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Credit Risk Evaluation of SMEs Based on Supply Chain Financing

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Abstract
Supply Chain Financing (SCF) provides a new way for Small and Medium-Sized Enterprises (SMEs) in China to solve their financing problems, and of course it comes with credit risk. This article first studies the characteristics of SCF and present an index system for credit risk evaluation. Then logistic regression method is used to evaluate the credit risk of SMEs, and the effect of SCF financing model in improving the financing environment of SMEs is confirmed by results.

Key words: Supply chain finance; Credit risk evaluation; Logistic regression model

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INTRODUCTION
According to the statistics, SMEs account for 99% of the companies in our country, but they have a tremendous role in promoting the growing of China's economy. As they are small-sized and low-rated, it's difficult for them to get loans from banks. SCF originated from 1990s, it first conducted by advanced international logistics enterprises and commercial banks from the West. Designed for the structure, trade ways and operating characteristics of the supply chain, SCF focuses on the high-rated large enterprise, considers the whole chain as a total, and determines credit conditions of SMEs that associated with the large enterprise. The paper has actual meaning, which determines the key influence factors and assess credit risk levels of SMEs based on SCF.

1. REVIEW
SCF, as an important part of it, first developed from supply chain management. Tower Group define it as a designed series of solutions of working capital financing and cash flows of provider, which is based on real trade happened in a supply chain. Hofmann (2005) analyzed the structure and function of the supply chain, and he treated SCF as a way to realize the added value of the supply chain. However SCF is developed from practice to theory in China, Shenzhen Development Bank is the first bank to carry out this kind of financial business, through which their customers of trade financing and related business increased about 50% by 2006 and loaned almost 300 billion yuan throughout the year in the condition that the total bad loan rate was lower than 0.5%. Wang (2003) adopted a method based on a decision tree to establish an indicator system combining with characteristics of the supply chain according to the actual demand. Huang and Zhao (2009) used the naive bayes model to measure the repayment capacity of financing enterprises. Under the consideration of the strong uncertainty. Kong et al. (2010) assess credit risk levels of SMEs with fuzzed qualitative indicators and relations which are difficult to be quantified. Hu et al. (2011) find that SVM is more accurate and stable than BP in the classification of defaulting enterprises by empirical survey.

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2. SMES' CREDIT RISK EVALUATION INDEX SYSTEM BASED ON SCF

Compared to traditional credit business, SCF no longer only looks at the individual credit for loan enterprise, it pays more attention to the credit condition of the total chain. In traditional credit business, banks analyze loan enterprise's financial statement and determine whether to give money or not. In the new financing model, banks focus on the credit and operating condition of the whole supply chain and the strength of the large enterprise, rather than only consider individual situation of loan enterprise. So it requires banks to consider more influential factors when assess credit risk of financial enterprises. The selection of indicators and construction of the model determines the success of risk management of SCF.

According to the analysis above, the object of a bank is loan enterprise itself in the traditional model, bank focuses on profitability, solvency and other indicators which come from three financial statements. In SCF model, a bank concentrate more on the analysis of the whole supply chain and trade happened in the chain. We should follow four rules while building the index system. Firstly, credit risk should be fully reflected by indicators selected. Secondly, repetition of indicators should be avoided for some single index anomalies overlap each other in various degrees. Thirdly, index system should be built from low to high and from simple to complex. Forthly, data of the index should be easy to obtain and index can be measured. In reference to the index system used in the traditional model, combining with the characteristics of SCF, we focus on business relations between SMEs and the large enterprise, and establish a credit risk assessment index system which includes four aspects.

(a) The situation of finance enterprise. It's widely used in the traditional financing model, and mainly consists of basic quality, profitability, solvency and credit history. It measures the financing enterprise's ability and willingness to repay.

(b) The credit status of core enterprise. During SCF operation, core enterprise guarantees loans to SMEs in some ways. Basic quality, profitability, solvency and guarantee for third parties of core enterprise reflect the core enterprise's ability and willingness to repay.

(c) Supply chain's operations. It includes condition, stability and development potential of the supply chain and loan enterprise's place in the chain.

(d) Macro-environmental factors. It consists of present status of supply chain's industry, competitive situation and related economic and legal policy.

A index system includes 4 first-grade indices, 15 second-grade indices and 60 third-grade indices are obtained based on the preliminary analysis. Correlational analyses show that correlation coefficients of 15 indices are greater than 0.6, so we delete them according to rule (b). As it's shown in Table 1, now we have a SCF-based SMEs' credit risk evaluation index system which includes 45 third-grade indices.

3. EMPIRICAL RESEARCH ON CRIDIT RISK EVALUATION OF SMES

3.1 Logistic Regression Model

When build the model, we set variable $X=(x_1, x_2, \cdots, x_n)^T$ to represent n third-grade indices of a small and middle-sized enterprise, and to represent enterprise's credit status, where $Y=0$ indicates the enterprise repays the loan and $Y=1$ indicates default on payment. Loan payment probability of borrowing enterprise $P(Y=0 \mid X)=\pi(X)$ is a function of X,

$$\pi(X) = \frac{e^{\theta_0+\theta_1 x_1+\theta_2 x_2 6+\cdots+\theta_n x_n}}{1+e^{\theta_0+\theta_1 x_1+\theta_2 x_2+\cdots+\theta_n x_n}},$$

where $\theta=(\theta_0,\theta_1,\theta_2,\cdots,\theta_n)^T$ is the coefficient vector of X.

Maximum likelihood method is used to estimate θ, the maximum likelihood equation is shown bellow,

$$L(\theta_0,\theta_1,\theta_2,\cdots,\theta_n)=\prod_{i=1}^{n}\pi(X_i)^{Y_i}[1-\pi(X_i)]^{1-Y_i},$$

where X_i is the index vector of the *ith* enterprise, Y_i is the credit status ot it.

$$\frac{\partial \ln L}{\partial \theta_0}=0,\frac{\partial \ln L}{\partial \theta_1}=0,\cdots,\frac{\partial \ln L}{\partial \theta_n}=0.$$

Solve these equations, and we'll have estimated value of, $\hat{\theta}$. Once $\hat{\theta}$ is putted into Logistic equation, we'll acquire the fitting value of $\pi(X_i)$, which is the loan payment probability of the *ith* borrowing enterprise. The closer that this value is to 1, the more credit-worth the enterprise is.

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Table 1
Credit Risk Evaluation Index System for SMEs in SCF

	First-grade indices	Second-grade indices	Third-grade indices
Credit risk evaluation index system for SMEs in SCF	The situation of finance enterprise	Basic quality	Enterprise management
			Qualityof leaders
			Qualityof employees
			Qualityof finance information
		Profitability	Return on sales
			Return on assets
		Solvency	Quick ratio
			Debt asset ratio
			Time interest earned ratio
		Credit record	Trade performance
			Loan performance
		Operating capacity	Receivable turnover
			Inventory turnover
			Current assets turnover
			Total assets turnover
			Capital return cycle
		Growth ability	Growth rate of total assets
			New product development capability
			Sales growth
			Profit growth rate
	The credit status of core enterprise	Basic condition of the core enterprise	Industrial sales ratios
			Enterprise-scale
			Management level
		Profitability	Return on equity
			Return on sales
		Solvency	Current ratio
			Time interest earned ratio
		Credit record	Credit rating
			Loan performance
			Guarantee for third parties
			Assets-pledged/backed
	Supply chain's operations	Competitiveness	Competitive position
			Total capital profit ratio
			Customer satisfaction
		Supply chain relationship	Relationship strength
			Relationship quality
			Relationship duration
		Loan enterprise's place in the chain	Dependence on products of upstream/downstream
			Price competitiveness
	Macro environmental	Macorpolicy	Economic policy
			Legal policy
			Government support
		Industry condition	Competitive intensity
			Development prospect
			Average profit growth rate

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3.2 Data Selection and Procession

20 SMEs from the car industry in Guangzhou were chosen for our study. Financial data used in model comes from CSMAR, while qualitativedata was given by expert. Data was standardized and descriptive statistic analysis was conducted, results showed that our data was valid.

Before we employ logistic model, we should eliminate the colinear among all the variate and reduce variate quantity. We used SPSS 21 to perform principal component analysis. Results of KMO & Bartlett's test are shown in Table 2.

Table 2
KMO & Bartlett's Test

KMO measure of sampling			
Adequacy			0.772
Bartlett's test of sphericity	Approx. chi-square		1433.125
		df	356
		Sig.	0.000

Since value of the first line is greater than 0.6 and *p*-value of Bartlett's test is 0.000, factor analysis can be conducted next. The accumulative contribution rate of 17 principal components is 87%, so F_1, F_2, ^, F_{17} are selected as final indices for the model.

3.3 Credit Risk Evaluation in SCF

Forward stepwise was used to test the significance of the logistic regression model. As shown in Table 3, logistic regression model passes the significance test under 5%(sig) for *p*-value is 0.000.

Nagelkerke's R^2 ranges from 0.454 to 0.876, that means the model explains more than 87.6% of changes in independent variables.

Parameter estimation of step 6 is shown in Table 5. F_1,F_2,F_5,F_7,F_9,F_{14},F_{17} are remained in the model while others are deleted. *P*-values of these principal components and constant are all less than 0.05.

Now we have

$$\ln \frac{\pi(X)}{1-\pi(X)} = 3.062 + 1.315F_1 + 3.876F_2 + 2.401F_5 + 3.542F_7 + 1.430F_9 + 2.139F_{14} + 1.743F_{17}.$$

Table 3
Omniubus Tests of Model Coefficients

		Chi-square	*df*	Sig.
Step1	Step	47.159	1	0.000
	Block	47.159	1	0.000
	Model	47.159	1	0.000
Step2	Step	12.343	1	0.003
	Block	74.933	2	0.000
	Model	74.933	2	0.000
Step3	Step	11.241	1	0.008
	Block	120.756	3	0.000
	Model	120.756	3	0.000
Step4	Step	8.107	1	0.000
	Block	133.449	4	0.000
	Model	133.449	4	0.000
Step5	Step	5.781	1	0.021
	Block	144.005	5	0.000
	Model	144.005	5	0.000
Step6	Step	6.732	1	0.000
	Block	152.048	6	0.000
	Model	152.048	6	0.000

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Table 4
Model Summary

Step	-2Log likelihood	Cox & snell *R* square	Nagelkerke *R* square
1	124.596	0.276	0.454
2	103.169	0.407	0.673
3	86.343	0.436	0.719
4	65.182	0.571	0.794
5	58.967	0.626	0.823
6	50.322	0.674	0.876

Table 5
Variables in the Equation of Step 6

	B	S.E.	*df*	Sig.
F1	1.315	0.949	1.000	0.001
F2	3.876	0.838	1.000	0.000
F5	2.401	0.952	1.000	0.000
F7	3.542	0.735	1.000	0.026
F9	1.430	0.813	1.000	0.000
F14	2.139	0.630	1.000	0.003
F17	1.743	0.271	1.000	0.000
Constant	3.062	0.774	1.000	0.000

$$\pi(X) = \frac{e^{3.062+1.315F_1+3.876F_2+2.401F_5+3.542F_7+1.430F_9+2.139F_{14}+1.743F_{17}}}{1+e^{3.062+1.315F_1+3.876F_2+2.401F_5+3.54F_7+1.430F_9+2.139F_{14}+1.743F_{17}}} .$$

By this equation, we can judge whether an enterprise will default or not. When $\pi(X)>(\leq)0.5$, it means that the enterprise has good (bad) credit. The closer that this value is to 1(0), the more credit-worth (weak) the enterprise is.

Classification results of logistic regression model are shown in Table 6. The totalaccurate rate is 90.59%, while accuracies of bad and good credit enterprises are 88.06% and 92.23%. Type I error (credit-weak enterprise is judged as credit-worth) rate is 11.94%, and type II error (credit-worth enterprise is judged as credit-weak) rate is 7.77%.

Table 6
Classification Tablein SCF

Observed	Predicted			
	Y		Percentage correct	
	0	1		
Y	0	95	8	92.23
	1	8	59	88.06
Overall percentage				90.59

3.4 Credit Risk Evaluation in Traditional Model and Analysis

Banks only take the situation of finance enterprise into account in the traditional model. Act as what we have done above, we can build another logistic regression model. The results of classification are shown in Table 7. The total accurate rate is 67.65%, error rate of type I is 30.30%, and error rate of type II is 27.18%.

Table 7
Classification Tablein Traditional Model

Observed	Predicted			
	Y		Percentage correct	
	0	1		
Y	0	75	28	72.82
	1	27	40	59.70
Overall percentage				67.65

Total accuracy in the traditional model is less, while tpye I error rate is greater. So the same small or middle-sized enterprise is more likely to be judged to be good credit in SCF and can get loan from bank.

CONCLUSION

The paper discussed the characteristicsof SCF, paid more attention to the credit condition of the total chain and

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established an index system for credit risk evaluation of SMEs in the new financial model. Quantitative method is applied to compare credit risk of SMEs in traditional model and SCF, results showed that credit risk of SMEs was decreased in SCF. So SCF can help to solve financing problems of SMEs in some ways.

REFERENCES

Hofmann, E. (2105). Supply chain finance: Some conceptual insights. *Logistik Management, 7,* 203-214.

Hu, H. Q., Zhang, L., & Zhang, D. H. (2012). Research on SMEs credit risk assessment from the perspective of supply chain finance—A comparative study on the SVM model and BP model. *Managenet Review, 24*(11), 70-80.

Huang, J., & Zhao, T. Z. (2009). Supply chain finance credit risk forecast base on plain bayes. *Logistic Sci-Tech, 32*(8), 134-137.

Kong, Y. Y., Wang, H. S., Zhu, K., & Li, S. (2010). The application of fuzzy influence diagram method in evaluation of supply chain finance credit risk. *Mathematics in Practice and Theory, 40*(21), 80-86.

Wang, Q. (2010). On credit risk evaluation system of supply chain finance based on decision tree. *New Finance,* (4), 38-41.

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