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Research Article

Correlation Analysis between Chinese Agricultural Price and Food Price Based on Grey Relational Analysis

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Abstract: In order to analyze the correlation characteristics between the Chinese agriculture price and food price, the grey relational analysis is applied in it. Firstly, the basic situation of agricultural price and food price is discussed. Secondly, the basic theory of grey relational analysis is studied and the corresponding algorithm is designed. Thirdly, the food price index and seven agricultural price indexes are used as the analysis variables and the corresponding correlation analysis is carried out based on grey relation analysis and results show the relationship between food price and other agricultural prices.

Keywords: Agriculture price, food price, grey relational analysis

INTRODUCTION

Food price is an important index for affecting the living level of resident, the relative stability of food price level can affect the smooth development of macroeconomics. In recent years, Chinese economy is strong, the rate of economic growth is remaining at a high level, however the fluctuations of price levels is still in the non-equilibrium state, consumer's price index number in partial years has big fluctuation. For example, the CPI in 2005 only increases 1.8% on year-on-year basis, the CPI increases 1.5% in 2006, but after 2007 Chinese price shows the trend of big jump, on April 2007, the rising range of Chinese CPI firstly breaks 3% and this index is running in a high level. With increasing of price, the food price and agricultural price also show the unusually rise. According the relationship between the food and agricultural price, a lot of raw material comes from agricultural price and the fluctuation of agricultural price is a critical factor for food price. The rising food price has something with inflation and a lot of grain stored because of inflation can lead to violent fluctuation of food price (Zhao, 2014). The upstream, middle and downstream prices have long period balance relationship, the upstream and middle prices has obvious transmission effect, the downstream price and middle prices has reversed transmission with reverse conduction. In recent years, the effect of agricultural price and food price on the price level is studied in depth by some scientists and the agricultural price and food price have obvious effect on the price level, however the correlation analysis between the agricultural price and the food price has not been concerned, therefore it is necessary to carry out the correlation analysis for it through choosing an advanced method. The grey system theory can use less or uncertain data series to express the characteristics of grey system and describe the continuous changing procession of internal events in grey system (Irz *et al*., 2013). The grey relational degree analysis is an important part of grey system theory, which is applied in the engineering fields, such as agriculture, medicine and chemistry. The grey relational degree analysis can be used to describe the extent between two factors based on grey procession and therefore it is feasible to apply the grey relational degree analysis in the correlation analysis between Chinese agricultural prices and food price.

METHODOLOGY

Basic situation of agricultural price and food price: The agricultural production comes from original product of agriculture, which concludes the plant, animal, microbe and their products, while the food is the end product or raw material for human consumption or drinking. According to the statistical data of food and agriculture organization, the average food price index is 179.4 on February 2015 and decreases 1% relative to January and decreases 14% relative to February 2014. The price of corn, meat especially sugar last month decreases and the price of oil is stable, the dairy price bounce back stronger again (Serra and Gil, 2013).

Since April 2014, the food price index enters into the downstream channel and falls to the lowest level since July 2010. The dairy price index is 181.8 on February 2015, this is the first increasing since February 2014. The whole milk powder price has the biggest gains, followed by skim milk and butter, the cheese price keeps constant. The drought in some countries leads to the decreasing of milk yield, or the

export supply in some countries is limited, therefore the diary price rises suddenly.

The meat price index is 187.4 on February 2015 and decreases 1.4% relative to January, the main reason is the decreasing of beef and mutton price and the price of poultry does not change, the pork price rises again after deceasing 4% continuously, the currency relative to the dollar of some countries and sufficient supplies lead the decreasing of pork export, the pork price of other countries will be limited. The sugar price is 207.1 on February 2015, which decreases 4.9% relative to January. This situation mainly reflects improvement of harvest after rainfall in main production zone (Babcock, 2012).

The agricultural price can be affected by the weather or management. The agriculture product is obtained through producing and processing crops, the growth and harvest of crops can affect the final production greatly (D'Souza and Jolliffe, 2014). With scale and integrated development of agricultural cultivation, the weather situation affects the agricultural output greatly, the weather factor cannot be controlled by people and the extreme weather will affect the fluctuation of agricultural price. Then the supply and demand relation is the basis of deciding the agricultural price, the supply and demand relation should be analyzed during the processing of analyzing the trend of agricultural price. The output, inventory, consumption and export data of the agricultural production should be concerned.

Basic theory of grey relational analysis: The grey relational analysis is an important method of grey system theory, the research object is the "small sample", "poor information" uncertain system that part information is known and the part information is unknown, the valued information is developed through the known information and the certain description of system running rules can be generated. The basic idea of this method can judge the relational degree according to the approximate degree of series curve geometry shape. The closer the curve shape is, the bigger the relational degree between series is. Then the main and secondary factor of system can be judged (Kose *et al*., 2013).

The linear data pre-processing method can be expressed as follows (Omoniwa, 2014):

$$x_i^* = \frac{x_i(k)}{x_{0j}(k)},\ i = 1,2,\cdots,m;\ j = 1,2 \tag{1}$$

where,

x_i^* = The normalized series
$x_i(k)$ = The original series
$x_{0j}(k)$ = The reference series

The grey relational coefficient can be computed based on formula (1). The grey relational coefficient of unknown x_i for x_{0j} can be expressed as follows (Lu and Pei, 2013):

$$\gamma(x_{0j}(k), x_i(k)) = \frac{\Delta_{\min} + \eta\Delta_{\max}}{\Delta_{0i}(k) + \eta\Delta_{\max}},\ 0 < \gamma(x_{0j}(k), x_i(k)) \le 1 \tag{2}$$

where, η denotes the distinguishing factor, which can show the relational degree between $x_{0j(k)}$ and $x_i(k)$, η = 0.5 in this research; $\Delta_{0i}(k)$ denotes the deviation series of the reference series, the test series:

$$\Delta_{0i}(k) = |x_{0j}(k) - x_i(k)| \tag{3}$$

$$\Delta_{\min} = \min_i \min_k |x_{0j}(k) - x_i(k)| \tag{4}$$

$$\Delta_{\max} = \max_i \max_k |x_{0j}(k) - x_i(k)| \tag{5}$$

The grey relational grade can be expressed as follows (Omoniwa, 2014):

$$\gamma(x_{0j}, x_i) = \sum_{k=1}^{n} \omega_k \gamma(x_{0j}(k), x_i(k)) \tag{6}$$

where, ω_k denotes the weight value, which can be obtained based on the following steps (Zhang, 2013):

Step 1: Define the mother and sub indexes, the most important index in the plan evaluated is taken as the mother index and the vector of index value corresponding to the mother index is expressed as follows:

$$Y_0 = (x_{10}, x_{20}, \cdots, x_{n0})^T \tag{7}$$

where Y_0 denotes the mother series.

The other factors are considered as sub indexes, the vector of index value corresponding to sub indexes is expressed as follows:

$$Y_j = (x_{1j}, x_{2j}, \cdots, x_{nj})^T \tag{8}$$

where Y_j is sub series.

Step 2: The original procession is carried out for Y_0 and Y_j, which is expressed as follows:

$$x'_{i0} = \frac{x_{i0}}{x_{10}} \tag{9}$$

$$x'_{ij} = \frac{x_{ij}}{x_{1j}} \tag{10}$$

Then $Y'_0 = (x'_{10}, x'_{20}, \cdots, x'_{n0})^T$, $Y'_j = (x'_{1j}, x'_{2j}, \cdots, x'_{nj})^T$ and the original index matrix is obtained, $B = (Y'_0, Y'_j)$.

Step 3: The relational coefficient between Y_0 and Y_j is computed according to the following expression:

$$y_{ij} = \frac{\min\limits_{1\le j\le m}\min\limits_{1\le i\le n} | x_{i0}^{'} - x_{ij}^{'} | + \mu \max\limits_{1\le j\le m}\max\limits_{1\le i\le n} | x_{i0}^{'} - x_{ij}^{'} |}{| x_{i0}^{'} - x_{ij}^{'} | + \mu \max\limits_{1\le j\le m}\max\limits_{1\le i\le n} | x_{i0}^{'} - x_{ij}^{'} |} \quad (11)$$

And the relational matrix is obtained, which is expressed by:

$$Y = \{y_{ij}\}_{n\times m} \quad (12)$$

Step 4: Compute the average value of column for the relational matrix, which is expressed as by:

$$y_i = \frac{1}{n}\sum_{i=1}^{n} y_{ij},\ j = 1,2,\cdots,m \quad (13)$$

Formula (7) shows that relational degree between j^{th} index and mother index. When j^{th} index is closer to the mother index, the effect of it on the plan evaluated is bigger, then this index will occupy bigger space in whole index space V.

Step 5: The normalization is used to deal with y'_j and the weighting value can be obtained by the following expression:

$$\omega_k = \frac{y_k}{\sum\limits_{k=1}^{m} y_k},\ k = 1,2,\cdots,m \quad (14)$$

Then the grey relational degree can be acquired, which can show the relational degree between the reference series and testing series.

Analysis steps of the grey relational analysis for analyzing the investment in science and technology and economics output of the petrochemical enterprises: The grey system can be established using variables of investment in science and technology and economics growth, which is defined by $\{X_i, X_j, \ldots\}$, i, j denote different variables, where X_i denotes the value of variable i from 2003 to 2014, which is expressed by:

$$X_i = [x_i(1), x_i(2),, x_i(10)] \quad (15)$$

The computing procedure is listed as follows:

Step 1: Process the original like value. Because X_i sequence reflects the value with different magnitude, for eliminating the effects of dimensions and the original like value is carried out for X_i, the following expression is listed as:

$$X_i^{'} = \frac{X_i}{x_i(1)} = [x_i^{'}(1), x_i^{'}(2),, x_i^{'}(10)] \quad (16)$$

Step 2: Deal with the parameters. The difference sequences of X'_i to X'_j are computed by the following expression:

$$\Delta_{i,j} = [\Delta_{i,j}(1), \Delta_{i,j}(2), \cdots, \Delta_{i,j}(10)] \quad (17)$$

where, $\Delta_{i,j}(\cdot) = | x_i^{'}(\cdot) - x_j^{'}(\cdot) |$, the collection of difference sequences is defined by $\{\Delta_{i,j}\}$.
The environmental parameter is expressed by:

$$\Delta(\max) = \max_i \max_j \{\max \Delta_{i,j}(\cdot)\} \quad (18)$$

$$\Delta(\min) = \min_i \min_j \{\min \Delta_{i,j}(\cdot)\} \quad (19)$$

The identification coefficients is set as ε, ε = 0.5.

Step 3: Compute the relational degree. The grey relational coefficient is expressed by:

$$\gamma_{i,j}(\cdot) = \frac{\Delta(\min) + \varepsilon\Delta(\max)}{\Delta_{i,j}(\cdot) + \varepsilon\Delta(\max)} \quad (20)$$

Then the grey relational degree is computed based on the following formula:

$$\gamma_{i,j} = \frac{1}{10}\sum_{=1}^{10} r_{i,j}(\cdot) \quad (21)$$

RESULTS AND DISCUSSION

Case study: The food price index and agricultural price index are used in this research, the food price index is the main index of inflation, which can be used as the explanatory variable and the agricultural price index is the proportion of agricultural production to the currency, which is the currency performance of agriculture production. The analyzing variables choose food price index (X), the fresh fruit price index (Y_1), corn price index (Y_2), meat price index (Y_3), the egg price index (Y_4), the vegetable price index (Y_5), the sugar price (Y_6), the oil price (Y_7). The time range is from January 2003 to December 2014, there are 150 samples. Based on the formula (7) to (21) the correlation coefficients between food price index and agricultural price index can be computed, the corresponding calculating results are shown in Table 1.

Table 1: Correlation coefficient between food price index and agricultural price index

Item	Correlation coefficient
X to Y_1	0.465
X to Y_2	0.542
X to Y_3	0.631
X to Y_4	0.774
X to Y_5	0.643
X to Y_6	0.854
X to Y_7	0.669

As seen from Table 1, the correlation coefficients between food price index and other agricultural price index are obtained. The correlation coefficient between food price and sugar price index is maximum and the correlation coefficient between the food price index and fresh fruit is minimum. Results show that correlation coefficient between food price index and other agricultural price index is different and the results can be affected by the production of crops and rational expectation of consumer. When the requirement elastic of agriculture is big, the price of the agricultural product can increase, the corresponding requirement will decrease and then the food price can decrease accordingly. The rising price of agriculture can lead to the expandable production, if the production period is short, the supplying of the agricultural product will expand and then food price can decrease.

CONCLUSION

The food price has closer contact with the agricultural price, the changes of food price is affected by the fluctuation of the agricultural price. The grey relational degree analysis is applied in the correlation analysis between the food price and agriculture price, the correlation coefficients between the food prices and other agriculture price are computed finally, the effect of different agricultural price on the food price are obtained, the corresponding reasons are discussed, results also show that the grey relational analysis is an effective tool for analyzing the correlation characteristics between the food price and agricultural price.

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