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Financial Performance Evaluation of Electric Power Listed Companies Based on Principal Component Analysis

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Abstract: In this paper, 64 electric power listed companies in China are selected as the research objects, and 11 indicators reflecting the financial development of electric power listed companies in China are selected to evaluate the financial performance of electric power listed companies in China by principal component analysis. Four principal components are extracted from the relevant financial data, and then the score and ranking of the comprehensive financial performance of the 64 power listed companies are obtained. The current situation of the financial performance of China's power listed companies is comprehensively and objectively evaluated through the analysis of the scores and rankings. It provides the basis for the listed companies in China's power industry to take effective measures to solve the problems and improve their comprehensive ability.

Keywords: Electric power listed company, Financial performance, Principal component analysis

INTRODUCTION

Financial performance evaluation, mainly through the analysis of the financial indicators to evaluate the development of enterprises in the overall level of the industry, and then get comprehensive evaluation results (Che, et al., 2018). Financial performance evaluation can evaluate the business efficiency and the performance of the operators in a certain period of operation, and help the information users to make relevant decisions (Wang, et al., 2014). It is conducive to the sustainable development of enterprises (Fan, et al., 2021). Therefore, how to make a scientific and objective evaluation of the financial performance of listed companies has become the focus of theoretical research. China's electric power industry is the basic industry to support the development of other industries and an important guarantee for the survival and development of the people. Therefore, it is particularly important to make a scientific and comprehensive evaluation of the financial performance of the listed companies in China's electric power industry (Yin, 2016). By studying the financial performance of listed companies in China's electric power industry, it is of great practical significance for the government to formulate corresponding policies and the company to make operational and management decisions.

THE THINKING AND STEPS OF PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) is a method of extracting principal components, which transforms many indexes with correlation into several uncorrelated comprehensive indexes (Zhu, 2006). Because these comprehensive indexes lose less information, they can still reflect most of the original information (Zheng, et al., 2012). PCA can simplify many complex problems and get more scientific and effective results, so it is widely used in the evaluation of financial performance. For example, in the study of the financial performance of coal industry (Wang, 2019), real estate industry (Wei, et al., 2016; Wang, 2020), power industry (Che, et al., 2018), and environmental listed companies (Wang, et al., 2019), PCA has been applied.

Steps of PCA

1) Standardization of original data.

Suppose there are n evaluation objects and p evaluation indexes, then the original data can form a matrix of n rows and p columns: X=$(x_{ij})_{n\times p}$. The specific formula is as follows:

$$Z_{ij}=\frac{X_{ij}-\overline{X}_j}{S_j} \tag{1}$$

Among them: i=1,2,3,...,n; j=1,2,3...,p. $\overline{X_j}$ and S_j are the mean and square difference of the j-th variable respectively.

2) The covariance matrix V of standardized matrix Z is calculated. Namely:

$$\mathrm{V}=(v_{ij}) \tag{2}$$

Among: $v_{ij}=\frac{1}{n-1}\sum_{i=1}^{m}(Z_{li}-\overline{Z}_i)(Z_{lj}-\overline{Z}_j)$,

i=1,2,3...,n;j=1,2,...,p.

3) Find the eigenvalues of covariance matrix V and the corresponding eigenvectors of orthogonalization and unitization.

The m eigenvalues of the covariance matrix V are $\lambda_1\geq\lambda_2\geq\Lambda\ \lambda_n\geq 0$, and their corresponding eigenvectors are $t_1,t_2,\Lambda\ t_n$, $t_i=(t_{i1},t_{i2},\Lambda\ ,t_{in})$,

i=1,2,3...,n. λ_i is the variance of the i-th principal component F_i. When describing the evaluated object, it can reflect the effect of the i-th principal component.

4) The cumulative variance contribution rate of principal component is calculated.

Variance contribution rate of the k-th principal component F_k :

$$a_k = \lambda_k / \sum_{i=1}^{n} \lambda_i \quad (3)$$

The cumulative variance contribution rate of the first k principal components:

$$a(k) = \sum_{j=1}^{k} \lambda_i \sum_{i=1}^{n} \lambda_i \quad (4)$$

Cumulative variance contribution rate can reflect the amount of information. The larger the value is, the more original information is reflected, and the more convincing the result is.

5) Select principal component

The final selection of several principal components is based on the corresponding eigenvalues and cumulative variance contribution rate of principal components. Usually, the first k principal components with eigenvalues greater than 1 and cumulative variance contribution rate greater than 85% are selected.

6) Calculate the comprehensive score value

First, the first k principal components are determined according to the score coefficient matrix:

$$F_i = t_{i1}X_1 + t_{i2}X_2 + \Lambda + t_{in}X_n \text{ (i=1,2,...k)} \quad (5)$$

Then, the ratio of the variance contribution rate of each of the first k principal components to the cumulative variance contribution rate of the first k principal components is used as the weight to obtain the comprehensive evaluation value:

$$F = \frac{\lambda_1 F_1 + \lambda_2 F_2 + \Lambda \ \lambda_k F_k}{\sum_{i=1}^{k} \lambda_i} \quad (6)$$

The final evaluation of financial performance of listed companies is based on the value of F.

SAMPLE SELECTION AND INDEX SYSTEM CONSTRUCTION AND ANALYSIS

Selection of samples and financial indicators

According to the current development characteristics of China's power industry, this paper selects 64 power listed companies in Shanghai and Shenzhen stock exchanges in 2019 as research samples. Before principal component analysis, it is necessary to establish a financial performance index system for evaluation (Cheng, 2020). This paper selects the current ratio, quick ratio, equity ratio, net profit rate of sales, return on net assets, net profit growth rate, growth rate of operating revenue, growth rate of total asset , basic earnings per share (year-on-year growth rate), inventory turnover and accounts receivable turnover are 11 indicators reflecting the financial situation of listed power companies. PCA and SPSS.22 software are used to comprehensively evaluate the financial performance of 64 listed power companies. The type, name and assignment of the 11 indicators are shown in Table 1 below.

Table 1. Variables of financial indicators

Index type	Index name	Variable assignment
Solvency	Current ratio	X_1
	Quick ratio	X_2
	Equity ratio	X_3
Profitability	Net profit rate of sales	X_4
	Return on net assets	X_5
Development capacity	Net profit growth rate	X_6
	Growth rate of operating revenue	X_7
	Growth rate of total assets	X_8
	Basic earnings per share	X_9
Operating capacity	Inventory turnover	X_{10}
	Accounts receivable turnover	X_{11}

Principal component analysis

1) KMO and Bartlett inspection

KMO and Bartlett test were used to test the correlation of the selected indicators. The test results are shown in Table 2. The statistical result of KMO test is 0.517 > 0.5, and the significance probability of Bartlett test is 0 < 0.05. Therefore, it can be determined that there is correlation between the variables studied, so the PCA method can be used to optimize the selected indicators.

Table 2. KMO and Bartlett test

KMO sampling suitability quantity		.517
Bartlett's sphericity test	Last card read	694.574
	df	55
	sig	.000

2) Principal component extraction

When PCA is used to extract principal components, the results shown in Table 3 below are obtained. It can be seen from the table that the initial eigenvalues of the first four principal components are all greater than 1, which are 2.508, 2.376, 1.313 and 1.227 respectively. The cumulative variance contribution rate is 67.485%. Although it does not reach 85%, it can reflect most of the financial characteristics. Therefore, in order to reduce the number of original financial indicators, it is feasible to extract four main components to carry out relevant empirical analysis.

Table 3. Explanation of total variance

	Initial eigenvalue			Extract the load sum of squares		
assembly	total	Variance percentage	Cumulative%	total	Variance percentage	Cumulative%
1	2.508	22.800	22.800	2.508	22.800	22.800
2	2.376	21.599	44.398	2.376	21.599	44.398
3	1.313	11.934	56.332	1.313	11.934	56.332
4	1.227	11.152	67.485	1.227	11.152	67.485
5	.996	9.056	76.541			
6	.918	8.341	84.882			
7	.690	6.273	91.156			
8	.650	5.911	97.066			
9	.313	2.843	99.909			
10	.009	.084	99.993			
11	.001	.007	100.000			

The initial load matrix of each financial index corresponding to the four principal components is shown in Table 4. It can be seen from the table that in the first principal component, the basic earnings per share (year-on-year growth rate) and net profit growth rate, which can reflect the growth ability of listed companies, have a high load. Therefore, the growth ability of power listed companies is mainly reflected by the first principal component. The second principal component mainly reflects the solvency of listed power companies, because the two financial indicators, namely, current ratio and quick ratio, can reflect the solvency have high load. In the third principal component, the inventory turnover rate has a high load, so the third principal component is mainly used to reflect the operating capacity of power listed companies. In the determined fourth principal component, the load of the financial index of net profit rate of sales, which can reflect the profitability of listed companies, is 0.672. Therefore, the fourth principal component is regarded as the principal component reflecting the profitability of listed power companies.

Table 4. Initial load matrix

	Assembly			
	1	2	3	4
Basic earnings per share	.895	-.187	.257	-.204
Net profit growth rate	.878	-.187	.278	-.214
Return on net assets	.716	-.228	-.411	.067
Current ratio	.213	.904	.124	-.163
Quick ratio	.219	.896	.106	-.170
Growth rate of total operating revenue	.082	-.482	.382	-.044
Equity ratio	-.378	-.454	.279	-.231
Accounts receivable turnover	-.017	.319	.246	.243
Inventory turnover (Times)	.157	-.164	.749	-.317
Net profit rate of sales	.317	.164	-.277	.672
Growth rate of total assets	.235	-.201	.229	.643

3) Building financial performance evaluation function

In this paper, F_1, F_2, F_3, and F_4 are used to represent the four principal components. The correlation coefficient is obtained from the component score coefficient matrix in Table 5, and the expressions of the following four principal components are obtained by multiplying it with the standardized
data:

$$F_1 = 0.085ZX_1 + 0.088ZX_2 - 0.151ZX_3 + 0.126ZX_4 + 0.286ZX_5 + 0.035ZX_6 + 0.033ZX_7 + 0.094ZX_8 + 0.357ZX_9 + 0.063ZX_{10} - 0.007ZX_{11}$$

$$F_2 = 0.38ZX_1 + 0.377ZX_2 - 0.191ZX_3 + 0.069ZX_4 - 0.096ZX_5 - 0.079ZX_6 - 0.203ZX_7 - 0.084ZX_8 - 0.079ZX_9 - 0.069ZX_{10} + 0.134ZX_{11}$$

$$F_3 = 0.094ZX_1 + 0.081ZX_2 + 0.213ZX_3 - 0.211ZX_4 - 0.313ZX_5 + 0.212ZX_6 + 0.291ZX_7 + 0.174ZX_8 + 0.196ZX_9 + 0.57ZX_{10} + 0.187ZX_{11}$$

$$F_4 = -0.133ZX_1 - 0.138ZX_2 - 0.188ZX_3 + 0.547ZX_4 + 0.055ZX_5 - 0.174ZX_6 - 0.036ZX_7 + 0.524ZX_8 - 0.166ZX_9 - 0.259ZX_{10} + 0.198ZX_{11}$$

Table 5. Component score coefficient matrix

	Assembly			
	1	2	3	4
Current ratio	.085	.380	.094	-.133
Quick ratio	.088	.377	.081	-.138
Equity ratio	-.151	-.191	.213	-.188
Net profit rate of sales	.126	.069	-.211	.547
Return on net assets	.286	-.096	-.313	.055
Net profit growth rate	.350	-.079	.212	-.174
Growth rate of total operating revenue	.033	-.203	.291	-.036
Growth rate of total assets	.094	-.084	.174	.524
Basic earnings per share	.357	-.079	.196	-.166
Inventory turnover (Times)	.063	-.069	.570	-.259
Accounts receivable turnover	-.007	.134	.187	.198

Finally, the variance contribution rate of each principal component is divided by the cumulative variance contribution rate of the four principal components, and the quotient obtained is used as the weight for weighted summary. The calculation formula of the comprehensive score of China's power industry listed companies in 2019 is obtained:

$$F = 0.338F_1 + 0.32F_2 + 0.177F_3 + 0.165F_4$$

FINANCIAL PERFORMANCE EVALUATION OF CHINA'S POWER LISTED COMPANIES BASED ON PCA

In this paper, the data are put into four main components and comprehensive score calculation formulas, and calculated by Excel, and the financial performance ranking of 64 listed power companies is obtained, as shown in Table 6 below:

Table 6. Comprehensive evaluation results

listed company	Comprehensive performance		listed company	Comprehensive performance	
	F	ranking		*F*	ranking
Hunan development	2.401	1	Jiangsu Guoxin	0.346	8
Sichuan investment energy	1.198	2	Jiaze Xinneng	0.243	9
Mindong Electric Power	0.672	3	Linyang energy	0.222	10
Lingda shares	0.633	4	Fuling electric power	0.220	11
Sanfang Lane	0.595	5	Hubei energy	0.196	12
United States Holdings	0.438	6	Beijing Express	0.177	13
Suihengyun a	0.379	7	China Fujian energy	0.156	14
Dalian thermal power	0.135	15	Baoxin new energy	-0.122	40
Chuanneng power	0.126	16	Gansu Power Investment	-0.123	41
Shenneng shares	0.115	17	Qianyuan electric power	-0.124	42
China Guanghe	0.111	18	Huadian, Inner Mongolia	-0.126	43
Shenzhen Energy	0.109	19	Jingneng power	-0.133	44
Energy saving wind power	0.103	20	Ningbo thermoelectric	-0.148	45
Funeng Co., Ltd	0.094	21	Huaneng hydropower	-0.152	46
Jiangsu Xinneng	0.086	22	Huadian International	-0.160	47

Continued table

listed company	Comprehensive performance		listed company	Comprehensive performance	
	F	ranking		*F*	ranking
Shaoneng Co., Ltd	0.084	23	Chendian International	-0.168	48
Wanneng power	0.060	24	Laurel crown power	-0.195	49
solar energy	0.052	25	SDIC power	-0.199	50
Guang'an Aizhong	0.050	26	Shanghai Electric Power	-0.238	51
Guangzhou Development	0.046	27	Huaneng International	-0.261	52
Changyuan power	0.043	28	Jidian Co., Ltd	-0.261	53
Xichang electric power	0.027	29	Silver Star Energy	-0.282	54
Leshan power	0.016	30	Guidong electric power	-0.305	55
Star power	0.014	31	Henan energy holding	-0.329	56
Wenshan power	0.003	32	Huayin power	-0.338	57
China Nuclear Power	0.002	33	Guodian power	-0.343	58
Guangdong electric power a	-0.029	34	Datang Power	-0.358	59
Yangtze Power	-0.036	35	Tongbao energy	-0.490	60
Shennan power a	-0.040	36	Zhangze electric power	-0.503	61
Three Gorges Water Conservancy	-0.064	37	Jinshan Co., Ltd	-0.723	62
Ganneng Co., Ltd	-0.097	38	Tianfu energy	-0.955	63
Construction investment energy	-0.114	39	Huitian thermal power	-1.779	64

Through the analysis of the comprehensive score, Hunan development ranked first with a comprehensive score of 2.401, and Huitian thermal power ranked last with a comprehensive score of -1.779. The difference between the maximum and minimum value is relatively large, which shows that the financial performance of Listed Companies in China's power industry has great differences, and the financial situation among industries is unbalanced. Although some listed companies are at the top of the comprehensive ranking, there are still many areas that need to be improved. For example, Hunan development, which ranks first in the comprehensive ranking, has a negative profitability score and a lower ranking. This is mainly because during the reporting period, the disposal of equity and creditor's rights of Hunan development Kangnian, the uneven inflow of water in the basin and the policy reduction of on grid electricity price led to the decrease of business income. The reason why Hunan's development ranks first is that it has obvious advantages in growth ability and debt paying ability.

Although some companies are poor in overall ranking, they also have advantages in some aspects. For example, Huitian thermal power, which ranks last in comprehensive ranking, ranks fifth in solvency and third in profitability, indicating that Huitian thermal power has strong solvency and profitability. Therefore, the company should continue to maintain its advantages and improve its existing problems.

In terms of growth ability, 43 of the 65 power listed companies have positive scores, and 22 have negative scores. The first is Hunan development, and the last is Huitian thermal power. Moreover, the scores of the two companies are quite different, which indicates that there is a big gap in the growth ability of China's power listed companies.

In terms of solvency, the companies with negative scores account for more than 70%, which indicates that the overall solvency of listed electric power companies in China is not strong, which may be related to the characteristics of large investment scale, slow capital flow and long recovery cycle of power industry.

In terms of operating capacity, the maximum value is 2.350, and the minimum value is -2.068. The difference is relatively large, and only half of the companies have positive scores. On the one hand, it shows that there is a big gap in the operation ability of China's power listed companies, on the other hand, it also shows that the overall capital recovery rate of the industry is not very high, and needs to be improved.

In terms of profitability, it is faced with the same problem as solvency. 62% of the companies scored negative. The power listed companies still face the problem of weak overall profitability.

CONCLUSION

Based on the principle of index construction, this paper selects 11 indexes to reflect the financial situation, and makes a comprehensive evaluation on the financial performance of 64 listed companies in China's electric power industry by means of SPSS software and principal component analysis. Generally speaking, there is a serious imbalance in the development of listed companies in China's power industry, and there is a significant gap in the comprehensive capacity of 64 listed power companies. From the perspective of each principal

component, this paper finds that the abilities of Listed Companies in China's electric power industry are insufficient. There is a big gap in the abilities of some companies. Some abilities rank very high, while some abilities rank very low. This shows that there is an imbalance in the development of various aspects within some companies. Through the comprehensive evaluation of the financial performance of electric power listed companies, on the one hand, it can provide the corresponding reference value for the government to formulate relevant policies; on the other hand, it can help the managers of electric power listed companies have a deeper understanding of their own financial performance, and at the same time, it can further improve their performance level by comparing with other enterprises.

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