Grey Correlation Between Agricultural Input Factors and Regional GDP Growth in Anhui Province

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Abstract In order to analyze the relation between agricultural input factors and economic growth in Anhui Province, the evaluation index system of agricultural input is built from the perspectives of subject, object and tools based on grey system theory. The government investment in agricultural science and technology is selected as the index of labor subject, that is labor-related index(X_1), the total sown area of crops is selected as the index of labor object(X_2), the investment in rural water and electricity construction is chosen as the index of tools(X_3), and the GDP of Anhui Province is denoted by X_0. According to the relevant data, the improved model of grey correlation analysis is adopted to calculate the correlation among the investment in agricultural water and electricity construction, total sown area of crops, government investment in agricultural science and technology, and the GDP in Anhui Province during 2004 -2008. Results show that investment in agricultural science and technology contribute the largest to GDP growth, the increase and change of the total sown area and the investment in rural water and electricity construction have a weak correlation with GDP, they are in a less consistent development trend. On this basis, the government of Anhui Province further proposes to increase the investment in agricultural science and technology, enhance the protection of arable lands, keep the total sown area of crops, and properly maintain the rural water and electricity construction.

Key words Anhui Province, Agricultural input factors, Grey correlation, GDP, China

To prosper agriculture by science and technology has become a primary task in maintaining the long-term and stable development of agriculture, to consolidate and strengthen the foundation of agriculture in national economy, deepen rural reform, develop agricultural productivity, improve the scientific and cultural quality of farmers, promote the sustainable, stable and healthy development of agriculture and rural economy are currently the main purpose and means to develop national agriculture. Therefore, the quantitative evaluation of agricultural input factors becomes very important. As one of the two pillars in grey system theory, grey correlation analysis is an important quantitative analysis method to conduct systematic analysis within an uncertain system with less data and poor information. Combining the metric space and point set topological space together, it conducts an overall comparison with a reference frame and digital measurement, which can be adopted in analyzing the primary and secondary of system factors, recognizing patterns, choosing optimum scheme, disposing behaviors and so on[1-4]. The evaluation of agricultural input factors is a complex multi-factor system, which is fuzzy, random and lack of complete information, and is a typical grey system. So far, many scholars use the grey correlation analysis model to study the correlation between the primary industry and social economic growth, and have made certain achievement[5-8]. Using the improved grey correlation model and combining with the actual facts, the author calculates and analyzes the grey correlation from the normative, practical and scientific points of view so as to provide reference for the sustainable economic growth in Anhui Province.

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1 Index selection, data source and research method

1.1 Index selection The growth of agricultural economy depends largely on the agricultural science and technology inputs. Modern agricultural production is a mechanized production process, in which human is the labor subject while land is the labor object, taking both the subject and object into consideration is of great help to the accuracy of the evaluation. Besides, as the economic and social development is symbolized by the continuous advancement of tools, it is reasonable to take into account the investment in production tools in evaluating relation between the agricultural inputs and regional GDP, thus the index of the investment in rural water and electricity construction should be selected. After a comprehensive consideration, the index system of agricultural input factors in Anhui Province is built by selecting the government investment in agricultural science and technology as the index of labor subject, that is labor-related index(X_1), the total sown area of crops as the index of labor object(X_2), the investment in rural water and electricity construction as the index of tools(X_3), and denoting the GDP of Anhui Province with X_0, the system will reflect the agricultural input factors from the perspectives of subject, object and tools.

1.2 Data source The relevant data about the agricultural input factors and regional GDP in Anhui Province is obtained from *China Statistical Yearbook*-2009 *and China Statistical Yearbook on Science and Technology*-2009 (Table 1)[9-10].

1.3 Research method The grey correlation degree is adopted to analyze the relationship between agricultural input factors and regional GDP growth. The calculation steps of grey correlation analysis model are as follows:

Table 1 Agricultural input factors and the GDP in Anhui Province during 2004 –2008

Year	GDP of Anhui Province X_0 // $\times 10^8$ yuan	Investment in rural science and technology X_1 // $\times 10^8$ yuan	Total sown area of crops X_2 // $\times 10^4$ hm^2	Investment in rural water and electricity construction X_3 // $\times 10^4$ yuan
2004	4 759.32	2.073	411.05	53 193
2005	5 375.12	2.26	410.89	52 285
2006	6 131.1	2.512	409.25	32 423
2007	7 364.18	2.973	411.69	38 942
2008	8 874.17	3.012	412.01	17 812

(1) The establishment of reference and comparison sequences. Generally when there are n indexes and m comparison objects, firstly $X_0 = \{x_0(1), x_0(2), \ldots, x_0(n)\}$ is determined as the reference sequence, while $X_i = \{x_i(1), x_i(2), \ldots, x_i(n)\}$, $(i = 0, 1, 2, \ldots, m)$ is the comparison sequence of related factors.

(2) The calculation of the initial value of each sequence. The raw data is made dimensionless so as to eliminate the impact of the dimension, the calculation formula is as follow:

$$X' = \frac{X_i}{x_i(1)} = \{x'_i(1), x'_i(2), \ldots, x'_i(n)\}, \ (i = 0, 1, 2, \ldots, m) \quad (1)$$

(3) The evaluation of the maximum and minimum difference. The calculation formula is as follow:

$$M = \max_i \max_k \Delta_i(k), \ m = \min_i \min_k \Delta_i(k) \quad (2)$$

In this formula, $\Delta_i(k) = |x'_0(k) - x'_i(k)|$, $(k = 1, 2, \ldots, n;\ i = 1, 2, \ldots, m)$

(4) The evaluation of the correlation coefficient. The calculation formula is as follows: $\gamma_{0i}(k) = \frac{m + \xi M}{\Delta_i(k) + \xi M}$, $(k = 1, 2, \ldots, n;\ i = 1, 2, \ldots, m)$

In this formula, $\xi \in (0, 1)$ is the resolution coefficient, generally $\xi = 0.5$. then the mean of each correlation coefficient sequence is calculated by the formula (4):

$$\bar{\gamma}_{0i} = \frac{1}{n}\sum_{k=1}^{n}\gamma_{0i}(k), \ (i = 1, 2, \ldots, m) \quad (4)$$

(5) The calculation of stability. The formula is :

$$S(\gamma_{0i}) = \sqrt{\frac{1}{n}\sum_{k=1}^{n}(\gamma_{0i} - \bar{\gamma}_{0i})^2}, \ (i = 1, 2, \ldots, m) \quad (5)$$

(6) The evaluation of grey similarity correlation degree. The formula is :

$$R_{0i} = \frac{\gamma_{0i}}{1 + S(\gamma_{0i})}, \ (i = 1, 2, \ldots, m) \quad (6)$$

2 Results and analysis

The GDP of Anhui Province during 2004 –2008 is taken as a reference sequence X_0, the government investment in rural science and technology is taken as a comparison sequence X_1, the total sown area of crop as the comparison sequence X_2, the investment in rural water and electricity construction as the comparison sequence X_3, then the correlation coefficient sequence can be obtained by the formula (1) –(3):

$\gamma_{01} = (1.000\ 0, 0.951\ 3, 0.909\ 1, 0.871\ 1, 0.650\ 1)$

$\gamma_{02} = (1.000\ 0, 0.854\ 9, 0.723\ 3, 0.583\ 6, 0.470\ 1)$

$\gamma_{03} = (1.000\ 0, 0.839\ 3, 0.529\ 8, 0.484\ 1, 0.333\ 3)$

The mean of correlation coefficient can be calculated by formula (4):

$\bar{\gamma}_{01} = 0.876\ 3$, $\bar{\gamma}_{02} = 0.726\ 4$, $\bar{\gamma}_{03} = 0.637\ 3$

The stability of correlation coefficient in each sequence of input factors could be evaluated by formula (5):

$S(\gamma_{01}) = 0.135\ 3$, $S(\gamma_{02}) = 0.210\ 6$, $S(\gamma_{03}) = 0.273\ 8$

The calculation results above show that the sequence X_1 is more stable than sequence X_2 and sequence X_3.

Finally, the grey similarity correlation degree between each input factor and GDP is calculated by formula (6) (Table 2).

$$R_{01} = \frac{\gamma_{01}}{1 + S(\gamma_{01})} = 0.771\ 9, \ R_{02} = \frac{\gamma_{02}}{1 + S(\gamma_{02})} = 0.600\ 0, \ R_{03} = \frac{\gamma_{03}}{1 + S(\gamma_{03})} = 0.500\ 3$$

Table 2 Grey correlation between each agricultural input factors and regional GDP in Anhui Province

Agricultural input factors	Similarity correlation with X_0 (GDP)	Ranking
Investment in rural science and technology X_1	0.771 9	1
Total sown area of crops X_2	0.600 0	2
Investment in rural water and electricity construction X_3	0.500 3	3

As shown in Table 2, the grey similarity correlation of each input factor is moderate, and R_{01} is the largest, which shows that there is a strong correlation degree between the sequence of agricultural science and technology inputs and the sequence of the GDP in Anhui Province, that is to say, agricultural science and technology inputs in Anhui Province make the greatest contribution to its GDP growth. While both R_{02} and R_{03} are smaller than R_{01}, which indicates that, the weaker the correlation degree, the smaller the contribution; which also proves that the total area of arable lands and the investment in rural water and electricity construction in Anhui Province develop inconsistent with its GDP growth.

3 Conclusion and suggestions

3.1 Conclusion After an analysis on the grey correlation between the agricultural production inputs factors in Anhui Province and its GDP, it can be concluded that:

(1) As the subject, the government investment in agricultural science and technology has a close relationship with regional GDP. During 2004 –2008, with the increase of the government input in agricultural science and technology, the GDP in Anhui Province also saw an increasing trend, it can be seen that the increased inputs in agricultural science and technology

have a significant catalytic role in the development of agricultural economy and other economies, which also explains that the agricultural economic growth depends largely on the investment in agricultural science and technology.

(2) As the index of labor object, the total sown area of crops has no significant similarity correlation with the regional GDP, which, however, is higher than the similarity correlation between the total sown area of crops and the investment in rural water and electricity construction as the index of tools. In recent years, the government continues to strengthen the management of agricultural lands so that the change range of the cultivated area is narrowed, so there is a small similarity correlation between cultivated area and regional GDP, but it should not be denied that the cultivated land is still a prerequisite for agricultural and national economic growth.

(3) As the index of labor tools, the investment in rural water and electricity construction has the smallest similarity correlation degree with the regional GDP, as shown in the data during 2004 – 2008, the investment in rural water and electricity construction saw a continuous declining trend, and the national economy shows a good momentum of growth, this is because as labor tools, rural water and electricity construction brings long-term benefits, which means, the benefits from the investment could be enjoyed within a few years or even decades after the inputs. Therefore, although the investment in agricultural water and electricity of Anhui Province is declining, the total investment in agricultural science and technology is still increasing in the years after 2004.

3.2 Suggestions In the future, Anhui provincial government should continue to increase the investment in agricultural science and technology, enhance the protection of cultivated lands, keep the total sown area of crops and properly maintain rural water and electricity construction, that is to say, the economic work should focus on increasing the investment in the "subjective part", maintaining the state of the "objective part" and keeping the good operation of the "tools" so as to guarantee the sustainable and coordinated development of the overall society in Anhui.

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services support of products. On the contrary, multinational enterprises have relatively perfect technical service system, which increases the added value of products, as well as the price. Therefore, domestic enterprises should learn from the multinational enterprises and try to enhance customer service for a longer period of time in future.

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