Credit Risk Quantification of Micro and Medium-Sized Enterprises and Optimization Model of Bank Credit Strategy

Xuesong Wang[1,a], Yuhang Liu[2,b*]

Email: wangxuesong@sgeri.sgcc.com.cn[a]
*Corresponding author. Email: 3186039668@qq.com[b]

State Grid Energy Research Institute Co., Ltd. Beijing, China[1]
Capital University of Economics and Business, No. 121 Zhangjia Road, Huaxiang, Fengtai District, Beijing, China[2]

Abstract. Combined with social hot spots and international political situation, this paper focuses on the credit decision of a bank to micro and medium-sized enterprises, and analyzes the impact and risk rating changes of enterprises in various industries under the actual unexpected factors such as the COVID-19 pandemic and the sanctions imposed by the United States on Chinese enterprises. Using analytic hierarchy process (AHP) and fmincon function to solve the optimal solution of nonlinear programming model, a multi-objective decision model based on AHP is constructed. Based on the relevant data of 123 enterprises with credit records, this paper draws the conclusion that the optimal credit strategy of a bank for 123 enterprises with credit records when the annual total credit is fixed, and the credit strategy of 302 enterprises under the influence of sudden factors, and puts forward reasonable suggestions for the bank based on the actual situation.

Keywords: credit decision; analytic hierarchy process; nonlinear programming model

1 INTRODUCTION

The general office of the State Council issued the opinions on the implementation of financial support for the development of small and micro enterprises. In order to further improve the financial services for small and micro enterprises and fully support the benign development of small and micro enterprises, the following suggestions are put forward: accelerate the enrichment and innovation of financial services for small and micro enterprises; Focus on strengthening the credit enhancement service and information service for small and micro enterprises; We will actively develop small financial institutions. In practice, due to the relatively small scale, unstable development and lack of mortgage assets of small, medium-sized and micro enterprises, banks are intermediaries in money and credit business, and credit is its main source of income[1]. Usually, according to credit policies, enterprise transaction bill information and the influence of upstream and downstream enterprises, banks provide loans to enterprises with strong strength and stable supply and demand relationship, and can provide loans to enterprises with high reputation, high credit and stable supply and demand relationship Enterprises with low credit risk will be given preferential interest rates. Based on this attribute, the ability of

ICBBEM 2023, May 19-21, Hangzhou, People's Republic of China

DOI 10.4108/eai.19-5-2023.2334351

banks to bear risks is weak; Coupled with the relatively small scale of small, medium and micro enterprises and the lack of mortgage assets, the risk of bank loans to them is relatively large[2].

In view of this, based on the relevant data of 123 enterprises with credit records, 302 enterprises without credit records and the statistical data of 2019 on the relationship between loan interest rate and customer churn rate, this paper studies the credit decision-making of small and medium-sized enterprises. Help to solve the problem of financing difficulty and high cost of small and medium-sized enterprises, Support its stable and rapid development and promote China's economic and social progress.

2 LITERATURE REVIEW

Ji Jing[3] reviewed and compared the existing international commonly used credit risk measurement models in 2008. She made an in-depth analysis of the connotation of five basic indicators for measuring credit risk: PD, LGD, EL, CVaR and UL. Based on the above indicators, she focused on the common credit risk measurement models. Finally, according to the actual situation of our country, the specific countermeasures and suggestions of credit risk measurement are put forward.

From the perspective of commercial banks, Liu Linghao[4] in 2018, mainly supported by two theories of information asymmetry and credit decision, combined with actual cases, starting from the aspects of transaction costs, credit decision, credit assessment, etc., fully researched the real problems and intrinsic reasons of commercial banks in the issuance of credit funds for SMEs, analyzed the defects of existing domestic credit rating methods, drew on the advanced experience of domestic and foreign commercial banks, and finally gave specific solutions and optimization suggestions for commercial banks to support SME financing.

This paper summarizes the past, constructs the multi-objective decision-making model and nonlinear programming model based on analytic hierarchy process, and carries out the credit risk rating of enterprises. On this basis, it focuses on the impact of various sudden factors on small and medium-sized micro enterprises, and finally gives the specific scheme and optimization suggestions of banks' credit strategy for small and medium-sized micro enterprises.

3 DATA AND MODEL

3.1 Data sources

The data used in this paper are from the relevant data of 123 enterprises with credit records, 302 enterprises without credit records and the 2019 statistical data of the relationship between loan interest rate and customer churn rate. At the same time, the invoices issued by the seller when purchasing products and the invoices issued by the buyer when selling goods, i.e. Input invoices and output invoices, are given for each enterprise from 2017 to early 2020.

3.2 Research methods

First of all, we need to make a quantitative analysis of the credit risk of 123 enterprises. According to the idea of AHP, referring to Wang Sujuan's 2013 study on the impact degree analysis of credit risk factors of commercial banks for small and micro enterprises using FAHP method[5], we first hierarchy the problem, construct a hierarchical structure model, and draw the relationship hierarchy chart. Finally, we can get the quantitative results by the weight of each influencing factor. Then according to the quantitative indicators, the objective function is established, and the constraint conditions are listed, then the bank's credit strategy for micro enterprises can be given.

This paper constructs a structural hierarchy for enterprise credit risk evaluation, dividing credit risk into a total of four criterion layers, i.e., solvency, creditworthiness, contingency factors, and operating environment; and then dividing the four criterion layers into a total of 14 program layers, as shown in the Fig. 1:

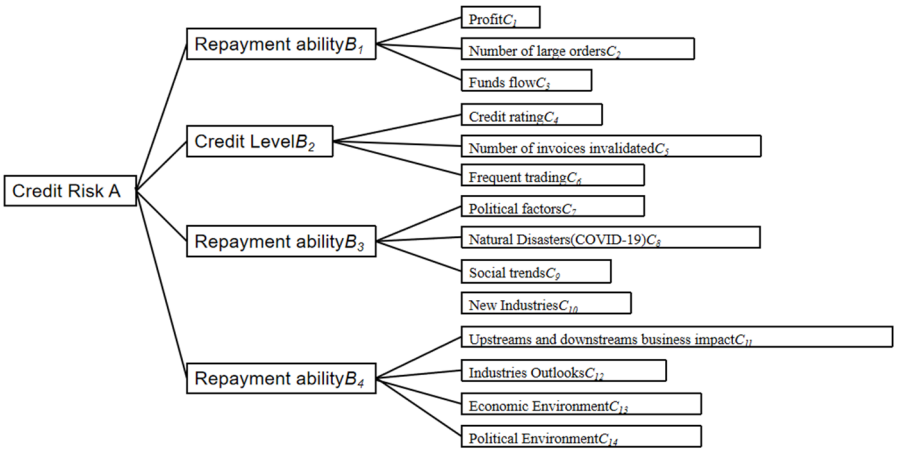

Fig. 1. Composition System of factors affecting credit risk of small, medium and micro enterprises.

4 EMPIRICAL ANALYSIS

First construct the construct judgment matrix. Using MATLAB to solve, the weight of each factor affecting credit risk is 0.5068 for strength, 0.2641 for reputation, 0.0863 for unexpected factors, and 0.1428 for operating environment, which quantifies the credit risk.

Excluding the enterprises with a credit rating of D, 82 Enterprises' information is retained. These 82 Enterprises are divided into 10 categories according to the national industry classification. The final ranking is: Science and technology industry, information and communication industry, administration and auxiliary industry, agriculture and forestry industry, others, manufacturing industry, wholesale and retail industry, building materials industry, logistics industry, and self-employed business.

When the credit rating is A, the relationship between customer churn rate and interest rate: $y = 7.524x_1 - 0.098$

When the credit rating is B, the relationship between customer churn rate and interest rate: $y = 7.351x_1 - 0.118$

When the credit rating is C, the relationship between customer churn rate and interest rate: $y = 7.468x_1 - 0.138$

For high-risk enterprises, choose not to lend. For low-risk enterprises, adjust the loan amount and give appropriate interest rate preference. Considering the customer churn rate caused by interest rate changes of enterprises with different credit ratings, the following model is established comprehensively:

$$Z = [12*(1.098-7.574*x2)+24*(1.118-7.351*x2)+6*(1.138-7.468*x2)]*x1*x2*x3+ [13*(1.098-7.574*x5)+5*(1.118-7.351*x5)+2*(1.138-7.468*x5)]*x4*x5*x6$$

$$\text{s.t.}\begin{cases} 42x1+20x4 \le C \\ 10 \le x1 \le 100 \\ 0.04 \le x2 \le 0.15 \\ \frac{1}{12} \le x3 \le 1 \\ 10 \le x4 \le 100 \\ 0.04 \le x5 \le 0.12 \\ \frac{1}{12} \le x6 \le 1 \end{cases}$$

Fixed annual total credit C, so take six fixed total credit values, respectively, and bring them into the model to calculate the values of each variable, and finally give the lending strategy that the bank should adopt in any fixed annual total credit.

Total fixed annual credit (10000)	Medium risk enterprise		Low risk enterprise				Maximum annual interest of Bank (yuan)
	Loan limit (10000)	lending rate	Loan term (year)	Loan limit (10000)	lending rate	Loan term (year)	
500	10	0.0751	0.9989	10	0.0738	0.9976	25.6917
1000	19.0476	0.075	1	10	0.0737	1	41.6285
3000	66.6667	0.075	1	10	0.0737	1	125.2964
5000	100	0.075	1	40	0.0737	1	208.3479
6000	100	0.075	1	90	0.0737	1	249.1545
8000	100	0.075	1	100	0.0737	1	257.3159

Fig. 2. lending strategy

The bank's lending strategy in any fixed total annual credit is shown in Fig 2,observing the changes of other amounts when the total amount of credit is fixed in different years, we can find that when the total amount of credit is fixed, the result always meets the upper limit of the loan limit for medium risk enterprises first, and then meets the loan limit for low risk enterprises. When the fixed loan limit increases, the value of the objective function in the given results increases, that is, the maximum annual interest of the bank also increases.

Affected by the above sudden factors, the sales of various industries show different changes, and the degree of impact of each industry is different. Use the conclusion of AHP to score and standardize the credit risk of each enterprise, and finally use the quartile difference method to grade the score, and divide the enterprise risk into low risk, medium risk High risk.When the total annual credit amount is 100 millions, with the goal of maximizing the annual interest of the bank, the model is built with the objective of maximizing the bank's annual interest, i.e., C in the above model is specified as 10000.

The result is: X1 = 59.1837, X2 = 0.0760, X3 = 1, X4 = 100, X5 = 0.0755, X6 = 1

5 CONCLUSIONS

The research mainly found that when the annual total amount of loans was fixed, the bank's lending strategy: the number of medium-risk enterprises was about twice that of low-risk enterprises. When lending, it was considered to meet the loan quota of medium-risk enterprises first, and then to meet the loan quota of low-risk enterprises. At the same time, the loan interest rate of medium-risk enterprises was slightly higher than that of low-risk enterprises to make more profits. It was appropriate to give preferential interest rates to low-risk enterprises to attract customers and realize two-way profits. Due to the impact of sudden factors, for enterprises with low loan risk, the bank can slightly increase the interest rate and loan limit, so as to improve the interest income. According to the observation, among the enterprises with low loan risk, the building materials industry and self-employed enterprises are more, so banks can appropriately increase the proportion of loans to the building materials industry and self-employed enterprises, so as to seek stability in the risk and obtain better income.

References

[1] Qishupeng, Fengyan, lijingxiao. Analysis of the impact of economic cycle on credit risk management of China's commercial banks -- An Empirical Study Based on VAR model [j]. financial regulation research, 2015 (4): 1-14

[2] Wang Zheng, Li Min, xueguanjia, liangsongjiang, research group of the credit information management office of the people's Bank of China, Nanjing Branch. Research on the internal rating method of the central bank for small and micro enterprises [j]. financial review, 2019 (1): 74-82

[3] Ji Jing. Review and comparison of credit risk measurement models [j]. world economic situation, 2008 (1): 67-70

[4] Liu Linghao. Research on countermeasures of commercial banks to support financing of small and medium-sized enterprises [D]. Shandong University of Finance and Economics,2018.

[5] Wangsujuan, wangjunpeng. Analysis on the influence of credit risk factors of small and micro enterprises in commercial banks based on FAHP [j]. science and technology and industry, 2013,13 (4): 76-79