Research on the Credit Risk Management of Small and Medium-Sized Enterprises Based on Supply Chain Finance

Xingang Weng[1], Xiaohua Lv[1], Yujiao Wu[2], Xiaorong Li[2]

[1]Logistics Institute, Beijing Wuzi University, Beijing, China

[2]Department of Graduate, Beijing Wuzi University, Beijing, China

Email address:

wengxingang@263.net (Xingang Weng), 771971104@qq.com (Xiaohua Lv), 547306488@qq.com (Yujiao Wu),
lixiaorong426@icloud.com (Xiaorong Li)

To cite this article:

Xingang Weng, Xiaohua Lv, Yujiao Wu, Xiaorong Li. Research on the Credit Risk Management of Small and Medium-Sized Enterprises Based on Supply Chain Finance. *Journal of Finance and Accounting*. Vol. 4, No. 5, 2016, pp. 245-253. doi: 10.11648/j.jfa.20160405.11

Abstract: Small and medium-sized enterprises have made great contribution to the prosperity of market economy and the stability of social order in China, but they often suffer from the financing difficulties. Supply chain finance model is a new angle of view to solve the financing difficulties of small and medium-sized enterprises. Firstly, this paper defines the related theory of supply chain finance. Secondly, it analyzes the three main financing models of supply chain finance: the financing model of prepayment, the financing model of inventory pledge and the accounts receivable financing model. Thirdly, it combines the expert evaluation method and the fuzzy comprehensive evaluation method to establish the comprehensive evaluation model of financing credit risk of small and medium-sized enterprise. Finally, it provides some suggestions in the financial institutions aspect to prompt the financing development of small and medium-sized enterprises. The contents of this study have certain innovative and practical significance, it may benefit to solve the financing problems of small and medium-sized enterprises in China.

Keywords: Supply Chain Finance, Small and Medium-sized Enterprises, Credit Risk Management, Risk Rating, Fuzzy Comprehensive Evaluation Method

1. Introduction

In the recent years, the supply chain finance develops in high speed and created a lot of achievement in China. Banks, enterprises and related institutions are committed to the financing of small and medium-enterprises based on supply chain finance. For instance, China National Materials Storage and Transportation Corporation, CMST for short, had been extended its business to more than 27 provinces in 2010. Bank of Ping'an launched the supply chain finance 3: Orange electronic network platform in 2014, which is an industrial chain financial ecosystem including four flows. The People's Bank of China issued the *Some Opinions on Financial Support for Increasing Efficiency of Industrial Steady Growth and Adjusting Structure* in February 24th, 2016. It clearly pointed out that "promote more supply chain to join into the financing service platform of receivable accounts through financial reform to ease the financing difficulties of small and medium-sized enterprises" [1]. However, there are many questions of financial risk. For example, Shanghai steel trade events, Qingdao port financed huge loan by cheating events, the capital black hole events of Huainan Mining Logistics Corporation Limited. The development of supply chain finance is facing a great number of challenges, strengthening the management of financial risk will have great significance for the sustainable, stability and healthy development of the small and medium-sized enterprises.

2. Related Concepts of Supply Chain Finance

2.1. Concept of Supply Chain

Supply chain is a complete functional network structure which starting from the procurement of raw materials, the production of intermediate products and final products, and

finally sell by the sales network to the consumers. The supply chain takes the core enterprise as the leading, its members include suppliers, manufacturers, distributors, retailers, consumers and so on [2]. The basic model of supply chain is shown as the figure 1.
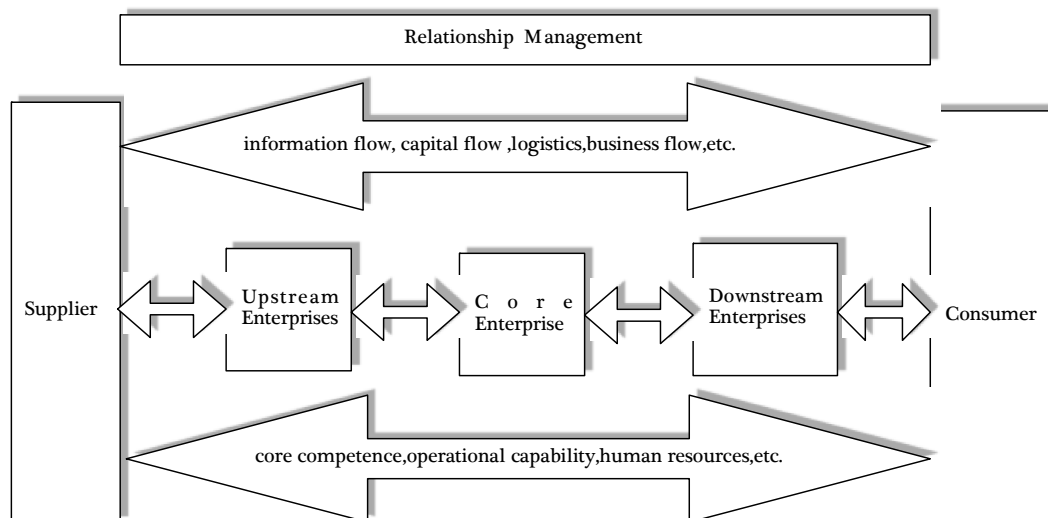

Figure 1. *The basic model of supply chain.*

2.2. Concept of Supply Chain Finance

Supply chain finance refers to a kind of integrated financial services. It is on the base of analyzing the internal transaction rules of supply chain, the use of the credit model of self-liquidating trade finance, and the introduction of the new risk control variables such as core enterprise, logistics supervision company, capital flow guide tools and so on, to provide credit support and other enclosed settlements for the different nodes of the supply chain. That is to say, supply chain finance is a kind of integrated financial services which link up the core enterprise, upstream enterprises and downstream enterprises, to provide them flexible financial products and services [3]. The basic model of supply chain finance is shown as the figure 2.
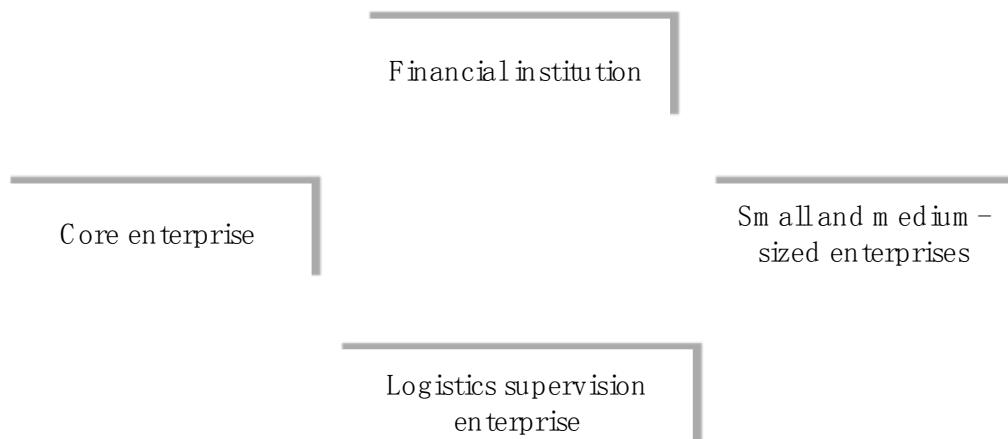

Figure 2. *The basic model of supply chain finance.*

2.3. The Difference Between the Traditional Financing Model and Supply Chain Financing Model

In the financing model of Small and medium-sized enterprises, the traditional financing model thinks the upstream enterprises and downstream enterprises are separate, the financial institutes would separately provide the credit granting and loan administration to them. The relationship between the financial institutes and the other members of the supply chain under the traditional financing model is shown as the figure 3. In the supply chain financing model, the core enterprise plays the role of leading, the design project of enterprise financing comprehensively considerate the factors of supply chain's operation scale, credit situation, product turnover, capital source and so on [4]. The business of supply chain finance not only breaks out the traditional credit requirements of commercial banks, but also increases the financing chance for the small and medium-sized enterprises. The relationship between the financial institutes and the other members of the supply chain under the model of supply chain finance is shown as the figure 4.
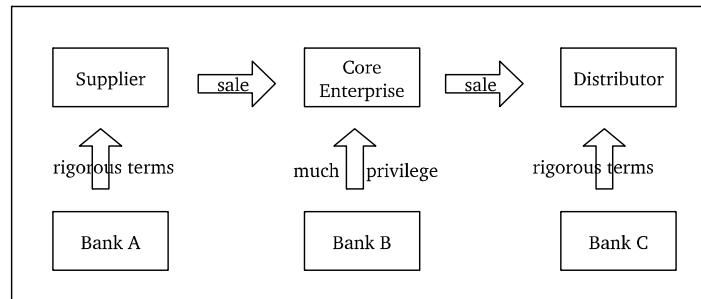
Figure 3. The relationship between financial institutes and the other members of the supply chain under the traditional financing model.
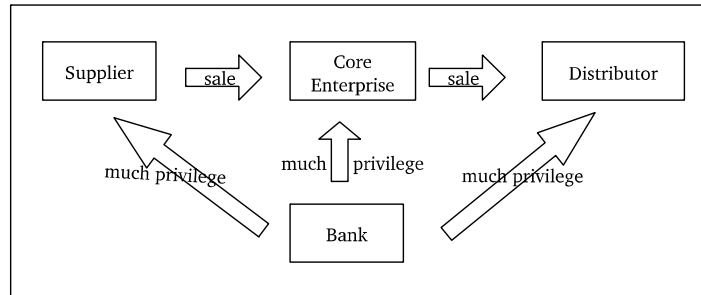

Figure 4. The relationship between the financial institutes and the other members of the supply chain under the mode of Supply chain finance.

3. Financing Model of Small and Medium-Sized Enterprises from the Perspective of Supply Chain Finance

Because of all the enterprises transactions in China are implemented accrual basis, that is to say, the sales and revenue confirmation do not necessarily occur in the same period, capital expenditure and revenue confirmation also occurred at different times, sometimes there will be a negative cash flow, to make ends meet to form a gap. Generally speaking, in the supply chain, the cash flow gap often appears in three stages: procurement stage, operation stage and sales stage. From the perspective of the entire supply chain, the banks usually provide the financing model of prepayment, the financing model of inventory pledge and accounts receivable financing mode accordingly.

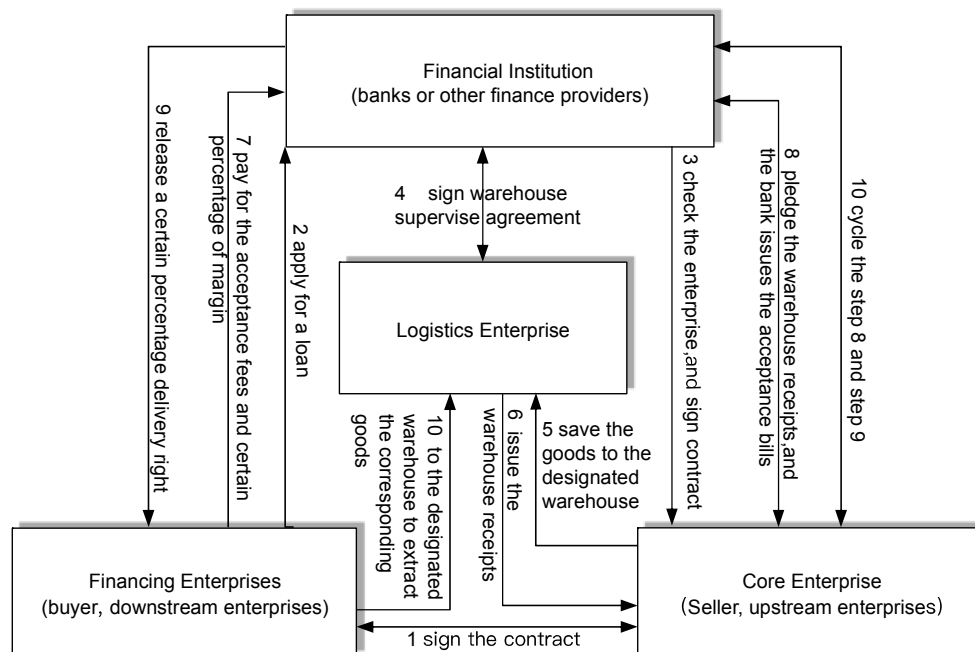## 3.1. The Financing Model of Prepayment

Figure 5. The flow diagram of the financing model of prepayment.

The model of financing enterprise uses the prepayment that was generated in the process of transaction to apply for financing business to banks and other financial institutions is called the financing model of prepayment. Some manufacturing enterprises need to pay the money to upstream enterprises before they obtain the necessary raw materials, semi-finished products and so on. The financing model of prepayment is a short-term credit provided by the banks, which is guaranteed by the advance payment of the enterprise [5].

The participators of the financing model of prepayment include four parties: supplier, financing enterprise, bank and logistics enterprise. In process of dealing the financing business, the supplier needs to make a promise that the financing enterprise will use the prepayment to buy the raw materials which as collateral for bank loans. The bank should supervise and control the financing business of the warehouse receipt pledge. In this business, the logistics enterprise will provide guarantee acceptance. The flow diagram of the financing model of prepayment is shown as the figure 5.

3.2. The Financing Model of Inventory Pledge

The financing model of inventory pledge is an innovative financing service. Through the close cooperation between the third party logistics enterprises and commercial banks, it can provide financial comprehensive product and logistics services for the financing enterprises. Inventory pledge specifically refers to the financing of enterprise, the third party logistics enterprises and commercial banks sign a tripartite agreement which base on the financing business, verify the responsibilities and obligations of the numbers [6]. The financing enterprises apply to banks for capital by mortgaging the raw materials, inventory and other production goods. When the maturity of the loan, the financing enterprise if not timely repays the capital and its interest, banks have the right to auction the collateral, the proceeds from the auction belong to the bank.

The financing model of inventory pledge not only provides a high level of logistics services for enterprises, but also solves the financing problem for small and medium-sized enterprises, it can solve the cash flow in the operation of the capital gap. The flow diagram of the financing mode of inventory pledge is shown as the figure 6.
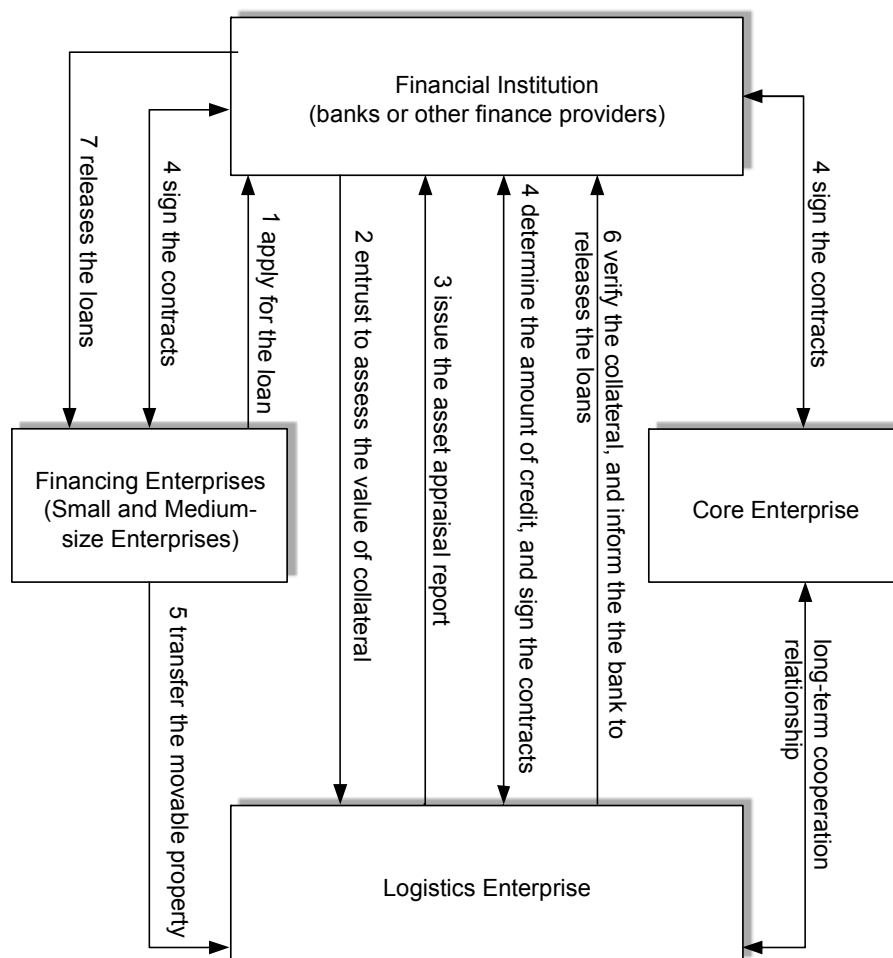

Figure 6. The flow diagram of the financing model of inventory pledge.

3.3. The Accounts Receivable Financing Model

The model of the enterprise uses the receivable which is formed in the process of commodity trading to apply for capital to the banks is called the accounts receivable financing model [7]. Accounts receivable financing includes receivable pledge financing and accounts receivable factoring.

The accounts receivable financing model specially refers to enterprises use finance the company's accounts receivable as collateral to sign a contract with banks, and obtain short-term loans to banks and other financial institutes. In the accounts receivable financing model, the risk becomes shared by the core enterprise and the other enterprises of supply chains together. In the supporting of the supply chain finance, the financing environment of small and medium-size enterprises will be largely improved. The flow diagram of the accounts receivable financing model is shown as the figure 7.
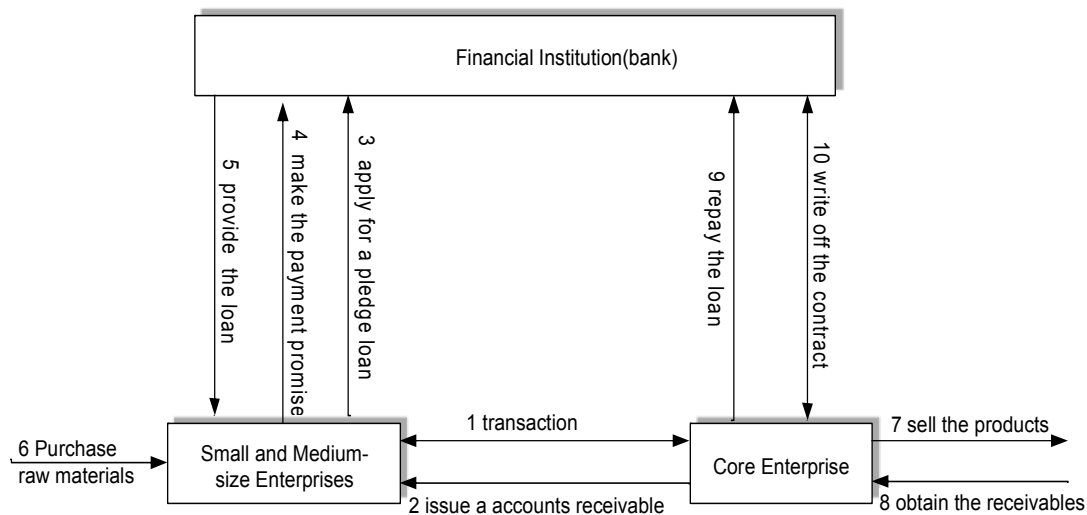

Figure 7. The flow diagram of accounts receivable financing model.

4. Measure the Small and Medium-Sized Enterprises Credit Risk Based on the Supply Chain Finance

4.1. Thoughts on the Model of Credit Risk Measurement

Basing on the characteristics of supply chain finance, the credit risk evaluation index system is constructed at first, and the fuzzy comprehensive evaluation method is used to estimate the financing credit rank of the small and medium-sized enterprises.

The basic ideas of fuzzy comprehensive evaluation method includes the following points: (1) To determine the evaluation factors, the criteria of the evaluation and the evaluation weights; (2) To determine the vector of membership degree of the single factor evaluation and form the membership degree matrix; (3) According to a certain algorithm, the comprehensive evaluation vector is calculated; (4) According to the rating criteria, the credit rating of small and medium-sized enterprises is evaluated.

4.2. To Establish the Credit Risk Index System

Evaluation index of traditional credit risk hasn't taken the credit risk of small and medium-sized enterprises into the supply chain, and hasn't taken the important influence of core enterprise into consideration either. In order to better evaluate the credit status of small and medium-sized enterprises in the supply chain, this paper redesigns the credit risk assessment index system of small and medium-sized enterprises, the main content as follows:

i. Self-quality and credit standing of financing enterprises. The higher quality of the enterprises, the more likely to repay the loan on time, and more likely to perform the contract, such as strictly following the terms to product the productions and provide the service. Good self-quality and credit standing of financing enterprises become smaller risk to banks.

ii. Self-quality and credit standing of core enterprise. The core enterprise usually keeps close relation with the banks, the banks can update its credit record in time. If the core enterprise has good credit status, means the profitability and solvency are in line with the requirements of the banks, when occur the event of breach of the small and medium-sized enterprises, core enterprise would fulfill the guarantee obligation basing on the contracts. Guarantee of core enterprise can effectively reduce the risk of the banks in some degree.

iii. Self-quality and credit standing of the third party logistics enterprise. In reality, the logistics enterprise can grasp the information of goods circulation and financing enterprises, therefore, good quality and credit standing of the third party logistics enterprise has some advantage in risk control.

iv. The quality of financing project. Basing on the particularity of the supply chain finance, the financing project will directly determine whether the small and

medium-sized enterprises can join into the supply chain. Therefore, the banks should pay more attention to researching the financing project before providing the capital supporting to the small and medium-sized enterprises.

v. The relationship of members in supply chain finance. The closer relationship between small and medium-sized enterprises and the core enterprise, the more willingness and ability to repay the loan.

According to the analysis of the existing literature (Qiao Wei, 2008; Wang Zhen, 2009; Xia Liming, Zong Hengheng, Meng Li, 2011; Wang Ran, 2013; etc.) [8-11] and the original indicators of small and medium-sized enterprises credit evolution that obtained from the banks' business practice. The credit risk index system is shown in the following table 1.

Table 1. The credit risk index system.

No.	Index Classification	Concrete Index
1	Self-quality and credit standing of financing enterprise	enterprise scale, financial status, credit records, market growth rate, sales revenue growth rate, loan repayment rate, profit growth rate, net assets, management quality, staff quality, new product development ability, total assets turnover, cost, net profit, assets and liabilities rate, etc.
2	Self-quality and credit standing of core enterprise	industry status, enterprise scale, credit records, capital sufficiency rate, market growth, sales income, loan repayment rate, finances, loan performance, new product development ability, the total asset turnover, return on equity, etc.
3	Self-quality and credit standing of the third party logistics enterprise	monitoring technology, enterprise scale, net assets, return on equity, sales profit margin, asset liability ratio, speed ratio, current ratio, credit records, performance status, external guarantee and assets mortgage pledge, etc.
4	The quality of financing project	information symmetry degree, product life cycle, cost, products liquidity, profitability of products, order quantity, accounts receivable turnover rate, inventory turnover rate, assets turnover rate, cash flow rate, the rate of products can be replaced, order completion rate, customer satisfaction, credit cycle, etc.
5	The relationship of members in supply chain finance	total profit ratio, the degree of information sharing, the relationship strength of core enterprise and other enterprises, the association degree of the interests counterparts, supply chain transactions default rate, transaction period and frequency, economic growth rate, partners comprehensive capacity, etc.

4.3. Implementation Steps of Fuzzy Comprehensive Evaluation Method

According to above analysis, this paper selects a small manufacturing enterprise R as an example to analyze.

4.3.1. To Determine the Evaluation Factors, the Criteria of the Evaluation and the Evaluation Weights

The credit risk index system of the small manufacturing enterprise R includes two grades, the first grade includes five index classification (see Table 1); the second grade includes seven concrete index, details is shown as follows.

Table 2. The rating criteria of financial institutions.

Number	Grade	Score Section
1	Excellent	85-100
2	Good	70-85
3	Middle	60-70
4	Pass	50-60
5	Poor	Lower than 40

i. Rating criteria of financial institutions

Rating criteria is not the unique, financial institutions can

evaluate the financing enterprises based on the historical data. The Credit Risk of small and medium-sized enterprises have five grades: excellent, good, middle, pass and poor. The rating criteria of financial institutions is shown in table 2.

ii. Score of each index

In order to effectively carry out the research on the credit risk of the small manufacturing enterprise R basing on the supply chain finance. Firstly, this research used the expert evaluation method to score every index, send 15 questionnaires to three categories of experts. The first category is the theory research experts of supply chain finance, send 5 questionnaires, took back 4 questionnaires, the recovery rate is 80%, the effective rate is 100%. The second category is the bank administrators whose work experience more than 3 years, send 5 questionnaires, took back 3 questionnaires, the recovery rate is 60%, the effective rate is 100%. The third category is the financial personnel whose work experience more than 3 years, send 5 questionnaires, took back 3 questionnaires, the recovery rate is 60%, the effective rate is 100%. Summary of the relevant experts to judge the scoring, details as shown in the following tables (table 3 to table 8).

Table 3. The first grade index and weight.

No.	Index	Weight
1	Self-quality and credit standing of financing enterprises	0.3
2	Self-quality and credit standing of core enterprise	0.3
3	Self-quality and credit standing of the third party logistics enterprise	0.1
4	The quality of financing project	0.15
5	The relationship of members in supply chain finance	0.15

Table 4. *The second grade index and score of core enterprise.*

Index	Weight	Excellent (NNT)	Good (NNT)	Middle (NNT)	Pass (NNT)	Poor (NNT)
Enterprise scale	0.1	7	1	0	2	0
Financial status	0.15	6	2	2	0	0
Credit records	0.15	6	1	3	0	0
management quality	0.15	7	1	1	1	0
Market occupancy	0.15	6	2	2	0	0
Total asset turnover	0.15	7	1	2	0	0
guarantee and assets mortgage pledge	0.15	8	2	0	0	0

Table 5. *The second grade index and score of self-quality and credit standing R.*

Index	Weight	Excellent (NNT)	Good (NNT)	Middle (NNT)	Pass (NNT)	Poor (NNT)
Enterprise scale	0.1	0	2	4	2	2
Credit records	0.15	0	3	4	2	1
Loan repayment rate	0.15	0	2	1	3	4
Market growth rate	0.15	0	2	3	2	3
Uncommitted assets	0.15	0	3	4	1	2
New product development ability	0.15	0	2	8	0	0
Assets and liabilities rate	0.15	0	2	2	6	0

Table 6. *The second grade index and score of the third party logistics enterprise.*

Index	Weight	Excellent (NNT)	Good (NNT)	Middle (NNT)	Pass (NNT)	Poor (NNT)
Enterprise scale	0.1	7	1	0	2	0
Monitoring technology	0.15	6	1	3	0	0
Credit records	0.15	7	1	1	1	0
Total assets turnover	0.15	6	2	2	0	0
Management quality	0.15	7	1	2	0	0
Net assets	0.15	8	2	0	0	0
Guarantee and assets mortgage pledge	0.15	6	2	2	0	0

Table 7. *The second grade index and score of the quality of the financing project.*

Index	Weight	Excellent (NNT)	Good (NNT)	Middle (NNT)	Pass (NNT)	Poor (NNT)
Expected market profit	0.2	2	3	3	2	0
Total cost	0.2	1	2	4	3	0
Information symmetry degree	0.2	1	2	5	2	0
Products life cycle	0.1	3	3	2	1	1
Inventory turnover rate	0.1	1	4	3	1	1
The rate of products can be replaced	0.1	2	3	3	1	1
Cash flow rate	0.1	4	2	1	2	1

Table 8. *The second grade index and score of the relationship of members.*

Index	Weight	Excellent (NNT)	Good (NNT)	Middle (NNT)	Pass (NNT)	Poor (NNT)
Transaction period and frequency	0.1	2	2	4	2	0
Supply chain transactions default rate	0.1	2	3	3	1	1
The total profit ratio supply chain finance	0.15	0	2	5	3	0
The association degree of the interests counterpart	0.15	1	2	5	2	0
Partners comprehensive capacity	0.1	6	2	2	0	0
The degree of information sharing	0.25	2	5	3	0	0
Economic growth rate	0.15	3	2	5	0	0

4.3.2. To Determine the Factor Set F and the Evaluation Set E

Factor set F is a collection of evaluation items or indicator, typically $F = \{f_i\}, i = 1, 2, \ldots, n$. For instance, in this research, $F = \{f_1, f_2, f_3, f_4, f_5, f_6, f_7\}$.

Evaluation sets E is a collection of evaluation grades, typically $E = \{e_j\}, j = 1, 2, \ldots, m$. For instance, in this research, $E = \{e_1, e_2, e_3, e_4, e_5\} = \{\text{excellent, good, meddle, pass, poor}\}$.

4.3.3. To Determine the Vector of Membership Degree of the Single Factor Evaluation, and Form the Membership Degree Matrix

Membership degree r_{ij} refers to multiple evaluation subjects regard the degree of possibility of a certain evaluation object f_i works in the aspect of e_j. It is one of the most important concept in the fuzzy comprehensive method.

The vector of membership degree is $R_i = (r_{i1}, r_{i2}, \ldots, r_{im}), i = 1, 2, \ldots, n, \sum_{j=1}^{m} r_{ij} = 1$. The membership degree matrix is $R = (R_1, R_2, \ldots, R_n)^T = (r_{ij})$.

For instance, in this research, the membership degree matrix of the core enterprise is

$$R = \begin{pmatrix} 0.7 & 0.1 & 0 & 0.2 & 0 \\ 0.6 & 0.2 & 0.2 & 0 & 0 \\ 0.6 & 0.1 & 0.3 & 0 & 0 \\ 0.7 & 0.1 & 0.1 & 0.1 & 0 \\ 0.6 & 0.2 & 0.2 & 0 & 0 \\ 0.7 & 0.1 & 0.2 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \end{pmatrix}$$

4.3.4. To Determine the Weight Vector WF

Weight vector W_F refers to weight or weight coefficient of index. For instance, in this research, the weight vector of core enterprise is $W_F = (0.1, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15)$.

In addition, it is necessary to let the evaluation set to become a result value W'_E. For instance, in this research, the result value of weight vector of core enterprise is $W'_E = (100, 85, 70, 55, X)$, the meaning of X is non-adoption.

4.3.5. According to a Certain Algorithm, the Comprehensive Evaluation Vector Is Calculated

According to a certain algorithm, this step is to calculate the comprehensive evaluation vector S (comprehensive membership degree vector S) an d the comprehensive evaluation value μ (comprehensive score μ)

For instance, in this research, the comprehensive membership degree vector s_1 and comprehensive score u_1 of the core enterprise respectively:

$$s_1 = (0.672, 0.143, 0.143, 0.0429, 0); \quad u_1 = 91.75.$$

4.4. According to the Rating Criteria, the Credit Rating of Small and Medium-Sized Enterprises Is Evaluated

According to above steps (4.3.3, 4.3.3 and 4.3.4), this step can obtain the results respectively.

The comprehensive score u_2 of the Self-quality and credit standing of the small enterprise R is:

$u_2 = 58.10$;

The comprehensive score u_3 of the third party logistics enterprise is:

$\mu_3 = 91.75$;

The comprehensive score u_4 of the quality of financing project is:

$u_4 = 73.65$;

The comprehensive score u_5 of the relationship of members in supply chain is:

$u_5 = 78.30$.

Therefore, the total score of the small enterprise R is:

$u_{Total} = u_1 * 0.3 + u_2 * 0.3 + u_3 * 0.1 + u_4 * 0.15 + u_5 * 0.15 = 91.75*0.3 + 58.10*0.3 + 91.75*0.1 + 73.65*0.15 + 78.30*0.15 = 76.92$

According the total score of 76.92 and referring to the rating criteria of financial institutions, we can know the credit risk of the small enterprise R is Good. The financial institution can provide the corresponding financing plan to the small enterprise R that according to its credit level.

5. Conclusions

According to the characteristics of supply chain finance, this paper analyzed the related concepts and the three main modes of supply chain finance. To better provide financing project to small and medium-sized enterprises, this research tried to establish a credit risk assessment index system in the perspective of supply chain finance. According to the essential characteristics of financing enterprise, core enterprise, logistics enterprise, financing project and the relationship of members in supply chain finance, this paper combined the expert evaluation method and the fuzzy comprehensive evaluation method to calculate the credit risk score of the small and medium-sized enterprise.

At present, the financial institutions still lack of the accumulation of credit risk accuracy data in China. The fuzzy comprehensive evaluation method would be a good method to evaluate the credit risk degree of financing enterprises. In addition, this method can kindly help to solve the financing problems of small and medium-sized enterprises. This paper tries to meet the financing needs of small and medium-sized enterprises, and also tries to provide an evaluation method when financial institutions make financing projects.

References

[1] Information Office of the State Council of the people's Republic of China: http://www.scio.gov.cn/xwfbh/xwbfbh/yg/2/Document/1469592/1469592.htm. 2016.

[2] Donald J. Bowersox, David J. Closs, Supply Chain Logistics Management [M]. Beijing: China Machine Press, 2014.

[3] Xu Juanjuan, Research on the financing mode and its credit risk of small and medium-sized enterprises based on Supply Chain Finance [D]. Wuhan: Wuhan University, 2012.

[4]   Feng Gengzhong, He Juan, Li Yixue, Wang Shouyang. Logistics financial innovation: operation and management [M]. Beijing: Science Press, 2014.

[5]   Zhang Jinqing. Financial risk management [M]. Shanghai: Fudan University Press, 2015.

[6]   Fu Xudong. Financial logistics [M]. Beijing: New world press, 2013.

[7]   Li Na. Analysis of trade financing business opportunities and risk prevention of commercial banks in the supply chain [J]. Guangdong finance research, 2008 (3): 46-49.

[8]   Qiao Wei. SME credit rating model and its application based on a new credit rating index system [D]. Kaifeng: Henan University, 2008.

[9]   Wang Zhen, Research on financing credit evaluation of small and medium sized enterprises in China [D]. Jinan: Shandong University, 2009.

[10]   Xia Liming, Zong Hengheng, Meng Li. The construction of credit risk evaluation index system of small and medium sized enterprises based on supply chain finance. [J], Finance Forum, 2011, 73-79.

[11]   Wang Ran. Research on the financial risk of the financing platform based on the multi-level fuzzy comprehensive evaluation method [D]. Wuhan: Huazhong Agricultural University, 2013.

[12]   Wang Luoying. Systems engineering [M]. Beijing: Machinery Industry Press, 2014.

[13]   Tian Meiyu, He Wenyu. Credit risk assessment of small and medium sized enterprises based on the model of supply chain finance – the automobile industry as an example [J]. Journal of Industrial Technological & Economics. 2016 (6), 154-160.

[14]   Huang Youjun. An analysis of risk of supply chain finance business based on fuzzy comprehensive evaluation method [J]. Securities & Futures of China, 2013 (9).

[15]   Ji Wei. The research of risk evaluation of online supply chain finance- steel trade electricity business platform H company as an example based on fuzzy comprehensive evaluation method [J]. Modern Business Trade Industry, 2015 (9), 61-63.

[16]   Wang Baosen, Yuan Weijie. Risk assessment of supply chain finance. [J]. Logistics Technology. 2012 (17). 343-346.

[17]   Sheng Qiaoling, WU Yantai. Fuzzy comprehensive evaluation of supply chain inventory pledge financing risk based on AHP [J]. Science and Technology Management Research. 2012 (11), 52-57.

[18]   Bai Shaobu. A fuzzy comprehensive the of the credit level of enterprises with supply chain financing [J]. Economic Survey. 2011 (5), 108-112.