

Research on the Enterprise Credit Risk Rating System in Supply Chain Finance Based on Jingdong

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Abstract: In recent years, with the rapid development of Internet in our country and the continuous expansion of the trading volume of e-commerce, supply chain finance came into being. The supply chain financing has not only found a new way out for SME financing difficulties, but also enhanced the stability of the overall operation of the supply chain. Therefore, this article focuses on the management of corporate credit risk under the supply chain finance model. Firstly, we select the economic data of 120 listed SMEs in China as the research sample in 2016, and establish the corresponding credit risk evaluation model by using principal component analysis and Logistic regression. Further, this paper takes Jingdong as an example, uses the model to measure its credit risk, and compares the probability of Jingdong compliance with the supply chain finance financing model and the traditional bank credit model. There is a credit rating system to improve the creditworthiness and financing ability of Chinese enterprises and provide more reference ideas for the healthy development of supply chain finance in our country.

Keywords: Supply Chain Finance Credit Risk, Principal Component Analysis, Logistic Regression

1. Introduction

SME in China have faced general financing problems including narrow channels and high costs in practice. However, the improvement of the Internet and informatization of the industry has enabled supply chain finance models come into being, making the financing channels more diversified and the comprehensive financing cost reduced for Internet platforms and enterprises.

This paper will analyze the credit risk control situation of Jingdong in supply chain finance, aiming to provide some reference opinions for the improvement of its supply chain finance risk management system, and also providing ideas for other supply chain finance companies. Moreover, the research is designed and the data is collected and progressed in application with the methods of paper reading, case study, econometric regression and others. The research idea of the enterprise credit risk rating system in the supply chain finance is formed, and foundation for the case analysis of Jingdong is constructed. Taking the typical successful case of supply chain finance Jingdong as an example, the current situation and the future risks of supply chain finance development model of Jingdong are specifically analyzed, proposing corresponding measures in the meanwhile.

Selecting 120 SME listed companies in China in 2016 as research samples, using STATA14.0 software to carry out principal component analysis and Logistic regression analysis, the corresponding SME credit risk evaluation model is obtained. Furthermore, the difference between the compliance probability between the integrated e-commerce platform model of Jingdong and the traditional bank model in the supply chain finance of enterprises is studied.

2. Literature Review

The study of supply chain finance is comparatively abundant due to the early development of foreign supply chain finance. In 2011, Hofmann E believed that supply chain finance is a financial activity based on the real transaction background, and the essence is to help members in the chain to activate liquid assets [1]. In 2013, Meynell D defined supply chain finance as a combination of service and technology solutions, linking demand side, supply side and financial service providers [2]. In terms of risk

management of supply chain finance, in 2014, Zhu Guoyu believed that the credit risk of supply chain finance is mainly manifested in disputes over controlling rights, capital withdrawal, invisible liabilities, and non-related diversified investments [3]. In 2016, Zhai Mingming proposed that supply chain finance is conducive to promoting the stability and smooth circulation of the "production-supply-market" chain of core supply chain enterprises and upstream and downstream supporting enterprises [4]. In 2016, Xiong Xiong used the financial data of listed companies and the randomly simulated qualitative index assignment data to construct a model for empirical analysis, and gave an innovative evaluation method [5]. In 2012, Shen Chengyong conducted a specific analysis on the difference between the potential risks of enterprises' inventory pledge financing activities and other financing methods, and pointed out the corresponding application scenarios and risk prevention strategies [6].

In 2014, Song Bin believed that the risk of supplier supply, distribution, and the information are the main risks of SME in the supply chain [7]. In 2014, Zhou Lijun proposed a set of credit risk evaluation system for supply chain finance. The indicators include supply chain operation status, financing enterprise qualification, etc. [8]. In 2014, Tian Haotian pointed out that the mainstream credit risk evaluation system relies heavily on expert scoring and is too subjective [9]. In 2016, Yang Xinyu analyzed the development status of JD's supply chain financial model, and pointed out the difference in the probability of compliance between JD's supply chain financial model and the traditional bank credit model [10]. In 2015, Zhao Huiling and others believed that supply chain finance should establish a guarantee mechanism and conduct closed management of logistics, information flow, and capital flow [11]. In 2016, Gu Zhenwei analyzed its risk control measures from the perspective of commercial banks, constructed a credit risk evaluation model with principal component analysis, and proposed to realize the bank's control of cargo rights to control risks.

3. Overview of Supply Chain Finance Theory

After sorting out a large number of related literatures on supply chain finance, the connotation, risk characteristics and key points of risk management of supply chain finance are systematically analyzed.

3.1. Supply Chain Finance and its Risk Characteristics

3.1.1. The Connotation of Supply Chain Finance

Supply chain finance is essentially based on the grasp of the structural characteristics and transaction details of the supply chain, with the help of the credit strength of core enterprises or the self-compensation level of a single transaction and the value of goods circulation, providing comprehensive services to a single or multiple enterprises in the supply chain. [4].

3.1.2. Risk Characteristics of Supply Chain Finance

Consisting of several enterprises, the risk characteristics in Supply Chain Finance are different from that of a single enterprise:

First, the supply chain financial risk is transitive. The supply chain from the initial raw material procurement to the final product circulation is jointly participated by different node enterprises. Risks will flow in the chain of the supply chain.

Second, there are games and cooperation in supply chain finance. Because of the pursuit of profit maximization, each enterprise in the supply chain will choose to compete with other enterprises in the supply chain or cooperate with each other according to their known of information.

Finally, owing to the fact that most enterprises in the supply chain only make decisions based on the needs of adjacent upstream and downstream enterprises, the Bullwhip Effect often takes place, leading to the financial risks of huge distinction between the actual demand and supply from the beginning to the end of the supply chain.

3.2. Risk Management of Supply Chain Finance

Combined with the actual situation of supply chain finance, the risk management of supply chain finance is to achieve the purpose of discovering hidden risks and avoiding them by analyzing and communicating risks based on data in advance. Risk management includes the following:

First of all, it is necessary for each enterprise in the supply chain to communicate and negotiate

frequently regarding the causes and consequences of risks and how to deal with them. Effective communication and negotiation help all parties to clarify their responsibilities and implement corresponding plans on the basis of understanding and decision-making.

Secondly, the enterprises in the supply chain should jointly conduct risk assessment and analysis of supply chain finance. They should firstly discover and understand hidden risk points, risk sources, and risk impact scope through comprehensive data, and assess whether risks need to be dealt with in time and find appropriate risk treatment strategies and methods.

Finally, enterprises need to monitor and review risks. Each enterprise in the supply chain records the risk management process on the basis of clearing responsibilities, aiming to provide systematic risk monitoring for the entire supply chain.

4. Analysis on the Current Development Status of the Supply Chain Finance of Jingdong

Jingdong is a representative of the integrated e-commerce platform model in supply chain finance. With its leading position in the e-commerce platform, JD.com took the lead in exploring a supply chain financial model and a credit risk rating system with characteristics of its own.

4.1. Overview of Jingdong

Jingdong is a TOP5 e-commerce company in the world, ranking TOP10 in Internet companies with the highest market value in the world. It has more than 100 million active users and 65,000 suppliers nationwide [10]. As of March 2017, Jingdong has set up 9 logistics centers across the country, operating 263 large warehouses, and its distribution covers nearly 95% of the country's population. In recent years, Jingdong has achieved amazing development. From 2011 to 2016, the total transaction volume of Jingdong grows continuously. As of 2016, in the B2B e-commerce enterprise market, Jingdong Mall ranked second with a market share of 22.9%. Although the growth rate of Jingdong's total transaction volume has fluctuated to a certain extent, the growth rate exceeded 100% in 2012 and 2014, following a downward trend. But in general, the growth rate of Jingdong's total transaction volume is positive, and the growth rate is relatively large.

4.2. Supply Chain Finance Development Model of Jingdong

In 2012, supply chain finance business became a key project of Jingdong. With the development of Jingdong platform transactions and the progress of informatization, many historical transaction data information in the transaction chain has been deposited on the Jingdong. Then it cooperates with banks, carrying out supplier financing activities and credit activities, with Jingdong providing guarantees for the authenticity of the data and banks providing funds. At this stage, relying on the e-commerce platform, Jingdong has created a complete financing ecosystem for suppliers. The specific model is as follows:

4.2.1. Financing Model Based on Order

When the supplier has financing needs, it can apply for a tripartite contract with Jingdong and the bank by virtue of the order contract with Jingdong. Then the relevant information of the supplier from Jingdong would be handed over to the bank for credit review. If the application is approved, the bank will provide the supplier with short-term funds for purchasing raw materials, organizing production, and transporting goods under the order. The supplier must be with strong compliance and high-quality credit in the Jingdong database, and the product is easy to store and has little price fluctuation.

4.2.2. Financing Model Based on Godown Entry

When the supplier has financing needs, the supplier can pledge the goods rights such as the godown entry and the combined order to the bank, and after the goods are transferred to the warehouse of Jingdong, the supplier can apply for financing from the bank. After the goods is sold on Jingdong, the sales amount is directly repaid to the bank.

4.2.3. Financing Model Based on Accounts Receivable

When a supplier has Accounts Receivable from Jingdong, it can transfer the creditor's rights of the accounts receivable to the bank after deducting a certain interest, and obtain funds in advance. After that Jingdong will contact the bank at the end of the account period to checkout.

4.2.4. Financing Model Based on Loan by Mandate

Jingdong directly provides loans to high-quality upstream and downstream suppliers, and the bank lends money to them on their behalf, monitors the flow of the funds, and assists Jingdong to recover the loan.

4.3. The Risk Rating System of Jingdong

First of all, Jingdong has accumulated a large amount of historical transaction data and contract performance of suppliers, and only suppliers on Jingdong are eligible to borrow.

Secondly, suppliers with borrowing qualifications need to submit complete credit information. In addition, internal transaction data such as sales and returns on Jingdong, user evaluations, logistics data, and user's visit time in stores are integrated, which is also used as the basis for the system credit rating.

Thirdly, external credit data from the People's Bank of China, Taobao and other e-commerce platforms are also considered for higher reliability.

5. Empirical Analysis of Supply Chain Financial Risk-Taking Jingdong as an Example

After constructing the risk evaluation system, we select 120 SME listed companies in China in 2016 as research samples, using STATA14.0 to conduct principal component analysis and Logistic regression analysis. After obtaining the corresponding SME credit risk evaluation model, the difference in the probability of compliance between the Jingdong integrated e-commerce platform model and the traditional bank model in supply chain finance will also be figured out.

5.1. Index System Construction and Model Setting

5.1.1. Construction of Credit Risk Evaluation Index System

At present, most of the credit ratings of Chinese enterprises are completed by commercial banks, but the major banks have not yet formed a unified standard. The system below draws on the basic framework of traditional business credit evaluation, following the principles of comprehensiveness, pertinence and rationality. At the same time, it combines the characteristics of supply chain finance. This system focuses on the following four aspects of the evaluation system:

(1) Qualification of the enterprise applying for a loan.

It mainly examines the financial status, operation and management level, cash flow, solvency, and possibility of enterprise development of the enterprise applying for a loan.

(2) Qualification of counterparty

It examines the qualifications of counterparty enterprises in supply chain finance business. In supply chain finance, the bank grants credit to a single transaction, and the qualification of the counterparty company directly affects the quality of the transaction, so it will also pay attention to the qualification of counterparty.

(3) Trading assets

It also takes the feature of trading items as an important factor. Because the bank gives credit according to the value of the transaction assets after measuring the value of them; in addition, the monetization of the transaction assets is also a measure for the compensation for losses after the enterprise defaults.

(4) Supply Chain Operations Conditions

This indicator is the bank's comprehensive evaluation of transaction quality. It avoids biased assessments caused by companies' fraud and concealment of information from the perspective of the entire supply chain, which mainly includes the industry status, the closeness of cooperation, and the performance of previous transactions.

5.1.2. Model Settings

At present, the main credit risk rating systems in academia can be divided into traditional and modern. Because the modern credit risk measurement model has relatively high data requirements, and the

construction of the credit risk database in Chins is very new, so the traditional credit risk measurement model is more commonly used. Among them, the expert system method relies too much on individual subjectivity and is less practical. In contrast, the credit scoring method uses statistical model points to analyze various indicators of the enterprise to judge the probability of compliance of the enterprise, which avoids the subjectivity problem to a large extent. Because there are many factors that will affect the corporate credit rating, considering the relationship between the comprehensive principle and multicollinearity, before constructing the Logistic model, this paper first uses the principal component analysis method to perform factor analysis on the relevant indicators.

5.2. Factor Loading Matrix and Principal Component Analysis

The core of factor analysis is a model that uses several principal component factors to reflect most of the information. This paper uses the CSMAR to select the economic data of 120 listed companies in the SME sector in 2016 as the factor analysis object. Among them, 90 companies with relatively small default risks are selected, and 30 companies with relatively large abnormal performance may be selected. Due to the different standard boundaries of evaluation indicators, this paper evaluates the data in four grades according to Xiong Xiong's evaluation theory, and divides the sample data into four grades of 10, 7, 4, and 0 according to each indicator. After normalizing the scoring data, the following matrix is obtained, as shown in Table 1:

Table 1: Supply Chain Finance Credit Risk Evaluation Indicators and Their Descriptions.

	F1	F2	F3	F4	F5	F6	F7	F8
A1	0.126	-0.083	0.109	0.756	0.058	0.088	-0.051	-0.117
A2	0.007	0.043	0.000	-0.410	-0.172	0.033	0.079	-0.001
A3	0.154	-0.074	-0.005	0.426	0.193	0.097	-0.101	0.130
A4	0.144	0.035	-0.201	0.511	-0.190	0.128	-0.100	0.124
A5	-0.066	0.945	0.167	-0.013	-0.057	-0.022	-0.018	-0.007
A6	0.387	0.331	0.034	0.060	-0.249	0.022	0.029	-0.107
A7	-0.181	-0.112	0.191	0.498	-0.118	-0.034	-0.180	-0.182
A8	-0.032	0.049	0.174	-0.365	-0.127	-0.031	-0.201	-0.194
A9	0.911	-0.179	0.077	0.037	0.021	-0.270	-0.080	0.175
A10	0.913	-0.001	0.091	0.046	0.004	-0.082	-0.076	-0.033
A11	0.386	0.129	-0.245	-0.003	-0.010	-0.132	-0.089	-0.144
A12	-0.011	0.037	0.886	-0.010	-0.003	-0.071	0.004	0.072
A13	0.081	0.083	0.778	0.093	0.102	0.228	-0.013	0.051
A14	0.241	0.2481	0.412	-0.122	-0.205	-0.253	-0.033	0.028
A15	-0.049	0.191	0.265	0.209	-0.057	0.019	0.476	-0.010
A16	0.007	-0.037	-0.029	0.028	0.003	-0.058	0.290	0.219
A17	0.033	0.092	-0.516	-0.002	0.046	0.037	0.042	0.463
A18	-0.022	0.070	0.043	-0.028	0.104	0.118	0.029	0.662
A19	0.157	0.008	-0.065	0.137	-0.292	0.356	0.120	0.019
A20	-0.017	-0.019	0.107	-0.059	0.014	-0.408	-0.058	-0.027
A21	-0.119	-0.005	0.052	-0.128	0.082	0.304	0.237	0.100
A22	0.118	-0.172	0.767	0.170	0.209	-0.238	0.173	0.064
A23	-0.009	0.098	-0.405	-0.002	-0.309	0.176	0.028	-0.077
A24	0.007	0.013	0.061	-0.049	-0.504	0.017	0.035	-0.114
A25	0.057	0.024	0.083	-0.003	0.667	-0.016	-0.047	0.050
A26	-0.071	0.035	-0.042	0.065	0.105	0.006	-0.298	-0.084

After performing principal component analysis, the cumulative contribution ratio of the first eight principal component eigenvalues is 69.71%. Therefore, this paper selects F1, F2, F3, F4, F5, F6, F7, F8 as the final indicators for analysis. The factor loading matrix can represent 26 indicators respectively:

The first factor F1 mainly explains the three indicators of A9, A10, A11, namely the current ratio, the quick ratio and the asset-liability ratio, and their loadings on the factors are 0.911, 0.913, and 0.386, respectively. Therefore, this factor reflects the solvency of the company.

The second factor F2 mainly explains the two indicators of A5, A6, namely return on equity and profit margin on sales, and the loadings on the factor are 0.945 and 0.331, respectively. Therefore, this factor reflects the profitability of a business.

The third factor F3 mainly explains the indicators of A12, A13, A14, A22, A23. The loadings on the factors are 0.886, 0.778, 0.412, 0.767, and -0.405, respectively, reflecting the development prospects of enterprises and the development of the industry.

The fourth factor F4 mainly explains the indicators of A1, A2, A3, A4, A7, A8. The loadings on the factors are 0.756, 0.518, -0.420, 0.426, 0.498, and -0.365, respectively, reflecting the operation of the enterprise. Management quality and operational capability.

The fifth factor F5 mainly explains the two indicators of A24, A25. The loadings on the factors are -0.504 and 0.667, respectively, reflecting the close cooperation degree of enterprises.

The sixth factor F6 mainly explains the three indicators of A19, A20, A21. The loadings on the factors are 0.356, -0.408, and 0.304, respectively, reflecting the characteristics of the enterprise's pledge.

The seventh factor F7 mainly explains the three indicators of A15, A16, A26. The loadings on the factors are 0.476, 0.290, and -0.298, respectively, reflecting the credit rating and industry characteristics of the counterparty, as well as the company's past default situation.

The eighth factor F8 mainly explains the two indicators of A17, A18. The loadings on the factors are 0.463 and 0.662 respectively, reflecting the profitability and solvency of the counterparty of the enterprise.

Among them, the score of each factor can be calculated according to the following formula:

$$\begin{aligned}
 F1 &= 0.126A1 + 0.007A2 + 0.154A3 + \dots + 0.057 A25 - 0.071A26; \\
 F2 &= -0.083A1 + 0.043A2 - 0.074A3 + \dots + 0.024 A25 - 0.035A26; \\
 &\dots \\
 F8 &= -0.117A1 - 0.001A2 + 0.130A3 + \dots + 0.050 A25 - 0.084A26; \tag{1}
 \end{aligned}$$

5.3. Logistic Model Regression

In this paper, using STATA14.0 measurement software, the research samples are regressed with the Logistic model, and the occurrence of default is used as the dependent variable, and the 30 listed companies on the small and medium-sized board of 30 bad companies with relatively large abnormal performance may be assigned as 1, assigning the value of 0 to 90 listed companies on the small and medium-sized board with relatively low default risk, and using the above 8 factors as independent variables, the regression results are as follows shown in Table 2:

Table 2: Model Estimation Results.

	B	S.E.	Wals	df	Sig.	Exp(B)
F1	-0.334	0.306	1.195	1		0.716
F2	-2.607	0.627	17.334	1	0.060	0.074
F3	1.811	0.574	10.059	1	0.102	6.097
F4	-0.104	0.294	0.125	1	0.726	0.901
F5	-0.120	0.299	0.167	1	0.689	0.887
F6	0.287	0.331	0.571	1	0.450	1.314
F7	0.165	0.303	0.296	1	0.586	1.179
F8	0.327	0.303	1.173	1	0.279	1.381
Cons.	-2.071	0.435	24.242	1	0.000	0.096

According to the above table, at the 10% significance level, F1, F2, F3, F4, F5, F6, F7, F8 have no significant effect on the dependent variable. Therefore, this paper builds the model again for regression analysis by using the forward stepwise regression method, and finally selects the regression results of the fourth step, that is, F1, F3, F4, F7 are retained in the model, indicating that these four factors are important for prediction. The company's compliance rate has a significant impact, and the specific results are shown in Table 3:

Table 3: Final Regression Results.

	B	S.E.	Wals	df	Sig.	Exp(B)
F1	-1.412	0.506	7.715	1	0.005	0.244
F3	0.811	0.475	10.053	1	0.002	4.504
F4	0.984	0.454	4.690	1	0.026	0.371
F7	1.165	0.553	13.296	1	0.000	3.179
Cons.	-2.501	0.411	24.972	1	0.000	0.126

According to the above results, it can be concluded that the estimated logistic regression model is:

$$\ln \frac{p}{1-p} = -2.501 - 1.412F_2 + 0.811F_3 + 0.984F_4 + 1.165F_7 \quad (2)$$

$$p = \frac{1}{1 + e^{-(2.501 - 1.412F_2 + 0.811F_3 + 0.984F_4 + 1.165F_7)}} \quad (3)$$

In this paper, 0.5 is used as the cut-off point, and the sample data is substituted into the Logistic model. If the P value is greater than 0.5, the company is judged as a company with high default risk, and vice versa. In the end, among the 90 good companies with relatively small default risks, the model accurately analyzed 79 companies, and the model's correct rate at this time was 87.78%; relatively speaking, among the 30 bad companies that may not perform normally, the model accurately analyzes 22 companies, and the correct rate of the model at this time is 73.33%. To sum up, combined with the weight analysis, the overall correct rate of the model judgment is 84.17%.

5.4. Credit Risk Evaluation—Taking Jingdong as an Example

This paper takes Jingdong, a typical representative of China's supply chain finance, as an example, using the CSMAR to obtain Jingdong financial statements in 2017. Using the above model to measure Jingdong credit risk, the probability of non-compliance under the traditional bank credit model and Jingdong supply chain finance model are compared.

5.5. Empirical Summary

Comparing the compliance probability of the creditor under the supply chain financial model with that of the creditor under the traditional bank credit model, it can be seen that the compliance probability of the creditor is as high as 83.4%, providing good financing conditions for Jingdong. Based on the indicators that are emphasized in the traditional financing model, the probability of Jingdong compliance is only 43.6%. The credit status reflected by it is greatly reduced, which will make it difficult to obtain stable loan support from banks. It is foreseeable that the risk measurement of the supply chain financial model has greatly improved the probability of compliance with a series of companies represented by Jingdong, and on the basis of reducing their credit risk, it is helpful for their financing.

6. Suggestions for Strengthening Financial Risk Control of Jingdong Supply Chain

To develop a supply chain financial model for comprehensive e-commerce represented by JD.com, in addition to controlling the traffic and data on the platform, it is also necessary to vigorously develop financial technology and strengthen cooperation with counterparties.

6.1. Risk Control Based on Process and Data

Although a relatively comprehensive credit evaluation system for supply chain finance has been established in this paper, its accuracy could still be affected by some unobtainable data, the random data generation method and scoring method. Therefore, Jingdong should try to obtain more data in the transaction chain by restoring the entire transaction chain, like data such as warehousing, purchase orders, and buying and selling to establish a more complete database and a more complete dynamic analysis model, so that its risk control ability becomes stronger.

6.2. Fintech Helps Solve Supply Chain Financial Dilemma

The supply chain finance model unifies all enterprises in the production chain, strengthening cooperation and realizing information sharing. Using blockchain technology to enhance the trust of all parties, it reduces operational risks and transaction costs; through the Internet of Things technology, it achieves the mutual synchronization management of online databases and offline inventory, and reduces the cost of goods supervision.

6.3. Deepen Cooperation between Jingdong and Suppliers

In the supply chain finance model, Jingdong must enhance collaboration with suppliers. On the one hand, Jingdong can gather real financial information, transaction information, etc. to suppliers in a timely manner, so as to facilitate smooth connection between suppliers; On the other hand, the information feedback from suppliers through timely communication is beneficial to the further development of Jingdong.

7. Conclusion

Based on the theoretical analysis of credit risk management in supply chain finance, this paper selects the economic data of 120 SMEs listed on the small and medium-sized board in China in 2016 as research samples, having constructed a credit risk assessment index system. Using principal component analysis to select four main factor, it completes logistic regression analysis. This paper further takes Jingdong, a typical supply chain finance company, as an example to measure its credit risk. It compares the difference in the probability of the creditor's compliance under the risk management of Jingdong supply chain finance and the traditional financing model. It is found that the risk calculation under the supply chain finance model is conducive to correctly deriving the default probability of Chinese enterprises, making the financing channels of small and medium-sized enterprises more diversified. At the same time, the development of the supply chain financial model will help to further improve China's credit evaluation system and database system.

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