Study on High Quality Development Evaluation and Temporal and Spatial Differentiation of Agricultural Economy in the Yangtze River Delta

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Abstract

Based on the original data from 2007 to 2019, this paper constructed a comprehensive evaluation system with 4 dimensions and 12 indicators, and used entropy weight TOPSIS method to comprehensively analyze and evaluate the quality development level of agricultural economy in the Yangtze River Delta region, and discussed its spatio-temporal differentiation characteristics. The results show that: (1) The overall level of High-quality agricultural economic development in the Yangtze River Delta has been continuously improved. (2) There are significant differences in the High-quality development level of agricultural economy among three provinces and one city in the Yangtze River Delta. (3) There is a small gap in the High-quality development level of agricultural economy among cities in the three provinces. (4) The green development of agricultural economy has a significant impact on the high quality development of agricultural economy in Yangtze River Delta. Accordingly, the following suggestions are made: (1) Accelerate agricultural modernization in the process of Yangtze River Delta integration. (2) Promote cooperation among three provinces and one city. (3) Adhere to the green development path of agricultural economy. (4) Increase investment in agricultural science and technology innovation, carry out industrial structure reform and improve the agricultural economic structure.

Keywords

Yangtze River Delta; Agricultural Economy; High Quality Development; TOPSIS; Spatiotemporal Differentiation.

1. Introduction

Since the reform and opening up, the state has attached great importance to the development of rural agricultural economy. In the early stage of reform and opening up, the state's requirement for agriculture is to improve agricultural supply and increase grain output, so that the people can achieve food and clothing. [1] At present, China's economy has changed from high-speed growth stage to High-quality development stage, and China's requirements for agriculture have changed from high-yield development to High-quality development. High quality agricultural development is a comprehensive embodiment of the total agricultural economy and agricultural economic benefits of a region. [2] Moreover, the High-quality development of agricultural economy is also an important guarantee for China to tackle poverty, promote rural revitalization and realize agricultural and rural modernization. [3] However, there is a long-term lag in the economic development of rural areas, resulting in many problems in the High-quality development of agriculture. At present, there are problems in the High-quality development of agriculture, such as the change of consumption concept [4], regional differences in farming, weak production foundation and the influence of other objective factors [5], which make it difficult to significantly improve the High-quality development of agriculture in the short term, maintain low development efficiency and realize large-scale production.

Therefore, the agricultural economy must pay attention to innovation and reform, promote structural reform, production reform and efficiency reform, strive to overcome difficulties and make up for weaknesses, and realize the High-quality development of agricultural economy.

2. Journals Reviewed

The High-quality development of agricultural economy is an important embodiment of China's agricultural modernization and an objective requirement for China to build a powerful socialist modern country. Zhang Chunling and others analyzed the role of Rural Revitalization in promoting the High-quality development of agriculture in China by using the fuzzy hierarchical comprehensive evaluation model from the aspects of agricultural resources, agricultural cost and agricultural production structure. [6] He Xiugui analyzed the High-quality development of agriculture in China from the "six highs" of High-quality agricultural products and high income level of farmers, and put forward six ways to promote the High-quality development of agriculture, such as continuously expanding the increment of High-quality agricultural products. [7] Chang Xuan and others analyzed the shortcomings faced by the current construction of agricultural "three haves" economic system, and put forward corresponding policy suggestions from five aspects such as agricultural factor market. [8] Luo Qiyou and others believe that the High-quality development of agriculture includes the high quality of agricultural product quality, and study the role of spatial layout in promoting the High-quality development of agriculture in China through data analysis and other methods. [9] On the construction of agricultural High-quality development index system, scholars from all walks of life have used different methods to study agricultural High-quality development, mainly including data analysis method, entropy weight method and so on. For example, Wang Xingguo and others constructed a comprehensive index system of agricultural High-quality development from four aspects such as the total agricultural economy, using 11 three-level indicators, and conducted a spatial correlation test. It was analyzed that the development of rural financial system in different regions was quite different, and the construction of rural financial system could promote the High-quality development of agriculture. [10] Xin Ling and others constructed an evaluation system of 8 primary indicators and 22 secondary indicators from four aspects. They evaluated the High-quality agricultural development of 31 provinces, autonomous regions and cities in 2017 by using entropy method, and found that the restrictive factors of High-quality agricultural development in different regions are different. [11] Yu Ting and others constructed a 20 index comprehensive evaluation index system of agricultural High-quality development based on TOPSIS entropy weight method, and concluded that in order to further promote China's agricultural High-quality development, we should start from five aspects, such as agricultural high-level opening-up. [12] Li Xinwu and others constructed a comprehensive evaluation system of 12 three-level indicators and 35 four-level indicators from the five dimensions of innovation, and studied, analyzed and evaluated China's agricultural development. [13]

At present, there are few studies on the spatio-temporal differentiation of High-quality development of agricultural economy. Liu Zhongyu et al. analyzed and evaluated the High-quality agricultural development level of eight comprehensive economic zones by using the panel data of 31 provinces in China from 2011 to 2018 using entropy weight method. [14] Ji Zhiheng analyzed the spatial differences and driving mechanisms of High-quality rural agriculture development in China from 2005 to 2018, using the evaluation values of High-quality agricultural and rural development at provincial level from 2005 to 2018. [15] Du Yuneng et al. evaluated the agricultural modernization degree of each province from five aspects, such as agricultural production. [16] Wang Xiaohong et al. used weighted principal component analysis and Moran's I to measure the level of agricultural High-quality

development and its spatial relationship. [17] For the research on the High-quality development and temporal and spatial differentiation of agricultural economy in the Yangtze River Delta, the existing literature mainly focuses on the High-quality development of agriculture and rural economy. Dai Bing and others studied the evolution of agricultural spatial structure in the Pan Yangtze River Delta region through the specific data of provinces and cities in the Pan Yangtze River Delta region. [18] Gui Zheng and others used data envelopment analysis (DEA), Tobit model analysis and mathematical analysis methods to study the cultivated land use efficiency and its influencing factors in the Yangtze River Delta and various regions. [19]

Based on this, this paper uses the relevant data of the Yangtze River Delta from 2007 to 2019 to establish TOPSIS model to study the High-quality development and temporal and spatial differentiation of agricultural economy in the Yangtze River Delta.

3. Model Building

3.1. Model Setting

TOPSIS is a commonly used comprehensive evaluation method, which is often used to study the spatial-temporal differentiation between regions. It can make full use of the information of the original data and accurately reflect the differences between them. However, the impact of each index on the research object is different, so the index needs to be weighted. In this paper, entropy weight method is used to objectively weight the index. The model establishment process is as follows:

3.1.1. List the Standardized Matrix As

$$Z=\begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1m} \\ z_{21} & z_{22} & \cdots & z_{2m} \\ \vdots & \cdots & \ddots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nm} \end{bmatrix}$$

N stands for n evaluation objects ; m stands for m evaluation indicators ; z_{ij} represents the standardized value of the j-th evaluation index (j = 1,2,..., m) under the i-th object (i= 1,2,...,n).

3.1.2. Calculate the Probability Used in the Calculation of Information Entropy

$$p_{ij}=\frac{z_{ij}}{\sum_{i=1}^{n} z_{ij}}$$

From the constructed index system, we can get that $z_{ij} \geq 0$

3.1.3. Calculate Entropy Weight

First calculate its information entropy:

$$e_j=-\frac{1}{\ln n}\sum_{i=1}^{n} p_{ij}(\ln p_{ij})(j=1,2,...,m)$$

Information utility value can be obtained from information entropy: $d_j=1-e_j$

Then the entropy weight can be calculated:

$$w_j = d_j \ / \ \textstyle\sum_{j=1}^{m} d_j \ (j=1,2,\ldots,m)$$

3.1.4. Calculate the Distance between the Standardized Index Value and the Optimal Solution and the Worst Solution

$$D_i^+ = \sqrt{\textstyle\sum_{j=1}^{m} w_j (Z_j^+ - z_{ij})^2}$$

$$D_i^- = \sqrt{\textstyle\sum_{j=1}^{m} w_j (Z_j^- - z_{ij})^2}$$

Z_j^+ represents the maximum value (optimal solution) of the j-th index, and Z_j^- represents the minimum value (worst solution) of the j-th index (j=1,2,…,m); D_i^+ is the distance between the ith evaluation object and the maximum value, and D_i^- is the distance between the ith evaluation object and the minimum value. (i=1,2,…,n)

3.1.5. Calculate the Comprehensive Score

$$S_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

S_i stands for comprehensive score.

3.2. Construction of Index System

The high quality development of agricultural economy is the high quality development of agricultural product quality, primary industry system, rural life and rural social economy. Based on this foundation and previous studies, a comprehensive evaluation system of high quality development of agricultural economy in Yangtze River Delta region with 4 dimensions and 12 indicators was constructed. Based on the original data from 2007 to 2019, the weight of each index is obtained by entropy weight method. See Table 1 for details.

3.3. Data Sources

This paper collects the original agricultural data of three provinces and one city in the Yangtze River Delta from 2007 to 2019. The data are mainly from Anhui statistical yearbook, Jiangsu statistical yearbook, Zhejiang statistical yearbook, Shanghai Statistical Yearbook and the statistical yearbooks of 41 cities in the Yangtze River Delta. Since the use intensity of chemical fertilizer and other indicators have a negative impact on the High-quality development of agricultural economy, these indicators need to be positively treated, that is, very small indicators are transformed into very large indicators, and the transformation formula is as follows:$max - x$. max represents the maximum value of the same index; x represents the index value. Due to the different dimensions of different indicators, in order to eliminate their influence, it is necessary to standardize the data after normalization. The standardized processing formula is $z_{ij} = x_{ij} \ / \ \sqrt{\sum_{i=1}^{n} x_{ij}^2}$, The standardized matrix is recorded as $Z.z_{ij}$ stands for each element in Z; i=1,2, …, n; j=1,2, …, m.

Table 1. Comprehensive evaluation index system of High-quality development of agricultural economy

Target layer	Index layer	Index connotation	Company	Index direction	Weight
Agricultural economic structure	Proportion of output value of primary industry in GDP of Yangtze River Delta	The output value of the primary industry divided by the GDP of the Yangtze River Delta multiplied by 100	%	+	0.1323
	Proportion of employed persons in primary industry in total employed persons	Total employed persons in the first industry divided by 100	%	+	0.1111
	Land productivity	Total value of agriculture at the end of the year divided by cultivated land area	10000 yuan / ha	+	0.0568
Innovative development of agricultural economy	Mechanization level	Total mechanical power divided by cultivated land area	kw / ha	+	0.0141
	Agricultural financial investment ratio	Agricultural fiscal expenditure divided by total fiscal expenditure * 100	%	+	0.0061
	Agricultural scale	Sown area divided by rural population	ha / person	+	0.0798
Green development of agricultural economy	Use intensity of chemical fertilizer	Fertilizer application divided by sowing area	ton / ha	_	0.1655
	Pesticide use intensity	Pesticide application divided by sowing area	ton / ha	_	0.1349
	Increased power consumption in agriculture	Electricity consumption divided by agricultural added value	kW·h / yuan	_	0.1407
Rural social and economic development	Urbanization rate	Urban population divided by resident population at the end of the year multiplied by 100	%	+	0.0060
	Rural per capita disposable income	Rural per capita disposable income	ten thousand yuan	+	0.0179
	Consumption ratio of urban and rural residents	Per capita consumption expenditure of urban residents divided by per capita consumption expenditure of rural residents	_	_	0.1348

4. Analysis of Empirical Results

4.1. Overall Evaluation of Agricultural Development Quality in the Yangtze River Delta

Based on the original data from 2007 to 2019, the comprehensive score of High-quality agricultural economic development in the Yangtze River Delta from 2007 to 2019 is obtained by using TOPSIS method.

Table 2 shows the distance between the standardized index value and the optimal solution, the distance from the worst solution and the comprehensive score. The smaller the distance between the standardized index value and the optimal solution, the better, while the larger the distance from the worst solution, the better. The closer the comprehensive score is to 1, which

means the higher the High-quality development level of agricultural economy in that year. In Table 2, D^+ is decreasing year by year as a whole, and D^- is increasing year by year as a whole. From the comprehensive score, the High-quality development of agricultural economy in the Yangtze River Delta region shows an overall upward trend year by year, and the comprehensive score keeps approaching 1. Before 2013, the High-quality development of agricultural economy in the Yangtze River Delta showed fluctuations, which was the minimum in 2007 (0.1652) and the maximum in 2012 (0.3909).

Table 2. High quality development level of agricultural economy in the Yangtze River Delta from 2007 to 2019

year	D^+	D^-	S_i	sort
2007	0.4078	0.0807	0.1652	13
2008	0.3509	0.1317	0.2730	9
2009	0.4087	0.0969	0.1917	12
2010	0.3897	0.1143	0.2268	11
2011	0.3149	0.1938	0.3810	7
2012	0.3310	0.2124	0.3909	6
2013	0.3517	0.1172	0.2499	10
2014	0.3209	0.1561	0.3273	8
2015	0.2743	0.1973	0.4184	5
2016	0.2192	0.2446	0.5274	4
2017	0.1831	0.2803	0.6049	3
2018	0.1568	0.3296	0.6775	2
2019	0.1053	0.4104	0.7958	1

4.2. Analysis on the High-quality Development Level of Agricultural Economy in Various Cities

Based on the original data of 41 cities in the Yangtze River Delta in 2019, the comprehensive score of High-quality agricultural economic development of cities in the Yangtze River Delta in 2019 is calculated, so as to analyze and evaluate the spatial evolution characteristics of High-quality agricultural economic development in the Yangtze River Delta.

Table 3. In 2019, 41 cities in the Yangtze River Delta achieved High-quality agricultural economic development

Yangtze River Delta	City	D^+	D^-	S_i	Sort
Shanghai	Shanghai	0.2137	0.1143	0.3485	41
Zhejiang Province	Nanjing	0.1767	0.1467	0.4536	27
	Wuxi	0.1993	0.1127	0.3612	40
	Xuzhou	0.1464	0.1609	0.5236	10
	Changzhou	0.1744	0.1312	0.4293	32
	Suzhou	0.1989	0.1165	0.3693	38
	Nantong	0.1545	0.1469	0.4874	19
	Lianyungang City	0.1555	0.1590	0.5056	14
	Huai'an	0.1366	0.1615	0.5418	4

	Yancheng	0.1174	0.1985	0.6284	1
	Yangzhou City	0.1500	0.1552	0.5085	12
	Zhenjiang City	0.1657	0.1574	0.4872	20
	Taizhou	0.1381	0.1605	0.5375	6
	Suqian	0.1436	0.1649	0.5346	7
Jiangsu Province	Hangzhou	0.1709	0.1441	0.4575	26
	Ningbo	0.1820	0.1225	0.4023	35
	Wenzhou City	0.1878	0.1095	0.3682	39
	Jiaxing	0.1753	0.1353	0.4355	29
	Huzhou	0.1550	0.1597	0.5074	13
	Shaoxing	0.1613	0.1366	0.4587	25
	Jinhua	0.1796	0.1122	0.3844	37
	Quzhou	0.1501	0.1533	0.5051	15
	Zhoushan City	0.1309	0.1836	0.5839	2
	Taizhou	0.1673	0.1289	0.4352	30
	Lishui	0.1493	0.1462	0.4948	17
Shanghai	Hefei	0.1762	0.1285	0.4217	34
	Wuhu	0.1670	0.1437	0.4625	24
	Bengbu	0.1433	0.1772	0.5528	3
	Huainan	0.1562	0.1757	0.5293	8
	Ma'anshan City	0.1543	0.1629	0.5136	11
	Huaibei	0.1667	0.1637	0.4954	16
	tongling	0.1819	0.1386	0.4324	31
	Anqing	0.1582	0.1528	0.4912	18
	Huangshan City	0.1545	0.1813	0.5399	5
	Chuzhou	0.1580	0.1403	0.4703	22
	Fuyang	0.1820	0.1362	0.4280	33
	Suzhou	0.1732	0.1362	0.4402	28
	Lu'an	0.1878	0.1185	0.3868	36
	Bozhou	0.1438	0.1584	0.5242	9
	Chizhou	0.1637	0.1439	0.4678	23
	Xuancheng City	0.1531	0.1436	0.4840	21

Through table 3, we can see that there is a certain gap in the High-quality development level of agricultural economy in 41 cities in the Yangtze River Delta. Among them, there are five in Jiangsu Province, four in Anhui Province and one in Zhejiang Province. Among 41 cities, the highest comprehensive score of High-quality development of agricultural economy is Yancheng

City (0.6284), and the lowest comprehensive score is Shanghai City (0.3485), of which the highest score is about 1.8032 times of the lowest score. The comprehensive score of Yancheng city is the highest, which is 1.7398 times that of Wuxi City; The comprehensive score of Zhoushan City is the highest, which is 1.5858 times that of Wenzhou City; Bengbu City has the highest comprehensive score for the High-quality development of agricultural economy in Anhui Province, which is 1.4292 times that of Lu'an City.

4.3. Study on Temporal and Spatial Differentiation of High-quality Development of Agricultural Economy in the Yangtze River Delta

Through the original data from 2007 to 2019, the comprehensive scores of High-quality agricultural economic development in three provinces and one city in the Yangtze River Delta region were obtained. Due to the length of the paper, the data from 2007 to 2019 cannot be completely listed. This paper selects five time nodes (2007, 2010, 2013, 2016 and 2019) for calculation, so as to analyze the spatial and temporal differentiation characteristics of High-quality agricultural economy development in the Yangtze River Delta region.

Table 4. Temporal and spatial evolution of High-quality development of agricultural economy in three provinces and one city

Year	2007		2010		2013		2016		2019	
Region	score	sort	score	sort	score	sort	score	sort	score	sort
Shanghai	0.4273	4	0.4690	3	0.5058	3	0.4509	3	0.4596	4
Jiangsu Province	0.5150	2	0.5013	2	0.5088	2	0.5292	2	0.5403	2
Zhejiang Province	0.4499	3	0.4236	4	0.4214	4	0.4104	4	0.4664	3
Anhui Province	0.6783	1	0.6200	1	0.5547	1	0.6608	1	0.6152	1

With the passage of time, the quality of agriculture in the eastern part of the Yangtze River Delta can be gradually reduced compared with that in the eastern part of the Yangtze River Delta. In the five-year data listed, the comprehensive score of High-quality development of agricultural economy in Anhui Province and Jiangsu Province has always been in the first and second place, and Shanghai and Zhejiang Province have always been in the last two places. In 2007, Anhui Province with the highest comprehensive score was 1.5874 times that of Shanghai. In 2010, only Shanghai's comprehensive score in the Yangtze River Delta increased, while the High-quality agricultural economic development in the other three provinces all declined. But their agricultural economy high quality development gap has certain reduction. In 2013 and 2016, the High-quality development level of agricultural economy in various regions of the Yangtze River Delta increased and decreased. In 2019, the High-quality development level of agricultural economy in three provinces and one city in the Yangtze River Delta was further reduced, and Anhui Province ranked first in the comprehensive score was 1.3386 times that of Shanghai. On the whole, the High-quality development level of agricultural economy in three provinces and one city in 2019 is higher than that in 2007.

5. Research Conclusions and Policy Recommendations

5.1. Research Conclusion

Through the entropy weight TOPSIS method and based on the original data of the Yangtze River Delta from 2007 to 2019, we can draw the following conclusions:

(1) The overall level of High-quality agricultural economic development in the Yangtze River Delta has been continuously improved. Yangtze river delta region in 2007-2019 the agricultural

economy development high quality composite scores while falling in part of the year, but on the whole present a steady upward trend, and with the passage of time, the agricultural economy development reaches a certain level, high quality comprehensive score is close to 1, the development of economy and high quality agricultural growth is also falling, To reach a stable state.

(2) There are significant differences in the High-quality development level of agricultural economy among three provinces and one city in the Yangtze River Delta. In the listed five-year data of three provinces and one city, although the comprehensive score gap of three provinces and one city has been reduced, there are still some differences in the High-quality development level of agricultural economy among three provinces and one city. In 2019, the average comprehensive score of High-quality development of agricultural economy in 41 cities was 0.4729, but the comprehensive scores of most regions were quite different, and the comprehensive scores of cities fluctuated significantly. Among them, Yancheng city with the highest comprehensive score of High-quality development of agricultural economy is 1.8032 times higher than Shanghai city with the lowest comprehensive score.

(3) There is a small gap in the High-quality development level of agricultural economy among cities in the three provinces. In the data calculated by 41 cities in 2019, the average comprehensive score of cities in Jiangsu Province is 0.4898, the average comprehensive score of cities in Zhejiang Province is 0.4575, and the average comprehensive score of cities in Anhui Province is 0.4775. All cities in the three provinces fluctuate around the average comprehensive scores of all provinces, and the comprehensive scores of all cities in the province are relatively stable.

(4) The green development of agricultural economy has a significant impact on the High-quality development of agricultural economy in the Yangtze River Delta. From the entropy method, we can get the weight of four dimensions, among which the green development of agricultural economy accounts for the largest proportion. Among the 12 indicators, the three indicators of the green development dimension of agricultural economy rank among the top three. It can be seen that there are significant differences in the green development level of agricultural economy in each city. Improving agricultural governance and reducing the green development level of agricultural economy in each city is a powerful way to improve the High-quality development of agricultural economy.

5.2. Countermeasures and Suggestions

(1) Accelerate agricultural modernization in the process of Yangtze River Delta integration. Agriculture will be three provinces and one city that is associated with high quality and economic development, formed a strong overall, give full play to the regional advantage industry, constantly coordination problems existing in each area, the key problem jointly overcome difficult, strengthen agriculture internal contact three provinces and one city, and to experience exchanges and cooperation, the implementation of relevant agricultural modernization project.

(2) Promote cooperation among three provinces and one city. All governments should give full play to their role of guidance and supervision, timely grasp the latest trends in the High-quality development of agricultural economy, coordinate the relationship between various industries, reasonably increase agricultural financial investment, provide a sound agricultural service system for the High-quality development of agricultural economy, and constantly narrow the gap between regions in the High-quality development of agricultural economy.

(3) Adhere to the green development path of agricultural economy. The agricultural industry should reduce all kinds of energy consumption, increase investment in agricultural environmental pollution control, use scientific and technological innovation to find a High-quality agricultural production, operation and management system, produce High-quality

agricultural products, realize agricultural green development, and provide fundamental guarantee for the sustainable development of agricultural economy.

(4) Increase investment in agricultural science and technology innovation, carry out industrial structure reform and improve the agricultural economic structure. The weight of agricultural economic innovation and development in the four dimensions is not high, which shows that the difference of agricultural innovation level in each region is smaller than that in the other three dimensions, which does not mean that agricultural innovation and development is not important to the improvement of High-quality development level of agricultural economy. From the original data, there is still a certain gap between the agricultural innovation ability of three provinces and one city in the Yangtze River Delta and the advanced innovation level of international agricultural High-quality development. Therefore, all regions should increase investment in agricultural scientific and technological innovation, integrate the scientific and technological resources of three provinces and one city, establish agricultural scientific and technological alliance, improve the agricultural economic structure, optimize the agricultural scientific and technological innovation system, and realize large-scale agricultural production.

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