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Research on Credit Strategy of small and medium-sized Enterprises based on Optimization method

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Abstract: *Aiming at the credit strategy of small and medium-sized enterprises, this paper makes a related research on risk assessment. First of all, carry on the corresponding risk assessment to the small and medium-sized enterprises and divide the corresponding grades, and finally determine the proportion of the credit funds of certain enterprises to the total credit of the bank in the whole year. Then a scientific risk assessment model is established by grading and calculating the proportion of funds. Based on the simplex method of linear programming, this paper studies the annual credit allocation of enterprises, and obtains the optimization model of bank loan income, and then produces the optimal scheme of annual credit allocation of enterprises.*

Keywords: *Small and medium-sized enterprises, Loan risk assessment, Linear programming, Optimization*

1. Introduction

Today, with the rapid development of economy, small and medium-sized micro-enterprises have also developed rapidly. Some small and medium-sized micro enterprises are in urgent need of financial support in order to expand their scale [1], and some are faced with a shortage of funds affected by some sudden factors. This kind of breaking of capital chain has become an important factor hindering their development. therefore, its financing is still an urgent problem to be solved [2]. From the bank's point of view, banks can charge corresponding interest for each loan, and each loan has a certain risk, and it is very likely that there is no interest or even the principal can not be recovered in time. The bank loan has a large market, so it is necessary to make a reasonable risk prediction and corresponding planning for the loan, so the research on the credit decision-making of small and medium-sized micro-enterprises is of great significance [3].

2. Credit risk classification

2.1 Credit risk assessment

This paper classifies all the enterprises involved, first calculates the amount of loans that should be allocated to each category of enterprises, and then allocates equally to each enterprise in this category. The focus of all the models is how to allocate the total capital share for each type of enterprise [4].

Points corresponding to different grades:

Table 1: Grade and score

Credit rating	A_1	……	A_i	……	A_n
Financial ability level	B_1	……	B_i	……	B_n
Score (S)	n	……	$n+1-i$	……	1

Note: ① $S(A_i)$: a function that represents the score of credit rating A_i;

② $S(B_j)$: A function that represents the value of an B_i financial ability level.

Suppose we divide small, medium and micro enterprises into P categories, number them successively

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from 1 to P, and grade credit rating and financial ability [5] according to relevant data of different categories of enterprises. As shown in the table:

Table 2: Risk assessment index

Category	Credit degree	Financial ability	Number of enterprises	Score
1	A_{1i}	B_{1j}	b_1	$(n+1-S(A_{1i}))+(n+1-S(B_{1j}))$
……	……	……	……	……
p	A_{pi}	B_{pj}	b_p	$(n+1-S(A_{pi}))+(n+1-S(B_{pj}))$

Note (1) A_{ai} : the credit rating of category a enterprises;

(2) B_{aj} : The financial capability level of the enterprise in Class a.

2.2 Grade division

As you can see from the first step, the score for each category is on the [2,2n] interval. According to the specific situation of these enterprises[6], we divide them into m levels. The specific division is as follows:

Table 3: Grade division

Comprehensive grade.	First Class	……	k Class	……	m Class
Fractional interval	$[q_1,2n]$	……	$[q_k, q_{k-1}]$	……	$[2, q_{m-1}]$

Note: (1) q_k : the interval [2,2n] have m-1 points, can be divided according to the actual situation, in which $2n \geq q_1 > \ldots > q_k > \ldots > q_{m-1} \geq 2$;

(2) Different categories of businesses are assigned their own scores into the corresponding composite rating.

3. Establishment and solution of Credit Strategy Model

3.1 Model solving

Assume that the total annual credit amount of the bank is Y million yuan, and the loan amount is allocated to the enterprises of m levels, where the available loan amount corresponding to K level is X_k million yuan, the number of enterprises is N_k , and the annual loan interest rate is M_k . After a year, the bank will be able to obtain a profit of Z million yuan. The model established is as follows:

$$\begin{cases} \max Z = \sum_{k=1}^{m-1} X_k M_k \\ s.t. X_k \leq 100 N_k \\ X_K \geq 10\mathrm{N}_K \\ \sum_{k=1}^{m-1} X_k \leq Y \\ X_k \geq 0, \quad k = 1,2,3,\ldots, \quad m-1 \end{cases} \tag{1}$$

Note: N_k is the sum of the number of enterprises of different comprehensive levels. According to the score interval $[q_k, q_{k-1}]$, the total number of enterprises of a certain category corresponding to each score within the interval is obtained.

3.2 Solution of the model

Since there is a certain relationship between the annual interest rate of a bank and the customer churn rate, we need to determine the value or approximate range of annual interest rate before solving the model.

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In the process of determination, we can take the bank's profit after lending as the basis, and then we can get the relationship:

Income= Annual interest rate × Loan amount × Number of loans × (1-Customer turnover rate) × time

Take the value of loan amount, loan number and time as 1. After sorting and analyzing the relevant data, the following diagram is obtained:

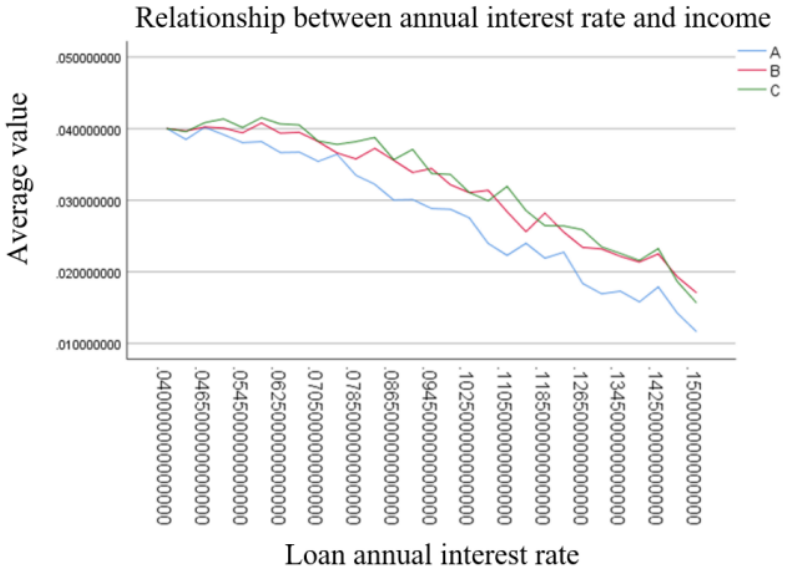

Figure 1: Relationship between annual interest rate and income

As can be seen from the line chart, within the range of [0.04,0.0705], the bank's income is relatively high and stable. Based on this, we can determine the annual interest rate within this range.

4. Credit allocation decision-making scheme

First of all, we need to classify the 123 enterprises into five categories according to their industry attributes: manufacturing, scientific research, foreign trade, service, and others. Then take a category of an enterprise as a whole to calculate its credibility level and financial capability level, divide it into a comprehensive level through the converted score value of the level, and finally solve the problem using the principle of linear programming.

4.1 Credit risk assessment

The paper divide the credibility level and financial ability level into four levels, namely, the credibility level: A_1, A_2, A_3, A_4 , and the financial ability level: B_1, B_2, B_3, B_4 ,The corresponding scores of different grades are as follows:

Table 4: Grade and score

Credit rating	A_1	A_2	A_3	A_4
Financial ability level	B_1	B_2	B_3	B_4
Score	4	3	2	1

The creditworthiness grade and financial ability grade were fitted. The specific calculation method is as follows:

(1) **Credit rating**: Each enterprise gets the corresponding credit rating according to the change record. Because the credit level of each enterprise is not the same, that is, the same category of companies have different credit levels. Convert the credit grade according to the actual situation.

(2) **Financial ability level:** First of all, we should delete the relevant data of invalid invoices and use the relevant data of valid invoices to calculate the profitability of a certain type of enterprises, and then reflect the financial capacity of this kind of enterprises.

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The formula for calculating the profitability is as follows: profit = the invoice value of the output item-the total price and tax of the input invoice, in which all invoices are valid invoices.

According to the profitability of each category of enterprises, the financial capacity of these enterprises is divided into four levels, namely B_1, B_2, B_3, B_4.

(3) **Risk Assessment Score:** The risk assessment scores of each type of enterprise are calculated according to the corresponding scores of credit rating and financial capability rating.

4.2 Grade division

According to the above calculation, we can know that the final score value of these five categories is [2, 8], so the paper divide these enterprises into four levels.

Table 5: 123—Grade division

Comprehensive grade	Level 1	Level 2	Level 3	Level 4
Score	8, 7	6, 5	4, 3	2

Table 6: 123—Comprehensive grade evaluation reference

Enterprise type	Manufacturing (1)	Scientific research (2)	Foreign Trade (3)	Services (4)	Other (5)
Number of enterprises	27	22	22	8	44
Profit (ten thousand yuan)	0.0414	-0.0906	0.0031	0.0092	-0.0935
Credit score	3	2	3	2	3
Financial ability score	4	2	3	3	1
Comprehensive score	7	4	6	5	4
Comprehensive grade	Level 1	Level 3	Level 2	Level 2	Level 3

Since banks do not lend to enterprises with a credit rating of D in principle, related enterprises with a comprehensive rating of 4 do not participate in the allocation of credit amount.

5. Model solving

Put the relevant data obtained above into the model established by us to obtain the following equations:

$$\begin{cases} \max Z = 0.05X_1 + 0.06X_2 + 0.07X_3 \\ s.t.\ X_1 \le 100 \times 27 \\ X_2 \le 100 \times (22+8) \\ X_3 \le 100 \times (22+44) \\ X_1 \ge 10 \times 27 \\ X_2 \ge 10 \times (22+8) \\ X_3 \ge 10 \times (22+44) \end{cases} \tag{2}$$

(1) The annual total credit of the bank is fixed, but the specific amount is not stated. Therefore, the formula related to the annual total credit of the bank is omitted from the model $(X_1 + X_2 + X_3 \le Y)$. The paper just need to figure out the corresponding variables and convert those variables to the corresponding percentages.

(2) According to the 123 - comprehensive grade evaluation reference table, then can get:

$$\begin{aligned} N_1 &= b_1 = 27 \\ N_2 &= b_3 + b_4 = 22 + 8 = 30 \\ N_3 &= b_2 + b_3 + b_4 + b_5 = 22 + 44 = 66 \end{aligned} \tag{3}$$

The results are X_1=2430, X_2=2700, X_3=6000

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In the end, when the total amount of bank loans is fixed, the proportion of the total amount of credit of one, two and three is 21.3%, 24.3% and 53.9% respectively. To sum up, the results obtained after solving the model under hypothetical conditions are roughly consistent with the actual situation in life, indicating that the model is reasonable and has strong applicability in real life.

6. Conclusion

This paper makes a risk assessment of the loan business model of small and medium-sized enterprises, and establishes a scientific risk assessment model of the loan business model of small and medium-sized enterprises through the risk assessment, classification and capital proportion calculation of the loan business model of small and medium-sized enterprises. The enterprises are divided into different grades, and on this basis, the allocation of credit lines is conducive to the preliminary screening of customers by banks. This paper can provide some reference for credit strategy and method.

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