Comprehensive Competitiveness Evaluation of Listed Companies in Communication Device Manufacturing Industry based on Entropy TOPSIS Cluster Analysis

Xie Bo, Wang Yifei, Lin Ximan

Beijing University of Chemical Technology, Beijing 100029, China

Keywords: communication equipment manufacturing industry; influencing factors; competitiveness; entropy weight TOPSIS method; cluster analysis

Abstract: In order to promote the healthy development of the communications equipment industry and improve the efficiency of investors' use of funds, objectively evaluate the comprehensive competitiveness of financial risk of listed companies in my country's communications equipment manufacturing industry. Taking 25 listed companies in the communication equipment manufacturing industry in China as the research object, selecting indicators that reflect debt solvency, operating capacity, profitability, risk level, development capacity, etc., using entropy method, TOPSIS evaluation method and cluster analysis to establish communication Comprehensive competitiveness evaluation system for financial risk of equipment manufacturing industry. The results of the study show that debt solvency and surplus capacity have a greater impact on the comprehensive competitiveness of corporate financial risks, and the concentration of equity also plays an important role in whether a company can achieve long-term stable financial development. Finally, it puts forward specific suggestions for the listed companies in the communication equipment manufacturing industry to improve their comprehensive competitiveness in financial risk and achieve their sustainable development.

1. Introduction

In recent years, the communication equipment manufacturing industry has developed rapidly with the support of technology and policies. In the past five years, my country has maintained a relatively high amount of fixed asset investment in the communication equipment industry, improved my country's information and communication infrastructure and broadband network construction, and promoted social demand for communication equipment. This also puts forward the requirements for steady development of communication manufacturing enterprises to maintain market supply. Financial management is an issue that cannot be avoided on the path of a company's steady development. Better control of the company's current financial status and competitiveness will help long-term stable development.

Research on the evaluation of corporate competitiveness at home and abroad is in the stage of development and improvement, and there are many choices of index systems and evaluation methods for competitiveness evaluation. The classic evaluation of enterprise competitiveness through Zhang Xiaowen pointed out in the paper that the factors affecting enterprise competitiveness can be divided into three aspects: ability resources, ability system and mechanism, and ability status. When establishing an enterprise competitiveness evaluation system, it should be scientific and systematic. , The principle of relativity (2003). The financial evaluation index system can help companies fully understand and predict their own financial risks and competitiveness levels, and take timely and precise measures to avoid risks in advance. In her research, Lu Ying'e evaluated the financial risks of equipment manufacturing companies in terms of debt solvency, operating ability, development ability, and profitability based on the entropy TOPSIS model. The empirical research found that the solvency and development ability of the equipment manufacturing company's financial risk evaluation The impact is greatest, and the overall financial risk of this type of enterprise is relatively high (2018). Some scholars have evaluated the financial risks of forestry

enterprises based on factor analysis and cluster analysis. They believe that the main reasons for the higher financial risks of such enterprises are the decline in operating profits, low net profits, small capital scale and high asset-liability ratio. Problem (Chen Qian, 2017). Fu Haoyan et al. evaluated the financial competitiveness of construction enterprises based on analytic hierarchy process and fuzzy comprehensive evaluation (2018). In addition, there are fuzzy comprehensive evaluation-BP network combination model, improved DEA method and other applications in the evaluation of corporate financial competitiveness.

Based on previous studies on the evaluation of corporate financial competitiveness, the entropy TOPSIS method-cluster analysis is used to analyze the comprehensive competitiveness of financial risks of listed communication equipment manufacturing companies, and the selected indicators focus on the company's own financial status and partial capabilities Resource factor. First, use the entropy method to determine the weight of each indicator and calculate the corresponding comprehensive score of the enterprise according to the size of the indicator difference, and then use the TOPSIS method to calculate the distance between the evaluation object and the positive ideal solution and the negative ideal solution and calculate the closeness, that is The comprehensive scores rank the comprehensive financial competitiveness of enterprises according to their numerical values, and use systematic cluster analysis to divide listed companies into four levels. Finally, based on the analysis of the characteristics of various levels of enterprises and the evaluation results of the factors affecting the comprehensive competitiveness of financial risks, targeted recommendations are put forward. In this paper, the TOPSIS model is added for comprehensive evaluation based on the entropy method, so that the comprehensive score ranking can accurately reflect the financial competitiveness gap between enterprises, and cluster analysis is used to aggregate the results, and then extract the common characteristics of all levels of enterprises, which is beneficial to Reference for investors and business operators.

2. Index construction and data preprocessing for comprehensive evaluation of corporate financial risk competitiveness

2.1 Indicator construction

Principles should be followed when constructing a comprehensive competitiveness index system for corporate financial risks. An objective index system can comprehensively analyze the company’s own capabilities and industry conditions. The indicators in Figure 1 focus on constructing from the perspective of the company’s own financial competitiveness, and analyze separately from the perspectives of financial indicators and non-financial indicators. Financial indicators are divided into solvency, operating capacity, profitability, risk level, and development capacity. Operating leverage is an inverse indicator; equity concentration in non-financial indicators has a greater impact on the evaluation of comprehensive competitiveness of financial risks and is also included in the evaluation system.

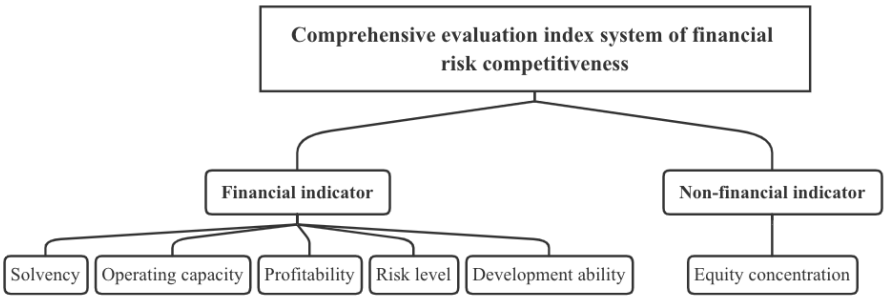

Figure 1 Structure diagram of comprehensive evaluation index system of financial risk competitiveness

2.2 Data source and preprocessing

The data comes from the Guotaian database. The financial data and non-financial data of the

listed companies in the communication equipment manufacturing industry in 2019 are selected, and the companies with incomplete data are excluded, and 25 listed companies in the communication equipment manufacturing industry are selected as the research sample.

Before the entropy TOPSIS method and cluster analysis, the data is preprocessed as follows:

Assuming that there are m samples to be evaluated and n evaluation indicators, x_{ij}represents the jth evaluation index of the i-th evaluation sample, forming the original index data matrix A=$(x_{ij})_{mn}$, where $1 \le i \le m$, $1 \le j \le n$. The initial matrix is:

$$(x_{ij})_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{11} & x_{11} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

The extreme value method is used to eliminate the dimension of each index data, and the matrix is normalized. The calculation formula is as follows:

$$P_{ij} = \frac{x_{ij}-\min(x_{ij})}{\max(x_{ij})-\min(x_{ij})}+1\text{(Positive indicator)}$$

$$P_{ij} = \frac{\max(x_{ij})-x_{ij}}{\max(x_{ij})-\min(x_{ij})}+1\text{(Negative indicator)}$$

3. Establishment of comprehensive competitiveness evaluation system for corporate financial risks

3.1 Entropy method to determine weight

3.1.1 Research principle

The concept of entropy comes from thermodynamics and can be used to measure the uncertainty of the system state. In information theory, information is a measure of the degree of order of the system, and entropy is a measure of the degree of disorder of the system. The absolute value of the two is equal and the sign is opposite. Entropy method is a weighting method that determines the weight of each indicator through information entropy according to the difference between indicators. The entropy method highlights local differences and shows the degree of importance according to the degree of difference between different observations of the same indicator. Specific steps are as follows:

The first step is to use the entropy method to calculate the entropy based on the normalized datae_j.

$$f_{ij} = \frac{P_{ij}}{\sum_{i=1}^{m} P_{ij}}$$

$e_j = -k\sum_{i=1}^{m} f_{ij} ln f_{ij}$（i=1,2,…,m;j=1,2,…,n);

Where $k = -\frac{1}{lnm}$ and m is the sample size. 0《e_j《1, so it can be seen that the size of the weight coefficient is determined by the difference of the scheme.

The second step is defined as the degree of consistency of the contribution of each scheme under the jth attribute [6]:

$$D_j = 1 - e_j$$

The third step is to calculate the weight corresponding to each indicator according to the calculated entropy value and the following formula w_j.

$$W_j = \frac{D_j}{\sum_{j=1}^{n} D_j}$$

The advantage of the entropy method is to directly use the information given by the decision matrix to calculate the weight without introducing the subjective judgment of the decision maker.

3.1.2 Research results

Using Python language and programming according to the principle of entropy method, the index entropy and weight of the selected sample of 25 listed companies are shown in Table 1, and the evaluation system table is shown in Table 2.

Table 1 Entropy and weight of indicators

index	Entropy	Weights	index	Entropy	Weights
x1	0.995784719	0.070333833	x8	0.99379172	0.103587907
x2	0.995772391	0.070539529	x9	0.99477955	0.087105527
x3	0.995892131	0.068541612	x10	0.995141192	0.081071369
x4	0.99566492	0.072332737	x11	0.99668365	0.055334773
x5	0.995488887	0.075269923	x12	0.995844432	0.069337498
x6	0.998204957	0.029951083	x13	0.995403562	0.076693604
x7	0.996220809	0.063057474	x14	0.995394601	0.076843132

Table 2 Evaluation System of Comprehensive Financial Risk Competitiveness of Listed Companies in my country's Communication Equipment Manufacturing Industry

First level indicator	Weights	Secondary indicators	Weights
Financial indicators			
Solvency	0.28174	Current ratio	0.07033
		Quick ratio	0.07054
		Cash ratio	0.06854
		Interest coverage ratio	0.07233
Operating capacity	0.16828	Inventory turnover	0.07527
		Accounts payable turnover rate	0.02995
		Liquid assets turnover rate	0.06306
Profitability	0.27176	Return on assets	0.10359
		Roe	0.08711
		Profit margin	0.08107
Risk level	0.05533	Operating leverage	0.05533
Development ability	0.14603	Growth rate of fixed assets	0.06934
		Growth rate of total assets	0.07669
Non-financial indicator	0.07684	Equity concentration	0.07684

It can be seen that the highest of the primary index weights given by the entropy law is the solvency index, followed by the profitability index, indicating that these two types of primary indicators have greater overall financial risk competitiveness for the enterprise. This result is also in line with the actual economic situation. Under the condition of low debt repayment pressure and good profitability, companies can maintain low financial risks, can operate for a longer time, and can resist external factors such as economic downturns. The impact.

The top three ranked second-level indicators are return on assets, return on net assets, and cost and expense margin, followed by total asset growth rate and equity concentration indicators. The top three are all profitability indicators, followed by It is a development capability index and a non-financial index. Combined with the first-level index ranking, a comprehensive evaluation of the financial risk competitiveness of a company can be obtained to a large extent. Comprehensive competitiveness and reduce financial risks.

3.2 Comprehensive evaluation based on TOPSIS method

3.2.1 Research principle

The TOPSIS method is also known as the multi-attribute decision-making method that

approximates the ideal solution and the ideal solution. It is a multi-attribute decision-making method that obtains the ideal solution by approaching the ideal point. The core idea is to construct a weighted normalized matrix based on the normalized matrix, and then determine the positive and negative ideal solutions based on the maximum value of the index of the evaluated object, and calculate the closeness of each evaluated object to the positive ideal solution. The specific steps are as follows:

The first step is to calculate the distance between the evaluation object and the ideal solution and the negative ideal solutiond_i^+, d_i^-.

$$d_i^+ = \sqrt{\sum_{i=1}^{n} w_j\left(P_{ij} - P_j^+\right)^2}\ ,\ \ i = 1,2,\dots,m; 0 \le d_i^+ \le 1$$

$$d_i^- = \sqrt{\sum_{i=1}^{n} w_j(P_{ij} - P_j^-)^2}\ ,\ \ i = 1,2,\dots,m; 0 \le d_i^- \le 1$$

The second step is to calculate closenessC_i.

$$C_i = \frac{d_i^-}{d_i^- + d_i^+}\ ,\ \ i = 1,2,\dots,m; 0 \le C_i \le 1$$

The third step is to sort the samples according to the value of C_i. The larger the closeness C_i, the closer the sample is to the positive ideal solution, the better the overall performance of the evaluated object, and the stronger the comprehensive financial competitiveness of the company. After sorting the closeness of the selected enterprises, the comprehensive competitiveness ranking of the selected communication equipment manufacturing enterprises is obtained.

3.2.2 The positive and negative ideal solutions of each index

Table 3 shows the Euclidean distance d_i^- to the positive ideal solution and the Euclidean distance d_i^+ to the negative ideal solution of the above 25 companies, which respectively represent the closeness of each listed company to the positive ideal solution.

Table 3 Positive and negative ideal solutions of each index

Company Name	Positive ideal solution	Negative ideal solution	Company Name	Positive ideal solution	Negative ideal solution
Huakong SEG	0.11138	0.05990	Sanhuan Group	0.18525	0.05221
Tsinghua Unigroup	0.15369	0.05266	Wanma Technology	0.11449	0.05817
Lianchuang Electronics	0.13737	0.05569	Jucan Optoelectronics	0.10896	0.05751
Sunlord Electronics	0.15347	0.05446	Jinli permanent magnet	0.15398	0.05536
Chaohua Technology	0.11588	0.05721	Daheng Technology	0.13348	0.05474
Xingsen Technology	0.15630	0.05627	Fiberhome Communications	0.13295	0.05725
Infinova	0.11104	0.05663	Xinjiang Zhonghe	0.12546	0.05402
Danbang Technology	0.11258	0.05085	Quectel	0.14165	0.05623
Xichuang Medical Benefits	0.13327	0.05558	Torch Electronics	0.17966	0.05762
Changxin Technology	0.18469	0.05501	Bomin Electronics	0.14191	0.05739
Jinfu Technology	0.12539	0.05533	Qingyi Optoelectronics	0.14553	0.05766
Xinwei	0.20482	0.05689	Jiayuan Technology	0.20718	0.02995

Communication					
Innolux	0.14003	0.05775			

3.2.3 Enterprise overall score and ranking

According to the principle of TOPSIS method, using Python programming to solve, the comprehensive scores and rankings of 21 listed companies in the communication equipment manufacturing industry are as follows:

Table 4 Comprehensive scores and rankings of 25 companies

Company Name	overall ratings	Rank	Company Name	overall ratings	Rank
Huakong SEG	0.48014978	6	Sanhuan Group	0.42517252	18
Tsinghua Unigroup	0.46297132	10	Wanma Technology	0.5003888	4
Lianchuang Electronics	0.42630055	17	Jucan Optoelectronics	0.50786491	3
Sunlord Electronics	0.41159784	20	Jinli permanent magnet	0.41876208	19
Chaohua Technology	0.4281448	16	Daheng Technology	0.46305547	9
Xingsen Technology	0.41110853	21	Fiberhome Communications	0.45451966	12
Infinova	0.55424495	1	Xinjiang Zhonghe	0.46980994	7
Danbang Technology	0.46904653	8	Quectel	0.50787714	2
Xichuang Medical Benefits	0.43286845	13	Torch Electronics	0.36800209	25
Changxin Technology	0.39443935	23	Bomin Electronics	0.42928531	15
Jinfu Technology	0.39679972	22	Qingyi Optoelectronics	0.45578007	11
Xinwei Communication	0.37246017	24	Jiayuan Technology	0.49892574	5
Innolux	0.42961635	14	Company Name		

Table 4 shows the comprehensive scores and rankings of selected 25 listed companies in the communications equipment manufacturing industry. Among them, Infinova has the highest score, reaching 0.5542, and Torch Electronics ranks last with a comprehensive score of 0.368. Overall, the comprehensive score is concentrated between 0.4-0.5. Generally, the score is not very high and the gap is small, indicating that there are still high financial risks in the communication equipment manufacturing industry, and the industry is still in the development stage, with no obvious differentiation and comprehensive competition. The force is concentrated near the same level.

Combining the comprehensive score rankings and indicator weights, it can be found that companies with the highest comprehensive scores generally have the characteristics of better debt solvency and strong liquidity, and the proportion of equity that accounts for the first shareholder equity in the equity concentration index is all in More than 20%, which shows that equity concentration, as a non-financial indicator, is closely related to the financial risks and comprehensive competitiveness of enterprises, and can play a better guiding role for internal operators and external investors.

4. Hierarchical division of comprehensive scores of corporate financial risk competitiveness based on cluster analysis

4.1 Research principle

Cluster analysis is a multivariate statistical analysis method that classifies things according to their own characteristics. The research objects that have a certain degree of similarity are classified into groups, and the objects that are more related to each other are aggregated into one category, and then aggregated until all the samples are End of polymerization.

The systematic clustering method is mainly used to further objectively analyze the data. The basic principles are as follows:

Suppose that n samples are equally divided into k categories: G_1,G_2,…, G_k, X_{ti}represents the i-th sample inG_t Suppose the number of samples in G_t isN_t, and the center of gravity of $G_t$is $\bar{X}_t$, the sum of squared deviations of samples in each category is obtained as:

$$S_t = \sum_{i=1}^{N_t} (X_{ti} - \bar{X}_t)'(X_{ti} - \bar{X}_t)$$

The sum of squared deviations within class K is:

$$S = \sum_{i=1}^{k} S_t = \sum_{t=1}^{k} \sum_{i=1}^{N_t} (X_{ti} - \bar{X}_t)'(X_{ti} - \bar{X}_t)$$

When the sum of squared deviations within a class is less than the sum of squared deviations between classes, the classification is proved to be correct. After dividing n samples into n categories one by one, the number of categories is reduced, and the two categories are selected to merge according to the criterion of the smallest increase of the squared deviation of the deviation, that is, the two categories with the closest or the most similar properties are merged to obtain n -1 category, and so on, stop when n samples are all classified into one category.

The distance between G_p andG_q is defined as follows, and G_r is the union of G_p and G_q:

$$D_{pq}^2 = s_r - s_p - s_q$$

Then the distance formula of the combined class under the sum of square deviation method can be further obtained:

$$D_{kr}^2 = \frac{N_K + N_p}{N_r + N_k} D_{kp}^2 + \frac{N_K + N_p}{N_r + N_k} D_{kq}^2 - \frac{N_K}{N_r + N_k} D_{pq}^2$$

4.2 Research results

Use SPSS software to perform cluster analysis on the comprehensive score results of 25 companies, and obtain classification results and cluster diagrams, as shown in Table 5 and Figure 2 below:

Table 5 Clustering results of 25 companies' comprehensive scores

Company Name	Classification	Company Name	Classification
Huakong SEG	1	Sanhuan Group	2
Tsinghua Unigroup	1	Wanma Technology	1
Lianchuang Electronics	2	Jucan Optoelectronics	1
Sunlord Electronics	2	Jinli permanent magnet	2
Chaohua Technology	2	Daheng Technology	1
Xingsen Technology	2	Fiberhome Communications	1
Infinova	3	Xinjiang Zhonghe	1
Danbang Technology	1	Quectel	1

Sichuang Medical Benefits	2	Torch Electronics	4
Changxin Technology	4	Bomin Electronics	2
Jinfu Technology	4	Qingyi Optoelectronics	1
Xinwei Communication	4	Jiayuan Technology	1
Innolux	2		

The cluster analysis results show that 25 listed companies are divided into 4 levels according to their comprehensive scores. 11 companies including Huakong SEG, Ziguang Co., Ltd., Danbang Technology, and Wanma Technology are classified into the first category. Nine companies including Netoelectronics, Chaohua Technology and Xingsen Technology are classified into the second category, the third category is Infinova, and Changxin Technology, Jinfu Technology, Xinwei Communication and Torch Electronics are classified into the fourth category.

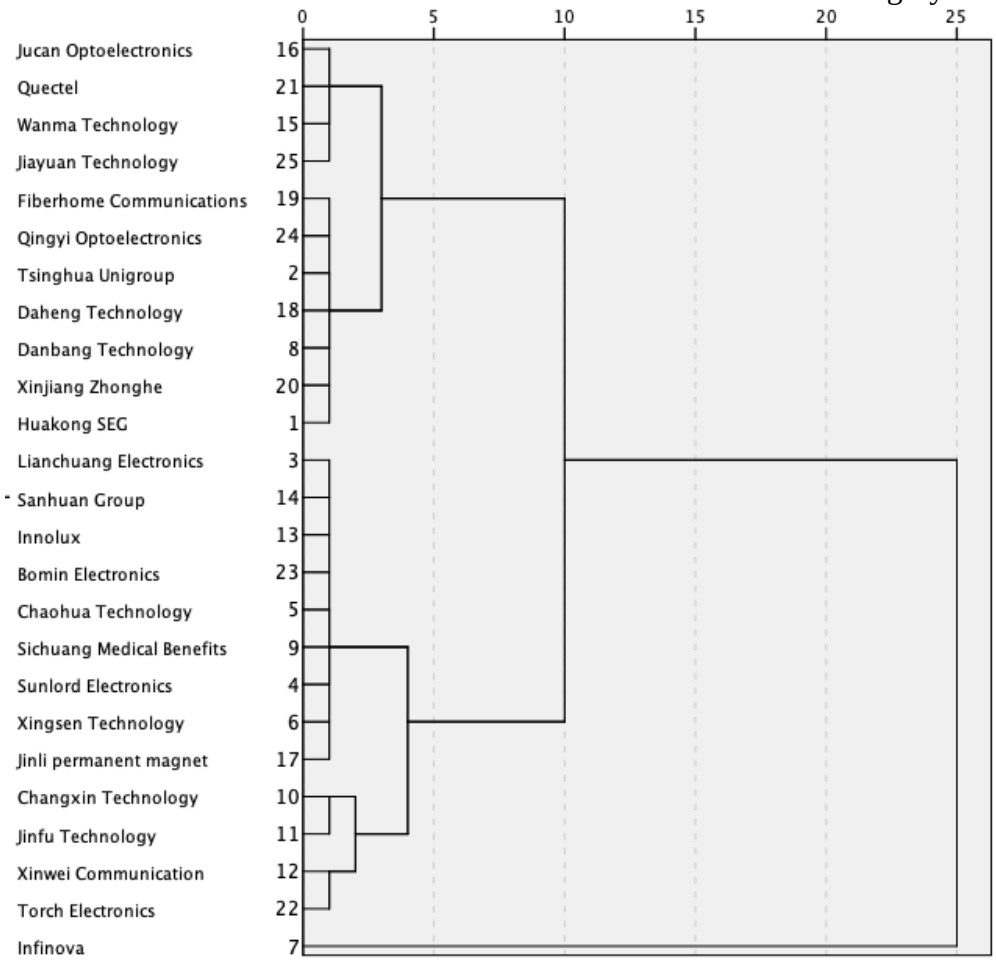

Figure 2 Genealogy diagram of cluster analysis of 25 companies

The cluster analysis tree diagram clearly and intuitively shows the process of clustering the enterprise's comprehensive score. Combining the comprehensive score and the weight of each comprehensive evaluation influencing factor, it can be seen that the first and third types of cluster analysis are enterprises with higher scores, and the variance of the overall index data in this classification is smaller, and the data is more than that of the second and first types. The four types of enterprises are also more concentrated. The first category of companies is characterized by relatively high current ratio, quick ratio and cash ratio, as well as the growth rate of total assets and the concentration of equity. The solvency and development capabilities are relatively good, and indicators such as leverage and operating capabilities remain in the industry. Intermediate level. The fourth type of company corresponds to the lower part of the comprehensive score. Although its profitability index is higher than that of other types of companies, and the inventory turnover rate and interest guarantee multiple are also higher, the total asset growth rate of this type of company is

generally low or negative. The high operating leverage is not conducive to the development of long-term high profitability. The results of the study indicate that it is necessary to start from a financial perspective and adjust the business strategy in a timely manner to enhance overall competitiveness and reduce corporate financial risks.

5. Conclusions

(1) This paper selects 14 indicator variables to construct a comprehensive evaluation system for corporate financial risk competitiveness. Entropy method overcomes the shortcomings of traditional subjective weighting, giving first-level indicators solvency, profitability, and second-level indicators of total asset growth rate And the weight of higher concentration of equity. This shows that good profitability and the ability to repay loans are the foundation of a company's sustainable development, which is in line with economic theory and the actual situation of the company. The expansion of financial risks in this industry is mainly due to the backlog of inventories and low profitability. The chain causes the company's cash flow to stop flowing, and the debt repayment pressure is high.

(2) Analyze the results after the entropy method by using the TOPSIS method, and obtain the comprehensive ranking and its ranking. The overall overall score of the enterprise is not high, and most of the enterprise scores are concentrated between 0.4-0.5, indicating that the competitiveness gap of listed companies in this industry is not obvious, the industry is in the stage of development and differentiation, and my country’s communication equipment manufacturing enterprises have high-tech With regard to the shortage of talents, the domestic legal protection environment needs to be improved.

(3) According to the classification results of comprehensive score ranking and cluster analysis, companies with strong overall competitiveness, in addition to better surplus and solvency, usually have higher total asset growth rate and equity concentration , The rapid development of the enterprise reduces the operating and credit risks brought by the diversification of equity, which is conducive to the execution and transmission of the company's overall decision-making.

References

[1] Zhang Xiaowen, Yu Wu, Hu Yunquan. Quantitative Evaluation Method of Enterprise Competitiveness [J]. Management Review, 2003(01): 32-37+63.

[2] Lu Ying'e, Guan Hongbo. Financial risk assessment of listed companies in the marine engineering equipment manufacturing industry [J]. Shanghai Management Science, 2018, 40(04): 60-64.

[3] Chen Qian, Tian Zhiwei. Research on Financial Risk Evaluation of Forestry Listed Companies——Based on Factor Analysis and Cluster Analysis [J]. Finance and Economics Theory and Practice, 2017, 38(01): 103-108.

[4] Fu Haoyan, Liu Shuang, Yin Zimin. Comprehensive evaluation and empirical research on the financial competitiveness of construction enterprises[J]. Journal of Liaoning University of Technology (Natural Science Edition), 2018, 38(04): 273-276.

[5] Li Rongjin, Lei Tingting. Research on the Evaluation of Enterprise Earnings Quality Based on Entropy TOPSIS Method——Taking Real Estate Listed Companies as an Example [J]. Friends of Accounting, 2019(24): 72-78.

[6] Luo Chuhan, Chen Fuyi, Gan Chensong. Application of Cluster Analysis and Entropy Method in Performance Evaluation of Listed Companies [J]. China Business Journal, 2020(13): 37-43.

[7] Dong Zhiqing, Huang Julin. Application of Correspondence and Clustering Analysis in Evaluation of Competitiveness of Construction Enterprises [J]. Journal of Chongqing Jiaotong University (Natural Science Edition), 2012, 31(01): 141-143+162.

[8] Zhang Dan. Evaluation of the competitiveness of my country's listed garden companies from the financial perspective: an empirical analysis based on correspondence and cluster analysis [J]. Times Finance, 2019 (30): 63-64+67.

[9] Song Hui, Wang Yudi. Comprehensive evaluation of urbanization based on entropy method and Topsis method[J]. Rural Economy and Technology, 2019, 30(24): 78-81+114.