

Research on credit strategy of small, medium, and micro enterprises based on commercial banks

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Abstract. -In order to help banks formulate Credit Strategies for small, medium-sized and micro enterprises, this paper analyzes enterprises from two aspects. On the one hand, starting from the enterprise's data and from the enterprise's relevant data, including qualitative indicators such as reputation level, invoice information, credit record and operating income, a model is established to quantitatively analyze the operation status and reputation status of the enterprise. On the other hand, through the analysis of the "maximum lending rate" and "maximum lending rate" of the bank, we can analyze the "maximum lending rate" and "how much lending rate" of the bank. Combining the above variables, we can get the best credit strategy of the bank under the factors of credit risk and income. Firstly, without considering the influence of other data, this paper abstracts five indicators to measure the reputation status and enterprise-scale from the data of small and medium-sized enterprises with credit rating, quantifies the indicators. At the same time, the Euclidean distance is calculated by MATLAB modeling, the correlation between lending enterprises and non-lending enterprises is analyzed, and the high-risk enterprises in lending enterprises are selected. Then, among the remaining enterprises that can issue loans, five different credit strategies are formulated according to the weighting of their credit rating and enterprise scale as the primary basis for the number of bank loans and interest rate. Secondly, the focus is on how to comprehensively quantify the credit status and business problems of small, medium-sized and micro enterprises without credit records. Without considering the influence of other data, this paper mainly analyzes the correlation between the enterprises without credit records and the enterprises mentioned above that do not grant loans. It preliminarily obtains the enterprises that can grant loans. Then, through decision tree modeling, the loan demand of enterprises with different credit levels is estimated as a variable. By fitting the curve between interest rate and customer churn rate, different interest rate ranges under different levels are obtained as the second variable. Finally, through the above two variables, we establish the profit function of bank credit, find the corresponding variables at the maximum value, and formulate relevant credit strategies.

Keywords: Small, medium and micro enterprises, credit rating, credit portfolio, credit risk management.

1. Introduction

With the rapid development of China's economy, small, medium-sized and micro enterprises show an explosive growth trend. By the end of 2019, small, medium and micro enterprises will account for more than 60% of GDP and 50% of taxes. Among them, the loan balance of inclusive small and micro enterprises with a total credit of 10 million yuan or less for a single household was 13.91 trillion yuan, nearly doubling compared with the beginning of 2018. It can be seen that small, medium-sized and micro enterprises have become an essential part of China's economy. The credit rating system of banks is generally divided into two parts: quantitative analysis and qualitative analysis. They complement each other and jointly determine the credit rating of enterprises. In recent years, the state has paid more and more attention to the development of small, medium-sized, and micro enterprises, and continuously issued relevant policies to encourage banks and other financial institutions to make credit investments in small, medium-sized, and micro enterprises. In this process, credit risk assessment and decision-making are particularly important. However, there are some problems in the actual evaluation process, such as the opacity of relevant information of small, medium-sized, and micro enterprises and the poor lending environment of small, medium-sized, and micro enterprises.

Small, medium-sized and micro enterprises themselves have the characteristics of small enterprise scale, weak repayment ability, no guarantee and pledge, fuzzy enterprise credit measurement standards, etc. It leads to the risk of enterprise bankruptcy, enterprise industrial and commercial information fraud, enterprise-related pledge or guarantee contract forgery after bank loans. In addition, some borrowers will also cause losses to the state finance by using illegal means such as falsely high relevant tax invoices and forged value-added tax invoices.

In conclusion, two sets of reliable quantitative indicators for credit risk are set up for the credit problems of small and micro businesses nowadays. And through data correlation, data mining and other means of future prediction to solve the existing credit risk problem.

2. Small and micro businesses credit risk related factors

In this paper, it is required to quantify the related factors affecting the credit risk of small and medium-sized enterprises, so as to formulate high-quality credit strategies for banks. Therefore, the analysis of this problem mainly focuses on the following two aspects:

Carry out a correlation analysis between the initially obtained enterprises that can issue loans and the enterprises that do not issue loans, and eliminate the enterprises with high correlation for the second time to obtain further the enterprises that can issue loans. The size of the selected enterprises that can make loans shall be measured separately, excluding the influence of other factors, and the enterprise size shall be screened through the enterprise's operating income. The enterprises whose enterprise size does not meet the standard shall also not make loans.

2.1 Principle of Euclidean distance model

Euclidean distance, also known as Euclidean distance, is a commonly used distance, which reflects the distance between two points in m-dimensional space. It is widely used in reality. Euclidean distance can generally be regarded as the similarity of signals. In the two-sample data of enterprises studied in this paper, it is necessary to ignore the small changes between the data. Besides, it will be affected by the instability of the covariance matrix. Therefore, the Euclidean distance is selected as the correlation data in this paper.

$$d_{12} = \sqrt{\sum_{k=1}^n (\chi_{1k} - \chi_{2k})^2} \quad (1)$$

2.2 Preprocessed data

Firstly, this paper selects 26 enterprises that have defaulted or whose credit rating is d. According to the research content of this paper, we will not grant loans to them and take the remaining 95 as the object of loans. After that, this paper selects the evaluation indicators to measure the credit status of small, medium-sized, and micro enterprises, including five indicators: Scrap ticket rate, the ratio of value-added tax to gross profit, the ratio of input scrap ticket to the total price and tax of all invoices, operating revenue and gross profit, and makes an overall analysis of the business status and credit status of the enterprise.

Taking the above five indicators as the five variables in the model analysis, the correlation between 95 enterprises that can issue loans and 26 enterprises that do not issue loans is analyzed by MATLAB. Enterprises with high relevance to nonlending will be directly included in the list of nonlending.

2.3 Establishing model solution

With the scrap rate, the ratio of VAT to gross profit, the ratio of input scrap to the total price and tax of all invoices, gross profit and operating revenue as the five dimensions in the five-dimensional space, 95 non-defaulting enterprises can be regarded as 95 points in the five-dimensional space. Suppose, the average value of the distance (i.e., Euclidean distance) between the corresponding point of a non-defaulting enterprise and the related point of other non-defaulting enterprises in the five-dimensional space is high. In that case, it can be considered that its correlation with the non-defaulting

enterprise is low, and the credit risk is high. On the contrary, the correlation is low and the credit risk is low.

Due to the different orders of magnitude in different dimensions, the direct calculation of Euclidean distance will give different dimensions different weights. It is necessary to normalize the data of different dimensions to obtain standardized data. Normalization is a dimensionless expression that maps data between (0,1).

$$x_{norm} = \frac{x - x_{min}}{x_{max} - x_{min}} \quad (2)$$

x_{norm} is the standardized data, x is the original data, and x_{max} and x_{min} represent the maximum and minimum values of the original data, respectively.

Through the above modeling analysis, it is screened out that the enterprises with high similarity with the enterprises that do not grant loans, that is, the enterprises with high risk, are included in the list of enterprises that do not grant loans, as follows:

Table 1: Possible risks

Row label	Output effective price tax total	Credit rating	Euclidean distance mean
E1	4698633441	A	0.63451305
E7	596230696.8	A	0.69149252
E9	369412037.9	A	0.958710117
E26	42429070.82	A	0.664486353
E59	30932889.16	A	0.846059496
E42	26235453.61	A	0.633818533
E88	2721179.65	A	0.909579659
E91	2694565.5	A	0.861754556
E71	12227309.62	B	0.747735719
E70	10682038.48	B	0.595941252
E40	34507751.31	C	0.850186748

As mentioned in the above table, in order to minimize the risk when enterprises carry out relevant risk control, the above 11 enterprises with high risk can be included in the list of non-granting loans, and the minimum number of enterprises that can grant loans is 84.

Table 2 By analyzing the scale of the above models, enterprises with a smaller scale are also included in the list of loans that are not granted.

Enterprise code	Total effective price tax	Credit rating
E93	1520337	B
E96	1481350	C
E98	1445110.8	B
E94	1084795.89	C
E97	1000542.9	B
E105	952563.89	C
E106	603677.86	B
E104	270530	C
E110	202827.51	C

2.4 final loan strategy

Based on the establishment of the above model and comprehensive analysis of relevant variables, the following credit strategies can be obtained:

The following lending strategies are based on three conditions: the lending amount is between [101 million], the lending interest rate is certain, and the loan term is evenly distributed for more than one year.

3. Credit standing analysis of small and medium-sized enterprises

First, the credit risk of small and micro businesses without credit records is quantified, the total loan amount of 100 million is allocated reasonably, and a reasonable loan interest rate is set.

Without considering the influence of other data, this paper mainly analyzes the relevant quantitative characteristics of enterprises without credit records and enterprises that do not issue loans in question 1, and preliminarily obtains the enterprises that can issue loans. Through Matlab using five indicators to determine the enterprises that do not grant loans and small, medium-sized and micro enterprises without credit records for correlation analysis, it is concluded that the enterprises with high correlation are included in the enterprises that do not grant loans, which achieves the purpose of preliminary screening. Then, through modeling, the loan quantity demand of enterprises with different credit levels (Class A, B and C) is estimated as a variable. The curve is constructed through the points corresponding to the interest rate and customer churn rate, and the different interest rate ranges under varying levels of enterprises (a, B and C) are obtained through the curve as the second variable. Establish the income function of bank credit through the above two variables, find the corresponding variables when the income is the maximum, and comprehensively evaluate the income of enterprises of different grades and sizes to obtain the optimal bank credit strategy.

As a method of approaching discrete function value, decision tree algorithm is essentially used to classify a series of data. Decision tree model is to determine the characteristic data index through data analysis, and generate a tree structure model through machine learning, so as to complete the process of continuous classification of data. We can classify other similar values through decision tree model and divide their attribute intervals.

This paper establishes a decision tree model to screen enterprises twice with corresponding quantitative indicators. The first screening is to decide whether to grant loans by analyzing the enterprises that do not grant loans and the enterprises without credit records. In the second screening, after the first screening, the decision tree algorithm is applied again in the enterprises that can make loans to obtain the division of credit grades of different enterprises. For bank risk control, the highest credit rating of enterprises without credit records can only be set as level B, and so on.

4. Impact of sudden factors and credit risk on loans

4.1 impact of unexpected factors on loans

Combined with credit risk and sudden factors, the credit adjustment strategy is determined when the total bank credit is 100 million. Therefore, in this paper, the COVID-19 epidemic is a sudden factor, combined with relevant literature, data and reports, to understand COVID-19's three industries (agriculture, processing, and manufacturing, modern service industry, or business).

Since the enterprises involved in this problem do not include the primary industry (Agriculture), they are divided into the secondary industry (processing and manufacturing) and the tertiary industry (modern service industry or commerce). Due to the non-uniformity of the epidemic's impact, it is known that the output of the secondary industry decreased by an average of 2.07%. In comparison, the output of the tertiary industry decreased by an average of 1.19% [3]. Therefore, under this condition, XX method is used to further classify and screen the data obtained in problem 2, further adjusting the interest rates of the tertiary and secondary industries.

4.2 impact of credit risk on loans

When deciding whether to lend to enterprises, banks should pay attention to the industry characteristics of enterprises to refine relevant investments. [4] Therefore, combined with the conclusion of credit risk, this paper divides it into second industries and third industries according to the characteristics of the industry names. Combined with COVID-19, we can see that the output of the third industry is less than that of the second industries, so this article will make appropriate adjustments to the conclusion of the credit income.

Enterprises are divided into the tertiary industry (modern service industry or commerce) and the secondary industry (processing and manufacturing industry) according to their name characteristics (keywords such as building materials, processing, commerce, and trade);

According to the classification and summary of the existing data, it is found that the bank will adjust its mortgage interest rate by ± 0.005 according to the industry characteristics of the enterprise under certain interest rate conditions. Therefore, the enterprise is classified, and its interest rate is adjusted under the condition of credit risk.

4.3 model conclusion

(1) Data preprocessing

Use the filter in Excel to screen the keywords of the results of question 2, so as to get the third-largest industry (modern service industry or commerce) and the second-largest industry (processing and manufacturing). The number of the three major industries in the ABC statistics table is x at the same time:

Table 3 Hierarchical Industrial Classification

Hierarchical Industrial Classification	B	C
The second industry	9	51
The third industry	26	187

(2) Since the overall output trend of the tertiary industry is better than that of the secondary industry, under the existing ABC and other division conditions, the interest rate for the secondary industry increases by 0.005, and the interest rate for the tertiary industry decreases by 0.005. Therefore, table x is obtained:

Table 4. Hierarchical Industrial Classification 2

Hierarchical Industrial Classification	B	C
The second industry	0.0615	0.0705
The third industry	0.0515	0.0605

When $M11 = 1$ million, $M12 = 1$ million, $M21 = 0$ million, $M11 = 213900$, the bank's income is the largest, and the maximum amount is 6.569000 yuan. (among them, $M11$ and $M12$ are the average loan amount of the bank with the predicted credit degree of B and C for the enterprises in the secondary industry, and $M21$ and $M22$ are the average loan amount of the bank with the predicted credit degree of B and C for the enterprises in the tertiary industry)

5. Conclusion

Based on the relevant purchase and sales order information given in the title and combined with real life, this paper further obtains the capital situation, such as the operating revenue of each enterprise. The residual effective value is obtained after further screening and processing according to the enterprise scale and other information. Concerning the current information of credit rating D, this paper analyzes the correlation of ABC and selects the enterprises with low correlation, that is, low risk for credit business. According to the quantitative data analysis of credit risk of small,

medium-sized, and micro enterprises, the information is screened, the information similar to ABC grade is obtained and divided. At the same time, combined with the daily living conditions, the customer churn rate and credit interest rate of different grades are analyzed, and the corresponding relationship is obtained so as to further allocate the loan limit and interest rate of various enterprises when bringing the maximum return value of the bank. [8]

The credit indicators determined in this paper are universal to all banks and easy to be popularized in the bank credit mechanism in real life. After full use of the given data, establish the corresponding model, and use Excel to integrate, splice and calculate the initial data, which has strong operability and simplifies the calculation process. The data processing flow is relatively clear, and the data modeling is carried out utilizing preprocessing (deletion, splicing table, screening, etc.), data visualization processing, correlation analysis, and other means, so as to ensure the scientificity of problem-solving methods and the preciseness of problem-solving steps.

Euclidean distance is used in analyzing the correlation between enterprises, and the weight of each credit index is the same. However, the index's weight involved in daily life will change accordingly in combination with the specific situation. Therefore, in the later stage, the weighted analysis of different indicators can be carried out according to the research results of relevant experts. The industry classification under the epidemic conditions involved in sudden factors is limited to the three major industries, among which the industries contained therein are not subdivided. If the types of enterprises are subdivided at two or even multiple levels, and considering their specific industry characteristics and specific data during the epidemic, the applicability and practicability of the model will be further expanded. At the same time, due to the limited scope of check data and the influence of unexpected factors, the adjustment range of interest rate may be deviated to some extent. In the later stage, we can consider further refining its range to make the result more accurate.

References

- [1] Zhang Xueyu Research on credit rating optimization of small and medium-sized enterprises in China [D] East University, 2018 Master's thesis
- [2] Zhang Yurun, Zhang Qiang Research on financing difficulties and Countermeasures of small and micro enterprises [J] Journal of Bengbu University, 2020,9 (04): 23-30
- [3] Zhou Meifang, Liu Yu, Zhang Jinzhu, Cui Qi The macroeconomic effects of novel coronavirus pneumonia and the effectiveness of policy response [J]. Research on quantitative economy and technical economy, 2020,37 (08): 24-41
- [4] Ren Chenxi An empirical study on the relationship between industrial policy, industry characteristics and enterprise debt financing [D] Shenyang University of technology, 2019 Master's thesis
- [5] PI Changxing Thoughts on credit risk management of small and medium-sized enterprises under the new financial normal [J] Financial circles, 2020 (26): 24-25
- [6] Duan Zhen Research on optimal loan portfolio pricing of commercial banks -- Analysis Based on risk adjusted capital return maximization model [J] Price theory and practice, 2019 (08): 92-95
- [7] Shi Feng, Hu Yan Application Research on credit classification of small and Medium-sized Listed Enterprises -- classification method based on BP neural network and SVM [J] Journal of Hunan Institute of Engineering (SOCIAL SCIENCE EDITION), 2020,30 (01): 1-5
- [8] Liu Mengyu Credit risk classification and tax management services are more accurate [J] China credit, 2020 (06): 44-45