Research on the Financial Securities Prediction Method Based on Neural Network

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Abstract

The rapid development in the new century has greatly impacted the traditional financial securities market. The accuracy of securities prediction greatly influences economic development of a country and the investment intention of overseas investors. For this purpose, this paper specifically explores a prediction method for the financial securities market based on previous research by adopting a fuzzy neural network structure model according to the current situation of theories related to neural network and the financial securities market. According to the research, the fuzzy neural network structure model is more accurate and effective than the traditional prediction method. The research is expected to provide reference for accurate prediction of the financial market in the future.

Keywords: Neural Network, Financial Securities, Prediction Method, Empirical Analysis.

1. RESEARCH ON BACKGROUND

1.1 Literature Review

Up to now, many scholars have studied the financial securities prediction based on neural network to form certain literature foundation and viewpoints. Based on predictability of stock market, Ouyang Linqun proposed an artificial neural network model learning algorithm by combining genetic algorithm and BP algorithm, with quantifiable stock price influence factors as the input variable, and established a stock prediction model based on artificial neural network. Simulation was then conducted, with the closing price and stock market index of Hisense Telecom as the prediction target, to verify the feasibility of the stock prediction model (Ou Yang, 2006). Aiming at the complexity of the securities market operation, an improved BP neural network model was proposed by Lu Xiuze and was applied to stock price prediction for a financial street. Genetic algorithm was adopted for optimizing network structure and weights to improve the network prediction precision, increase the convergence speed and overcome the disadvantage of the traditional prediction method (Lu et al., 2010). Based on the traditional CAPM, a higher-order was introduced by Dai Niannian. With the advantage of wavelet neural network in nonlinear function approximation, the stock data in Shanghai Stock Exchange was used for empirical analysis from second to fourth-order CAPM respectively. It is found that the higher-order CAPM is obviously superior in prediction accuracy and stability to the traditional CAPM (Dai and Chen, 2011). Huang Zhaodi et al. proposed a BP neural network optimization securities investment portfolio method based on particle swarm PSO algorithm in view of the disadvantages of the traditional artificial neural network, such as limitation in BP neural network, frequent iterations, low convergence accuracy and poor generalization (Huang et al., 2013). Yang Nan analyzed the current situation of financial securities market research by interpreting the definition and characteristics of neural network, and then explored the application of neural network in securities market prediction from BP network, fuzzy neural network and combined neural network perspectives (Yang, 2016).

1.2 Research Purpose

Since the financial securities market are vulnerable to political, economic, psychological and many other uncertain factors, the time series changes frequently due to the interaction between various factors, and this change is of highly complex, nonlinear, dynamic characteristics and accompanied by noise, randomness, non-stationary, periodicity, tendency, regularity, self-organization adjustment, etc. (Wu et al., 2002) The relationship between input and output variables of the time series of financial securities changes over time, which greatly reduces the accuracy of traditional linear analysis. In order to improve the accuracy of prediction methods of financial securities, this paper combines the nonlinear analysis method of fuzzy neural network and financial securities
theories in view of high complexity of financial securities market information, and makes prediction for financial securities market by modeling, feature extraction, time series data analysis for securities market, etc. It is found that the new method makes up for the deficiencies of the traditional methods to better predict financial securities information in a more scientific, accurate and intelligent way. The research is expected to supplement the literature foundation in financial securities prediction field and optimize traditional prediction method, providing reference for accurate calculation and prediction of similar changes nonlinear variable time series parameters.

2. RELEVANT THEORETICAL BASIS

2.1 Connotations and Characteristics of Neural Network

Neural network refers to parallel distributed processor network composed of a large number of simple neurons, also known as artificial neural network. As with the human brain, neural network also has functions for storage, operation and use to some extent, which can be regarded as a human brain with abstract functions (Xia et al., 2004). According to physiological reactions in creatures, biologists have developed a model of intelligent information processing technology, namely a neural network model. It makes use of its own algorithms to obtain information from the outside world, which is to obtain calculation targets required by transmission and operation of neurons.

Neural network is characterized by three main characteristics, namely generalization ability, strong adaptability and input and output mapping. Among them, the generalization ability means reasonable statistics for unfocused training data so as to ensure precision of data to accurately predict securities market development. The strong adaptability is a basic characteristic of neural network, which can change the value of its own synaptic weight to correctly handle the external environment information changing at any time and adapt to the external environment changes. In the operation process, the network connection weight value is set to change with time at first, which can ensure that the neural network system will not be affected by the change of external causes such as environment. Input/output mapping means to transmit a random sample scheme in the sample database to the network, by which its connection weight is adjusted until there is no significant synaptic weights to be fixed (Liu and Ma, 2008). At this point, the sample tends to be balanced or stable, and the input and expected value of each sample are unique in the entire operation.

2.2 Current Situation of the Financial Securities Market

In the 1980s, Feilo Audio issued ten thousand shares to the public, becoming the first stock with public offering since the founding of new China, which also brought the domestic capital market and the financial securities industry to the new era. Then, three securities companies, Wanguo, Haitong and Zhenxing were founded in Shanghai closely followed by the opening of Shanghai Stock Exchange and Shenzhen Stock Exchange, providing opportunities for the financial securities industry development in China. After 20 years of rapid development, the total assets of China's financial securities industry are now more than 6.42 trillion yuan with net assets of 1.45 trillion yuan, increased by more than 5 trillion yuan and 1 trillion yuan respectively compared to that of 2008. According to data released by the Securities Association of China, the number of securities companies in China reached 125 as of the beginning of 2016, with a total operating revenue of 575.2 billion yuan and net profit of 244.8 billion yuan.

In recent years, the number of domestic securities companies is gradually increasing to result in increasingly fierce business competition. At present, a severe industry competition situation is formed in the domestic financial securities market, which is manifested as follows: First, homogeneous competition is severe in traditional financial securities business with booming innovation business urging securities companies to expand capital; Second, the concentration degree of the financial securities industry is low resulting in a gradual integration trend. Third, the financial securities industry is gradually opening up, intensifying the market competition is more intense; Fourth, the competition between the securities industry and other financial industries is also increasing.

3. ANALYSIS OF THE FINANCIAL SECURITIES PREDICTION METHOD BASED ON NEURAL NETWORK

3.1 Model Selection

Though having learning ability, nonlinear mapping ability and distributed, fault-tolerant and parallel processing
abilities, the traditional fuzzy neural network fail to realize the self-organization of fuzzy rules and the self-adaption of membership functions (Liu Xiaoya, 2015). In-order-to further improve the effectiveness and superiority of the prediction method, this paper adopts a new fuzzy activation function with low complexity to design structure and algorithm for the fuzzy neural network of financial securities prediction. The specific formula is as follows:

\[ f(x) = \begin{cases} \text{sign}(x), & |x| \geq L \\ -\left(\frac{x}{L}\right)^2 + 2x/L, & \text{otherwise} \end{cases} \]  

(1)

According to the formula above, the function value at the specific point \( x_0 \) is \( f(x_0) = (-1)u_1(x_0) + ax_0u_2(x_0) + (+1)u_3(x_0) \), and the saturation region of the activation function is \( f(x) = \pm 1 \). Then the fuzzy rule is defined and the saturation region of the neuron \( k \) is \( \{ w_k x + S_k \geq L \mid w_k x + S_k \leq -L \} \) where the bias of \( k \) is \( S_k \).

First, calculate the input and output of the input layer. \( x_i^{(0)} \) and \( y_i^{(0)} \) represent input and output of the \( i \)th node of the \( l \)th layer respectively. The formula is \( x_i^{(1)} = x_i, y_i^{(1)} = x_i^{(1)}, i = 1, 2, ..., n \). Divide all the nodes into \( n \) groups. The input component of each fuzzy neuron node belongs to the subordinating degree function of fuzzy sets of language variables. Use \( f(x) \) to activate the output, then the input and output of the fuzzification layer plus activation layer are \( x_i^{(2)} = y_i^{(1)}, y_i^{(2)} = f(x_i) \).

Second, calculate the adaptability of each rule in the rule layer, the formula of which is \( y_j^{(3)} = \Sigma_i^m w_{ji}^{(3)} y_i^{(2)}, (i = 0, 1, 2, ..., n, j = 0, 1, 2, ..., 2n) \), where \( w_{ji} \) is the connection weight between fuzzy layer and rule layer.

Third, calculate the input and output of each node in the fuzzy layer. Assume there are \( 2n \) nodes in the layer and let \( i = 0, 1, 2, ..., 2n, j = 0, 1, 2, ..., 2n \), then the input and output formulas of each node in defuzzification layer are \( y_j^{(6)} = \Sigma_i^m w_{ji}^{(6)} x_i^{(6)} = \Sigma_i^m w_{ji}^{(6)} y_i^{(3)} \).

Finally, calculate the input and output of the output layer. Assume there are \( 1 \) nodes in the output layer and the formula \( y = y_j^{(5)} = \Sigma_j^{2n} w_{j}^{(5)} y_j^{(4)}, w_{j}^{(5)} (j = 0, 1, 2, ..., 2n) \), which is the coupling weight from the \( j \)th node of the fourth layer to the output layer node.

3.2 Empirical Analysis

Assume the time series of the data selected by the financial securities market is \( \{x_i\} \), the future time \( n + m + k(k > 0) \) and the historical data \( \{x_{n+1}, x_{n+2}, x_{n+m}\} \). The prediction value \( x_{n+m+k} \) predicting the future market of the financial securities can be determined by calculating the nonlinear function relationship between the historical data and future time. Then the neural network prediction equation of the linear output node is \( x_{n+m+k} = f_k(x)X_{n+m} + f_{k+1}(x)X_{n+m-1} + \cdots + f_{k+m}(x)X_{n+1} + e_{n+m+k} \) where \( f_l(x) = f_l(X_{n+m}, X_{n+m-1}, ..., X_{n+1}, e_{n+m+k}) \), \( i = k, k + 1, ..., k + m \), with a total of \( m \) input neurons in the neural network.

Then, the prices of the financial securities in the training stage and the prediction analysis stage are predicted respectively according to the time series. The estimated value of \( X_{n+m+k} \) is calculated to be \( \hat{x}_{n+m+k} = f_k(x)X_{n+m} + f_{k+1}(x)X_{n+m-1} + \cdots + f_{k+m}(x)X_{n+1} + \delta \), with the error of \( \delta = (\hat{x}_{n+m+k} - X_{n+m+k})/X_{n+m+k} \).

3.3 Result Analysis

Basic financial stock market data of Shanghai-listed Shanghai Pudong Development Bank from October 12, 2010 to March 12, 2015 are selected, including individual stocks daily lowest and highest prices, opening price, closing price, volume and put them into the above formula to calculate the closing result prediction for Shanghai Pudong Development Bank from March 8, 2015 to March 12, as shown in Table 1.
Table 1: Closing Price Prediction Results

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<tr>
<td>EMA</td>
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<tr>
<td>Error value</td>
<td>8.2716e-4</td>
<td>-4.26e-4</td>
<td>-6.8789e-4</td>
<td>-8.691e-3</td>
<td>-4.153e-3</td>
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The above table suggests the new fuzzy neural network with low complexity has made an accurate and effective prediction of the financial securities market.

4. CONCLUSION

In the financial securities market, more investment and amount may bring more return, but high profits are always accompanied by high risks. Therefore, the main purpose of financial securities investors is to maximize profits and minimize risks, the basis of which is to accurately predict the changing trend of security prices (Wang Shi and Wang Baosheng, 2012). At present, scholars have realized that the traditional linear prediction method can hardly make decisions for financial securities, and the analysis and prediction results of different experts varies significantly. Therefore, this paper creates a new neural network model with parallelism, adaptive learning, nonlinear mapping, knowledge distribution and storage, approximation to any complex continuous function and other information processing abilities based on previous research by adopting a new fuzzy activation function with low complexity. According to the research, this method overcomes the defect in processing random non-stationary time-varying information of the traditional prediction method and make neural network successfully applied in the financial securities field.

REFERENCES