

Credit Risk Assessment for Rural Credit Cooperatives based on Improved Neural Network

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Abstract—At present, the researches on credit risk analysis mainly focus on commercial bank loan or consumer credit risk, and there is little research about the credit risk of rural credit cooperatives. The purpose of this paper is to evaluate credit risk for the rural credit cooperatives using artificial neural network model. We establish credit risk assessment index system for rural credit cooperatives. Then, a kind of credit risk assessment model based on particle swarm optimized neural network is put forward. The proposed scheme has fast convergence speed and high accuracy. We can conclude that the propose model has good development prospect in the field of credit risk assessment.

Keywords—credit risk assessment; rural credit cooperatives; neural network

I. PARTICLE FILTERING ALGORITHM

Along with the deepening of reform and opening up, domestic economy has obtained the rapid development, and national income has increased significantly, which gradually leads to the people's consumption idea has very big change[1,2]. The change of credit consumption is most significant, which has become one of the main forms of consumption. Personal credit consumption in our country has been a rapidly developed since 1997, its total scale expands rapidly, the rapid development of credit business change the pattern of bank assets in our country, and business credit becomes one of the important assets business project[3,4].

In this case, the credit risk management is particularly important for banks. Credit risk management is a kind of management method to maximize security based on bank risk identification, measurement, analysis and control, on the premise of cost minimization[5]. The bank's credit risk mainly is made up of company credit business and personal credit business. Due to the restriction of such factors as economic system in the past, most of the domestic banks focus on company's credit risk management research and development, and ignores the personal credit risk management research and practice[6,7]. To improve and perfect the existing management system is very necessary. Artificial neural network is one of the credit risk research methods. Artificial neural network has very extensive application in the field of computer[8]. Artificial neural network has achieved certain results in many non-computer fields, such as image processing, signal processing, health care, welding, transportation, agriculture and so on. In terms of the credit risk control, researchers have formed a mature theoretical system and research methods, and these methods are widely applied to the credit risk management of commercial banks. With the development of commercial

banks and the gradual maturity of capital market, the domestic research on credit risk assessment method and application gradually increases, the most widely used methods are statistical analysis method and artificial intelligence technology. At present, the research on credit risk analysis mainly focus on commercial bank loan or consumer credit risk, and there is little research about the credit risk of rural credit cooperatives. Research methods mainly focus on qualitative analysis, quantitative analysis is less and the used method is unitary. Back-propagation neural network was used to predict the solubility of sulfur in hydrogen sulfide[9]. Artificial neural network and adaptive ant colony optimization was used in intelligent technique for robot path planning[10]. PSO-neural network model was used in prediction of groundwater level in Handan city[11]. Neural networks was also used in the security and risk assessment of information[12]. Research on the fabric defect detection method based on improved PSO and NN algorithm was presented by Jia He[13]. Back-propagation neural network combined with a particle swarm optimization algorithm for travel package demand forecasting was put forward by Han-Chen Huang[14]. The paper is organized as follows. In the next section, index system of credit risk assessment for rural credit cooperatives is given. In section 3, credit risk assessment model based neural network is designed. In section 4, experiments are done to test the performance of proposed model. In the end, some remarks are given.

II. INDEX SYSTEM OF CREDIT RISK ASSESSMENT FOR RURAL CREDIT COOPERATIVES

Financial information, is the most common decision-making information. Financial information does not reach the ideal level of people's minds. However, from the perspective of verifiability and practical, it is the preferred decision-making information. Usually, we classify the indexes into five categories: profitability ability, operation ability, debt paying ability index, cash flow index, and liquidity index. Profitability indicators reflect the profitability of the enterprise. Enterprise's profit ability is the most fundamental ability. Enterprise profitability declining inevitably leads to repayment difficulties, and increases the bank's credit risk. We select the interest income ratio index.

Operation ability refers to assesses operating efficiency of an enterprise. The index has close relationship with industry characteristics and business decision making. The total asset turnover and operating fee are selected in this paper.

Company's ability to repay its debt has a direct effect on the safety of bank loan, so it is the main analysis content of

credit risk. Security refers to ensure the safety of the funds to avoid the requirement of operational risks. Because of the rural credit cooperatives belongs to industry of high risk and high liabilities. Therefore, security has a great significance for bank performance evaluation. The index system is shown in table 1.

Table 1. Credit risk assessment index

The second level	The third level
Profitability indicators	Interest income ratio
Operation ability indicators	Total asset turnover operating rate
Solvency indicators	Their own capital ratio Interest on the recovery efficiency Interest payable ratios Non-performing loan ratio Asset-liability ratio
cash flow indicator	Cash flow ratio
Liquidity indicators	Medium and long term loan ratio The loan-to-deposit ratio Current ratio

III. RISK ASSESSMENT MODEL BASED ON IMPROVED ELMAN NETWORK

Artificial neural network method has strong ability of information extraction, and has higher prediction accuracy of credit risk discriminant. Therefore, the purpose of this paper is to evaluate credit risk of the rural credit cooperatives using artificial neural network model to realize the sample training of the rural credit cooperatives, and provide reliable basis for the decision-making of credit risk management. The basic Elman network consists of four layers, which respectively is input layer, output layer, hidden layer and undertaken layer as shown in figure 1. It is the same as multilayer feedforward neural network, input layer has the function of signal transmission, the output layer plays a role of linear weighting, and hidden layer can be activated by linear or nonlinear function. The undertaken layer can be considered to be one step delay operator, which is used to output of hidden layer unit in the last moment. The network input has r number of nodes, the hidden layer and undertaken layer has n nodes, and the output layer has m nodes. The network input u is a vector of r dimension, the hidden layer x and the undertaken layer output x_c are vectors of n dimension. The output y is a vector of m dimension. The connection weight w^x is a matrix of $n \times n$, w^u is a matrix of $n \times r$ and w^y is a matrix of $m \times n$. The relation between input and output is

$$x(k) = f[(w^x x_c(k)) + w^u u(k-1)].$$

$$x_c(k) = x(k-1).$$

$$y(k) = g(w^y x(k)).$$

$f(\cdot)$ is activation function of hidden layer and $g(\cdot)$ is activation function of output layer.

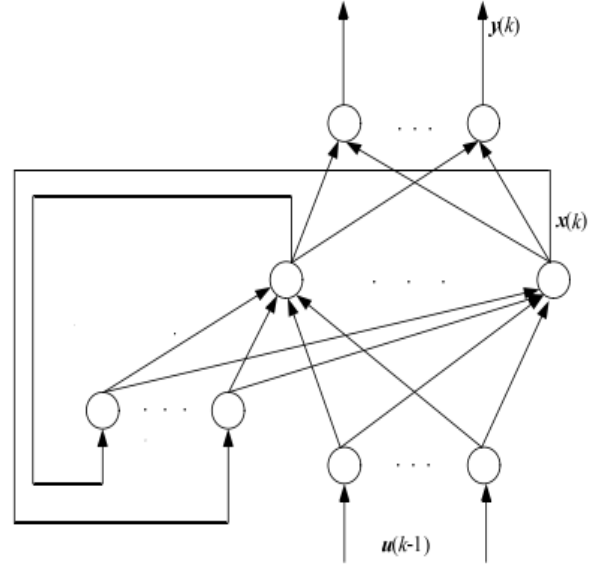


Figure 1. Neural network structure

Because the BP algorithm has only one step, and basic Elman network has poor learning stability for structural unit connection weight. When the system order increases or hidden layer units increase, it will lead to corresponding learning rate small, which is difficult to guarantee the convergence of the network. PSO algorithm has few parameters, the algorithm process is more concise and is easy to be implemented. In continuous nonlinear optimization and combinatorial optimization problems, it has good application effect. Compared with the traditional BP algorithm, PSO algorithm does not use the gradient information, and there is no complicated differential process. PSO algorithm has the ability of global optimization, so we use PSO algorithm to train Elman network. We use the PSO algorithm to optimize the initial weights of Elman neural network, and each particle vector is taken as the connection weights of Elman neural network.

We use the global search capability of PSO algorithm, giving each particle different weighted coefficient and particles with different weighted coefficients may produce different optimization solution. The optimization solution space with more than one solution can be formed, and then the characteristic of strong local convergence of BP algorithm is used. The optimal solution is obtained in the space of the smaller scale. The fitness function is

$$\frac{\partial x_j(k)}{\partial w_{jl}^x} = f'_j(x) \left[x_l(k-1) + \sum_{i=1}^n w_{ji}^x \frac{\partial x_j(k-1)}{\partial w_{ji}^x} \right].$$

The particle position is updated according to the following formula.

$$v_{iD}^{k+1} = v_{iD}^k + c_1 r_1 (p_{iD} - x_{iD}^k) + c_2 r_2 (p_{gD} - x_{iD}^k).$$

$$x_{iD}^{k+1} = x_{iD}^k + v_{iD}^{k+1}.$$

IV. EXPERIMENT

Considering the reform of rural credit cooperatives in China, the increasing competition turns up in the industry, and data collection of the competitiveness evaluation system has certain difficulty. In order to validate the the feasibility of credit risk assessment of rural credit cooperatives, and considering the difficulty of getting data, we choose 12 indicators of the evaluation index system for empirical analysis. There are 160 number of training samples and 40 number of testing samples.

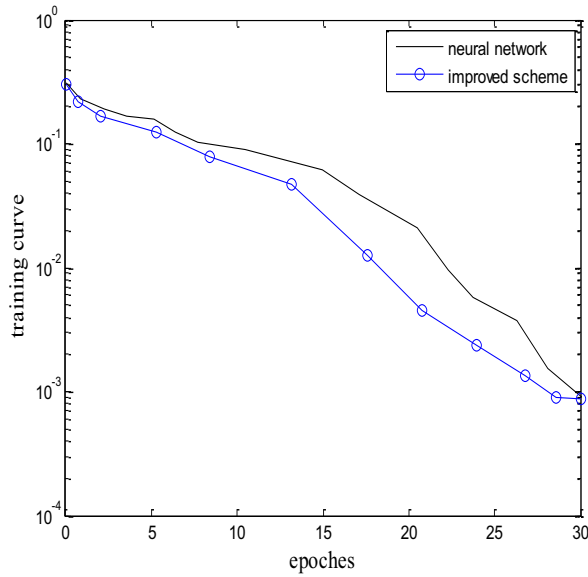


Figure 2. Network training error curve

MATLAB software has the function of data visualization, powerful numerical calculation function and convenient drawing functions, it has high programming efficiency, strong expansion ability, good interactivity, and is more convenient. Neural network toolbox is one of the many toolboxes developed under MATLAB environment, which is based on artificial neural network theory. A variety of typical neural network activation function is constructed with MATLAB language, and according to the network weights fixed rules and network training process, it writes all sorts of network design and training subroutine, which can make the users directly call the network activation function and training program. The neural network toolbox contains almost the existing results of various network model, and provides a large number of demo sample, so we can use it to quickly realize the model to solve the actual problem. Users can save a lot of programming time, making

them put more effort into network design rather than a specific program implementation. The input data is normalized according to

$$\bar{x}_i = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}}.$$

x_i is input data, x_{\max} is the largest data and x_{\min} is the smallest data. The network training error curve is shown in figure 2. It can be seen that the improved scheme has fast convergence speed. The network model output of testing sample is shown in table 2.

Table 2. The network model output of testing sample

No	Network output	Expected output
1	0.9113	0
2	0.9916	1
3	0.0019	0
4	0.9891	1
5	0.9897	0
6	0.9976	1
7	0.0000	0
8	0.9917	1
9	0.0000	0
10	0.0056	1
11	1.0000	0
12	0.0001	0
13	0.9013	1
14	0.0001	0
15	0.9071	1
16	0.0000	0
17	0.0000	0
18	1.0000	1
19	0.0000	0
20	0.0010	0
21	1.0000	1
22	0.0018	0

The total accuracy of proposed scheme is 87.3%. The above results show that the model output is in line with the expected output, so we can use this model for credit risk analysis of rural credit cooperatives. Neural network credit risk assessment model and database establishment, and maintenance need strong computer professional knowledge. Rural credit cooperatives also have electronic operation in handling business, and personnel who are skilled at the computer are very few, their professional skills is low, and equipment malfunction cannot be ruled out in time. So it is necessary to introduce technical personnel of computer professional to better realize the evaluation of credit risk management.

V. CONCLUSIONS

We firstly reviewed the historical development of the rural credit cooperatives credit risk management. Then, we constructed BP neural network model that was applied

to credit risk assessment. At last, we do experiments to verify the performance of this model. Using neural network technology to identify the credit risk can achieve very high accuracy rate and overcome the credit of many uncertain factors. The model can provide scientific reference to the rural credit cooperatives credit policy and credit risk management. It also has good development prospect in the field of bank credit risk assessment.

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