Green Credit Risk Assessment under the Background of 
Water Ecological Civilization City Construction——Based on 
BP Neural Network Model

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Abstract: The construction of water ecological civilized cities requires a large amount of capital, but at the same time, the project itself has certain risks. Commercial banks are not only the main providers of credit funds, but also the main bearers of project risks. Strengthening the credit risk management of water ecological civilized urban construction projects and enhancing the financial support of commercial banks for water ecological civilized urban construction projects have become the key to further promoting the construction of water ecological civilized cities. At present, the credit risk assessment of commercial banks in China is based on traditional methods, and it is difficult to achieve the desired effect. This paper applies the AHP method to construct the credit risk index system of water conservancy projects, and establishes a credit risk assessment model through BP neural network technology. Finally, it combines 39 listed companies. The data is empirically analyzed for the model to verify the accuracy of the predictions.

1. Introduction
Water ecological civilization city refers to the objective law of harmonious development of people, water and society. It follows the rules of human water ecological balance and the urban settlement environment. It is the ecological foundation for the harmonious development of the future city and the inevitable destination of modern urban development. In 2013, the Ministry of Water Resources issued the guidance document on “Opinions on Accelerating the Construction of Water Ecological Civilization”, and selected two batches of 105 cities and counties with good basic conditions, representativeness and typicality to carry out water ecology.

The construction of water ecological civilized cities requires a lot of capital, but at the same time, the project itself has certain risks. Commercial banks are not only the main providers of credit funds, but also the main bearers of project risks\(^1\). Strengthening the credit risk management of water ecological civilized urban construction projects and enhancing the financial support of commercial banks for water ecological civilized urban construction projects have become the key to further promoting the construction of water ecological civilized cities. At present, the credit risk assessment of commercial banks in China is mostly based on traditional methods, and it is difficult to achieve the desired results, and the applicability of traditional rating methods to the credit risk assessment of water conservancy projects is not strong\(^2\).
2. Research methods

2.1. BP neural network model
Artificial Neural Network (ANN) is a new subject of neural computing. It simulates the input and output units of a group of structures, and establishes nonlinear mathematical models through learning rules and self-organization. Each two nodes are connected by a weighted value of a signal. This weight is the memory of the artificial neural network, and the output result varies according to the connection mode of the network, the excitation function, and the like. Including forward signal transmission and error reverse correction two processes:

2.1.1 Forward signal transmission of BP neural network
The output layer node output is:
\[ O_k = f(\text{net}_k), k = 1,2,\ldots,l \]
(1)
\[ \text{net}_k = \sum_{j=0}^{m} w_{jk} y_j, k = 1,2,\ldots,l \]
(2)
The hidden layer node output is:
\[ y_j = f(\text{net}_j), j = 1,2,\ldots,m \]
(3)
\[ \text{net}_j = \sum_{i=0}^{l} v_{ij} x_i, j = 1,2,\ldots,m \]
(4)

2.1.2 Error correction of BP neural network
When the output does not match the expected output, the output error is generated, and the error signal is defined. Finally, the calculation formula of the weight adjustment of the BP learning algorithm of the three-layer feedforward network is obtained:
\[ \Delta w_{jk} = \varphi \delta_k^o y_j = \varphi (d_k - o_k) o_k (1 - o_k) y_j \]
(5)
\[ \Delta v_{ij} = \varphi \delta_j^x x_i = \varphi \left( \sum_{k=1}^{l} \delta_k^o w_{ij} \right) y_j (1 - y_j) \]
(6)
The weight is adjusted according to the calculated weight adjustment amount, and there is a new weight in the next round of training:
\[ w_{jk}(t+1) = w_{jk}(t) + \Delta w_{jk} \]
(7)
\[ v_{ij}(t+1) = v_{ij}(t) + \Delta v_{ij} \]
(8)

2.2. AHP model
The AHP model is suitable for the study of green credit risk. Under the premise of less quantitative data, the green credit risk is decomposed according to elements, the weight of each indicator is scientifically determined, and the risk is reasonably estimated. The method has an intermediate layer under the target layer, and the intermediate indicator layer contains a plurality of elements. According to the established hierarchical structure, the indicators under each level are compared in pairs and evaluated according to the degree of importance. Construct a judgment matrix, see Table 1. According to the degree of importance, it is divided into five levels, as shown in Table 2.

| Table 1. Judgment matrix |
|--------------------------|
| A1 | A2 | ... | A_j | Feature vector |
| A1 | W_{11} | W_{12} | ... | W_{ij} | W_1 |
The intermediate indicator layer contains elements $A_1$, $A_2$, $A_3$ . . . $A_n$. These indicators are compared in pairs to form an $n \times n$ judgment matrix. The constructed judgment matrix is a positive reciprocal matrix, and the eigenvector corresponding to the largest eigenvalue can be obtained, and then the normalization process can be used to obtain the weight value of each index. The weight value obtained is related to the consistency of the judgment matrix. If the consistency condition is not satisfied, the accuracy of the analysis result will be reduced. However, the order of the matrix is often judged, and it is difficult to fully meet the consistency requirement. Usually 0.1 is set as the test. The threshold, that is, the test coefficient of less than 0.1, is considered to pass the consistency test. Based on the above analysis, we construct a judgment matrix to define the quantified value and importance.

2. 3. Construction of the indicator system

The indicators of risk assessment of traditional commercial banks involve financial indicators and non-financial indicators. Based on the traditional credit risk assessment model, this paper adds water conservancy factors, selects energy conservation and emission reduction, compliance management, emergency environmental incident management, environmental facilities, and information. The six indicators of disclosure and social impact assess the water conservancy elements. After determining the index system, the AHP model is used to construct the hierarchical structure in yaahp software, and the relative importance rating of the indicators is formed to form a judgment matrix. The consistency test result is 0.0542, less than 0.1, and the software is used for normalized calculation and processing. The final weight calculation result can be obtained. According to the Wi weight of each indicator, the indicators of the loan applicants are scored to obtain a comprehensive score. The indicator system is shown in Table 3.

| Table 2. Judgment matrix scale |
|--------------------------------|
| Quantitative | Value          |
|---------------|----------------|
| 1             | Equally important |
| 2             | Slightly important |
| 3             | Stronger important |
| 4             | Strongly important |
| 5             | Extremely important |

| Table 3. Credit risk assessment indicator system for water conservancy projects |
|--------------------------------|
| Target layer | indicator layer | sub-indicator | weight |
|---------------|-----------------|---------------|--------|
| Water conservancy elements | Environmental facilities | 0.4461 |
| (0.3108) | Environmental Incident Management | 0.2609 |
| | Energy saving and emission reduction | 0.1452 |
| | Social impact | 0.063 |
| | Compliance Management | 0.0487 |
| | Environmental Information Disclosure | 0.0362 |
| | Profit ability | Basic earnings per share | 0.4287 |
| | Net profit | 0.1937 |
| | Return on equity | 0.2304 |
2.4. Credit risk rating criteria

The data of empirical research in this paper mainly comes from the straight flush database. The selection of indicators includes environmental indicators, financial indicators and non-financial indicators. In order to judge the degree of risk more scientifically, comprehensively consider the rating standards of rating agencies and financial institutions, and establish a green credit risk rating standard with reference to the five-level classification of credit quality, as shown in Table 4.

| Risk category       | Score |
|---------------------|-------|
| Normal              | 80-100|
| Special-mentioned   | 60-80 |
| Subprime            | 40-60 |
| Suspicious          | 20-40 |
| Loss                | 0-20  |

### Table 4. Green credit risk assessment rating

3. Empirical research

3.1. Sample data source and processing

This paper selects the data of 39 listed companies 2014, 2015 and 2016 annual reports for financial analysis, including agriculture, environmental protection, tap water production and supply, hot water production and supply, urban underground pipe network construction, water conservancy projects and other industries. On this basis, the financial factors, non-financial factors and environmental protection elements in the indicator system are quantified through the expert scoring method.

3.2. Empirical analysis

In this paper, the 22 comprehensive indicators obtained by factor analysis are standardized, and the standardized data is taken as input, and the risk interval in which the credit score F falls is output. In the empirical analysis, the acceptable error standard is 0.001 and the number of training is 5000. The implicit layer activation function uses the logsig function, the output layer transfer function selects the purelin function, and the training function selects the trackingdx function. Using the established BP neural network model, a total of 144 sets of data from 36 companies in China from 2014 to 2017 were simulated, as shown in Figure 1. The BP neural network ended the training after 70 simulations. At this time, the training target reached 0.000983, which was less than the preset target value of 0.001, as shown in Figure 2.
Figure 1. BP neural network training

Figure 2. BP neural network fitting effect

Using the established BP neural network model, 12 sets of data of the remaining 3 listed companies were tested, and the test results were compared with the actual results, as shown in Table 5. The results show that the accuracy of the 12 test samples is 91.7%, and the prediction accuracy is high. From this we can conclude that the BP neural network model has a good applicability to the risk assessment of commercial banks’ water credit projects.

Table 5. BP neural network sample training results

| number | Actual results | Forecast results | Actual risk level | Predicted risk level |
|--------|----------------|------------------|-------------------|----------------------|
| 1      | 76             | 81               | Special-mentioned | Normal               |
| 2      | 65             | 62               | Special-mentioned | Special-mentioned    |
| 3      | 84             | 86               | Normal            | Normal               |
| 4      | 83             | 80               | Normal            | Normal               |
| 5      | 76             | 77               | Special-mentioned | Special-mentioned    |
| 6      | 73             | 69               | Special-mentioned | Special-mentioned    |
| 7      | 77             | 70               | Special-mentioned | Special-mentioned    |
| 8      | 59             | 57               | Subprime          | Subprime             |
| 9      | 78             | 72               | Special-mentioned | Special-mentioned    |
| 10     | 76             | 67               | Special-mentioned | Special-mentioned    |
| 11     | 94             | 91               | Normal            | Normal               |
| 12     | 75             | 73               | Special-mentioned | Special-mentioned    |

4. Conclusion

Based on the actual construction of water conservancy, this paper constructs a green credit risk evaluation index system for commercial banks. The risk assessment indicator system includes water, non-financial and non-financial elements, totaling 22 indicators. The AHP method is used to reasonably determine the weight of each factor, which provides a reliable evaluation index system for the green credit risk assessment of China's commercial banks in water conservancy project construction.

This paper constructs a green credit risk assessment model through BP neural network, and adds ecological environmental protection and water conservancy construction factors, so that the model has better applicability to credit risk assessment in the construction of water ecological civilized cities. Commercial banks are in the water conservancy project. This model can be used to determine the initial credit risk of the customer.

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