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Loan risk identification and prevention of supply chain finance

Song He and Huang Yuan-sheng

North China Electric Power University, China

ABSTRACT

In the supply chain finance service, banks face in various types of small and medium-sized enterprises in supply chain. In order to evaluating supply chain finance risks reasonable, we should consider about not only the enterprise internal risks, but also the risks of enterprise external and the impact of supply chain. This paper according to the differences of small and medium enterprises, combined with the characteristics of supply chain, constructs the loan risk identification and evaluation system of supply chain finance. We use Entropy weight method to calculate the weight of evaluation vectors, and Fuzzy comprehensive evaluation method is used to determine the membership function. Through the example of verification, the system gets a good result.

Key words: Supply chain finance; Fuzzy comprehensive evaluation; Analytic hierarchy process; Entropy weight method

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INTRODUCTION

It is a common mode of development that the small and medium-sized enterprises cluster around a product processing chain to provide related spare parts processing services. The developments of this kind of small and medium enterprises usually with relate products and have rapid growth. But because of small scale of enterprises, the business always depends on upstream and downstream manufacturers, which resulting in a weak trend in supply chain. The weak trend position often causes the accounts receivable cycle is long, the accounts payable period is short, which seriously affects the normal flow of funds of the enterprises. On the other hand, small and medium-sized enterprises always have low credit level, and it is difficult for them to raise funds through bank loans [1-2].To solve the problem, Shenzhen Development Bank Limited Company (now PingAn Bank acquisitions) as the representative of a number of financial enterprise especially for the small and medium-sized enterprises set up a special loan channel, namely, supply chain finance service.

Regarding the financial enterprises, supply chain finance service must resolve how to combine the characteristic of supply chain, accurate, effective evaluation of the service object of loan risk. Because the supply finance service in China of the time is not long, the research data is limited. Zhaobing etc. have established a risk evaluation system of financial enterprises in the supply chain. The index system has considered the logistics enterprises' credit risks, but has not considered the lower risk guarantee enterprise [3]. In 2009, Majia, Xiongxiong etc. tried to through regression statistical methods to evaluate the small and medium-sized enterprise loan risk, but the chosen index did not fully take into account the system risk in supply chain, which limited the extension range [4]. In 2011 Liyixue Etc. attempted to evaluate the risk of supply chain financial loan through AHP method, but in this paper, there is no new content in supply chain loan risk index analysis [5].

Based on the above analysis, combine the characteristics of the supply chain operation, and in view of the differences of various small and medium-sized enterprises, the construction of supply chain finance loan risk identification and prevention will be more scientific, more consummate, which will protect the carry out of supply chain finance and is of great significance to promote the development of small and medium-sized enterprises. This

paper based on the analysis of supply chain, identification of small and medium enterprises property, as well as the risk factors business contained. At the same time, we have attention to the enterprise credit risk of downstream guarantee. In view of the various kinds of small and medium-sized enterprises, the reality is we cannot objective analysis loan risks only by objective methods. To solve this problem, we determine the index weight by using entropy weight method, a combination of many factors in evaluation index system has considerable uncertainty, the application of fuzzy comprehensive evaluation model for enterprise loan risk identification and evaluation makes the evaluation result more accurate and objective. Through the example, it turns out that the index system is scientific and reasonable, the evaluation method is effective [6-9].

Establishment of risk identification and evaluation system of financing companies

The source of risk in the supply chain enterprises diversified, therefore, banks should consider not only the internal situation, also need to consider the external environment of the enterprise, who is in a certain supply chain, to evaluate the loan risk. The risks can be summarized as following:

(1) Supply chain overall operational risks, which include the macro environment, industry, policy, legal and moral risks.

(2) Real trade background risks, which include the pledge authenticity, the receivable accounts authenticity, and the trade contracts authenticity.

(3) Guarantee enterprise risks, which include credit status, the state of operation, solvency, the level of supply chain management etc.

(4) Enterprise inertial credit risks, which include the quality of enterprise itself and the finance status.

(5) Mortgage risks, which include the pledge of depreciation, liquidity and legitimacy.

(6) Supervision risks of logistic enterprises, which include the credit level of logistic enterprises, the supervision level, industry reputation and service level etc.

(7) Operation risks, mainly refers to the operator risk and the operation process risk.

We can identify the supply chain risks and construct the risk index system after analysis of the above risk sources. In order to subdivide the basic risk indexes, based on the three levels of risk index, the individual factors are divided into four level, which established the risk index system: The 7 second level risk evaluation indexes contain supply chain overall operational risks, real trade background risks, guarantee enterprise risks, enterprise inertial credit risks, mortgage risks, supervision risks of logistic enterprises and operation risks. There are 23 second level risk indexes and 18 third level risk indexes in the index system. The system is in Fig1.

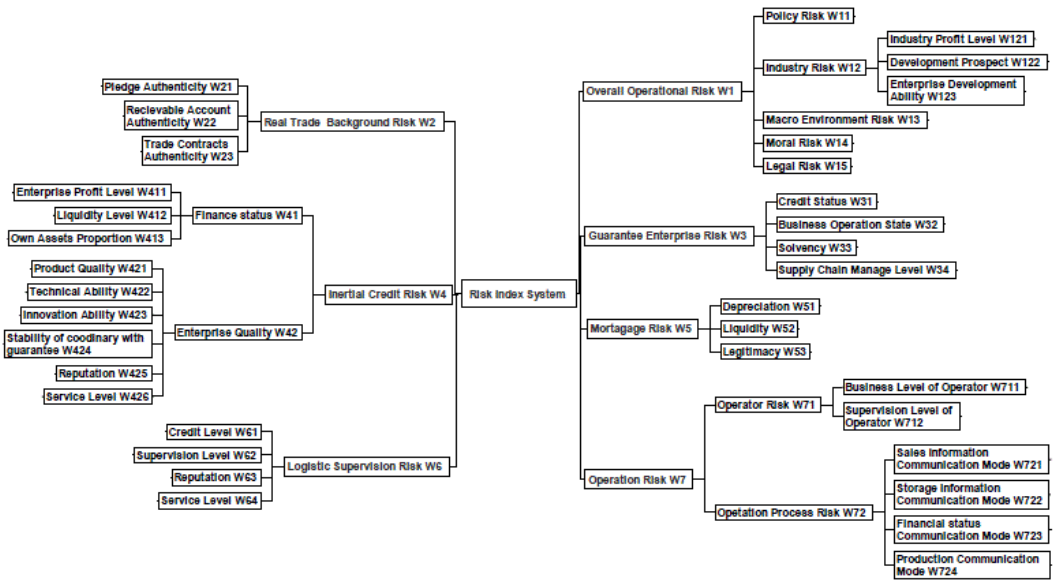

Figure 1: The three level index system of risk identification and evaluation of financing enterprises

Fuzzy analytic hierarchy process based on entropy weight

Basic idea

(1) Determines the index set. Depends on the above three level index system, we constructed first level index set $W=\{w_1,w_2,...,w_m\}$, second level index set $W_m=\{w_{m1},w_{m2},...,w_{mj}\}$, third level index set $W_{mj}=\{w_{mj1},w_{mj2},...,w_{mjl}\}$.

(2) Construct index weight set by using entropy weight method. First level index weight set $\mathrm{A}=\{a_1,a_2,...,a_m\}$, $m=1,2,...,n$, $\sum_{m=1}^{n}a_m=1$. Second level index weight set $\mathrm{A}_m=\{a_{m1},a_{m2},...,a_{mj}\}$, $j=1,2,...,k$, $\sum_{j=1}^{k}a_{mj}=1$. Third level index weight set $\mathrm{A}_{mjl}=\{a_{mj1},a_{mj2},...,a_{mjl}\}$, $l=1,2,...,q$, $\sum_{l=1}^{q}a_{mjl}=1$

(3) Fuzzy operation to target feature matrix W and the index weight vector A. Because the quantifiable and non-quantifiable indicators exist at the same time in the established index system, we select the triangular fuzzy number to construct fuzzy judgment matrix, it can effectively avoid the subjective fuzzy unilateral problem.

(4) Use fuzzy operation to the triangular fuzzy number R and get the final evaluation results.

Construct the model of index entropy weight

(1) Depend on the index system, we invited experts to score for enterprises. We can get mark x and the matrix $X=(x_{ij})_{m\times n}$, where i represents the number of enterprises: $i=1,2,...,n$,j represents the number of indexes: $j=1,2,...,m$.

(2) Dimensionless treatment to indexes. According to the meaning of the different indicators, the indicators are divided into three categories: the bigger the better index, the smaller the better index and the index will be optimal at a certain point. According to the characteristics of different indexes, dimensionless the indexes by suitable formula. Because the scoring of experts is subjective, we in order to eliminate the subjective cause variability, we chose standardized method of dimensionless treatment.

The bigger the better:

$$a_{(x)}=\begin{cases}0 & b\le x<a\\ (x-a)/(b-a) & a\le x<b\\ 1 & b\le x\end{cases} \quad (1)$$

The smaller the better:

$$a_{(x)}=\begin{cases}0 & b\le x\\ (b-x)/(b-a) & a\le x\le b\\ 1 & b\le x<a\end{cases} \quad (2)$$

Optimal at a certain point:

$$a_{(x)}=\begin{cases}(x-a)/(b-a) & a\le x<b\\ (c-x)/(c-b) & b\le x<c\\ 0 & other\end{cases} \quad (3)$$

Dimensionless treatment of the indexes: $a'_{ij}=(x_{ij}-\bar{x}_j)/\sigma_j$

$\bar{x}_j$ is the mean value of index j, σ_j is the standard deviation of index j.

(3) Calculate the weight of indexes.
H_{ij} is the scoring of enterprise i under index j.

$$H_{ij} = a_{ij} / \sum_{i=1}^{n} a_{ij} \tag{4}$$

e_j is the entropy of index j.

$$e_j = -k \sum_{i=1}^{n} h_{ij} \ln h_{ij}, k = 1/\ln n \tag{5}$$

a_j is the weight value of index j.

$$a_j = (1-e_j) / \sum_{j=1}^{m} (1-e_j) \tag{6}$$

Construct the evaluation model of triangle fuzzy number
Depend on the index system, experts score for enterprises. We use triangle fuzzy number to represent the evaluation scorings. We can get the weight value by entropy method, and use triangle fuzzy number to express. Then, fuzzy mathematics algorithms are used to calculate the value of comprehensive evaluation value, which is also expressed in triangle fuzzy number form. At last, dimensionless treatment is used to get the final evaluation results.
Triangle fuzzy number$\tilde{\alpha}$ is defined by its membership function $\beta_\alpha \to [0,1]$:

$$U_{\tilde{\alpha}(x)} = \begin{cases} (x-a)/(b-a) & a \le x < b \\ (x-c)/(b-c) & b \le x < c \\ 0 & other \end{cases} \tag{7}$$

a is the lower bound of triangle fuzzy number $\tilde{\alpha}$, b is the medium value of triangle fuzzy number $\tilde{\alpha}$, c is the upper bound of triangle fuzzy number $\tilde{\alpha}$. We can express αas (a, b, c).

Addition of fuzzy number "⊕":

$$\tilde{\alpha}_1 \oplus \tilde{\alpha}_2 = (a_1, b_1, c_1) \oplus (a_2, b_2, c_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2)$$

Multiplication of fuzzy number "⊗":

$$\tilde{\alpha}_1 \otimes \tilde{\alpha}_2 = (a_1, b_1, c_1) \otimes (a_2, b_2, c_2) = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2)$$

(1) Establish the target feature matrix of evaluation index W, which relates to the evaluation object:

$$W = \begin{pmatrix} \tilde{\alpha}_{11}\ \tilde{\alpha}_{12} \cdots \tilde{\alpha}_{1n} \\ \tilde{\alpha}_{21}\ \tilde{\alpha}_{22} \cdots \tilde{\alpha}_{2n} \\ \vdots \\ \tilde{\alpha}_{m1}\ \tilde{\alpha}_{m2} \cdots \tilde{\alpha}_{mn} \end{pmatrix} \tag{8}$$

(2) Calculate the target feature matrix W and the index weight vector A by fuzzy algorithm:

$$R = W \otimes A^T$$

$$\begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_m \end{bmatrix} = \begin{bmatrix} \tilde{\alpha}_{11} \otimes \tilde{a}_1 \oplus \tilde{\alpha}_{12} \otimes \tilde{a}_2 \cdots \tilde{\alpha}_{1n} \otimes \tilde{a}_n \\ \tilde{\alpha}_{21} \otimes \tilde{a}_1 \oplus \tilde{\alpha}_{22} \otimes \tilde{a}_2 \cdots \tilde{\alpha}_{2n} \otimes \tilde{a}_n \\ \vdots \\ \tilde{\alpha}_{m1} \otimes \tilde{a}_1 \oplus \tilde{\alpha}_{m2} \otimes \tilde{a}_2 \cdots \tilde{\alpha}_{mn} \otimes \tilde{a}_n \end{bmatrix} \tag{9}$$

(3) Dimensionless triangle fuzzy number R. Turns triangle fuzzy number $\tilde{a} = (a, b, c)$ to trapezoidal fuzzy number $\tilde{a} = (a, b, b, c)$. After dimensionless

$$v=\frac{a+b+c+d}{4} \quad (10)$$

Solving examples

We invited 20 experts to score depending on the status of the enterprises. The questionnaire is designed as Likert scale format, the measurement method is Likert scale. The measurement level is divided into 3 grades: excellent, good, bad by using semantic scale. For calculation, we quantify the subjective evaluation semantics scale and assign the semantics as 8,4,2. The quantitative evaluation of standard we designed is shown in Table 1.

Table.1: quantitative evaluation of standard

semantics	level	value
excellent	E1	$x_i>0.7$
good	E2	$0.5<x_i\leq0.7$
bad	E3	$x_i\leq0.5$

By comparing their characteristics, we dimensionless the indexes using the standardized method of triangular fuzzy numbers and then we get the entropy of the indexes. The weight of second level and third level indexes is in Table 2.

Table.2: the entropy weight of second level and third level indexes

W	A_m	W_{mj}	A_{mj}	W	A_m	W_{mj}	A_{mj}
W_1	0.1522	W_{11}	0.04	W_4	0.1304	W_{41}	0.05
		W_{12}	0.05			W_{42}	0.05
		W_{13}	0.04	W_5	0.1522	W_{51}	0.04
		W_{14}	0.04			W_{52}	0.04
		W_{15}	0.04			W_{53}	0.04
W_2	0.1304	W_{21}	0.04	W_6	0.1522	W_{61}	0.04
		W_{22}	0.04			W_{62}	0.05
		W_{23}	0.04			W_{63}	0.04
W_3	0.1522	W_{31}	0.05			W_{64}	0.04
		W_{32}	0.05	W_7	0.1304	W_{71}	0.04
		W_{33}	0.05			W_{72}	0.04
		W_{34}	0.05				

When we get the index weight, we can determine the third level index degree of membership depending on comments.

$$\begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_m \end{bmatrix} = \begin{bmatrix} \tilde{\alpha}_{11} \otimes \tilde{a}_1 \oplus \tilde{\alpha}_{12} \otimes \tilde{a}_2 \cdots \tilde{\alpha}_{1n} \otimes \tilde{a}_n \\ \tilde{\alpha}_{21} \otimes \tilde{a}_1 \oplus \tilde{\alpha}_{22} \otimes \tilde{a}_2 \cdots \tilde{\alpha}_{2n} \otimes \tilde{a}_n \\ \vdots \\ \tilde{\alpha}_{m1} \otimes \tilde{a}_1 \oplus \tilde{\alpha}_{m2} \otimes \tilde{a}_2 \cdots \tilde{\alpha}_{mn} \otimes \tilde{a}_n \end{bmatrix}$$

Through the above formula, we calculated the three level evaluation vector indicators. After normalization:

Second level evaluation vector indicators: R= (0.37, 0.29, 0.34)

Third level evaluation vector indicators: R= (0.38, 0.30, 0.32)

Table.3: evaluation results of second and third level index

W	R_m	W_{mj}	R_{mj}	W	R_m	W_{mj}	R_{mj}
W_1	0.68	W_{11}	0.18	W_4	0.65	W_{41}	0.23
		W_{12}	0.20			W_{42}	0.24
		W_{13}	0.19	W_5	0.76	W_{51}	0.22
		W_{14}	0.17			W_{52}	0.23
		W_{15}	0.17			W_{53}	0.18
W_2	0.62	W_{21}	0.18	W_6	0.80	W_{61}	0.22
		W_{22}	0.21			W_{62}	0.25
		W_{23}	0.20			W_{63}	0.21
W_3	0.77	W_{31}	0.21			W_{64}	0.22
		W_{32}	0.23	W_7	0.56	W_{71}	0.18
		W_{33}	0.24			W_{72}	0.18
		W_{34}	0.24				

The enterprise evaluation result:$W = \sum_{m=1}^{7} A_m R_m = 0.6967$

The final conclusion is as follows: According to a set of comment level, we know the risk level of W1, W2, W4, W7 are good, the risk level of W3,W5,W6 are excellent. The total risk level of the enterprise is good.

Depend on the loan risk identification and evaluation system, by using fuzzy analytic hierarchy process method, we can soon give credit rating to the enterprises in the case. We concluded that the sources of the risks are:

(1) Operation risks. Because the supply chain financial services regulation involves the supply chain upstream and downstream firms and third party logistics enterprises, therefore in the sharing of information and staff put forward higher requirements.

(2) Real trade background risks. It is one of the risks that the upstream and downstream manufactures of forged trade information, thereby defrauding loans.

(3) Enterprise inertial credit risks. How to effectively monitor the small and medium-sized enterprises is another risk in supply chain finance.

(4) Supply chain overall operational risks. Whether the macro environment and industry environment will be a big upheaval to effect financing enterprises normal payment of a loan risk is one more significant risk index.

Based on the above conclusions, we get the financing enterprise risk identification and evaluation system and the actual business process is basically consistent with the bank. The calculate results accord with the actual situation, in the process of financing business this paper can provide reference for risk evaluation of financial enterprises.

CONCLUSION

Loan risk of supply chain financial service not only comes from the enterprise itself, more attention should be paid to the systematic risk of the entire supply chain. This paper analyzed the enterprise inertial risk, upstream and downstream enterprise risk and the risk of supply chain. We established a risk evaluation index system, which is comprehensive, reasonable, covering the guarantee enterprises and logistics enterprises. By combining the application of entropy method and Fuzzy AHP, we can avoid the subjective empowerment is not objective because of many indicators we need to consider. At last we use verified that the evaluation system is effective and reasonable by an example.

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