Research on the Credit Risk Assessment of Small and Medium Enterprises Based on BP Neural Network

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Abstract: Small and medium-sized enterprises play an important role in China's economic development. However, they face many problems in their development, among which credit financing is particularly important. This paper mainly focuses on the correlation of small and medium-sized enterprise credit problems. Combined with the characteristics of small and medium-sized enterprises in China, this paper builds a more scientific and reasonable evaluation model based on the evaluation index system and uses BP neural network to grade the credit capacity and risk of small and medium-sized enterprises. It also puts forward relevant suggestions from the perspective of enterprises and banks to help banks make reasonable decision-making plans and find the optimal credit strategy.

1 INTRODUCTION

With the rapid development of China's economy and the adjustment of economic structure, China's small and medium-sized enterprises have developed rapidly and played an important role. In the development process of small and medium-sized enterprises, there are often various problems due to their scale and organizational structure. High credit risk, difficult financing, and expensive financing are still the primary problems faced by China's small and medium-sized enterprises. Through investigation and research, the existing internal management regulations of commercial banks in China are not very perfect and lack scientific and reasonable credit risk assessment methods and systems for the evaluation and prevention of small and medium-sized enterprise creditability. Therefore, it is particularly important to establish a perfect credit risk evaluation model for small and medium-sized enterprises in commercial banks.

Based on the theoretical research at home and abroad, Wu Jingmei puts forward an evaluation system suitable for the company's financial quality and solvency. She is the first economist in China to deeply study the credit evaluation index system. Based on a commercial bank in Zhejiang Province, Shi Zhen and Xu Feng used BP neural network training sample model to predict and evaluate their risk evaluation. Through empirical research, the model can be used as the basis for credit risk decision-making of urban commercial banks. Based on the credibility research theory, Liu Cheng and Liu Xiangdong combined analytic the hierarchy process with credibility measurement to establish a comprehensive risk index system from multiple levels and form a framework and model that can reflect the characteristics of small and medium-sized enterprises. Wu Jingru selects and modifies the indicators that can reflect its characteristics, establishes and tests the credit evaluation index system of small and medium-sized enterprises by using fuzzy analytic hierarchy process.

Based on previous studies, combined with the characteristics of small and medium-sized enterprises in China, this study intends to build a more scientific and reasonable evaluation model based on the establishment of the evaluation index system, and use BP artificial network to evaluate the credit capacity and risk of small and medium-sized enterprises in China.

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2 DATA SOURCES AND INDEX SELECTION

2.1 Index System Construction

This paper will build a credit strategy system from two aspects of enterprise-strength and credit level (see Table 1). The hierarchy under "credit level" is divided into the following two categories: credit level and default. The hierarchy of "enterprise-strength" is divided into the following four categories: capital flow, transaction vitality, profitability, and supply, and demand. To analyze and solve the problems more specifically, these four aspects are further subdivided, and it is decided to select 10 quantities such as total annual profit, profit margin, price and tax stability of purchase (Sales), the efficiency of purchase (Sales) invoice and invoicing stability of purchase (Sales) invoice as the evaluation index.

Table 1: Index System.

Primary index	Secondary index
Enterprise strength	Input price tax stability
	Output price tax stability
	Input invoicing stability
	Output invoicing stability
	Total profit for the year
	Profit margin
Credit level	Credit rating
	Default or not

2.2 Data Sources and Assumptions

The data in this paper are all from the relevant invoice data of 123 enterprises with credit records and 302 enterprises without credit records provided in the appendix of question C of the "2020 Higher Education Association Cup National Mathematical Contest in Modeling for College Students" released by the organizing Committee.

In order to ensure the scientificity and rationality of the system construction, the following assumptions are established:

(1) It is assumed that the screening data is true and effective without deviation.

(2) It is assumed that the enterprise has a certain risk control ability.

(3) It is assumed that in addition to the selected index system, other factors have little impact on risk assessment and decision-making.

(4) It is assumed that the optimal loan amount should maintain the same change rate as the enterprise as a whole.

3 ESTABLISHMENT AND SOLUTION OF THE MODEL

3.1 Model Overview

BP neural network was proposed by McClelland and Rumelhart in 1986. It is a kind of multilayer feed-forward neural network trained by an error backpropagation algorithm. BP neural network does not need to determine the mathematical equation of the mapping relationship between input and output in advance but can get the result closest to the expected output value after giving the input value through its training and learning of corresponding rules. Its core idea is the gradient descent method, which uses gradient search technology to minimize the error mean square deviation between the actual output value and the expected output value of the network. The structure of the BP neural network is shown in Figure 1:

(1)

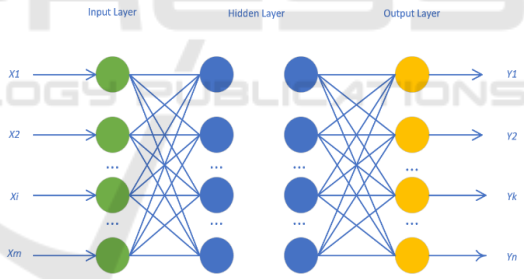

Figure 1: Structure of multilayer neural network.

3.2 Model Establishment

For a single neuron, its structure includes input, synaptic weight, sum plus bias, activation function, and output.

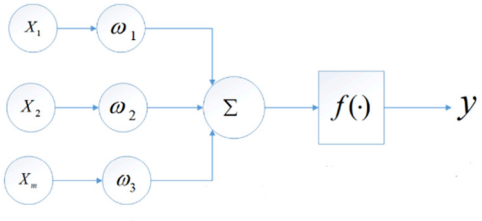

Figure 2: Schematic diagram of the single-neuron structure.

1) Input vector of the input layer

$$X = (X_1, X_2, \dots, X_m)$$

as $X_i = (X_{i1}, X_{i2}, \dots, X_{in})$

2) Hidden layer vector of layer 1:

$$H^l = \left(h_1^l, h_2^l, \dots, h_j^l, \dots, h_{s_l}^l\right)$$

as $l = 2,3, \dots, L-1, j = 1,2, \dots, s_l$

3) Output layer output vector:

$$Y = (y_1, y_z, \dots, y_n)$$

4) Set w_{ij}^l is the connection weight from the ith neuron in layer $l-1$ to the jth neuron in the layer, is the b_j^l offset of the jth neuron in the layer, including:

$$h_j^l = f(net_j^l)$$

$$net_j^l = \sum_{j=1}^{s_l-1} w_{ij}^l + b_j^l$$

as net_j^l is the input of the jth neuron in the lth layer, and is the activation function. The activation function can introduce nonlinear function. In this paper, the Sigmod function is selected as the activation function, that is:

$$f(x) = \frac{1}{1+e^x}$$

5) The error function is introduced to measure the gap between the output result and the expected output. Assuming that there are p training samples of enterprise data, $d(i)$ is the expected output corresponding to, assuming that a single training sample has n outputs, $E(i)$ is defined as the training error of a single sample:

$$E(i) = \frac{1}{2}\sum_{i=0}^{n}\left(d_k(i) - y_k(i)\right)^2$$

therefore, the global error function:

$$E = \frac{1}{2p}\sum_{i=1}^{p}\sum_{k=1}^{n}\left(d_k(i) - y_k(i)\right)^2$$

The weight and bias are updated. In BP neural network, gradient descent method is generally used to realize this step:

$$w_{ij}^l = w_{ij}^l - \alpha\frac{\partial E}{\partial w_{ij}^l}$$

$$\mathrm{b_j^l} = \mathrm{b_j^l} - \alpha\frac{\partial \mathrm{E}}{\partial \mathrm{b_j^l}}$$

3.3 Solving the Model

In this paper, 123 known credit rating and default record data are used as the training set and prediction set. The proportion of training and prediction samples is about 80% and 20% respectively. That is, the data of the first 100 enterprises are used as the training set and the data of the last 23 enterprises are used as the prediction set. The training times are determined as 15000 times, the convergence error is 0.1 and the learning rate is 0.0001. After the results of the training set converge, the data records of the last 23 enterprises are put into the trained neural network for the test, and the accuracy is 82.6%.

The prediction accuracy is high, so further prediction can be carried out. The data of 302 enterprises with unknown credit ratings can be brought into the trained BP neural network. The final results are shown in Table 2:

Table 2: Evaluation Results.

Score	Level	Number
>0.9	Excellent	21
0.75-0.9	Good	114
0.6-0.75	Commonly	143
<0.6	Poor	24

Based on the analysis of the advantages of the model algorithm, the value of AUC is 0.74, which indicates that the model has a predictive value and the establishment of the model is more reasonable

4 CONCLUSIONS

4.1 Conclusion

In real life, due to the scale and structure of small and medium-sized enterprises, banks will evaluate the loan risk of each enterprise when providing loans. Banks prefer to provide loans to enterprises with strong strength and stable supply-demand relationships, and will give preferential interest rate policies to enterprises with high reputations and low credit risk. To do a good job in loan risk management, banks need to establish corresponding models according to the actual situation of enterprises, comprehensively consider through the model solution, and judge the risk of each enterprise, to effectively avoid the emergence of non-performing loans.

This study starts with the identification of credit risk of small and medium-sized enterprises, and mainly studies the application of the BP neural network model in credit customer risk management of commercial banks. This study takes the credit rating of each enterprise as the evaluation standard of loan risk, and the relationship between impact index and credit rating can be trained through BP neural network. It has the characteristics of simple structure, fast convergence speed, easy implementation, and high prediction accuracy. The establishment of this model is convenient for banks to estimate the credit rating of small and medium-sized enterprises more scientifically and reasonably, and then formulate the Credit Strategies of enterprises with different ratings to achieve a win-win situation between banks and enterprises.

4.2 Suggestion

(1) Enterprises should strengthen their construction and improve their awareness and ability of risk prevention and control.

Small and medium-sized enterprises should first start from themselves, establish a set of management structures suitable for the long-term development of enterprises, and improve the internal control and management system of enterprises. At the same time, by constantly improving the enterprise system and standardizing the financial system, enterprises can improve the transparency and authenticity of financial information, smooth the enterprise capital chain, fundamentally control the generation of non-performing loans and reduce the credit risk of commercial banks. In terms of credit, enterprises should repay the principal and interest on time, strengthen communication and cooperation with banks, and provide detailed and accurate financial information and enterprise information to banks in time. Enterprises should form a good cooperative relationship with banks and maintain their own reputation, so as to achieve win-win cooperation.

At the same time, enterprises should establish a corresponding incentive system and supervision system. Small and medium-sized enterprises through the implementation of reward and punishment measures to improve the enthusiasm of employees and create more benefits for enterprises. The corresponding supervision mechanism is conducive to eliminating the improper behavior that is not conducive to the development of enterprises.

(2) Banks should improve the credit evaluation system and optimize the way of credit management.

First, strengthen the pre-loan and post loan supervision of small and medium-sized enterprises, reduce the problem of information asymmetry with enterprises, and establish a perfect information disclosure platform to ensure the openness and transparency of information. Second, optimize the lending process of small and medium-sized enterprises to achieve efficiency and effectively avoid risks. Third, establish and improve the credit risk early warning mechanism of small and medium-sized enterprises in commercial banks, improve the level of risk management, and use scientific and effective risk identification and early warning models to improve the Scientific and applicability of credit decision-making.

(3) Improve the quality and ability of evaluation personnel and optimize post setting

Banks should improve the quality of employees and cultivate their risk assessment ability in various ways. On the one hand, introduce high-quality risk assessment talents, especially those with rich experience, who can use and continuously improve the risk assessment model to adapt to the actual situation of different enterprises. On the other hand, improve the bank's employee training system and enhance employees' risk management awareness. Relevant staff must master relevant legal knowledge, credit rules and regulations, and deeply understand the actual situation of the enterprise to evaluate and handle credit business, so as to improve their own risk management level.

A bank shall improve the comprehensive quality of all staff in the whole process of credit business handling, and improve their own ability and professionalism. Only by strengthening the awareness of relevant personnel from the level of consciousness can they significantly improve their personal ability and strengthen the risk control of commercial banks.

At the same time, the bank shall improve the risk management structure and clarify the responsibilities of each department and post. Not only in quantity but also in quality to ensure the matching of posts, so as to form the organizational guarantee of risk prevention and control.

(4) Strengthen external supervision and communication and obtain data from multiple channels

Banks should speed up the establishment of a perfect information disclosure platform to ensure the openness and transparency of market information.

Banks should constantly strengthen the information exchange between enterprises and financial institutions such as banks, implement effective communication, and reduce the problem of information asymmetry with enterprises, so as to reduce financial risks and provide high-quality credit services for enterprises.

A bank shall establish a responsibility system for the authenticity of financial information, appoint special personnel to supervise and implement an accountability system. Banks should also strengthen the management of the authorization system, clarify the authorized personnel and operators, and conduct strict supervision and inspection. At the same time, with the advent and development of the big data era, many information industries dominated by big data are developing rapidly and playing an important role in the modern Internet. Banks can use big data to make credit data more specific, so as to promote the construction of credit system more and more comprehensive.

REFERENCES

Liu Cheng, Liu Xiangdong, Chen Gang Credit risk assessment of small and medium-sized enterprises based on credibility theory [J] Research on technology, economy, and management, 2014,10:3-7.

Shi Zhen, Xu Feng Application of BP neural network in credit risk assessment of Chenghai credit cooperatives [J] Consumer guide, 2008 (21): 104-104.

Sun Qingwen, Yang Xuebin Research on credit risk management of small and medium-sized enterprises in China's commercial banks [J] Shanxi agricultural economy, 2021 (03): 113-114.

Wu Jingmei Credit evaluation of Chinese enterprises and securities [M] Beijing: CITIC Press, 1994.

Wu Jingru Construction of credit risk evaluation index system for small and medium-sized enterprises [J] Accounting newsletter, 2016 (26): 102-104.

Yao Nan Analysis on credit risk and Preventive Countermeasures of small and medium-sized enterprises in commercial banks [J] Modern marketing (Business Edition), 2019 (09): 189.

Zhao Yu Causes and Countermeasures of the credit risk of small and medium-sized enterprises [J] Investment and cooperation, 2021 (07): 43-44.