Credit Risk Evaluation under Supply Chain Finance Mode

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Abstract: In recent years, the financing mode of supply chain finance has developed rapidly and has become an effective way to solve the financing difficulties of small and medium-sized enterprises. However, at present, a set of effective methods for credit risk evaluation of supply chain finance has not yet been formed. This paper studies the credit risk evaluation under the supply chain finance model, puts forward the credit risk evaluation system considering the main body rating and the debt rating, and establishes the credit risk evaluation model by using the principal component analysis method and Logistic regression method, so as to reduce the limitation that the current evaluation of the supply chain finance business mostly depends on expert evaluation. Regression analysis results show that the operation ability of financing enterprises, financing quality of enterprise and credit status, credit level of core enterprises, overall level of supply chain and asset quality under financing are the key influencing factors of credit risk.

1. Introduction

In recent years, the competition situation in the banking industry has been constantly changing. The traditional income source of commercial banks-interest spread has been shrinking. The competition to expand the loan business of small and medium-sized enterprises is warming up. Banks have accelerated the research and development of financial products [1]. Supply chain finance is to design a series of working capital financing and cash flow solutions based on the value of commercial transactions occurring in the supply chain. The purpose of supply chain finance is: banks inject funds or credit into the supply chain to promote the smooth flow of "supply-production-sales" and stable chain of supply chain core enterprises and their upstream and downstream supporting enterprises [2]. The biggest characteristic of supply chain finance is to provide financial support for the supply chain starting from the big core enterprises in the supply chain. Supply chain finance has changed the highly centralized customer structure of financial institutions to large-scale enterprise customers, opening up the small and medium-sized enterprise market while stabilizing high-end large-scale enterprise customers, and at the same time changing the business form of financial institutions from the past to provide financing credit to individual enterprises [3]. In order to achieve a high degree of agreement between financial capital and real economy, enhance the core competitiveness of the supply chain, and build an industrial ecology of mutually beneficial coexistence, sustainable development and benign interaction between banks, enterprises and the supply chain. Based on the credit risk evaluation of the traditional financing mode, this paper puts forward the credit risk evaluation under the supply chain financial mode, and establishes the credit risk evaluation model by using the principal component analysis method and Logistic regression method, which overcomes the defect that the expert evaluation is too subjective and improves the objectivity of the evaluation.

2. Credit Risk Evaluation of Supply Chain Finance Mode

Compared with the traditional credit granting mode, the supply chain financial financing mode weakens financial analysis and access control, and replaces static analysis of financial statements with dynamic control of logistics and capital flow. The core feature of its credit evaluation is to combine the main body rating and debt rating into one [4]. Mainly affected by macroeconomic

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environment, policy and regulatory environment, industry conditions and other factors, industry risks reveal the extent of the impact of industry factors on business operations. Due to the asymmetric information between trading parties in the credit market, adverse selection and moral hazard problems are flooding the credit market. Therefore, banks are usually more willing to choose to provide credit support for large enterprises when faced with qualified large enterprise customers and small and medium enterprise customers with poor information transparency. Due to the late start of the supply chain financial model in China, the lack of financing business and the lack of relevant data and evaluation criteria, the supply chain financial risk evaluation index system is constructed according to the characteristics of supply chain financial risk. In risk assessment, fundamental changes have taken place in the risk management system by examining not only financial indicators but also the credit standing of counterparties, price stability of commodities involved, control ability of transaction process, past transaction records of enterprises and the operation status of the entire supply chain [5].

Qualification of financing enterprises. The qualification of financing enterprises is similar to the evaluation index of banks in traditional loan business. It mainly inspects the basic financial situation and enterprise management ability of financing enterprises. The imbalance between the strong financing demand of small and medium-sized enterprises and the supply of bank credit leads to the financing bottleneck of small and medium-sized enterprises, which seriously restricts the rapid growth and stable development of small and medium-sized enterprises. This paper uses the basic framework of traditional business credit evaluation for reference, and designs it according to the characteristics of supply chain finance's own business, that is, combining with the borrower's credit level, it focuses on the characteristics of self-liquidation of a single financing business and the lender's ability to organize the transaction. According to the actual development of the risk monitoring work of financial institutions, combined with the supply chain finance, the risk brought by the operation and development of small and medium-sized enterprises is reduced [6]. However, the theoretical research and practice of supply chain management have long been inclined to the level of real logistics and information flow, while insufficient attention has been paid to the level of capital flow. Since the supply chain finance business is to grant credit to a single transaction, it pays more attention to the quality of this transaction for small and medium-sized enterprises.

Table 1 Evaluation index and its description

Primary indicator	Secondary index	Level 3 indicators	Indicator description
1. Qualification of the applicant	quality of enterprise	Leadership qualities C_1	Education background and the number of years the manager has continued to operate in the industry.
	Operational capability	Operational turnover capacity C_2	Sales revenue/(average prepaid balance+average receivable balance+average inventory balance)
	Profitability	ratio of income as percentage of sales C_3	Sales profit/revenue
2. Counterparty	Counterparty credit rating	Credit rating C_4	The credit rating of the counterparty in the bank
	Industry Characteristics of Counterparty	Industry status C_5	The characteristics of industry concentration, monopoly and cycle
3. Assets under Financing	Qualitative characteristics	Price stability C_6	Last quarter's fluctuation range
	Accounts receivable characteristics	Aging and accounting period C_7	80% of accounts receivable account length
4. Supply chain operation	Industry status	Industry growth rate C_8	Judging from the industry average level
	Degree of close cooperation	Transaction life C_9	Number of years of transactions between the trustee and the counterparty
	Past performance	Default rate C_{10}	Number of defaults/total transactions

Supply chain operation is the bank's overall evaluation of the transaction quality of trusted enterprises. Considering its business ability, performance and cooperation with its counterparties from the whole supply chain, the bank will have a wider evaluation scope and reduce the decline in evaluation quality caused by information asymmetry caused by enterprises concealing information

[7]. In the pre-admission stage, the focus is on the basic status of small and medium-sized enterprises, including enterprise status, credit status and qualitative characteristics. The bank grants credit according to the value of the assets under the financing. If the trustee defaults, the bank can realize the assets to make up for the losses. Therefore, the asset status under the financing is the top priority of the bank's investigation. The whole evaluation system is divided into four categories with 10 indicators. The index system is shown in Table 1.

3. Credit Risk Evaluation Model of Supply Chain Finance Model

Credit evaluation uses many methods, including discriminant analysis, Logistic regression, linear programming, neural network and classification tree. To judge whether an evaluation method or model is good or bad, one should not only take the error classification rate as the only criterion, but also combine the robustness of the model. This method combines qualitative and quantitative analysis, which can improve the comparability and objectivity of evaluation objects. According to the nature of the problem and the overall goal to be achieved, the method divides the problem into different components, including both financial indicators and non-financial indicators. For financial index data, it can be directly calculated based on the data in the financial statements of sample enterprises. Although the prediction accuracy of linear scoring methods such as discriminant analysis, Logistic regression and linear programming is lower than that of non-linear methods such as neural networks, the robustness of these models is stronger than that of non-linear methods such as neural networks, which may be more important for China, where the credit market is in a period of rapid development [8]. Therefore, the development of different industries, the cooperation between enterprises and the support of logistics enterprises need continuous assessment.

Therefore, for China in transition, the degree of asymmetric information is very deep, and its influence is great. In order to obtain a good comprehensive effect, a certain degree of precision loss is preferred in exchange for higher robustness of the model. In other words, linear scoring methods such as discriminant analysis, Logistic regression and linear programming are relatively better choices. According to the correlation degree and subordination relation between the elements, the elements are grouped and combined according to different levels, thus forming a multi-level analysis system, which organizes and stratifies the problems. This method can effectively quantify qualitative problems. Considering the high dimension of enterprise credit risk evaluation index based on supply chain finance and the sensitivity of logistic regression method to multicollinearity, this paper needs to make factor analysis on evaluation index before using logistic regression method to build credit risk evaluation model.

In view of the current situation of supply chain finance business development, the constraint of insufficient data volume and the background that supply chain finance business is mainly applicable to small and medium-sized enterprises, the sample data selected in this paper are financial data of 20 listed companies in a certain database of small and medium-sized enterprise boards, and other indicators are simulated using random data due to unavailability. Before performing factor analysis on the sample data, the correlation between the data should be detected. Only the data with high correlation is suitable for factor analysis to investigate the risks of supply chain financing, especially the three main modes of supply chain finance including financing warehouse, confirmation warehouse and accounts receivable. With the help of large-scale core enterprises' in-depth understanding of small and medium-sized suppliers, select well-qualified upstream and downstream enterprises as financing targets for commercial banks. The sample data are divided into four grades of 10, 7, 4 and 0 according to each index to be scored, and the scoring results are standardized, and then the data are analyzed. Table 2 below shows the factor score coefficient matrix.

Table 2 Is a factor score coefficient matrix

	Component									
	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
C_1	0.023	-0.441	-0.003	0.464	-0.014	0.116	-0.463	-0.321	0.702	-0.341
C_2	0.078	-0.105	-0.486	-0.466	0.644	0.498	-0.468	0.144	0.468	-0.481
C_3	0.031	-0.125	-0.745	-0.154	0.489	0.147	0.494	-0.540	-0.456	-0.245
C_4	-0.021	0.336	-0.165	-0.188	-0.487	-0.154	0.160	0.451	-0.561	0.185
C_5	0.081	0.034	-0.163	0.614	-0.187	-0.157	0.496	0.546	--0.645	-0.458
C_6	0.082	0.006	0.014	0.449	0.497	0.148	0.461	-0.154	-0.548	-0.014
C_7	0.052	0.033	-0.337	0.521	0.156	0.121	-0.458	-0.465	-0.015	-0.356
C_8	0.021	0.256	0.416	-0.196	-0164	-0.004	-0.146	-0.169	-0.480	0.146
C_9	0.319	-0.189	0.454	0.515	-0.407	-0.314	0.156	-0.781	0.145	0.785
C_{10}	0.228	-0.460	0.168	0.484	-0.265	-0.114	-0.014	0.056	-0.150	0.018

The above method is used to calculate the hierarchical single ranking of the criterion layer to the target layer and the index layer to the criterion layer respectively. If the obtained fuzzy matrix satisfies the compatibility and consistency indexes, the hierarchical total ranking calculation of the index layer to the target layer can be further calculated. Using SPSS statistical software for principal component analysis, the cumulative contribution rate of eigenvalues of the top ten principal components has reached 73.687%. Select $F_1, F_2, F_3, F_4, F_5, F_6, F_7, F_8, F_9, F_{10}$. As the final index for analysis. From the factor score coefficient matrix (Table 2), the original 10 indexes can be respectively expressed as:

Select $F_1, F_2, F_3, F_4, F_5, F_6, F_7, F_8, F_9, F_{10}$ as the final indicators for analysis.

$$F_1 = -0.023C_1^* + 0.078C_2^* + 0.031C_3^* - 0.021C_4^* + 0.081C_5^* + 0.082C_6^*$$
$$+ 0.052C_7^* + 0.021C_8^* + 0.319C_9^* + 0.228C_{10}^* \tag{1}$$

$$F_2 = -0.441C_1^* - 0.105C_2^* - 0.125C_3^* - 0.165C_4^* - 0.163C_5^* + 0.006C_6^*$$
$$+ 0.033C_7^* + 0.256C_8^* - 0.189C_9^* - 0.460C_{10}^* \tag{2}$$
$$\vdots$$

Where C_i^* is the value normalized by the data normalization formula $C_i^* = \dfrac{C_i - \overline{C}}{S_i}$. ($\overline{C}$ is the average of C_i and S_i is the standard deviation).

The regression method is to select the introduction method step by step forward, that is, the probability of the likelihood ratio obtained by maximum likelihood estimation is taken as the standard of the introduction variable, and iterative method is adopted to calculate step by step until the log likelihood ratio does not change any more. Then, according to the principle of judging the compatibility and consistency of the fuzzy complementary judgment matrix, the above results are verified to check whether they have compatibility and consistency. After checking, the compatibility and consistency indexes of the fuzzy complementary judgment matrix meet the requirements [9]. Therefore, in order to reduce the comprehensiveness of the factor and make its practical significance more clear, it is necessary to rotate the coordinate axis to make the load as close to 1 or 0 as possible. Therefore, the credit evaluation of small and medium-sized enterprises should not only be limited to the small and medium-sized enterprises themselves, but also analyze the business relationship between the loan enterprise and the core enterprise from the perspective of supply chain.

After obtaining the hierarchical single ranking of the criteria layer to the target layer, it is necessary to further carry out the corresponding hierarchical single ranking for the secondary

indicators corresponding to each criteria layer. Using the same method mentioned above, it is possible to carry out the hierarchical single ranking for the corresponding secondary indicators respectively. In factor analysis, it is not enough to explain the meaning of the common factor only through the rotated factor load. Usually, it is also necessary to obtain the value of the common factor so as to make further research using the common factor, such as regression score. As can be seen from Table 3, F_1, F_2, F_3, F_8 and F_9 are retained in the model by selecting the regression results of the fifth step, which shows that F_1, F_2, F_3, F_8 and F_9 have significant influence on the compliance rate of the predicted trustee. The parameter estimation and statistical test are shown in Table 3. The effect of statistical test for each coefficient is significant.

Table 3 Variables entering the regression equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step5(e)	F1	0.975	0.381	6.354	1	0.014	2.361
	F2	0.661	0.327	20.241	1	0.000	5.331
	F3	1.475	0.413	8.036	1	0.003	3.027
	F8	1.473	0.436	10.284	1	0.022	4.339
	F9	0.738	0.351	5.034	1	0.001	2.025
	Constant	0.281	0.441	10.036	1	0.037	3.301

The estimated Logistic regression model is as follows:

$$In\frac{p}{1-p} = 0.281 + 0.975F_1 + 1.661F_2 + 1.475F_3 + 1.473F_8 + 0.738F_9 \tag{3}$$

$$p = \frac{1}{1 + e^{-(0.281 + 0.975F_1 + 1.661F_2 + 1.475F_3 + 1.473F_8 + 0.738F)}} \tag{4}$$

The P-value table obtained by Formula (4) shows the compliance probability of this customer. Substituting customer data into the model to predict the credit status, and calculating the P value. The closer the P value is to 1, the better the credit of the applicant, and the closer the P value is to 0, the worse the credit of the applicant.

From the weight vector, we can see that the weight of industry growth is 0.572, which is slightly higher than that of macro environment. When analyzing the industry risk, we should pay more attention to industry growth on the basis of macro environment analysis. The accuracy rate of prediction classification is 85.3% under the condition of probability limit of 0.5. Among them, the accuracy rate of good credit customers is 92.0%, and the accuracy rate of poor credit customers is 76.1%. And the probability value corresponding to each statistic is less than 0.05, which indicates that the parameter estimation value of each variable in the regression model is relatively significant at the significance level of 5%.

Sensitive to the multi-dimensional correlation of independent variables in the model, it is necessary to use factor analysis or variable clustering analysis to select representative independent variables to reduce the correlation between candidate variables. Qualitative characteristics and accounts receivable characteristics rank first, followed by corporate solvency, past performance and industry growth [10]. This ranking result is different from traditional credit risk evaluation, which reflects that the credit risk evaluation of supply chain financing pays more attention to the asset status under financing, and also needs to pay attention to factors such as corporate solvency, supply chain operation status and industry characteristics. The independent variables are ranked F_6, F_2, F_3, F_1 and F_4 in descending order according to the coefficient of variables. This shows that under the supply chain finance financing mode, the operation ability of financing enterprises has the greatest impact on enterprise credit risk, followed by the financing quality of enterprise and credit status, and the core enterprise credit level has the third impact. With the development of bank supply chain finance business, the content and accuracy of enterprise data information will be greatly improved, more enterprise information will enter the model, and the accuracy of the fitting model will also be

improved.

4. Conclusion

On the whole, with the improvement of credit risk management technology of our banks and the increasingly prominent role of SMEs in economic development, banks will vigorously explore the SME customer market in order to optimize the customer structure and broaden their development space. According to the characteristics of credit risk evaluation of supply chain finance, this paper constructs an evaluation index system, and uses principal component analysis and Logistic regression methods to establish a credit risk evaluation model. The method organically combines qualitative analysis and quantitative analysis, and the evaluation results are objective, which can effectively evaluate the credit risk of supply chain finance. As the risks brought by supply chain financing to SMEs and the whole supply chain are dynamic, it is necessary to analyze and evaluate the risks in different stages of the supply chain financing process, thus facilitating the development of supply chain finance business of financial institutions.

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