An Improved on BP Neural Network for Financial Crisis Prediction

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Abstract Different from the previous study, this article, taking full account of China's current situation of accounting information supply, constructs a six- category warning index system. The system constitutes index reflecting the solvency, assets and liabilities management, profitability, growth, cash flow and the condition of existing accounting information offering. In addition, given that the Shanghai and Shenzhen stock exchanges use listed company's financial situation of the year (t-1) to determine whether to give the company special treatment in the year, it is useless to forecast using data from one year before the crisis happen. This article tests the effect of the forecasting model of the improved BP neural network, sampling ST Companies' data of two years, three years and four years before they were special treated. The results show that BP neural network model has an accuracy rate of 88.5% two years before the financial crisis of, with obvious advantages and value.
Key words The condition of existing accounting information offering Neural Networks Financial crisis forecasting

1 Introduction

Financial crisis early warning model has important economic research value, and foreign scholars have conducted many researches and achieved many results. For example :Beaver（1966）、Altman（1968）、Ohlson（1980）、Odom（1990）、Messier和Hansen（1998）、Feng Yu Lin and Sally Mc Clean（2001）and so on. Due to the impact of the later development of the securities market, domestic scholars on the research of the financial crisis early warning are of a late start, but still achieved good results, especially in the research of the construct of early-warning model on China's listed companies and have made great contribution on financial crisis early warning. But so far, research of building forecasting system indicators from the perspective of the quality of accounting information, with deep study of the unique of existing accounting information supply conditions, breaking through conventional forecasting indicators，is not obvious.

As is known to all, China's major listed companies are restructured from the former state-owned enterprises, or sponsored by the former state-owned enterprises. They are products of state-owned enterprises through the shareholding system reform of the capital market, a majority of which are controlled by State. Because of this uniqueness, China's listed companies are different from the general sense of the listed companies, leading to the factor that the affecting factors of financial crisis should also have their unique characteristics. Relevant existing laws, regulations and accounting standards and policy, will especially have important influence on the financial crisis forecasting. This article finally constructs a series of the forecasting indicator system with 48 indicators aggregating the previous studies and taking into account China's current situation of accounting information supply.

2 Typical model comparison and research design

2.1 Comparison of the typical forecasting model

The financial forecasting model develops from single variable to multivariable, statistical methods to the non-statistical methods, single model to mixed mode. Typical forecasting model mainly includes multivariate linear discriminate method, Logistic regression analysis model, Probit model and so on. The Multiple linear discriminate method has some advantages, but it has practical restrictions because it has relatively strict requirements in the process of the application of the data types, sample

characteristics and the sample mathematical characteristics. Although Logistic model has the advantages of not requiring the assumptions of subject to obeying multivariate normal distribution and two equal covariance, it may lead to problems of deviation of parameters estimates and the existence of the effectiveness when the number of samples is limited or the existence of samples completely separates. Besides, it will affect accuracy because of the approximation in the computation. The calculation method of Probit Model is similar to that of the Logistic. It requires enterprises' samples to obeying the standard normal distribution and is more complex in calculating, and analysis cost is also higher. Neural network is a kind of artificial network with a large number of processing units connected widely, aiming to simulate the system structure and function of the brain, charactering of the distributed storage and parallel collaborative processing of the information. It particularly applies to imprecise and vague problem, and the situation when many factors and conditions need considering at the same time.
The principle of the neural Network for listed companies financial warning is: using the indicator information of measuring the financial situation of listed companies as input vector of the neural network, the results of the classification as a vector output of the neural network; using training samples to train the network, to make sure that different input has different output. Once the training is over, it will be an effective tool as a forecast of the listed company's financial failure.

2.2 The design of financial forecasting model based on BP neural network

The financial forecasting model Based on the neural network is a kind of the multi-layer network architecture including input layer, hidden layer and output layer. The input of the model is the financial indicators of companies and the number of the neurons of input layer is identified by the financial indicators. This article aims to tell that it has a better effect to construct with key indicators than to construct directly with financial indicators. Thus two neural network models are constructed at the same time. So the number of the neurons of input layer will has two situations. In addition, both the direct modeling and modeling with key indicators will be required for the importation of normalized treatment in order to remove the impact of different dimension. That is adjusting the initial input to a smaller range through a certain method, and assigning a small random number to the connecting right at the same time, in order to prevent networks from a saturation value resulted of large input or weight.
About the determination of the number of hidden layers it is proved in some literature that a three-tier BP neural network can approximate any arbitrary precision mapping to relations under certain conditions. After that experiment, compared with one hidden layer, it does not help to improve the accuracy of forecast with two hidden layer neural network training. So this article adopts a three-level feed-forward topology neural network.
The number of the neurons of the output layer is decided by the output categories. According to the requirements of this article, the network output layer is defined as neurons in this article. In its training samples set, Y is the output of the sample 'i', defined as: When the sample 'i' is a ST company, Y = 0; when the sample 'i' is a non-ST company, Y = 1.

Construction of neural network model is to forecast the listed company's financial crisis. The empirical study is on the basis of that, and the specific topology structure is set to two different models respectively.

3 Selections of samples and forecasting indicators

3.1 Sample selection

In China, only the listed companies' financial information are published and easily accessed, and so far none of China's Listed Companies has bankrupted, so the best starting point of the theoretical study ought to forecast whether the company's financial situation is healthy, rather than whether the company will be bankrupt or when it will be bankrupt. In the sample selection, foreign countries tend to take bankruptcy applying as a sign of financial crisis. However, China has special circumstances. For example, currently listed enterprises experienced no bankruptcy; China's A-share listed companies use

domestic accounting standards and accounting systems and audited by domestic accounting firms, while the B-share listed companies use international accounting standards and audited by foreign accounting firms, making two types of financial information non-comparable; Shanghai and Shenzhen Stock Exchange started a provision in 1998 that when the listed company showed "financial situation abnormal", "special treatment" would be used to the listed companies. And the financial situation abnormal was clearly defined. Therefore, the choice of a sample of this article is the A-share listed companies with "abnormal financial situation" and was specifically treated.

During the gradual process of the enterprise's financial crisis from infancy to the serious deterioration, various risk factors are directly or indirectly reflected through the change of sensitive financial indicators. By observing the pros and cons changes of those sensitive financial indicators, it can forecast financial crisis. Therefore, the article chooses the sample data of three consecutive years to study in order to make the model have the effect of forecasting.

Since the Shanghai and Shenzhen stock exchanges determine whether to give the company special treatment in the year t according to the listed company's financial situation of the year (t-1), if the financial reports of some listed company can be easily got, it will be decided whether the company will be specially treated for abnormal financial situation and the forecast is useless. So this article samples ST Companies' data of two years, three years and four years before they were special treated, that is the data of the year (t-2), (t-3), (t-4). It is worth noting that some financial indicators is the sequence, and the data of the year (t-5) is also used as the supporting data. The earliest record of the database used by this article (provided by the Centre for Economic Research) is in 1994, although the ST system has already been introduced in 1998, the ST companies in 1998 will be excluded because of data incompletion. In addition, since the end of this study is ahead of the Annual Report 2007, this article will select the ST company between 1999 and 2006 as a crisis sample, and a corresponding number of paired samples. Based on the foregoing basis and the principle of choice, incomplete data are eliminated. This paper chose 220 companies with financial crisis and 220 normal companies as matching companies, collecting data of two years, three years and four years before ST and normal samples' annual data.

3.2 Screening of financial indicators

Theoretically, traditional statistical model in require construction of the index system. It should not only comprehensively reflect the "quality" characteristics and not missed, but also make sure that the indicators in the target system are not highly correlated. Neural network model is a natural nonlinear model, it can identify and simulated nonlinear relation of the data, without assumptions of multivariate normal distribution and prior probability or. Based on the requirements of forecasting indicators by the neural network, this study is according to whether company's forecasts crisis is related, as well as the frequency of appearance on study both domestic and abroad. The principle is that it reflects financial characteristics comprehensively and takes into account China's actual conditions, and chooses indicators from multi-angle perspectives. Five financial indicators (solvency, assets and liabilities management, profitability, growth and cash flow) are chosen, taking into account China's current situation of accounting supply information, adding indicators reflecting the quality of accounting information as well as the degree of earning management. Finally 48 indicators are chosen.

4 Empirical Analysis

Based on the established system of forecasting indicators, this paper uses ST companies' crises data two years, three years and four years before they were specially treated, and the data from corresponding normal companies. By direct modeling and rank-sum test, key indicators are screened out. Finally, the neural network model is rebuilt to conduct empirical test.

4.1 The neural network model test results

In this study, the neural network is three-tier feed forward network. The topology of neural network

model modeling directly modeled with forecasting indicators is 48 * 9 * 1. Before neural network are created and trained, all samples data are divided into two by random. 120 groups of the neural network are used for training, while 100 groups are used to simulate the neural network. Fast network training method is used, that is, training with function traingdx, and the Matlab language. After repeated tests, these parameters are used:

the cycle interval number 100, target error 0.02, the learning rate 0.05, increase ratio of learning rate 1.05, momentum factor 0.9, the highest cycles 1000.

This paper uses the data to create the neural networks and training, which is ST crises data of two years, three years and four years before they were special treated, and the data of corresponding normal company. So the two groups have their own corresponding network training and simulation procedures. First, 48 indicators corresponding to the sample data are stored in database files, and the pi is the (t-i-1)years' training sample data, the qi is output of the (t-i-1) year's expectations of training samples, the fi is simulation sample data in the year (t-i-1). The preparation process is run in Matlab, and the output is the random number between [0,1] ,with the critical value of 0.5. The failing company will stay at [0,0.5), while the financial normal company will stay at (0.5,1]. Through analysis simulation results of ST samples can be obtained. Results are shown in table 1:

Table 1 simulation results by direct modeling with financial indicators in neural network model

	ST forecast accuracy	Non-ST forecast accuracy	accuracy of overall Simulation sample
2 years before ST	83%	79%	81%
3 years before ST	78%	73%	75.5%
4 years before ST	69%	64%	66.5%

Judging from the table, neural network is quite effective after it was trained using the financial data of two years before ST. But with date from three years and four years before, the results is relatively poor, especially the result of four years ago. That is because any financial crisis has the process of gradual appearance and deterioration. The extents of changes are higher when it is closer to the crisis, and the effect of forecast is better. The extents are less obvious when the crisis is far away from happening. Because at the time the company is making money, the financial situation has not seriously deteriorated. Thus to say that this company is ST using their date as a standard of ST company will have great error.

From the table, ST's prediction accuracy rate is higher than the corresponding non-ST's. This is because the model predicted the existence of two types of errors: financially healthy company is considered to have financial crisis, or the company that has financial crisis is considered as financially healthy company. These two types of errors can not be calculated, so it is impossible to accurately determine whose cost is larger. Normally, the first category cost more, so this study tend to reduce the happening of the first category error through testing the training parameters reputably,

4.2 After the rank sum test the neural network model test results

By running rank sum test of the 48 indicators through the Matlab language program, key financial indicators are selected to build forecasting neural network model. By rank sum test results we can find: when a company is close to be ST, the difference compared to the normal companies would be shown in more and more indicators, which matches the reality. By comparison, 27 indicators will be chosen to replace the 48 indicators in the model as the input variables. Topology structure of rebuilt neural network model with key indicators is 27 * 14 * 1. The calculating and testing process is almost the same as direct modeling. Through an analysis of the output results can be obtained of two years, three years and four years before ST, and the data of corresponding normal company. The results are shown in the table below:

Table 5 simulation results of the neural network model after rank sum test

	ST forecast accuracy	Non-ST forecast accuracy	Simulation accuracy of all
2 years before ST	92%	85%	88.5%
3 years before ST	84%	79%	81.5%

4 years before ST	71%	68%	69. 5%

It is quite effective with the financial data of first two years of ST financial data to train the neural network. Determined by the results it can be seen in this model that ST's prediction accuracy rate is higher than the corresponding non-ST's .

In addition to the two models' sharing features, from the table of results of the model, the overall accuracy rate of the results is higher without rank sum test. That is to say after the rank sum test, the main indicators of the original information are comprehended, and the fitting degree of neural networks is better.

4.3 comparison of forecasting effect of two models

Although both are modeling with direct financial indicators, selection of key indicators has not improved that much. But it is worth noting that this study does not use the data of previous year, as mentioned. According to the Annual Report of China's listed companies to disclose system, the listed companies must publish their annual reports before next year's April 30. Therefore, the annual report for last year and that whether it is specially treated almost happen at the same time, that is, once the pre-crisis year of a company's annual report information is got, it can almost be sure whether the company will be specially treated because of the "abnormal financial situation".

Therefore, the data of the previous year is not available in the actual forecast. Moreover, Ohlson's research in 1980 also shows that the use of the information after bankruptcy to establish model will overestimate the predictive ability. Taking into account this reason, the correct rate of the model has been relatively high. Therefore, the model of this article is effective, particularly that after the rank and test. Its overall prediction accuracy rate is up to 88.5%.

Also, because the data used in this study is from three consecutive years of two, three and four years before, the model has better results ahead of forecast.

5 Conclusion

Construction of this neural network model fully embodies the advantage of the neural network technology in the area of forecast, and is highly normative and practical. At the same time, reviewing the literature of the financial forecasting model both at home and abroad, in light of China's accounting information supply situation, this article explores a set of forecasting indicators system, confirmed a good value.

In addition, the rapid training methods used in this paper that the introduction of the training function traingdx greatly improves the accuracy of the forecast simulation compared with the standard method. Parameter selection of the training is under repeated testing, so that the neural network has good predictive results. However, to make the financial forecasting model reach a real practical value level, there is still a long way to go, which is a long-term, complex project. This article is bound to have some limitations, for example, in considering the reliability of financial information and the fair itself, as well as non-financial indicators of information. These will be the future research directions.

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