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An empirical analysis on the competitiveness of the equipment manufacturing industry in Liaoning province

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ABSTRACT

This paper presents an in-depth analysis of economic index, benefit index, innovation index, the support provided by government policy and other policy variables, based on external data pertinent to industrial competitiveness. According to the data of industrial enterprises (2012) from ten eastern provinces, this paper describes the present situation of equipment manufacturing industry cluster. On this basis, the paper articulates to what extent the competitiveness of Liaoning equipment manufacturing industry is currently within the corresponding sector of China.

KEYWORDS

Competitiveness; Equipment manufacturing; Province; Chinese Liaoning.

Industrial competitiveness is often evaluated using the comprehensive index method, completed by the linear weighted sum method. It is particularly important to determine the weights of the various indicators, which directly determines the objectivity, scientificity and reliability of the statistical results. This paper uses the principal component analysis method and the idea of dimension reduction. The original data was taken through dimensionless processing, with representative variables extracted, and then the weights of indexes were determined.[1] In this way, a number of meaningful factors were identified in place of the original variables, so that multiple complex variables can be attributed into a smaller set of several principal components, which help to clearly describe the contributions of each individual factor.

THE SELECTION OF EVALUATION METHODS

The mathematical model for the principle component analytic function

P variables are expressed as X_1... X_p; P linear combinations are expressed as Z_1... Z_P; X_{ij} represents the j-th indexed data unit of the i-th section; sigma represents the covariance matrix; a represents the mean of random vector X; and then the linear combination of the original variables becomes:

$$\begin{cases} Z_1=a_{11}X_1+a_{12}X_2+\ldots a_{1p}X_p \\ Z_2=a_{21}X_1+a_{22}X_2+\ldots a_{2p}X_p \\ \ldots\ldots\ \ldots\ldots\ \ldots\ldots \\ Z_p=a_{p1}X_1+a_{p2}X2+\ldots_{app}X_p \end{cases} \quad \textbf{(1)}$$

The process of the principal component analytic function

(1) Given P is the number of index data, n is the estimated number of samples, the amount of the original data is n*p (the research samples are 10 Eastern Provinces excluding Hainan Province).

(2) The Index data are standardized – the average value of each variable is 0, and the variance is 1.

(3) Establish the covariance matrix R to reflect and measure the level of data standardization, i.e. the greater the value of R, the more necessary it is to carry out an analysis of its principal components.

(4) According to the covariance matrix R, the characteristic value, the principal component contribution rate and the cumulative contribution rate, collectively determine the number of principal components. The characteristic value is the variance of the principal components, which is used to measure its influence. It is required that the characteristic value is greater than 1, while the cumulative contribution rate is greater than 85%. Principal component contribution rate is calculated as $W_i = \lambda_i / \sum_1^m \lambda_i$ ($i = 1,2,3,4\cdots m$, m is the number of principal component)

(5) Establish the initial factor load matrix, interpret the principal components

(6) Calculate the comprehensive scoring function F_J (J is the number of samples), calculate the comprehensive value of regional competitiveness, and then sort the values in descending order using the following formula:

$$F_j = W_1F_{1J} + W_2F_{2J} + \cdots W_mF_{mj} \quad \textbf{(2)}$$

INDEX SELECTION AND DATA SELECTION

Index and data selection must follow the principles including objectivity, availability, comparability, scientificity and comprehensiveness. Estimation of the industry competitiveness is rooted in a broadly comprehensive survey of economic indicators, efficiency indicators, and indicators of innovation and government support policy variables. Specifically, it is carried out through 4 first level indexes : industrial scale, market size, profit ability and the scientific research activities; as well as 18 second levels indexes, explained and analyzed as below.

The scale of the industry

The scale of the industry is a main source of competitiveness and thus an important influence factor. It can be further expressed by 5 second level indexes: the number of enterprises, the per capita capital assets ratio, industry labor productivity, enterprise scale and profit-tax rate.

X1: The enterprise-quantity ratio. The enterprise-quantity ratio = the numbers of regional equipment manufacturing enterprises / the total numbers of Eastern equipment manufacturing enterprises. It is to measure the level of the regional industrial scale and industrial agglomeration. The data is taken from “China industrial economy statistical yearbook 2012”.

X2: Share per capita assets. Share per capita assets = regional per capita assets / per capita assets in the Eastern area. This index not only explains and compares the enterprise size and strength of the areas, but also has a noticeable function on the regional industrial competitiveness. The scale of assets = net fixed assets + current assets.[2]

X3: Total fixed assets. Total fixed assets = regional industrial fixed assets / eastern regional industrial fixed assets, this index can measure the size and level of regional industry cluster. The data is taken from “The statistical yearbook 2012” of the provinces.

X4: Net bal value of fixed assets. NBV of fixed assets = regional industry NBV of fixed assets / eastern regional industrial NBV of fixed assets, this index can measure the scale and level of regional industry cluster, and can reflect the efficiency and level of fixed asset management activities. The data is taken from “The statistical yearbook 2012” of the provinces.

X5: Industry labor productivity. Industry labor productivity = regional GDP per capita / eastern regional GDP per capita. The data is taken from "China industrial economy statistical yearbook 2012".

X6: Enterprise sales revenue. Enterprise sales revenue = regional enterprises average sales revenue / eastern enterprises average sales revenue. This index can also measure the industry scale and the size of regional equipment manufacturing enterprises. The data is taken from "The statistical yearbook 2012" of the provinces.

X7: Tax-rate level. Tax-rate level = tax rate of regional asset / tax rate of eastern asset. Tax-rate level not only reflects the scale of the enterprises, but also reflects the level of enterprise capital operation. The higher the level of tax rate, the better the economic benefit index of the enterprise is. The data is taken from "The statistical yearbook 2012" of the provinces.

The size of the market

X8: market share. Market share = regional industry sales / eastern area sales. This index can reflect the equipment manufacturing industry market size and potential, and thus is an important factor affecting the core competitiveness of enterprises. The data is taken from the "statistical yearbook 2012" of the provinces.

X9: Industry specialization index. Industrial specialization index = the ratio between regional equipment manufacturing industry output value and total industrial output value of the regional equipment manufacturing / the ratio between eastern equipment manufacturing industry output value and the total industrial output value of the eastern area. Industrial specialization index can reflect regional equipment manufacturing industry economies of scale, benefit level, and management level. The data is taken from "China industrial economy statistical yearbook 2012".

X10: Product sales rate. Product sales rate = regional equipment manufacturing sales / gross output value of equipment manufacturing industry in the eastern area. This index can effectively reflect the economic benefits and market competitiveness of regional equipment manufacturing industry. The data is taken from "China industrial economy statistical yearbook 2012".

The capability of industry profitability

X11: The contribution rate of total assets. The contribution rate of total assets = profit + tax + interest / assets. This index can reflect asset quality, management capability and profitability of the enterprise. The data is taken from "China industrial economy statistical yearbook 2012".

X12: Asset liability ratio. Asset liability ratio = total liabilities / assets. This index reflects the capital adequacy level of the enterprise. At the same time, it reflects the management and profitability level of enterprise asset. The data is taken from "China industrial economy statistical yearbook 2012".

X13: Rate of cost-profit. Rate of cost-profit = gross profit / total cost. This index measures the economic benefit of the capital operation of enterprises and reflects the enterprise management ability. Total cost = sales cost + management cost + cost expenses.[3]

The capability of industry technological innovation

X14: R&D input level. R&D input level = the ratio between regional R&D funding and industrial sales income / the ratio between national R&D funding and industrial sales income. This index directly measures the level of scientific research investment, enterprise technology R&D capability and innovation capability. The data is taken from "China Science and Technology Statistics Yearbook 2012".

X15: Scientific and technological personnel input level. Scientific and technological personnel input level = regional scientific and technological personnel / the proportion of national employees. This index can measure the level of regional industry innovation, and can effectively reflect the regional science and technology innovation environment and the government policy towards science and technology. The data is taken from "China Technology Statistics Yearbook 2012".

X16: Enterprise research activities. Enterprise research activities = the ratio between regional research-active enterprises and the total number of regional industrial enterprises / the ratio between national research-active enterprises and the total number of national industrial enterprises. This index can reflect the overall strength of the regional science and technology innovation. The data is taken from "China Science and Technology Statistics Yearbook 2012".

X17: The level of invention patents. The level of invention patents = the number of regional invention patents / the number of national invention patents. This index reflects the achievements and research level of regional science and technology it also has influence to the regional industry level. The data is taken from "China Technology Statistics Yearbook 2012".

X18: Technical innovation ability. Technical innovation ability = the ratio between the funding for importing technology and for applying technology into practice. This index measures the ability of applying technology into practice, as well as reflects the existing technology level and R&D capability of the enterprises. The data is taken from the "China Technology Statistics Yearbook 2012".

THE EMPIRICAL ANALYSIS

Calculation of characteristic value and variance contribution rate, and the cumulative contribution rate

After the establishment of the competitiveness evaluation index system, this paper uses the SPSS 15.0 principal component analysis to initialize the 15 variables out of the 29 samples. The results are based on 5 common factors and cumulative variance contribution rate of 87.65 (>85%), which meets the conditions of the principal component analysis. See TABLE 1:

TABLE 1 : Total variance explained table

Initial Characteristic value	Rotate sums of squared loadings

No. Principal component	Characteristic value	Contribution rate%	Cumulative contribution rate %	Characteristic value	Contribution rate%	Cumulative contribution rate %
1	5.26	38.23	38.23	5.87	42.66	42.66
2	3.37	24.49	62.72	2.67	19.40	62.06
3	1.97	14.32	77.04	1.75	12.72	74.78
4	1.23	8.94	85.98	1.54	11.19	85.97

According to the TABLE, this paper selects 4 principal components in place of the 18 original variables (the cumulative contribution rate has reached 85.97%). The 4 principal components are independent of each other, which effectively avoids multicollinearity during the empirical analysis, and thus can truly reflect the basic information of the original variable, ensuring a scientific analysis process.

TABLE 2 : The rotating factor loading matrix

Rotated Component Matrix Component				
	Factor1	**Factor2**	**Factor3**	**Factor4**
X1	-0.321	0.213	0.241	0.001
X2	0.437	0.772	0.152	0.007
X3	0.122	-0.101	0.001	-0.021
X4	0.476	0.709	0.019	-0.016
X5	0.122	0.101	-0.021	0.001
X6	0.851	0.372	0.013	-0.015
X7	0.103	0.115	-0.031	0.003
X8	0.785	0.401	-0.109	-0.021
X9	0.365	0.852	0.157	0.001
X10	0.837	0.201	0.007	-0.031
X11	0.525	0.103	-0.019	0.012
X12	0.103	-0.027	0.826	0.016
X13	0.279	-0.104	0.707	0.103
X14	0.124	-0.019	-0.015	0.007
X15	-0.301	-0.201	0.008	-0.061
X16	0.205	0.007	0.125	0.503
X17	0.101	0.021	-0.133	0.001
X18	0.351	0.106	0.004	0.839

The original variable load matrix of the main components

After determining the specific value, variance contribution rate and the cumulative contribution rate, this paper concludes that the original variable load matrix of 4 principal components is able to replace the 22 original indicators, and reflects the key information embodied by the original variables. According to the rotated main factor of the original variable load matrix, this paper chooses the factor loading matrix which is the varimax orthogonal rotation to the power of five.[4] See TABLE 2

The resource is from "China industrial economy statistical yearbook 2012"

The TABLE above suggests the variables correspond to the four principal components:

Factor1: It is mainly determined by four variables, including enterprise sales revenue, market share, the contribution rate of total assets and the original value of fixed assets. These four variables mainly reflect the market size and the market potential of regional equipment manufacturing industry. Hence, they can be regarded as market performance factors.

Factor2: It is mainly determined by the two variables, X_2 and X_4 respectively. Share per capita assets and NBV of fixed assets mainly identifiy the scale and comprehensive strength of regional equipment manufacturing industry. Hence, they can be regarded as comprehensive strength factors.

Factor3: It is mainly determined by the two variables, X_{12} and X_{13} respectively. Asset liability ratio and rate of cost-profit mainly reflect the management and market profitability of enterprise. Hence, they can be regarded as management ability factors.

Factor4: It is mainly decided by a single variable, $X_{18.}$ Technical innovation ability not only reflects the technical level of regional industry development, but also reflects the regional industry input level and innovation ability. Hence, it can be regarded as the technology factor.

Set up a comprehensive evaluation model

Using comprehensive evaluation model, $F_j = W_1 F_{1J} + W_2 F_{2J} + \cdots W_m F_{mj}$, regional competitiveness score can be calculated as below.[5]

TABLE 3 : Four-level hierarchical equipment manufacturing industry competitiveness evaluation model

The target layer	the main factor separation layer	Industry index layer
The comprehensive competitiveness score of J province F_j	W_1=0.4266	X_6、X_8、X_{10}、X_{11}
	W_2=0.1940	X_2、X_4
	W_3=0.1272	X_{12}、X_{13}
	W_4=0.1119	X_{16}、X_{18}

According to the formula, regional principal component score is calculated[3] as:

$$F_{1J} = \frac{0.851 X_{6J} + 0.785 X_{8J} + 0.837 X_{10J} + 0.525 X_{11J}}{0.851 + 0.785 + 0.837 + 0.525}$$
$$F_{2J} = \frac{0.772 X_{2J} + 0.709 X_{4J}}{0.772 + 0.709} \quad (3)$$
$$F_{3J} = \frac{0.826 X_{12J} + 0.707 X_{13J}}{0.826 + 0.707}$$
$$F_{4J} = \frac{0.839 X_{18J} + 0.503 X_{16J}}{0.985 + 0.503}$$

The regional equipment manufacturing industry competitiveness comprehensive score

The scores of four principal components in equipment manufacturing industry of 10 eastern provinces of China are obtained with SPSS15.0. See TABLE 4 for details.

TABLE 4 : Factor score of each principal component values and ranking order

NO.	Area	principal component1	ranking	principal component2	ranking	principal component3	ranking	principal component3	ranking
1	Liaoning	-0.96	10	-0.24	6	-1.21	9	1.57	1
2	Beijing	0.03	6	0.11	5	0.03	6	1.03	2
3	Tianjin	-0.55	8	-1.35	10	1.02	1	0.85	3
4	Hebei	-0.56	9	-0.88	9	0.77	2	-0.56	8
5	Shandong	0.11	5	-0.17	7	0.73	3	-0.27	7
6	Zhejiang	0.19	4	-0.86	8	0.46	4	-0.56	6
7	Shanghai	0.36	2	0.51	3	-0.85	7	0.2	4
8	Jiangsu	0.27	3	0.68	2	-1.07	8	0.16	5
9	Fujian	-0.15	7	0.13	4	0.19	5	-1.45	10
10	Guang dong	1.26	1	2.07	1	-1.25	10	-0.95	9

According to TABLE 4, the equipment manufacturing industry of Liaoning province gets higher scores in the first and fourth principal components. It can explain that the equipment manufacturing industry of Liaoning province has strong competitiveness in enterprise scale and technological transformation, i.e. where its core competitive advantage lies. However, on the other hand, the score of Liaoning province is way lower than Guangdong, Jiangsu and Shanghai in the second and the fourth principal components. Unfortunately, such score is even lower than Tianjin and Shandong, which used to be regarded as less competitive provinces.

THE CONCLUSION OF EMPIRICAL ANALYSIS

1. In summary, the equipment manufacturing industry of Liaoning has a large scale and strong competitiveness, sitting in the middle range amongst the eastern regions. The current status explains that the equipment manufacturing industry foundation of Liaoning province is solid, and the expansion of enterprise scale played an important role in enhancing its overall competitiveness.

2. The technological transformation level of Liaoning equipment manufacturing industry is relatively high. It is able to effectively apply new technologies into practice. For a traditional industrial base, this status is quite positive and demonstrates very good potential in the future development.

3. The asset quality of Liaoning equipment manufacturing industry is poor. Capital and operational management are less than efficient. The heavy historical burden for the old industrial base has a strong impact and accounts for the main reason why Liaoning stays behind the other provinces in the eastern region.

4. Product market competitiveness of Liaoning equipment manufacturing industry is weak. It mainly relies on the expansion of scale to promote industrial growth, whereas the products are lack of technological contents and market operation ability is not strong. This is a result of imbalanced development of the economic system.

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