Green Supply Chain Finance Risk Assessment Model Based on TOPSIS Method

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Abstract. This study constructs a green supply chain finance risk assessment model based on the TOPSIS method and conducts an empirical analysis using Company H as a case study. First, an assessment indicator system covering exogenous risks, endogenous risks, and subject risks is developed, with the entropy weight method employed to determine indicator weights and reduce subjective influence. Subsequently, the TOPSIS method is used to calculate the green supply chain finance risk assessment values for Company H from 2016 to 2023. The results show an overall downward trend in risk levels, decreasing from 0.7959 in 2016 to 0.2427 in 2023, indicating significant achievements in the company's green supply chain finance risk management. However, a slight increase (0.0001) in the risk assessment value was observed between 2021 and 2022, suggesting that the company should remain vigilant to potential new risks and continuously optimize its management system. This study enriches the theoretical framework of green supply chain finance risk assessment and provides a scientific decision-making basis for enterprises and financial institutions, contributing to the sustainable development of green supply chain finance.

Keywords: Green supply chain finance, Risk assessment, TOPSIS method, Entropy weight method, Sustainable development.

1 Introduction

With global environmental challenges becoming increasingly severe, green development has become a crucial direction for economic transformation across countries [1]. Supply chain finance, as a vital link between supply chain enterprises and financial institutions, plays a key role in promoting industrial chain collaborative development and alleviating financing difficulties for small and medium-sized enterprises. However, traditional supply chain finance models often fail to fully consider environmental factors, leading to problems such as excessive financing for high-carbon enterprises and limited financing for green enterprises [2]. To promote sustainable development, green supply chain finance has emerged, with its core focus on incorporating environmental and social responsibility factors into financial decision-making to help supply chain

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enterprises achieve green transformation. However, the development of green supply chain finance also comes with various risks, including policy risks, market risks, credit risks, and environmental risks [3]. How to scientifically and effectively assess these risks has become a topic of common concern in both academic and practical fields.

Currently, domestic and international scholars have conducted extensive research on green supply chain finance risk assessment, primarily focusing on risk identification, assessment methods, and risk prevention and control. In terms of risk identification, some scholars have constructed risk classification frameworks based on supply chain finance characteristics, covering credit risk, operational risk, market risk, and environmental risk [4-6]. Regarding assessment methods, existing research has employed methods such as analytic hierarchy process, fuzzy comprehensive evaluation, and grey correlation analysis for quantitative assessment [7-9]. However, these methods have certain limitations in handling multi-indicator comprehensive evaluation and struggle to fully reflect the impact of various risk factors on overall assessment results. Additionally, some studies have attempted to construct intelligent assessment models based on big data and machine learning technologies to improve risk prediction accuracy [10]. However, current research on comprehensive risk assessment for green supply chain finance remains relatively limited, lacking scientifically sound comprehensive evaluation models that can meet practical needs.

To address the limitations of existing research, this study constructs a green supply chain finance risk assessment model based on the TOPSIS method, using Company H as a case study for empirical analysis. As an effective multi-attribute decision analysis tool, the TOPSIS method can fully consider the relative importance of various risk factors and their impact on decision-making results, thereby improving the scientific nature and accuracy of the assessment. This study optimizes the risk assessment indicator system by incorporating green finance characteristics and employs the entropy weight method for weighting to reduce the influence of subjective factors on assessment results. This research not only enriches the theoretical system of green supply chain finance risk assessment but also provides scientific decision-making basis for enterprises and financial institutions, contributing to the healthy development of green supply chain finance.

2 Methodology

2.1 Current Development Status of Company H

Company H is a listed company focusing on intelligent logistics services. Founded in Hangzhou, Zhejiang Province in 2001, the company was listed on the Shenzhen Stock Exchange in 2004. In 2015, Company H integrated its premium logistics resources into the listed company and repositioned itself as a smart logistics leading company. Currently, Company H has built a "Logistics + Technology + Finance" service platform, providing intelligent logistics services and supply chain financial services to manufacturing and commercial enterprises.

2.2 Green Supply Chain Finance Risk Assessment Indicator System

Green supply chain finance risks can be primarily categorized into exogenous risks, endogenous risks, and subject risks. Based on these three major factors of green supply chain finance risks, this paper constructs an indicator system using exogenous risks, endogenous risks, and subject risks as primary indicators [4-10]. Combined with the principles of scientific validity, comprehensiveness, and feasibility of green supply chain finance risk indicators, an operational risk assessment system has been developed, as shown in Table 1.

Table 1. Green supply chain finance risk assessment indicator system.

Primary indicators	Secondary indicators	Tertiary indicators
Exogenous risks of green supply chain finance	Market economic environment	GDP growth rate, Retail price index, Carbon price index
	Government support	Subsidy amount, Number of green finance support policies
	Environmental protection system	Pollution control level, Pollution control investment
Endogenous risks of green supply chain finance	Supply chain enterprise relations	Bad debt ratio of accounts receivable, Top 5 suppliers procurement ratio, Top 5 customers sales ratio, Green certified supplier's ratio
	Green operation management	Green logistics facilities ratio, Carbon emission intensity, Number of new energy vehicles delivered, Number of photovoltaic station projects
	Green logistics services	New energy logistics vehicle ratio, Logistics energy consumption intensity
Subject risks of green supply chain finance	Emission rights status	Green pledge rate, Emission rights valuation
	Operational capability	Accounts receivable turnover rate, Inventory turnover rate, Current assets turnover rate, Total assets turnover rate, Green business revenue ratio
	Profitability	Return on total assets, Return on net assets, Earnings per share
	Solvency	Asset-liability ratio, Current ratio, Quick ratio
	Growth potential	Total assets growth rate, Sales revenue growth rate, Net profit growth rate, Green investment return rate
	Cash flow	Total assets cash recovery rate, Operating revenue cash rate, Green project cash flow ratio, Carbon trading cash flow ratio
	Personnel quality	Bachelor's degree and above ratio, Environmental protection professional's ratio, Carbon finance professional's ratio, ESG management talent ratio

2.3 Data Sources and Processing

This paper conducts an empirical analysis of H Company's green supply chain finance risk assessment from 2016 to 2023, taking into account data availability and the accessibility of indicators in certain domains. The research data is primarily sourced from H Company's annual reports, Environmental, Social, and Governance (ESG) reports, social responsibility reports, and databases such as the World Bank. For missing data in certain years, cubic linear interpolation and linear extrapolation methods are used for supplementation. Subsequently, natural logarithmic processing is applied to economic-related indicators that are susceptible to abnormal fluctuations due to factors such as prices and seasonal variations, thereby avoiding the impact of excessive abnormal fluctuations [11]. Finally, range standardization is employed to eliminate the dimensional effects on various indicators.

2.4 Entropy Weight Method

The entropy weight method is an objective weighting method widely used in multi-indicator comprehensive evaluation. Its fundamental concept is based on the entropy concept from information theory, determining the importance weights of various indicators by calculating their information entropy to measure their information content [12]. The entropy weight method features strong objectivity, rigorous calculation, and broad applicability, making it commonly used in decision analysis across fields such as economics, environment, and engineering management. In a multi-indicator evaluation system, information entropy measures the amount of information provided by each indicator. The larger the information entropy, the more uniform the data distribution of that indicator, indicating lower variability and less information content, which should result in a lower corresponding weight. Conversely, smaller information entropy indicates that the indicator provides more information, warranting a higher weight. Therefore, reasonable objective weights for each indicator can be determined by calculating their information entropy.

2.5 TOPSIS Method

TOPSIS method first proposed by Hwang and Yoon in 1981, is suitable for evaluation scenarios that compare multiple solutions based on multiple indicators. This method is essentially a relative evaluation approach, with its basic concept centered on first identifying the positive ideal solution and negative ideal solution within the entire evaluation system [13]. The positive ideal solution refers to the optimal solution in a hypothetical scenario, where all indicator values are the best among the candidate solutions, while the negative ideal solution is the opposite. Then, by calculating the Euclidean distance between each solution and both the positive and negative ideal values, the method analyzes how close each solution is to the optimal (or worst) solution, using this as the criterion for evaluating the merits of different solutions. Since TOPSIS can fully reflect the differences between various solutions and features advantages such as simple calculation and intuitive results, while having no special requirements for sample data, it has been widely applied to evaluation problems across various fields.

3 Results

This paper uses TOPSIS method to conduct a comprehensive assessment of H Company's green supply chain finance risks, with results shown in Fig. 1.

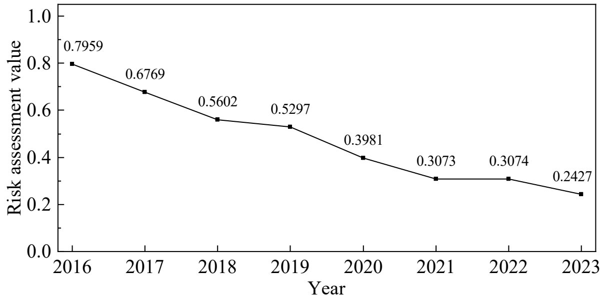

Fig. 1. Results of H company's green supply chain finance risk assessment model.

As shown in Fig. 1, from an overall trend perspective, H Company's green supply chain finance risk assessment values demonstrate a clear continuous downward trend, decreasing year by year from 0.7959 in 2016 to 0.2427 in 2023, reflecting significant achievements in the company's green supply chain finance risk management and control. In terms of the rate of change, the risk assessment values show a pattern of "faster early, slower later" decline. The largest decrease occurred during 2016-2018, followed by a gradual slowdown, which aligns with the general pattern of risk management optimization: in the initial stage of system construction, risk levels can be quickly reduced through institutional development and process optimization; however, when risk levels decrease to lower ranges, the space for further improvement relatively narrows, requiring more detailed management measures to achieve continuous optimization. Notably, there was an extremely slight increase in risk assessment values between 2021-2022 (an increase of 0.0001). Although the magnitude of change is minimal, it suggests that the company needs to remain vigilant about potential new risk factors and continue to improve its risk management system. By 2023, the risk assessment value dropped to 0.2427, reaching its lowest level in eight years, indicating that the company's green supply chain finance risk management has achieved a relatively ideal state.

4 Conclusion

This study assesses the green supply chain finance risk of Company H using the TOPSIS method. The results indicate an overall decline in risk levels, demonstrating significant progress in the company's green finance management. However, the findings also reveal a slowdown in risk reduction during the later stages of risk management optimization, with a slight fluctuation observed between 2021 and 2022. This reflects the continuous and complex nature of green supply chain finance risk management. To further mitigate risks, enterprises should continuously optimize green supply chain finance policies, enhance market environment monitoring, and improve the green operational capabilities of supply chain enterprises. This study not only validates the applicability of the TOPSIS method in green supply chain finance risk assessment but also provides scientific risk identification and decision-making support for enterprises and financial institutions, contributing to the stable development of the green financial system.

References

1. Wang, H., & Liu, M. Credit Risk Assessment of Green Supply Chain Finance for SMEs Based on Multi-Source Information Fusion. Sustainability, 17(4), 1590 (2025).
2. Liu, Y., Li, S., Yu, C., & Lv, M. Research on green supply chain finance risk identification based on two-stage deep learning. Operations Research Perspectives, 13, 100311 (2024).
3. Jamil, M. A., Mustofa, R., Hossain, N. U. I., Rahman, S. A., & Chowdhury, S. A structural equation modeling framework for exploring the industry 5.0 and sustainable supply chain determinants. Supply Chain Analytics, 6, 100060 (2024).
4. Sun, K., Ooi, K. B., Wei-Han Tan, G., & Lee, V. H. Small and medium-sized enterprises' path to sustainable supply chains: exploring the role of supply chain finance and risk management. Supply Chain Management: An International Journal, 30(1), 1-18 (2025).
5. Nirmal, D. D., Nageswara Reddy, K., & Singh, S. K. Application of fuzzy methods in green and sustainable supply chains: critical insights from a systematic review and bibliometric analysis. Benchmarking: An International Journal, 31(5), 1700-1748 (2024).
6. Liu, H., Wei, Z., Hu, D., Yang, J., & Linghu, D. Robust Financing Decisions of Green Supply Chain under Market Risk. Sustainability, 16(18), 7942 (2024).
7. Javed, A., Basit, A., Ejaz, F., Hameed, A., Fodor, Z. J., & Hossain, M. B. The role of advanced technologies and supply chain collaboration: during COVID-19 on sustainable supply chain performance. Discover Sustainability, 5(1), 46 (2024).
8. Layode, O., Naiho, H. N. N., Labake, T. T., Adeleke, G. S., Udeh, E. O., & Johnson, E. Addressing cybersecurity challenges in sustainable supply chain management: A review of current practices and future directions. International Journal of Management & Entrepreneurship Research, 6(6), 1954-1981 (2024).
9. Judijanto, L., Utami, E. Y., & Harsono, I. Green Supply Chain Finance: A Bibliometric Review of Financing Instruments, Challenges, and Opportunities. West Science Interdisciplinary Studies, 2(03), 647-655 (2024).
10. Chaudhuri, R., Singh, B., Agrawal, A. K., Chatterjee, S., Gupta, S., & Mangla, S. K. A TOE-DCV approach to green supply chain adoption for sustainable operations in the semiconductor industry. International Journal of Production Economics, 275, 109327 (2024).
11. Xu, Z. Coupling Coordination Development and Driving Factors of New Energy Vehicles and Ecological Environment in China. Wuhan University Journal of Natural Sciences 30(1), 79-90 (2025).
12. Xu, Z. Machine Learning-Based Quantitative Structure-Activity Relationship and ADMET Prediction Models for ERα Activity of Anti-Breast Cancer Drug Candidates. Wuhan University Journal of Natural Sciences 28(3), 257-270 (2023).
13. Xu, Z., Lin, Y., Cai, H., Zhang, W., Shi, J., & Situ, L. Risk assessment and categorization of terrorist attacks based on the Global Terrorism Database from 1970 to 2020. Humanities & Social Sciences Communications 11, 1103 (2024).