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Original Research Articles

Financial Performance Evaluation of Leading Fisheries Enterprises Based on Entropy-Weighted TOPSIS Method

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Fishery is a strategic and fundamental core industry in China. Since the 18th National Congress of the Communist Party of China, the central government has attached great importance to the fishery industry and has issued a series of policies to promote its revitalization and vigorous development. In the favorable policy environment, it is crucial for leading fisheries enterprises to pay attention to financial performance evaluation and strive to improve their own operational efficiency.

In this study, we selected seven leading fisheries enterprises as research subjects and used the entropy-weighted TOPSIS method to construct a financial performance evaluation system from four dimensions: debt-paying ability, operational capability, profitability, and development potential. We then conducted performance evaluations on the seven sample companies.

The research findings indicate that enterprises should focus on their development capabilities to improve their potential for sustained development, enhance the operational efficiency of fisheries enterprises, and promote their continuous and healthy growth.

INTRODUCTION

The United Nations “2030 Agenda for Sustainable Development” proposes the development of fisheries and aquaculture to support food security and nutrition supply and to utilize natural resources in a sustainable manner for economic, social, and environmental development.[1] Fisheries are a fundamental industry in China’s national economy, and publicly listed fishing companies represent the most representative form of fishing productivity, playing a leading role in the development of the fishing industry. They are of great significance in guiding the modernization of the fishing industry, promoting the adjustment of the industry structure, and realizing rural revitalization.

Since the reform and opening up, the number of publicly listed fishing companies in China has gradually increased, accelerating the development and upgrading of the fishing industry and improving operational efficiency. They have played a crucial role in the fishing industry and made significant contributions. In addition, the development of leading enterprises also affects the development of the fishing economy and the national economy. Therefore, evaluating the performance of representative fishing companies is a meaningful task. The most direct reflection of the core competitiveness of publicly listed fishing companies is financial information. Through this information, not only can investors make clear judgments about the operational level and development prospects of fishing companies, but it also helps company management understand the strengths and weaknesses of the company and make correct decisions. Based on the company’s financial performance, the company’s strategy can be adjusted to improve its competitiveness in the industry. Therefore, studying the financial performance evaluation of leading fishing companies has both theoretical and practical significance.

In terms of theoretical significance, publicly listed fishing companies, as an important driving force for rural revitalization, have received extensive attention from the academic community. Existing research on financial performance evaluation has achieved fruitful results in various industries such as real estate, retail, and cultural industries, but research on the operational performance of publicly listed fishing companies is relatively limited. By studying their financial performance, constructing a multi-dimensional and multi-angle financial performance evaluation system and evaluation methods, it not only allows the

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management of publicly listed fishing companies and government agencies to have a deep understanding of the company's operations, thus formulating reasonable and appropriate policies based on the characteristics of the company, but also contributes to the standardization and effective supervision of the fishing market, which is of great theoretical significance in promoting rural revitalization.

In terms of practical significance, this study selects publicly listed fishing companies that are already listed on the stock exchange, publicly tradable, and of a certain scale as research samples. By using the entropy weight method and the TOPSIS method combined with financial performance evaluation, a multidimensional and systematic financial performance evaluation model is established. This not only helps to scientifically and reasonably indicate the key areas and directions of financial operations for publicly listed fishing companies but also has important practical significance in improving their financial performance, enhancing their core competitiveness in the industry, and promoting the overall development of the fishing industry.

RESEARCH STATUS

As the theory of performance evaluation continues to develop, scholars from various countries have shifted their focus from theoretical research to the study of performance evaluation methods. Entropy, compared to other financial performance evaluation methods, is considered objective in terms of indicator selection and weight calculation. Increasingly, scholars have applied the entropy weighting method to the field of financial analysis.

In their study on the factors influencing comprehensive financial performance of enterprises, Tinya Hsleh and Moriis H.L. Wang (2001) used the entropy method as a value to measure the degree of financial performance in companies. They calculated the impact weights of various indicators on financial performance, where indicators with larger weights have a greater influence on the company's operational performance.[2] Based on entropy theory, Song Weiwei (2009) established a financial early warning system for the road passenger transportation industry and demonstrated its feasibility through extensive empirical analysis.[3] Zhao Hengqin (2018) conducted an empirical analysis on the mining industry using the entropy weighting method, and the results proved its feasibility for high-tech enterprises in the mining industry.[4] Yin Xianan and Bao Xinzhong (2019) used the entropy-weighted TOPSIS method to construct the weight of financial evaluation indicators in high-tech enterprises, thereby establishing a comprehensive financial evaluation system for high-tech enterprises.[5] Zhang et al (2019). conducted a study on the financial performance evaluation of fisheries enterprises using the entropy weighting method. They analyzed the financial indicators of different fisheries enterprises and calculated the weights of these indicators using the entropy method. The study found that the entropy weighting method can effectively assess the financial performance of fisheries enterprises and provide valuable insights for decision-making.Liu et al(2020). explored the factors influencing the financial performance of aquaculture enterprises. They used the entropy weighting method to determine the importance of various factors such as production scale, technology level, and market conditions. The study found that the entropy weighting method can help identify the key factors affecting the financial performance of aquaculture enterprises and provide guidance for improving their financial performance. Wang and Li (2021) conducted a comparative analysis of the financial performance of different types of fisheries enterprises, including fishing companies, seafood processing companies, and aquaculture companies. They used the entropy weighting method to evaluate the financial performance of these enterprises and compared their performance across different sectors. The study found significant variations in financial performance among different types of fisheries enterprises and highlighted the importance of sector-specific analysis.

RESEARCH DESIGN

RESEARCH METHOD

The entropy weight TOPSIS method is a statistical analysis method that can avoid the subjectivity caused by the determination of weights in low-level and multi-factor situations. The main focus of this study is to evaluate the financial performance of 7 publicly listed fishing companies in China from 2018 to 2022 using the entropy weight TOPSIS method. Therefore, this study needs to first calculate the weights of each indicator in the constructed financial performance evaluation index system for Chinese publicly listed fishing companies using the entropy weight method. The weights are then multiplied by the original data to obtain the specific values of each financial performance evaluation indicator. Based on this, the financial performance of fishing companies can be analyzed and evaluated horizontally and vertically. At the same time, the TOPSIS method is used to rank the comprehensive financial performance of companies and analyze and compare benchmark enterprises in the fishing industry.

INDICATOR SELECTION

The selection of financial indicators in this study follows the principles of guidance, SMART, scientific and comprehensive, importance, adaptability, and systematicity.[6] Based on the characteristics of small-scale and highly competitive fishing enterprises, as well as the fact that their financing mainly relies on loans, and combined with previous research results, a financial performance evaluation index system is constructed from four dimensions: solvency, profitability, operational capability, and development potential. The system includes 14 secondary financial indicators, as shown in **Table 1**.

MODEL ESTABLISHMENT

1.Construct the original data matrix. Assuming there are m samples to be evaluated, each sample contains n eval-

Table 1. Financial Performance Evaluation Index System for Publicly Listed Fishing Companies

Dimensions	Financial Indicators	Indicator Types
Debt repayment capability x_1	Current ratio x_{11}	Moderation indicators
	quick ratio x_{12}	Moderation indicators
	cash ratio x_{13}	Moderation indicators
	interest coverage ratio x_{14}	Moderation indicators
	debt ratio x_{15}	Moderation indicators
operational capability x_2	accounts receivable turnover ratio x_{21}	Positive indicators
	inventory turnover ratio x_{22}	Positive indicators
	total asset turnover ratio x_{23}	Positive indicators
profitability capability x_3	return on equity x_{31}	Positive indicators
	operating profit margin x_{32}	Positive indicators
	net profit margin x_{33}	Positive indicators
Growth capability x_4	operating profit growth rate x_{41}	Positive indicators
	revenue growth rate x_{42}	Positive indicators
	earnings per share growth rate x_{43}	Positive indicators

uation indicators, the original data matrix can be constructed.x (i=1,2,3 , ... , m ; j=1,2,3,...,n) 。

$$X = \begin{bmatrix} \mathrm{X}_{11} & \cdots & \mathrm{X}_{1\mathrm{n}} \\ \vdots & \ddots & \vdots \\ \mathrm{X}_{\mathrm{m1}} & \cdots & \mathrm{X}_{\mathrm{mn}} \end{bmatrix}$$

2.Data processing. When using the TOPSIS method, the indicators used must be positive indicators. To eliminate the influence of different dimensions on the evaluation results, the original data needs to be standardized. In this study, the range change method is used to construct a new standardized matrix. Calculate the weight of the indicator as the proportion it occupies in the calculation of the probability matrix.The probability matrix $Z = (z_{ij})_{m\times n}$, the weight of the j is $P_{ij} = \frac{z_{ij}}{\sum_{i=1}^{n} z_{ij}}$.

3.Determine the entropy weight of each indicator. First, calculate the entropy. The entropy of the jth indicator is calculated as $e_j = -\frac{1}{ln(m)} * \sum_{i=1}^{n}(P_{ij}\ln(P_{ij}))$, where p is the probability of each sample in the jth indicator. If P_{ij} is 0, ln(0) is undefined, so we define ln(0) as 0. Then calculate the entropy weight of each indicator as the ratio of the entropy of the jth indicator to the sum of all entropies. Jth entropy weight of indicators $W_j = \frac{1-e_j}{\sum_{i=1}^{n} 1-e_j}$

4.Obtain the positive and negative ideal solutions based on the probability matrix. The positive ideal solution (p_j^+) is defined as the maximum value of each sample in the jth indicator in the probability matrix, while the negative ideal solution (p_j^-) is the opposite, i.e., the minimum value.

$$p_j^+ = \{\max(P_{11}, P_{21}, \ldots, P_{m1}), \quad \max(P_{12}, P_{22}, \ldots, P_{m2}), \max(P_{1n}, P_{2n}, \ldots, P_{mn},)\}$$

$$p_j^- = \{\max(P_{11}, P_{21}, \ldots, P_{m1}), \quad \max(P_{12}, P_{22}, \ldots, P_{m2}), \max(P_{1n}, P_{2n}, \ldots, P_{mn},)\}$$

5.Calculate the distance between each observation (P_{ij}) and the positive and negative ideal solutions. The optimal distance is calculated as the Euclidean distance between each observation and the positive ideal solution, while the worst distance is calculated as the Euclidean distance between each observation and the negative ideal solution.Optimal distance $D_i^+ = \sqrt{\sum_{j=1}^{m} W_j * \left(P_j^+ - P_{ij}\right)^2}$, The worst distance $D_i^- = \sqrt{\sum_{j=1}^{m} W_j * \left(P_j^- - P_{ij}\right)^2}$

6.Calculate the relative closeness degree and rank the samples. The relative closeness degree refers to the relative distance between the indicators of each sample and the positive and negative ideal solutions. The closer the distance to the negative ideal solution and the farther from the positive ideal solution, the higher the relative closeness degree, indicating a better evaluation for that sample. Conversely, if the distance to the negative ideal solution is closer and the distance to the positive ideal solution is farther, the evaluation for that sample is considered worse.

EMPIRICAL ANALYSIS

SAMPLE DATA SELECTION

In this study, we selected financial data from 7 fisheries companies in the National Statistical Yearbook for the year 2022 as sample data. The selected companies are Zhongshui Fisheries, Zhangzidao, Baiyang Stock, Zhonglu B, Kaichuang International, Dahugu Stock, and Haodangjia.

CALCULATION OF ENTROPY WEIGHT USING ENTROPY METHOD

Based on the financial performance evaluation indicator system constructed in the previous section and the annual reports of each sample company for the year 2022, we calculated the relevant financial indicators for each company and constructed the original matrix. Since the indicators have different dimensions and directions, we need to standardize the original data. For positive indicators, we perform standardization, $Z_{ij} = \frac{X_{ij}-X_{min}}{X_{max}-X_{min}}$ and for negative in-

Table 2. Entropy Weight and Ranking of Financial Indicators

Items	e	Entropy weight	Ranking	proportion
Current ratio x_{11}	0.9237	0.0763	13	23.85%
quick ratio x_{12}	0.8597	0.1403	9	
cash ratio x_{13}	0.7002	0.2998	5	
interest coverage ratio x_{14}	0.8151	0.1849	7	
debt ratio x_{15}	0.9516	0.0484	14	
accounts receivable turnover ratio x_{21}	0.7045	0.2955	6	17.85%
inventory turnover ratio x_{22}	0.842	0.158	8	
total asset turnover ratio x_{23}	0.8925	0.1075	10	
return on equity x_{31}	0.6697	0.3303	3	16.18%
operating profit margin x_{32}	0.9217	0.0783	12	
net profit margin x_{33}	0.9001	0.0999	11	
operating profit growth rate x_{41}	0.45	0.55	1	42.13%
revenue growth rate x_{42}	0.6767	0.3233	4	
earnings per share growth rate x_{43}	0.5494	0.4506	2	

dicators $Z_{ij} = \frac{X_{max} - X_{ij}}{X_{max} - X_{min}}$, X_{max}, X_{min} calculate the maximum and minimum values among the sample companies. Then, we calculate the probability matrix P and information entropy e_j according to the model mentioned earlier, and finally obtain the entropy weight for each indicator. The specific W_j results are shown in **Table 2**.

According to **Table 2**, it can be seen that based on the financial data of the selected 7 leading fisheries companies in 2022, the three indicators included in the growth ability dimension account for 42.13% of the entire indicator system. Among the secondary indicators in the development ability, the highest proportion is the operating profit growth rate, with a weight of 17.50%. The weight of the net asset growth rate per share ranks second, accounting for 14.34%. The weights of other secondary indicators vary. In the debt-paying ability dimension, the highest proportion of secondary indicators is the cash flow ratio. In the profitability dimension, the highest proportion of indicators is the return on equity (ROE), which is 10.51%. In the operating ability dimension, the highest proportion is the accounts receivable turnover ratio. In summary, the development ability contributes the most to the results in financial performance evaluation. From the perspective of secondary indicators, the highest weighted indicator is the operating profit growth rate, indicating that the growth of operating profit has a significant impact on the financial performance of the company. Its significance lies in the fact that a high operating profit growth rate indicates a stronger development ability of the company, which can enhance profitability and contribute to the healthy operation of the company.

TOPSIS RANKING

Based on the probability matrix to determine the positive and negative ideal solutions, combined with the entropy weights of the determined indicators mentioned above, the optimal distance and the worst distance can be calculated. Then, the relative fit of each fisheries company can be calculated, as shown in **Table 3**.

From Table 3, it can be seen that the top three companies with the highest relative closeness degree among the 7 leading fisheries companies are Haodangjia, Zhongshui Fisheries, and Zhonglu B. These three companies have performed well in various financial indicators, especially in the development capability, which has a higher weight. However, overall, there is a significant difference in financial performance among these 7 fisheries companies.

Haodangjia ranks first in terms of relative closeness degree and is the first listed company in the marine food industry in China. Haodangjia has a 100,000-acre seawater aquaculture base (including a 50,000-acre offshore aquaculture base) and an 800,000-square-meter factory aquaculture workshop. It has developed into a large-scale national enterprise group integrating offshore fishing, ecological seawater seedling cultivation, aquaculture, marine biomedicine and health care, marine food processing and export, thermal power and papermaking, and coastal tourism. Haodangjia has made significant progress in its development history and is expected to benefit from the increasing demand for home services and consumption upgrades.

Dahugu Stock ranks last in terms of relative closeness degree, with a value of only 0.047, which is significantly lower than the top-ranked Haodangjia by approximately 0.892. Analysis of Dahugu Stock's 2022 annual report reveals that the company's losses are mainly due to increased fixed costs of newly built hospitals and impairment of goodwill provision of approximately 40 million yuan. If these factors are excluded, the company's various businesses have shown steady development in 2022. With the continuous expansion of medical service demand and favorable policies for private medical services by the government, the health care service sector presents development opportunities. In addition, the stable operation of the "bal-

Table 3. Ranking of the relative fit degree of each enterprise

Items	D_i^+	D_i^-	S_i	Ranking
Zhongshui Fisheries	3.304	3.811	0.536	2
ST Zhangzidao	6.717	0.419	0.059	5
Baiyang Stock	7.098	0.424	0.056	6
Zhonglu B	4.977	2.137	0.3	3
Kaichuang International	5.507	1.61	0.226	4
Dahugu Stock	6.785	0.336	0.047	7
Haodangjia	0.459	7.096	0.939	1

last" health water product business provides strong performance support and stable cash flow for the company.

RESEARCH CONCLUSION

In this study, the 2022 financial data of 7 leading fisheries companies were used as samples to characterize their financial performance using 14 indicators across 4 dimensions. The entropy weight method was used to objectively assign weights to the indicators, and the TOPSIS method was used to rank and evaluate the financial performance of these 7 companies. The research findings are as follows: Using the entropy weight method for objective weighting, the development capability dimension has the highest weight among the four dimensions, accounting for 42.13% of the total weight, indicating a strong correlation between development capability and financial performance. Among the 14 secondary indicators, the top five in terms of weight are operating profit growth rate, earnings per share growth rate, cash flow ratio, accounts receivable turnover ratio, and return on equity, with a cumulative weight of 49.36%. Companies should focus on these five financial indicators and conduct a comprehensive evaluation of financial performance from multiple perspectives. From the TOPSIS scores, it can be observed that the average relative closeness degree of companies in the top two performance groups is more than 0.4 higher than that of the bottom two groups, indicating a significant performance gap among the leading fisheries companies.

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DATA ACCESSIBILITY

The datasets generated and/or analyzed during the current study are available from the corresponding authors upon reasonable request.

AUTHOR CONTRIBUTIONS

Conceptualization: Shan Gao (Lead). Investigation: Shan Gao (Lead). Writing – original draft: Shan Gao (Equal), Jiang Qingqing (Equal), Zhuming Zhao (Equal), Wu Biao (Equal). Writing – review & editing: Shan Gao (Equal), Jiang Qingqing (Equal), Zhuming Zhao (Equal), Wu Biao (Equal). Supervision: Jiang Qingqing (Lead), Wu Biao (Lead).

CONFLICT OF INTEREST STATEMENT

The authors declare that this article was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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