Risk management of supply chain finance in the new energy vehicle industry: a comprehensive evaluation model

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Abstract. In recent years, the new energy vehicle (NEV) industry has rapidly grown and become a vital part of the automotive sector. Supply chain finance plays a critical role in the NEV industry as it affects the operation and development of the entire industry chain. The supply chain of NEVs is different from the traditional automobile industry due to its complexity, fragility, and forecasting difficulties. Managing the risks associated with supply chain finance in the NEV industry presents new challenges. Commercial banks need to establish scientific risk assessment models and take preventive measures to ensure the provision of financial services while safeguarding their funds. This study focuses on the supply chain financial services of NEVs provided by commercial banks. It employs various methods to assess financial risks, establishes a risk index model, and uses the analytic hierarchy process, entropy weight method, and fuzzy comprehensive evaluation to determine weights and provide risk assessment opinions. The proposed evaluation model effectively assesses risks and provides preventive measures with potential practical applications. Future research can further refine and apply this model to benefit enterprises and financial institutions in the NEV industry.

1 Introduction

With the continuous improvement and development of the new energy automobile industry chain, supply chain finance has gradually become an important financing method for new energy automobile enterprises. As the main financing channel for enterprises, commercial banks also provide supply chain financial services for new energy automobiles enterprises, such as order financing, accounts receivable pledge financing, factoring financing, advance payment financing, confirmed warehouse financing and other financing methods [1]. But at the same time, commercial banks face the challenge of supply chain finance risks, such as supplier default, lack of demand, market fluctuations and other risks. The traditional supply chain finance risk assessment model cannot accurately assess and predict the supply chain finance risk because it is not adapted to the particularity and complexity of the new energy automobile industry. This threatens commercial banks' capital security and customers' interests.

From the studies that have been done, supply chain finance is an important part of supply chain management, and it is especially critical for the new energy automotive industry. However, due to the special characteristics of the new energy automobile supply chain, its financial risk management faces new challenges. Researchers have conducted extensive studies on supply chain finance, exploring its definition, role and function from different perspectives [2, 3]. Researchers have classified and assessed supply chain finance risks, including external market, internal enterprise, and supply chain network risks [4-9]. However, the research on the supply chain financial risk of new energy vehicles is still relatively limited. Current research mainly focuses on supply chain finance models and risk assessment methods but needs a complete assessment system [10].

This study aims to comprehensively investigate the risk assessment and prevention of supply chain finance in commercial banks within the new energy automobile industry. It focuses on establishing a scientific risk assessment model and implementing corresponding risk prevention measures. By quantitatively evaluating and mitigating supply chain finance risks, the study aims to enhance commercial banks' risk management capabilities and service quality, promoting the sustainable and healthy development of the new energy automobile industry. The research methodology combines the analytic hierarchy process (AHP) and entropy weight method to conduct a risk assessment and forecast the risk level of supply chain finance.

2 Establishment of multilevel risk indicators

According to the literature review method, this paper examines relevant literature on the financial risks in the traditional automotive supply chain and the new energy vehicle supply chain. By combining theoretical knowledge with practical insights, a comprehensive

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assessment framework for supply chain financial risks in the new energy vehicle industry is established from the perspective of commercial banks. Building upon the foundation of financial risks in the traditional automotive supply chain, this study introduces new indicators tailored to the unique challenges of the new energy vehicle supply chain. These indicators include the level of information transparency in the new energy vehicle supply chain, the support from core enterprises to the supply chain, the bargaining power of financing companies within the supply chain, and the regulatory measures governing the supply chain. The specific details of the indicators are presented in Table 1.

Table 1. Financial Risk Indicators in the New Energy Vehicle Supply Chain from the Perspective of Commercial Banks

Evaluation Subject	Primary Indicators	Secondary Indicators
Evaluation System for Financial Risks in the New Energy Vehicle Supply Chain from the Perspective of Commercial Banks	Core Enterprise Qualifications	Transparency of Supply Chain Information
		Support from Core Enterprises
		Position of Financing Companies
		Regulatory Measures
	Financing Company Qualifications	Credit Standing
		Profitability
		Collaboration with Core Enterprises
		Payment Ability
	Supply Chain Quality	Industry Prospects
		Competitiveness of the Supply Chain
		Stability of the Supply Chain
	Pledged Asset Risks	Price Fluctuations
		Liquidation Ability
		Quality of Pledged Assets
	Quality of Accounts Payable	The credit of Core Enterprises
		Payment Ability of Core Enterprises

2.1. Determination of evaluation indicator weights

In this paper, the weights of evaluation indicators for the financial risks in the new energy vehicle supply chain from the perspective of commercial banks are determined based on the Analytic Hierarchy Process (AHP). Following the steps mentioned earlier.

2.2 Establishment of hierarchy structure model

The AHP divides the problem into three levels: the goal level, the criterion level, and the alternative level. The hierarchy is decomposed from the goal level to obtain specific alternatives to achieve the goals. The hierarchy structure model for this paper is detailed in Table 1 above.

2.3 Construction of pairwise comparison judgment matrix

The AHP involves pairwise comparisons of indicators within the same level to assess their relative importance.

3 Data analysis and processing

3.1. Analytic hierarchy process

This paper applies the methods above to analyze the scoring data from 10 experts. All 10 experts have research experience in the field of supply chain and possess extensive expertise in evaluating supply chain financial risks. The collected questionnaire data is processed using SPSS software for weight analysis and consistency testing. Through the analysis, we obtained the results shown in Table 2.

The analysis of the weights of financial risks in the new energy vehicle supply chain shows that the main sources of financial risks in the new energy vehicle industry's supply chain primarily stem from the proportion attributed to core enterprises in the supply chain. The transparency of supply chain information and the position of financing companies, which determines their bargaining power, are critical influencing factors. Additionally, the qualifications of financing companies and the risks associated with pledged assets are significant factors. The former determines the investment value of the financing company, while the latter determines whether the losses incurred due to credit risks of the financing company can be mitigated.

3.2. Entropy weight method for objective weight determination

The concept of entropy represents the complexity and uncertainty of data. The weights of various indicators can be determined by assessing the entropy value of data. The introduction of the entropy weight method aims to objectively adjust the subjective weighting in the Analytic Hierarchy Process (AHP) to balance subjective judgments and obtain a scientifically derived risk indicator model.

To apply the entropy weight method, we distributed questionnaires to Company B, a renowned enterprise in the new energy vehicle industry. We invited 5 company managers, 5 external experts, and 30 employees to rate the performance of various indicators on a percentage scale. A higher score indicates better performance of the respective indicator. The scores were divided into three categories: company managers, company employees, and external experts. The arithmetic mean score for each category was calculated for each indicator, resulting in the original score matrix $X' = (X_{ij}')$ as follows. Based on the judgment matrix and the original scores, the calculated weights of the indicators are presented in Table 3.

Table2. Risk Assessment Weight Table

Primary Indicator	**Weight**	**Secondary Indicator**	**Weight**	**Composite Weight**
Core Enterprise Qualifications	41.612%	Transparency of Supply Chain Information	43.078%	8.6156%
		Support from Core Enterprises	9.299%	1.8598%
		Position of Financing Companies	26.084%	5.2168%
		Regulatory Measures	21.539%	4.3078%
Financing Company Qualifications	18.315%	Credit Standing	33.333%	6.6666%
		Profitability	16.667%	3.3334%
		Collaboration with Core Enterprises	33.333%	6.6666%
		Payment Ability	16.667%	3.3334%
Supply Chain Quality	8.864%	Industry Prospects	54.848%	10.9696%
		Competitiveness of the Supply Chain	21.061%	4.2122%
		Stability of the Supply Chain	24.091%	4.8182%
Pledged Asset Risks	20.806%	Price Fluctuations	28.571%	5.7142%
		Liquidation Ability	57.143%	11.4286%
		Quality of Pledged Assets	14.286%	2.8572%
Quality of Accounts Payable	10.40%	The credit of Core Enterprises	66.667%	13.3334%
		Payment Ability of Core Enterprises	33.333%	6.6666%

Table 3. Composite Weight Table

Risk Evaluation Indicators	**AHP**	**Entropy Weight Method**	**Composite Weight**
Core Enterprise Qualifications	0.42	0.16	0.36
Financing Company Qualifications	0.18	0.22	0.21
Supply Chain Quality	0.09	0.28	0.14
Pledged Asset Risks	0.21	0.18	0.20
Quality of Accounts Payable	0.10	0.16	0.09
Transparency of Supply Chain Information	0.43	0.25	0.43
Support from Core Enterprises	0.09	0.22	0.08
Position of Financing Companies	0.26	0.27	0.27
Regulatory Measures	0.22	0.26	0.22
Credit Standing	0.33	0.28	0.36
Profitability	0.17	0.18	0.12
Collaboration with Core Enterprises	0.33	0.26	0.34
Payment Ability	0.17	0.28	0.18
Industry Prospects	0.55	0.36	0.57
Competitiveness of the Supply Chain	0.21	0.29	0.18
Stability of the Supply Chain	0.24	0.35	0.25
Price Fluctuations	0.29	0.37	0.31
Liquidation Ability	0.57	0.33	0.56
Quality of Pledged Assets	0.14	0.30	0.13
The credit of Core Enterprises	0.67	0.50	0.66

Payment Ability of Core Enterprises	0.33	0.50	0.34

3.3. Fuzzy comprehensive evaluation method

After determining the composite weights, as mentioned earlier, a secondary evaluation and scoring were conducted for the sub-indicators. A corresponding survey questionnaire was designed and distributed to ten employees from Company B to assess the risk sub-indicators. A fuzzy comprehensive evaluation was established using the evaluation set V={Excellent, Good, Qualified, Unqualified}, with assigned values of {95, 85, 70, 50}. After calculating the composite scores, the evaluations were categorized as follows: scores above 90 were classified as "Excellent," scores between 80 and 90 were classified as "Good," and scores between 60 and 80 were classified as "Qualified." Scores below 60 were classified as "Unqualified." The results of the evaluation are presented in Table 4.

Table 4. Composite Weight Table

Secondary Indicator	Composite Score	Evaluation Level
Transparency of Supply Chain Information	78	Qualified
Support from Core Enterprises	74	Qualified
Position of Financing Companies	80	Good
Regulatory Measures	69.5	Qualified
Credit Standing	82.5	Good
Profitability	91	Excellent
Collaboration with Core Enterprises	87	Good
Payment Ability	80	Good
Industry Prospects	88.5	Good
Competitiveness of the Supply Chain	81.5	Good
Stability of the Supply Chain	81.5	Good
Price Fluctuations	77.5	Qualified
Liquidation Ability	67.5	Qualified
Quality of Pledged Assets	78	Qualified
The credit of Core Enterprises	76.5	Qualified
Payment Ability of Core Enterprises	79	Qualified

Based on the scoring of the secondary indicators, a matrix for evaluating the secondary indicators are constructed. This matrix is multiplied with the composite matrix mentioned in the previous text to obtain the comprehensive evaluation results of the primary indicators. Furthermore, the matrix of the comprehensive evaluation results of the primary indicators is multiplied by the assigned value matrix to obtain the final evaluation results of the primary indicators. As shown in Table 5, the final evaluation score for Company B's supply chain financial risk is 78.58, indicating a qualified level.

Table 5. Evaluation Results of Primary Indicators

Primary Indicator	Composite Score	Evaluation Level
Core Enterprise Qualifications	76.36	Qualified
Financing Company Qualifications	84.59	good
Supply Chain Quality	85.50	good
Pledged Asset Risks	71.96	Qualified
Quality of Accounts Payable	77.34	Qualified

4 Conclusion

The main focus of this study is the evaluation of supply chain financial risks in the new energy vehicle industry from the perspective of commercial banks. It aims to provide a risk assessment model for financing and offers targeted recommendations for risk control.

Based on the results, the overall evaluation score for Company B's supply chain financial risks is 78.58, indicating a qualified performance level. Overall, risk control can be considered good with improvements in certain risk indicators. The evaluation results of the primary indicators in Table 18 reveal that Company B needs to improve the quality of accounts payable and support from core enterprises. Company B's liquidation ability for pledged assets could be more optimistic, mainly attributed to the depreciation rate of new energy vehicles. Compared to other industries, the low retention value of new energy vehicles directly affects their liquidation ability and leads to inventory pressure. This is an important indicator that needs to be focused on in future risk assessments.

Additionally, regulatory measures play a role in determining the support from core enterprises. The supply chain is still developing in the new energy vehicle industry, needing a well-established and standardized regulatory model. More coverage of digital platforms also helps information sharing and mutual supervision within the supply chain.

The evaluation of supply chain financial risks is crucial for the development of financial services in commercial banks. A relatively comprehensive logistics financial risk evaluation indicator system has been established by selecting risk indicators and determining the weights using the AHP-entropy method. Applying the fuzzy comprehensive evaluation method based on the composite indicator weights provides valuable guidance for risk assessment in new energy vehicle enterprises. It helps financing companies, banks, and new energy vehicle companies effectively mitigate risks.

Authors contribution

All the authors contributed equally, and their names were listed alphabetically.

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