

RESEARCH ON SUPPLY CHAIN FINANCING RISK ASSESSMENT OF CHINA'S COMMERCIAL BANKS

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ABSTRACT. *In China, the supply chain financing is still at the starting stage. Because of its multiple parties and complicated steps, it seems particularly important to establish the risk assessment mechanism for supply chain financing. By means of analyzing the risk factors of all parties in confirming storage financing mode, this paper tries to establish indicator system for the supply chain risk assessment of commercial banks. This paper adopts the Logistic regression tool to measure the default probability of the risk model, and makes an empirical analysis of the model based on 177 sample data from China's commercial banks concerning automobile and steel industries. In addition, this paper summarizes the dominant factors affecting the credit risk of commercial banks in supply chain financing. On this basis, the paper proposes suggestions for commercial banks' risks assessment and control.*

Keywords: Supply chain finance, Logistic regression, Credit risk assessment

1. Introduction. In recent years, with the in-depth development of business management, the capital flow management of supply chain has drawn more and more attention. The core is the financial problem. However, in practice, under the circumstance of poor credit environment and lack of mortgages, it is hard for small and medium-sized enterprises to obtain loans from financial institutions. The financing problem of small and medium-sized enterprises is a world-wide issue, especially in China. Financing difficulties make small and medium-sized enterprises fail to effectively meet the market demands, which further affects the efficiency and profits of supply chain, hindering the national economic development.

This paper considers that the financing credit extension of supply chain enterprises should be different from the traditional way of credit extension. The risk evaluation index design should pay more attention to the overall operation of the industrial chain and related credit extension. For upstream and downstream enterprises, this paper considers that the index of existing production or sales capacity should be focused on, because it is directly related to the contract performance ability. For the core enterprise, this paper considers that the overall financial situation should be focused on, because it is helpful to control the overall risk of supply chain financing. The above key points and analyses are also shown in this paper.

As for the supply chain financing mode, foreign scholars performed studies from different angles. Santomero agreed that with the maturity of financial intermediary, the cooperation of supply chain and financial intermediary would bring the financial industry into a new development level [1]. Sadlovska also pointed out that supply chain financing

was a new opportunity for enterprises improving financial conditions and creating costs advantages [2-4]. Matoussi and Krichène used the Logit model and BP neural network technology to assess the credit risk and concluded that the BP evaluation was better [5]. Buzacott and Zhang applied the asset-backed financing to production decision, providing an important reference for the research of supply chain financing [6]. Blome and Schoenherr thought that supply chain financing risk management had become a major factor in the financial crisis [7]. For the risk management of supply chain financing mode, Chinese scholars conducted more detailed researches. Zhang and Zhou analyzed the relationship of industrial symbiosis and supply chain finance [8]. Shi established the risk assessment mechanism for supply chain financing which would help banks correctly understand the risks in the credit process [9]. Zhao and Ma pointed out that the standardization and professionalism of the third party logistics enterprises were sources of risks for confirming storage financing mode [10]. Feng and Wu studied the supply chain financing business of commercial banks and divided the sources of risks into two types [11]. Guo studied the innovation mode and the corresponding risk management of logistics enterprises from the perspective of the third party logistics enterprises [12]. The review of literature proves that there is no relatively mature system or more prominent paper about the risk assessment of supply chain financing in China.

On the basis of analyzing and drawing on previous researches on risk factors, this paper analyzes all the participators in supply chain financing process and presents the assessment indicators, makes factor analysis of these assessment indicators by SPSS and gets the common indicators. Then, this paper uses the Logistic regression model to assess the credit risks, constitutes the supply chain financing risk assessment model, conducts an empirical analysis of the indicator system, and finally draws conclusions and proposes suggestions.

The paper includes four parts. The first part is introduction. The second part is building the index system of supply chain financing risk assessment. The third part is constructing the supply chain financing risk assessment model of China's commercial banks. The fourth part is conclusion.

2. Supply Chain Financing Risk Assessment Mechanism.

2.1. The sources of commercial banks' supply chain financing risks. The precondition and basis for risk assessment is to identify the risks. This paper takes the different nodes of supply chain financing and the social environment into consideration, and proposes four types of risks, i.e., risks of financing enterprises, risks of core enterprises, risks of third enterprises, and external risks.

2.1.1. Risks of financing enterprises. The demand side of supply chain financing is mainly from small enterprises upstream or downstream. However, the chaotic financial system and traditional management pattern in small sized enterprises make the credit analysis system for large enterprises fail. Based on the analysis above and related investigations, this paper determines to make risk assessment of financing enterprises from the following aspects. An enterprise's financial conditions: firstly, get to know the solvency of an enterprise during the financing period according to its short-term asset structure; secondly, get the efficiency of the enterprise's capital utilization based on its business efficiency and profitability; finally, know about the enterprise's development prospect and competitiveness on the basis of enterprise's general quality, business management level, size, and level of policy support. The solvency in financing period is mainly assessed by asset-liability ratio, current ratio, and multiples of interest payment. The efficiency of capital utilization can be evaluated through inventory turnover, total asset turnover, accounts receivable turnover ratio, current asset turnover, cost margin, total return on assets, and return on

sales. An enterprise's prospect for development can be measured by the average quality level of employees, the quality of managers, market share, and regional policy support.

2.1.2. *Risk assessment indicators for core enterprises.* Compared with some small enterprises in supply chain, the core enterprise has relatively more mature and perfect financial system, relatively better management team and staff. The credit of core enterprise can be investigated from its business operation level, solvency, competitiveness, and the ratio of cooperation with financing enterprises. The cooperation relationship with financing enterprises could be analyzed through the years of cooperation, the depth of cooperation, and the return ratio of operation.

2.1.3. *Indicators for risks of third-party enterprises.* The financing involves the third-party enterprise's services for guaranty, logistics and transport, inspection, and warehousing. Starting from commercial banks, on the basis of necessary summarization, this paper agrees that logistics enterprise participates in the supply chain financing, basically as a collateral manager, and may cause the risk of qualification. Therefore, banks should mainly consider the qualification of third-party logistics enterprises as they measure the risks. Then, this paper chooses the rate of customer complaint on third-party, market share, the average quality of the staff, and management quality as indicators for assessing the risks of third-party enterprises.

2.1.4. *External risk indicators.* Commercial banks running the financing business are based on the development of the whole industry chain and core enterprises. Especially under the current economic system, the legislation system has a profound impact on the long-term development of an industry. Through deep and comprehensive analyses, this paper determines to use the industrial policy support to measure the macroeconomic conditions, the theoretical maturity to measure the risks of supply chain financing theory, and the maturity of legislation to measure the legal risks during the financing process.

2.2. **The establishment of indicator system.** Through a theoretical analysis of indicators above, make primary selection and form the initial indicator pool in Table 1, including four subclasses and 35 indicators, which comprehensively and objectively help commercial banks to investigate the risks during the supply chain financing.

Through a comprehensive consideration and analysis, this paper notices that some qualitative indicators, such as the quality of staff and the management level of managers, could not be measured by specific data and model. Therefore, considering the convenience of model construction and the accuracy of model, this paper uses the Delphi Method to get relevant references for qualitative indicators through questionnaire.

3. Empirical Analysis of Supply Chain Financing Credit Risk Assessment.

3.1. **Constructing the model.** Establish the indicator system based on analyses above and conduct an empirical research through the Logistic regression analysis. Logistic regression model is a probabilistic model, which is widely used in case-control and follow-up studies. The occurrence of results must be two categories or multiple categories. The more common application is the two-classification Logistic regression. Under normal circumstances, this model is mainly used to identify the main impact indicators, judge or predict the probability of a happening. The main purpose of this paper is to investigate the participators in supply chain financing and eventually establish a risk assessment indicator system, providing references for commercial banks' risk assessment in supply chain financing, namely to assist commercial banks to forecast the default rate of financing projects. Logistic regression analysis is widely used in credit risk assessment model. The advantage is capable of eliminating the partial influences of abnormal data on the system,

TABLE 1. Risk evaluation index system of commercial banks based on supply chain finance

Risk evaluation index of financing enterprise	The financial situation	Asset liability ratio A11 Current ratio A12 Multiples of interest payments A13 Cost margins ratio A14 Total assets profit ratio A15 Profit ratio on sales A16 Inventory turnover ratio A17 Total asset turnover ratio A18 Current assets turnover ratio A19
	Competitiveness of enterprise	Average quality of the employees A21 Managers quality A22 The market share A23 Regional policy support A24
	Willingness of repayment	Loan repayment rate A31 Interest repayment rate A32
Evaluation index of the core enterprise risk	The financial situation	Asset liability ratio B11 Current ratio B12 Multiples of interest payments B13 Payment rate of settlement B14 Accounts receivable turnover B15 Cost margins ratio B16 Total assets profit ratio B17 Return ratio on sales B18 Return ratio on total assets B19 Inventory turnover ratio B110 Total asset turnover ratio B111 Current assets turnover ratio B112
	Willingness of repayment	Turnover rate of settlement B21
Risk evaluation index of the third party enterprise	Goodwill value	Customer complaints ratio C11
	Competitiveness of enterprise	Market share ratio C21 Average quality of employees C22 Average quality of management C23
External risk evaluation index	Maturity of the theory policy	Industry policy support D11 Legal maturity D12 The theory of maturity D13

which improves the accuracy of the model process. Therefore, Logistic regression model is very advantageous in this paper, specifically with the following advantages.

(1) The Logistic model directly gives a yes or no for the prediction, while other methods merely give probabilities and need to be judged subjectively.

(2) The Logistic model has a comparative advantage over others in data process. Theoretically, it is better than linear regression. The methods of processing discrete variables and continuous variables are the same. Besides, as for processing the two-classification defaults, this model has better applicability.

(3) The Logistic model is capable of processing a large amount of data effectively and assessing the occurrence of a default comprehensively.

In summary, the Logistic model can effectively complete the selection of risk indicators and conduct the prediction for probability of default. The basic principle of Logistic model

is to divide the dependent variables into two opposing results, namely the default or no default in this paper. Suppose the no-default probability P , then the default probability $(1 - P)$, and then:

$$P = pi(Y = 1|X_1 = x_1, \dots, X_n = x_n) = \frac{e^{\beta_0 + \beta_1 x_1 + \dots + \beta_n x_n}}{1 + e^{\beta_0 + \beta_1 x_1 + \dots + \beta_n x_n}} \tag{1}$$

$$1 - P = pi(Y = 0|X_1 = x_1, \dots, X_n = x_n) = \frac{1}{1 + e^{\beta_0 + \beta_1 x_1 + \dots + \beta_n x_n}} \tag{2}$$

where P is the no-default probability, $1 - P$ is the default probability, Y is the variable defined as 1 or 0, β is the regression coefficient, and X is the concomitant variable of Logistic model.

Then, $P/(1 - P)$ is the dominance ratio of the event.

$$\log\left(\frac{P}{1 - P}\right) = \beta_0 + \beta_1 x_1 + \dots + \beta_n x_n \tag{3}$$

Conduct a regression analysis of indicators of influencing commercial banks' risks of supply chain financing default, get the intercept and parameters, and finally use the model to estimate whether a customer defaults or not, and then assess the credit risk.

Use the SPSS to make Logistic regression of the data above. In establishing the initial model, conduct an overall test of the model with variables. The Logistic regression model usually provides three kinds of test methods, respectively the relative likelihood ratio test between steps, the relative likelihood ratio test between blocks, and the relative likelihood ratio test between models. Table 2 shows the general test result of the model. The value of sig is close to 0, which indicates that the model has a significant statistical meaning.

TABLE 2. The model indicator integrated test

		chi-square	df	sig			chi-square	df	sig
Step 1	Step	33.901	28	0.204	Step 2	Step	-1.716	1	0.001
	Block	33.901	28	0.204		Block	12.082	1	0.001
	Model	33.901	28	0.204		Model	12.082	1	0.001

Notice: Only including the starting and closing steps.

TABLE 3. Variables in the equation

95% of EXP(B) C.I.										
		B	S.E	Wals	df	Sig	Exp(B)	The up limit	The low limit	
Step 1	Constant	-9.437	6.911	1.865	1	0.172	0			
	Asset liability ratio A11	-0.004	0.014	0.107	1	0.743	0.996	0.969	1.023	
	Current ratio A12	0.001	0.001	0.816	1	0.336	0.999	0.998	1.001	
	Return ratio on sales A16	0	0	0.064	1	0.800	1	1	1	
	Inventory turnover ratio A17	-0.005	0.009	0.322	1	0.570	0.995	0.977	1.013	
	Total asset turnover ratio A18	0	0	0.810	1	0.368	1	1	1	
	Current assets turnover ratio A19	0.005	0.005	0.881	1	0.348	1.005	0.995	1.014	
	Average quality of employees A21	1.136	1.681	0.457	1	0.499	3.115	0.116	84.01	
	The market share A23	2.014	2.779	0.525	1	0.469	7.496	0.032	1738	
	Regional policy support A24	1.904	2.283	0.696	1	0.404	6.715	0.076	580.8	
	Loan repayment rate A31	-3.274	2.146	2.327	1	0.127	0.038	0.001	2.540	
	Interest repayment rate A32	13.821	5.605	6.079	1	0.014	1.051	17.01	5.951	
	Total asset turnover ratio B11	-0.007	0.013	0.298	1	0.585	0.993	0.969	1.081	
	Current ratio B12	-0.002	0.002	0.545	1	0.460	0.998	0.994	1.003	
	Accounts receivable turnover ratio B15	0	0	2.371	1	0.124	1	1	1	
Inventory turnover ratio B110	0	0	0.405	1	0.525	1	1	1		
Asset turnover ratio B111	0.002	0.005	0.211	1	0.646	1.002	0.993	1.011		

In data process, how to effectively select variables and get the most effective assessment model are the points of the study. The software provides a way of selecting variables based on the significance of variables. The main way is:

For wand: Conditional/LR/Wald: based on the conditional parameter likelihood ratio test results/partial likelihood ratio test results/Wald test results, present the forward method of variable exclusion.

Back wand: Conditional/LR/Wald: based on the conditional parameter likelihood ratio test results/partial likelihood ratio test results/Wald test results, present the backward method of variable exclusion.

In this paper, the author presents the backward exclusion of variables through the Wald test results of SPSS model and conducts the Logistic regression analysis. The significance level is at 0.05, which better controls the accuracy of the model and finally gets the relevant logistic regression equation by multiple iterations. Logistic regression variables are shown in Table 3.

Input all variables in Table 1 in step one. Results show that financing enterprises' risk assessment indicators and core enterprises' risk assessment indicators exert relatively more prominent efforts on commercial banks' supply chain financing assessment model, which are the emphases for commercial banks in financing investigation. Meanwhile, this paper excludes the indicator of third-party enterprise risks and the indicator of external risks because they have no significant impacts on commercial banks' supply chain financing risk assessment.

3.2. Empirical analysis. On the basis of the model above, this paper conducts a credit risk assessment and empirical analysis of a commercial bank, as follows:

Get the Logistic regression equation based on Table 3, and give the default equation:

$$P = p_i(Y = 1|X_1 = x_1, \dots, X_n = x_n) = \frac{e^{1.136x_1+2.014X_2+1.904X_3-3.274X_3+13.821x_4-9.8}}{1 + e^{\beta_0+\beta_1x_1+\dots+\beta_nx_n}} \quad (4)$$

x_1 stands for the average quality of the staff in financing enterprise b_{21} , regional policy support b_{24} , loan repayment ratio b_{31} , and interest repayment ratio b_{32} .

By retrospective analysis of data, this paper notices that causing the results above may be the small size of data sample. Besides, because this paper just focuses on the same commercial bank's third-party enterprises and the number of third-party enterprises is small, it is difficult to form relatively more significant data impacts in the model. As for the impacts of external risks, there is not a proper objective quantitative measurement, while assessment of external risks is relatively more subjective. Meanwhile, the sample data in this paper is basically on the basis of regional supply chain, lacking powerful comparative data for reference in policy. As a result, the external risks are insignificant in the model assessment in the paper.

3.3. Model test results. The ultimate purpose of the model is to conduct risk assessment of commercial banks' supply chain financing. The regression equation based on data process needs to be verified by cases. The verification principle of Logistic regression analysis is to set a cut-off value. Input the customer-related indicators into the model. If the probability is greater than the cut-off value, it means the default of customer. Otherwise, it means no default.

This paper adopts the judgment system of SPSS and conducts the sampling verification on original data. Finally, get the predicted probability of the model. Results are in Table 4.

According to the classified prediction results above, the customer's risk assessment and prediction in the model are at a normal level. Under the cut-off value of 0.5, the accuracy rate of judgment for non-default customer is 91.7%, and rate for default customer is

TABLE 4. The classified prediction results of the model

Observed		Predicted			
Step 1	Default	Default	No default	Correcting percentage	
		Default	28	16	63.6
		No Default	8	125	94.0
	Total percentage			86.4	
Step 21	Default	Default	No default	Correcting percentage	
		Default	31	13	70.5
		No Default	11	122	91.7
	Total percentage			86.4	

Cut value is 0.5.

relatively lower, at 70.5%. The probability of mistaking default customer as non-default customer is 29.5%. The general accuracy rate of the model is 86.4%.

4. Conclusions. This paper analyzes supply chain financing risk evaluation of commercial banks' in four aspects: financing business, the core business, the third-party companies and external risks. And it tries to establish the risk evaluation model for the supply chain financing of commercial banks. The study predicts the default probability of supply chain financing of commercial banks. Under the boundary value of 0.5, the judgment accuracy rate of default equation for non-default customer is 91.7%. The judgment accuracy rate of default equation for default customer is 70.5%. The probability of misclassifying default customer for non-default customer is 29.5%. The overall accuracy rate of the model is 86.4%. The study provides a meaningful model for commercial banks on the risk assessment of supply chain financing.

By understanding the entire financing process and analyzing the factors causing defaults, this paper proposes the following countermeasures for decreasing commercial banks' credit risks in supply chain financing process. Firstly, establish a professional supply chain financing platform. Secondly, strengthen the cooperation with the third-party enterprises. Thirdly, enhance the management of inventory system. Finally, pay close attention to the conditions of commodities and confirm the quantity of commodities in pledge.

As a result of supply chain financing involving widely, professional method is needed on evaluation of logistics and the small and medium-sized enterprise management level. The data in this paper involves the financing business of one bank for a certain period of time. The sampling range of data is relatively narrow. This leads to the differences in the operational risk of commercial banks which cannot be shown well. So the further research directions are expected to strengthen the exchange and analysis of data of different banks in order to establish much more perfect system of supply chain financing.

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