Competitiveness Evaluation of Chinese Renewable Resources Related Listed Companies Based on Entropy Weight-TOPSIS

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Abstract. In view of the competitiveness evaluation of listed companies related to renewable resources in China, this paper constructs the entropy weight-TOPSIS competitiveness evaluation model from the four aspects of operating status, profitability, viability and growth ability for evaluation. This paper selects 12 representative listed companies related to renewable resources in China. Through its 2018 related data, all data comes from the wind database, and empirical analysis of competitiveness. The results show that in the recycling resource recycling industry, metal recycling and new material manufacturing are relatively mature and competitive. It provides some guidance for industry research and can also be used as an investment analysis.

1. Introduction

The international emphasis on the renewable resources industry is constantly increasing. International scholars discuss how to overcome the obstacles to the development of renewable energy through government policies. The importance of deploying competitive clusters, R&D and venture capital is raised. The competitiveness of renewable resource companies has been interpreted from different angles [1-5]. China has a more mature research on the performance evaluation of renewable resources industry. Scholars have made useful explorations in the empirical analysis of recycling of renewable resources, enriching and perfecting the evaluation index system of renewable resources and its measurement [6-7]. In the aspect of enterprise competitiveness evaluation, scholars use factor analysis method, entropy weight-TOPSIS and other methods to analyze the competitiveness of logistics enterprises from different dimensions [8-9]. There is little research on the competitiveness of listed companies in renewable resources. The research on the competitiveness of renewable resource enterprises provides theoretical reference and practical basis for the enterprise competitiveness improvement strategy.

China is stepping up its efforts to provide policy support and institutional regulation for the use of renewable resources. The industry has great investment and development opportunities. However, under the influence of the market mechanism, the renewable resource industry is greatly limited [10]. This paper establishes an evaluation model based on financial indicators for some listed companies related to renewable resources. The use of information entropy weighting method and TOPSIS to evaluate competitiveness can promote enterprises to correctly judge the actual operating level of enterprises, improve their operational capabilities, and thus increase the overall efficiency of...
enterprises. Firstly, the information entropy method is used to weight the indicators. Secondly, TOPSIS is introduced to describe the distance between the company's performance and the ideal solution and the negative ideal solution. Finally, the enterprise competitiveness is ranked by closeness. It provides a feasible method for evaluating the competitiveness of listed companies related to renewable resources.

2. Construction of competitiveness evaluation system for listed companies related to renewable resources

There is a lack of a mature evaluation system in the competitiveness of renewable energy listed companies. This has caused an unclear impact on the competitiveness of industry research. It is not conducive to the formulation of relevant strategies for improving the competitiveness of the industry. Therefore, this paper comprehensively refers to this set of evaluation system put forward by combining literature and practical practice. The details are as follows:

| Table 1. The competitiveness evaluation system of listed companies related to renewable resources. |
|-----------------------------------------------|
| **Target layer** | **Primary indicators** | **Secondary indicators** |
| Competitiveness of listed companies related to renewable resources A | Operational status B₁ | Total asset turnover C₁₁ |
| | | Accounts receivable turnover C₁₂ |
| | | Inventory turnover C₁₃ |
| | Profitability B₂ | Enterprise earnings per share C₂₁ |
| | | Sales margin C₂₂ |
| | | Return on equity C₂₃ |
| | | Return on total assets C₂₄ |
| | Survivability B₃ | Asset-liability ratio C₃₁ |
| | | Total assets C₃₂ |
| | | Operating income C₃₃ |
| | Growth ability B₄ | Operating income growth rate C₄₁ |
| | | Net profit growth rate C₄₂ |
| | | Growth rate of total assets C₄₃ |

The above indicators contain some information about a company's past, present and future. The competitiveness of enterprises includes the current development status and potential competitiveness. Operational status and profitability can reflect the current development of the competitiveness of listed companies related to renewable resources. The development potential is reflected by the ability to survive and grow, and is an important manifestation of the company's potential competitiveness.

3. Establishment of Entropy Weight-TOPSIS Model

Entropy weight-TOPSIS is a mature method. Entropy weight method is an objective weighting method. According to the original data, the index weight is obtained to avoid the influence of subjective factors. The TOPSIS method, which approximates the ideal value, is a multi-index decision-making method that is widely used in the fields of socio-economics and engineering technology. Kuang H [11] and Xu J[8] used this method to evaluate the competitiveness of ports and logistics companies. This paper constructs a competitiveness evaluation model of listed companies based on entropy weight-TOPSIS based on renewable resources, as shown below:
3.1. Standardization of evaluation data
Let \( n \) denote the number of evaluation objects, \( m \) denote the number of evaluation indicators, \( x'_{ij} \) denotes the canonical value of the \( j \)-th evaluation index of the \( i \)-th evaluation object, and \( x_{ij} \) denotes the data under the \( j \)-th evaluation index of the \( i \)-th evaluation object value. Since the raw data has different units of measurement, the data is dimensionless before the competitive analysis, as follows:

When \( X_{ij} \) is an efficiency indicator:

\[
\frac{x_{ij} - \min \{X_j\}}{\max \{X_j\} - \min \{X_j\}}; 1 \leq i \leq n, 1 \leq j \leq m
\]

When \( X_{ij} \) is a negative indicator:

\[
\frac{\max \{X_j\} - x_{ij}}{\max \{X_j\} - \min \{X_j\}}; 1 \leq i \leq n, 1 \leq j \leq m
\]

3.2. Determination of entropy weight of each evaluation index
Calculate the proportion of the \( j \)-th evaluation index value of the \( i \)-th evaluation object according to the principle of information entropy:

\[
Y_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{n} x'_{ij}}; 1 \leq i \leq n, 1 \leq j \leq m
\]

Calculate the information entropy value of each indicator:

\[
e_j = -k \sum_{i=1}^{n} \left( Y_{ij} \cdot \ln Y_{ij} \right); 1 \leq j \leq m
\]

In this formula, \( k = \frac{1}{\ln n} \), when \( Y_{ij} = 0 \), \( Y_{ij} \cdot \ln Y_{ij} = 0 \).

The entropy weight of the \( j \)-th evaluation index is:

\[
w_j = \frac{1 - e_j}{\sum_{j=1}^{m} (1 - e_j)}; 1 \leq j \leq m
\]

3.3. TOPSIS analysis
The weighted evaluation matrix is obtained by weighting the different evaluation index normative values by the information entropy weight obtained above, wherein \( Z_{ij} = w_j \cdot x'_{ij} \), the matrix is as follows:

\[
3.1. Standardization of evaluation data
3.2. Determination of entropy weight of each evaluation index
3.3. TOPSIS analysis

Figure 1. Evaluation model of competitiveness of listed companies related to renewable resources based on entropy Weight-TOPSIS
Determine the positive and negative ideal solutions based on the weighting matrix $$ Z $$:

Let $$ z_j^+ = \max_{1 \leq j \leq m} z_{ij}, 1 \leq j \leq m $$ and $$ z_j^- = \min_{1 \leq j \leq m} z_{ij}, 1 \leq j \leq m $$ respectively represent the optimal and worst values of the $$ j $$-th indicator. Therefore:

The positive ideal solution is: $$ Z^+ = (z_1^+, z_2^+, \ldots, z_m^+) $$ (7)

The negative ideal solution is: $$ Z^- = (z_1^-, z_2^-, \ldots, z_m^-) $$ (8)

Taking the entropy weight Euclidean distance as the criterion for judging the competitiveness of an enterprise close to a positive ideal point and away from a negative ideal point is defined as:

$$
\begin{align*}
d_i^+ &= \left[ \sum_{j=1}^{m} w_j \times (z_{ij} - z_j^+)^2 \right]^{1/2}; 1 \leq i \leq n, 1 \leq j \leq m \\
d_i^- &= \left[ \sum_{j=1}^{m} w_j \times (z_{ij} - z_j^-)^2 \right]^{1/2}; 1 \leq i \leq n, 1 \leq j \leq m
\end{align*}
$$ (9)

According to the concept of relative progress, the evaluation value of the $$ i $$-th company's competitiveness is:

$$ C_i = \frac{d_i^-}{d_i^+ + d_i^-} $$ (10)

In this formula, $$ C_i \in (0, 1) $$. If the $$ C_i $$ closer to 1, it indicates that the listed company is more competitive with the listed renewable resources, and vice versa, if the $$ C_i $$ closer to 0, it indicates that the listed companies that are evaluated by renewable resources are less competitive.

4. Case study

In order to ensure the objectivity and comprehensiveness of the competitiveness evaluation of listed companies in China's renewable resources, this paper selects 12 representative listed companies related to China's renewable resources and selects some financial data for 2018. All data comes from the wind database to ensure the reliability and authenticity of the data.

4.1. Evaluation of Competitiveness of Listed Companies Related to Renewable Resources

According to formulas (1)~(5), the entropy and entropy weights of the company's competitiveness evaluation index are calculated, as shown in Table 2:

| Target layer | Primary indicators | Secondary indicators |
|--------------|--------------------|----------------------|
| Competitiveness of listed companies related to renewable resources A | Index code | Entropy weight | Index code | Entropy | Entropy weight in index system |
| B1           | 0.3494             |                      | C11        | 0.7459  | 0.1324 |
|              |                    |                      | C12        | 0.7099  | 0.1512 |
|              |                    |                      | C13        | 0.8736  | 0.0658 |
| B2           | 0.2227             |                      | C21        | 0.8502  | 0.0780 |
|              |                    |                      | C22        | 0.8752  | 0.0650 |
|              |                    |                      | C23        | 0.9247  | 0.0392 |
According to formulas (1)~(10), the comprehensive ranking of the competitiveness of listed companies related to renewable resources is obtained. The results are shown in the following table:

| No. | Company name              | $d^+$  | $d^-$  | Competitive evaluation value | Competitive order |
|-----|---------------------------|--------|--------|------------------------------|-------------------|
| 1   | GEM                       | 0.0792 | 0.0420 | 0.3464                       | 5                 |
| 2   | CRE                       | 0.0951 | 0.0210 | 0.1809                       | 11                |
| 3   | Dongjiang Environment     | 0.0897 | 0.0304 | 0.2533                       | 6                 |
| 4   | Tianqi shares             | 0.0921 | 0.0226 | 0.1973                       | 9                 |
| 5   | Ye Chiu                   | 0.0878 | 0.0220 | 0.2006                       | 8                 |
| 6   | Guofeng Plastic           | 0.0958 | 0.0228 | 0.1925                       | 10                |
| 7   | Huahong Technology        | 0.0906 | 0.0233 | 0.2048                       | 7                 |
| 8   | Yuguang gold lead         | 0.0587 | 0.0725 | 0.5526                       | 1                 |
| 9   | Sino-latinum Metals       | 0.0661 | 0.0636 | 0.4903                       | 2                 |
| 10  | Chifeng Gold              | 0.0928 | 0.0152 | 0.1404                       | 12                |
| 11  | Tus-Sound                 | 0.0783 | 0.0618 | 0.4411                       | 3                 |
| 12  | Truchum                   | 0.0700 | 0.0534 | 0.4331                       | 4                 |

4.2. Analysis of evaluation results

In Table 2, the weight of the accounts receivable turnover rate $C_{12}$ is 0.1512. This indicator has a large entropy weight in the indicator system and is a key factor in the competitiveness of listed companies related to renewable resources. Key factors should be grasped. In addition, the operating status weight is 0.3494, which is a key capability for the competitiveness of China's renewable resources listed companies. The growth ability has the lowest weight, only 0.1442. It shows that listed companies related to renewable resources attach importance to operating capacity, ignoring the contribution of growth capacity advantages to the company's competitiveness. Listed companies related to renewable resources have paid insufficient attention to the improvement of the company's potential development capabilities. Therefore, listed companies related to renewable resources should appropriately increase the potential competitiveness of the company, and focus on improving the growth ability to transform into the company's competitive advantage.

According to Table 3, we can know the evaluation value of the competitiveness of listed companies related to renewable resources. In 2018, the competitiveness of these 12 companies can be divided into three levels. The first level: Yuguang gold lead, Sino-latinum Metals, the competitiveness value is above 0.45; the second level: Tus-Sound, Truchum, GEM, the competitiveness value is above 0.34; other enterprises are at the third level. The top three companies are mainly related to the recycling of metals. This means that in the renewable resource industry, from the perspective of categories, there are greater value spaces in the two categories of electrical waste and automobile waste. Investors can pay attention to related companies, and they can pay attention to Yuguang gold lead, Sino-latinum Metals and Tus-Sound in individual stocks.

5. Conclusion

In this paper, by using the method of entropy-TOPSIS, the financial data of listed companies related to renewable resources is used as data support to evaluate its competitiveness. The entropy weight
method overcomes subjective influence and is an objective method of weighting. The entropy weight-TOPSIS model provides a new idea for the competitiveness evaluation of listed companies related to renewable resources. It provides decision support for its management and provides investors with reference. As an important practical way of ecological civilization construction, the renewable resources industry has received unprecedented attention and development. It is needed to bring into play the value of the renewable resources industry and contribute its social value to the urban and rural ecological civilization construction. This paper uses operating financial data as a data source, and has insufficient research on other factors affecting competitiveness, such as business scope and geographical location. These issues need to be further analyzed and discussed in the future.

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