

The Empirical Analysis of Liaoning Equipment Manufacturing Industry Competitiveness

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Abstract. This paper uses principal component analysis (PCA) method to effectively interpret the contribution of various factors by the idea of dimension reduction, a dimensionless processing on the original data and extraction of the representative variables in order to determine the weights of indicators, to identify meaningful factors which exert significant influence on the competitiveness of Liaoning Equipment Manufacturing Industry.

1 Introduction

Known as the “Armaments Department of China”, Liaoning province is one of the old industrial bases of northeast and even the whole country, and equipment manufacturing industry (EMI) has already become the pillar of the rapid growth of regional economy and the important engines [1]. The EMI in Liaoning ranks the top ten in China and holds around 5% of the share in the whole country, and hence has obvious advantages of scale because of its size, production, gross assets, main business income and added value[2]. In division, industry of general purpose machinery in Liaoning has prominent advantage due to its 152 enterprises (including 131 large and medium-sized ones), 72.79 billion yuan of total assets and 326.138 billion yuan of main business income in which Shenyang Machine Tool Co., Ltd and Shenyang Heavy Equipment Group play vanguard role in their special industry in China [3]. At the same time, major businesses such as AVIC Shenyang Aircraft Group, AVIC Liming Engine Group, Dalian Shipyard, Wafangdian Bearing Group enjoy strong influence on domestic and international market [4].

This paper uses principal component analysis (PCA) method to effectively interpret the contribution of various factors by the idea of dimension reduction, a dimensionless processing on the original data and extraction of the representative variables in order to determine the weights of indicators, to identify meaningful factor analysis instead of the original variables, and to boils down the complex multiple variables to a few unrelated principal component.

2 Choice of evaluation method

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2.1 Basic model

Variables are respected as X_1, X_2, \dots, X_p , linear combinations are expressed as Z_1, Z_2, \dots, Z_p , X_{ij} shows the indicator data of number j belongs to unit i , and the covariance matrix is Σ , a shows the mean value of the random vector combination X . So, a linear combination of the original variables may be written as follows:

$$\left\{ \begin{array}{l} Z_1 = a_{11}X_1 + a_{12}X_2 + \dots + a_{1p}X_p \\ Z_2 = a_{21}X_1 + a_{22}X_2 + \dots + a_{2p}X_p \\ \dots \dots \dots \\ Z_p = a_{p1}X_1 + a_{p2}X_2 + \dots + a_{pp}X_p \end{array} \right. \quad (1)$$

2.2 Basic steps of principal component analysis

(1) Determine P as the number of index data, n as the estimated number of samples, and hence the number of the original data is $n \times P$. we take the east 10 provinces (Hainan province is not included) as the research sample.

(2) Standardize the indicator data to insure the average value of each variable is 0, and the variance is 1.

(3) Establish a covariance matrix R to reflect and measure the affinity degree of standardized data. The bigger is R , the necessity of principal component analysis is higher.

(4) Determine the number of principal components according to the eigenvalues of covariance matrix R , the principal component contribution rate and cumulative contribution rate. Eigenvalue is the variance of each main component and used to measure its influence. Eigenvalue should bigger than numerical value 1 and the cumulative contribution rate should bigger than numerical value 85%. Given Principal component contribution rate as

$$W_i = \lambda_i / \sum_1^m \lambda_i, \quad (i = 1, 2, 3, 4 \dots m, m \text{ is the number of main components}).$$

(5) Establish the initial factor loading matrix and then explain the main component.

(6) Calculate the comprehensive score function F_j (J is the number of samples), calculate the comprehensive values of regional competitiveness, and put them in descending order. The formula

$$F_j = W_1 F_{1,j} + W_2 F_{2,j} + \dots + W_m F_{m,j} \tag{2}$$

3 Indexes and data selection

Firstly, the choice of indicator data must follow the principle of objectivity, availability and comparability [5]. Secondly, when estimate the comprehensiveness of industry, economic indicators, efficiency indicators, innovation and even government supporting indicators should be involved [5]. Specifically, this paper will choose 4 first-level indicators including industrial scale, market scale, profitability and scientific research activities, and choose 18 second-level indicators including assets per share, market share, product sales, asset-liability ratio, R&D input level, etc.(see table 1). Relative data are from 2015 statistical yearbooks of the eastern provinces, *2015 China Statistical Yearbook on Science and Technology*, and *2015 China Industry Economy Statistical Yearbook*.

Table 1. Indexes system of industry competitiveness evaluation.

	First-level indicators	Second-level indicators
System of Industry Competitiveness Evaluation	Industrial scale	Ratio of Enterprise number Assets per share Original value of fixed assets Net value of fixed assets Industry labor productivity Company sales revenue Tax paid levels
	Market scale	Market share Industrial relative specialization index Product sales
	Profitability	Contribution of total assets Asset-liability ratio profit rate of costs and expenses
	Scientific research activities	R&D input level Science and technology personnel number Enterprise scientific research activities Level of invention patents Ability of technical innovation

3.1 Industrial scale

Industry scale is important source and influencing factors of competitiveness and can be shown by 7 second-level factors including enterprise quantity, Per capita assets ratio, industry labor productivity, enterprise scale and tax paid level.

X_1 : Ratio of enterprise number. It can be calculated as follow: *number of area formed EMI enterprises / number of national EMI enterprises*, which is used to measure the regional industry scale and that of industrial agglomeration. ^[7]The related data are from *2015 China Industry Economy Statistical Yearbook*.

X_2 : Assets per share. It can be calculated as follow: *regional assets per person / assets per person in the East*, which can indicate and compare regional enterprises size and their strength, and has the effect that cannot be ignored to the regional industry competitiveness. Assets scale can be defined as *Net value of fixed assets + liquid assets*.

X_3 : Fixed assets. It is defined as follow: *industrial total fixed assets in eastern areas / industrial fixed assets*. This index can be used to measure regional industry scale and the cluster status. The related data are from statistical yearbook 2015 of each province.

X_4 : Net fixed assets. It is defined as follow: *fixed assets of regional industry / net fixed assets of industry in the east*. This index can measure both the regional industry scale, the cluster level, and can reflect the management efficiency and level of fixed assets. The related data are from statistical yearbook 2015 of each province.

X_5 : Industry labor productivity. It can be showed as follow: *regional per capita output /per capita output of eastern area*. The related data are from 2015 China Industry Economy Statistical Yearbook.

X_6 : enterprise sales revenue. It can be defined as follow: *average sales revenue of regional enterprise / average sales revenue of the enterprise in eastern area*. This indicator can measure industry scale and regional enterprise scale of EMI. The related data are from statistical yearbook 2015 of each province.

X_7 : Tax paid levels. It is defined as follow: *rate of regional tax paid / rate of tax paid in eastern area*. This indicator can reflect the scale of the enterprise, and can also reflect the level of enterprise capital operation. In general, the higher it is, the better is the enterprise's economic benefit. The related data are from statistical yearbook 2015 of each province.

3.2 Market scale

X_8 : Market share. It is shown as follow: *regional industry sales revenue / industry sales revenue in the eastern area*. This index can indicate both the market scale of EMI and potential of EMI, and is a main factor that affects the core competitiveness of enterprises. The related data are from statistical yearbook 2015 of each province.

X_9 : Industry specialization index. This index can be calculated as follow: regional EMI production value accounts for the proportion of industrial gross output value / EMI output value accounts for the proportion of gross industrial output value in the eastern area.^[8] Industry specialization index can effectively reflect the comprehensive ability of regional EMI economic scale, benefit level, management level, etc. The related data are from 2015 China Industry Economy Statistical Yearbook.

X_{10} : Production sales rate. This index is defined as follow: regional sales of EMI / gross output of EMI in the eastern area. This index is a good indicator to reflect the economic benefits and market competitiveness of regional EMI.^[9] The related data are from 2015 China Industry Economy Statistical Yearbook.

3.3 Industry profitability

X_{11} : Contribution rate of total assets. This index is defined as follow: *(profit + interest + tax) / total assets*. It reflects the assets quality, management capability and profitability of an enterprise. The related data are from 2015 China Industry Economy Statistical Yearbook.

X_{12} : Asset-liability ratio. It is calculated as follow: *debt/total assets*. This index reflects the assets sufficiency of an enterprise, and at the same time it reflects the management capability and profitability of an enterprise. The related data are from 2015 China Industry Economy Statistical Yearbook.

X_{13} : profit rate of costs and expenses. This index is defined as follow: *profit / cost and expense*. It is used to measure the economic benefits of enterprise capital operation and can reflect the enterprise operation and management ability. Usually, Total cost and expense can be calculated as: *sales cost + management fees + financial costs*. The related data are from 2015 China Industry Economy Statistical Yearbook.

3.4 Ability of technical innovation

X_{14} : R&D input level. This index can be defined as follow: *proportion of R&D funds of regional industrial sales / R&D funds proportion of national industrial sales*. It can directly measure the R&D level, technical research and development ability and innovation ability of an enterprise. The related data are from 2015 China Statistical Yearbook on Science and Technology.

X_{15} : Input level of science and technology personnel. It is defined as below: *personnel of regional science and technology / national science and technology personnel*. In general, input of scientific research personnel indicates the innovation vigour of regional industry, and at the same time, it well reflects the regional innovation environment and the science and technology policies of government. The related data are from 2015 China Statistical Yearbook on Science and Technology.

X_{16} : Enterprise scientific research activities. This index is defined as below: *ratio of regional industrial enterprises that carry out R&D activities / ratio of national industrial that carry out R&D activities*. It indicates the overall strength of regional scientific and technological innovation. The related data are from 2015 China Statistical Yearbook on Science and Technology.

X_{17} : Level of invention patents.it is defined as follow: *quantity of regional invention patents / quantity of national invention patents*. It can reflect the regional scientific and technological achievements and scientific research level, and has a certain influence on the regional industry level. The related data are from 2015 China Statistical Yearbook on Science and Technology.

X_{18} : Ability of technical innovation which can be scribed as the proportion of funds for technology transfer, digestion and absorption. It can measure enterprise technology absorption and transformation ability, and also reflects the existing technical level and R&D capabilities. The related data are from 2015 China Statistical Yearbook on Science and Technology.

4 Procedure of empirical analysis

4.1 Calculation of eigenvalue, variance contribution rate and cumulative variance proportion

After establishing competitiveness index evaluation system, this paper takes advantage of SPSS15.0 giving a principal component analysis by using 10 samples of 18 variables. 5 common factors are chosen in the analysis result, and the accumulative variance contribution rate (87.65%) meets the analysis conditions (>85%). Detailed analysis results are shown in table 2.

Table 2. Total variance explained.

Component	Initial Eigen values		Extraction Loadings		Sums of Squared	
	Eigen values	% of Variance	Cumulative %	Eigen values	% of Variance	Cumulative %
1	5.26	38.2	38.23	5.87	42.6	42.66
2	3.37	24.4	62.72	2.67	19.4	62.06
3	1.97	14.3	77.04	1.75	12.7	74.78
4	1.23	8.94	85.98	1.54	11.1	85.97

According to table 2, we replace the original 18 with 4 principal component variables (the rate has reached 85.97%), which is independent of each other. This processing course effectively avoided multicollinearity, and reflected the basic information of the original variables.

4.2 Original variable load matrix

After determining the eigenvalue, variance contribution rate and cumulative variance proportion, the original variable load matrix of 4 principle components are calculated and shown in table 3.

Table 3 The original variable load matrix.

Rotated Component Matrix				
	Component			
	Factor1	Factor2	Factor3	Factor4
X1	-0.448	0.007	-0.027	-0.001
X2	0.105	0.103	-0.213	-0.107
X3	0.554	0.47	0.017	0.005
X4	0.634	0.109	-0.009	-0.01
X5	0.706	0.107	0.005	0.005
X6	0.815	0.501	0.201	0.176
X7	0.457	0.27	0.09	0.001
X8	0.671	0.776	0.709	0.503
X9	0.289	-0.448	-0.448	-0.448
X10	0.105	0.105	0.105	0.105
X11	0.576	0.516	0.516	0.516
X12	-0.397	-0.024	-0.024	-0.024
X13	0.51	0.442	0.102	0.001
X14	0.771	0.403	0.103	0.009
X15	0.005	0.013	-0.003	-0.015
X16	-0.017	0.001	-0.011	-0.011
X17	-0.356	0.001	-0.002	-0.002
X18	0.516	0.317	0.516	0.417

Principal components taking place of the original 18 indicators, mainly reflects the basic information of the original variables. Based on rotating the original variable load matrix, and after 5 times Varimax orthogonal rotation, the rotated component matrix is determined and shown in table 4.

Table 4 Rotated component 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

From the table above, we can identify 4 principal components corresponding to each variable: Factor1: mainly determined by four variables, X_6, X_8, X_{10} and X_{11} , namely, the enterprise sales revenue, rate of market share, the original value of fixed assets, total assets. These 4 variables mainly reflect regional market size and market potential of EMI, can be seen as market performance factors. Factor2: mainly determined by two variables, X_2 and X_4 , namely, assets per share and net value of fixed assets. They can mainly measure regional EMI scale and its comprehensive strength, and can be seen as comprehensive strength factors. Factor3: mainly determined by X_{12} and X_{13} , namely, asset-liability ratio, profit rate of costs and expenses. The two variables can indicate the enterprise management ability and market profitability, and can be seen as management factors. Factor4: mainly determined by variable X_{18} . The ability of technical absorbing and innovation reflects the technological level of the regional industry development, the regional investment level and innovation ability, and can be regarded as technical factors.

4.3 Construction of comprehensive evaluation model

By using the comprehensive evaluation model $F_j = W_1F_{1j} + W_2F_{2j} + \dots + W_nF_{nj}$, we can obtain the regional competitiveness shown in table 5.

Table 5 Four hierarchical model of EMI competitiveness evaluation

Destination layer	Score of main factor	Industry index layer
F_j , comprehensive competitiveness Score of province(or city) 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 data in table 5, scores of main factors in each region can be calculated and shown in formula (3):

$$\begin{aligned}
 F_{1,j} &= \frac{0.851X_{6,j} + 0.785X_{8,j} + 0.837X_{10,j} + 0.525X_{11,j}}{0.851 + 0.785 + 0.837 + 0.525} \\
 F_{2,j} &= \frac{0.772X_{2,j} + 0.709X_{4,j}}{0.772 + 0.709} \\
 F_{3,j} &= \frac{0.826X_{12,j} + 0.707X_{13,j}}{0.826 + 0.707} \\
 F_{4,j} &= \frac{0.839X_{18,j} + 0.503X_{16,j}}{0.985 + 0.503}
 \end{aligned}
 \tag{3}$$

4.4 Comprehensive scores of EMI in different regions

Based on the analysis by using SPSS15.0, the EMI scores of 4 principal component in 10 provinces (or cities) can be obtained and shown in table 6.

Table 6 Factor score of each principal component and rank order

N	Area	PC1	R	PC2	R	PC3	R	PC4	R
1	LN	-0.96	10	-0.24	6	-1.21	9	1.57	1
2	BJ	0.03	6	0.11	5	0.03	6	1.03	2
3	TJ	-0.55	8	-1.35	10	1.02	1	0.85	3
4	HB	-0.56	9	-0.88	9	0.77	2	-0.56	8
5	SD	0.11	5	-0.17	7	0.73	3	-0.27	7
6	ZJ	0.19	4	-0.86	8	0.46	4	-0.56	6
7	SH	0.36	2	0.51	3	-0.85	7	0.2	4
8	JS	0.27	3	0.68	2	-1.07	8	0.16	5
9	FJ	-0.15	7	0.13	4	0.19	5	-1.45	10
10	GD	1.26	1	2.07	1	-1.25	10	0.95	9

5 Conclusions of the empirical analysis

Firstly, Overall, EMI in Liaoning province has a large scale and some certain competitive power, and is in the row of medium place in the eastern region. This analysis result proves that EMI in Liaoning province has a good foundation, and its scale expansion has a certain influence on its competitiveness.

Secondly, after renovation, EMI in Liaoning province has a higher technical absorption and transformation ability. This analysis result proves that transformation of old industrial base in Liaoning province has obtained significant results. As for the old industrial base, it is a very good phenomenon and excellent developing trend.[10]

Thirdly, EMI in Liaoning province has poor assets quality and low capital management and operation efficiency due to heavy historical burden as an old industrial base which are far behind other provinces in the eastern region.

Fourthly, EMI in Liaoning province has weak competitiveness related to the immature of economic system in Liaoning province. As a result, growth of EMI in Liaoning province depends not on high product technology content and strong market operation ability, but mainly on scale expansion.

References

1. Jianfeng Cui. Brief Analysis of Industrial Clusters and Technical Innovation. SOCIAL SCIENCE FRONT, 2011(11): 252-257
2. Yanqing Zhang. technology innovation of small and medium-sized enterprisesand governmental behavior In industrial cluster .Enterprise Economy,2011(9):107-111
3. Shijie Li.Industry cluster development and the revitalization of old industrial areas : A study of Liaoning province . Beijing Shi : Zhongguo jing ji chu ban she, 2010
4. Guiping, Xiaqian. Enterprise strategic alliance stability analysis.Journal of Wuhan Science and Engineering University, 2007, 29(3): 151-152.

5. Lin Wenbao. Factors affecting the correlation between interactive mechanism of strategic alliance and technological knowledge transfer performance .Journal of High Technology Management Research, 2007(2): 139-155.
6. DAS T K, RAHMAN N. Determinants of partner opportunism in strategic alliances: a conceptual framework .Journal of Business and Psychology, 2010(1):55-74.
7. Bo Wu, Shenghua Jia. The cluster firms' network-based growth mechanics and models with the evolution of regional industry cluster. Hangzhou : Zhejiang da xue chu ban she, 2008
8. Mark Dodgson,David Gann; Ammon Salter.The management of technological innovation : strategy and practice . New York : Oxford University Press, 2008
9. Jici Wang.Industrial Clusters in China and Their Implications to Other Developing Countries. Areal Researchand Development, 2004(4):1-4
10. Paul R Krugman. Geography and trade. Cambridge, Mass:MIT Press, 1991