ISSN 2616-5902 Vol. 5, Issue 12: 133-137, DOI: 10.25236/AJBM.2023.051223

Research on credit evaluation of enterprises in supply chain finance business

Siyu Liu, Xiaowen Ying, Ying Xie, Jiali Bai

School of Finance, Shanghai Lixin University of Accounting and Finance, 201209, Shanghai, China

Abstract: *As a crucial link in the survival and development of enterprises nowadays, supply chain finance covers all aspects of enterprises and financial institutions. This study is dedicated to using techniques such as big data mining, mathematical modeling, industry standard definition and visualization analysis to apply the relationship between enterprises and each enterprise into a weighted directed network, determine credit rating weights using entropy weight method and TOPSIS, and monitor the information changes of enterprises in real time. With the relationship as the core, we collect and integrate enterprise credit information by means of feature extraction and graph construction, early warning risks, visualize and present complex business relationships, accurately supervise and serve the collateral and pledges by means of information technology, and timely grasp the operation status of goods and commodity price fluctuations staring the market, and visualize and present complex business relationships.*

Keywords: *Supply Chain Finance, TOPSIS, K-means Analysis*

1. Introduction

As a crucial link in the survival and development of enterprises nowadays, supply chain finance covers all aspects of enterprises and financial institutions [1-2]. This study is dedicated to using techniques such as big data mining, mathematical modeling, industry standard definition and visualization analysis to apply the relationship between enterprises and each enterprise into a weighted directed network, determine credit rating weights using entropy weight method and TOPSIS, and monitor the information changes of enterprises in real time[3-4]. With the relationship as the core, we collect and integrate enterprise credit information by means of feature extraction and graph construction, early warning risks, visualize and present complex business relationships, accurately supervise and serve the collateral and pledges by means of information technology, and timely grasp the operation status of goods and commodity price fluctuations staring the market, and visualize and present complex business relationships [5].

2. Assessment index construction and solution for supply chain credit risk

2.1 Assessment index construction of supply chain credit risk

By reviewing a large amount of literature and combining our complex network model, we constructed four first-level indicators for small and medium-sized financing enterprises, core enterprises, supply chain relationships, and enterprise assets[6-7], and finally obtained the rating system as shown in Table 1.

For the selection of indicators, we followed the following four basic principles.

Comprehensiveness: Most of the current supply chain finance is "M+1+N" model, therefore, when constructing the credit risk evaluation system, we should not only evaluate a single category of indicators, but also examine the core enterprises, upstream and downstream enterprises of the core enterprises, the strength of the relationship between the supply chain and the asset status in a comprehensive and complete way, and try our best to achieve a multi-faceted and deep-seated We should try our best to show the operation and status of each enterprise from multiple perspectives and deep levels. In addition, the linear relationship between enterprises in the complex network and the market environment are also the focus of the evaluation model.

ISSN 2616-5902 Vol. 5, Issue 12: 133-137, DOI: 10.25236/AJBM.2023.051223

Table 1: Evaluation index system

First-order index	Secondary index	Three-level index
Small and medium-sized financing enterprises	Management personnel	Management level（X_1）
	Profitability of small and medium-sized financing enterprises	Return on equity（X_2）
		Net operating margin（X_3）
	Management ability	Gross profit ratio(X_4)
		Inventory turnover(X_5)
		Accounts receivable turnover rate(X_6)
	Solvency	Quick ratio(X_7)
		Current ratio(X_8)
		Interest cover multiple(X_9)
		Asset-liability ratio(X_{10})
	Development ability	Net profit growth rate(X_{11})
		Growth rate of total assets(X_{12})
	Sales capacity	Sales staff turnover rate(X_{13})
		Net profit rate on sales(X_{14})
	Innovation ability	Ratio of technical personnel(X_{15})
		New technology multiplier(X_{16})
		Intensity of R&D investment(X_{17})
Core enterprise	Solvency	Shareholders' equity ratio(X_{18})
	Credit standing	Credit rating(X_{19})
Supply chain relationship	Relationship strength	Transaction frequency(X_{20})
Enterprise assets	Asset position	Inventory turnover rate(X_{21})
		Accounts receivable period(X_{22})
		Return on invested capital(X_{23})

Scientific: We have selected three levels of indicators to reflect the actual situation of the enterprise in Mo, while each indicator follows the principle of independence and is not related to each other. We adopt a scientific and rigorous method to screen the indicators and apply the criteria of financial standards to ensure the scientific nature of the selection of indicators.

Targeted: We have added a new indicator to reflect the relationship strength of the supply chain, which is reflected by the frequency of transactions between each independent enterprise. Compared with the previous monolithic evaluation, we have upgraded the indicators to be more targeted according to the characteristics of the supply chain credit chain, and the prediction of credit risk is more targeted.

Operability: In the actual operation process, in order to avoid the problems of difficult data search and incomplete information, we choose clear and highly operable indicators to build the credit evaluation system. At the same time, most of the indicators are available in corporate information disclosure websites such as Flush, Choice, etc. We simplify the information screening process while making the evaluation of indicators quantifiable and avoiding the influence of subjectivity on credit ratings.

2.2 Supply Chain Credit Risk Resolution

We currently have different solutions for the credit risk of three different financing models.

For accounts receivable financing model, it is difficult to supervise the authenticity of the trade as well as the destination of the financing money.

For the core enterprises and small and medium-sized trade, it is difficult to monitor the authenticity of the trade and to supervise the destination of the financing money. With the use of big data storage technology, all transaction records can be traced, and financial institutions can judge the financing credit of SMEs by discovering the credit relationship of related enterprises. At the same time, we can determine the financing amount based on the traced historical transaction records as well as various payment categories and whereabouts, providing a basis for the next credit assessment. This approach can effectively solve the information asymmetry problem between SMEs and financing institutions, and each transaction of SMEs will be open to all financial institutions, thus effectively avoiding the credit risk caused by opaque information[8].

For the prepaid financing account model, banks and other financial institutions can determine the amount of financing by confirming the number of SME deposits and the sales of goods of SME financing

ISSN 2616-5902 Vol. 5, Issue 12: 133-137, DOI: 10.25236/AJBM.2023.051223

enterprises as well as the repurchase ability of core enterprises due to the sales of goods of SME financing enterprises and the repurchase ability of core enterprises. Therefore, when faced with such a situation, if the downstream financing company has credit problems or the core company is unable to repurchase the goods, we will use this as the basis to determine whether the SME should be financed and the amount of financing[9-10].

In response to the credit problems that exist in traditional inventory pledge financing, banks and other financial institutions can choose whether to finance SMEs by confirming whether the logistics and warehousing sector has the ability to keep the pledged items and the ability to properly assess the value of the pledged items due to the problems of supervising warehouses and third-party logistics companies. We can build a digital logistics information network through GPS locators and other means to supervise in real time thus ensuring the stability of transactions and effectively avoiding risks.

3. Evaluation model building and solving

3.1 TOPSIS superiority and inferiority solution distance method

The above indicators are all very large indicators, using TOPSIS superior and inferior solution distance method, the original data matrix to normalize the original data, to get

$$Z=\begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ z_{n1} & z_{n2} & \cdots & z_{n4} \end{bmatrix} \tag{1}$$

The best and worst values of each index form the best value vector Z+ and the worst value vector Z-, respectively.

$$Z^{+}=(z_1^{+},z_2^{+},\cdots,z_p^{+});Z^{-}=(z_1^{-},z_2^{-},?\ ,z_p^{-}) \tag{2}$$

$$z_j^{+}=\max\left\{z_{1j},z_{2j},\cdots,z_{nj}\right\},\ j=1,2,\cdots,p \tag{3}$$

$$z_j^{-}=\min\left\{z_{1j},z_{2j},\cdots,z_{nj}\right\},\ j=1,2,\cdots,p \tag{4}$$

Calculate the distance of each evaluation unit from the optimal and inferior values

$$D_i^{+}=\sqrt{\sum_{j=1}^{p}(z_{ij}-z_j^{+})^2};D_i^{-}=\sqrt{\sum_{j=1}^{p}(z_{ij}-z_j^{-})^2} \tag{5}$$

Calculate the relative proximity of each evaluation unit to the optimal value

$$C_i=\frac{D_i^{-}}{D_i^{+}+D_i^{-}},i=1,2,\cdots,n \tag{6}$$

In order of relative proximity, the larger Ci indicates that the i-th evaluation unit is closer to the optimal level. Finally, we can normalize Ci.We can also normalize Ci to obtain the score of enterprise credit as the nodal power, and through the z-score model.We can effectively obtain the enterprise bankruptcy risk.

3.2 Z Fractional Model

According to Altman's Z-score model, which is also known as multivariate model, liquidity, profitability, leverage ratio, debt-servicing ability and activity are the five factors that affect the probability of debt default. The basic expression of the Z-score model is:

$$Z=1.2X_1+1.4X_2+3.3X_3+0.6X_4+0.999X_5 \tag{7}$$

The specific meaning of each indicator is shown as follows: X1 indicates the liquidity of the enterprise's assets and the size characteristics. X1 indicates the liquidity and size characteristics of the

ISSN 2616-5902 Vol. 5, Issue 12: 133-137, DOI: 10.25236/AJBM.2023.051223

company's assets, and is expressed as working capital at the end of the period/total assets at the end of the period, which is positively correlated with the liquidity of the company's assets. The larger the value, the stronger the company's ability to compete in the market and its ability to innovate; X3 indicates the company's ability to continue to repay its debts with EBIT / I total assets at the end of the period, which is used to measure the company's profitability, the larger the value, the stronger the company's profitability and the lower the risk of debt; X4 indicates the financial structure of the company. X4 indicates the financial structure of the enterprise, and the market value of equity capital/total book value of liabilities at the end of the period, which is used to measure the investment value of the company, and the larger the value, the more it indicates that the company is worth investing; X5 indicates the ability of the enterprise to generate and create income from assets, and the revenue from main business/total assets at the end of the period, which is used to measure the liquidity of the enterprise, and the larger the value, the stronger the liquidity of the enterprise. The Z-value model is used as a comprehensive indicator of financial default risk. The Z-value is inversely proportional to the likelihood of financial risk, and a smaller Z-value means a higher likelihood of financial risk. Altman believes that the threshold value of risk is $Z > 2.675$, $Z < 1.81$, which indicates that the enterprise's financial situation deteriorates and there is a risk of bankruptcy; $1.81 < Z < 2.675$, which indicates that the enterprise's financial situation is extremely unstable and may lead to risk: $Z > 2.675$, which indicates that the enterprise's financial situation is good and there is no risk of bankruptcy.

3.3 K-means analysis

The extracted eigenvalues were analyzed by K-means using SPSS, and the analysis process is shown in Figure 1.

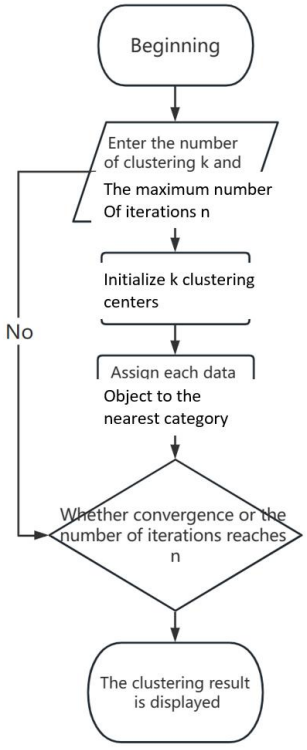

Figure 1: K-means analysis flow

Finally, we perform regression predictions to test for heteroskedasticity using BP test and White's test, respectively, to adjust the goodness of fit.

4. Conclusions

This paper uses complex network, modeling, visualization and other related technologies to infer enterprise credit, enhance the cost of violation, and apply the credit relationship between core enterprises and their upstream and downstream SMEs in the complex network diagram around the "M+1+N" scheme, so that the credit relationship between them is clear and three-dimensional; it is conducive to the transfer

ISSN 2616-5902 Vol. 5, Issue 12: 133-137, DOI: 10.25236/AJBM.2023.051223

of high-quality credit lines from core It is conducive to the transfer of high quality credit lines from core enterprises to supply chains, and creates conditions for financing of SMEs. On the one hand, theoretically, we use a series of methods such as complex network, Z-score model, entropy weight method, TOPSIS, cluster analysis, multiple regression, etc. to overcome the credit risk in traditional supply chain finance in a targeted way, and propose a more accurate prediction model through quantitative research and digital description of the risk, so as to propose a new direction for the research of credit risk in supply chain finance. On the other hand, in reality, we use its accurate risk warning capability to effectively reduce risk monitoring costs and improve risk management efficiency of financial institutions. Core enterprises are more willing to grant credit to small and medium-sized platforms in the regulatory platform, and as a result, the efficiency of SME financing is significantly improved. The better financing credit status between the upstream and downstream of the industry will also further form a negative feedback regulation, increasing the efficiency of the transaction between the upstream and downstream of the industry, and enterprises deepen the business relationship between.

Acknowledgements

This paper was supported by the Innovation and Entrepreneurship Training Program for college students of Shanghai Lixin University of Accounting and Finance (Project Number: 202211047012).

References

[1] Wei Yicheng, Liu Xiaoyu. Credit risk management problems and preventive measures in supply chain finance [J]. Banker, 2022(10):116-120.
[2] Yang Yueyun. Credit risk study of supply chain finance accounts receivable asset securitization [J]. China CPA, 2022(02):60-63. DOI:10. 16292/j. cnki. issn1009-6345. 2022. 02. 010.
[3] Chen Xiangzhou, Tao Lihong. Credit risk assessment of SME supply chain finance based on MLP neural network [J]. Journal of Hunan University of Science and Technology (Natural Science Edition), 2021, 36(04):91-99. DOI:10. 13582/j. cnki. 1672-9102. 2021. 04. 013.
[4] Lin YM, Shi MJ, Chen L, Wang H. Credit penetration and multiparty win-win: A study on the innovation of blockchain-based supply chain finance model [J]. Credit, 2021, 39(05):28-34.
[5] Tian Kun, Zhuang Xintian, Zhao Wanting. Credit risk assessment of small and medium-sized enterprises under the supply chain finance model--analysis based on data of automobile manufacturing industry [J]. Industrial Technology Economics, 2021, 40(05):15-20.
[6] Yi Jianhua, Guo Feng. The selection and application of enterprise credit risk assessment index system from the perspective of supply chain finance [J]. Journal of Jinan University (Social Science Edition), 2021, 31(02):103-112+159-160.
[7] Group of Business Management Department, Chengdu Branch, People's Bank of China, Long Juntao. Supply chain finance and micro and small enterprise financing: transmutation from credit isolation to credit penetration [J]. Southwest Finance, 2020(07):65-75.
[8] Li Guangrong. Credit risk causation in agricultural supply chain finance: a systematic framework and empirical analysis: 780 survey data from five provinces and districts in the middle and upper reaches of the Yellow River [J]. Financial Theory and Practice, 2020, 41(03):17-24. DOI:10. 16339/j. cnki. hdxbcjb. 2020. 03. 003.
[9] Kuang H-B, Du H, Feng H-Y. Construction of credit risk index system for small and medium-sized enterprises under supply chain finance [J]. Scientific Research Management, 2020, 41(04):209-219. DOI:10. 19571/j. cnki. 1000-2995. 2020. 04. 022.
[10] Li J, Zhang JL. Research on credit risk identification and early warning model of supply chain finance [J]. Economic Management, 2019, 41(08):178-196. DOI:10. 19616/j. cnki. bmj. 2019. 08. 011.