Research on Credit Risk Factors of Bank of Chongqing from the Perspective of Supply Chain Finance

Zi Ying[1], Qianyou Gu[2], Wenqing Guo[3, *]

[1]School of Economics and Management, Northeast Agricultural University, Harbin, Heilongjiang, 150038, China

[2]School of Finance, Southwestern University of Finance and Economics, Chengdu, Sichuan, 611130, China

[3]School of Business, East China University of Science and Technology, Shanghai, 200237, China

*Corresponding author: guowenqing0311@163.com

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Abstract: Supply chain finance (SCF), an emerging financial service, develops rapidly and gradually becomes an important field in which banks compete for profits. It is of great significance to study the influencing factors behind its economic development for promoting enterprise development, expanding commercial banks' business scope, improving the profit rate of industrial subjects and controlling the possible credit risk. Based on the perspective of SCF, this paper makes an empirical study on the core enterprise supported by Chongqing Bank using principal component analysis (PCA). We extracted six representative principal components which have contribution to 86%. And taking Logistic regression with principal components. It is found that enterprise risk level is strongly correlated with enterprise performance rate. The Logistic regression have 100% precision. Starting from the influencing factors, this paper puts forward some policy suggestions for the development of SCF, such as strengthening credit management mechanism, accelerating the integration with science and technology, strengthening internal risk control and optimizing business process, so as to provide theoretical support and thinking perspective for promoting the development of SCF and issuing relevant policies.

1. Introduction

With the release of the Guideline on Actively Promoting Innovation and Application of Supply Chain in November 2017, the state requires accelerating the development of SCF to serve SCF for the real economy better. On August 20, 2018, the First meeting of The State Council Leading Group on Promoting the Development of small and Medium-sized Enterprises (SMEs) was held. The meeting stressed the need to promptly solve major problems in the development of SMEs: adhere to the basic economic system, treat state-owned and private sectors equally, treat large and small enterprises equally, and focus on creating an environment for the development of enterprises. In promoting China's economic growth and stabilizing China's social situation, the contribution of SMEs cannot be ignored.

Thus, SCF is not only a professional field of commercial bank credit business, but also a new channel of SME financing. In this context, the business of commercial banks gradually began to adapt to the needs of economic development, and began to carry out relevant SCF services based on the financial model of the supply chain, so as to meet the financial needs of enterprises in the supply chain. The financial services of commercial banks mainly take core enterprises as the entry point of the supply chain and relieve financing difficulties for other enterprises in the supply chain by virtue of their own credit and economic strength. The model of SCF broadens the business scope of commercial banks and improves their market competitiveness. At the same time, there are many risk factors in supply chain financial services. Therefore, innovating business and preventing the credit risk of commercial banks in the supply chain has become a focus that cannot be ignored. In this paper, the financial statements of 25 supply chain enterprises supported by Bank of Chongqing in 2020 are analyzed, the financial index system is constructed for empirical analysis, and the influencing factors of credit risk of Bank of Chongqing are analyzed and relevant suggestions are given. This paper analyzes the financial statements of 25 supply chain enterprises supported by Bank of Chongqing in 2020. This paper makes an empirical analysis with the financial index system, analyzes the influencing factors of Bank of Chongqing credit risk and gives relevant suggestions.

2. Development Status of Supply Chain Finance

Since 2019, SCF has been further sinking. Participants from the state to local governments, financial institutions, private enterprises and other participants have been shining in the field of financial contribution. In general, market participants have shown diversified development. As a new financial service, SCF develops rapidly and gradually becomes an important field in which banks compete for profits. The combination of SCF and technology has become an inevitable trend.

Because of its unique characteristics and financing mode, SCF has great advantages in effectively solving SMEs' financing difficulties and expensive problems. The more active the market, the more frequent the transactions, and the more developed the supply chain. At the same time, the supply chain can promote economic transactions between markets as a positive feedback factor. Therefore, the prosperity of supply chain reflects the quality and level of economic development from another perspective, as well as the implementation degree of policies. Figure 1 shows the relationship between supply chain, market and transaction.
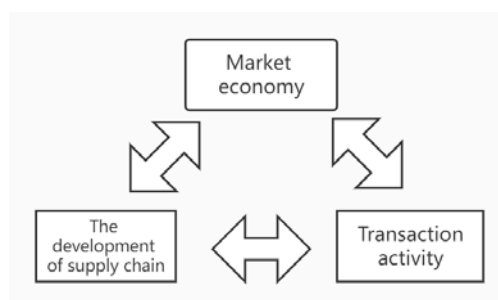

Figure 1. The relationship between supply chain, market and transaction

From the perspective of commercial banks, the advantages of supply chain integration are mainly reflected in:

(1) Customer base: Through SCF services, commercial banks can expand their customer base, thus driving the growth of many profitability indicators;

(2) Non-performing loan ratio: From the above case analysis, it can be seen that SCF has significant advantages in reducing the non-performing loan ratio;

(3) Difficulty in business development: in the mode of SCF, the difficulty of business is much simpler than the traditional "N+M" mode because there are commercial banks in the middle to guarantee and adjust;

(4) Credit structure: One of the objectives of SCF is to solve the financing difficulties of SMEs, so that the upstream capital flows to the downstream, which significantly improves the credit structure;

(5) Scale of risky assets: Risks will also rise when banks expand the scale of assets. SCF can reduce banks' overall risk to a large extent, which is conducive to the future business development of banks.

To sum up, SCF business has achieved remarkable results in maintaining the bank's continuous, rapid, and stable development. Compared with traditional business of domestic and foreign commercial banks, SCF has an absolute advantage in terms of business profit.
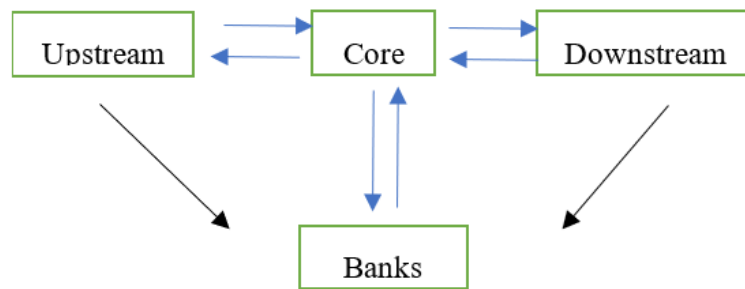

Figure 2. SCF business model

3. Analysis of Research Status

There have been some studies on the connotation of SCF in the literature. As a new financing model, SCF takes the bank as the main source of loan capital to relieve the financial pressure for the upstream and downstream enterprises of the supply chain. Enterprises borrow from banks by their credit certificates, which improve the efficiency of enterprise management, speed up information integration, strengthen the strength of enterprises, and effectively reduce the cost of upstream, middle, and downstream enterprises in the supply chain.

Jiang and Yao(2016) found that in the early stage of the implementation of supply chain financial services, in order to prevent their own credit risks, banks paid more attention to the nature of enterprises when providing loans to enterprises and were more willing to offer services to state-owned enterprises. Due to the information asymmetry between lenders and borrowers, it is generally difficult for SMEs to obtain financing, which many scholars have studied. Diamond (1985) proposed that a high level of information

disclosure could reduce external investors' access to private information and thus increase the number of transactions, so that information transmission in the supply chain could be smoother and financing constraints of enterprises could be alleviated. As the concept of supply finance was put forward, Williams-Timme (2000) believed that SCF was a cooperative relationship between supply chain members and financial institutions. Sarah Jones believes that SCF is a new type of capital circulation system, in which all parties play different roles and rely on others to facilitate the financing and create value for all parties. Some scholars believe that implementing SCF can effectively reduce the financing cost of enterprises. Michael (2007) believes that SCF promotes the rapid transmission of information, reduces the transaction cost of members on the chain, and its combination with financial instruments can reduce the financing cost of enterprises. Gong et al. (2020) believe that digital SCF and traditional SCF each have certain advantages, but the choice of financing method depends on the number of up-chain enterprises and the quality of up-chain information.

Wright(1988) compared the risks between SCF model and traditional credit model. In his opinion, the fundamental difference between the two is that traditional credit only grants credit to single financing enterprises, while SCF requires the overall risk control of the supply chain, which is the whole process of risk control for all enterprises in the supply chain. In terms of empirical research, Xiong et al. (2009) proposed to break the limitation of relying on expert evaluation and establish a risk evaluation model with the help of regression equation and PCA, so as to establish an evaluation system of subject rating and debt rating. Junjun He et al. (2018) applied the Logistic model to add customer concentration into the SME credit risk evaluation model. She empirically verified that the customer concentration index could improve the accuracy of SMEs' credit risk prediction and reduce supply chain financial business risks more effectively. Lv et al. (2021) conducted an empirical analysis on the competitiveness of financial policies in SCF. They believed that the financing cost of private enterprises decreased significantly during the epidemic period, and financial institutions' concerns in implementation led to the phenomenon that they were unwilling or afraid to make loans to private enterprises. Yang and Fang rated the credit risk of core enterprises by constructing the property value system. The rating shows the loan default rate of core enterprises, reducing the supply chain capital turbulence caused by core enterprise default. Zhang selected the financial indicators of small and medium-sized enterprises for analysis, and studied the credit risks of banks by calculating the default rate of small and medium-sized financing enterprises to achieve the purpose of controlling financial risks

To sum up, western scholars started their research on SCF earlier. In contrast, China's SCF credit risk evaluation has just started empirical analysis and research in recent years due to limitations such as insufficient data accumulation, and its scope is relatively narrow. Some scholars use the empirical analysis model to analyze the credit risk of SCF, but the evaluation accuracy of credit risk of SCF is not enough due to the lack of some data and other problems.

This paper selects 16 financial indicators of profitability, financing ability, operation ability and growth ability of 25 listed companies supported by Bank of Chongqing SCF services. PCA and Logistic model are

used to construct and evaluate core enterprises' credit risk system indicators. Assuming that the enterprise's performance probability is subject to Logistic distribution, this paper takes financial indicators as independent variables to establish a Logistic model, and predicts the performance probability P of the financing enterprise. The dependent variable F of the Logistic model only has two values of 0 and 1, where 1 represents performance and 0 represents default. In this paper, 50% probability is taken as the boundary point. When $P < 0.5$, F=0. This indicates that the enterprise has a high default rate and low credit level, which is not suitable for loan financing; Conversely, when $P > 0.5$, F=1. This shows that enterprises have a higher compliance rate and a higher credit level, which can be used for loan financing.

4. Data Selection

SCF business mainly serves upstream, middle and downstream enterprises, aiming to solve SMEs' financing difficulties and expensive situation. However, it is challenging to study the large number and wide distribution of Chinese enterprises. Therefore, in order to improve the feasibility of the study, this paper takes the core enterprise as the research object and carries on the risk analysis of SCF.

Referring to Zhang's research, this paper selects the financial statement data of 25 listed companies supported by Bank of Chongqing in 2020 as the index reflecting the credit risk perception factor in SCF. The following table shows the classification of financial indicators selected in this paper.

Table 1. Financial index system

Target Layer	Elements Layer	Index Layer
Profitability analysis of core enterprises in the supply chain supported by Bank of Chongqing	Profitability	Earnings Per Share (EPS)
		Operation Profit of Entirety (OPE)
		Return on Equity (ROE)
		Operating Profit Margin
		Net Profit Margin on Total Assets
	Supply Chain Financing Capacity	Asset-liability Ratio
		Inventory Turnover
		Current Asset Turnover
	Operation Ability	Total Asset Turnover
		Current Ratio
		Quick Ratio
		Cash Ratio
	Growth Ability	Accounts Receivable Turnover

	Growth Rate of Main Business Income
	Growth Rate of Net Profit
	Growth Rate of Total Assets

In this paper, 16 indicators in the financial data of core enterprises are selected as independent variables, and the default rate of enterprises is taken as the dependent variable. Descriptive statistics of relevant data of 25 core enterprises analyzed by Stata software are shown in Table 2. Among them, the variance of accounts receivable turnover rate and inventory turnover rate is the largest, 295.70 and 1386.6 respectively, indicating that the operating efficiency gap of enterprises is very large, while the variance of other indicators is almost within 10, showing no great difference.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Current Ratio	25	2.17970	2.42020	0.34040	12.2880
Quick Ratio	25	1.75230	2.02720	0.32370	9.66630
Cash Ratio	25	0.75910	1.02880	0.07719	4.17430
Asset-liability Ratio	25	0.47360	0.22700	0.08019	0.87040
Operation Profit of Entirety (OPE)	25	2.35660	6.53390	-12.5160	29.6610
Accounts Receivable Turnover	25	140.530	295.700	0.77360	1031.40
Inventory Turnover	24	306.510	1386.60	0.12550	6803.30
Total Asset Turnover	25	0.59320	0.31440	0.12360	1.25400
Current Asset Turnover	25	1.23530	0.64240	0.12910	2.99140
Net Profit Margin on Total Assets	25	0.06689	0.07401	-0.10950	0.21700
Return on Equity (ROE)	25	0.14030	0.23760	-0.27980	1.11700
Operating Profit Margin	25	0.13340	0.16520	-0.28710	0.49610
Growth Rate of Total Assets	25	0.30110	0.56960	-0.11050	2.78910
Growth Rate of Net Profit	24	-5.16970	18.1860	-66.4110	4.53630
Growth Rate of Main Business Income	24	0.33520	1.01350	-0.33800	4.77580
Earnings Per Share (EPS)	25	0.81520	0.92530	-0.65590	3.62070

5. Model selection

In order to construct the evaluation system more scientifically and effectively, this paper adopts PCA, and uses the factors extracted from PCA to carry out Logistic regression.

5.1 Principal Component Analysis

PCA is a method to analyze things by making principal components a linear combination of original variables and selecting a few principal components with a large proportion in the total amount of variation information through correct and appropriate mathematical transformation. The greater the proportion of principal components invariance information, the greater its role in a comprehensive evaluation.

First of all, Bartlett's spherical test was carried out with the help of Stata software to judge whether PCA could be carried out, and then the principal component PCA was carried out.

The specific steps are as follows:

(1) Standardize the original data;

(2) Conduct dimension reduction factor analysis and calculate feature quantity and feature vector;

(3) Extract principal components whose eigenvalue is greater than 1 and whose variance contribution rate accumulates to about 85%;

(4) Calculate the score of each principal component:

$$F_i = W_{i1}X_1 + W_{i1}X_1 + \cdots + W_{in}X_n \tag{1}$$

Where $W_{in} = \frac{\theta_j}{\sqrt{\lambda_i}}$ represents the weight of each variable in the principal component. θ_j is the coefficient corresponding to each variable in the component matrix. $\sqrt{\lambda_i}$ is the open root of the eigenvalues corresponding to the λ_i principal components.

5.2 Logistic Regression

Logistic regression is suitable for binary prediction, and the predicted value is always between [0,1]. Its function is to calculate the two-point distribution probability of y for a given x.

$$\begin{cases} p(y = 1|x) = F(x, \beta) \\ p(y = 1|x) = 1 - F(x, \beta) \end{cases} \tag{2}$$

$$p(y = 1|x) = F(x, \beta) = \frac{\exp(x'\beta)}{1 + \exp(x'\beta)} \tag{3}$$

Where β is the regression parameter. With P=0.5 as the boundary point, when $P < 0.5$, the predicted value of F is 0, indicating that the default rate of the enterprise is high.

6. Empirical Analysis

Since there are 16 financial indicators in the sample data, in order to avoid multicollinearity, PCA method is adopted to refine the above independent variables. The effective indicators can be retained by extracting new and unrelated comprehensive indicators. This paper refers to the practice of Zhang et al. to construct the index system for PCA.

6.1 Bartlett's Sphericity Test

In order to judge whether the data is suitable for principal component analysis, we first conduct a Bartlett's Sphericity Test. The null hypothesis of this test is that data variables are not suitable for factor analysis. In this study, the P-value of Bartlett's test was less than 0.001, rejecting the null hypothesis. That is, research data can be extracted from principal components.

Table 3. Bartlett spherical test judgment

	Approx. Chi-Square	363.548
Bartlett's Test of Sphericity	df	120
	Sig.	0.000

6.2 Principal Component Analysis

According to the regression coefficient of principal component, the coefficient of net profit rate on total assets and return on net assets in component 1 is the largest, indicating that component 1 mainly reflects corporate profitability and liquidity ratio. The quick ratio and cash ratio coefficient of component 2 is the largest, indicating that component 2 mainly reflects the operating capacity of the enterprise. The coefficient of growth rate of total assets in component 3 is the largest, meaning that component 3 mainly reflects the growth ability of enterprises. The coefficient of inventory turnover in component 4 is the largest, showing that component 4 mainly reflects supply chain financing ability. The coefficient of main business profit accounted for the largest in component 5, indicating that component 5 mainly reflects profitability. In component 6, the coefficient of inventory turnover is the largest, demonstrating that component 6 mainly reflects supply chain financing capacity.

Thus, the cumulative contribution of the first six principal components reaches 86%. The six principal components cover all aspects of enterprise capabilities, and the extraction of principal components is more reasonable. Table 3 shows the result.

Table 4. The result of Principal Component Analysis

Component	Variance	Cumulative
1	0.2854	0.2854
2	0.2522	0.5376
3	0.1004	0.6380
4	0.0879	0.7259
5	0.0722	0.7981
6	0.0619	0.8600
7	0.0426	0.9026
8	0.0377	0.9403
9	0.0239	0.9642

10	0.0203	0.9845
11	0.0067	0.9912
12	0.0049	0.9960
13	0.0021	0.9982
14	0.0015	0.9997
15	0.0002	0.9999
16	0.0001	1

Referring to Yang's (2017) judgment on the credit risk of core enterprises, this paper also makes a comprehensive evaluation of core enterprises from Securities Star. If enterprises are rated as the highest level, it will be evaluated as 1 at the highest level; otherwise, it will be judged as 0.

The default rate of the enterprise is taken as the dependent variable, and the extracted principal component is the independent variable. Stata software was used to carry out Logistic regression in this paper, and the results are shown in Table 5.

Table 5 Regression coefficients of logistic regression

Log pseudolikelihood=	0
Rating	Robust Coef
Comp1	501.2536
Comp2	887.4147
Comp3	-228.6747
Comp4	702.4224
Comp5	184.1326
Comp6	439.4358
_cons	-1894.473

The formula can be obtained from Table 4:

$$p = \frac{1}{1+e^{-(\text{cons}+\sum_{i=1}^{6} F_i * Comp_i)}} \tag{4}$$

Where P value is the contract-keeping rate of small and medium-sized financing enterprises, by inserting the customer data of Bank of Chongqing into the formula, the enterprise's probability of keeping contract can be obtained. When the P value is approximately close to 1, it indicates that the better the enterprise's credit, the lower the default rate; On the contrary, the closer P value is to 0, it means that financing enterprises are prone to default. The significance level is 0.0033, indicating that the regression results are significant at a 99% significance level.

Stata was used to back-test all the data, and the financial data of all enterprises were substituted into the Logistic model obtained. The prediction accuracy of 100% indicates that all enterprises are correctly judged. The overall prediction effect of the model is strong, and the prediction accuracy of the Logistic model is

100%. Therefore, it is concluded that Our model has good adaptability to study the default of supply chain finance

7. Conclusions and Suggestions

This paper selects four first-level indicators and 16 second-level indicators for analysis, covering profit margin, liquidity ratio, quick ratio and so on. By analyzing the default rate of the enterprises supported by The Bank of Chongqing, this paper studies the credit risk of the Bank of Chongqing and selects a mature Logistic model to study the default rate. In order to avoid multicollinearity between indicators, principal component analysis was used in this paper to extract the principal components of the selected 16 financial indicators, and finally, six principal components were extracted. The risk index is the risk assessment of the selected enterprise by the Securities Star financial Review. With six principal components as independent variables and risk rating as dependent variables, the principal component coefficients of the Logistic model are derived, and the formula of the compliance rate of 25 representative enterprises with financial support from Bank of Chongqing is finally obtained. By substituting the customers' data of Bank of Chongqing into the formula, the model's accuracy is 100%. Therefore, it is concluded that Our model has good adaptability to study the default of supply chain finance

Measures that commercial banks can take: Dynamically monitor and strengthen the credit granting subject access management mechanism. In order to realize the win-win situation in the upstream, middle and downstream of SCF, the stability of the industrial chain should be paid attention to first. And pay more attention to the analysis of enterprise financial indicators.

Measures that the Government can take: Improve the macro environment, improve the corresponding laws and regulations. The development momentum of SCF is fierce, involving social credit system, financial supervision system, e-commerce and other aspects. However, relevant laws and policies are slightly backward and cannot match the current development status. Only by strengthening legislation and law enforcement can we create a just and equitable legal environment. Based on the sound legal ecosystem, it can not only improve the sense of social responsibility of banks, but also reduce administrative intervention, and provide a guarantee for the business operation and risk control of banks.

Measures that core enterprises can take: Actively cooperate and play a leading role. Core enterprises should actively play the role of "core" enterprises in the industrial chain. Core enterprises should support and cooperate with upstream and downstream SMEs in supply chain financing, strive to share their high-quality credit with upstream and downstream SMEs, and help alleviate the financing difficulties and high costs of SMEs.

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