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Research Article

Supply Chain Financial Risk Evaluation of Small- and Medium-Sized Enterprises under Smart City

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Prevention and control of risks are an eternal theme of financial institutions. Although, to some extent, the emergence of supply chain finance can enhance the financing capacity of small- and medium-sized enterprises (SMEs) and reduce financial risks of financial institutions, with the development of smart city and smart finance, the financial risks of SMEs are more complex, infectious, dormant, and difficult to accurately identify and measure. Facing this status, financial institutions have been required to understand and evaluate the financial risks of SMEs from a new perspective. Therefore, this paper, based on the study of financial risks assessment of SMEs under the smart city and smart finance, innovatively constructs a new index evaluation system for supply chain finance, based on improved hesitant fuzzy linguistic PROMETHEE method, and the effectiveness and advantages of the model have been verified through an example. To a certain degree, the SMEs financing the evaluation model and improved PROMETHEE method can not only help financial institutions reduce the risks in the specific financial transactions but also reduce the survival threat of financial institutions. Moreover, it is of positive significance to the stable operation of the financial system.

1. Introduction

According to statistics, China's SMEs (including individual industrial and commercial households) accounted for 94.15% of the total number of enterprises. Their final product and service value created was equivalent to 60% of China's total GDP [1]. In terms of promoting China's national economic development, this sector has becoming increasingly important. Unfortunately, the amount of successful loan applications for these small- and medium-sized enterprises (SMEs) has been steadily decreasing over the years. Small scale, weak financial strength, and lack of credit ethics might bring operational risks to financial institutions [2, 3].

With the development of China's economy and society, the market environment is getting better and better. Supply chain finance has emerged as an effective and innovative financial service. It is a kind of credit business relying on the core enterprises in the supply chain and providing effective capital injection to the upstream and downstream enterprises to ensure the normal operation of industrial chain enterprises [4]. This new development model has brought great opportunities to all aspects of the economy and society, especially to the financing of SMEs [5]. Many financial institutions have begun to develop and design new supply chain financing services and products to solve the financing problems faced by SMEs [6]. However, to solve the capital problems of SMEs facing the traditional supply chain is difficult and challenging. The main reason is that traditional supply chain finance still relies on the credit investigation of transaction subjects and stable business relations. Under smart city and smart finance, supply chain finance urgently needs to shift from traditional interpersonal trust to digital trust [7].

Smart city is the general trend of today's economic and social development. It is a new idea and a new model of using the new generation of information technology to promote smart urban planning, construction, management, and service [8]. In the context of smart city, smart technology has swept all traditional industries, including finance. In recent years, relying on Internet technologies and platforms, intelligent financial services using cloud computing, artificial intelligence, big data, blockchain, and other fintech means have developed rapidly; the age of smart finance has arrived [9]. Technological innovation can help expand financial service channels and improve operational efficiency, but it cannot replace the basic functions of finance, nor does it change the hidden, contagious, and sudden nature of financial risks. In other words, prevention and control of risks are an eternal theme of financial institutions, in particular, to guard against financial risks of SMEs.

With the development of the financial industry, rather than financial risk assessment focusing on a single issue, credit status of the entire supply chain is now used [10]. When it comes to loan assessments, financial institutions no longer simply use industry, enterprise scale, and guarantee methods associated with the applied SMEs as the sole bases in their risk assessments. Now they would take a more holistic approach and consider the applicants' entire supply chain as a whole instead [11]. Such changes encourage financial nstitutions to provide loans to SMEs on the basis of fully mastering the logistics, information flow, and capital flow of supply chain and financing SMEs [12]. At the same time, financial institutions could gain a better understanding of the real operating conditions of SMEs and significantly reduce their risks.

Moreover, such model is far from perfect. Under smart city and smart finance, on the one hand, the use of technology and supply chain finance models to boost financing efficiency at the same time broke the limit of time and space of risk conduction, financial risk of companies is more complex, infectious, spread-faster and concealment, and financial risk is more difficult to accurately identify and measure. On the other hand, with the development of fintech, financial services have become more virtual, business boundaries have become more ambiguous, and the challenges faced by risk management and control have become more and more severe. In the end, the large number of participants in supply chain finance with flexible financing mode and complicated contract designs [13], the issues on how to systematically identify and evaluate the specific risks of supply chain finance, and how to effectively control them have increasingly become an urgent subject that needs to be addressed.

Current literature reviews have shown that domestic and foreign scholars have mainly focused on the causes [14], countermeasures [15, 16], and evaluation index system [17] that associated with SMEs supply chain finance risk management. For example, Liang et al. proposed an SME financing evaluation model for supply chain finance based on the theory of the triple bottom line (economy, environment, and society) from a sustainable development perspective [18]. Rosen and Saunders analyzed the risks of supply chain financing which are associated with information sharing. After a discussion on the advantages and disadvantages in supply chain financing, some corresponding solutions are provided [19]. Meanwhile, Demica observes that supply chain finance tends to be carried out by international banks. This is because they have the capacity to bear greater risk than other traditional credit businesses. Providing opportunities for banks to strengthen potential big customer relationships aside, the banks could make a higher margin by charging a higher fee [20]. By analyzing the credit risks of core enterprises in supply chain finance, Mou et al. measured and evaluated the credit risks of core enterprises with a fuzzy analytic hierarchy process. In such way, Mou et al. have established a credit risk evaluation system of supply chain finance [21]. According to the business characteristics of supply chain finance, a credit risk evaluation index system has been put forward by Xia et al., which consists of three subevaluation systems: credit risk evaluation of financing subjects, credit risk evaluation of financing debts, and macroenvironmental risk evaluation. Such index can be used as a reference for financial institutions to carry out their credit risk evaluations [22].

By applying the fuzzy analytic hierarchy process on four aspects, an index weight system for supply chain risk assessment has been established by Zhao and Li [23]. By using the multilevel gray comprehensive evaluation method to evaluate the risks associated with different financial evaluation systems, a risk evaluation index for SMEs has been constructed by Yan [24]. Xiong et al. put forward a credit risk evaluation system for main body rating and debt rating. By combining the principal component analysis method and logistic regression method, a credit risk evaluation model has been established by them. They have also proposed that the construction of the customer basic database should be strengthened. Such move would make the new credit risk evaluation system more accurate and robust [25].

Overall, the above literature reviews have indicated that there is still a lack of a comprehensive and practical method to evaluate supply chain financial risks. The traditional supply chain finance mainly analyzes the operation condition, financing mode, and development prospect of enterprises from the single economic factor [26]. With the advent of globalization and global warming, organizations around the world found that they increasingly have to balance their economic performance and environmental performance [27]. Moreover, whether the enterprise can fulfill the corresponding social responsibility and pass the environmental friendly audit of relevant departments has become an important factor for the survival and operation of the enterprises [28, 29]. However, they have not taken the overall consideration for the development of SMEs (such as industrial risks and new information technology application) into account. As supply chain finance is a financial service for the whole supply chain system, it is also indispensable to assess the overall industry risk of SMEs [30]. In addition, industry risk is also affected by technological evolution [31].

Current evaluation models on supply chain financial risks are based on multilevel gray comprehensive evaluation and principal component analysis method. The former has the problem of relying heavily on expert scoring and being too subjective. Although the latter is more scientific and can improve objectivity in the evaluation process, due to its large sample requirements, its prediction accuracy is not very high [32].

After years of research, the multiattribute decision-making method has achieved outstanding results in political and economic fields [33, 34]. In a multidecision environment, decision-makers can now use a single linguistic term to express their preferences and ideas. They can also express their views based on different influencing factors or uncertain problems.

Among them, the PROMETHEE method put forward by Brans et al. in 1986 is a multiattribute decision-making method [35]. This is a method that is based on the precedence relation of two comparison schemes; the precedence relation between different schemes is determined by preference function and the weight of each attribute given by the decision-maker. Compared with ELECTRE, the PROMETHEE method has very good performance and can be explained directly by using indexes. Such method has drastically improved information accuracy. As its proposed hesitation fuzzy linguistic ranking is based on multiattribute decision-making, it has a good linear preference advantage over other methods.

Under smart city and smart finance, this paper establishes an effective risk evaluation mechanism for SMEs in supply chain finance. The evaluation index expands from traditional single financial evaluation to economic, social, environmental, and industrial risks. By applying the improved hesitant fuzzy PROMETHEE method, it first constructs a multiobjective decisions model to set out the risks that are associated with supply chain financing for SMEs. The uncertainties of uncertain information and decision-makers' perceptions are then transformed into fuzzy concepts; qualitative problems are then quantified.

2. Constructing a Supply Chain Financing Evaluation Index System

With the continuous development of smart finance, it is changing not only the traditional financial channels but also the financial risk control system. The financial evaluation system is a comprehensive evaluation model that includes the following factors into account: corporate economic growth, social responsibility, environmental governance, and industry risk factors. Such comprehensive system would provide financial institutions with more risk assessment options and help them to reduce further financial risk.

In 2012, Ahi and Searcy tried to pick out some key indicators from 445 existing sustainable supply chain management articles. Out of this exercise, they had identified 2555 unique indicators in total, yet most of them were used only once [36]. This shows there is a lack of consensus on how to measure performance in these areas on the subject. Nevertheless, this paper selects some commonly used specific indicators from the economic, social, and environmental risks from the analysis and the summary indicators of Ahi and Searcy as the bases for its financing evaluation indicators.

2.1. "Economic Risk" Evaluation Indicators. The economic performance study identified asset management indicators, development capability indicators, debt indicators, and financial indicators as "economic risks." Based on the value of corporate performance evaluation criteria, this paper constructs an economic risk indicator system from five aspects, asset investment, financial quality, asset quality, capital structure, and operational level, and explains different evaluation indicators.

2.2. "Social Risk" Evaluation Indicators. The "social risk" measures the ability and effectiveness of companies to fulfill their social responsibilities. Corporate social responsibility is composed of two parts: general responsibility and narrow responsibility. Among them, general responsibility refers to corporate responsibility and economy [37]. According to the Global Reporting Initiative, narrow social responsibility includes five aspects of employment compensation, labor security, training, education, occupational safety, and social donations, and further specific indicators such as employment status and labor contract signing rates.

2.3. "Environmental Risk" Evaluation Indicators. Based on the theory of sustainable development, this paper uses the indicators recommended in the Global Sustainability Reporting Guidelines [38] to analyze the actual situation of SMEs supply chain financing. These environmental risks are divided into four specific indicators: waste discharge, energy consumption, resource utilization, and environmental protection.

2.4. "Industry Risk" Evaluation Indicators. This paper will explain the existing credit risk indicators based on the enterprise, such as industry barrier and new information technology application. At last, the industry risk indicator system is constructed and six specific indicators are selected.

Based on the analysis of economic risk, social risk, environmental risk, and industry risk assessment indicators, Table 1 is prepared as follows:

3. Evaluation Using the Hesitation Fuzzy Linguistic PROMETHEE Method

3.1. Preliminary Knowledge. When making multiattribute decisions, because of the uncertainty and complexity of objective things and the fuzziness of human thinking, numerical scale cannot reflect the preference of decision-maker effectively and accurately. Therefore, in order to reasonably express the subjective judgment of decision-makers, scholars put forward the method of expressing with language variables and quantified the qualitative problems by setting a unified language terms set and corresponding language transformation methods. We discuss preliminary knowledge as follows.

Table 1: Summary table of supply chain financing evaluation index system.

Target layer	Subtarget layer	Criterion layer	Indicator layer	References
Supply chain financing evaluation index system	B1 economic criteria	C1 asset investment	D1 actual total investment	[18, 22, 24, 25, 30]
		C2 financial quality	D2 return on equity	[18, 21–25, 30]
			D3 return on total assets	[18, 21–25, 30]
		C3 asset quality	D4 asset turnover rate	[18, 22, 23,25, 30]
			D5 accounts receivable turnover rate	[18, 22, 23, 25, 30]
		C4 capital structure	D6 asset-liability ratio	[18, 21–25, 30]
		C5 operational level	D7 sales growth rate	[18,21,22,24,25,30]
	B2 social criteria	C6 employment contribution	D8 employment opportunities	[18, 26, 30]
			D9 average wage level of workers	[18, 30, 36]
		C7 labor security	D10 labor contract signing rate	[18, 30, 36]
			D11 employee social security purchase rate	[18, 30, 36]
		C8 training education	D12 average annual training time of employees	[18, 26, 30, 36]
		C9 occupational safety	D13 casualty rate	[18, 36]
		C10 social contribution	D14 social contribution	[18, 36]
	B3 environmental criteria	C11 waste discharge	D15 exhaust emissions	[18, 30, 36]
			D16 sewage discharge	[18, 30, 36]
			D17 solid waste discharge	[18, 30, 36]
		C12 energy consumption	D18 total direct energy consumption	[18,30, 36]
		C13 resource utilization	D19 recycling rate	[18, 30, 36]
		C14 environmental protection	D20 environmental protection investment proportion	[18, 30, 36]
	B4 industry criteria	C15 industry cycle	D21 industry life cycle	[21–24]
		C16 industry barrier	D22 technology monopoly	[21, 22, 25]
			D23 government controlled monopoly	[21, 22, 25]
		C17 corporate relationship	D24 upstream and downstream industry concentration	[22–25]
		C18 industry informatization level	D25 new information technology application breadth and depth	[22, 24–26, 32]
		C19 industry technology evolution	D26 rate of industry technology evolution	[22, 24–26, 32]

Definition 1 (see [39, 40]). Set

$$S = \left\{ S_g \,\middle|\, g = 0,\, 1, \ldots, \tau \right\}. \quad (1)$$

For the linguistic terms set, $\alpha_i \,\varepsilon\, A$, $\{i = 1, 2, \ldots, N\}$; the mathematical form of the hesitant fuzzy linguistic set on A is

$$H_S = \left\{ < \alpha_i, h_S(\alpha_i) > \,\middle|\, \alpha_i \in A \right\}, \quad (2)$$

where function $h_s(\alpha_i)$: $A \longrightarrow S$ is the possible membership of the element $\alpha_i \in A$ mapped to the collection $X \subset A$ and $h_S(\alpha_i)$ is a continuous list of possible values in the linguistic terms set S. While $h_s(\alpha_i) = \left\{ s_c(\alpha_i) \mid s_\varphi(\alpha_i) \in S, \quad l = 1, 2, 3, \ldots, L(\alpha_i) \right\}$, $\varphi \in \{0,\, 1,\, 2, \ldots, \tau\}$ is the subscript of the linguistic terms set. For the sake of simplicity, $h_s(\alpha_i)$ is called hesitant fuzzy linguistic number, and H_S is the set of all hesitant fuzzy linguistic numbers on the linguistic terms set S.

Definition 2 (see [39, 40]). Set S as linguistic terms set and set G_H as text-free grammar. Then the elements of the text-free grammar $G_H = (V_N, V_T, I, P)$ can be defined as follows: V_N = {subject, compound, unary, binary, conjunction}; V_T = {"more than," "less than," "at most," "at least," "between," "and," "s_0,, "s_1,, …, "s_τ"}; $I \in V_N$; P = {I refers to a subject or compound, while subject is "s_0," "s_1," …, "s_τ,". Compound words refer to one-way relationship + subject or binary relationship + conjunction + subject; one-way relationship means "less than" or "more than," binary relationship means "between," and conjunction means "and."

Definition 3 (see [39, 40]). Set E_{GH} as the conversion of a language expression generated by text-free grammar G_H into a function of hesitant fuzzy linguistic set; S is the set of linguistic terms used in grammar. S_{ll} is a collection of all expressions generated for the grammar G_H. The language expression generated by the grammar G_H generation rule can be converted to a hesitant fuzzy linguistic set by the conversion formula $E_{GH} : s_{ll} \longrightarrow H_s$. For example,

$$
\begin{aligned}
&E_{GH}\left(S_g \middle| S_g \in S\right)\\
&E_{GH}\,(\text{no more than } S_\alpha) = \left\{S_g \middle| S_g \in S, \quad S_g \le S_\alpha\right\},\\
&E_{GH}\,(\text{less than } S_\alpha) = \left\{S_g \middle| S_g \in S, \quad S_g < S_\alpha\right\},\\
&E_{GH}\,(\text{at least } S_\alpha) = \left\{S_g \middle| S_g \in S, \quad S_g \ge S_\alpha\right\},\\
&E_{GH}\,(\text{more than } S_\alpha) = \left\{S_g \middle| S_g \in S, \quad S_g > S_\alpha\right\},\\
&E_{GH}\left(\text{between } S_\alpha \text{ and } S_\beta\right) = \left\{S_g \middle| S_g \in S, \quad S_\beta \le S_g \le S_\alpha\right\}.
\end{aligned}
\tag{3}
$$

In order to understand the characteristics of different hesitant fuzzy linguistic terms more clearly, we should also calculate the two hesitant fuzzy linguistic terms. Liao et al. [39] used the method of linguistic terms for verification and assume that $b = \{b_l \mid l = 1, 2, \ldots, \#b\}$ means hesitant fuzzy linguistic number and $\#b$ denotes the number of hesitant fuzzy linguistic terms in b; then b^+ and b^-, respectively, represent the largest language and the smallest language in b. Meanwhile $\xi\,(0 \le \xi \le 1)$ is optimization parameter; then $b = \xi b^+ \oplus (1-\xi) b^-$ represents at least a few elements in the number. Set $\xi = 0.5$.

Definition 4 (see [41]). The positive ideal solution A^+ and the negative ideal solution A^- of hesitant fuzzy linguistic are $A^+ = \{h_s^{1^+}, h_s^{2^+}, \ldots, h_s^{n^+}\}$ and $A^- = \{h_s^{1-}, h_s^{2-}, \ldots, h_s^{n-}\}$:

$$
\begin{aligned}
h_s^{j+} &= \begin{cases}
\max\limits_{i=1,2,\ldots,m} h_s^{ij+} = \max\limits_{\substack{i=1,2,\ldots,m\\ j=1,2,\ldots,\#h_s^{ij}}} \{S_{\delta^{ij}}\}, & \text{for benefit criterion } C_j,\\[2ex]
\min\limits_{i=1,2,\ldots,m} h_s^{ij+} = \min\limits_{\substack{i=1,2,\ldots,m\\ j=1,2,\ldots,\#h_s^{ij}}} \{S_{\delta^{ij}}\}, & \text{for cost criterion } C_j,
\end{cases} \quad \text{for} \quad j = 1, 2, \ldots, m,\\
h_s^{j-} &= \begin{cases}
\max\limits_{i=1,2,\ldots,m} h_s^{ij+} = \max\limits_{\substack{i=1,2,\ldots,m\\ j=1,2,\ldots,\#h_s^{ij}}} \{S_{\delta^{ij}}\}, & \text{for cost criterion } C_j,\\[2ex]
\min\limits_{i=1,2,\ldots,m} h_s^{ij-} = \max\limits_{\substack{i=1,2,\ldots,m\\ j=1,2,\ldots,\#h_s^{ij}}} \{S_{\delta^{ij}}\}, & \text{for benefit criterion } C_j,
\end{cases} \quad \text{for} \quad j = 1, 2, \ldots, m.
\end{aligned}
\tag{1}
$$

Definition 1 shows the relationship between the elements after the quantitative evaluation results, and Definition 2 introduces how to extract the key elements and obtain the quantified indicators. Definition 3 transforms the text-free grammar into a corresponding set of hesitant fuzzy linguistic. Definition 4 determines the positive ideal solution and the negative ideal solution.

3.2. Hesitant Fuzzy Linguistic PROMETHEE Multiattribute Decision-Making Method Based on Improved Preference Function. There are some decision-making problems that cannot be measured quantitatively but can only be evaluated qualitatively in real life. For these decision-making problems, according to the needs of the actual decision-making process, hesitant fuzzy language allows decision-makers to qualitatively describe objective things when information is incomplete or there are uncertainties generated between multiple different language information. This paper combined the hesitant fuzzy linguistic PROMETHEE method based on the improved linear standard preference function and constructed a new supply chain financial risk measurement model.

This measure model consists of two main steps: the construction of hesitant fuzzy linguistic sets and the calculation of PROMETHEE method. In the step of construction of hesitant fuzzy linguistic sets, firstly, every expert will make a qualitative evaluation of each SME based on the evaluation indicators system. Then, by the text-free grammar conversion and the conversion function transition, we can convert the qualitative evaluations of SMEs to the hesitant fuzzy linguistic set used for the calculation of PROMETHEE method. Finally, by the calculation of PROMETHEE method and the comparison of the net flow of each SME, we can choose the reasonable investment decision-making scientifically. The logic of the measure model is shown in Figure 1.

3.2.1. Improved Preference Function. The method adopted in this paper is based on the improvement of the linear standard in the PROMETHEE method. The following mainly introduces the original linear standard, the improved steps, and the application method of the improved hesitant fuzzy linguistic PROMETHEE method.

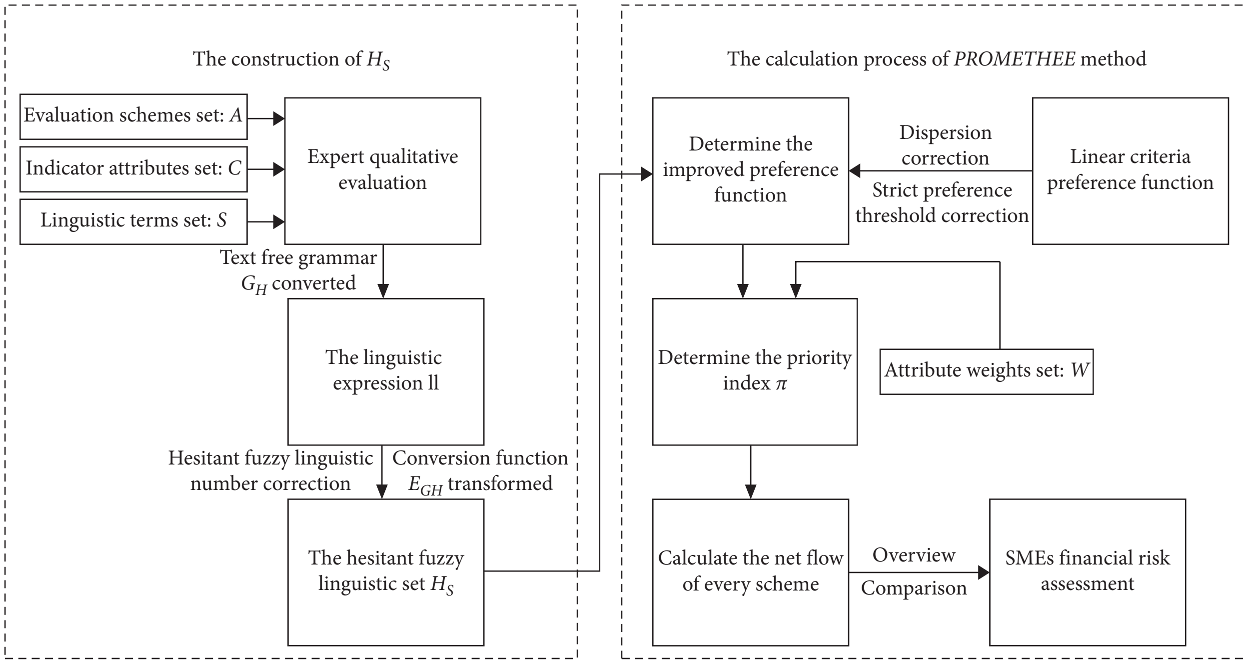

Figure 1: Research framework.

There are six forms of preference functions in the PROMETHEE method [35], where the linear criteria are given as follows:

$$P_j(a_i,a_k)=\begin{cases}0, & d_j(a_i,a_k)\le 0,\\ \dfrac{d_j(a_i,a_k)}{\nu}, & 0<d_j(a_i,a_k)\le \nu,\\ 1, & d_j(a_i,a_k)>\nu.\end{cases} \tag{5}$$

Regardless of which preference function is chosen, it should be calculated.

$d_i(\alpha_i, \alpha_k) = f(\alpha_i) - f(\alpha_k)$, which characterizes the preference difference of any two alternatives. However, in the hesitant fuzzy linguistic environment, the two attributes are described in a hesitant fuzzy linguistic. This cannot be directly operated and thus cannot be directly used in the above preference function of PROMETHEE to calculate the dispersion $d_i(\alpha_i, \alpha_k)$ of the two schemes under the same attribute. Therefore, the preference function of the PROMETHEE method cannot be used effectively, and the above preference function of the PROMETHEE method needs to be further improved as follows:

Step 1: set $h_s^{ij} = \{s_{\delta_i}^{ij} \mid l = 1,2,\ldots, \#h_s^{ij}\}\,(i = 1,2,\ldots, m; j = 1,2,\ldots,n)$ indicates the degree of satisfaction of the scheme a_i on the attribute c_j. For each hesitant fuzzy linguistic set, define $\sigma_s^{ij} = \sum_{l=1}^{\#h_s^{ij}} \delta_l^{ij}$ as the sum of all hesitant languages in the episode. On the attribute c_j, the dispersion of any pair of schemes a_i and a_k is

$$d_i(\alpha_i,\alpha_k)=\sigma_s^{ij}-\sigma_S^{kj},\quad i,k=\{1,2,\ldots,n\}. \tag{6}$$

Step 2: determine the positive and negative ideal solutions A_j^+ and A_j^- under the criterion c_j, and calculate the dispersion $d_j(A_j^+, A_j^-)$.

Step 3: using the linear preference standard function in the preference function, the strict preference threshold is taken as $\nu = \theta d_j(A_j^+, A_j^-), 0 < \theta < 1$. The decision-maker chooses the value of the parameter θ according to the actual needs of the decision-making process and its subjective preference. When the difference between the sums is 0, it indicates that the schemes a_i and a_k are indistinguishable; when the difference between the sums is greater than $\theta d_j(A_j^+, A_j^-)$, it indicates that the scheme a_i is strictly superior to the scheme a_k. Therefore, the linear criteria preference function can be modified shown as follows:

$$P_j(a_i,a_k)=\begin{cases}0, & d_j(a_i,a_k)\le 0,\\ \dfrac{d_j(a_i,a_k)}{\theta d_j\left(A_j^+,A_j^-\right)}, & 0<d_j(a_i,a_k)\le \theta d_j\left(A_j^+,A_j^-\right),\\ 1, & d_j(a_i,a_k)>\theta d_j\left(A_j^+,A_j^-\right),\end{cases}$$

$$P_j(a_i,a_k)=\begin{cases}0, & d_j(a_i,a_k)\le 0,\\ \dfrac{d_j(a_i,a_k)}{\theta d_j\left(A_j^+,A_j^-\right)}, & 0<d_j(a_i,a_k)\le \theta d_j\left(A_j^+,A_j^-\right), \quad \text{for benefit criterion,}\\ 1, & d_j(a_i,a_k)>\theta d_j\left(A_j^+,A_j^-\right),\end{cases}$$

$$P_j(a_i,a_k)=\begin{cases}1, & d_j(a_i,a_k)>\theta d_j\left(A_j^+,A_j^-\right),\\ \dfrac{d_j(a_i,a_k)}{\theta d_j\left(A_j^+,A_j^-\right)}, & \theta d_j\left(A_j^+,A_j^-\right)<d_j(a_i,a_k)\le 0, \quad \text{for cost criterion.}\\ 0, & d_j(a_i,a_k)>0,\end{cases}$$

$$0<\theta<1. \tag{7}$$

Considering that the selected indicator may contain the cost attribute, the above preference function only reflects the degree of superiority to the income attribute, so the preference function is adjusted as formula (7).

3.2.2. Hesitant Fuzzy Linguistic PROMETHEE Method. The evaluation steps of the hesitant fuzzy linguistic PROMETHEE method based on the improved linear standard preference function are given as follows:

Step 1: define a multiattribute decision-making problem: determine the set of programs consisting of n schemes $A=\{\alpha_1,\alpha_2,\ldots,\alpha_n\}$ and the set of attributes consisting of m attributes $C=\{c_1,c_2,\ldots,c_m\}$; the set of weights of each attribute is $\omega=(\omega_1,\omega_2,\ldots,\omega_m)^T$, where $0\le\omega\le 1$ and $\sum_{i=1}^{m}\omega_i=1$.

Step 2: for the above decision-making problem, the linguistic expression is used to give a qualitative evaluation of the performance of each scheme a_i under each attribute c_j. According to the text-free grammar G_H given by Definition 2, the linguistic expression is generated as ll.

Step 3: according to the conversion function E_{GH} given by Definition 3, the linguistic expression ll is transformed into the hesitant fuzzy linguistic set H_s. For the convenience of operation, a new linguistic term is added, and the hesitant fuzzy linguistic number is the same number of linguistic terms.

Step 4: determine the preference function. Under the benefit type and cost type attribute c_j, the degree to which scheme a_i is better than scheme a_k is represented by the preference function. The modified linear standard preference function is shown in formula (3).

Step 5: determine the priority index $\pi(a_i,a_k)$. The priority index indicates the degree to which scheme a_i is better than scheme a_k. The closer to 1, the better the degree of scheme a_i.

$$\pi(a_i,a_k)=\sum_{r=1}^{m}\omega_j P_j(a_i,a_k),\quad j=\{1,2,\ldots,m\};i,\; k=\{1,2,\ldots,n\}. \tag{8}$$

Step 6: according to the priority index, calculate the inflow $\phi^+(a_i)$ and the outflow $\phi^-(a_i)$ of each scheme:

$$\phi^{+}(\alpha_i) = \sum_{r=1}^{m} \pi(\alpha_i, \alpha_k) = \sum_{j=1}^{n}\sum_{r=1}^{m} \omega_j P_j(\alpha_i, \alpha_k), \quad (9)$$

$$\phi^{-}(\alpha_i) = \sum_{r=1}^{m} \pi(\alpha_k, \alpha_i) = \sum_{j=1}^{n}\sum_{r=1}^{m} \omega_j P_j(\alpha_k, \alpha_i), \quad (10)$$

where $j = \{1, 2, \ldots, m\}; i, k = \{1, 2, \ldots, n\}\phi^{+}(a_i)$ indicates the degree to which a_i is superior to other schemes, and the larger the value is, the better a_i is; $\phi^{-}(a_i)$ indicates the possibility that other schemes are better than scheme a_i, and the smaller the value, the higher the superiority of scheme a_i, relative to other schemes.

Step 7: calculate the net flow of the solution a_i:

$$\phi(a_i) = \phi^{+}(a_i) - \phi^{-}(a_i). \quad (11)$$

The larger $\phi(a_i)$ indicates that the scheme is better. If $\phi(a_i) > \phi(a_k)$, scheme a_i is better than scheme a_k. Similarly, the full ordering of the scheme is available.

4. Case Study

Suppose that a financial institution intends to invest five different small- and medium-sized enterprises. The evaluation of the following five SMEs is then considered under the four economic, social, environmental, and industrial criteria. Next, the financial institution sets the weights of each level and its inclusion indicators according to the characteristics of the market environment and the preferences for each indicator. The corresponding weights of the economic, social, environmental, and industrial levels are as follows:

$$\omega = (0.3, 0.2, 0.2, 0.3)^{T}. \quad (12)$$

The following is a calculation of the performance of five companies in four aspects, respectively.

4.1. Economic Criteria (b_1). In this scenario, there are five criteria: asset investment (c_1), financial quality (c_2), asset quality (c_3), capital structure (c_4), and operational level (c_5). Adjust the weights of these five attributes according to the characteristics of economic criteria:

$$\omega = (0.3, 0.2, 0.2, 0.15, 0.15)^{T}. \quad (13)$$

Step 1: the set of linguistic terms S of the above five attributes can be expressed as $S = \{s_0 = \text{very low}, s_1 = \text{low}, s_2 = \text{low}, s_3 = \text{medium}, s_4 = \text{high}, s_5 = \text{high}, s_6 = \text{very high}\}$.

Step 2: in order to obtain a more reasonable and effective evaluation result, investors set up a decision-making group that includes experts to evaluate the economic indicators of small- and medium-sized enterprises. The decision-making data comes from experts' subjective evaluation of economic indicators of different enterprises. In the evaluation process, each expert independently gives an assessment of the economic indicators of the company. Different experts may have different views on the economic indicators of the same company. For example, an expert may think that the financial quality of a_3 is "very high" and another may be considered "high." If they are unable to convince each other, the evaluation information given by the decision-makers in the decision-making group can be expressed as $\{s_5, s_6\}$. If all decision-makers agree that the asset investment performance of company a_3 is "medium," the evaluation information given can be expressed as $\{s_3\}$. After discussion by the decision-making group, qualitative evaluation information-based linguistic expressions were given to evaluate the performance of the five candidate companies under the five attributes.

Step 3: according to the conversion function E_{G_H}, the expert's linguistic expression $\ell\ell$ is transformed into the hesitant fuzzy linguistic number, and the hesitant fuzzy linguistic evaluation matrix H_s is constructed.

Step 4: among these five attributes, the capital structure (c_4) is the cost attribute, and the other four attributes are the return attribute, which determines the positive ideal solution of the fuzzy hesitant language. $A^{+} = \{s_6, s_6, s_5, s_0, s_6\}$ and $A^{-} = \{s_2, s_1, s_1, s_6, s_0\}$ compute $d_j(A^{+}, A^{-})$. The degree to which enterprise a_i ($i = 1, 2, 3, 4, 5$) is better than another enterprise a_k ($k = 1, 2, 3, 4, 5$) is calculated by the improved linear standard preference function, and the calculation result is as follows in Table 2 (set $\theta = 0.6$).

Step 5: according to formula (8), calculate the priority index. The results are shown in Table 3.

Step 6: calculate the inflow $\phi^{+}(a_i)$ and the outflow $\phi^{-}(a_i)$ of each scheme according to formula (9) and formula (10), and finally calculate the net flow $\phi(a_i)$ of the scheme according to formula (11). The results can be seen in Table 4.

4.2. Social Criteria (b_2). According to the characteristics of social norms, the weights of the five attributes employment contribution (c_6), labor security (c_7), training and education (c_8), occupational safety (c_9), and social contribution (c_{10}) are adjusted; the weights are

$$\omega = (0.3\ ,\ 0.2, 0.1, 0.3, 0.1)^{T}. \quad (14)$$

Step 1: same as step 1 in Section 4.1.

Step 2: same as step 2 in Section 4.1.

Step 3: according to the conversion function E_{G_H}, the expert's linguistic expression ll is transformed into the hesitant fuzzy linguistic number, and the hesitant fuzzy linguistic evaluation matrix H_s is constructed.

Table 2: Economic criteria dispersion.

	c_1	c_2	c_3	c_4	c_5
$P_j(a_1,a_2)$	0	2/3	0	0	0
$P_j(a_1,a_3)$	0	0	0	0	0
$P_j(a_1,a_4)$	0	1/6	0	5/36	0
$P_j(a_1,a_5)$	0	0	0	0	0
$P_j(a_2,a_1)$	5/12	0	1	1	1
$P_j(a_2,a_3)$	0	0	1	5/18	1
$P_j(a_2,a_4)$	0	0	0	1	5/9
$P_j(a_2,a_5)$	0	0	0	5/6	5/36
$P_j(a_3,a_1)$	1	5/6	5/12	1	5/18
$P_j(a_3,a_2)$	5/8	1	0	0	0
$P_j(a_3,a_4)$	0	1	0	1	0
$P_j(a_3,a_5)$	5/12	1/6	0	5/6	0
$P_j(a_4,a_1)$	1	0	1	0	5/6
$P_j(a_4,a_2)$	5/6	1/2	0	0	0
$P_j(a_4,a_3)$	5/24	0	1	0	5/9
$P_j(a_4,a_5)$	5/8	0	0	0	0
$P_j(a_5,a_1)$	5/8	2/3	1	5/9	1
$P_j(a_5,a_2)$	5/24	1	5/24	0	0
$P_j(a_5,a_3)$	0	0	1	0	35/36
$P_j(a_5,a_4)$	0	5/6	5/24	25/36	5/12

Table 3: Economic criteria priority index.

$\pi(a_1,a_2)$	2/15	$\pi(a_1,a_3)$	0	$\pi(a_1,a_4)$	13/240	$\pi(a_1,a_5)$	0
$\pi(a_1,a_2)$	5/8	$\pi(a_2,a_3)$	47/120	$\pi(a_2,a_4)$	7/30	$\pi(a_2,a_5)$	7/48
$\pi(a_3,a_1)$	89/120	$\pi(a_3,a_2)$	31/80	$\pi(a_3,a_4)$	7/20	$\pi(a_3,a_5)$	17/60
$\pi(a_4,a_1)$	5/8	$\pi(a_4,a_2)$	7/20	$\pi(a_4,a_3)$	49/120	$\pi(a_4,a_5)$	3/16
$\pi(a_5,a_1)$	181/240	$\pi(a_5,a_2)$	103/240	$\pi(a_5,a_3)$	83/240	$\pi(a_5,a_4)$	3/8

Table 4: The net of economic criteria.

SMEs	$\phi^+(a_i)$	$\phi^-(a_i)$	$\phi^{b_1}(a_i)$
a_1	3/16	659/240	−2.5583
a_2	67/48	13/10	0.0958
a_3	227/120	55/48	0.7458
a_4	377/240	81/80	0.5583
a_5	457/240	37/60	1.2875

$$\begin{bmatrix} (S_3,S_4) & (S_2,S_3,S_4) & (S_5,S_6) & (S_4,S_5) & (S_0,S_1,S_2) \\ (S_1,S_2) & (S_0,S_1) & (S_4,S_5,S_6) & (S_2,S_3) & (S_4,S_5,S_6) \\ (S_4,S_5) & (S_4,S_5) & (S_0) & (S_1,S_2) & (S_5,S_6) \\ (S_2,S_3) & (S_6) & (S_4,S_5) & (S_3,S_4) & (S_2,S_3,S_4) \\ (S_4,S_5,S_6) & (S_1,S_2) & (S_5,S_6) & (S_4) & (S_4,S_5) \end{bmatrix}. \quad (15)$$

Step 4: among these five attributes, the occupational safety (c_9) is the cost attribute, and the other four attributes are the return attribute, which determines the positive and negative ideal solutions of the fuzzy hesitant language. $A^+ = \{s_6, s_6, s_6, s_1, s_6\}$ and $A^- = \{s_1, s_0, s_0, s_5, s_0\}$. We can calculate the improved linear standard preference function. The results are shown in Table 5 (set $\theta = 0.6$).

Step 5: according to formula (8), calculate the priority index. The results are shown in Table 6.

Table 5: Social criteria dispersion.

	c_6	c_7	c_8	c_9	c_{10}
$P_j(a_1,a_2)$	2/3	25/36	5/36	0	0
$P_j(a_1,a_3)$	0	0	1	0	0
$P_j(a_1,a_4)$	1/3	0	5/8	0	0
$P_j(a_1,a_5)$	0	5/12	0	0	0
$P_j(a_2,a_1)$	0	0	0	5/6	1
$P_j(a_2,a_3)$	0	0	1	0	0
$P_j(a_2,a_4)$	0	0	5/36	5/12	5/9
$P_j(a_2,a_5)$	0	0	0	5/8	5/36
$P_j(a_3,a_1)$	1/3	5/12	0	1	1
$P_j(a_3,a_2)$	1	1	0	5/12	5/36
$P_j(a_3,a_4)$	2/3	0	0	5/6	25/36
$P_j(a_3,a_5)$	0	5/6	0	1	5/18
$P_j(a_4,a_1)$	0	5/6	0	5/12	5/9
$P_j(a_4,a_2)$	1/3	1	0	0	0
$P_j(a_4,a_3)$	0	5/12	1	0	0
$P_j(a_4,a_5)$	0	1	0	5/24	0
$P_j(a_5,a_1)$	1/2	0	0	5/24	35/36
$P_j(a_5,a_2)$	1	5/18	5/35	0	0
$P_j(a_5,a_3)$	1/6	0	1	0	0
$P_j(a_5,a_4)$	5/6	0	5/18	0	5/12

Step 6: calculate the inflow $\phi^+(a_i)$ and the outflow $\phi^-(a_i)$ of each scheme according to formula (5) and formula (6), and finally calculate the net flow $\phi(a_i)$ of the scheme according to formula (11). The results are shown in Table 7.

Table 6: Social criteria priority index.

$\pi(a_1,a_2)$	127/360	$\pi(a_1,a_3)$	1/10	$\pi(a_1,a_4)$	13/80	$\pi(a_1,a_5)$	1/12
$\pi(a_2,a_1)$	7/20	$\pi(a_2,a_3)$	1/10	$\pi(a_2,a_4)$	7/36	$\pi(a_2,a_5)$	29/144
$\pi(a_3,a_1)$	7/12	$\pi(a_3,a_2)$	23/36	$\pi(a_3,a_4)$	187/360	$\pi(a_3,a_5)$	89/180
$\pi(a_4,a_1)$	25/72	$\pi(a_4,a_2)$	3/10	$\pi(a_4,a_3)$	11/60	$\pi(a_4,a_5)$	21/80
$\pi(a_5,a_1)$	223/720	$\pi(a_5,a_2)$	233/630	$\pi(a_5,a_3)$	3/20	$\pi(a_5,a_4)$	23/72

Table 7: The net flow of social criteria.

SMEs	$\phi^+(a_i)$	$\phi^-(a_i)$	$\phi^{b_2}(a_i)$
a_1	503/720	229/144	−0.8917
a_2	203/240	4189/2520	−0.8165
a_3	161/72	8/15	1.7028
a_4	787/720	287/240	−0.1028
a_5	5791/5040	25/24	0.1073

4.3. Environmental Criteria (b_3). The weights of the four attributes waste discharge (c_{11}), energy consumption (c_{12}), resource utilization rate (c_{13}), and environmental protection (c_{14}) are adjusted according to the characteristics of environmental criteria; the weight set is

$$\omega = (0.4, 0.2, 0.3, 0.10)^T. \quad (16)$$

Step 1: same as step 1 in Section 4.1.

Step 2: same as step 2 in Section 4.1.

Step 3: the hesitant fuzzy linguistic evaluation matrix H_s is constructed:

$$\begin{bmatrix} (s_1,s_2) & (s_2,s_3) & (s_3,s_4) & (s_1) \\ (s_4) & (s_2) & (s_4,s_5) & (s_5,s_6) \\ (s_5,s_6) & (s_4,s_5) & (s_0,s_1) & (s_3,s_4) \\ (s_3,s_4) & (s_1,s_2) & (s_4) & (s_5,s_6) \\ (s_4,s_5) & (s_4,s_5,s_6) & (s_1,s_2) & (s_2) \end{bmatrix}. \quad (17)$$

Step 4: among these five attributes, waste discharge (c_{11}) and energy consumption (c_{12}) are the cost attributes. The positive and negative ideal solutions of the fuzzy hesitant language are $A^+ = \{s_1, s_1, s_5, s_6\}$ and $A^- = \{s_6, s_6, s_0, s_1\}$. Then the improved linear standard preference function can be calculated. The results are shown in Table 8 (set $\theta = 0.6$).

Step 5: according to formula (8), calculate the priority index. The results are shown in Table 9.

Step 6: calculate the inflow $\phi^+(a_i)$ and the outflow $\phi^-(a_i)$ of each scheme according to formula (5) and formula (6), and finally calculate the net flow $\phi(a_i)$ of the scheme according to formula (11). The results are shown in Table 10.

Table 8: Environmental criteria dispersion.

	c_{11}	c_{12}	c_{13}	c_{14}
$P_j(a_1,a_2)$	5/6	0	0	0
$P_j(a_1,a_3)$	1	2/3	1	0
$P_j(a_1,a_4)$	2/3	0	0	0
$P_j(a_1,a_5)$	1	5/6	2/3	0
$P_j(a_2,a_1)$	0	1/6	1/3	1
$P_j(a_2,a_3)$	1/2	5/6	1	2/3
$P_j(a_2,a_4)$	0	0	1/6	0
$P_j(a_2,a_5)$	1/6	1	1	1
$P_j(a_3,a_1)$	0	0	0	5/6
$P_j(a_3,a_2)$	0	0	0	0
$P_j(a_3,a_4)$	0	0	0	0
$P_j(a_3,a_5)$	0	1/6	0	1/2
$P_j(a_4,a_1)$	0	1/3	1/6	1
$P_j(a_4,a_2)$	1/6	1/6	0	0
$P_j(a_4,a_3)$	2/3	1	1	2/3
$P_j(a_4,a_5)$	1/3	1	5/6	1
$P_j(a_5,a_1)$	0	0	0	1/3
$P_j(a_5,a_2)$	0	0	0	0
$P_j(a_5,a_3)$	1/3	0	1/3	0
$P_j(a_5,a_4)$	0	0	0	0

Table 9: Environmental criteria priority index.

$\pi(a_1,a_2)$	1/3	$\pi(a_1,a_3)$	5/6	$\pi(a_1,a_4)$	4/15	$\pi(a_1,a_5)$	23/30
$\pi(a_2,a_1)$	7/30	$\pi(a_2,a_3)$	11/15	$\pi(a_2,a_4)$	1/20	$\pi(a_2,a_5)$	2/3
$\pi(a_3,a_1)$	1/12	$\pi(a_3,a_2)$	0	$\pi(a_3,a_4)$	0	$\pi(a_3,a_5)$	1/12
$\pi(a_4,a_1)$	13/60	$\pi(a_4,a_2)$	1/10	$\pi(a_4,a_3)$	49/60	$\pi(a_4,a_5)$	41/60
$\pi(a_5,a_1)$	1/30	$\pi(a_5,a_2)$	0	$\pi(a_5,a_3)$	7/30	$\pi(a_5,a_4)$	0

Table 10: The net flow of environmental criteria.

SMEs	$\phi^+(a_i)$	$\phi^-(a_i)$	$\phi^{b_3}(a_i)$
a_1	11/5	17/30	1.6333
a_2	101/60	13/30	1.25
a_3	1/6	157/60	−2.45
a_4	109/60	19/60	1.5
a_5	4/15	11/5	−1.9333

4.4. Industry Criteria (b_4). The weights of the five attributes industry cycle (c_{15}), industry barrier (c_{16}), corporate relationship (c_{17}), industry informatization level (c_{18}), and industry technology evolution (c_{19}) are adjusted according to the characteristics of industry criteria; the weight set is

$$\omega = (0.2, 0.3, 0.2, 0.2, 0.1)^T. \quad (18)$$

Step 1: same as step 1 in Section 4.1.

Table 11: Industry criteria deviation.

	c_{15}	c_{16}	c_{17}	c_{18}	c_{19}
$P_j(a_1,a_2)$	5/8	5/6	1	0	5/8
$P_j(a_1,a_3)$	0	5/18	0	0	5/24
$P_j(a_1,a_4)$	5/24	0	1	5/12	1
$P_j(a_1,a_5)$	0	0	1	0	0
$P_j(a_2,a_1)$	0	0	0	5/12	0
$P_j(a_2,a_3)$	0	0	0	0	0
$P_j(a_2,a_4)$	0	0	0	5/6	5/12
$P_j(a_2,a_5)$	0	0	5/36	0	0
$P_j(a_3,a_1)$	5/6	0	0	5/6	0
$P_j(a_3,a_2)$	1	5/9	1	5/12	5/12
$P_j(a_3,a_4)$	1	0	1	1	5/6
$P_j(a_3,a_5)$	5/8	0	1	5/24	0
$P_j(a_4,a_1)$	0	5/18	0	0	0
$P_j(a_4,a_2)$	5/12	1	0	0	0
$P_j(a_4,a_3)$	0	5/9	0	0	0
$P_j(a_4,a_5)$	0	5/18	5/36	0	0
$P_j(a_5,a_1)$	5/24	0	0	5/8	0
$P_j(a_5,a_2)$	5/6	5/6	0	5/24	5/8
$P_j(a_5,a_3)$	0	5/18	0	0	5/24
$P_j(a_5,a_4)$	5/12	0	0	1	1

Step 2: same as step 2 in Section 4.1.

Step 3: the hesitant fuzzy linguistic evaluation matrix H_s is constructed.

$$\begin{bmatrix} (S_3,S_4) & (S_2,S_3,S_4) & (S_0,S_1) & (S_2,S_3,S_4) & (S_4,S_5,S_6) \\ (S_2) & (S_1,S_2) & (S_4,S_5) & (S_2) & (S_3,S_4) \\ (S_5,S_6) & (S_2,S_3) & (S_0,S_1) & (S_1) & (S_4,S_5) \\ (S_3) & (S_3,S_4) & (S_4,S_5) & (S_3,S_4,S_5) & (S_2,S_3) \\ (S_3,S_4,S_5) & (S_3) & (S_4,S_5,S_6) & (S_1,S_2) & (S_5) \end{bmatrix}. \tag{19}$$

Step 4: among these five attributes, corporate relationship (c_{17}) and industry informatization level (c_{18}) are the cost attributes. The positive and negative ideal solutions of the fuzzy hesitant language are $A^+ = \{s_6, s_4, s_0, s_1, s_6\}$ and $A^- = \{s_2, s_1, s_6, s_5, s_2\}$. The results are shown in Table 11 (set $\theta = 0.6$).

Step 5: according to formula (8), calculate the priority index. The results are shown in Table 12.

Step 6: calculate the inflow $\phi^+(a_i)$ and the outflow $\phi^-(a_i)$ of each scheme according to formula (5) and formula (6), and finally calculate the net flow $\phi(a_i)$ of the scheme according to formula (11). The results are shown in Table 13.

4.5. Results Processing. According to each company's performance in four aspects and the weights preferences, through the formula $\phi^*(a_i) = \sum_{i=1}^{5} \phi^{b_j}(a_i)\omega_b$, $(i = 1, 2, 3, 4, 5)$ calculate the scores and rankings of each company. The results are shown in Table 14.

According to the results of the hesitant fuzzy PROMETHEE method analysis, as shown in the table above, from the perspective of the net outflow of the enterprise, the ranking of the five enterprises is $a_3 > a_4 > a_5 > a_1 > a_2$.

Table 12: Industry criteria priority index.

$\pi(a_1,a_2)$	51/80	$\pi(a_1,a_3)$	5/48	$\pi(a_1,a_4)$	17/40	$\pi(a_1,a_5)$	1/5
$\pi(a_2,a_1)$	1/12	$\pi(a_2,a_3)$	0	$\pi(a_2,a_4)$	5/24	$\pi(a_2,a_5)$	1/36
$\pi(a_3,a_1)$	1/3	$\pi(a_3,a_2)$	83/120	$\pi(a_3,a_4)$	41/60	$\pi(a_3,a_5)$	11/30
$\pi(a_4,a_1)$	1/12	$\pi(a_4,a_2)$	23/60	$\pi(a_4,a_3)$	1/6	$\pi(a_4,a_5)$	1/9
$\pi(a_5,a_1)$	1/6	$\pi(a_5,a_2)$	25/48	$\pi(a_5,a_3)$	5/48	$\pi(a_5,a_4)$	23/60

Table 13: The net flow of industry criteria.

SMEs	$\phi^+(a_i)$	$\phi^-(a_i)$	$\phi^{b_4}(a_i)$
a_1	41/30	2/3	0.7
a_2	23/72	67/30	1.9139
a_3	83/40	3/8	1.7
a_4	67/90	17/10	−0.9556
a_5	47/40	127/180	0.4694

Table 14: Evaluation results.

SMEs	$\phi^*(a_i)$	Rank
a_1	−0.4092	4
a_2	−0.4587	5
a_3	0.5843	1
a_4	0.1630	2
a_5	0.1619	3

Therefore, enterprise 3 has the best risk control performance and is the most suitable target.

At present, there are few related researches on this kind of scientific problems. In terms of engineering practice, it still mainly relies on the subjective experience judgment of the decision-maker, which may affect the objectivity of the research results. Such inconsistent evaluation criteria lead to decision-making errors. In addition, as some indicators data are not easy to obtain in the process of scientific research, this makes researches difficult to carry out.

4.6. Sensitivity Analysis. The purpose of the sensitivity analysis is to detect whether there is a difference in the evaluation results when selecting different decision-makers or different evaluation criteria for SMEs that need financing. In order to judge the degree of influence of the evaluation factors on the decision-making results, eight different evaluation criteria with specific details are selected (see Table 15).

Figure 2 is a graphical representation of the evaluation results under different evaluation criteria. Among them, conditions 1, 2, 3, and 4 only consider single economic, social, environmental, and industrial factors. From analyzing the ranking changes of SMEs, we can deduce that using traditional single economic indicators to assess SMEs financing decisions may bring about considerable risks.

Table 15: Sensitivity analysis conditions comparison table.

Condition	Decision criteria	Ranks
1	c1, c2, c3, c4, c5	5 > 3 > 4 > 2 > 1
2	c6, c7, c8, c9, c10	3 > 5 > 4 > 2 > 1
3	c11, c12, c13, c14	1 > 4 > 2 > 5 > 3
4	c15, c16, c17, c18, c19	3 > 1 > 5 > 4 > 2
5	c1, c2, c3, c4, c5, c6, c7, c8, c9, c10	3 > 5 > 4 > 2 > 1
6	c6, c7, c8, c9, c10, c11, c12, c13, c14	4 > 1 > 2 > 3 > 5
7	c11, c12, c13, c14, c15, c16, c17, c18, c19	1 > 4 > 3 > 5 > 2
8	c1, c2, c3, c4, c5, c6, c7, c8, c9, c10, c11, c12, c13, c14, c15, c16, c17, c18, c19	3 > 4 > 5 > 1 > 2

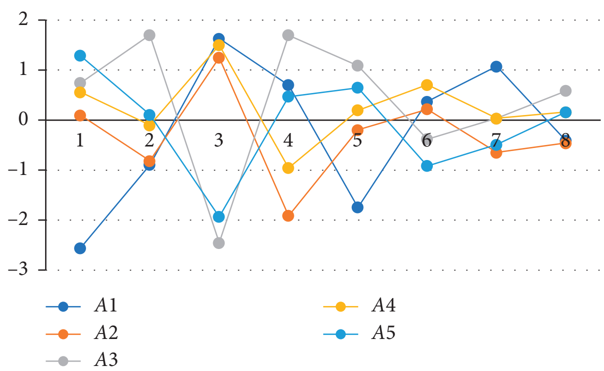

Figure 2: Sensitivity analysis results.

Conditions 5, 6, and 7 are assessments that have taken economic and social indicators, social and environmental indicators, and environmental and industry indicators into their accounts; their various choices depend on the focus of the evaluation indicators. Meanwhile condition 8 considers economic, social, environmental, and industry indicators. It can be seen that as the number of selected indicators increases, the score gap between different enterprises decreases, and the ranking of enterprises also changes.

According to the sensitivity analysis, the selection of the standard type and the standard quantity in the evaluation process is sensitive to evaluation results. This means that when applying risk evaluation system to corresponding enterprises, financial institutions should select the evaluation criteria and quantity carefully in their evaluation process. Comprehensive and scientific evaluation of supply chain financing can further reduce the risk of making supply chain financing decisions.

5. Conclusion

With the progress of financial industry and the rapid development of information technology, the concepts of smart city and smart finance have attracted a lot more attention from financial institutions than ever before. This change has led to differentiating in the financial evaluation system of financial institutions. Single-focus assessments were disappearing and they are replaced by more holistic approaches. At present, most of the evaluations of supply chain financial risks only consider the impact of economic unilateral factors on supply chain financial risks. While other factors such as the wealth of the industry and its operating environment as a whole were ignored, such negligence had exposed financial institutions with considerable unnecessary risks.

In order to ameliorate the situation, this paper constructs a more complete supply chain financial evaluation system for SMEs from the perspectives of economy, society, environment, and industry. By taking these factors into account, the new model would provide a more scientific and less subjective footing to enable financial institutions to reach better investment decisions. This is beneficial to SMEs in the long run also. With a clearer and quantifiable assessment system, they could take actual practical steps to adjust their enterprises and meet the new environmental criteria that had been set forth by the financial institutions. In such way, these enterprises could get the loans they badly needed to avoid credit crunches. At the same time, social and economic growth can be achieved on a sustainable basis. From a macro perspective, such comprehensive assessment method would also help government agencies to regulate and allocate appropriate credits to SMEs more efficiently in the future.

Through the above case analysis, the following can be seen:

(1) In the context of smart finance, taking into account the economic conditions, social benefits, industry characteristics, and other indicators related to the measurement of supply chain financial risk, this paper establishes a relatively comprehensive index system for the evaluation of supply chain financial risk, which provides a reliable reference for the objective completion of multiobjective measurement.

(2) The improved PROMETHEE method proposed in this paper not only solves the calculation problem of hesitant fuzzy linguistic dispersion but also proposes a more scientific approach to determine strict preference threshold value. As the values are based on the hesitant linguistic fuzzy number characteristics of each scheme under different attributes, this avoids the influence of subjective experience. In addition, the improved PROMETHEE method is not affected by missing index data. This new model can deal with multiattribute decision-making problem in uncertain and fuzzy environment successfully.

Even though by expanding the evaluation content of financial institutions' credit financial risks for SMEs this paper has enriched the theory of supply chain financial risk assessment, there are still many limitations:

(1) When applying the evaluation method, the weight selection of each evaluation index would still contain a certain degree of subjectivity. Further research on how to eliminate the problem with subjectivity (particularly on consensus bias) is needed.

(2) In the background of smart finance, financial risks are very complex. Different regional financial institutions may have different financial preferences on their evaluation subjects. This means that deviations in the performance of the indicators from one financial institution to the next are unavoidable. Further research on how to expand the system into dealing with regional specificities is also required.

Data Availability

The data used to support the findings of this study were supplied by a decision-making group that includes experts to evaluate the risk indicators of small- and medium-sized enterprises. These risk indicators of different enterprises are from experts' subjective evaluations. Data are available from Yunlong Xiao (xiaoyunlongg@163.com) for researchers who meet the criteria for access to confidential data.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

The study was designed by Keyu Wang. The data were collected by Yunlong Xiao. The results were analyzed by Yangjingjing Zhang. The policies related to the research were reviewed by Yangjingjing Zhang and Yunlong Xiao. This paper was edited by Fuhai Yan and Lexi Gu.

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