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Establishment of a Mathematical Model for Enterprise Credit Risk Recognition and Rating Based on Hybrid Learning Algorithms

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Establishment of a Mathematical Model for Enterprise Credit Risk Recognition and Rating Based on Hybrid Learning Algorithms

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Abstract. With the increasing trend of economic globalization, the market competition among enterprises is becoming increasingly fierce. The fierce market competition makes enterprises face increasing financial risks. Financial risk not only damages the interests of investors and creditors, but also threatens macroeconomic stability. In this paper, the theory and method of comprehensive evaluation of mixed learning algorithm are used to evaluate the enterprise credit. Principal component analysis method is used to determine the weight of each index, then the comprehensive evaluation value of each sample enterprise is calculated by the efficiency coefficient method. Finally, the quantitative judgment standard of each credit rating is determined by the ordered clustering method. The internal credit rating model of commercial banks is constructed to improve the credit risk management level in the credit approval process. Finally, a mathematical model is given and discussed with examples to show that the results are quantitative, scientific and objective.

1.　Introduction

Corporate credit rating plays a key role in corporate financing, listing, and debt issuance. However, the current mainstream enterprise credit rating research and rating model are still dominated by large and medium-sized enterprises, and there is little authoritative research on the credit rating of small and micro enterprises [1]. Under the modern market economy conditions, credit risk classification and identification management is the basic activity of the financial system and financial institutions. As the main body of China's financial system, commercial banks play a pivotal role in creating currency deposits, achieving financial policy efficiency, and realizing social investment [2]. Under the "new normal" economic atmosphere, the development and growth of emerging technologies, emerging industries and emerging markets provide a rare historical opportunity for the development and growth of small and micro enterprises. Through the investigation of the causes of the banking crisis, we find that although the direct causes of the crisis are different and the social and economic backgrounds of the crisis are different, the imperfect internal risk management of banks and the weak external supervision of the banking regulatory authorities are the common and important reasons for the banking crisis [3]. With the deepening of economic globalization and the frequent flow of capital in the world, the liberalization and integration of the world economy, trade and finance have become the trend of development. Therefore, it is of great significance to actively carry out credit evaluation of enterprises and expand the financing channels of enterprises in China to foreign countries.

The method based on hybrid learning algorithm is a learning mechanism that combines multiple learning methods. In this study, a small number of labeled samples and a large number of unlabeled samples are used to combine semi-supervised classification method with unbalanced classification method, thus forming a financial risk prediction method based on hybrid learning strategy [4]. Strengthening the management of enterprise credit risk can effectively solve the difficulties faced by commercial banks in recent years due to credit problems. In the future, the competition in the banking industry is not only a contest between capital and scale, but also a contest of risk management. The scale of funds is large. If the level of risk management is not improved, the profit will not be guaranteed, and the bank will lose its motivation for development. The root of survival [5]. Financial institutions are often reluctant to finance small and micro enterprises for security reasons. However, the role of small and micro enterprises in the national economy and social life is irreplaceable. Due to the lack of credit rating of small and micro enterprises, the credit level of small and micro enterprises cannot be scientifically evaluated, which intensifies the financing difficulties of small and micro enterprises.

2. Methodology

In the credit approval operation, commercial banks use the credit rating model to judge the information provided by the borrowing enterprise, and estimate whether the company will default in the future. It is already a pre-primary approval process, so the effectiveness of the rating model is The common concern of domestic commercial banks [6]. Because listed companies can provide standardized public financial information, and their financial statements are audited by independent CPAs. In theory, financial information is highly credible. Therefore, this paper selects some enterprises from listed companies as modeling. sample. Determine the scope of sample selection, that is, select a number of enterprises with a clear credit rating measured by the authoritative credit rating department. Based on the idea of principal component analysis (PCA) dimensionality reduction, several indicators are transformed into several comprehensive indicators under the premise of little information loss. Then, fast clustering method, self-organizing competitive neural network and fuzzy neural network are used to identify, classify and predict enterprise credit risk. The lack of enterprise credit, on the one hand, increases the cost of market transactions and reduces the efficiency of transactions, on the other hand, increases the risk of bank credit and threatens the stability of financial markets. Therefore, how to establish an applicable enterprise credit rating model and strengthen enterprise credit management has become an urgent problem for academia and industry.

Because of the different types of indicators and the different analysis standards, it is necessary to transform the data before analysis and remove the obstacles caused by the different types. According to the mainstream standardization method, the calculation is carried out through the following formulas:

$$\sigma = \sqrt{\ln(1 + \frac{v_r}{m^2})}$$

(1)

Faced with different types of data at each level, first convert them into the same type, and perform the same direction as follows:

$$D_j = \sum_{i=1}^{n} (H_P \times V_p)$$

(2)

When evaluating the validity of the model, we need to consider the cost of different error types. In this paper, we adopt two exchange criteria for the division of the industries to which the enterprises belong, namely, dividing the industries to which the enterprises belong into five categories: industry, commerce, real estate, public utilities and comprehensive industries. At the same time, in the few labeled samples, the data sets of enterprise credit rating tend to show the characteristics of unbalanced distribution. As far as the error rate is concerned, the model results are generally divided into two types of errors. The first is to misjudge the enterprises with lower credit level as those with higher credit level, and the second is to misjudge the enterprises with higher credit level as those with lower credit level. It is an accounting statement that reflects the financial situation of an enterprise on a specific date. It is

based on the relationship between assets, liabilities and owners' equity, according to certain classification criteria and certain order. The recognition rate includes a bad recognition rate and a total recognition rate, and the bad recognition rate indicates the proportion of the non-performing loans in the test sample recognized by the model. Therefore, when qualitative analysis selects the evaluation indicators that reflect the profitability of the enterprise, we have consciously selected some indicators. Specifically, the indicators we selected to reflect corporate profitability are operating profit margin, net profit margin, cost expense margin, return on equity, and return on assets. It is used to solve the unbalanced problem of unlabeled samples and data distribution in corporate credit rating, thus providing new ways and means for corporate credit rating.

Let the input of the fuzzy inference engine be the fuzzy set on S. If the synthetic operation is used, the fuzzy set S on r derived by each fuzzy inference rule is:

$$S(r_k) = \sum_{r_k \neq r_i} w(r_i) D_r(r_k, r_i)$$

(3)

The dimensions that describe the characteristics of things are diverse. To facilitate analysis and comparison, we need to normalize the matrix to eliminate this interference during the calculation. There are several standardization methods, such as:

$$\beta_{xy} = \frac{I_{xy}}{\sum_{a-1}^{g-1} I_{xa}}$$

(4)

For the i-th neuron in the M interconnected neurons, the sum of the external inputs affects its activation value. The state of the i-neuron forms an output with a certain function, that is:

$$R_i = M_i \sum_{i=1}^{N_r} \hat{R}_{i,r}$$

(5)

The function f (x) expresses the input and output characteristics of neurons. In the credit evaluation model, it is defined as a step function:

$$f(x) = \sum_{i=1}^{D} |x_i|^{(i+1)}$$

(6)

If threshold b is considered as a special weight, then f(x) can be rewritten as follows:

$$f(x) = (z \cdot \phi(x)) + b$$

(7)

Compared with the complicated index scoring system, the model is simpler in application. Firstly, it collects and calculates the index values of samples. Secondly, it brings in the model to calculate the category values, which can judge the credit risk status of enterprises. The assets, liabilities and owner's rights and interests of an enterprise on a certain date are arranged appropriately, and a large number of data formed in daily work are highly condensed and compiled. Because macroeconomic variables are not macroeconomic variables at a certain time point, but reflections of the trend of changes of relevant macroeconomic variables during the loan period, they are not the concept of a time point, but the concept of a change trend of a certain time period. This shows that there are many duplicate information in evaluating the profitability of enterprises in the indicators selected by qualitative analysis. Therefore, some profit indicators should be excluded. According to the maximal irrelevant method of culling indicators, the one with the largest complex correlation coefficient should be eliminated. At the same time, considering the non-equilibrium characteristics of data distribution, the semi-supervised classification method is combined with the non-equilibrium classification method to form a new enterprise credit rating method. They can respond to small changes in the business. These indicators should change significantly when the company's operations are generally volatile. For the characteristics of small and micro enterprises' main products and market conditions, the analytic hierarchy process is used to determine the weighting coefficient of individual indicators.

3. Result Analysis and Discussion

The development of the socialist market economy has brought about tremendous changes in China's economic and financial environment. Enterprises must conduct production and operation in accordance with market rules, and banks must also deal with trading relationships with enterprises in accordance with market rules. The method based on hybrid learning algorithm has achieved better improvement results. This is because the financial distress prediction method of listed companies based on hybrid learning strategy also pays attention to the large number of unlabeled data and data distribution imbalance in the financial distress prediction of listed companies. . The training sample and test sample data are brought into three models, and the predicted result is compared with the actual credit rating, and the prediction accuracy rate and the error rate can be obtained. Due to the high sensitivity of these indicators, timeliness, predictability and advancement in monitoring and identification can be guaranteed. A representative indicator should be chosen. Representational indicators refer to indicators with a certain degree of comprehensiveness, stability and feasibility. On the basis of fully considering the factors causing credit risk of small and micro enterprises, the comprehensive credit rating index system of small and micro enterprises is divided into three parts: the main character of small and micro enterprises, the industry market and the financial factors of enterprises. For commercial enterprises, we believe that the performance of the liquidity ratio index has been relatively satisfactory; for industrial enterprises, the enterprise has not reached a satisfactory level. This may be because this method pays more attention to the sample of misclassification in the process of Forecasting Financial Distress of listed companies, so it can significantly improve the classification accuracy of financial distress enterprises.

According to the comprehensive credit evaluation system of micro-enterprises, the original survey data were obtained in order to investigate among bankers and university financial experts. By calculating the acquired data, the following results are obtained (Table 1).

Table 1 Comparison of the relative importance of the evaluation indicators of the main business lines of enterprises

U	U1	U2
U1	2	1
U2	0.3	0.6

Identify and monitor the credit risk of the enterprise. The designed indicators must be able to describe and indicate the state of the research enterprise and the cycle activities of the overall operation. Therefore, these indicators must be indicators with clear economic significance, which can accurately reflect the quantitative characteristics and changes of the operation of the research enterprise. The relative importance of small and micro enterprises, corporate funds, market conditions, industry evaluation, and evaluation indicators in the main products are all tested by consistency, so that the entire calculation process and calculation results are acceptable. These results indicate that the application of the above model in credit rating needs to be emphasized when measuring the specific credit rating. The evaluation of different credit rating indicators with different economic meanings, dimensions, orders of magnitude and industry characteristics can be transformed into evaluation values with the same measurement nature. In the process of hybrid learning, more labeled data are added to labeled data sets in each iteration, and these labeled data have high confidence, thus improving the quality of training samples for financial distress prediction of listed companies. If the number of test samples is increased, it will show better convergence performance and prediction accuracy, which will more accurately predict the credit risk status of listed companies.

When the operation of the enterprise shows fluctuation, the index system should change obviously. Once the abnormal fluctuation occurs, the index system can send out the indication signal in time. That is to say, the index system must be able to reflect the small changes in the course of the operation of the enterprise's funds. The establishment of a comprehensive credit rating system for small and micro enterprises has a key significance in resolving the financing difficulties of small and micro enterprises. If the comprehensive credit rating system for small and micro enterprises can be promoted and developed in financial institutions, then financial institutions can carry out credit rating for small and micro

enterprises smoothly, which will solve the financing difficulties of small and micro enterprises. Profitability is the key to ensuring that companies can repay their loans on a contractual basis. Therefore, the weight of the rating indicators that reflect profitability should be relatively large. It means that enterprises can provide sufficient debt protection under normal conditions, but in the long run, there may be some factors that cause credit risk, and the credit situation is unstable. When observing the sample data of two types of errors in the test results of each model, this paper finds that the customer credit rating, customer credit rating, and operating income/personal indicator in the sample data are different from ordinary values, so such samples need to be artificial. Pay attention to the pre-lending review.

4.   Summary

The purpose of enterprise credit risk identification and classification is to show enterprises through more macroscopic and comprehensive indicators monitoring, which areas are weak, and the risk accumulation in these weak links is an important direction of financial research, especially for bank credit work. Reference and guidance. Actually establish a corporate credit risk rating model. This paper believes that when establishing the enterprise credit rating model, it is theoretically possible to separately model the financial factors and non-financial factors, and then combine the evaluation results of the two models to form a comprehensive model that comprehensively reflects the size of the corporate credit risk. The multi-level fuzzy comprehensive evaluation theory solves the fuzzy factors that are difficult to quantify in the common method; Moreover, by using the method of fuzzy weighted average and the method of solving the fuzzy relation equation, the optimum weight of each index can be determined. Aiming at the problems of unlabeled data and unbalanced data in enterprise credit rating, a method of enterprise credit rating based on hybrid learning strategy is proposed. Finally, the financial risk prediction model based on hybrid learning strategy is introduced into the application of financial distress prediction of listed companies. It is superior to the traditional multiple regression model in terms of convergence performance and prediction accuracy, and can more accurately predict enterprise credit risk.

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