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Research Article

Study on Early Warning of Fluctuation in the Prices of Ginger

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Abstract: The fluctuation in the prices of agricultural products can influence people's consumption level and the national food security, especially the rising of the price is the key factor to push CPI up. Taking ginger as the research objective, this study, uses Grey Prediction Model to study the historical price data of ginger and those related factors which lead to its price fluctuation and analyzes the tendency of price fluctuation by the relevance between the key factors and the price itself. The final purpose is to make a more accurate prediction about the price of ginger in China. The findings of this study can be used to give early warning to the fluctuation in the prices of agricultural products such as ginger, provide reference to rational planning of people's consumption and offer theoretical support for the government to set up related policies.

Keywords: Ginger, grey prediction model, relevance, waveform prediction model

INTRODUCTION

Agricultural products are the most important necessities in people's life, which can be used to provide the important raw materials for the development of the national economy. Agricultural products fluctuation can influence farmers' basic interests and dwellers' consumption standard, at the same time the development of national agricultural industrialization and the security of national food as well. Therefore, it is quite significant to study what can be seen from the price fluctuation of agricultural products and then release the early warning (Deng, 1987).

Ginger occupies an important position of agricultural products and it is demanded largely in people's daily life. In recent years, price changes of agricultural products like ginger are quite dramatic, even in local culture people talk like "jiang ni jun" which is borrowed from playing chess to show ginger's important functions, like the air or water in people's life. While the price fluctuation of ginger and other agricultural products raises people's awareness. It is quite significant for the research in agricultural market which is closely related to people's living standard.

The rapid rising of ginger's price can stimulate the market of agricultural products greatly, because the other products will follow under the influence of chain effect, like garlic. Its price soars up sharply within a week. As a result, citizen's consumption is strongly influenced. As the representative, the drastic changes of ginger price have become a serious problem in society, because its rapid rise of price is due to the inherent defects of market economy system. As an economic system, market economy system is not perfect and its inherent defect is its lag-behind regulation. This study starts from grey prediction model and the basic principle of supply and demand of economics to analyze and study relevant problems about ginger price. The purpose is to provide references for national production and offer the basis for relevant departments to set up policies.

MATERIALS AND METHODS

Problem analysis and research design: At present, there are many ginger producers in China, which are divided into three types: retailers, specialized wholesalers and enterprises. Ginger market in China mainly belong to small scaled producers (retailers and specialized producers), who can hardly resist natural risks and market risks. Domestic market of ginger consumption is quite simple, mostly for people's daily life. It still needs a long way to go to process and export ginger product, so it is obviously seen that the domestic market of ginger in China is rather competitive. In this market, producers are on the passive side, they cannot decide the price of ginger products in the market. In order to seek profits, the producers have to adjust their products and their quantity according to the market needs. On the premise of the same cost, the higher ginger price will encourage producers to increase yields and vice versa.

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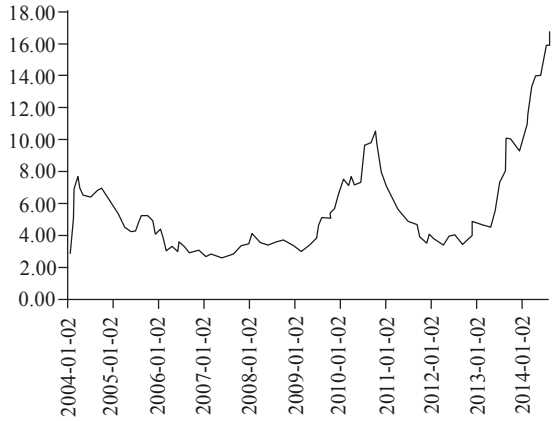

Fig. 1: Ginger price trend from 2004 to 2014

The present stage of ginger production and sales market in China fits the assumptions of dynamic cobweb theory. Under normal circumstances, supply and demand will achieve balance at the time "t" and the cost when economic profit of ginger production is zero (Li and Xu, 2014). Affected by some factors at random, the market balance is broken and after a production cycle of ginger the market has experienced, the supply of ginger should be less than the demand of citizens at the time of "t+1", then supply and demand will go to a new balance at a higher price. Producers will decide the production quantity next round according to the higher ginger price; therefore, the yield of ginger at the time of "t+2" will be larger than equilibrium quantity, which causes the price of ginger dropping dramatically during next period and the deviation will be larger and larger.

In a completely competitive market, if ginger producers decide the production quantity of next round totally depending on the price, there may be large fluctuation of ginger price and it will have the tendency to go further. Therefore, periodic fluctuation must take place in ginger market under the condition of spontaneous regulation in the market mechanism.

This study tries to analyze ginger historical price data and the production cost prices and then set up its framework of the model. The model will be used to calculate and predict ginger's price in the future, based on which to offer suggestions to the government and the public.

Data selection: We select 560 data from January 2, 2004 to September 26, 2014 to analyze and data source is from the website of the Ministry of Commerce (Chen *et al*., 2014). According to the basic analysis, from Fig. 1 it is shown that the historical fluctuation of ginger price is dramatic and it has the tendency to rise in recent years.

Model building and problem solving: From the knowledge of historical data, the fluctuation of ginger historical price is so dramatic that it is hard to calculate by some conventional methods, that is why Waveform Prediction Model is introduced. It is expected to predict ginger's future price. Waveform prediction model is one of the most commonly used Grey Prediction models and its modeling methods are as follows.

The original data column $x^{(0)}$ $x^{(0)} = \{x^{(0)}(1)\ x^{(0)}(1), x^{(0)}(2)\ x^{(0)}(2), \cdots, x^{(0)}(n)\ x^{(0)}(n)\}$, which has n variables $x^{(0)}x^{(0)}$ had been added up once and it generates the data column $x^{(1)}$ $x^{(1)}$, $x^{(1)}$ $x^{(1)} = \{x^{(1)}(1)\ x^{(1)}(1), x^{(1)}(2)\ x^{(1)}(2), \cdots, x^{(1)}(n)\ x^{(1)}(n)\}$, in which $x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}$ (i) $x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}$ (i), so $x^{(1)}$ $x^{(1)}$ is considered as the 1-AGO sequence of $x^{(0)}$ $x^{(0)}$, which is written by 1-AGO (Accumulated Generating Operation). Because Sequence $x^{(1)}$ (k) $x^{(1)}$ (k) fits: exponential growth, the differential equation can be concluded as:

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = u\frac{dx^{(1)}}{dt} + ax^{(1)} = u \tag{1}$$

The formula above is called basic Waveform Prediction model, in which a and u are model parameters, using discrete form to stand for differential term, the result is:

$$\frac{\partial x^{(1)}}{\partial t} = \frac{x^{(1)}(k+1) - x^{(1)}(k)}{k+1-k} = x^{(1)}(k+1) - x^{(1)}(k)$$
$$= \beta^{(1)} = \beta^{(1)}\ [x^{(1)}(k+1)]x^{(1)}(k+1)] \tag{2}$$

In which $\beta^{(1)}$ $\beta^{(1)}$ is defined as a subtraction operation, an inverse operation of accumulated generation. While $x^{(1)}$ $x^{(1)}$ takes the value the average number of k and k+1, that is:

$$x^{(1)} = \frac{1}{2}[x^{(1)}(k+1) - x^{(1)}(k)]x^{(1)} = \frac{1}{2}[x^{(1)}(k+1) - x^{(1)}(k)] \tag{3}$$

If formula (2) and (3) are put into (1), the result is:

$$\beta^{(1)}\ \beta^{(1)}\ [x^{(1)}(k+1)\ x^{(1)}(k+1)] + \frac{1}{2}\ a\ [x^{(1)}(k+1) - x^{(1)}(k)]\ \frac{1}{2}\ a\ [x^{(1)}(k+1) - x^{(1)}(k)] = u \tag{4}$$

While when k = 1, 2, ⋯, n-1, formula (4) can be written in matrix form as X = BA, in which:

$$X = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \cdots \\ x^{(0)}(n) \end{bmatrix} \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \cdots \\ x^{(0)}(n) \end{bmatrix}, \quad A = \begin{bmatrix} a \\ u \end{bmatrix} \begin{bmatrix} a \\ u \end{bmatrix}$$

$$B = \begin{bmatrix} -\frac{1}{2}x^{(1)}(1) + x^{(1)}(2) & 1 \\ -\frac{1}{2}x^{(1)}(2) + x^{(1)}(3) & 1 \\ \cdots & \\ -\frac{1}{2}x^{(1)}(n-1) + x^{(1)}(2n) & 1 \end{bmatrix}$$

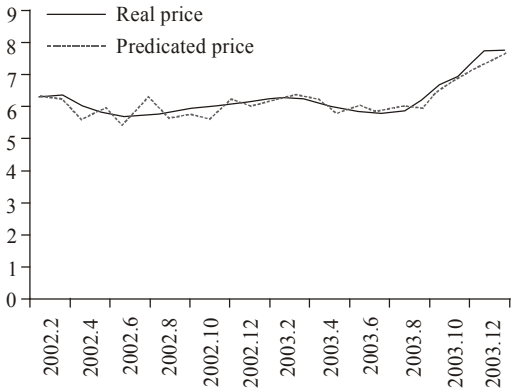

Fig. 2: Real price and predictive price of ginger

$$\begin{bmatrix} -\frac{1}{2}x^{(1)}(1)+x^{(1)}(2) & 1 \\ -\frac{1}{2}x^{(1)}(2)+x^{(1)}(3) & 1 \\ \cdots & \\ -\frac{1}{2}x^{(1)}(n-1)+x^{(1)}(2n) & 1 \end{bmatrix}$$

According to least squares parameter estimation, the following result can be got:

$$\hat{A}=\begin{pmatrix}\hat{a}\\ \hat{u}\end{pmatrix}\hat{A}=\begin{pmatrix}\hat{a}\\ \hat{u}\end{pmatrix}_{=}(B^TB)^{-1}B^TX(B^TB)^{-1}B^TX$$

According to differential equation the answer of basic Waveform Prediction Model is:

$$\hat{x}^{(1)}(k+1)=\left[x^{(0)}(1)-\frac{\hat{u}}{\hat{a}}\right]e^{-\hat{a}k}+\frac{\hat{u}}{\hat{a}}$$
$$\hat{x}^{(1)}(k+1)=\left[x^{(0)}(1)-\frac{\hat{u}}{\hat{a}}\right]e^{-\hat{a}k}+\frac{\hat{u}}{\hat{a}} \quad (5)$$

If an Inverse Accumulated Generating Operation (IAGO) is done, the result should be:

$$\hat{x}^{(0)}(k+1)=\hat{x}^{(1)}(k+1)-\hat{x}^{(1)}(k)$$
$$\hat{x}^{(0)}(k+1)=\hat{x}^{(1)}(k+1)-\hat{x}^{(1)}(k) \quad (6)$$

In which k = 0, 1, 2, …, n. And formula (5) and (6) are the time response function models, which is the specific function formula of Waveform Prediction Model.

In order to test the reliability of the model, this study made use of the historical data before 2002 to forecast ginger price from February, 2002 to December, 2003. And the result can be seen in Fig. 2.

The relative error of forecast data $\hat{x}^{(0)}(n)$ and $x^{(0)}(n)$ averaged 1.59% and it is well seen that forecasting has high precision. It is clear that the degree of fitting between original series and forecasting ones is high, which shows that the Grey Prediction model this study adopts is quite practical, especially on the study of this field and it can be used to calculate ginger price.

RESULTS AND DISCUSSION

The following part is the forecast of ginger price in 2015 through Grey Prediction model which is established according to the data from 2008 to 2013.

Contour selection: Select contour ς_i = 1, 2, ... …,12, because most data fluctuates between the intervals (4.10, 16), so select the contour with equal interval in this section. Number the horizontal axis chronologically and take time point of ginger as modeling sequence and $t_i = i + \varsigma_{i-1}/x$ (i+1) is contour time sequence. While "i" is the broken line time sequence of i interval. By this way contour time sequences of 12 groups can be got:

$$Q_1^{YOY},\ Q_2^{YOY}\cdots,\ Q_{12}^{YOY}$$

GM (1, 1) modeling: Now taking 14 Yuan/kg contour as an example, establish GM (1, 1) model and other contours can be calculated in the same way. Specific steps are as follows:

- Give an accumulated generating to Q^0_i Yi = 1, 2, 3, |.12Y and then get the sequence Q^0_i Yi = 1, 2, 3, |12Y
- Structure data matrix B and data vector Y and then get the new sequence Q^0_i Yi
- Count a, b, based on the input data, a = |0.34257 and $Z^{(1)}$ (k) = 6.12347 can be calculated. Then get time response function:

$$\hat{x}^{(1)}(k+1)=\left(x^{(1)}(0)-\frac{b}{a}\right)e+\frac{b}{a}=25.7559e^{0.42443k}-16.7559 \quad k=1,2,\ldots$$

Model testing: According to Grey Prediction theory, e (k) is residual and e (k) = x (k) - $\hat{x}$ (k) $\hat{x}$ (k). When C_0, p is, respectively satisfied the standard as shown in the list below, it can be predicted (Table 1).

After testing, it is clear that the model C_0 = 0.3398 is in level two which is satisfactory; p = 1 is small probability of error satisfaction model, so it can be predicted. According to the forecast, 10.1 Yuan/kg will be shown at the moment of 57.6.

According to this method, prediction models of the rest 11 groups can be obtained:

$$\hat{x}^{(2)}(k+1),\ \hat{x}^{(3)}(k+1),\ \ldots,\ \hat{x}^{(12)}(k+1)$$

Table 1: Accuracy testing levels

Index critical value	Deviation ratio	Small error total probability
Level one (excellent)	0.35	0.95
Level two (good)	0.50	0.80
Level three (pass)	0.65	0.70
Level four (failed)	0.80	0.60

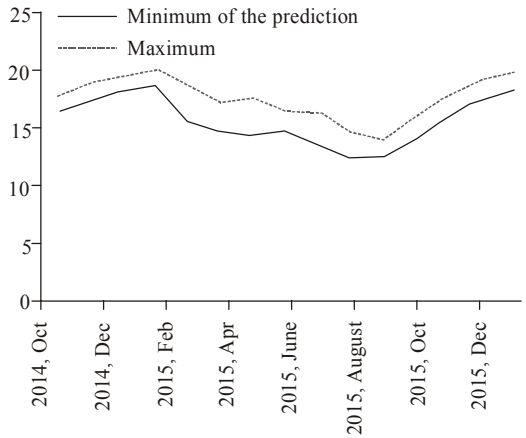

Fig. 3: Predictive results of ginger price

Data prediction: If the result of generating sequence value $\hat{x}^{(0)}$ (k+1) and model reduction value $\hat{x}^{(0)}$ (k+1) is wanted, the following should be done: let k = 1, 2, 3…, 12, from time response function above $\hat{x}^{(1)}$ can be counted, among which initial value can be taken: $\hat{x}^{(1)}$ (1) = $x^{(1)}$ (0) = $x^{(0)}$ (1). From $\hat{x}^{(0)}$ (k) = $\hat{x}^{(1)}$ (k-1) ς_i contour time sequence (i = 1, 2, ….12) and $\hat{Q}_1{}^{(0)}$, $\hat{Q}_2{}^{(0)}$, …, $\hat{Q}_{12}{}^{(0)}$ can be achieved.

According to the contour values corresponded to predicted expectation of contour of time series, these high points are drawn on time series, while the minimum of the integers is taken at non-integer time points; when there are several predicted values at the same time point, that is $\hat{q}_i$ (k) = $\hat{q}_J$ (t), i|j will take the average; if there is no value at the time point of x (k), change-point value should be got by linear interpolation.

By calculation predicted time series can be got; while according to the data of predicted time series, price trend chart of all series can be drawn as well. For the convenience of observation, here is the partial graphics (Fig. 3).

Analysis of relational grade: Take historical price of ginger as reference sequence and related factors data series which influence ginger price (ginger price, production cost) as comparative factors sequence and analyze key factors which influence ginger price by the method of grey correlation degree:

- Suppose that ginger price sequence is y_k, k = 1, 2, 3… and from December 2005 to December 2006. Take the data every half a month and take the average over this range. Suppose that all other factors are:

  x_i (k), i = 1, 2, …6; k = 1, 2, …23; i = 0, 1, 2, …6; k = 2, 3, …23

- According to the data, get the result: Δ_{min} = 0, Δ_{max} = 0.8333.

- If ρ = 0.5, coefficient of correlation can be got and advantages analysis can be done as well, so the direct price factor is r_{01} = 0.6988 and indirect price factor is r_{02} = 0.5877. From the analysis of relational degree, r_{01}>r_{02}, it can be concluded that the influencing proportion of ginger price is larger than the proportion of production cost. Analysis of influencing factors can lay a good foundation for further analysis of ginger price trend.

CONCLUSION

This study adopts waveform prediction model to predict ginger price and establishes contours through data processing. Then use waveform prediction model to predict ginger price and the prediction accuracy is pretty high. The main factors leading to dramatic fluctuation in the price of ginger can also be got according to the correlation analysis of relevant factors. The model is able to be improved which can be used to predict price trend of other agricultural products and give early warnings to their price fluctuation (Zhou, 2006; Zhou *et al*., 2007).

This study selects two associated factors, ginger price and production cost, but because of the inadequate data acquisition, the trend of ginger price can hardly be analyzed thoroughly. And there must be some poor situations which influence the result of model prediction. This study does a good job in weakening the data which has dramatic fluctuations and adopts Grey Prediction model in the whole process. But some factors are not taken into account of this model, like inflation and financial crisis, so it is a little bit limited in giving a comprehensive analysis and prediction from the perspective of value.

In this study, based on the data of ginger historical price, contours are selected and GM (1.1) model is established, so ginger historical data can be well used to take model validation (Nai and Zhou, 2007; Liu and Lin, 1998). Test shows that the error of established waveform prediction model is less than other methods and its prediction is quite effective. Therefore, according to ginger historical prices, its trend in the future can be predicted as follows: from September 2014 to December 2015 ginger price will fluctuate from 14.29 to 18.75 Yuan/kg. According to the price prediction, consumers can purchase ginger in advance based on their ginger consumption requirement which can avoid the decline of their consuming power and diminishing marginal utility caused by the risk of ginger price change. While by observing price fluctuation of ginger and its price trend producers can have a clear view on the supply and demand of ginger market and adjust their production activities to increase profits after a comprehensive calculation of related factors, like production cost etc. The model also helps the government formulate relevant policies, such as raise the subsidy of ginger planting, by which ginger production, transportation, even processing activities can be stimulated and the balance of supply and

demand will be balanced. The purpose is to keep a safe and sustainable market.

REFERENCES

Chen, M.J., J.F. Li and T. He, 2014. Market analysis of 2013 of Chinese ginger market and prospect of 2014. Chinese Veg., 1: 57-60.

Deng, J.L., 1987. Basic Methods of Grey System. Huazhong University of Science and Technology Press, China.

Li, Z.H. and Y.L. Xu, 2014. Asymmetry research on price fluctuation of agricultural products. J. Hunan Univ., Soc. Sci. Edn., 1: 53-57.

Liu, S.F. and Y. Lin, 1998. An introduction to grey systems theory. J. Grey Syst., 1: 18-20.

Nai, X. and J.Z. Zhou, 2007. Improvement of application of grey neural network model in the prediction of electricity. Hydroelectr. Power, 6: 69-73.

Zhou, Z.G., 2006. Prediction and application of time series data mining technology of fused grey system theory and artificial neural network. Hydroelectr. Power, 30-32.

Zhou, Z.G., K. Guo and L.G. Li, 2007. Grey neural network technology of time data prediction. Jungle Knowl., 1: 130-131.