Research on the Financial Risk Evaluation of Listed Coal Companies Based on Entropy TOPSIS Method

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Abstract: The coal industry is a pillar industry in China. It is very important for risk assessment of listed companies in the coal industry. Selecting 24 listed companies in the coal industry in China as the research object, build risk assessment indicators for listed coal companies from five aspects: debt-paying ability, profitability, operational ability, development ability, and cash flow ability, and use entropy weight method and TOPSIS method to calculate the weight of each index, finally calculated the closeness and ranking of each listed company and the best plan, and provided guidance for the risk management of coal enterprises.
Key words: Entropy TOPSIS; Coal listed companies; Risk assessment

1.Introduction

Coal resources have always occupied a dominant position in China's energy economy, providing security for China's economic development. However, at present, China's economic growth rate is slowing, and the coal market is in a downturn. The "ten-year golden cycle" of the coal industry has become the past, and the coal industry is facing the predicament of overcapacity, high costs, and declining benefits. Under the background of the implementation of supply-side reforms in the country, the coal industry is required to integrate resources, and the complexity and particularity of the coal industry's own living environment makes the reform more difficult., and various risks will be encountered in the reform. The risk will eventually be reflected in the financial risk of the company. Therefore, this paper constructs the financial risk indicators of listed coal companies, evaluates the financial risks of the company, identifies the financial risks of listed coal companies, and avoids certain financial risks for the company.

2.literature Review

Overseas studies on financial risks started earlier and the research results were also more abundant. Among them, most scholars' research focused on the relevant variables and evaluation methods in terms of financial risk evaluation, and constructed a variety of financial risk assessment models. Fitzpatrick first used a univariate approach, selected 19 companies, and used bankruptcy and non-bankruptcy groupings to analyze their financial data. Research shows that debt-to-equity ratios and Rate of Return on Common Stockholders' Equity have the greatest impact on corporate financial risks[1]. Altman selected 66 manufacturing companies as the research object, identified 22 financial indicators, and used the multivariate method to determine the five financial indicators with the least errors. The Z-score model was constructed to evaluate financial risks[2]. Doumpos M et al. use multi-criteria classification procedures to assess financial risks, classify the alternatives under consideration (companies, investment projects, portfolios, countries, etc.) into predefined risk categories, and pass case studies on national risk assessment issues to illustrate the efficiency of this method [3]. Toma et al. used the 5-year data of the Yahoo Finance website to study the application of quantitative techniques in financial and insurance risk assessments[4]. Kociu et al. used a linear regression model to analyze the financial ratios issued by SMEs' balance sheets, income and expense schedules, and cash flow statements in the Gjirokastra region during 2009-2013, and assess the capital structure risk, liquidity risk and bankruptcy risk of Albanian SMEs[5].

Chinese scholars started late in the research on financial risk assessment, but they have also gradually received the attention of many scholars.Chen Qian et al. built a risk evaluation system in terms of profitability, cash ability, debt repayment ability, operational ability, and growth ability. Factor analysis was used to extract the common factors with large influence factors, and the scores of each sample company were calculated and used. The clustering method classifies the sample companies for risk level classification[6]. Based on the cash flow statement, Zhang Wenling selects the cash flows generated by the three activities of

operation, investment, and financing, designs the financial risk cash flow model for colleges and universities, evaluates the financial risks in college fund operations, and analyzes the reasons for its appearance[7]. Yin Xianan et al. take the biopharmaceutical industry as an example, and select ten indicators from debt service, operations, profitability, growth, and cash flow. The entropy method is used to calculate the weight of each index, and the entropy weight TOPSIS method is constructed based on the theory close to the ideal solution. Evaluation model, research results show that the risk can be quantitatively evaluated[8]. In order to evaluate the financial risks of commercial banks scientifically and reasonably, Cai Yanping et al introduced the risk assessment method of financial risk from the concept of VaR to measure the risk surplus and cash flow of listed commercial banks. It shows that commercial banks generally have good profitability, but some commercial banks have cash flow risks[9]. Duan Shifang uses analytic hierarchy process to construct financial risk evaluation indicators for small and medium-sized enterprises from the perspectives of debt repayment ability, operating ability and profitability. According to the expert's score, the weight value of each evaluation index is calculated, and it is found that the financial risk of SMEs is poor. The biggest reason is the single financing channel[10].

In summary, scholars at home and abroad have gradually used relevant data and models to assess the risk of a certain industry and company in terms of financial risk assessment. Among them, many multi-dimensional and multi-faceted indicators are used in the selection of trend evaluation indicators, while the subjective methods are mostly used to obtain the index weight values, which results in inaccurate evaluation results. By studying the literature, it was found that the method combining the entropy weight method and the TOPSIS method was successively applied in the evaluation of performance, economic strength, and environmental risk, avoiding the phenomenon of artificially manipulating the index weight. At present, there are almost no literatures to apply this method to financial risk assessment. Therefore, based on previous studies, this paper uses TOPSISF method to evaluate the financial risk of listed coal companies based on the weights calculated by using entropy method.

3.Model Construction

3.1Entropy Weight Assignment Method

Entropy weight method is an objective evaluation method to calculate the weight of each evaluation index. The objectivity of this method makes it used in most research fields. If the entropy value calculated by the evaluation index is smaller, it indicates that the evaluation index has a greater degree of variation, and the more it can provide more information, the greater the weight in the evaluation process; conversely, if the entropy value is greater, then the evaluation index will occupy less weight. Assuming that there are m objects to be evaluated and n evaluation indexes, the specific steps for calculating the index weights using the entropy weight method are as follows:

The first step is the standardization of data.

According to the data of relevant sample evaluation indicators, the original data matrix is formed:

$$R = (r_{ij})_{m\times n} \quad (1)$$

In this formula, r_{ij} is the evaluation value of the i th evaluation object under the j-th index, in order to avoid the situation where the index data is negative and the weights cannot be calculated, the raw data needs to be standardized as follows:

$$r_{ij} = \frac{r_{ij} - \min(r_{ij})}{\max(r_{ij}) - \min(r_{ij})} \quad \text{The indicator which } j \text{ is the benefit indicator} \quad (2)$$

$$r_{ij} = \frac{\max(r_{ij}) - r_{ij}}{\max(r_{ij}) - \min(r_{ij})} \quad \text{The indicator which } j \text{ is the benefit indicator} \quad (3)$$

The second step is to calculate the weight of each evaluation index in each evaluation object:

$$b_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} (0 \le i \le m, 0 \le j \le n) \quad (4)$$

The third step is to calculate the information entropy of each indicator:

$$e_{ij} = -\frac{1}{\ln(m)} \sum_{j=1}^{m} (b_{ij} \times \ln b_{ij}) \quad (5)$$

The fourth step is to calculate the entropy of each evaluation index:

$$d_{ij} = 1 - e_{ij} \quad (6)$$

The fifth step is to finally find the weight of each evaluation index:

$$w_i = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (7)$$

3.2 Combination of Entropy Weighting Method and TOPSIS Method

TOPSIS method is a multi-objective decision-making method, which is based on the method of ranking a limited number of evaluation objects and idealized goals. Therefore, it is also referred to as the superior and inferior solution distance method. If the index being evaluated is close to the optimal solution and away from the worst solution, then the evaluation object has the best evaluation effect. Conversely, the evaluation effect is the worst. The specific steps for combining entropy weights with TOPSIS are as follows:

The first step is to find the normalized decision matrix based on the original data:

$$z_{ij} = r_{ij} / \sqrt{\sum_{i=1}^{m} r_{ij}^2} \quad (8)$$

The second step is to weight the normalization matrix and find the weighted matrix according to the index weight value obtained by the entropy method:

$$S_{ij} = W_{ij} * Z_{ij} \quad (9)$$

The third step is to determine the ideal solution and the negative ideal solution: the ideal solution consists of the largest number in each column of the normalization matrix, and the negative idealsolution consists of the smallest number in each column of the normalization matrix.

$$D^+ = \sqrt{\sum_{j=1}^{m} (r_{ij}^+ - r_{ij})^2} \quad (10)$$

$$D^- = \sqrt{\sum_{j=1}^{m} (r_{ij}^- - r_{ij})^2} \quad (11)$$

The fifth step is to calculate the closeness of each evaluation object to the ideal solution:

$$C_i = \frac{D^+}{D^+ + D^-} \quad (12)$$

3.3 Construction of financial risk evaluation index for coal listed companies

According to the above analysis, the TOPSIS evaluation method needs multi-dimensional indicators to measure the judgment results. Usually the indicators are established on the basis of comprehensive and systematic principles, and the corporate financial risks are usually reflected in many aspects such as debt –paying ability, profitability, operational ability, development ability, and cash flow ability, and they meet the requirements of multidimensional indicators of the TOPSIS method. After reviewing the relevant literature, most scholars also select these dimensions to comprehensively evaluate the financial risks of listed companies in various industries. Therefore, this article also stands on the basis of previous research and selects relevant indicators under five dimensions to construct the financial risk evaluation of coal listed companies. The nature and specific meaning of the indicators are shown in Table 1 below.

Table 1 Financial Risk Evaluation Index of Coal Listed Companies

Level 1 Indicators	Level 2 Indicators	Indicator Code	Indicator Type	Indicator Description
debt-paying ability	Current ratio	X_1	Benefit type	current assets / current liabilities
	Debt Asset ratio	X_2	Cost type	Total liabilities/ total assets

Table 1, cont.

Profitability	ROA	X_3	Benefit type	EBIT/ Average Assets
	REA	X_4	Benefit type	Net profit/owner equity
Operating capacity	Receivables Turnover Ratio	X_5	Benefit type	Net income from main operations/average balance of accounts receivable
	Total Assets Turnover	X_6	Benefit type	Sales revenue / average total assets
Development ability	Increase rate of main business revenue	X_7	Benefit type	Revenue growth / total operating income for the previous year
	Total asset growth rate	X_8	Benefit type	Asset growth for the current year/total assets at the beginning of the year
Cash flow capability	Net profit cash ratio	X_9	Benefit type	Cash flow/net profit from operating activities
	Total cash recovery rate	X_{10}	Benefit type	Cash flow from operating activities/end balance of assets

4. Model application

4.1 Sample Selection and Data Sources

According to the classification of the China Securities Regulatory Commission of industry,this article selects 26 coal listed companies under the coal mining industry as the research object and removes ST Pingneng and ST An Coal from the 26 coal listed companies, and finally selects the 2016 annual data of 24 coal listed companies as a study sample. All research sample data comes from the CSMAR and the listed company's annual report.

4.2 Evaluation Index Weight Calculation

According to the calculation formulae (1) to (7) of the entropy method above, using the collected data with the aid of the Excel tool, and the weights of the relevant indicators are calculated, and the index weights are ranked. The specific results are shown in Table 2 below:

Table 2 Related evaluation indicators

	Evaluation Content	Weight	Rank
debt-paying ability	Current ratio	0.065819703	4
	Debt Asset ratio	0.056206963	5
Profitability	ROA	0.020392181	10
	REA	0.022639572	8
Operating capacity	Receivables Turnover Ratio	0.294170548	2
	Total Assets Turnover	0.100974455	3
Development ability	Increase rate of main business revenue	0.025220119	7
	Total asset growth rate	0.020610991	9
Cash flow capability	Net profit cash ratio	0.360165667	1
	Total cash recovery rate	0.033799800	6

Judging from the ranking of index weights, in the financial risk evaluation indicators of listed coal companies, the degree of impact on corporate financial risks is the Net profit cash ratio, Receivables Turnover Ratio, Total Assets Turnover, current ratio, Debt Asset ratio, Total cash recovery rate, Increase rate of main business revenue, REA(Rate of Return on Common Stockholders' Equity), Total asset growth rate and ROA(Return on Assets). Among them, the largest weighted value is the Net profit cash ratio, which is approximately 0.36, indicating that the cash flow capability of listed coal companies has a great influence on the financial risk of the company. It also indicates that the coal industry needs sufficient cash flow to ensure the normal operation of the company.

4.3 Evaluation of the Financial Risk of Listed Coal Companies

According to the principle of TOPSIS, combined with the first three steps of the above TOPSIS method, the ideal solution and the negative ideal solution of the evaluated index are determined. The specific results are shown in the following table 3:

Table 3 The ideal solution and negative ideal solution of relevant evaluation indicators

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
r_{ij}^{+}	0.06581 9703	0.05620 6963	0.02039 2181	0.02263 9572	0.29417 0548	0.10097 4455	0.36016 5667	0.0337 998	0.02522 0119	0.02061 0991

Table 3, cont.

r_{ij}^{-}	0.0000006582	0.00005621	0.00002039	0.00002264	0.00029417	0.00010097	0.00030619	0.00003380	0.00002522	0.00002061

Combined with the weight values of the above evaluation indicators, using the formulas (10) and (11) above, the Euclidean distances of 24 listed coal companies are calculated. The specific calculation results are shown in Table 4 below:

Table 4 Euclidean distances from ideal evaluation solutions to negative ideal solutions

Stock Code	D^{+}	D^{-}	Stock Code	D^{+}	D^{-}
000552	0.456775132	0.073678507	600714	0.465932196	0.093110419
000571	0.474545215	0.053422509	600758	0.447129806	0.063079486
000937	0.444373644	0.062802717	600971	0.29382792	0.233104124
000983	0.460722984	0.075215026	601001	0.447551884	0.066044598
002128	0.451618299	0.111897215	601088	0.431662815	0.088229126
600123	0.3731011	0.29611602	601101	0.253303132	0.368959797
600157	0.458100799	0.052413726	601225	0.447802289	0.066407083
600188	0.350173727	0.271302159	601666	0.406185099	0.103318759
600348	0.433683748	0.080326237	601699	0.463749847	0.048957167
600395	0.464562406	0.06176583	601898	0.441380232	0.059763014
600397	0.465190701	0.048161307	601918	0.441733146	0.060079599
600508	0.431553742	0.082930335	900948	0.430425018	0.078588804

Finally, according to formula (12), combined with the data in the above table, the closeness of each listed company to the ideal solution is determined and ranked. The specific results are shown in the following table 4:

Table 4 Proximity and ranking results of listed coal companies and ideal solutions

Company code	C_i	Rank	Company code	C_i	Rank
000552	0.138897166	13	600714	0.166553347	8
000571	0.101185179	22	600758	0.12363453	17
000937	0.123828163	16	600971	0.442379861	3
000983	0.140342773	12	601001	0.128592388	15
002128	0.198569892	6	601088	0.169706663	7
600123	0.442481239	2	601101	0.592932312	1
600157	0.102668432	21	601225	0.129144054	14
600188	0.436544949	4	601666	0.202783074	5
600348	0.156273689	10	601699	0.095487609	23
600395	0.117352302	20	601898	0.119253357	19
600397	0.093817315	24	601918	0.119725136	18
600508	0.161191256	9	900948	0.154394243	11

According to the calculation results in the above table, it can be seen that the degree of closeness to the ideal solution of the 24 sample companies selected is different, and the financial risk of listed companies is also not the same, which will increase with the decrease in the posting progress. Among them, the value of closeness of the listed company of Haohua Energy is the largest, which is about 0.59, which means that the listed company has the lowest financial risk among the 24 sample companies; and Big Energy has the smallest degree of closeness, which is about 0.09, indicating that the coal company Among the 24 listed companies, the financial risk is greatest. The posting progress of Lanhua Kechuang and Hengyuan Coal and Electricity is approximately 0.45, ranking second and third respectively, indicating that the two coal listed companies have a relatively low financial risk industry, and the posted progress of the remaining 22 listed companies is less than 0.2, indicating that there is a certain degree of risk.

5 Conclusion

Based on various factors, this paper comprehensively constructs the risk assessment indicators for coal listed companies from the perspectives of debt repayment ability, profitability, operational ability, development ability, and cash flow ability, and uses entropy method to objectively calculate the weights of each index, and at the same time, it seeks the combination of TOPSIS method. The closeness of each coal listed company to the optimal solution was used to rank the risk degree of each listed company. The research

shows that this method can objectively evaluate the financial risks of listed companies in the coal industry and can provide reference for risk control in the coal industry. Therefore, the coal industry must strengthen the centralized management of funds, optimize the allocation of resources, enhance the ability to create value, pursue the maximization of the effect of resource integration, and reduce the financial risks of the company.

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