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Research Article

Empirical Research of Local Food Industry Expenditure and Regional Food Economic Growth Based Grey Relational Degree Analysis

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Abstract: In order to promote the development of food economics, the grey relational degree analysis is applied in the relationship analysis between the local food industry expenditure and regional food economic growth. Firstly, the real situation of Chinese food industry economic growth is analyzed. Secondly, the theory model of relational analysis between local food industry expenditure and regional food economic growth is established and the algorithm procedure is designed. Thirdly, the analysis varities are defined based on the analysis requirement, finally the relational analysis is carried out and results show that the grey relational degree analysis is an effective method for carrying out the relational analysis for local food industry expenditure and regional food economic growth.

Keywords: Empirical research, grey relational degree analysis, localfood industry, regional food economic growth

INTRODUCTION

In recent years, Chinese food industry stable and healthy development, which shows the pattern “stable growth, smooth price, increasing price, good structure”, the production increases with volatility and rising speed falls, the imports and exports of food rise steadily. In 2014, the increase value of 37607 major food industry enterprises increases 7.8% compared to the year before and the rising speed falls 1.3%. The proportion of industrial production of food industry to that of national range reaches 11.9% in the whole year and improves 0.3% compared to the last year, the contribution rate to national industrial growth is 11.0%. The major prime operating revenue of major food industry enterprises is 10.89 million yuan and increases 8.0% compared to the last year and the total profit is 7581.46 billion yuan and increases 1.2% compared to the last year, the total taxes paid is 9241.55 billion yuan and increases 7.2% compared to the last year, the main business income margin is 7.0% and decreases 0.4% compared to the last year (Qiao *et al*., 2013).

For 4 major industries of food industry, the profit of agricultural and sideline food processing industry, wine, drinks and refined tea manufacturing industry decreases, the profit of tobacco industries keep Micro growth of 0.2% and profit of food manufacturing industry increases obviously (Amate and de Molina, 2013). The changes of consumption environment lead to improvement of food industry structure adjustment, while the cost increases quickly and the profit space is squeezed, the capital expenditure of food industry will rise and the profit will reduce accordingly. Therefore the local food industry expenditure is necessary for promoting the food industry increasing, the relationship between the local food industry expenditure and regional food economic growth should be studied in depth, in order to improve the effectiveness of analysis, the grey relationship degree analysis is applied in it (Liu *et al*., 2014).

Situation of Chinese food industry economic growth: In recent years, Chinese food industry has obtained rapid development. The nominal total output value increase by 10% every year. The total output value and increase value increases by 15 and 23%, respectively. These situations show that the nutritional system changes constantly and the proportion of food industry increases constantly, as seen from nutritional system, the proportion of food industry and catering trade increases quickly, the average rising speed of agriculture and food industry is shown in Table 1 and 2 respectively (García-Lomillo *et al*., 2014).

The food industry develops quickly, the structural reform is an important affecting factor for food

Table 1: Average rising speed of agriculture

Year	Total output value	Increase value
1990-1994	9.4	8.0
1994-1998	6.8	6.2
1998-2002	6.2	4.6
2002-2006	5.8	7.3
2006-2010	6.2	6.3
2010-2014	11.0	8.4

Table 2: Average rising speed of agriculture

Year	Total output value	Increase value
1990-1994	9.4	8.0
1994-1998	6.8	6.2
1998-2002	6.2	4.6
2002-2006	5.8	7.3
2006-2010	6.2	6.3
2010-2014	11.0	8.4

Table 3: Performance of food industry

	Industrial added value rate/%	Asset contribution factor/%	Profit rate of cost/%	Deficiency/%
Food processing industry	20.32	6.50	0.94	2.23
Food manufacturing industry	27.43	7.29	1.24	1.84
Beverage manufacturing industry	37.23	11.19	7.53	1.63
Tobacco processing industry	74.19	39.54	19.53	1.44
Light industry average	39.25	9.50	4.53	1.46
Industry average	24.10	8.21	3.29	1.39

industry, Chinese state food enterprises occupy 27% of all food enterprise, the proportion of foreign-funded enterprises has biggest proportion, the foreign-funded enterprises not only change the constitution of ownership, but also promote foreign communication and technological advances, the reform of ownership increases the capital investment and the variety of food is more plentiful and output of food production increases constantly and the service range is expanding (Handford *et al*., 2014).

In recent years, the sum of fixed assets-net value and annual surplus of the current assets for food industry increases quickly (Seck *et al*., 2013). The expanding of capital total sum can buy more advanced technical devices and improve the productivity of labor and improve the quality of food production and add new food production. Under support of local food industry expenditure, the new technologies are used in developing the food industry, a lot of new food technologies emerge accordingly, such as biological engineering, gas, fresh, cold dry, microwave, irradiation, membrane separation, extraction, extrusion, puffing, then the production efficiency of food industry can be improved and the food product quality can be amended. Achievement of mechanization, automation and continuous can promote the section energy, low consumption and increasing value, the new technologies can reduce the consumption coefficients of farm produce for food industry. The performance of food industry is shown in Table 3 in 2014.

Theory model of relational analysis between local food industry expenditure and regional food economic growth: The linear data pre-processing method can be expressed as follows:

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

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:

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

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

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

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

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

The grey relational grade can be expressed as follows:

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

where ω_k is the weight value, which can be obtained based on the following steps:

Step 1: Choose the mother and sub indexes, the critical index in the project evaluated can be considered as mother index and the vector of index value corresponding to the mother index can be defined as follows:

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

where, Y_0 is the mother series.
The other factors can be used as sub indexes, the vector of index value corresponding to sub indexes can be defined by (Kolar and Kammenou, 2013):

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

where, Y_j is sub series.

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

$$x'_{i0} = \frac{x_{i0}}{x_{10}} \quad (9)$$

$$x'_{ij} = \frac{x_{ij}}{x_{1j}} \quad (10)$$

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 confirmed, $B = (Y_0^{'}, Y_j^{'})$.

Step 3: The relational coefficient between Y_0 and Y_j is computed according to the following expression (Zeng *et al*., 2013):

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

And the relational matrix is confirmed, which is defined by:

$$Y = \{y_{ij}\}_{n\times m} \tag{12}$$

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

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

Step 5: The normalization is used to cope with y'_j and the weighting value is confirmed by the following expression (Dong and Guo, 2014):

$$\omega_k = \frac{y_k}{\sum\limits_{k=1}^{m} y_k}, \; k = 1, 2, \cdots, m \tag{14}$$

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

Algorithm procedure of relational analysis: 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 is the value of variable i from 2004 to 2013, which is expressed as follows (Peng and Zeng, 2014):

$$X_i = [x_i(1), x_i(2), , x_i(10)] \tag{15}$$

The computing flow is shown as follows:

Step 1: Process the original like value. Because X_i sequence can reflect the value with different magnitude, in order to eliminate the effects of dimensions and the original like value is carried out for X_i, the following expression is obtained:

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

Step 2: Process the parameters. The difference sequences of X'_i to X'_j can be expressed as follows:

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

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 as follows:

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

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

The identification coefficients is defined by ε, ε = 0.5 in this research.

Step 3: Calculate the relational degree. The grey relational coefficient can be expressed as follows:

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

Then the grey relational degree is calculated by the following expression:

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

Experiment design: In order to verify the effectiveness of theory model of relational analysis, the food industry data in a province is used as example and corresponding relational analysis is carried out.

Main indexes: The Regional Food Economic Growth (RFEG) is denoted by the total output of food industry (unit: billion yuan), this method exists a certain limitation, for example the negative effect led by regional food economic growth during the procession of statistics can not be considered, however this method is easy to use, the price fluctuation is ignored during the procession of analysis (Kolar and Kammenou, 2013).

The Local Food Industry Expenditure (LFIE) is used as a variable. This variable chooses total expenditure of food industry in this province (unit: million yuan). This index can measure the local food industry expenditure in this province, the food industry expenditure is main used in relating technical research and development, which is supported by local government of this province, enterprise capital and financial institution loan (Zhou *et al*., 2014).

RESULTS AND DISCUSSION

The RFEG is defined by X_0, the LFIE is defined by X_1, the investment of private capital is defined by X_2. X_0 belongs to mother series, X_1 and X_2 are sub series and the value of them are shown by the following vectors:

X_0 = [165433.2, 165378, 204246, 265438, 296743, 315438, 387361, 457852, 506732, 575198]
X_1 = [1863, 2254, 2973, 4542, 4164, 5582, 6759, 8582, 9727, 10542]
X_2 = [29.6, 30.3, 32.6, 33.5, 36.1, 35.8, 40.3, 42.0, 43.0, 42.5, 46.3]

Then final results can be obtained through processing in further, which are shown by the following:

X'_0 = [1.0, 1.12, 1.26, 1.47, 1.79, 2.11, 2.38, 2.88, 3.18, 3.32]
X'_1 = [1.0, 1.16, 1.37, 2.38, 2.49, 2.86, 3.42, 4.54, 5.17, 5.89]
X'_2 = [1.0, 1.15, 1.26, 1.37, 1.42, 1.49, 1.53, 1.67, 1.73, 1.84]

The difference series of X'_0 to X'_1 are defined by:

$\Delta_{0,1}$ = [$\Delta_{0,1}$ (1), $\Delta_{0,1}$ (2),…, $\Delta_{0,1}$(10)] = [0, 0.12, 0.26, 0.78, 0.42, 0.79, 1.14, 1.67, 1.82, 2.43]

The difference series of X'_0 to X'_2 are defined by:

$\Delta_{0,2}$ = [$\Delta_{0,2}$ (1), $\Delta_{0,2}$ (2),…, $\Delta_{0,2}$(10)] = [0, 0.09, 0.21, 0.46, 0.72, 0.83, 1.26, 1.39, 1.69, 1.86]

Based on expressions (20) and (21), the relative relational degrees $\gamma_{0,1}$ and $\gamma_{0,2}$ are computed, the final results are shown as follows:

$\gamma_{0,1} = 0.854$, $\gamma_{0,2} = 0.739$

According to the results, the local food industry expenditure is more important for regional food economic growth than private capital, the positive correlation degree between local food industry expenditure and regional food economic growth is stronger.

CONCLUSION

Chinese food industry has entered an optimal developing period, which has more chances. Through improving local food industry expenditure, the technology can be improved, the management level can be improved and the food industry structure can be updated. Then the food industry can achieve quick economic growth, the industrial output value of food industry can be improved accordingly, Chinese food industry can obtain strong competitive advantage. The grey relational analysis can be applied in analyzing the relational characteristic between the local food industry expenditure and economic growth effectively.

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