A study on credit risk assessment and credit decision making based on micro, small and medium enterprises

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Abstract: Micro, small and medium-sized enterprises (MSMEs) have flourished in recent years and are an important force in the composition of our economy, but they are naturally high in default, banks need to predict the credit risk of each enterprise in order to arrive at a safe, appropriate and efficient credit strategy. This paper mainly studies the data in the input invoices and output invoices of a company obtained by a bank. After screening, classification, and summary, the company's profit rate and the stability of supply and demand are calculated, and then a regression model is established by combining the company's reputation level and whether it is in default. This model helps banks predict credit risks and obtain credit strategies.

1. Introduction

The current studies, such as Tao Wang's "Risk Control and Prevention of Commercial Banks' Loans to SMEs"[1], Hengsong Hu's "Study on Financing Problems and Countermeasures of Small and Micro Enterprises-Based on Credit Policy Perspective"[2] and Jiongcheng Zhou's "Study on Risk Management of Commercial Banks' Loans to SMEs" [3], have analyzed the current situation of loans to SMEs, existing problems, and they put forward unique suggestions. However, they all remain at the qualitative level and lack quantitative analysis through data.

In practice, MSMEs are relatively small and lack collateral, so banks usually provide loans to strong enterprises with stable supply and demand relationships based on credit policies, information about their trading instruments and the influence of upstream and downstream enterprises, and give preferential interest rates to enterprises with high credit ratings and low credit risks. In this paper, we analyse the data of a bank to help it build a credit risk assessment model so that it can assess credit risk more accurately at a quantitative level and further determine whether to lend and the amount of loan, interest rate and loan term, etc. to obtain a more effective credit strategy.

2. Materials and Methods

Micro and small enterprises have long been in need of financial support, but at the same time it carries a high risk of default[4]. Banks assess the credit risk of enterprises based on their strength and corporate reputation, and then determine their credit strategy based on credit risk.

The strength of a company is reflected in its profitability and the stability of supply and demand. The higher the profit margin, the higher the ability of the enterprise to repay its debts; the more stable the supply and demand relationship, the stronger the enterprise's ability to resolve the crisis.

Corporate reputation is reflected by credit rating and performance. The higher the credit rating of an enterprise, the better its performance, and the greater the likelihood that it will repay its debts.
In this paper, we first analyze the enterprise information sheet and derive the decision of whether to lend or not by the relationship between credit rating and whether to default. Then carry out a quantitative analysis on the strength of companies that may lend. Calculate the profit rate of each enterprise according to the input and output invoice tables, and combine the number of successful transactions of each enterprise in a specific and equal time period to obtain the dispersion coefficient to indicate the stability of the enterprise's supply and demand relationship.

A binary logistic regression model was developed based on the relationship between the creditworthiness, profitability, stability and default of 123 enterprises to predict the probability of default in the future. Finally, the credit risk is assessed by combining the strength and creditworthiness of the enterprises, and a credit strategy is derived.

3. Results & Discussion

3.1. Data pre-processing
Check and filter data, invalid invoice and negative invoice data are invalid.

3.2. Analysis of credit rating
Analyzing the reputation level in the enterprise information table and whether it is in default, the default rate of the four reputation levels can be calculated, as shown in the following table.

| credit rating | A   | B   | C   | D   |
|---------------|-----|-----|-----|-----|
| default rate  | 0%  | 2.63% | 5.88% | 100% |

The graph shows that all firms with a credit rating of A do not default, all firms with a credit rating of D default, and firms with a credit rating of B or C may or may not default. Therefore, it is concluded that loans are given to all firms with a credit rating of A, but not to any firm with a credit rating of D.

The correlation between creditworthiness rating and whether or not to default was further analyzed by using EVIEWS to find the correlation coefficient between the two, as shown in the following table.

|     | Y      | Z      |
|-----|--------|--------|
| Y   | 1.00000 | 0.718004 |
| Z   | 0.718004 | 1.00000 |

It can be seen from the table that there is a significant linear relationship between the reputation level and the default.

3.3. Analysis of the strength of the business

3.3.1. Profit margin
According to the input and output invoices, we can use Excel to calculate the profit margin of each company.

\[ p^* = \frac{m}{C} = \frac{m}{(c+v)} \] (1)

The profit margin of an enterprise represents the strength of the enterprise, the higher the profit margin, the stronger the enterprise. We use EVIEWS to simulate the relationship between whether an enterprise defaults and its profitability, and simulate a regression model to observe and judge the strength and creditworthiness of MSMEs to make an assessment of their credit risk.

Using EVIEWS to draw a scatter plot and line graph of whether to default versus profitability, where x1 indicates corporate profit; y indicates whether to default: no - 0 yes - 1.
Table 3: Correlation coefficient between default and profit rate

|   | Y   | X1  |
|---|-----|-----|
| Y | 1.000000 | -0.070891 |
| X1 | -0.070891 | 1.000000 |

3.3.2. Stability of supply and demand

Based on the input and output invoices, we can use EXCEL to calculate the number of successful transactions for each enterprise in a specific equal time period and find the dispersion coefficient.

\[ c_r = \frac{\sigma}{\mu} \]  

We sort the time of all valid transactions in the output invoice table into four equal time periods. The mean and standard deviation of the four time periods were calculated to count the number of valid transactions by enterprises in each time period respectively. Given the different sizes of MSME firms, dispersion coefficients were used to indicate the stability of supply and demand for each firm.

The scatter plot and line graph of whether or not to default versus the dispersion coefficient were first drawn using EVIEWS(x2 indicates the stability of the firm's supply and demand relationship; y indicates whether or not to default: no - 0 yes - 1). And calculate the correlation coefficient:
3.4. Bank credit risk assessment models and research

A binary logistic regression model was established based on the relationship between the credit rating, profitability, stability and default of 123 enterprises to build a more complete logistic credit evaluation model for MSMEs to predict the probability of future default [5]. (x_i represents the mean value of the k-th factor to be estimated in the i-th year)

$$\hat{\lambda} = 0.684x_1 + 1.442x_2 - 0.001x_3$$

The model was tested to be significant at 0.283>0.05 (p-value), and for the data was calculated correctly at 0.958, which shows that the model has a good fit for the credit analysis of MSMEs and can predict well the value at risk of a loan to an enterprise.

| Hosmer-Lemeshaw test |
|-----------------------|
| step | Bangla | Degree of freedom | Significance |
| 1 | 10.032 | 8 | .263 |

| Classification table |
|-----------------------|
| Measured | prediction | Breach of contract | Correct percentage |
| No | Yes |
| Breach of contract | Step 0 | 69 | 0 | 100.0 |
| Yes | 3 | 0 | .0 |
| Overall percentage | 95.8 |

3.5. Banking credit strategy

Based on the above analysis, the credit strategy is derived as follows.

- All enterprises with a credit rating of A can be given loans, while those with a credit rating of D cannot be given loans. For companies rated as B and C, we judge whether to lend to them according to the established binary logistic regression model;
- To companies that are determined to lend, grant loans according to their needs;
- For enterprises with high creditworthiness and low credit risk, interest rate concessions are given between the specified interest rate ranges, and the relationship between customer turnover rate and annual interest rate is combined to comprehensively determine the loan interest rate for enterprises.

3.6. Strengths and weaknesses:

Compared with the previous research, this article introduces data to evaluate credit risk through quantitative analysis, and the research results are more accurate and implementable. The article has a clear process for processing the data and modeling, and it is suitable to be extended to other banks to evaluate the credit risk of small, medium and micro enterprises. It has certain reference significance for banks to make credit strategies.

However, this paper only uses a binary logistic regression model, and there may be other variables affecting credit risk that have not been mined and introduced into the model. Later on, a better and more complex model can be explored so that the credit risk of MSMEs can be better predicted and thus the credit strategy of banks can be better guided.
4. Conclusions
Based on actual and data information, this paper gives the bank's credit strategy for these enterprises when the total annual credit amount is fixed, by establishing a mathematical model to quantify the credit risk of 123 enterprises that expect to borrow from a bank.

The findings of this paper can provide a new method of credit risk analysis for banks, and have implications for the further improvement and optimization of banks' current loan evaluation systems for MSMEs.

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