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Research on Credit Strategy of Small and Medium-sized Banks based on RAROC

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Abstract

In the context of the business world, small, medium and micro enterprises represent the downstream of numerous industries within our nation. Consequently, it is of paramount importance to conduct credit risk analysis and research into credit strategies. The present paper employs mathematical modelling to quantitatively analyse the credit risk of enterprises, thereby obtaining the credit strategy of banks to enterprises and the credit adjustment strategy in the face of unexpected factors. The paper quantitatively analyses enterprise credit risk and provides the credit strategy of banks to enterprises, using the fuzzy comprehensive evaluation method to conduct qualitative and quantitative analysis of credit risk. The data presented in Annex I delineates the factors employed in this study, which include default record, credit rating, average monthly operating fund flow, average monthly profit, and average monthly profit growth rate. The evaluation set is determined based on the five-level classification system of loans: normal, concern, secondary. possible, loss; average combination weights is adopted to define the factors affecting the weight for A = [0.2096, 0.4285, 0.1639, 0.0971, 0.1009].Finally, the fuzzy evaluation matrix is obtained by scoring, and the credit risk of enterprises is obtained by matrix operation. The credit risk monitoring model based on RAROC (risk-adjusted return on capital) is used to determine the credit strategy, and the RAROC value of the enterprise is calculated by consulting the data.Through fitting, the relationship between customer churn rate and loan interest rate is obtained, attenuation factor B is introduced and multiplied by RAROC value, which is the return on capital reward. The reward is then divided into seven intervals, with the range of corporate loan limits and loan interest rates maintained constant within each interval.

Keywords

RAROC; Mall and Medium-sized Banks; Credit Strategy.

1. Introduction

This paper analyses the credit risk of 123 enterprises with credit records, and provides a credit strategy.Firstly, because the risk level is a fuzzy concept, the fuzzy comprehensive evaluation method is used to determine the credit risk of a named enterprise. The set of factors is determined according to the information in Annex I: default record and credit rating represent its previous integrity record, average monthly operating fund flow represents its scale, average monthly profit represents its repayment ability, and average monthly profit growth rate represents its development momentum.Then, based on the five-level classification system of loans, the set of comments is determined: normal, concerned, secondary, doubtful, and loss. The application of the weight method and the analytic hierarchy process ensures the accuracy and rigour of the average combined weight of each factor in the factor set.Finally, the evaluation matrix is scored, and the comprehensive evaluation results are obtained to determine the

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enterprise's credit risk.The credit risk monitoring model based on RAROC risk-adjusted return on capital determines the credit strategy.The RAROC values of seven representative enterprises can be obtained by consulting the data. The relationship between customer churn rate and interest rate can be obtained through Matlab fitting, and the attenuation factor B is introduced and multiplied with RAROC to become the reward index of return on capital.The reward is divided into seven intervals, and the enterprises in each interval implement similar credit strategies, that is, the range of their loan amount and the range of loan interest rate are the same.

2. Data Source

The data has been sourced from 123 enterprises with credit records, as well as from the National Bureau of Statistics of China.

3. Model Building

3.1. The Establishment of Credit Risk Model

This paper presents a quantitative analysis of the credit risk of 123 enterprises with credit records, and provides a credit strategy.Firstly, the factors affecting enterprise credit risk are determined according to the data in Annex I, and the analytic hierarchy process (AHP) and entropy weight method are used to determine the average combined weight of each factor on credit risk. The fuzzy comprehensive evaluation method is then employed to categorise credit risks into five distinct levels: normal, concern, secondary, suspicious and loss. The credit strategy is determined based on the RAROC risk-adjusted return on capital monitoring model.

3.1.1. Deterministic Factor Set

In order to ascertain the credit risk of enterprises, five indicators were selected: default record, credit rating, operating capital flow, average monthly profit, and average monthly profit growth rate.The operating capital flow represents the scale of the enterprise, i.e. the total value of tax input invoices. The average monthly profit can represent the enterprise's repayment ability, i.e. the difference between the amount input and the total value of tax and output invoice tax. The average monthly profit growth rate is a reflection of the development momentum of the company, indicating whether the company is thriving or declining.The factor set U = (default record u1, credit rating u2, operating capital flow u3, average monthly profit u4, average monthly profit growth rate u5) has been determined.

3.1.2. Determine the Set of Comments

The evaluation set is determined based on the five-level loan classification system, which comprises the categories normal v1, secondary v2, secondary v3, doubtful v4 and loss v5.

3.1.3. Determine the Weight of Each Factor

In order to ascertain the relative influence of various factors on credit risk with greater precision, a combination of the analytic hierarchy process and the entropy weight method is employed.

3.2. Analytic Hierarchy Process

Following a thorough review by experts in the field and consultation of pertinent literature on credit risk, a judgment matrix has been formulated to ascertain the relative significance of various impact factors, including default record, credit rating, operating capital flow, average monthly profit, and average monthly profit growth rate. The matrix is as follows:

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$$\begin{bmatrix} 1 & 1/2 & 2 & 3 & 3 \\ 2 & 1 & 5 & 7 & 7 \\ 1/2 & 1/5 & 1 & 1/2 & 1/2 \\ 1/3 & 1/7 & 2 & 1 & 2 \\ 1/3 & 1/7 & 2 & 1/2 & 1 \end{bmatrix} \quad (1)$$

The maximum characteristic root of the judgment matrix is obtained, Tmax=5.2484, the order of the judgment matrix is n=5, and C1=0.0621 is obtained from the formula C1= (Tmax-n)/(n-1), calculated by the consistency index. Referring to the random consistency index R1=1.12, the consistency ratio CR=CI/RI=0.0554<01 is obtained, thus demonstrating that the judgment matrix passes the consistency test.

In conclusion, the analytic hierarchy process (AHP) was employed to determine the weight, yielding the following values: [0.2287, 0.5076, 0.0732, 0.1082, 0.0822].

3.3. Entropy Weight Method

The calculation of the influence of the factor weight is performed by means of the entropy weight method, with the following results obtained: 0.2036, 0.4339, 0.0929, 0.1521 and 0.1174.

The subjective colour of the weights determined by the analytic hierarchy process is too strong, therefore the entropy weight method is employed in combination with the analytic hierarchy process to find the average combined weights:

$$A = \left\{ \frac{\sqrt{W_m w_m}}{\left\{\sum_{j=m}^{n} \sqrt{W_j w_m}\right.}, \frac{\sqrt{W_n w_n}}{\sum_{j=m}^{n} \sqrt{W_j w_j}} \right\} \quad (2)$$

In the formula, wj refers to the weight calculated by the analytic hierarchy process (AHP), whilst w_j refers to the weight calculated by the entropy weight method. The calculation of the average combination weights is as follows: A = [0.2096, 0.4285, 0.1639, 0.0971, 0.1009].

3.4. The Fuzzy Comprehensive Evaluation Matrix is Determined

In order to quantify credit risk by means of the fuzzy comprehensive evaluation method, it is necessary to determine a fuzzy comprehensive evaluation matrix. Each influencing factor is scored by means of consultation with experts and other methods, and the evaluation matrix is finally obtained.

3.5. Fuzzy Comprehensive Evaluation

The weight matrix is multiplied by the evaluation matrix, and the comment corresponding to the largest value is taken as the evaluation result.

Enterprise credit risk is quantified into a set of comments based on a five-level classification system, with the variable name EL[1]. A five-level classification system is used to quantify enterprise credit risk, and fuzzy comprehensive evaluation is used to get the bank's comments on each enterprise, that is, credit risk. The quantization assignment for the review set is as follows:

Table 1. Quantitative credit risk assignment table

Credit risk	Assign value
Normal	0.02
Concern	0.04
Secondary	0.06
Suspicious	0.07
Loss	0.10

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4. Credit Risk Monitoring Model based on RAROC Risk-adjusted Return on Capital

The subsequent analysis will utilise company E1 as a foundation to ascertain the bank's credit strategy for enterprises, employing the RAROC model[2] as a theoretical framework within the field of economics. It is posited that an augmentation in the RAROC value will concomitantly result in an escalation in the loan amount. Conversely, a diminution in the RAROC value will precipitate a reduction in the loan amount. The RAROC value is determined through the following calculation:

$$\text{RAROC} = \frac{r \times L - c \times L - i \times D - EL}{EC} \tag{3}$$

In this equation, r denotes the loan interest rate, L represents the nominal loan amount, c is the operating cost ratio, i is the bank's cost of funds rate, D signifies the amount of bank liabilities[3], EC denotes the occupation of economic capital, and EL is defined as credit risk. The calculation of economic capital occupancy (EC) is as follows:

$$\text{EC=L×K} \tag{4}$$

K is the capital requirement coefficient, which is related to the confidence level of loan default. The calculation formula for K is as follows:

$$K = \left\{ LGD \times \phi \left| \frac{\phi^{-1}(EDF)}{\sqrt{1-R}} + \phi^{-1}(0.999) \times \sqrt{\frac{R}{1-R}} \right. \right] - EDF \times \qquad LGD \Big\} \times \frac{1+(M-2.5)\times \text{b}}{b} \tag{5}$$

b represents the maturity adjustment that is necessary for loans extended to enterprises:

$$b = [0.11852 - 0.05478 \times \ln(EL)]^2 \tag{6}$$

By fitting the data in Annex III, the functional relationship between customer churn rate CCR and loan interest rate r can be obtained:

$$CCR = \lambda(r) = 640.9r^3 - 258.6r^2 + 37.97r - 1.121 \tag{7}$$

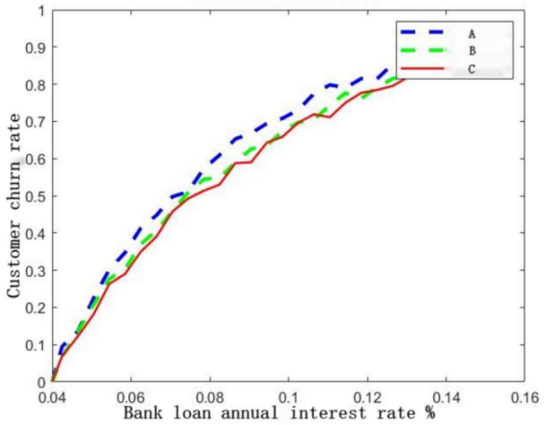

Figure 1. Fitting curve of customer churn rate CCR and loan interest rate r

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The purpose of this study is to define the attenuation factor β in order to provide a comprehensive explanation of the increase in customer churn[4] that has been observed in recent times due to rising interest rates:

$$\beta = \tanh(CCR) = \frac{e^{CCR} - e^{-CCR}}{e^{CCR} + e^{-CC}} = \frac{1 - e^{-2CCR}}{1 + e^{-2CR}} \tag{8}$$

Reward is defined as the indicator of risk-adjusted return on capital, with the proviso that attenuation factor β is taken into account:

$$\text{reward} = \beta \cdot \text{RAROC} \tag{9}$$

5. Model Solving

5.1. The Solution of Credit Risk Model

The following example utilises company E1 to ascertain the comprehensive evaluation results[5].

The default record is evaluated. In the event of a default record being present, 100% is designated as loss during the scoring process. Conversely, in the absence of a default record, 100% is categorised as normal. For the company E1:

$$R_1 = [1,0,0,0,0] \tag{10}$$

The following scoring rules are applicable to the four credit ratings of A, B, C and D:

Table 2. Credit rating score

Creditrating	Normal	Follow	Secondary	Doubtful	Loss
A	0.9	0.05	0.05	0	0
B	0.4	0.2	0.15	0.15	0.1
C	0.1	0.15	0.2	0.25	0.3
D	0	0	0	0	1

In the event of the enterprise E1 credit rating being designated as A, the following circumstances apply:

$$R_2 = [0.9,0.05,0.05,0,0] \tag{11}$$

In a similar manner, the operating capital flow, average monthly profit and average monthly profit growth rate should be scored according to the data presented in Annex I. The final step is to obtain the evaluation matrix:

$$R = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0.9 & 0.05 & 0.05 & 0 & 0 \\ 0.5 & 0.2 & 0.15 & 0.1 & 0.05 \\ 0 & 0.05 & 0.15 & 0.2 & 0.6 \\ 0.02 & 0.08 & 0.13 & 0.17 & 0.6 \end{bmatrix} \tag{12}$$

The matrix synthesis operation is carried out to obtain the comprehensive evaluation result:

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$$B=A\cdot R=[0.6792,0.0671,0.0737,0.0530,0.1270] \quad (13)$$

Utilising the comments with the most significant value as the evaluation result, it is evident that the company's E1 credit risk is deemed to be standard, and its credit default probability is minimal.

By analogy, the evaluation results of E21, E31, E41, E51, E61 and E71 are obtained as follows:

Table 3. Fuzzy evaluation results of enterprises

Code	Results	Credit risk
E21	[0.5424,0.1682,0.1214,0.0589,0.1028]	Normal
E31	[0.8142,0.1201,0.0782,0,0]	Normal
E41	[0.4872,0.1523,0.1253,0.1052,0.1169]	Normal
E51	[0.5263,0.1582,0.1251,0.1007,0.0632]	Normal
E61	[0.5241,0.1875,0.1362,0.0985,0.0352]	Normal
E71	[0.4821,0.1523,0.1152,0.1201,0.1333]	Normal

5.2. Evaluate the RAROC Value to Determine the Credit Strategy

Following the calculation of the credit risk index EL of enterprises, the RAROC model is employed to provide decision-making suggestions for bank loans. The credit risk index EL of the seven enterprises is 0.1. To ascertain the RAROC value of each enterprise, the unknown parameter EC in the RAROC model must first be calculated. This is determined by the nominal loan amount L and the capital requirement coefficient K, the calculation method for which is given by formula (8). The capital requirement coefficient K is set to 6.8, and the operating cost ratio c is selected as 0.01.The survey will determine the bank cost of capital rate.The product of bank liability D is set to a fixed value of 10,000 yuan, and the reward value of seven enterprises is finally solved in the following table:

Table 4. reward values of seven enterprises

Code	Reward
E1	0.12
E21	0.1175
E31	0.105
E41	0.08
E51	0.03
E61	0.063
E71	0.09

It is evident from the distribution of reward values of seven typical enterprises that seven reward levels have been determined. The loan amount and interest rate of each level are shown in the following table:

The arithmetic mean of the individual weights is employed to calculate the weight of each factor in the factor set. The combination of the analytic hierarchy process and entropy weight method ensures the results of the weight calculation are more accurate and rigorous. The fuzzy comprehensive evaluation method is relatively simple and easy to popularise and use among bank staff. It combines qualitative analysis with quantitative analysis, which is more conducive to the subsequent analysis and judgement of the relevant data.

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Table 5. Loan amounts and interest rates for each grade

Reward	Amount of credit	Interest rate
1-3%	10-23w	13-15%
3-5%	23-36w	11.5-13%
5-7%	36-49w	10-11.5%
7-9%	49-62w	8.5-10%
9-11%	62-75w	7-8.5%
11-13%	75-88w	5.5-7%
13-15%	88-100w	4-5.5%

6. Conclusion

The construction of credit risk and RAROC models enables the quantitative analysis of the credit risk of 123 enterprises, with the provision of credit strategy suggestions based on the RAROC model. The study employs the methods of fuzzy comprehensive evaluation and the analytic hierarchy process, with consideration given to numerous influencing factors. The reliability and practicality of the results is evidenced.

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