncertainty risk of R & D activities in the future, the introduction of innovative talents will help to enhance the competitiveness of industries in the region.

Keywords: industrial competitiveness; scientific and technological innovation ability; economic creativity; entropy weight method; K-mean cluster analysis

1 Introduction

Industry is an industry with powerful hematopoietic function. A powerful industry can provide economic guarantee for a country to control its own destiny. Its development level reflects the productivity level of a country. The level of industrial competitiveness directly reflects the long-term driving force and development potential of a region's real economic growth.

Constructing the evaluation index system of industrial competitiveness can analyse the influencing factors of industrial competitiveness of each province. The main purpose of constructing the comprehensive evaluation index of industrial competitiveness is to further analyse the level of industrial competitiveness in various regions and find out the factors that

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affect the level of competitiveness. So as to make up for the disadvantages of regional industrial competitiveness and give better play to the advantages of industrial competitiveness. It can find an efficient and sustainable development path for the industrial development of various regions.

2 Industrial competitiveness evaluation index system

Referring to the research experience of many scholars, this paper constructs the evaluation index system of industrial competitiveness from the four perspectives of economy, science and technology, energy and environment [1] [3], and follows the scientific, systematic, feasible and operable principles to make it more in line with the needs of industrial development in the new era. This study will build a three-level indicator system, including four secondary indicators and 14 tertiary indicators. The secondary indicators include four aspects: economic creativity, scientific and technological innovation, energy utilization and environmental protection.

2.1 Economic creativity

Economic creativity reflects the industrial creativity of each province, mainly including four indicators: industrial added value, number of Enterprises above Designated Size, total profits of Enterprises above Designated Size, and total assets of Enterprises above designated size.

2.2 Scientific and technological innovation ability

Scientific and technological innovation capability is the driving force of the industrial economic capacity of each province, mainly including four indicators: R&D funds of Industrial Enterprises above Designated Size, full-time equivalent of R&D personnel of Industrial Enterprises above Designated Size, new product sales revenue of Industrial Enterprises above Designated Size, and the number of effective issued patents of industrial Enterprises above designated size.

2.3 Energy utilization capacity

Energy utilization capacity reflects the main energy consumed and utilized by the industrial creation capacity of each province. Due to the lack of some data, only two indicators are selected in this part: power generation and total power consumption.

2.4 Environmental protection capacity

The environmental protection capacity reflects the pollution generated in the process of industrial development in each province and is the embodiment of environmental consumption. It mainly includes four indicators: the investment in industrial pollution control, the discharge of chemical oxygen demand in waste water, the discharge of SO2 in waste gas and the discharge of nitrogen oxide in waste gas.

To sum up, the evaluation index system of industrial competitiveness is shown in Table 1.

Table 1: Evaluation index system of industrial competitiveness.

<table>
<tr><th>Primary index</th><th>Serial number</th><th>Secondary index</th><th>Serial number</th><th>Tertiary indicators</th></tr>
<tr><td rowspan="14">Industrial Competitiveness</td><td rowspan="4">A</td><td rowspan="4">Economic creativity</td><td>A1</td><td>Industrial output</td></tr>
<tr><td>A2</td><td>Number of enterprises</td></tr>
<tr><td>A3</td><td>Total corporate profits</td></tr>
<tr><td>A4</td><td>Total enterprise assets</td></tr>
<tr><td rowspan="4">B</td><td rowspan="4">Scientific and technological innovation ability</td><td>B1</td><td>R&D expenses</td></tr>
<tr><td>B2</td><td>R&D personnel full time equivalent</td></tr>
<tr><td>B3</td><td>Sales revenue of new products</td></tr>
<tr><td>B4</td><td>Number of valid invention patents</td></tr>
<tr><td rowspan="2">C</td><td rowspan="2">Energy utilization capacity</td><td>C1</td><td>Generating capacity</td></tr>
<tr><td>C2</td><td>Total electricity consumption</td></tr>
<tr><td rowspan="4">D</td><td rowspan="4">Environmental protection capacity</td><td>D1</td><td>Completed investment in industrial pollution control</td></tr>
<tr><td>D2</td><td>COD discharge in Wastewater</td></tr>
<tr><td>D3</td><td>SO2 emission in exhaust gas</td></tr>
<tr><td>D4</td><td>NOx emission in exhaust gas</td></tr>
</table>

3 Basic analysis of each indicator data

3.1 Descriptive statistical analysis

According to the completeness of the data obtained in the China Statistical Yearbook, this study selects the relevant data in 2020 for research and analysis. Before the formal analysis, descriptive statistical analysis was conducted on the indicator variables to increase the visual understanding of the data, as shown in Table 2.

Table 2: Descriptive statistical analysis of industrial competitiveness evaluation index.

index	average value	median	kurtosis	skewness	minimum value	maximum
A1	10057.5	6990.8	3.4	1.8	158.6	39353.9
A2	12883.1	7099.0	3.2	1.9	167.0	58483.0
A3	2208.5	1506.5	3.8	1.8	19.2	9572.1
A4	42048.4	34255.8	2.9	1.7	2044.0	150717.8
B1	4926222.8	2974157.0	4.7	2.2	8944.0	24999527.0
B2	111626.1	48809.0	5.8	2.5	190.0	700017.0
B3	25423.4	14329.0	6.5	2.6	52.0	166140.0
B4	40126.7	19033.0	9.9	3.0	92.0	305665.0

C1	2509.4	2305.4	-0.6	0.5	88.9	5811.0
C2	2426.3	2025.0	1.3	1.3	82.0	6940.0
D1	146535.1	98020.0	1.9	1.5	476.0	531335.0
D2	82.7	69.3	-1.4	0.0	5.4	161.3
D3	10.3	9.7	0.0	0.4	0.2	27.4
D4	32.9	28.6	-0.7	0.4	4.1	77.0

It can be seen from table 2 that the data of various indicators are good and can be used for subsequent analysis. Among them, the kurtosis and skewness of class indicators are similar, which indicates that there are certain similarities among indicators of economic creativity; The skewness of class B indicators is relatively close, and only B4 is in kurtosis Relatively high, the data directly to the mutual verification effect is good; However, the average number of category C and Category D indicators is close to the median, indicating that the distribution of indicators is relatively balanced. In addition, the difference between the minimum value and the maximum value reflects the difference between different regions, which indicates that there is a large gap in the industrial competitiveness of different regions.

3.2 Correlation analysis

Next, the correlation between the indicators is further analysed. The results show that: first, there is a high correlation between class a indicators and class B indicators, which indicates that there is a complementary relationship between industrial economic creativity and scientific and technological innovation ability. Technological progress helps to promote economic growth. In turn, economic growth also helps to promote technological innovation. Second, there is also a high correlation between category a indicators and category C indicators, indicating that energy consumption is an essential element of economic growth. Generally speaking, scientific and technological progress will reduce the energy consumption rate. However, as scientific and technological progress will promote the leaping development of economy and increase the energy consumption, there is a positive correlation between scientific and technological innovation capability (b) and energy utilization capability (c). Third, there is also a positive correlation between Category D indicators and other three indicators, which indicates that various economic activities will naturally produce certain environmental pollution, and economic creativity, scientific and technological innovation and energy utilization capacity can obviously increase environmental protection capacity (d). Therefore, the indicators selected in this paper are more reasonable.

4 Seeking industrial competitiveness by entropy weight method

4.1 Entropy weight method

In order to measure the level of industrial competitiveness of a region more scientifically, referring to the practices of other scholars [2], this paper uses the entropy weight method to calculate the comprehensive score reflecting the level of industrial competitiveness.

The calculation idea of entropy weight method is as follows:

The first step is to dimension Alize the original indicators and calculate the same metrics p_{ij}, see formula (1).

$$p_{ij} = {x_{ij}}/{\sum_{j=1}^{m} x_{ij}} \quad (1)$$

Step 2: calculate the entropy e of each three-level index e_i, m is the number of samples, see formula (2).

$$e_i = -k \sum_{j=1}^{n} \left(\mathrm{p_{ij}} \cdot \mathrm{lnp_{ij}}\right), \ k = -{1}/{lnm} \quad (2)$$

Step 3: calculate the difference coefficient g of each three-level indicator g_i, see formula (3).

$$g_i = 1 - e_i \quad (3)$$

Step 4: calculate the weight W of each three-level indicator w_{ij}, and calculate the score, see formula (4).

$$w_{ij} = {g_i}/{\sum_{j=1}^{m} g_i}, \ F_i = \sum_{j=1}^{m} (w_{ij} \cdot p_{ij}) \quad (4)$$

4.2 Analysis of calculation results

According to the calculation steps, the main indexes of the entropy weight method can be calculated, as shown in Table 3. It can be seen that after the past dimensional treatment, the column entropy of the main indicators is relatively close, and the difference coefficient is similar among similar indicators. In terms of weight results, first of all, the total weight of scientific and technological innovation capability is 48.04%, which accounts for a high proportion in the competitiveness evaluation system, reflecting that scientific and technological innovation capability plays a major role in a region's industrial competitiveness, the role of scientific research input and scientific research output on Industrial development is self-evident, and the weights of three-level indicators are relatively balanced. Secondly, the weight of the four tertiary indicators of economic innovation capability is 26.68%, which is the second highest in the overall indicator evaluation system, reflecting that a good industrial foundation will bring good output under the market orientation. Thirdly, the weight of the four three-level indicators of environmental protection capacity is 17.72%, which fully illustrates the inevitable environmental pressure in the process of industrialization with the economic growth year by year and the continuous progress of technology. Among them, the weight of completed investment in industrial pollution control is 7.5%, which is relatively high, reflecting that with the economic development to a certain stage, various regions gradually pay more attention to environmental pollution control, and their governance capacity is also continuously enhanced.

Table 3: Weights of industrial competitiveness indicators.

	index	entropy	coefficient of difference	weight	total weight
A	A1	0.889	0.111	0.063	0.2668
	A2	0.847	0.153	0.087	
	A3	0.879	0.121	0.069	
	A4	0.914	0.086	0.049	
B	B1	0.823	0.177	0.100	0.4804
	B2	0.782	0.218	0.124	
	B3	0.777	0.223	0.127	
	B4	0.770	0.230	0.130	
C	C1	0.937	0.063	0.036	0.0756
	C2	0.929	0.071	0.040	
D	D1	0.868	0.132	0.075	0.1772
	D2	0.939	0.061	0.035	
	D3	0.931	0.069	0.039	
	D4	0.051	0.029	0.029	

5 Dynamic evaluation and analysis of industrial competitiveness

5.1 Ranking analysis of each factor

This part calculates the industrial competitiveness of 31 regions in China, calculates the factor score F, and selects the top three and the bottom three regions for analysis. The factor scores are shown in Table 4 (multiply by 10000 on the basis of the original data for comparison). It can be seen from the table that Guangdong, Jiangsu and Zhejiang have achieved the national leading level in economic creativity, scientific and technological innovation, energy utilization and environmental protection; The four major indicators of Hainan Province, Tibet Autonomous Region and Qinghai province all lag far behind the national average. This shows that the 14 three-level indicators can better reflect the gap between a strong industrial province and an industrial province. In the A1 index of industrial added value, Guangdong Province with the highest score is 248 times that of Tibet Autonomous Region with the lowest score, which is enough to explain that the industrial and economic gap in China is seriously uneven. In addition, the top three provinces are the eastern coastal areas, and the bottom three provinces are the southwest. Geographical environment is also the main factor that leads to the gap of China's industrial competitiveness. Obviously, the eastern coastal areas have concentrated most of the resources and created most of the economic value [4].

Table 4: Factor scores of some regions in 2020.

region	Guangdong	Jiangsu	Zhejiang	Qinghai	Tibet	Hainan
ranking	1	2	3	29	30	31
A1	79.428	77.095	45.669	1.599	0.320	1.125
A2	92.147	79.046	75.561	0.914	0.263	0.777
A3	87.978	70.062	53.373	0.948	0.176	1.224
A4	72.759	64.335	46.257	3.284	0.987	1.731
B1	103.013	98.139	57.519	0.427	0.037	0.482
B2	127.296	97.976	87.376	0.283	0.035	0.373

B3	132.652	82.100	106.468	0.246	0.042	0.813
B4	154.627	99.555	70.108	0.720	0.047	0.468
C1	42.274	42.206	28.566	7.701	0.719	2.795
C2	57.945	53.327	40.409	6.208	0.686	3.037
D1	32.619	73.604	69.969	0.401	0.290	0.066
D2	39.577	29.633	13.058	2.103	13.016	4.240
D3	23.117	22.267	10.184	7.930	1.127	1.167
D4	37.509	29.930	23.901	4.382	3.326	2.512

Table 5: GDP of some regions in 2020.

region	Guangdong	Jiangsu	Zhejiang	Qinghai	Tibet	Hainan
Comprehensive score	0.1083	0.0919	0.0728	0.0037	0.0021	0.0021
National Ranking	1	2	3	29	30	31
GDP in 2021 (100 billion yuan)	124.37	116.36	83.09	3.35	2.08	6.48
National Ranking	1	2	4	30	31	28
GDP in 2020 (100 billion yuan)	111.15	102.81	72.79	3.01	1.90	5.57
National Ranking	1	2	4	30	31	28

Guangdong Province ranks first in the country in terms of industrial competitiveness with a comprehensive score of 0.1083, followed by Jiangsu Province with a comprehensive score of 0.0919, and Zhejiang Province ranks third with a comprehensive score of 0.728. The comprehensive scores of the three provinces are far ahead of the other 28 regions, which is inseparable from the good industrial foundation of the three regions. It can be seen from Table 5 that the industrial competitiveness of each region is significantly and positively correlated with the GDP of the region, which fully shows that the supporting foundation of a strong economic province is the industrial economic level. If the industrial economic role of the province is not significant, other industries such as mining and tourism services may have higher supporting power.

5.2 K-means cluster analysis

Measure the industrial competitiveness of 31 regions in China, calculate the comprehensive score F, and then use k-means clustering analysis to divide the above results into three categories, with clustering centres of 0.08488, 0.0287 and 0.01068 respectively. The specific results are shown in Table 6.

Table 6: Dynamic evaluation of regional industrial competitiveness in 2020.

region	Comprehensive score	ranking	gradation
Guangdong	0.1083	1	Class I
Jiangsu	0.0919	2	Class I
Zhejiang	0.0728	3	Class I
Shandong	0.0665	4	Class I
Henan	0.0364	5	Class II
Anhui	0.0363	6	Class II
Sichuan	0.0358	7	Class II

Hebei	0.0344	8	Class II
Hubei	0.0341	9	Class II
Fujian	0.0329	10	Class II
Hunan	0.0288	11	Class II
Liaoning	0.0265	12	Class II
Inner Mongo	0.0260	13	Class II
Shanxi	0.0247	14	Class II
Jiangxi	0.0246	15	Class II
Shanghai	0.0210	16	Class II
Shaanxi	0.0210	17	Class II
Yunnan	0.0200	18	Class II
Guizhou	0.0186	19	Class III
Xinjiang	0.0169	20	Class III
Guangxi	0.0157	21	Class III
Chongqing	0.0155	22	Class III
Heilongjiang	0.0143	23	Class III
Beijing	0.0121	24	Class III
Tianjin	0.0112	25	Class III
Gansu	0.0097	26	Class III
Jilin	0.0093	27	Class III
Ningxia	0.0078	28	Class III
Qinghai	0.0037	29	Class III
Tibet	0.0021	30	Class III
Hainan	0.0021	31	Class III

According to the clustering results of the comprehensive scores of various regions in China, the national average value is 0.02841, and the overall industrial competitiveness is low. This is related to China's export-oriented economic growth model. Through the use of cheap resources and cheap labour to develop labour-intensive industries, although the economic growth is fast, the industrial technology progress is relatively slow. Therefore, paying attention to the endogenous evolution of technology, vigorously developing basic research, expanding R & D investment [5], and striving to cultivate innovative industrial enterprises are conducive to improving China's industrial competitiveness.

From the perspective of the national spatial pattern, the comprehensive score of industrial competitiveness shows a pattern of "high in the East and low in the west", and the industrial competitiveness of coastal areas is significantly higher than that of central and western regions. Grade I is the top 4 regions in the comprehensive ranking, all of which are eastern coastal regions. The comprehensive score of industrial competitiveness is much higher than that of other regions, so they are in a leading position. Level II refers to the regions with the comprehensive ranking of 5-18, totalling 14 regions, mostly in the central region and some resource-based regions. The central region has undertaken the industrial specialties from the eastern coastal areas, and its industrial competitiveness has been significantly enhanced; Resource-based regions such as Shanxi and Inner Mongolia Autonomous Region have a large amount of coal reserves, supported by relatively developed heavy industries such as coal chemical industry and steel smelting. The third level is the regions with the comprehensive ranking of 19-31. These 13 regions are mainly distributed in the west of China. The industrial development lags behind obviously, and the contribution of industry to the economic growth of the whole region is not significant. Among them, there are old brand heavy industrial areas such as Heilongjiang Province and Jilin Province, which shows that the economic development of these provinces is in the process of change and the industrial economic growth is weak. Obviously, similar to the spatial imbalance of economic development, the industrial competitiveness also has an obvious spatial imbalance, which is also related to China's industrial distribution. China's emerging industries are mainly distributed in the East and coastal areas, and the inland areas are mainly labour-intensive industries. The demand for industrial technology is not very high, and the industrial competitiveness is relatively low.

6 Conclusion

The difference analysis of industrial competitiveness and economic growth level in different regions shows that improving industrial competitiveness is an important way to improve the level of regional economic growth. In order to give further play to the regional agglomeration effect and enhance industrial competitiveness, on the one hand, we should pay attention to the balance between the input and output of scientific and technological research and development of industrial enterprises, specify industrial policies to promote the R&D funds of Industrial Enterprises above the scale, encourage enterprises to invest more scientific researchers, and ensure that new products are successfully converted into profits; On the other hand, all localities should adjust measures to local conditions and develop their own industries. At the same time, they should also pay attention to the balance of industrial structure.

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