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Research on mark - to - market design of internet supply chain finance based on logistic model

Wang Di[1], Wang Bao-sen[2,3]

Abstract. With the advantage of Internet platform, this study breaks through the current situation that the existing credit risk model relies too much on the financial index research, abandons the traditional credit risk evaluation index, and selects the non-financial influence index of Internet supply chain finance, such as the basic situation of enterprises, Internet transaction indicators, the quality of Internet services, supply chain industry status etc. And carry on the principal component analysis, then use Logistic regression model to predict default. The empirical shows that effective. This paper designs an innovation model of financial credit risk management in internet supply chain based on mark-to-market mechanism. The model simulate the futures mark-to-market system. Controlling the margin to reduce the credit risk through credit risk judgment by the Logistic risk discriminator.

Key words. Logistic model, internet supply chain finance, credit risk, mark-to-market.

1. Introduction

Internet supply chain finance is the supply chain financial ecosystem under the support of Internet platform. In the ecological, electricity provider, banks, logistics enterprises, the core enterprises and small and medium-sized enterprises cross-border cooperation can get win-win cooperation and gradually get rid of the situation which excessive reliance on traditional finance. Compare to the traditional supply chain finance that transfer the credit risk from small and medium-sized enterprise to the core enterprise of high qualification, Internet supply chain finance transforms credit risk control into credit risk control over the supply chain as a whole. How to manage the financial credit risk of Internet supply chain has become one of the most important topics actively explored by many large-scale Internet platforms.

[1]College of Management and Economics TianJin University Tianjin, 300072,China
[2]School of Economic of Beijing Wuzi University Beijing,101149, China
[3]Corresponding author: Wang Bao-sen

1.1. Literature review at home and abroad

As the Internet supply chain finance is the rise of the domestic, there is rare foreign literature involved in this field. Basu & Nair(2012) analyzed B2B platform of Internet business model of supply chain finance in advance payment and designed a stochastic dynamic programming model. He believed that the Internet platform of small and medium-sized enterprise financial position incomplete can increase the risk of credit. In domestic researches, the earliest articles on Internet supply chain finance is Liu Yinghuan(2012) research on the financial model of online supply chain. Research on financial credit risks in Internet supply chain only by Li Kuan (2014) comprehensive evaluation of financial credit risk in online supply chain. He analyzed the differences between online and offline supply chain financial credit risk management and used the fuzzy evaluation method to establish the mathematical model. However, he didn't give an empirical assessment in that article. Overall, domestic and foreign researches on financial credit risk management of the Internet supply chain are very few, and not comprehensive, not systematic.

2. Logistic Model

Logistic Model is a powerful tool to process categorical data and can explain variables without any confines. And it has extensive applicability.

2.1. Logistic brief introduction

Logistic Model is a probabilistic nonlinear regression model that be widely used when dependent variables are categorical data. According to the value of categorical data, the model can classify 3 type, binary logistical regression, multiple logistic regression classification, matching logistic regression. In this study, we mainly analyze binary logistical regression.

To the study about credit risks, categorical variables: break a contract and comply with a contract. We indentify define "y=1 means break a contract", "y=0 means comply with a contract ", "p(y=1) means the probability of breaking a contract", "x means credit risks indexes", the relationship between a company breaking a contract and credit risks is as below:

$$P = P(Y = 1 \,|X\,) = f(x), 0 \leq P \leq 1$$

Logarithmic transformation model as below:

$$\ln \frac{p}{1-p} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \varepsilon$$

At this point, β_0 is constant, $\beta_1, \beta_2, ..., \beta_k$are regression coefficient of credit risks indexes; P is probability of breaking a contract. The more P is, the more danger company credit risks is. In this study, we chose threshold value as "P=0. 5". if we predict the probability of a financing company break a contract is upon 0. 5 by

logistic regression model, we define the credit risks of internet Supply Chain Finance are obvious.

Otherwise, when the result calculated is under 0. 5, we can define the financing company comply with the contract and the credit risks of internet supply chain finance are controllable.

For parameter estimation of probability of breaking a contract, we estimate it by iterative method:

$$\hat{p} = \frac{\exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k)}{1 + \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k)}$$

2.2. Chose the credit risks of internet supply chain finance

Facing the middle and small-sized enterprises, the unsound financial regulations of the middle and small-sized enterprises, the public financial data which usually can't reflect the true state of operation, Supply Chain Finance should eliminate the invalid and fake information. We will take advantage of internet platform to get real time data resulting from asset price, capital flow, trading activity and so on to estimate client more effectively and true with entire assess and quantification to improve the reliability of loan decisions.

In this study, the credit risks indexes involve four aspect: enterprise basic condition index, internet trading index, internet service quality index, supply chain condition index, as shown in table 1 as below:

Table 1. Credit risk index

Risk index	Check point	The describe of indexes
enterprise basic condition index	annual sales revenue	The enterprise sales in one year
	storage area	The store space of enterprise's stock
	number of employees	Mainly production and research and development occupation
internet trading index	The rate of accumulated trading amount to industry	accumulated trading amount of internet trading at 2016/ accumulated trading amount of industry
	The rate of accumulated buyer amount to industry	accumulated buyer amount on internet platform at 2016/ accumulated buyer amount of industry
	Repeat purchase rate	Upon twice buyer rate
	Refund rate nearly 90 days	Refund client rate nearly 90 days
	Complaint rate nearly 90 days	Complain client rate nearly 90 days
internet service quality index	Degree of the cargo confirming to describe	Degree of the cargo confirming to describe comparing with industry average
	Response speed	The time from purchasing to delivering comparing with industry average
	Deliver speed	The percent of the deliver speed comparing with industry average
supply chain condition index	Repeat purchase rate	The rate of upon twice buyer comparing with industry average
	Refund rate nearly 90 days	The rate of refund client amount comparing with industry average
	Complaint rate nearly 90 days	The rate of complain client amount comparing with industry average

2.3. Principal component analysis

Principal component analysis transform multiple relevant variables to minority variables by dimensionality reduction and linear transformation. To eliminate redundant variable of credit risks indexes of internet Supply Chain Finance, we should process principal component analysis firstly.

The process of principal component analysis involve 5 parts mainly as below:

(1) Standardize the original data of credit risks indexes: Unify dimension, achieve standardized data matrix, the matrix elements as below:

$$\frac{Z^T Z}{n-1}, \frac{Z^T Z}{n-1}$$

and $\frac{Z^T Z}{n-1}$

$$\frac{Z^T Z}{n-1}, \frac{Z^T Z}{n-1}$$

(2) Calculate relevant coefficient matrix, as below:

$$\frac{Z^T Z}{n-1} = \frac{Z^T Z}{n-1}$$

and, $\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$, $\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$

(3) Calculate the eigenvalue of relevant coefficient matrix and relevant eigenvector. According to Jacobian method, Calculate the P characteristic roots of equation$\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$ and achieve the characteristic value of the relevant coefficient matrix R $\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$ and relevant eigenvector$\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$

(4) Achieve the expression of principal component:

$$\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$$

The core logic of principal component analysis is explaining original data by taking advantage of rate of variance contribution. In Math, it's the rate of one of the eigenvector of the principal component to all eigenvector. As below:

contribution rate $= \ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$

(5) Comprehensively assess principal component variables

After choosing principal component, we should pay attention to the practical interpretation of principal component variables. This kind of interpretation need combine with economical significance rather than fill mechanically.

3. Empirical analysis

The data of this study are from Alibaba. com, which selected 60 small and medium-sized enterprises, 30 enterprises as the training samples to build the model, and the other 30 enterprises are used as the test samples of the model, a total of 900 data. According to the above selection of credit risk index of Internet supply chain, this study involves 14 independent variables, annual revenue, storage area, staff number, total number of transactions, cumulative buyers, repeat purchase rate, nearly 90 days refund rate, nearly 90 days complaint rate, goods match, response speed, delivery speed, supply chain repetitive purchase rate, supply chain nearly 90 days refund rate, supply chain nearly 90 days complaint rate.

SPSS statistical software was used to analyze the results in the Table2. Four aspects are described: minimum, maximum, mean, and standard deviation. The descriptive statistics are mainly used for the next step of the principal component

analysis of the unified dimension.

Table 2. description of the statistics

N	Minimum value	maximum value	mean value	standard deviation
Annual Revenue X130	30	7000	1493. 67	1883. 514
Warehouse Area X230	50	7000	2115. 27	1900. 628
Staff Number X330	5	2924	247. 53	562. 631
Total Number of transactions X430	. 0741	33. 9912	4. 216567	7. 6461486
Cumulative Buyers X530	. 1250	34. 6875	3. 975090	7. 2392990
Repetitive Purchase Rate X630	. 00%	67. 00%	27. 3820%	16. 00730%
Nearly 90 days Refund Rate X730	. 00%	10. 00%	3. 4667%	2. 97962%
Nearly 90 days Complaint Rate X830	. 00%	. 50%	. 0450%	. 12434%
Goods Match X930	. 00%	10. 00%	5. 6333%	1. 92055%
Response Speed X1030	-47. 00%	40. 00%	. 8667%	23. 65373%
Delivery Speed X1130	-16. 00%	17. 00%	5. 5000%	7. 82459%
Supply Chain Repetitive Rate X1230	16. 38%	25. 31%	21. 9897%	2. 50163%
Supply Chain Nearly 90 days Refund Rate X1330	4. 52%	15. 93%	7. 0750%	2. 15798%
Nearly 90 days Complaint Rate of Supply Chain X1430	. 13%	. 34%	. 2523%	. 07186%
Credit Rating Y30	0	1	. 47	. 507
Effective N List Status 30				

3.1. Principal Component Analysis and its Results.

By using the SPSS statistical software, the principal component analysis of the 14 Internet supply chains financial credit risk index above was carried out, and the total variance was explained. According to the principle of principal component extraction, if the eigenvalues were greater than 1 and the cumulative variance was greater

than 85%, the cumulative variance contribution rate of the six main components can reach 87. 83% and can explain 87. 83% of the total variance was greater than 85%, indicating that the original data can effectively reflect the main information.

After the selection of the principal component, we further do the orthogonal rotation of the factor data through the factor load matrix, so we can get the component load matrix:

Supply chain repetitive purchase rate X12, supply chain nearly 90 days refund rate X13, supply chain nearly 90 days complaint rate X14 and other original variables information is mainly reflected in the factor F1, which is the whole expression of the supply chain.

The cumulative number of transactions X4, the cumulative buyers X5 and other original variables are mainly reflected in the factor F2, the expression of the Internet transaction frequency status of the financing side.

The information of the primary variables, such as annual revenue X1, warehouse area X2, is mainly reflected in factor F3, which expresses the basic situation of the main body of the financing party.

Response speed X10, delivery speed X11 and other original variables information is mainly reflected in the factor F4, the expression of the service quality of the situation of the financing side.

Nearly 90 days complaint rate X8 and other original variables of information is mainly reflected in the factor F5, the expression of the status of the supply chain downstream complaints.

Repetitive purchase rate X6 information such as the original variable is mainly reflected in the factor F6, the expression of the repeated purchase of the situation of the supply chain downstream.

In short, the six principal components represent the overall situation of the supply chain, the frequency of Internet transactions, the main basic conditions, quality of service, downstream supply chain complaints and duplication of procurement, explained 87. 83% of the main information of the internet supply chain enterprises.

3.2. Logistic Regression Results and Analysis

In this study, we treat six principal components as the independent variables, credit rating as a dependent variable, and use the SPSS statistical software Logistic regression model analysis to get the results shown in Table 3:

Table 3. Variables in the equation

		B	S. E,	Wals	df	Sig.	Exp (B)
Step 1a	FAC1_1	2. 034	2084. 521	15. 461	1	. 018	7. 645
	FAC2_1	-2. 111	13956. 724	4. 665	1	. 046	. 121
	FAC3_1	-1. 975	4051. 371	8. 793	1	. 004	. 139
	FAC4_1	-3. 008	1643. 653	3. 577	1	. 023	. 049
	FAC5_1	2. 386	2296. 748	8. 190	1	. 037	10. 870
	FAC6_1	-2. 690	5630. 062	4. 126	1	. 000	. 068
	constant	-2. 743	5197. 879	11. 284	1	. 002	. 064
a. The variable you entered in step 1: FAC1_1, FAC2_1, FAC3_1, FAC4_1, FAC5_1, FAC6_1.							

From Table 3 above, we see that under the significant level of 5%, the six principal components are significant, so the whole model is also significant. The default probability logistic regression model of the financier is as follows:

$$\ln \frac{p}{1-p} = -2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4 + 2.386F_5 - 2.69F_6$$

That is, the default probability of the financier is as follows:

$$\hat{p} = \frac{1}{1 + \exp\left[-\exp(-2.743 + 2.034F_1 - 2.111F_2 - 1.975F_3 - 3.008F_4)\right]}$$

Finally, we use the above formula to test the remaining 30 test samples back to verify the applicability of the model. In Table 4, we know that the average accuracy rate of the logistic regression model is 90%, and the first class has 13 out of 15 default samples, the accuracy rate is 86. 7%; the second category has 15 Non-default samples identified 14, the accuracy rate was 93. 3%. These results indicate that the Logistic regression model has a good predictive power.

Table 4. Classification tablea

	Observed		Predicted		
			Credit ratingY		Percent Correction
			0	1	
Step 1	Credit ratingY	0	14	1	93. 3
		1	2	13	86. 7
	Total Percentage				90. 0
a. The cutting value is . 500					

4. The Design of Mark-to-Market Model for Internet Supply -Chain finance

Using Logistic Regression Model to predict credit risk of financing enterprises in Internet supply chain finance has been proved by the empirical analysis that the method has the real-time dynamics. In this study, the pre-judgment method is applied in credit risk management. There are two core points in credit risk management of internet supply-chain finance : first, how to identify the identity of financing client and the authenticity of transaction. Second, how to Measure and judge credit risks dynamically.

Mark-to-market is applied to the credit risk management model of Internet supply chain finance is a risk discriminator added in this study to measure and judge credit risks dynamically.

4.1. The model of mark- to-market

The mark-to-market model structure of credit risk management of internet supply chain finance is constructed by this study just like picture 5-1. The credit risk management of Internet supply chain finance in this mode mainly involves five subjects: internet platform capital demand client fund supplier Logistics Enterprises(warehouse) Third-party payment platform. For the convenience of study, assume the internet platform capital demand client fund supplier Logistics Enterprises(warehouse) Third-party payment platform belong to sub-enterprises of internet platform enterprise group. The Alibaba Group and Jingdong group meet this assumption in reality. The internet platform is the core of whole credit risk control, because it is the nature of big date , these big date only through the internet platform can truely achieve the authenticity of monitoring transactions. The capital demand client can be supplier of internet platform and downstream sellers, include all of the internet platform companies, these companies can apply to the internet platform for loan if they achieve the condition of credit. The logistics enterprises and warehouse is important part in integration logistics. so if it is controlled by internet platform , the platform will gain the intangible collateral that not just include the accounts receivable orders warehouse receipts and so on. The fund supplier can be the Internet platform enterprise's own funds P2P small loan companies even is the traditional financial institutions etc. The focus of the closed-loop capital flow is the third-party payment platform, just like the Alipay Tenpay etc, that can realize the cycle of financing repayment and investment. The third-party payment platform through logistic risk discriminator to Instantly and dynamically monitor the capital demand client situation that will be the basis to Predict the Credit Risks of Demander. In the end they will complete the cycle of Capital allocation control post-loan monitoring and repayment.

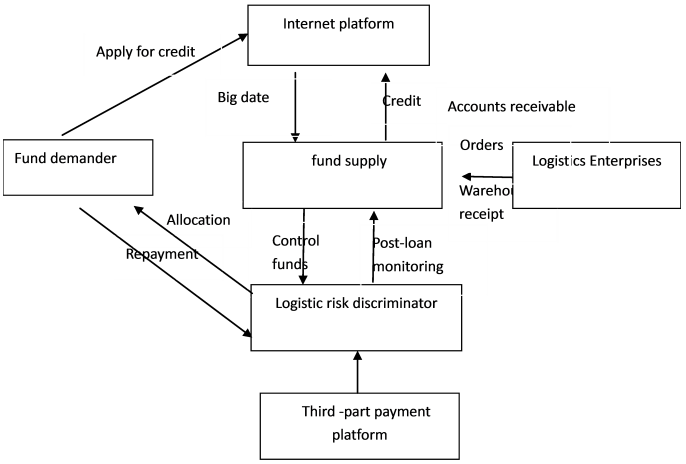

Fig. 1. Operation flow chart of mark-to-market of internet supply-chain finance

4.2. The realization of mark-to-market mechanism

In this study, we design the credit risk management model of internet supply chain finance by simulating the futures market. The capital demander and capital supplier are equivalent to buyers and seller of futures transaction. The third-payment platform just like the futures company.

The advantage of third-payment platform is that they can easily get relevant date and dynamic non-financial date for Logistic model calculation, such as transaction frequency??customer activity??satisfaction etc. Therefore the third-payment platform control the Logistic risk discriminator and manage the margin account number.

This mark-to-market system is divided into two parts that include before loan and after loan's credit risk management. The before loan credit risk management is capital applier rely on the internet platform big date to decide whether or not to approval the credit. And when the third-part payment know the loan quota and line of credit they will let The capital demander submit a certain percentage of the initial margin. The after loan credit risk management is the third-part payment use the Logistic model calculate the enterprise default probability. If the enterprise default probability lower than a certain value , the margin account funds will be unchanged. When it is higher than a certain value and lower than 0. 5 , if it is closer to the 0. 5, the more funds will need to submit. When the margin ratio is lower than the maintenance margin ratio, the third-part payment platform will claim more margin. If the default probability reach the 0. 5 or the capital demander don't add the margin, the capital supplier will stop lending, recover the balance of the loan and it has the right to charge all the remaining margin just like the forced liquidation in futures trading. At the same time, the third-party payment platform need to assist the capital supplier accomplish the collection management??early warning and loss

management.

5. Conclusion

This paper has constructed the credit risk model of Internet supply chain finance by Logistic, and carried on the empirical study, then designed the logistic risk discriminator. And with the mark to market principles designed an innovative credit risk management model. This model is suitable for a wide range of Internet platform. The key shortcoming of the existing Internet financial is a single line of credit is too small. For example, Ali's single line of credit is only around one million yuan. This related to its fully rely on big data for credit risk measurement. Since there is no mortgage, the corresponding risk compensation have higher requirement to achieve the purpose of diversification. This paper introduces the Logistic risk discriminator to realize the credit risk management under the Mark-to-market mechanism and effectively reduce the credit risk. This model makes up for the shortcomings of the Ali model can not be large amount of credit in order to achieve large-scale credit.

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