Research on optimization model of bank credit strategy

Siyuan Wang

School of Medical Imaging, Hangzhou Medical College, Hangzhou, Zhejiang, 310000

Abstract: Aiming at the lending strategy of small and medium-sized micro enterprises, the credit strategy is divided into three parts: whether to provide credit services, the credit line and the annual interest rate of loans. The fuzzy comprehensive evaluation method is used to obtain the credit degree matrix, and the optimization model is established to calculate the credit line and interest rate preferential scheme. This paper tests the model from two aspects: the form of enterprise profit (quarterly average profit and monthly average profit of two enterprises are randomly selected) and the regression analysis of customer churn rate (fitting the first-order function and power function).

1. Model preparation

1.1 Data preprocessing

Reject void invoice data

After the invoice was issued, the transaction was cancelled for some reason, making the invoice invalid.Therefore, void invoice data will be eliminated.

Exclude enterprises with credit rating D

Banks will not lend to enterprises with a credit rating of D.

Calculate the quarterly average profit of the enterprise

Excel is used to analyze the data of input invoice amount and output invoice amount of all enterprises in the data.Calculate the quarterly average profit of each enterprise (profit = the amount of sales invoice)The amount of the input invoice).

1.2 Factors affecting credit strategy

(A) Factors affecting credit line

(1) Enterprise strength (enterprise profit)

In this model, the profit of enterprises is divided into four grades (I, II, III, IV) artificial and the membership value of grade I enterprises is assumed to be 0.4, that of grade II enterprises is 0.3, that of grade III enterprises is 0.2, and that of grade IV enterprises is 0.1.

(2) Supply and demand (relationship between upstream and downstream enterprises)

When banks evaluate their credit risk, they give the upstream enterprises a slightly higher subordinate value and the downstream enterprises a slightly lower subordinate value.For the convenience of calculation, the membership value of upstream enterprises is assumed to be 0.7 and

that of downstream enterprises is assumed to be 0.3.

(3) Credit policy (whether it is a state encouraged enterprise)

For the convenience of calculation, in this model, it is assumed that the membership value of enterprises encouraged by national policies is 0.7 and that of enterprises not encouraged by national policies is 0.3.

(B) Factors affecting annual interest rate of loan

The annual interest rate of the loan is determined by the credit rating, customer churn rate and the bank's profit from the credit. It is decided by these three indicators. Taking the customer churn rate and the bank's profit through credit as decision variables, two loan interest rate optimization models are established.

1.3 Preparation for the establishment of credit matrix

Subordinate value of the first level indicators (enterprise strength, supply and demand, and credit policy, emergency)

Is the row vector, = (A1, A2... An). The secondary index matrix $\mathbf{R}ij$ is established, $R_{ij} = \begin{pmatrix} b_{11} & \cdots & b_{1j} \\ \vdots & \ddots & \vdots \\ b_{i1} & \cdots & b_{ij} \end{pmatrix}$, ($b_{ij}$ is the subordinate value of the i-th enterprise under the j-th index).

The formula of credit matrix can be obtained from above, such as formula (1):

$$M = R_{ij}A^T \tag{1}$$

1.4 Preparation for the establishment of loan annual interest rate optimization model

Matlab is used for regression analysis, and the function expressions of a, B and C credit grades about annual interest rate and customer churn rate are obtained, as shown in formula (2).

$$\begin{cases} y_A = 7.5241x - 0.0979 \\ y_B = 7.3511x - 0.1178 \\ y_C = 7.4684x - 0.1378 \end{cases} \tag{2}$$

(A) When banks aim to minimize customer churn

Suppose Xi is the annual interest rate of the bank to the i-th enterprise, and Yi (I = 1, 2,..., n) is the customer churn rate of the i-th enterprise. GJ (GJ = 1, 2, 3) is the credit rating, s is the average customer churn rate, l is the average profit, and N is the number of enterprises excluding the credit rating of D. Objective function:

$$\text{Min } S = \frac{\sum_{i=1}^{n} y_i}{n} \tag{3}$$

Where Yi (I = 1,2,..., n) is the customer churn rate of the i-th enterprise, and N is the total number of enterprises excluding the enterprises with credit rating D.

Constraints:

$$\text{s.t.} \begin{cases} 4\% \le x_i \le 15\% (i = 1,2....n) \\ L = \sum_{i=1}^{n} x_i p_i \ge 517.275 \\ G_i = 1, y_i = y_A \\ G_i = 2, y_i = y_B \\ G_i = 3, y_i = y_C \end{cases} \tag{4}$$

pi is the credit line of the i-th enterprise, RI is the credit number of the i-th enterprise, GJ (GJ =

1,2,3) is the credit rating, Y_i (I = 1,2,...., n) is the customer churn rate of the i-th enterprise.
The comprehensive formula (3) (4) can get the formula of bank customer churn rate model.

(B) When banks aim at the highest profit from credit
Objective function:

$$\text{Max L} = \frac{\sum_{i=1}^{n} x_i p_i}{n} \tag{5}$$

Constraints:

$$\text{s.t.} \begin{cases} 4\% \le x_i \le 15\%(i = 1,2.\ldots n) \\ S = \frac{\sum_{i=1}^{n} y_i}{n} \le 0.5 \\ G_i = 1, y_i = y_A \\ G_i = 2, y_i = y_B \\ G_i = 3, y_i = y_C \end{cases} \tag{6}$$

The formula of bank profit model can be obtained by synthesizing formula (5) (6).

2. Model establishment and solution.

2.1 Establishment and solution of credit line decision model

According to the analysis of enterprise profit, relationship between upstream and downstream enterprises and credit policy in 1.1.2 (a), in this model, it is artificially assumed that the subordinate value of enterprise strength (enterprise profit) is 0.5, that of supply and demand (relationship between upstream and downstream enterprises) is 0.3 and that of credit policy is 0.2.Substitute the specific value into Rij.At this time $\mathbf{A}=(0.5 \quad 0.3 \quad 0.2)$, $R_{ij} = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ \vdots & \vdots & \vdots \\ b_{i1} & b_{i2} & b_{i3} \end{pmatrix}$

Using MATLAB to analyze the credit degree of 99 enterprises (excluding the enterprises with credit rating D).

Then, excel is used to sort the credit degree of enterprises from big to small, and the serial number of enterprises is obtained. Then, the credit line decision-making model is established based on the serial number of enterprises and allocation table.ri

It is concluded that the loan amount of each enterprise is as follows:

Table 1: Standard table for the allocation of enterprise credit lines

R_i	p_i
1-32	70-100w
33-65	40-70w
66-99	10-40w

2.2 Establishment and solution of loan annual profit model

1. When banks aim to minimize customer churn

The objective function is Min $S = \frac{\sum_{i=1}^{99} y_i}{99}$

2. When banks aim at the highest profit from credit

Objective function: Max $L = \frac{\sum_{i=1}^{99} x_i p_i}{99}$

Using MATLAB to solve the enterprise, the specific annual loan interest rate of the enterprise is obtained. Some results are as follows:

Table 2: Result

Enterprise code	Credit line	Amount	Interest rate 1	Interest rate2
E1	0.2	10-40w	0.04	0.04
E2	0.55	70-100w	0.0432	0.15
E3	0.55	70-100w	0.15	0.15
E4	0.35	40-70w	0.04	0.04
...	...	...	...	...
E105	0.2	10-40w	0.04	0.04
E106	0.2	10-40w	0.04	0.04
E110	0.2	10-40w	0.04	0.04

2.3 Result analysis

1. The optimization of the expression of enterprise profit

Select two enterprises, sort out the relevant data, get the quarterly profit and monthly profit data, and make a line chart.According to the data, the quarterly average benefits of E2 and E46 are 395901225400 yuan and 8864082430 yuan respectively, and the monthly average benefits are 129167814500 yuan and 3280012800 yuan respectively. The limited value of quarterly benefits is close to three times of the limited value of monthly benefits.

2. Optimize the regression analysis of customer churn rate

After fitting the customer churn rate and the annual interest rate with a linear function, the fitting degree of the function is poor.In order to get a better fitting result, according to the trend assumption of midpoint distribution in scatter plot $y = a\sqrt{x}+b$. Matlab is used for regression analysis to get the regression analysis results of annual interest rate and customer churn rate of a credit rating.It can be concluded from the result that the fitting effect of the new fitting function is better than that of the original fitting function.It can be concluded that the annual interest rate and customer churn rate of enterprises with credit rating of a, B and C are as follows.

$$
\begin{cases}
y_A = 4.5724\sqrt{x} - 0.7689 \\
y_B = 4.4569\sqrt{x} - 0.7701 \\
y_C = 4.52\sqrt{x} - 0.7983
\end{cases}
$$

References

[1] Jiang, Qiyuan, Xie, Jinxing, YeJun. Mathematic model [M]. Higer educatio press, 2011.
[2] Baidu pepedia "corporate profit" entry.https://baike.baidu.com/item/corporate profit. 2020.9.11.
[3] Sina Finance - We Media comprehensive. People's livelihood macro: don't ignore the economic repair force capital market crisis organic.http://finance.sina.com.cn/stock/t/2020-02-01/doc-iimxxste8083921.shtml.2020.9.11.