Research on the Evaluation of the Competitiveness of the Transportation Equipment Manufacturing Industry in Hebei Province of China*

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Abstract The index system of the competitiveness of the transportation equipment manufacturing industry is built in accordance with the related research and the arrow theory model. The model of the competitiveness of the transportation equipment manufacturing industry is built by applying the technique for order preference by similarity to ideal solution and the entropy weight method. By applying the index system and the model, the competitiveness of the transportation equipment manufacturing industry in Hebei Province is evaluated. The conclusion shows that the competitiveness of the Hebei Province is not strong and the policies to promote the industry in Hebei Province of China are also given.
Key words Index system; Model; Competitiveness of transportation equipment manufacturing industry; Hebei province

1 Introduction

The equipment manufacturing industry is generally the manufacturing industry of creating a variety of technical equipments to meet the developments of the national economic sectors, including the metal products industry, the general equipment manufacturing industry, the special equipment manufacturing industry, the transportation equipment manufacturing industry, the electrical machinery and equipment manufacturing industry, the electronic and communication equipment manufacturing industry and the measuring instruments and office machinery manufacturing industry. And the industry is important to promote the industrial restructuring and the sustainable economic development.

The equipment manufacturing industry has been identified as the leading industry in Hebei Province and the transportation equipment manufacturing industry is the important sub-sector. The transportation equipment manufacturing industry includes the rail transportation equipment manufacturing, the automobile manufacturing, the motorcycle manufacturing, the bicycle manufacturing, the ship and floating device manufacturing, the aerospace manufacturing and the transport equipment and other transport equipment manufacturing. The high speed EMU, the automobiles and key parts and the shipbuilding and ship repairing are the important areas for the development of the transportation equipment manufacturing industry. Therefore, the evaluation of the competitiveness of the transportation equipment manufacturing industry is important to promote the development of the industry in Hebei Province.

The equipment manufacturing industry is a unique concept of China, so the researchers are mainly the Chinese scholars. In the past related researches, the principal component analysis was often used because of the large amount of data collection and calculation. However, using principal component analysis, loss of information, the different results of using different software and subjective weights of principal component will arise, and these will lead to evaluation results are not accurate.

By using the TOPSIS (technique for order preference by similarity to ideal solution) method and entropy weight method, the competitiveness evaluation model of the transportation equipment manufacturing industry is designed. The model's Features are clear logic and simple calculation. And the latest data are collected to evaluate the competitiveness of the industry in Hebei Province.

2 The Index System of the Competitiveness of the Transportation Equipment Manufacturing Industry

The index system needs to meet the comprehensive, representative, scientific, objective and feasible principles. And the index system should truly describe the evaluation object and be easy to use and promote.

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Reference to the index system of the competitiveness of the equipment manufacturing industry in Heilongjiang Province and the arrow theory model, the index system of the competitiveness of the transportation equipment manufacturing industry is built. See Table 1.

Table 1 The Index System

Target	Criteria	Index
The competitiveness of the transportation equipment manufacturing industry: X	Resource base: X1	Total assets: X11 (Hundred Million Yuan)
		The annual average number of total employees: X12 (Ten Thousand Employees)
	Production and operation: X2	Gross industrial output value: X21 (Hundred Million Yuan)
		Industrial sales output value: X22 (Hundred Million Yuan)
	Performance: X3	Total profit: X31 (Hundred Million Yuan)

3 The Competitiveness Evaluation Model of the Transportation Equipment Manufacturing Industry Based on the TOPSIS Method and Entropy Weight Method

3.1 The combination of the TOPSIS method and the Entropy weight method

The TOPSIS method is commonly used in the evaluation. The theory is that the options are evaluated by calculating the relative distance from the options to the ideal solution and the negative ideal solution. Using the method, the weight of each index need to be determined and the weights will directly affect the authenticity of the evaluation results.

The Entropy weight method is a method of objectively determining the weights. The theory is that the smaller information entropy of an index shows the greater variation of the Index values, the more provided information, the greater role in the evaluation and the greater weight. Conversely, the higher information entropy of an index shows the smaller variation of the Index values, the less provided information, the smaller role in the evaluation and the smaller weight.

The TOPSIS method is simple and straightforward. The calculation is scientific and rational. So the TOPSIS method, combined with the use of entropy weight method, can obtain the objective and accurate results.

3.2 The competitiveness evaluation model of the transportation equipment manufacturing industry

Suppose there are m evaluation program and n indexes, there are initial data matrix $X=\left(x_{ij}\right)_{m\times n}$.

(1) Standardization of the initial data matrix.

The matrix $X=\left(x_{ij}\right)_{m\times n}$ is standardized by using (1), and the standardized matrix is $Y=\left(y_{ij}\right)_{m\times n}$.

$$y_{ij}=\frac{x_{ij}-\min\limits_{i}\left(x_{ij}\right)}{\max\limits_{i}\left(x_{ij}\right)-\min\limits_{i}\left(x_{ij}\right)} \tag{1}$$

$$i=1,2,\cdots m; j=1,2,\cdots n$$

(2) The weights of the indexes.

The matrix $Y=\left(y_{ij}\right)_{m\times n}$ is transformed by using (2).

$$p_{ij}=y_{ij}\Big/\sum_{i=1}^{m}y_{ij} \tag{2}$$

$$\left(i=1,2,\cdots m; j=1,2,\cdots n\right)$$

The entropy e_j of index j is calculated by using (3) and assume $p_{ij}\ln p_{ij}=0$, when $p_{ij}=0$.

$$e_j = -(\ln m)^{-1} \sum_{i=1}^{m} p_{ij} \ln p_{ij} \quad (j = 1, 2, \cdots n) \tag{3}$$

The weight vector of the indexes $W = (w_j)_{1\times n}$ is reached by using (4).

$$w_j = 1 - e_j \Big/ n - \sum_{j=1}^{n} e_j \quad (j = 1, 2, \cdots n) \tag{4}$$

(3) The Weighted standardized matrix.

The Weighted standardized matrix $Z = (z_{ij})_{m\times n}$ is reached by using (5).

$$(z_{ij})_{m\times n} = (y_{ij} \bullet w_j)_{m\times n} \tag{5}$$

(4) The ideal solution and the negative ideal solution.

The ideal solution S^+ is reached by using (6) and the negative ideal solution S^- is reached by using (7).

$$S^+ = \left(\max_i z_{ij}\right)_{1\times n} = (z_j^+)_{1\times n} \tag{6}$$

$$S^- = \left(\min_i z_{ij}\right)_{1\times n} = (z_j^-)_{1\times n} \tag{7}$$

(5) The relative distance from the options to the ideal solution and the negative ideal solution.

The relative distance from the option i to the ideal solution is reached by using (8) and the relative distance from the option i to the negative ideal solution is reached by using (9).

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (z_{ij} - z_j^+)^2}, (i = 1, 2, \cdots m) \tag{8}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (z_{ij} - z_j^-)^2}, (i = 1, 2, \cdots m) \tag{9}$$

(6) The relative proximity of the options and the ideal solution.

The relative proximity c_i of the option i and the ideal solution is reached by using (10).

$$c_i = \frac{d_i^-}{d_i^+ + d_i^-} \times 100 (i = 1, 2, \cdots m) \quad 0 \le c_i \le 1 \tag{10}$$

The relative proximity c_i is used to evaluate the option i. The c_i closer to one, the more excellent option i.

4 Evaluation and Results

The data of the thirty one regions in Mainland China for 2008 are collected from the 2009 china industry economy statistical yearbook. see table 2. According to the model, the index X11, X12, X21, X22, X31, respectively 0.1985, 0.1747, 0.1957, 0.1960, 0.2351 weight. The scores and rank are shown in Table 2.

By analysis the index system, the five indexes influence each other to some extent. Comparing the weights of the indexes and the scores, the more important indexes are the X11 and the X31. The X11 means the most important base of the industry. The asset of the industry means the Production scale and the production capacity. The assets are all over 1000 hundred million yuan in the regions with the stronger competitiveness. The X31 shows the profitability of the industry and it also means the technical level. The higher technical level means the higher profitability and the ability of sustainable development.

5 Conclusion

The competitiveness of the transportation equipment manufacturing industry in Hebei Province Ranks sixteenth in the thirty one provincial regions of Mainland China. The competitiveness is at the middle level and not strong. It is far behind in Jiangsu, Guangdong, Shandong and other economically developed regions in the assets, employees, production value and profit. Therefore, as the backward province, the policy should focus on the areas of comparative advantage, increase investment of the areas, train human resources of the areas and improve the matching and radiation of the areas, in order to expand the scale of the industry. At the same time, it is also important to strengthen the technological innovation in the areas for the high profitability.

Table 2 The Initial Data and Results

Region	Index					Score	Rank
	X11	X12	X21	X22	X31		
Beijing	889.96	11.13	1153.3	1138.64	52.34	24.9504	11
Tianjin	789.73	13.13	1324.56	1319.79	97.77	30.6225	10
Hebei	607.84	13.58	648.87	637.14	40.23	17.3821	16
Shanxi	127.94	3.32	103.57	102.23	6.22	3.4424	23
Inner Mongolia	133.73	1.4	123.78	123.8	4.66	2.9893	24
Liaoning	2684.02	25.74	1869.97	1877.96	76.01	47.7421	8
Jilin	1627.43	18.67	2326.89	2298.26	137.25	50.0518	7
Heilongjiang	415.41	6.29	327.1	324.46	7.22	8.6227	21
Shanghai	2972.59	26.44	2571.72	2552.21	214.69	67.6818	4
Jiangsu	3665.56	58.9	3617.44	3575.07	273.21	93.9462	1
Zhejiang	2611.52	49.46	2624.49	2536.58	131.09	64.1387	6
Anhui	840.32	13.9	839.95	820.37	25.9	19.9873	15
Fujian	524.42	12.21	647.15	628.91	35.52	16.1500	17
Jiangxi	566.8	8.7	423.79	414.57	17.39	11.8029	20
Shandong	2461.6	34.88	3099.23	3037.07	168.06	67.8915	3
Henan	510.74	14.23	865.47	852.05	80.79	22.9571	12
Hubei	2742.03	28.61	2424.07	2397.03	216.15	66.0367	5
Hunan	492.66	9.74	538.5	522.35	27.02	13.4433	19
Guangdong	2539.31	40.79	3453.17	3380.71	310.42	82.8204	2
Guangxi	475.52	8.39	677.86	658.58	30.46	14.8666	18
Hainan	65.62	0.91	72.14	78.01	-1.48	1.6111	26
Chongqing	1390.27	33.94	1859.21	1842.34	64	42.0423	9
Sichan	732.61	15.43	826.1	806.9	65.6	22.4226	13
Guizhou	188.8	4.58	108.99	100.84	4.75	4.2868	22
Yunnan	118.16	1.7	101.89	97.48	5.09	2.7130	25
Xizang	0.36	0.01	0.61	0.59	0.03	0.2530	30
Shaanxi	923.91	15.72	723.82	702.19	35.62	20.2899	14
Gansu	33.43	1.01	26.69	25.03	1.23	0.9945	27
Qinghai	2.63	0.05	2.77	3.08	0.06	0.2642	29
Ningxia	0.41	0.02	0.53	0.53	-0.01	0.2464	31
Xinjiang	10.1	0.25	11.61	12.27	0.1	0.3840	28

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