

Optimal credit strategy for MSMEs

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Abstract. We address two main issues: one is to quantify the credit risk of enterprises and establish a complete credit risk system, and the other is to give the optimal credit risk strategy for banks. We first analyze and pre-process the data. From the data, we extracted a series of indicators such as the total amount of input and output, and the length of operation. We analyze the credit risk in three directions: strength, stability of supply and demand, and creditworthiness, and establish a credit risk quantification system for the enterprise. Then we quantify the credit risk of the enterprise by entropy method and TOPSIS. Second, a function is fitted to the bank's customer churn rate and the bank's lending rate. Using a planning-type model, the credit decisions of the firms are required to be given. We follow the principle of maximizing benefits and minimizing risks to build a multi-objective planning model. We base on the scores of each firm that have been solved, for the classification of firms, and follow the principle of low credit risk, low lending rate, and set the corresponding lending rate for each type of firm. The model is solved by the through-order solution method, and the linear weighting method is used to test the comparison. The credit decision for each enterprise is given.

Keywords: Entropy method, TOPSIS, Multi-objective planning model

1. Introduction

In practice, since MSMEs are relatively small in scale and also lack collateral assets, banks usually provide loans to enterprises with strong strength and stable supply and demand relationships based on credit policies, information on their trading notes and the influence of upstream and downstream enterprises, and can offer preferential interest rates to enterprises with high creditworthiness and low credit risks. Banks first assess the credit risk of MSMEs based on their strength and reputation, and then determine whether to lend and credit strategies such as loan amount, interest rate and maturity based on credit risk and other factors. This requires a reasonable and efficient credit risk quantification system and an optimal credit decision model based on credit risk. The study of the optimal credit decision of banks for MSMEs is beneficial to the healthy development of banks and the stability of the financial market on the one hand; on the other hand, it is beneficial to increase the chances of obtaining loans for MSMEs and promote the development of MSMEs.

2. Approaches

Firstly, for data pre-processing, enterprises with poor creditworthiness, i.e., those with default records and creditworthiness registration of D, were excluded. Then, evaluation indicators were determined, and through references, nine indicators such as total amount of input, standard deviation of monthly input invoices, and creditworthiness score were identified for evaluating credit risk. And the TOPSIS method based on entropy weight method is used to quantify the credit risk of each enterprise by totaling and scoring each enterprise.[1]

A function fit was performed by MATLAB for customer churn rate and annual interest rate, and by trying different fitting functions, a function curve with less error and more accuracy was determined.

Finally, we follow the principle of maximizing benefits and minimizing risks to build a multi-objective planning model, which we base on the scores of each enterprise. Following the principle of low credit risk, the loan interest rate is low, and the corresponding loan interest rate is set for each type of enterprise. The model is solved by the through-order solution method and is tested for comparison using a linear weighting method.

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3. Experimental Study

3.1 Data pre-processing

According to the realistic requirements, banks in principle do not lend to enterprises with default records and credit ratings of D. Therefore, these enterprises are excluded from the data pre-processing, and 96 enterprises with no default records and credit ratings of D or above are screened out, and only these enterprises are considered in the subsequent model solving and credit strategy.

3.2 Determination of evaluation indicators

Banks tend to lend to enterprises with strong and stable supply and demand relationships, in addition to the ability to repay loans and the degree of creditworthiness are also important factors affecting the credit strategy of banks. In this paper, nine indicators are constructed to evaluate the credit risk of enterprises in terms of their strength, business stability and creditworthiness, such as total amount of input, standard deviation of monthly input invoices and credit score. The evaluation system is schematized as follows.[1]

Table 1. Quantitative Indicators

Indicators	Meaning
R1	Total amount of input
R2	Total amount of output
R3	Number of months of input invoices
R4	Number of months of output invoices
R5	Standard deviation of input amount
R6	Standard deviation of output amount
R7	Number of upstream companies
R8	Number of downstream companies
R9	Credit score

3.3 TOPSIS method based on entropy weight method

After quantifying the characteristics of the screened 96 enterprises, the nine characteristics of the 96 enterprises are recorded as a matrix $A = (a_{ij})_{m \times n}$, where $m=96$ and $n=9$, a_{ij} denoting the j th characteristic indicator of the i th enterprise.

After determining each scientifically valid evaluation index, the importance evaluation model is constructed, and the weight of each index is calculated by the entropy weighting method to establish a TOPSIS-based multi-indicator evaluation model, the higher the score can reflect the importance of the supplier, and the larger the value, the higher the degree of importance. Entropy originally comes from thermodynamics, then introduced by Shannon into information theory, according to the definition and principle of entropy, when the system may be in several different states, the probability of each state is $p_i (i = 1, 2, \dots, m)$, then the entropy of the system can be defined as

$$e = -\frac{1}{\ln m} \sum_{i=1}^m p_i \ln p_i$$

Entropy weighting method to solve the weighting steps:

Steps
a. Calculate the weight of the i th evaluation object regarding the value of the j th indicator using matrix A
b. Calculate the entropy value of the j th index value
c. Calculate the coefficient of variation of the j th indicator
d. Calculate the weight of the j th indicator

3.4 Fit of customer churn rate as a function of APR

For the three types of ABC creditworthiness degree of enterprises, there is a certain functional relationship between the bank's annual interest rate on loans and customer churn rate, using Matlab software to fit the three curves can be derived from the functional relationship equation as follows.[2,3]

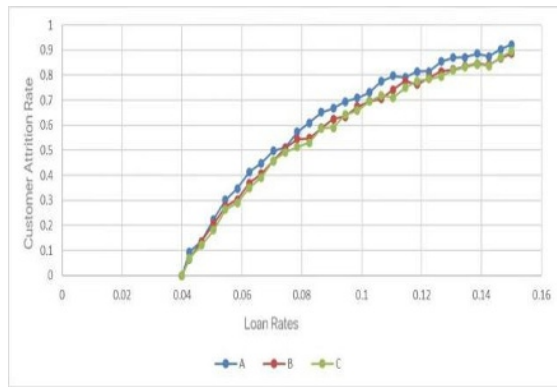


Figure1.Data Visualization of Customer Churn Rate and Loan APR

$$Li = \left\{ \begin{array}{l} -76.41I_i^2 + 21.98I_i - 0.6971 - -A \\ I_i^2 + I_i - 0.6504 - -B \\ I_i^2 + I_i - 0.6393 - -C \end{array} \right\}$$

where L_i denotes the customer churn rate when the bank lends to the i th firm, and I_i denotes the annual interest rate of the loan for the i th firm.

3.5 Solution of multi-objective planning

This paper assumes $R_i = 1 - u_i$ as an indicator of the risk level of the enterprise, where u_i is the result of the composite score of each enterprise solved. N is the number of 96 enterprises screened for lending in principle. R_i denotes the loan risk of the i th enterprise, L_i denotes the customer churn rate when the bank lends for the i th enterprise, and x_i denotes the loan amount granted by the bank to the i th enterprise

$$\textcircled{1} \min \left\{ \max_{1 \leq i \leq N} \{R_i x_i + L_i x_i\} \right\}$$

$$\textcircled{2} \max \left\{ \sum_{i=1}^N I_i x_i \right\}$$

$$s.t. \left\{ \begin{array}{l} 10 \leq x_i \leq 100 \\ \sum_{i=1}^N x_i \leq 5000 \end{array} \right.$$

For this problem, this paper writes a program to solve it using Matlab software with maximizing bank profit as the priority objective and minimizing loss as the secondary objective.[4,5]

4. Result

The combined scores of the 96 companies are shown below.

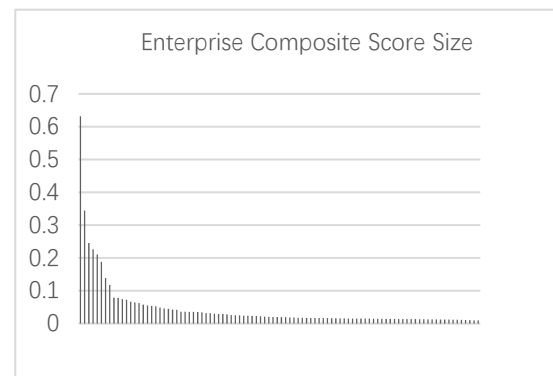


Figure 2.The distribution of the size of the overall score of enterprises

The basic idea of the priority method for solving multi-objective planning is to divide the objectives into different priority levels according to their importance, and first find the optimal value of the objective with high priority, and then find the objective function with low priority under the condition that the objective with high priority gets no less than the optimal value. The final results are presented in part as follows.

Table 2. Allocation of loans to 96 enterprises (part)

Top 10		The last ten	
Enterprises	Loan Amount	Enterprises	Loan Amount
E97	99.32973	E1	10
E96	99.00358	E75	7.855561
E94	99.59366	E2	7.855561
E86	98.88605	E8	7.855561
E69	99.21362	E4	7.855561
E68	99.74643	E13	7.855561
E43	99.76492	E7	7.855561
E39	97.81334	E6	7.855561
E110	97.35163	E14	11.35004
E104	98.93577	E3	11.35004

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