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Research Article

Study on Prediction of Chinese Food Price Based on Fuzzy Neutral Network

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Abstract: In order to improve the prediction precision and accuracy of Chinese food price, the application of fuzzy neutral network on it in studied in depth. Firstly, the situation of China food price is analyzed. Secondly, the basic theory of fuzzy neutral network is analyzed. Thirdly, the training algorithm of fuzzy neutral network is designed. Finally, a simulation analysis is carried out for food prices in a province and results show that the fuzzy neutral network is an effective tool for predicting the Chinese price.

Keywords: Chinese food price, fuzzy neutral network, prediction

INTRODUCTION

Food price is important part of consumer-price index, the price volatility of Chinese food price can affect the living cost and farmer income directly and which is an important strategic problem relating with livelihood. In recent years, the proportion of Chinese household food consumption expenditure to total expenditure is hovering somewhere around 40%. In case of slow growth, the growth of food price makes people feel the increasing of living cost, especially the increasing of food price will reduce living quality of low income groups. Under the background of Severe and complicated world economic situation and uncertainty, keeping Chinese food price stable relates with livelihood, which is an important part that keeping economic develop quickly. Therefore it is necessary to find out an advanced method for predicting the Chinese food price (Mainardi, 2012).

In recent years, artificial neutral network has been in the prediction analysis widely, BP neutral network is a good prediction means, however it has some disadvantages, it easy to fall into local minimum point and the prediction precision is not high. Fuzzy neutral network has some advantages, it has quick tracing speed and good smooth property and it can obtain higher predication precision comparing with BP neutral network and can improve the prediction accuracy of Chinese food price effectively. The fuzzy neutral network is used to predict the Chinese food price.

China food price situation: During the 12th 5 year plan period, Chinese food industry is in the period of important strategy chance. Chinese food industry not only faces the chance of market space continue development, agriculture production stable development, high and new technology application speed up, new food industry birth and development and macro environment continue improvement, but also meets the challenge and pressure of food safety risk wide existence, energy resource environment boundary exacerbation, transform and development mode gaining momentum. Chinese food industry should regulate the industry structure quickly, develop the food production industry, develop the feed production industry and control the deep processing of grain without food applications and ensure the supply safety of rations and food. Food price is the main affecting factor of CPI, in recent months and the maximum rebound rate of food price is vegetable and pork, the price of vegetable is affected by whether, the growth and transportation conditions, the non food price can be affected by over capacity (D'Souza and Jolliffe, 2014).

Expending the agricultural production will be limited by the critical production element land, the agricultural output is very high in recent years, the labor production rate has big rising space, however it can make farmer away from agriculture, therefore the price rising of energy and increasing of its cost can make the food price improve.

Price rising of food has something with strong Chinese food requirement. The most important reason of food price rising is that the consumer in emerging and developing economies grows richer, then the diet structure changes accordingly, this situation improves the requirement of sparse resource, for example, more lands may be used in pasture grazing, while not be applied in growing crops, more crops are used as animal feed. According to the statistical analysis of Chinese food price from 1990 to 2013, food price changes little from 1990-2000 and the changing speed of people's diet structure is quicker than that from 2000-2013. From 1990 to 2000, non food land needed increases about 9%, the main reason is that the land

needed of vegetable and garden, while the food land needed reduces about 3.6%. From 2000 to 2013, the non food land needed increases about 1.5% and the food land needed increases about 0.5%. Chinese food price is also affected by the world market and the world supplying factors such as biology fuel is also critical (Xavier *et al*., 2013).

Using a city in 2014 as example, the price of main non-staple foods has smooth trend. Comparing with food price in 2013, the food price increases with small amplitude, the price of egg increases obviously and the price of cooking oil, pork and vegetable falls. The price of food increases with shocks, the price of wheat and corn is 1.25 and 1.14 Yuan/catty, respectively and increases 0.9 and 4.6%, respectively. As seen from monthly trend, the food price shows the increasing with shock, where the price of wheat is stable in the first quarter and reduces slightly in the second quarter and changes little in the second half of 2014. Corn price is keeping the low and increases in the second quarter and the price reaches the highest in the third quarter, the price is 1.4 Yuan/catty and the corn price reduces in the fourth quarter. Because the food boosts production continuously, Chinese food supply and storage are sufficient and the Chinese food price is at historic high and is higher than the international food price, in addition, the food price has limited space of rising later.

The price of edible oil decreases continuously, the average retail price of barrels of oil is 51.5 Yuan/catty and the drop range has recently mandated double-digit increase comparing with the price in 2013. The average retail price of edible oil in bulk is 5.28 Yuan/catty and the drop range overpasses 9% comparing with that in 2013. The average price of Luhua peanut oil drum is 128.5 Yuan/barrel, the average price of Orchid barrels peanut oil is 113.5 Yuan/catty, which reduce 11.4 and 16.3%, respectively.

The price of pork first increases then decreases, the average price of tainted pork in 2014 is 12.8 Yuan/catty and decreases slightly 0.9% comparing with that in 2013. As seen from monthly trend, the price of pork first increases then decreases in 2014 and overall is still slightly decreased. The average of pork in January is 13.05 Yuan/catty and reduces to 11.3 Yuan/catty in March, then increases, the price of pork is highest in September. The price of pork in four quarters falls back in a certain degree, however the decreasing rang is limited and the pig breeding suffers serious losses, many farmer clear-out breeding sows, therefore the supply of pig reduces. The base price of pork is low in 2014.

The price of egg pierces all-time highs, the price of egg shows the trend of increasing and the average price is 4.78 Yuan/catty, which rises about 8.5% comparing with that in 2013, the top three quarters of 2014, the egg price is in the channel of rising, the rising range is biggest in the third quarter, which is about 13.6%. The price of egg is 5.6 Yuan/catty in September, which is highest in recent years. Although the price of egg in fourth quarter decreases, however the price of egg rises 20.5% in December than that in January.

The price of vegetable decreases year-on-year, in 2014 the price of vegetable shows the seasonal trends, the price of vegetable in the in the first half decreases continuously, the average price of it changes from 1.85 Yuan/catty in January to 0.97 Yuan/catty in June, the price of vegetable rebounds after entering the summer, however the rising range is lower than the same period in 2013 obviously. In July and August, the price of vegetable increases about 1.2%. The price of vegetable is affected by the temperature and seasonal requirement obviously, with the appearance frequently of cold air the price of vegetable will change obviously.

METHODOLOGY

Basic theory of fuzzy neutral network: Fuzzy neutral network has many advantages, which has good knowledge expression level and fault tolerance level and it can express and store the knowledge well. The fuzzy neutral network is applied in the predicting Chinese food price, the fuzzy membership degree can be used to describe the changing trend of Chinese food price, the neutral element and connecting weight are used to describe the distribution of Chinese food price, then the correct knowledge can be obtained, which is benefit for storing the knowledge and the prediction accuracy of Chinese food price can be improved (Muralisankar *et al*., 2011).

Fuzzy neutral network concludes five layers, which are input layer, fuzzification layer, fuzzy relational layer and relational layer after fuzzification and outputting layer. The corresponding diagram is shown in Fig. 1.

Inputting layer: This layer can make the inputting vector into next layer structure and the inputting vector is expressed as follows (Wu *et al*., 2014):

$$x = [x_1, x_2, \cdots, x_n]^T \tag{1}$$

The corresponding membership function can be expressed as follows:

$$\alpha_j(x) = \varphi_j\left(\frac{\left\|x - c_{ij}\right\|}{\sigma_{ij}}\right) = e^{-\frac{\left\|x-c_{ij}\right\|^2}{\sigma_{ij}^2}}$$

$$j = 1,2,\cdots,\sum_{i=1}^{n} N_i \tag{2}$$

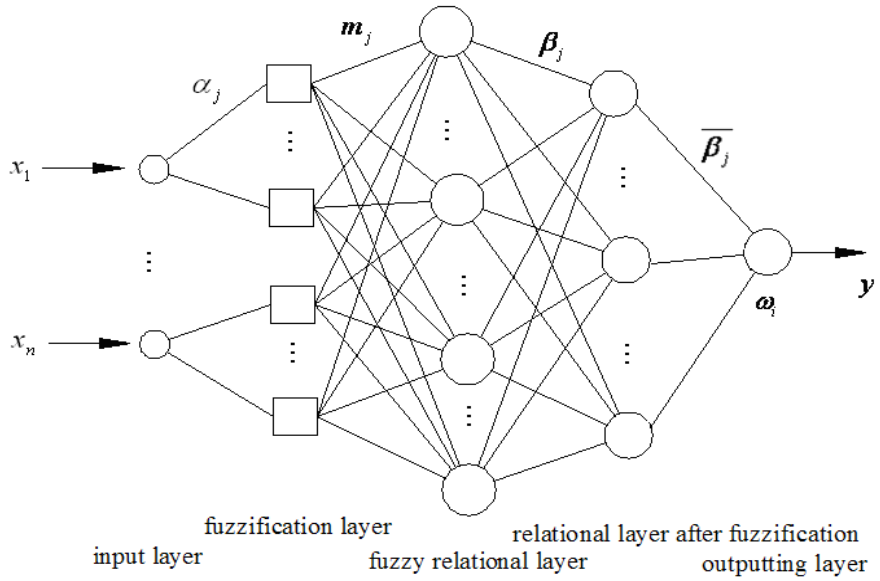

Fig. 1: Diagram of fuzzy neutral network

where,

c_{ij} and σ_{ij} : The center and width of membership function

N_i : The dimension degree of i^{th} inputting vector

Fuzzification layer: Every node of this layer corresponds to a language variable and can be applied in the solution of inputting membership function and the membership function is expressed as follows (Xiao *et al*., 2014):

$$m_j = e^{\frac{x-c_{ij}}{\sigma_{ij}^2}},\ j = 1,2,\cdots,\sum_{i=1}^{n} N_i \tag{3}$$

Fuzzy relational layer: This layer can carry out fuzzy sum of inputting variables from fuzzification layer and can obtain the fuzzy relational vector, which can be expressed as follows:

$$\beta_j = \min\{m_1, m_2, \cdots, m_k\},\ j = 1,2,\cdots,N_A$$
$$k = 1,2,\cdots,N_n \tag{4}$$

where $N_A = \prod_{i=1}^{n} N_i$.

Relational layer after fuzzification: The effect of this layer can carry out normalized calculation for relational vector and the computing expression is listed as follows (Zhang *et al*., 2013):

$$\overline{\beta_j} = \frac{\beta_j}{\sum_{i=1}^{N_A} \beta_i},\ j = 1,2,\cdots,N_A \tag{5}$$

$$\sum_{i=1}^{N_A} \overline{\beta_j} = 1 \tag{6}$$

Outputting layer: The effect of this layer carries out weighted linear sum of relational strength and the corresponding expression is listed as follows (Song and Wang, 2013):

$$y = \sum_{i=1}^{N_A} \omega_i \overline{\alpha_i} = \omega^T \Lambda \tag{7}$$

where, ω_i denotes the connecting weight between nodes, ω denotes the connecting vector between nodes, $\omega = [\omega_1, \omega_2, \cdots, \omega_{N_A}]^T$, $\Lambda = [\overline{\alpha_1}, \overline{\alpha_2}, \cdots, \overline{\alpha_{N_A}}]^T$.

Training algorithm of fuzzy neutral network: When the fuzzy division number of inputting vector is known, the parameters needed to be trained have connection weight between nodes ω_i, parameters of membership function c_{ij} and σ_{ij}. In order to improve the efficiency of fuzzy neutral network and the genetic algorithm is used to train the network, the genetic algorithm simulates the genetic evolution of biology, which a optimal algorithm for carrying out natural selection and survival of the fitness and the optimal parameters of membership function and connection weight value can be obtained, the corresponding algorithm procedure is listed as follows:

- In order to make the operation simple, the direct real number coding method can be chosen. During the procession of coding, firstly the different center of membership function and corresponding width are sorted, then the weight value between nodes is

sorted. Based on this method, the center and corresponding width changing at same time on every individual has big probability during the procession of interaction, then the width can change accordingly when the center changes.

- The value of fitness degree is solved and the fitness function is expressed as follows (Al Gizi *et al*., 2015):

$$Fitness = \frac{n}{\sum_{i=1}^{n}(d_i - y_i)^2} \quad (8)$$

where,
d_i : The rational output
y_i : The output of fuzzy neutral network

- Before interaction operation, the optimal individual in the current generation continues to the next generation, then the global optimal solution can be ensured to be found out, other individual can generate the new individual through interaction and mutation operation according to the interacting and mutation probability, finally the new individual can be generated.

CASE STUDY

In order to verify the effectiveness of fuzzy neutral network on prediction of Chinese food price, a simulation is carried out and the programmer is compiled by MATLAB software.

According to the real situation of Chinese food price the fuzzy neutral network training collection is generated, the neutral elements in inputting layer are used to describe the fuzzy set of sign signals and the experiment is carried out to confirm the number of neutral elements in hidden layer. When different number of nodes in hidden layer is chosen the training of fuzzy neutral network is trained, the corresponding training results are shown in Table 1. As seen from Table 1, when the number of neutral elements in hidden layer is chosen as 47, the training error is lest, the network has quickest convergence speed, therefore the number of neutral elements in hidden layer is chosen as 47 and the number of neutral elements in outputting layer is chosen as 4, which denotes the price of different food.

The food price data in a Chinese province from January of 2013 to December of 2014 is collected, the food price data from January of 2013 to December of 2013 is used as the training samples and the food price data from January of 2014 to December of 2014 is used as the verifying samples. When the original value and critical value are different, the convergence of network is different. Through cycling simulation analysis the optimal weight and critical value of network element are stored and the corresponding database of fuzzy neutral network on the prediction of food price can be generated. The training simulation curve of fuzzy neutral network is shown in Fig. 2. As seen from simulation results, the fuzzy neutral network can converge to error 0.001 through 2210 iteration training, results show that the structure of the fuzzy neutral network is proper.

The trained fuzzy neutral network is applied in prediction of corn, edible oil and egg, the corresponding prediction results are shown in Table 2.

As seen from Table 2, the actual price of pork, edible oil and egg is closer to the prediction value based on fuzzy neutral network, results show that the fuzzy neutral network can be applied in the prediction of Chinese food price effectively and the changing trend

Table 1: Simulation results when the number of neutral elements in hidden layer is different

Number of neutral elements	Training time	Error
5	6953	0.042088323
18	6321	0.043416628
25	3192	0.002366725
32	2749	0.000988261
47	2210	0.000921734
43	3682	0.000935729
40	3794	0.000932765
33	4018	0.000947270
31	4639	0.000961235

Table 2: Prediction of corn, edible oil and vegetable based on fuzzy neutral network in 2014

	Pork price/Yuan/catty		Edible price/Yuan/catty		Egg/Yuan/catty	
Time	Actual value	Prediction value	Actual value	Prediction value	Actual value	Prediction value
January	1.23	1.22	5.29	5.26	4.50	
February	1.26	1.24	5.30	5.31	4.52	4.50
March	1.23	1.21	5.27	5.25	4.54	4.52
April	1.25	1.22	5.24	5.22	4.55	4.51
May	1.28	1.25	5.23	5.20	4.56	4.53
June	1.24	1.20	5.21	5.23	4.57	4.55
July	1.29	1.25	5.17	5.18	4.59	4.56
October	1.30	1.31	5.16	5.14	4.62	4.60
September	1.32	1.30	5.10	5.12	4.63	4.61
October	1.33	1.32	5.07	5.06	4.65	4.62
November	1.35	1.32	5.04	5.02	4.66	4.59
December	1.33	1.29	5.02	5.01	4.68	4.67

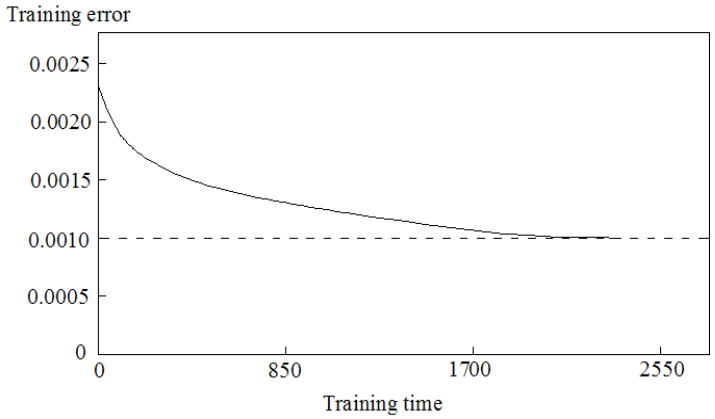

Fig. 2: Simulation error curve of fuzzy neutral network

of Chinese food price can be obtained correctly, this method not only saves the working quantity, but also improve the prediction precision and analysis results can offer effective theoretical basis for regulating the food price.

CONCLUSION

Food is entwined with the living of people, therefore the price of Chinese food cannot increase excessively, the government should regulate the food price effectively and therefore the prediction of Chinese food price is very important. The Fuzzy neutral network is applied in the prediction of Chinese food price and the relationship between food price and CPI can be displayed obviously, the fuzzy neutral network has quick convergence speed and strong suitable learning ability, simulation analysis is carried out, result show that the fuzzy neutral network can improve the prediction precision and efficiency.

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