

A Fuzzy Model Using Entropy Weight for Financial Risk Measurement and Analysis to Enhance Energy Performance: A Case Study of New Energy Vehicle in China

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ABSTRACT

With the tightening of government subsidies and the increasing thresholds for preferential policies, China's new energy vehicle industry has entered a critical period of transformation from being "policy-driven" to "policy and market-driven." As it becomes significantly more difficult for new energy vehicle enterprises to obtain government subsidies, they are likely to face heightened financial risks. This paper develops a financial risk evaluation index system based on four key aspects: financing risk, operational risk, investment risk, and income distribution risk. Using the entropy weighting method to calculate the weights and the fuzzy comprehensive evaluation method to assess the financial risks, the paper evaluates the financial risk of C Automobile Company. The findings reveal that the company's current assets, such as inventory and accounts receivable, exhibit a weak turnover rate, suggesting a need to improve its current ratio. Moreover, the returns generated by its total assets are low, indicating poor operational efficiency, which calls for better asset management and enhanced use of funds. Additionally, C Automobile Company's long-term equity investments are not sufficiently profitable, prompting a reassessment of the feasibility of these investment programs. Lastly, the company's joint venture has incurred substantial losses, which have hampered its growth, emphasizing the need for a sound business strategy and a focus on strengthening brand value management. This paper provides an analysis of C Automobile Company's financial risk, offering a reference for other enterprises in the new energy vehicle industry as they seek to implement comprehensive and effective financial risk evaluation and control strategies.

Keywords: Double carbon, new energy, fuzzy comprehensive evaluation, financial risk, automobile company

(MSC2020) Codes: 91B05, 28D20

1 | INTRODUCTION

China is a major carbon emitter, emitting more than 6 billion tons a year, China plans to achieve carbon peaking and carbon neutrality by 2030 and 2060 respectively, the automotive industry has relatively large carbon emissions, China's Ministry of Industry and Information Technology clearly

requires the automobile manufacturing industry to achieve the goal of zero emission before 2050. For the whole of 2022, China's oil consumption is slightly lower than last year, about 710 million tons. In 2022, China's crude oil imports of 508 million tons, last year's crude oil imports fell by 5.3%, this year fell by 6.3%, a decline of 1%. Foreign dependence fell to 71.2%. Facing the increasingly tight trend of global oil resources, vehicle electrification is an inevitable measure of energy saving and environmental protection. In 2023, the "new energy vehicles to the countryside" policy was officially released to help new energy vehicle companies explore the rural market and increase the consumption of new energy vehicles by rural consumers [1]. The release of this policy has enhanced rural consumers' acceptance of new energy vehicles. Affected by international factors, supply and other factors, the development of the entire automobile market in 2022 is not stable, but China's new energy vehicles in 2022 are not affected by too much of the environment, and still maintain a rapid development trend. In 2022, China's automobile production was 27.021 million units, an increase of 3.4% over the previous year, and the sales volume was 26.864 million units, an increase of 2.1% over the previous year. Despite several twists and turns, the annual automobile production and sales still maintained positive growth, and remained the world's first for 14 consecutive years.

Unreasonable capital structure, high asset-liability ratio, insufficient use of funds, unreasonable capital structure, and insufficient use of funds are all unique industry situations in the automotive industry. In the period of transformation of the automobile industry, the development cost of technology research and development in the early stage of transformation is relatively large, coupled with the problems of incompleteness and incompatibility, which make the road difficult for the automobile manufacturing enterprises to transform new energy vehicles [2]. Therefore, new energy vehicle companies should improve the awareness of risk prevention and control, and China's new energy vehicle manufacturing industry can be smoothly transformed and developed. In order to prevent the formation of large financial risks, it is very important to pay attention to financial risks. As a new energy vehicle company, C Automobile Company has developed rapidly in recent years, and the research and development of new energy vehicles is still in a period of rapid development. The new energy automobile industry is facing many difficulties, lack of core, rising raw material prices, etc., affecting the development of enterprises. In addition, the situation of "lack of core and less electricity" in the automotive industry, in the short term, it still brings many challenges and risks to the production and operation of enterprises, and the external environment of the automotive industry is complicated and difficult to control, and may also have an impact on enterprises. The enterprise also has internal conditions such as unreasonable internal control. Therefore, by analyzing the financial situation of C Automobile Company, this paper identifies its current financial risks and puts forward suggestions for the prevention of talents risks of C Automobile Company, which can provide reference for the current Chinese new energy automobile manufacturing.

Based on the industry characteristics of the new energy automobile manufacturing industry, this paper constructs a hierarchical index system, uses entropy weight method to calculate the weight of each index, establishes a fuzzy evaluation matrix model of financial risk, obtains the final score of C automobile company's financial risk and various first-level indicators, and analyzes the trend of financial risk. This paper comprehensively evaluates the financial risk of C Automobile Company, and puts forward corresponding risk prevention suggestions, which can provide research methods and ideas for new energy manufacturing vehicles. Finally, these problems are divided into internal and external financial risk analysis, and then give the relevant countermeasures. In recent years, while the automobile industry focuses on the research and development of new energy vehicles, enterprises are also facing various risks. If the risk identification and prevention are not timely and accurately, it will certainly have an adverse impact on the sustainable development of enterprises. This paper identifies the existing financial risks of C Automobile Company, and on this basis analyzes the risk prevention measures, so as to reduce the possibility of corporate financial crisis.

The structure of this paper is as follows: Section 2 reviews the literature on financial risk. Section 3 analyzes the new energy vehicle industry and identifies the financial risks of C Automobile Company. Section 4 constructs a financial risk evaluation system using the fuzzy comprehensive evaluation method. Section 5 calculates and analyzes the financial risk of C Automobile Company. Section 6 summarizes the findings, discusses implications, identifies limitations, and suggests future research directions.

2 | LITERATURE REVIEW

2.1 | Causes of Financial Risk

Organizing, summarizing and analyzing the specific causes of financial risks can help companies identify financial risks and reduce them. Latinen's study concluded that the causes of financial risk are inadequate financial system of the company, insufficient estimation ability of the management of the company, etc [3]. James and John extend the scope of financial risk by suggesting that financial risk is related to the loss of the ability to return the financial leverage-based regulation of corporate borrowing and the underlying benefits [4]. Ross sees equity risk as the risk borne by shareholders as a result of errors in corporate financial policies that increase financial risk, and as a result of corporations raising money owed to them and using it to expand their liabilities [5]. Clarke's study found that the causes of financial risk are related to the time of the firm and the environment in which it operates, and that unfavorable environments may increase a firm's financial risk [6]. Hwang investigated the extent to which financial risk is associated with expected return based on the financial securities market using the CAPM model [7]. Li clarifies the causes of payment risk, which refers to the risk arising from M&A firms caused by irrational choice of payment methods [8]. Liu believed that the occurrence of financial risk is

related to both the internal and external environments of a company [9]. Yang et al. conducted a study on the financial risk assessment of banks and suggested the reasons for the risk, such as the rate of bad credit and insufficient liquidity of assets [9]. Wang's investigation found that the lack of capital liquidity due to financing methods and insufficient funds can bring financial risks [10]. Muttanachai argued that the pattern and level of environmental, social and governance (ESG) performance of listed companies in the capital market are negatively related to corporate financial risk [11]. Zou and Wu believed that equity pledges will affect the debt structure of the company, and banks and other financial institutions will focus on short-term loans and mortgages for companies with equity pledges, while loans about credit will be reduced, which will in turn make the company's financial risk intensify [12]. Based on the above research status, the current scholars' analysis of the causes of financial risk is more comprehensive and rich, but with the changes in the internal environment and external environment, the causes are also changing. Therefore, in order to analyze the financial risk situation of an enterprise, it is essential to analyze the causes of its financial risk.

2.2 | Evaluation of Financial Risk

Research on the evaluation of financial risk, there are many domestic and international studies on the evaluation model and impact of financial risk. For example, Tam and Kiang argued that artificial neural network models are suitable for analyzing the financial risks of firms and are also applicable to risk management [13]. Marinakos analyzes the financial risk of the industry in question using a cash flow model [14]. Zhang examines the causes of financial risk by evaluating the financial risk of small and medium-sized enterprises, using a case evaluation system [15]. Wang used the fuzzy comprehensive evaluation method to analyze corporate financial risk by combining qualitative and quantitative methods [15]. Using the software of SPSS version 23.0 and Logistic regression method, Xu and Cheng screened the differentiation indicators of ST and non-ST listed companies and constructed a financial early warning model to help construction companies evaluate the financial risks [16]. Giannopoulos and Sigbjornsen studied the use of improved Z model to analyze the financial distress situation of firms and compared the accuracy of the results of the improved Z model [17]. Prabowo used Z-score and X-score models for financial risk prediction for Indonesia Tobacco Company respectively, and the results showed that there are some differences between these two models [18]. Li et al extensively considered subject-object and objective indicators and put quantitative data and fuzzy theory together to propose a financial risk assessment model based on MCDM and historical data [19]. Fali utilized regression methods to analyze the factors affecting corporate solvency risk, credit risk, and liquidity risk [20]. Shi and Zhao use the HGAT model to learn complex inter-entity relationships by integrating local and extensive structural information through multiple self-attention, which can effectively identify potential financial risks [21]. Wang examined the financial risk of real estate companies by using TOPSIS analysis with entropy value CRITIC synthetic assignment from the perspective of multiple shocks [22]. According to the above

literature review, the current research on financial risk evaluation methods and models has been relatively mature, and as the research continues to deepen, the methods and models for evaluating financial risk are also improving, which provides a reference for the research of this paper.

2.3 | Control Measures for Financial Risk

Scholars have also achieved relatively rich research results in risk prevention countermeasures. Tarsalewska argues that the realization of corporate synergies can be achieved through mergers, which in the context of an economic downturn can also improve operational efficiency and thus reduce the generation of risks [23]. Osypenko's research concludes that linking numerical modeling to a company's operational management can effectively reduce a company's financial risk without increasing its expenses [24]. By evaluating the financial crisis in the European Union, Petersen found that predisposing factors can lead to financial risk for firms [25]. Tahir and Anuar studied textile companies and concluded that effective management of working capital is conducive to the profitability of the company [26]. Yang and Wang studied the measures to enhance the financial risk prevention ability of small and medium-sized enterprises, and suggested to build a more comprehensive financial risk management mechanism and enhance the awareness of enterprise risk prevention [27]. Hamdamov's research points out that a rational financial risk evaluation system is very important for companies to carry out financial risk management [28]. Dwarka's study found that corporate financial risks can be prevented and controlled by conducting proper budgeting [29]. Tang pointed out that the establishment of a professional financial risk management team to control and manage the company's internal budget is conducive to risk prevention [30]. Akbar's study found that there is a correlation between the degree of integrity of the firm's management structure and the firm's financial risk [31]. Chalmers study found that firms can help reduce the incidence of financial risk by conducting sound internal controls [32]. Michael examined approaches to financial risk management, identification and assessment, noting that Collaborative Financial Risk Assessment (CFRA) is effective [33]. Cai's research points out that the use of artificial intelligence for the internal control of companies can reduce the financial risk of companies [34]. Liu's research found that diversification is a means for investors to reduce risk [35]. Yan believed that companies should use the Internet for financial risk prevention and control, while also taking into account the overall general environment out there [36]. Zhao and Jiang suggested that when investing, one should be wary of companies that may have currency fund fraud, a significant reduction in profitability, and negative net attributable profits [37]. Shi and Liu believed that clear business objectives, reasonable capital allocation and effective early warning can help to reduce the financial risk of enterprises [38]. Quang found that if firms adopt key differentiation or low-cost leadership strategies that give them a competitive advantage over their peers, their financial performance will improve significantly [39]. According to the above literature review, most scholars have put forward relevant

preventive countermeasures from multiple perspectives in terms of both internal and external environments to address the financial risk problems of listed enterprises.

2.4 | Financial Risk of New Energy Enterprises

When evaluating the financial risk of new energy enterprises, scholars at home and abroad have analysed the causes of the risk, identified its main financial risk points, and thus proposed targeted countermeasures. Delucchi believed that there is an urgent need for governments and professionals to find alternatives to internal combustion vehicles such as conventional petroleum fuels, and that new energy vehicles are one of the best options [40]. Yin's study found that the new energy industry has a high level of financial risk based on its own characteristics [41]. Larrosa used the energy matrix to study the new energy generation industry and obtained a response to the need for the industry to reduce production costs to reduce financial risk [42]. Zhao focuses on the study of financial risk control in the new energy industry under the environment of energy conservation and emission reduction, pointing out the current optimizing countermeasures in the new energy industry [43]. Yu found that the new energy industry can achieve effective control of financial risk through efforts to expand financing methods and channels and enhance the control of related costs [44]. Ann and Daniel link the macro-environment to financial risk, and the study points out the role of investment in influencing the financial risk of new energy companies [45]. Michaela and Kevin examined the role of the Chinese government in facilitating the development of China's new energy industry [46]. Using the mediation effects model, Xu found that to a certain extent government subsidies, although they can enhance the financial performance of firms, there are also situations that affect the ability of firms to detect financial risks [47]. Yin analyzed the impact of government subsidies on the new energy industry, pointing out that technological development is very important for the rural energy [48]. Pan and Wan established a financial and fiscal risk early warning model, which helps to strengthen the financial risk control ability of related enterprises [49]. Xin argued that assessing the performance of China's new energy vehicle industry is usually full of uncertainty and dynamics, and therefore proposes a q-order orthogonal fuzzy distance measure based on triangular orthocentricity and suggested a nonlinear integrated weighting method that combines subjective weight information with objective weight information [50]. Based on the above literature review, most of the scholars have analyzed the causes of financial risk of new energy enterprises to determine the financial risk points and put forward targeted control measures, which provides reference and reference for the research of this paper.

2.5 | Literature Summary

Many researches on financial risk has focused on its definition, causes, and countermeasures, integrating Chinese companies' specific circumstances with financial risk management theories to develop effective models and methods. While financial risk control is crucial for business growth, research on the new energy automobile industry remains limited, with narrow evaluation methods. The

dual-carbon goal has spurred the industry's development, revealing financial challenges. More case studies are needed to provide comprehensive insights. Each enterprise should build a tailored financial risk prevention system based on its financial situation and environment, with room for improvement in combining theory and practice.

3 | RISK IDENTIFICATION AND SYSTEM CONSTRUCTION

3.1 | Automobile Company Financial Risk Identification

The process of comprehensively anticipating, identifying and evaluating the financial risks that exist in an enterprise but are not yet apparent, and at the same time analyzing the causes of financial risks, is known as financial risk identification. This determines the level of financial risk management. Based on the relevant indicators of C Automobile Company for the year 2018-2022, this paper identifies its financing risk, operating risk, investment risk and income distribution risk.

3.1.1 | Funding Risk Identification

Financing risk is the possibility of loss of solvency and variability of the enterprise's profitability due to the borrowing of funds. Because of the needs of production and operation or foreign investment, the main body of financing uses financing to raise funds activities. In the financing activities, the enterprise may have the risk of not being able to return the funds and interest. The relevant financial indicators that may cause financing risk are the basis of the analysis in this paper. This paper mainly identifies and analyses the cash flow and solvency generated from financing activities.

3.1.2 | Operational Risk Identification

Operational risk is due to the changes in the environment, the company does not reflect the changes in the environment even though, resulting in the risk of loss in the operation of the company. This paper analyses the financial data such as assets and inventories of C Automobile Company based on 2018-2022. Typically, the turnover speed of assets, the faster the turnover, indicating the stronger the sales ability; the strength of the enterprise's operational risk it's whether the accounts receivable will be paid back in a timely manner is also an influencing factor [51], so this paper uses accounts receivable turnover indicators and asset turnover related indicators to identify the operational risk.

3.1.3 | Investment Risk Identification

Investment activity is the risk of loss that may develop when an enterprise carries out investment activities. According to the characteristics of investment, it can be categorized into inward and outward investment. Since the investment results of enterprises are closely related to the level of profitability, it is also necessary to analyse the return on investment through the profitability of the enterprise, which in turn leads to the existence of investment risk. Investment risk refers to the instability of returns and even the loss of assets by a company or an individual in order to achieve its investment objectives. For the company, the risk of its investment can be divided into two categories: internal investment risk is the

investment of funds in the enterprise, the formation of a variety of liquid assets and other assets resulting in financial risk; external investment risk is the enterprise in the external investment may form the economic loss. If the enterprise's investment risk increases, then the security and stability of its investment returns may be undermined.

3.1.4 | Identification of Income Distribution Risk

Income distribution risk is the risk that a business may incur by making earnings distributions. As the last part of the enterprise's financial chain, it affects the acquisition and distribution of the enterprise's earnings. When enterprises carry out production and operation activities and distribution of benefits, they may generate income distribution risk, and income distribution risk is the basis for enterprises to carry out the next production activities, which can affect the capital value of enterprises. This paper mainly identifies and analyses the four aspects of net profit growth rate, total assets growth rate, operating income growth rate and operating profit growth rate.

3.2 | Construction of Financial Risk Evaluation Index System

3.2.1 | Criteria for the Selection of Indicators

Evaluation of the financial risk of C Automobile Company requires the establishment of a risk evaluation model. The first step is to screen the indicators in the risk evaluation model, and there are four principles for the selection of indicators in this paper, which are: the principle of importance, the principle of comprehensiveness, the principle of comparability and the principle of operability. The principle of importance is to regard the indicators that appear frequently in the literature as indicators of importance, and to select financial risk evaluation indicators with a high degree of importance. The principle of comprehensiveness means that in the process of selecting indicators, indicators should be selected according to the different levels and perspectives of the enterprise, reflecting the various classes and levels of the enterprise, and not focusing on a certain indicator unilaterally, but ensuring the comprehensiveness of the selection of indicators [52]. The principle of comparability means that different enterprises in the industry can be compared with each other, and the selection criteria should be consistent and comparable. The principle of operability means that the selection of indicators should be operable, combining theory and practice, and selecting more important and easy-to-calculate indicators.

3.2.2 | Selection of Evaluation Indicators

According to the financial situation of C Automobile Company, in accordance with the four principles of evaluation index selection. Based on previous scholars' studies and CSMAR database, this paper selected financial indicators that meet the criteria for indicator selection in this paper. As shown in Table 1.

Table 1. Financial Risk Index System of C Automobile Company

	Primary indicators	Secondary indicators
		Quick ratio
C Automobile Company Financial Risk Indicator System	Funding risk	Asset-liability ratio
		Cash current liabilities ratio
	Operational risk	Total asset turnover ratio
		Inventory turnover ratio
		Accounts receivable turnover ratio
	Investment risk	Return on total assets
		Return on net assets
		Operating profit margin
	Income distribution risk	Growth rate of capital preservation
		Total asset growth rate
		Operating profit growth rate

3.2.3 | Identification of Evaluation Sets

This paper refers to the research of related scholars [53] and divides the degree of risk into five levels, which are very low, low, medium, high and very high. Then the relevant indicators are assigned quantitatively, and the resulting evaluation set is as follows:

$$V = \{V_1, V_2, V_3, V_4, V_5\} = \{\text{very low}, \text{low}, \text{medium}, \text{high}, \text{very high}\} = (100, 80, 60, 40, 20)$$

Specific rating scales are listed in Table 2.

Table 2. Distribution of Evaluation Grades

V	Score	Risk level
V1	100	very low
V2	80	low
V3	60	medium
V4	40	high
V5	20	very high

4 | DETERMINATION OF FINANCIAL RISK EVALUATION METHODOLOGY

4.1 | Entropy Weight Method

When this paper carries out financial risk evaluation, the entropy weight method is applied to the calculation of the weights of the financial indicators, and the weights of the financial risk level indicators are calculated in accordance with the mutual influence relationship of different financial indicators in this paper and in accordance with the entropy theory. The use of entropy weight method can scientifically and reasonably evaluate a company and help to evaluate the financial risk of enterprises.

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The following are the specific steps used in this paper using the entropy power method:

Constructing the evaluation matrix.

If the evaluation indicators in the overall evaluation is one and the evaluation object is one. The original data are matrix constructed as, where.

If there are a number of evaluation indicators and b number of evaluation objects in the overall evaluation, then the raw data are matrix constructed as

$$G=(X_{cd})_{mn}, \text{ where } c=(1,2,\cdots,a), d=(1,2,\cdots,b).$$

Standardized processing of financial data

When the indicator is a positive one (the type of indicator whose index value is negatively correlated with financial risk):

$$X_{cd}^1 = \frac{X_{cd} - \min X_d}{\max X_d - \min X_d} \quad (1)$$

When the indicator is a negative indicator (the type of indicator whose index value is positively correlated with financial risk):

$$X_{cd}^1 = \frac{\max X_d - X_{cd}}{\max X_d - \min X_d} \quad (2)$$

where the indicator is standardized as X_{cd}^1 , the actual value is X_{cd} , the maximum value of each indicator over a five-year period is $\max X_d$ and the minimum value of each indicator over a five-year period is $\min X_d$.

The ratio of the d object to the c indicator in the evaluation of the normalized treatment is

$$P_{cd} = \frac{X_{cd}^1}{\sum_{d=1}^b X_{cd}^1} \quad (3)$$

Determine the entropy value and entropy weight of each indicator.

$$E_d = -k \sum_{d=1}^b P_{cd} \ln P_{cd} \quad (4)$$

$$W_d = \frac{1 - E_d}{\sum_{d=1}^b (1 - E_d)} \quad (5)$$

Where $k = \frac{1}{\ln b}$, the entropy value of the d indicator is E_d , and the weight of the d indicator is W_d . Also, if $P_{cd} = 0$, then $P_{cd} \ln P_{cd} = 0$.

4.2 | Fuzzy Mathematical Affiliation

American automatic control expert L.A.Zadeh is the first creator of the affiliation theory of fuzzy mathematics. By linking the factors that are not easy to be quantified in the objective world with the precise mathematical method, he put forward the concept of “affiliation function”, and the fuzzy comprehensive evaluation method links the entropy weighting method with the fuzzy evaluation method [54]. In this paper, the fuzzy comprehensive evaluation method is selected for evaluating the financial risk of C Automobile Company. The primary reason for this choice is that the inherent uncertainty in the company’s production and operations makes qualitative analyses potentially less objective. On the other hand, fully quantitative analyses present challenges in methodology and indicator calculation. The fuzzy comprehensive evaluation method addresses both issues by ensuring objectivity while accurately quantifying the company's financial indicators. By applying the theory of affiliation degree and utilizing publicly available financial data, this paper avoids the subjectivity often associated with qualitative analysis.

4.3 | Steps in the Fuzzy Comprehensive Evaluation Method

Fuzzy comprehensive evaluation method is a comprehensive evaluation method that establishes a fuzzy comprehensive evaluation model, combines the affiliation degree in qualitative analysis and quantitative analysis, calculates the financial risk evaluation results of the indicator system and analyses them. The use of fuzzy comprehensive evaluation method for financial risk evaluation is through the research process of financial risk indicators for fuzzy language processing, according to a large number of financial data, data weighting calculation, you can get the evaluation results of the financial risk level, and finally put forward countermeasures. There are three specific steps in the fuzzy comprehensive evaluation method: First, the evaluation indicators selected according to the criteria for indicator selection are summarized to determine the set of evaluation indicators. Then, the weights of the first-level indicators are calculated to determine the degree of affiliation of each indicator. Finally, the calculation and evaluation results of the fuzzy comprehensive evaluation are derived. Figure 1 shows the steps of the fuzzy comprehensive evaluation method.

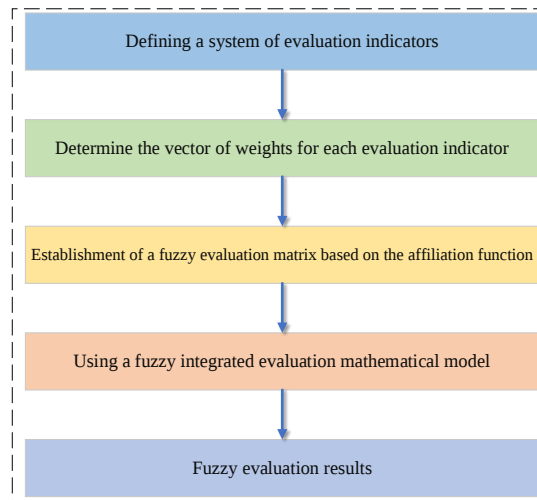


Figure 1: Steps of Fuzzy Comprehensive Evaluation Method

5 | Application of financial risk evaluation system in C Automobile Company

5.1 | Results of the Calculation of Indicator Weights

The data in this paper is obtained from the annual reports published by C Automobile Company for the years 2018-2022.

The above results are summarized and the weights of the primary and secondary indicators of the financial risk evaluation indicators in this paper are derived respectively, and the results of the combined weights are shown in Table 3.

Table 3. Comprehensive Weight Results

General indicators	Weights	Primary indicators	Weights	Secondary indicators	Weights	Weighting of primary indicators
Financial risk	1	Funding risk	0.2787	Quick ratio	0.0949	0.3407
				Asset-liability ratio	0.1025	0.3679
				Cash current liabilities ratio	0.0812	0.2915
				Total asset turnover ratio	0.0770	0.3522
		Operational risk	0.2188	Inventory turnover ratio	0.0699	0.3195
				Accounts receivable turnover ratio	0.0718	0.3283
				Return on total assets	0.0767	0.3254
		Investment risk	0.2358	Return on net assets	0.0759	0.3219
				Operating profit margin	0.0831	0.3526
		Income distribution risk	0.2667	Growth rate of capital preservation	0.1297	0.4864
				Total asset growth rate	0.0737	0.2763
				Operating profit growth rate	0.0633	0.2372

5.2 | Results of Financial Risk Evaluation

(1) Determination of evaluation criteria

Table 4 shows the evaluation standard values of the performance of automobile manufacturing companies in 2022, and the table of the evaluation standard values of the performance of automobile manufacturing companies for the years 2018-2021 is shown in the Appendix.

Table 4. Standard Value of Performance Evaluation of Automobile Manufacturing Companies in 2022

Indicators	Excellent values	Good values	Average values	Low values	Poor values
Quick ratio (%)	111.9	101.9	89.4	66.7	51.8
Asset-liability ratio (%)	48.0	53.0	58.0	68.0	83.0
Cash current liabilities ratio (%)	19.3	11.2	6.7	-1.8	-8.9
Total asset turnover ratio (frequency)	1.3	1.1	0.9	0.4	0.1
Inventory turnover ratio (frequency)	12.6	9.4	8.1	3.7	2.8
Accounts receivable turnover ratio (frequency)	13.0	7.7	7.5	3.3	2.5
Return on total assets (%)	8.6	5.3	3.5	-1.9	-6.7
Return on net assets (%)	13.5	8.5	8.0	0.7	-5.8
Operating profit margin (%)	7.9	4.9	3.8	-2.6	-7.7
Growth rate of capital preservation (%)	112.6	107.8	104.6	101.1	96.7
Total asset growth rate (%)	15.0	9.0	4.6	-6.0	-9.9
Operating profit growth rate (%)	9.5	3.6	-3.3	-7.7	-10.4

Source: Data published by SASAC.

(2) Determination of affiliation

This paper first quantifies the interval of each evaluation set, for example, the excellent is 100, the general is 80, and the poor is 60, and then compares the actual value calculated in this paper with the evaluation standard value to determine the range of the index index, so as to confirm the evaluation level of each index in this paper. For example, when the company's index score is 65, it is in the evaluation index set of (60, 80), 60 corresponds to the poor grade, 80 corresponds to the general grade, and the interpolation method is used to find the affiliation of the corresponding difference, and the result is $(65 - 60) / (80 - 60) = 0.25$ which it can be seen that the affiliation of the difference is 0.25, and then the affiliation of its general is 0.75. This paper takes the financial risk indicator data of C Automobile Company in 2022 as an example, and calculates the affiliation matrix of each financial risk indicator in this paper based on the interpolation method, and Table 5 shows the affiliation of financial indicators of C Automobile Company.

Table 5. Membership Degree of Financial Risk Index of C Automobile

Categorization of indicators		Indicator name	V1	V2	V3	V4	V5
Financial risk	Funding risk	Quick ratio	1	0	0	0	0
		Asset-liability ratio	0	0	0.7800	0.2200	0
		Cash current liabilities ratio	0	0.0867	0.9133	0	0
	Operational risk	Total asset turnover ratio	0	0	0.9200	0.0800	0
		Inventory turnover ratio	1	0	0	0	0
		Accounts receivable turnover ratio	1	0	0	0	0
	Investment risk	Return on total assets	0	0.7167	0.2833	0	0
		Return on net assets	0.9300	0.0700	0	0	0
		Operating profit margin	0.4667	0.5333	0	0	0
	Income distribution risk	Growth rate of capital preservation	0	0	0	0.1227	0.8773
		Total asset growth rate	0	0.7409	0.2591	0	0
		Operating profit growth rate	1	0	0	0	0

Data source: Author's collation of calculations.

Evaluation of primary indicators, e.g., the fuzzy evaluation matrix for funding risk is:

$$R = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.7800 & 0.2200 & 0 \\ 0 & 0.0867 & 0.9133 & 0 & 0 \end{bmatrix}.$$

Combine the weights of each indicator of financing risk in the financial risk of C Automobile Company in 2022, and then calculate the fuzzy comprehensive evaluation vector of financing risk:

$$G = W * R = (0.3407, 0.3679, 0.2915) * \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.7800 & 0.2200 & 0 \\ 0 & 0.0867 & 0.9133 & 0 & 0 \end{bmatrix} \\ = (0.3407, 0.0253, 0.5532, 0.0809, 0).$$

The steps for calculating the results of each level of indicator for operational risk, investment risk and revenue allocation risk are the same as above, resulting in the evaluation results for 2022, as shown in Table 6.

Table 6. Evaluation Results of Primary Indexes of Fuzzy Comprehensive Evaluation in 2022

Primary indicators	Weights	V1	V2	V3	V4	V5
Funding risk	0.2787	0.3407	0.0253	0.5532	0.0809	0
Operational risk	0.2188	0.6478	0	0.3240	0.0282	0
Investment risk	0.2358	0.4639	0.4438	0.0922	0	0
Income distribution risk	0.2667	0.2372	0.2047	0.0716	0.0597	0.4267

The affiliation of the above four financial risk primary indicators were calculated to arrive at the overall financial risk affiliation of C Automobile Company in 2022, and the results of the calculation are shown in Table 7.

Table 7: Membership Degree of Fuzzy Evaluation Financial Risk in 2022

Evaluation projects	V1	V2	V3	V4	V5
Financial risk	0.4093	0.1663	0.2659	0.0446	0.1138
corresponding score	100	80	60	40	20

(3) Final scores

As the above methodology, the results of the fuzzy comprehensive evaluation of the financial risk of C Automobile Company for the year 2018-2022 can be derived, and the calculation results are shown in Table 8.

Table 8. Fuzzy Comprehensive Rating Score of C Automobile from 2018 to 2022

Evaluation results	Financial risk	Funding risk	Operational risk	Investment risk	Income distribution risk
2018 year	53.8806	55.6180	64.9580	35.8600	58.9100
2019 year	52.2319	65.4200	71.3500	23.0780	48.5420
2020 year	78.2087	78.6600	78.4460	52.8080	100
2021 year	67.4327	75.0540	86.6160	53.7680	55.8120
2022 year	74.2533	72.5220	85.3480	87.4260	55.3140

5.3 | Analysis of the Results of the Financial Evaluation of C Automobile Company

5.3.1. | Funding Risk Analysis

(1) Cash flows from financing activities

The financing behavior of the enterprise's daily production and operation needs is called financing activities, usually, the enterprise's financing ability can be reflected by the net cash flow of the

enterprise's financing activities, and the enterprise's financing risk is inversely proportional to its financing ability.

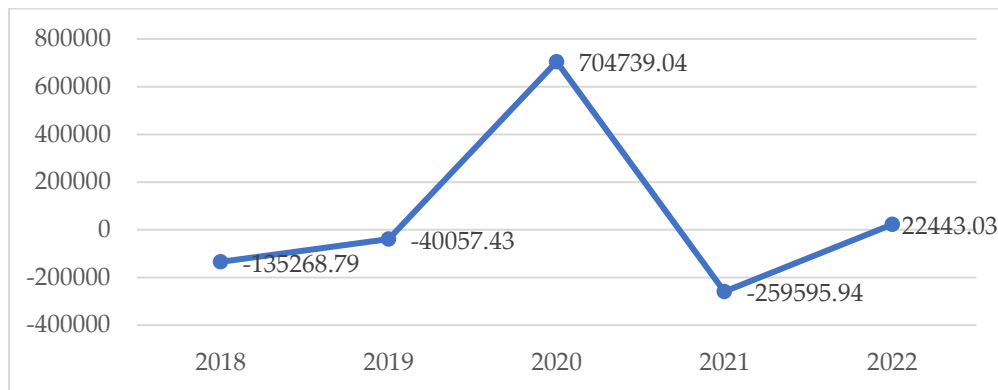


Figure 2: Trend Chart of Net Cash Flow from Financing Activities

As can be seen in Figure 2, C Automobile Company's net cash flow from fundraising activities shows an upward, downward and then upward trend from 2018. It is positive in 2020 and 2022 and negative in the remaining three years, while 2021 is the lowest in the last five years due to the fact that C Automobile Company has reduced its borrowing in 2021, thus reducing its fundraising activities, which may indicate that the firm's capital structure has become healthier and reduced the risk of borrowing. However, if the business needs to invest heavily in expanding its business or undertaking new projects but reduces its borrowing, then this may affect the future growth of the business. The reason for this may be due to profit distribution or debt repayment.

(2) Debt-paying ability

Table 9 shows the relevant indicators reflecting the solvency of C Automobile Company. This paper uses the liquidity and quickness index of C Automobile Company to reflect the ability of the enterprise to repay the debt. Based on the performance evaluation standard table of automobile manufacturing industry, the current ratio of 2 is the most ideal state for automobile manufacturing enterprises. According to the financial data of C Automobile Company, it can be found that the maximum value is 1.28 in 2022, and the current ratio of C Automobile company from 2018 to 2022 is not ideal. This indicates that the turnover rate of current assets such as inventory and receivables of C Automobile Company is weak, and the company's idle assets are increasing, and C Automobile Company needs to continue to improve the current ratio.

Table 9. Debt-paying Ability of C Automobile Company

Indicator name	2018 year	2019 year	2020 year	2021 year	2022 year
Current ratio	1.00	1.01	1.16	1.20	1.28
Quick ratio	0.82	0.89	1.04	1.05	1.18
Cash current liabilities ratio	-0.09	0.08	0.17	0.30	0.07
Asset-liability ratio	50.63	54.99	55.77	58.74	56.9
Cash ratio	23.12	25.36	51.45	68.55	67.31

In different industries, the optimal speed ratio is different. Therefore, according to the industry nature of C Automobile Company, this paper selects the value in the performance evaluation standard table of automobile manufacturing industry for evaluation. A quick ratio of 111.9% is excellent, 101.9% is good, and 89.4% is average. The quick ratio shows a rising trend between 2018 and 2022, and its value is less than 1 in 2018-2019 and more than 1 in 2020-2022, which indicates that C Auto company occupies more funds in quick assets. However, due to the large amount of accounts receivable, even though it seems that the quick assets are enough to pay off the short-term debts, C Auto Company has to pay off the short-term debts. Nor does it mean they are solvent. Based on the data of the performance evaluation standard table of the automobile manufacturing industry, the excellent cash ratio of the automobile manufacturing industry is around 19.3%, and the good range is 11.2%. Judging from the data, the cash flow debt ratio of C Automobile company has a low value in the past five years, indicating that the enterprise has debt repayment risk.

The ratio of total liabilities and total assets is the asset-liability ratio, which is related to the long-term solvency of the enterprise. Reasonable debt can help enterprises increase revenue, but excessive debt may cause financial risks. The low debt ratio indicates that the enterprise has strong anti-risk ability and long-term solvency. In the past five years, the company's asset-liability ratio is still in a moderate range, but it is still necessary to be vigilant about risks. The ability of a company to repay its debts at any time can be reflected by the cash ratio, which ranges from 23.8 percent to 17 percent. As can be seen from the financial data of C Automobile, the company's cash ratio in 2018 is at an excellent level, which means that its cash ratio is ideal and the company can repay its debts at any time. However, in recent years, the cash ratio is getting higher and higher, reaching 68.55% in 2021. Too high cash ratio may mean that the company's working capital is not fully utilized.

5.3.2. | Operational Risk Analysis

As shown in Table 10, the total asset turnover ratio of the company in the past five years is between 0.66-0.86, but still lower than the average value of 0.9. It shows that compared with the same industry, the enterprise has low benefits created by the total assets, and the operating ability is not good, and needs to be improved.

Table 10: Operational Risks of C Automobile

Indicator name	2018 year	2019 year	2020 year	2021 year	2022 year
Total asset turnover ratio	0.66	0.74	0.77	0.83	0.86
Inventory turnover ratio	11.81	14.53	15.51	13.67	15.21
Accounts receivable turnover ratio	41.23	62.82	56.76	55.10	51.12

The inventory turnover ratio reflects how efficiently a company can realize its inventory. A higher ratio indicates stronger inventory liquidity and faster turnover. According to Table 10, C Automobile Company's inventory turnover ratio showed a slight increase from 2018 to 2020 but declined in 2021 before rising to 15.21 in 2022. This improvement is likely due to the company's innovative sales models, such as "super commercial direct," which enhance asset utilization and sales efficiency. Despite this, as C Automobile invests more in R&D and expands production, its inventory will grow, presenting a potential risk that requires careful management.

The accounts receivable turnover ratio measures the efficiency of collecting receivables. According to Table 10, while this ratio improved in 2018 and 2019, it decreased from 62.82 in 2019 to 51.12 in 2022, indicating a reduced ability to collect funds and an increase in bad debts. This decline has negatively impacted the company's asset liquidity. C Automobile Company must strengthen its accounts receivable management; continued decreases in this ratio could lead to slower fund recovery and diminished liquidity, adversely affecting overall operations.

5.3.3. | Investment Risk Analysis

(1) Inward investment analysis

Investing money within a company is called inward investment. It generally refers to the funds spent by the company in the initial development. From the foregoing analysis of the overall situation can be seen, the company in the past five years in the purchase and construction of fixed assets, intangible assets and other aspects of the expenditure is large, and this item also belongs to the enterprise's internal investment part.

To facilitate the observation of changes in inward investment of C Automobile Company, Figure 3 shows a bar chart of inward investment statistics of C Automobile Company.

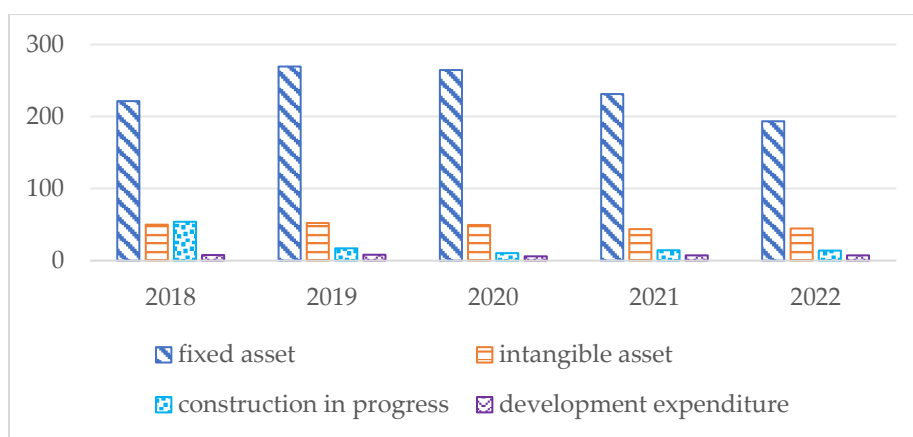


Figure 3: Statistical Chart of C Automobile Company's Inward Investment

As can be seen from Figure 3. in terms of internal investment, due to the company's new energy automobile whole industry chain, for new energy automobile upstream, midstream and downstream industry chain investment has become the focus of the investment of C Automobile Company, and the company pays more attention to the investment in fixed assets. In the past five years, the company's investment in fixed assets rose in 2019, and in the past three years, fixed assets have been declining, compared to 2019, fixed assets fell by nearly 28.18%, first rising and then falling. This means that companies are less willing to invest in purchasing equipment, plant and other fixed assets. This usually reflects the impact of a number of factors such as slower economic growth, increased uncertainty or lower market demand. Intangible assets, on the other hand, have been relatively stable over the last five years, mainly reflecting the increase in patented technologies, indicating that C Automobile Company is increasingly emphasizing its investment in research and development.

(2) Outward investment analysis

The investment other than inward investment of the company is outward investment, which specifically refers to the investment of funds from the company to external enterprises or individuals, which is the investment of the company to obtain benefits. This may result in loss of assets to the company, thus creating outward investment risk. This paper analyses selected investment risk indicators based on the accounting statements of C Automobile Company for the year 2018-2022.

In order to facilitate the observation of the changes of the analyzed indicators related to the outward investment of C Automobile Company in the past five years, Figure 4 shows a line graph of the outward investment of C Automobile Company.

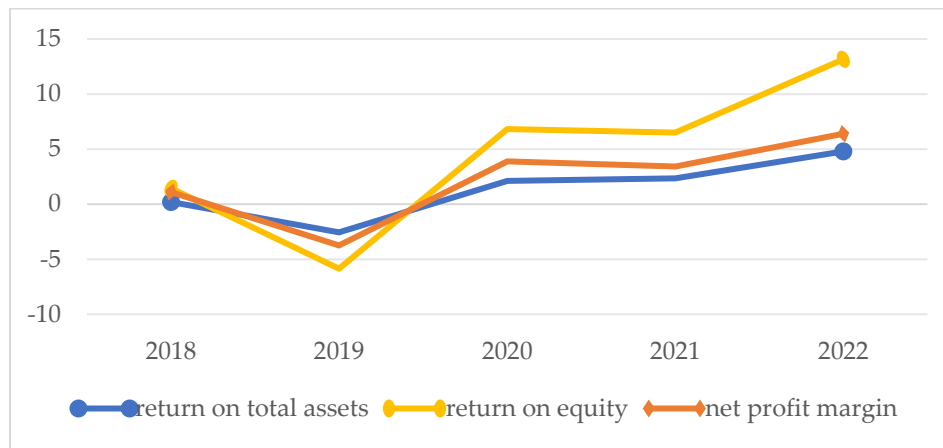


Figure 4: Foreign Investment of C Automobile Company

Profitability of assets, measured by return on total assets and return on net assets, reflects an enterprise's efficiency in generating income from its assets. Figure 4 shows a consistent trend among these indicators, with a high asset earning rate indicating efficient capital operation and a low rate suggesting inefficiency. Despite a gradual increase in C Automobile Company's return on assets, peaking at 4.79 in 2022, the overall performance remains unimpressive, with negative returns in 2019. This indicates that the company's assets are underutilized, resulting in decreased profitability. The return on net assets, which reflects asset utilization efficiency, shows that C Automobile Company only approached the industry's excellent level of 13.5% in 2022, with lower returns in other years. This could be due to cautious financial policies or operational challenges.

The net sales margin, which measures net profit relative to sales revenue, shows the company's operating profit efficiency. The trend for return on total assets, return on net assets, and net sales margin all follow a similar pattern: decreasing and then increasing, peaking in 2022. Although the rising net sales margin suggests improving capital efficiency, the company's performance remains average compared to the industry median of 7.32%. The significant decline in performance in 2019, marked by reduced sales and poor joint venture results, was further exacerbated by joint venture losses. Additionally, C Automobile Company's substantial foreign investments, particularly long-term equity investments, have seen fluctuating returns, with significant losses in 2021. This instability highlights the need for a reassessment of long-term investment strategies, as the company faces notable investment risks.

5.3.4. | Income Distribution Risk Analysis

Income distribution is the risk brought by the enterprise after obtaining income in the operation and management, and refers to the role of the enterprise income acquisition and distribution on the enterprise capital value. Table 11 shows the risk related indicators of income distribution of C Automobile Company. The ratio of the increase of the net profit of the enterprise in the same period to the net profit of the previous period is called the net profit growth rate, which is proportional to the profitability of the enterprise. According to Table 11, the net profit growth rate of C Automobile

Company was only 10.84% higher than the industry average in 2020, but it fell all the way in the following four years, especially in 2019, it fell off a cliff to -466.23%, because the joint venture of C Automobile Company suffered huge losses in that year, resulting in negative net profit. It can be seen that the company's net profit is shrinking year by year, and even a loss, and the development ability is weakened.

Table 11: Analysis Table of Risk Related Indicators of Income Distribution of C Automobile Company

Indicator name	2018 year	2019 year	2020 year	2021 year	2022 year
Net profit growth rate	-90.46	-488.81	225.54	6.87	119.52
Total asset growth rate	-11.91	4.42	23.87	11.98	7.86
Revenue growth rate	-17.14	6.48	19.79	24.33	15.32
Operating profit growth rate	-102.82	-946.03	224.54	42.16	104.63

The total assets growth rate, which measures the increase in total assets at the end of the year compared to the end of the previous year, reflects the enterprise's asset development. According to Table 11, C Automobile Company's total assets growth rate shifted from negative to positive between 2018 and 2019, aligning with the industry average. However, from 2020 to 2022, this growth rate declined and fell 7% below the industry's excellent value. Although there was a significant recovery in 2020, the growth rate dropped by 67.07% by 2022, indicating impaired asset performance. Table 11 also shows that the company's operating income growth rate increased year by year from 2018 to 2022, turning positive in 2019 but declining in 2022. With an industry benchmark of 10%-15%, C Automobile Company's operating income growth rate was 15.32% in 2022, reflecting the impact of market changes under the dual-carbon goals.

The growth rate of operating profit, calculated as the difference between operating profit at year-end and the previous year's total operating profit, indicates profitability changes. Table 11 shows a negative operating profit growth rate from 2018 to 2019, with a significant decline in 2019 affecting overall profitability. Although the rate recovered to 224.54% in 2020, it declined again in 2021, likely due to rising raw material costs and other expense pressures, leading to reduced operating profit margins. This instability suggests that C Automobile Company faces profit risks. The company should develop effective business strategies to manage these risks and ensure inter-departmental coordination to enhance operational efficiency and maintain stable profit growth.

6 | DISCUSSION

From 2018 to 2019, C Automobile Company faced medium overall risk, with high investment risk. The company's 2018 annual report emphasized its reliance on both autonomous and joint venture strategies. However, declining sales in a sluggish domestic auto market, coupled with reduced new

energy subsidies, led to issues with accounts receivable and increased bad debts, impacting the company's capital flow. By 2019, C Automobile's sales continued to decline, resulting in a net loss exceeding 2.6 billion yuan—a drastic 488.81% drop in net profit. This was largely due to reduced investment income from joint ventures and intensified market competition. Despite increased government subsidies for new energy vehicles in prior years, C Automobile faced adverse effects from the retreat of these subsidies. To mitigate these challenges, the company invested about 6.34% of its operating income in R&D, aiming to enhance technology and internal management for future growth.

In the period from 2020 to 2022, C Automobile Company experienced a relatively low risk level compared to previous years. Despite industry-wide stagnation due to the pandemic in 2020, the company saw increases in operating income and net profit, driven by improved product mix, sales growth, and strong performance in its autonomous segment. The company's sound financing strategy and low operating and earnings distribution risks contributed to this stability. In 2021, despite challenges like rising raw material prices and intensified competition, C Automobile continued to perform well by optimizing resource allocation, increasing new energy sales, and implementing cost-reduction measures.

In 2022, while C Automobile Company's financial risk remained low, it encountered several challenges. A major internal upheaval in February led to the dismissal of senior management and the introduction of a tenure system and KPI assessments. In May, the company faced issues related to false publicity. Policy changes also posed challenges, as new energy vehicle subsidies were reduced by 30% and eventually terminated, weakening price advantages and increasing cost pressures. These factors, coupled with unchanged technical requirements for batteries, created additional financial pressures. To ensure healthy and sustainable development, C Automobile Company must focus on effective financial risk control.

7 | CONCLUSION AND IMPLICATIONS

This paper examines the financial risk management of C Automobile Company using recent financial statements and establishes a risk evaluation system with twelve indicators. Employing the fuzzy comprehensive evaluation method, it assesses, identifies, and analyzes financial risks while proposing countermeasures. The analysis reveals that the company's turnover rate for current assets, such as inventory and accounts receivable, is weak, indicating a need to improve the current ratio, enhance internal financial controls, and reduce cash flow risks. Additionally, C Automobile Company's total asset benefits and operational capacity are lower compared to industry peers, necessitating better asset management, increased capital efficiency, and improved internal management to ensure steady profit growth. Investment returns have been poor, with negative profits for two consecutive years, suggesting the need for investment strategies aligned with the company's financial situation, careful project selection, and rigorous risk management. Finally, the underperformance of the joint venture affects sales and operating income, highlighting the need for a robust business strategy, strengthened

brand management, increased investment in technological innovation, and enhanced cooperation with upstream and downstream partners.

7.1. | Theoretical Implications

This paper analyzes the industry environment of C Automobile Company using the PEST model, focusing on four aspects: political, economic, social, and technological environments, specifically tailored to new energy vehicle manufacturing. It also identifies financial risks related to financing, operations, investments, and income distribution. The paper constructs a comprehensive financial risk evaluation index system, screens relevant indexes, and determines the evaluation set. The entropy weighting method is used to calculate weight coefficients, and the fuzzy comprehensive evaluation method further analyzes the current financial risk situation of C Automobile Company. This approach broadens the research methods for financial risk, enhances the statistical and quantitative techniques used in domestic financial risk research, and provides a more scientific and effective evaluation of financial risk. It also offers valuable case support for the theoretical analysis and research of financial risks in China's new energy vehicle manufacturing sector.

7.2. | Practical Implications

First, from an industry-wide perspective, C Automobile Company is one of the leading new energy vehicle manufacturers in China, and its development largely reflects the state of the entire automotive industry. To a certain extent, its operational and financial health can be seen as representative of China's broader automobile sector. Identifying and analyzing the financial risks of C Automobile Company can help reveal common financial risks throughout the industry. Second, from the perspective of C Automobile Company itself, identifying financial risks enables the company to better address existing risks and implement relevant measures to mitigate them. The company needs to strengthen asset management, improve fund utilization efficiency, and control costs to enhance profitability. Additionally, financial risk identification can raise the company's awareness of risk prevention and improve its ability to manage risks. Therefore, C Automobile Company should enhance its internal financial control systems, manage investment risks carefully, focus on strengthening brand management, continue investing in technological innovation, and foster stronger collaboration with upstream and downstream partners in the industrial chain.

7.3. | Limitations and Future Research Perspectives

Although this paper has constructed a more reasonable financial risk evaluation system for C Automobile company, there are still many shortcomings. First, this paper ignores the impact of non-financial indicators on financial risks. Second, this paper studies the current market conditions, but with the development of new financial risks may appear, so the evaluation index system and evaluation method of this study need to be further improved in order to obtain more accurate evaluation results.

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