ISSN: 2688-9323

Measurement of China's High Quality Agricultural Development System

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Abstract

In this paper, with the goal of high-quality agricultural development, we construct a system of high-quality agricultural economic development from five dimensions and 24 indicators: agricultural economic dynamics mechanism, agricultural economic structure optimization, agricultural economic system stability, agricultural economic green development, and agricultural economic welfare sharing, and use the entropy power method to measure high-quality agricultural development, combined with the Gaussian kernel function to estimate the Kernel density of high-quality agricultural development in China distribution map for evaluation. The results found that: the ranking of weight size under the five dimensions is agricultural economic welfare (0.377) > agricultural economic power mechanism (0.25) > agricultural economic structure optimization (0.195) > agricultural economic system stability (0.122) > agricultural economic green development (0.097). The overall high quality level of agriculture in China is low and there are obvious regional differences, the differences in the stability of agricultural economic system and green development of agricultural economy are not obvious, and there are significant differences in the intensity of agricultural mechanization and the average number of health beds per 1,000 rural population among provinces.

Keywords

Agricultural Economy; High Quality Development; Entropy Right Law.

1. Introduction

China's agricultural economy is shifting from high-speed development to high-quality development. Agriculture is an important foundation of the national economy, and achieving high-quality agricultural development is an important step for rural revitalization. However, China's agriculture is large in scale and variety plus there are obvious differences before the regions. Economically developed regions such as Shandong, Zhejiang and Jiangsu have basically modernized agriculture or are in the stage of agricultural development, while provinces such as Yunnan, Qinghai and Guizhou are still in the initial stage of agricultural development. Therefore, constructing a high-quality agricultural development system and objectively measuring the high-quality agricultural development system of each province can be of positive significance to better understand the current situation of agricultural development, deepen the supply-side structural reform and promote high-quality agricultural development.

Huang Xiujie constructed an agricultural high-quality evaluation index system of 23 indicators in seven dimensions, including product quality, industrial efficiency, production efficiency, operator quality, international competitiveness, and analyzed the high-quality development of China's agriculture based on inter-provincial data in 2016, concluding that the high-quality development of agriculture in each region varies significantly and the overall development level is low. Zhang Jianwei analyzed the regional characteristics of the agricultural high-quality development system to conclude that there is a large imbalance within the region, and governments at all levels should take the road of differentiated agricultural development

ISSN: 2688-9323

according to local conditions. Liang Liutao believes that there are regional differences in agricultural land production efficiency in China, which is high in the east and low in the west, and the east-west gap in production efficiency is gradually increasing.

2. Construction and Measurement of High Quality Agricultural Development System

2.1. The Construction of a High-Quality Agricultural Development System

In this paper, with reference to the research of Zhang Jianwei, Huang Xiujie and Liu Tao, the evaluation index system of high-quality development of agricultural economy is established as the target layer, which is divided into five subsystems: agricultural economic welfare, agricultural economic power mechanism, agricultural economic structure optimization, agricultural economic system stability and agricultural economic green development, and 24 specific indicators are constructed, as shown in Table 1 on the next page.

Table 1. Indicator system and weights for high-quality development of agricultural economy

Target layer	Guideline Layer	Element Layer	Indicator layer	Weight	Attribute
Indicator system for high-quality development of agricultural economy	Agricultural economic dynamics mechanism(0.25)	Efficiency Improvement(0.094)	Agricultural output rate	0.049	+
			Labor productivity	0.045	+
		Agriculture drive (0.156)	Comprehensive mechanization level of crop cultivation	0.011	+
			Agricultural mechanization intensity	0.077	+
			Agricultural irrigation rate	0.068	+
	Optimization of agricultural economic structure(0.195)	Industrial Structure(0.12)	Agricultural industry restructuring index	0.048	+
			Food output rate	0.033	+
			Food industry share	0.039	+
		Investment Structure(0.043)	Financial support for agriculture	0.043	+
		Employment Structure(0.032)	Agriculture, forestry, animal husbandry and fishery employment share	0.032	+
	Stabilization of the agricultural economic system(0.122)	Stable consumer prices (0.072)	Rural commodity retail price index	0.025	-
			Consumer Price Index for Rural Residents	0.047	-
		Stable production prices (0.05)	Agricultural production materials price index	0.011	-
			Producer Price Index for Agricultural Products	0.039	-
	Green development of agricultural	Agricultural consumption(0.049)	Unit fertilizer application amount	0.014	-
			Unit pesticide	0.018	-

ISSN: 2688-9323

	economy(0.097)		application rate		
			Unit use of agricultural plastic film	0.017	-
		Environmental Protection(0.025)	Rural toilet penetration rate	0.025	+
		Soil & Water Management(0.023)	Soil erosion control situation	0.023	-
	Agricultural Economy Welfare Sharing (0.337)	Welfare Improvement(0.256)	Per capita output value of agriculture, forestry, oyster and fishery	0.048	+
			Per capita housing funding	0.096	+
			Average number of health beds per 1,000 rural population	0.112	+
		Distribution of results(0.081)	Engel's coefficient	0.02	-
			Disposable income per capita	0.061	+

2.2. Research Methods and Data Sources

2.2.1. Comprehensive Evaluation Method for High-Quality Agricultural Development - Entropy Method

This paper adopts the extreme value method and the entropy method to measure the weights of the target layer and each criterion layer. The specific steps are:construct the original data matrix and standardize the original data using the extreme value method;determine the weights of 24 specific indicators in the evaluation index system of high-quality development of agricultural economy using the entropy method.

(1) Construct the original index data matrix

$$A=\begin{pmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{pmatrix}$$

X_{ij} is the value of the j indicator in the i province, $1 \le i \le m$, $1 \le j \le n$.

(2) Since the scale and order of magnitude of the indicators of the agricultural economy high quality evaluation system are not uniform, in order to eliminate the influence brought by the difference in scale and order of magnitude, it is necessary to homogenize the heterogeneous indicators and standardize the indicators, so as to solve the problem of homogenization of the values of the different qualitative indicators. In addition, since the values of positive and negative indicators represent different meanings, that is, the higher the value of positive indicators is better, and the lower the value of negative indicators is better. Therefore, the extreme value method is used to standardize the data. The specific calculation formula is as follows

$$\text{Positive indicators: } X_{ij}^{'}=\frac{X_{ij}-X_{\min}}{X_{\max}-X_{\min}}$$

$$\text{Negative indicators: } X_{ij}^{'}=\frac{X_{\max}-X_{ij}}{X_{\max}-X_{\min}}$$

ISSN: 2688-9323

Equation $X_{ij}^{'}$ is the value of the j indicator of the i province after standardization, X_{ij} is the original data, and $X_{\max}$ and $X_{\min}$ are the maximum and minimum values of the j indicator, respectively.

(3) Calculate the weight of the value of the j indicator of the i province with the following formula.

$$Y_{ij} = \frac{X_{ij}^{'}}{\sum_{i=1}^{m} X_{ij}^{'}}$$

(4) Calculate the entropy value of the j indicator with the following formula.

$$e_j = -k\sum_{i=1}^{m} Y_{ij} \ln Y_{ij}, k = \frac{1}{\ln n} > 0$$

(5) Calculate the coefficient of variation of the j indicator. For the j indicator, the greater the difference in the value of the indicator, the greater the impact on the evaluation results and the smaller the entropy value. The formula is as follows

$$d_j = 1 - e_j .$$

(6) Calculate the weight value of the j indicator with the following formula.

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

(7) Calculation of 5 subsystem indices in the criterion layer.

$$S_{is} = \sum_{i=1}^{q} W_j X_{ij}^{'}$$

(8) Calculation of the composite index.

$$S_i = \sum_{s=1}^{5} S_{is}$$

2.2.2. Data Source

The data in this paper are obtained from the 2021 China Statistical Yearbook, China Rural Statistical Yearbook and the statistical bulletin of each province, taking into account that the difference between years does not change much, and some data are replaced with data from 2020 due to missing.

3. Analysis of Evaluation Results of High-Quality Development of China's Agriculture

3.1. Determination and Assignment of Index Weights

Firstly, the data of each region are dimensionless as well as normalized, and then the weights of each indicator are calculated using the entropy method. In the criterion level, the weights are, in descending order, welfare improvement, agricultural drive, industrial structure, efficiency improvement, outcome distribution, consumer price stability, production price stability, agricultural consumption, investment structure, employment structure, environmental protection, and soil and water management. The greater weighting of welfare improvement is partly due to the larger number of indicators included in this guideline tier, and partly due to the greater variation in welfare improvement across the provinces and regions of China. In

ISSN: 2688-9323

terms of specific indicators, the indicators of average number of health beds per 1,000 rural population and housing expenses per capita have a greater weight, both close to 10%, while the indicators of price index of agricultural production materials, price index of agricultural production materials, unit fertilizer application, unit pesticide application, and unit agricultural plastic film use have a smaller weight, all below 2%.

3.2. Analysis of the General Characteristics of China's High-Quality Agricultural Development

Table 2. Evaluation of agricultural quality development indicators by region in China

Region	Agricultural economic dynamics mechanism	Optimization of agricultural economic structure	Stabilization of the agricultural economic system	Green development of agricultural economy	Agricultural Economy Welfare Sharing	Comprehensive Index	Rank
Jiang su	14.037	10.948	6.850	5.446	18.921	56.146	1
Zhe jiang	12.305	9.598	6.005	4.774	16.587	49.220	2
Shan dong	12.211	9.525	5.959	4.738	16.461	48.845	3
He bei	12.076	9.419	5.893	4.685	16.278	48.302	4
Xi zang	11.902	9.283	5.808	4.618	16.043	47.606	5
Tian jin	11.868	9.257	5.791	4.605	15.998	47.471	6
He nan	11.825	9.223	5.770	4.588	15.939	47.298	7
Fu jian	11.590	9.040	5.656	4.497	15.623	46.358	8
Hu nan	11.306	8.819	5.517	4.387	15.241	45.225	9
An hui	11.300	8.814	5.514	4.384	15.232	45.200	10
Hei longjiang	11.258	8.781	5.494	4.368	15.176	45.032	11
Shang hai	11.152	8.698	5.442	4.327	15.033	44.607	12
Xin jiang	10.999	8.579	5.367	4.267	14.826	43.994	13
Nei menggu	10.699	8.345	5.221	4.151	14.422	42.796	14
Jiang xi	10.664	8.318	5.204	4.138	14.375	42.657	15
Ning xia	10.498	8.189	5.123	4.073	14.152	41.993	16
Guang dong	10.097	7.875	4.927	3.917	13.610	40.386	17
Bei jing	10.078	7.861	4.918	3.910	13.585	40.313	18
Average	9.968	7.775	4.864	3.867	13.437	39.871	19
Hu bei	9.789	7.636	4.777	3.798	13.196	39.157	20
Liao ning	9.783	7.631	4.774	3.796	13.187	39.131	21
Ji lin	9.582	7.474	4.676	3.718	12.917	38.329	22
Shan xi	9.173	7.155	4.476	3.559	12.365	36.692	23
Gan su	8.801	6.865	4.295	3.415	11.864	35.204	24
Shan xi	8.483	6.617	4.140	3.291	11.435	33.932	25
Si chuan	8.345	6.509	4.072	3.238	11.249	33.379	26
Chong qing	8.213	6.406	4.008	3.187	11.071	32.852	27
Guang xi	8.030	6.264	3.919	3.116	10.825	32.121	28
Hai nan	7.374	5.752	3.598	2.861	9.940	29.495	29
Gui zhou	7.107	5.543	3.468	2.758	9.580	28.428	30
Qing hai	7.093	5.533	3.461	2.752	9.561	28.372	31
Yun nan	6.269	4.890	3.059	2.432	8.450	25.075	32

Through the weights of each indicator and the normalized data values of the indicators, the overall score is enlarged by 100 times for comparison, and the evaluation scores of each region in terms of agricultural economic dynamics mechanism, agricultural economic structure

ISSN: 2688-9323

optimization, agricultural economic system stability, agricultural economic green development and agricultural economic welfare sharing, as well as the overall evaluation score can be calculated.

Among the 31 provinces (municipalities and regions), Jiangsu Province has the highest comprehensive score of 56.146, Yunnan Province has the lowest comprehensive score of 25.075, and the national average comprehensive score of 39.871, while Hubei, Liaoning, Jilin, Shaanxi, Gansu, Shanxi, Sichuan, Chongqing, Guangxi, Hainan, Guizhou, Qinghai and Tibet have the highest comprehensive score. Guizhou, Qinghai, and Tibet are all regions with composite scores below the national average composite score.

The comprehensive evaluation value of agricultural high-quality development in each province in 2021 is used as the base data to estimate the Kernel density distribution of agricultural high-quality development in China using Gaussian kernel function (Figure 1). From Figure 1, we can see that;(1)the kernel density estimation curve of China's agricultural high-quality development level roughly shows a single-peaked trailing-tailed sub-distribution, but there is no polarization, indicating that there are some differences in the level of agricultural high-quality development between different parts of China, but it is not obvious.(2)The peak of the distribution curve of China's inter-provincial agricultural high-quality development is rising and the center is shifting to the right, indicating that the level of agricultural high-quality development in most provinces in China is improving.

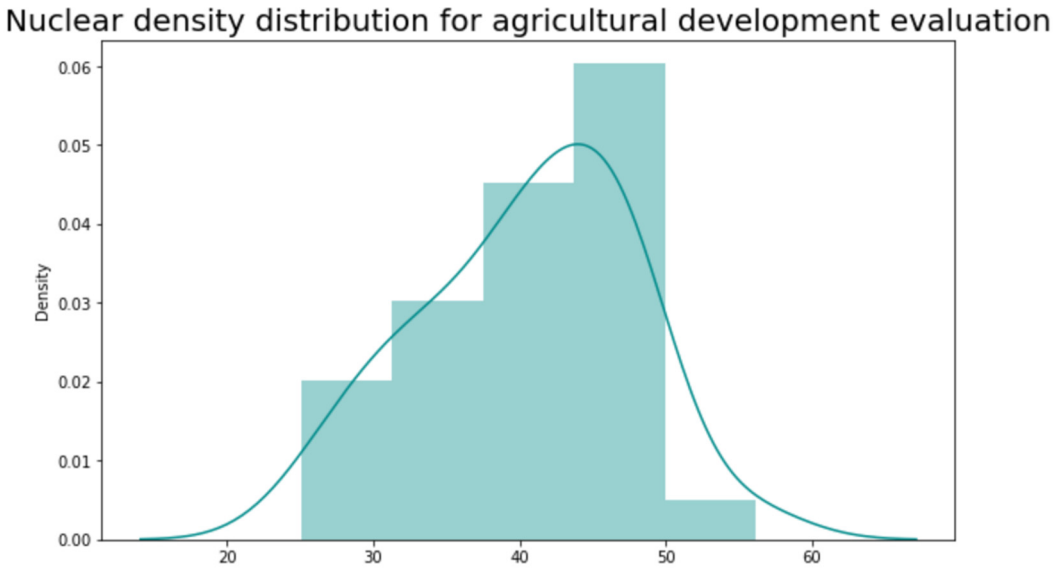

Figure 1. Kernel density distribution of high-quality agricultural development evaluation in China

3.3. Sub-dimensional Characteristics of High-Quality Agricultural Development in China

3.3.1. Agricultural Economic Power Mechanism

From the kernel density estimation graph of agricultural economic dynamics mechanism (Figure 2), the kernel density estimation curve of China's agricultural economic dynamics mechanism shows a single-peaked trailing-tail distribution, but there is no polarization, indicating that there are some differences in agricultural economic dynamics mechanism among different parts of China, but it is not obvious. Among them, Jiangsu, Zhejiang and Shandong regions have better agricultural economic dynamics mechanisms. This is mainly because the above regions are all regions with high levels of economic development and higher agricultural output rates and agricultural mechanization intensity. The center of the kernel

ISSN: 2688-9323

density estimation curve of agricultural economic dynamics mechanism is to the right, which indicates that the development level of agricultural economic dynamics mechanism in China has been improving.

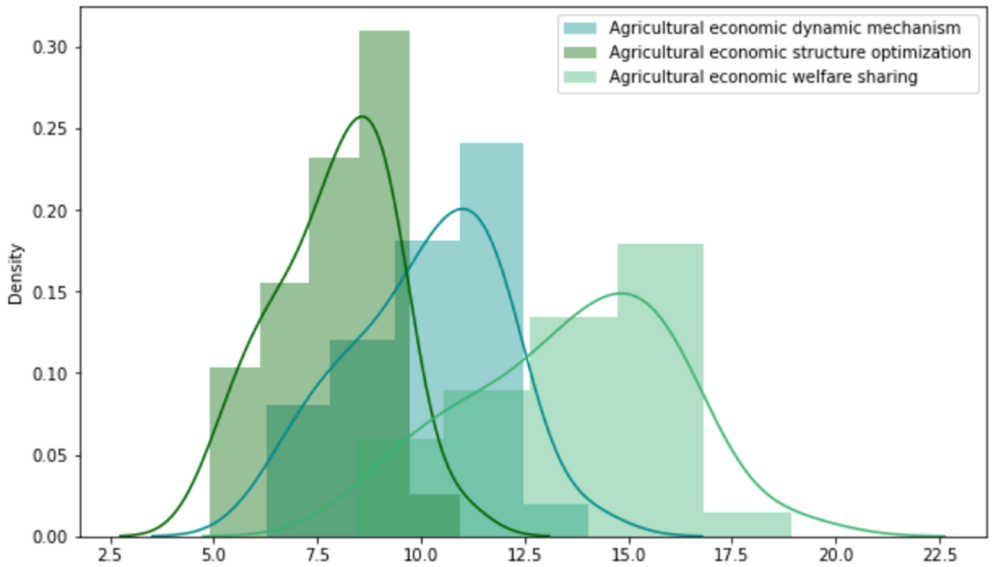

Figure 2. Kernel Density Distribution of Agricultural Economic Dynamics Mechanism, Agricultural Economic Structure Optimization and Agricultural Economic Welfare Sharing in China

3.3.2. Agricultural Economic Welfare Sharing

From the kernel density estimation graph of agricultural economic welfare sharing (Figure 2), the kernel density estimation curve of agricultural economic welfare sharing in China is centered, indicating that the agricultural economic welfare sharing in most provinces in China is at the national average level. Both welfare improvement and outcome distribution are higher in economically developed regions, which is related to the higher level of economic development in economically developed regions. Among them, Zhejiang, Jiangsu and Shandong have better development in agricultural economic welfare sharing, mainly reflected in higher levels of agricultural economic welfare sharing and better control of urban-rural income gap levels. Provinces such as Hainan, Guizhou, Qinghai and Yunnan are less well developed in terms of agricultural economic welfare sharing, mainly in terms of per capita agricultural, forestry, oyster and fishery output and per capita disposable income. It can be seen that in order to improve the development level of agricultural economic welfare sharing in economically backward regions, it is still crucial to focus on improving the level of agricultural economic welfare sharing in backward regions and narrowing the income gap between urban and rural areas.

3.3.3. Stability of the Agricultural Economic System

From the kernel density estimation graph of agricultural economic system stability (Figure 3), the kernel density estimation curve of agricultural economic system stability in China shows a single-peaked trailing-tail distribution with the center positioned to the right, indicating that the overall level of agricultural economic system stability in China is high, and the development of the rest of the regions is relatively balanced, except for individual regions with better development in agricultural economic system stability. Zhejiang, Jiangsu, and Shandong have a high level of agricultural economic system stability, while the development level of agricultural economic system stability in the rest of the regions has a typical normal distribution, with slight differences in the development level among regions.

ISSN: 2688-9323

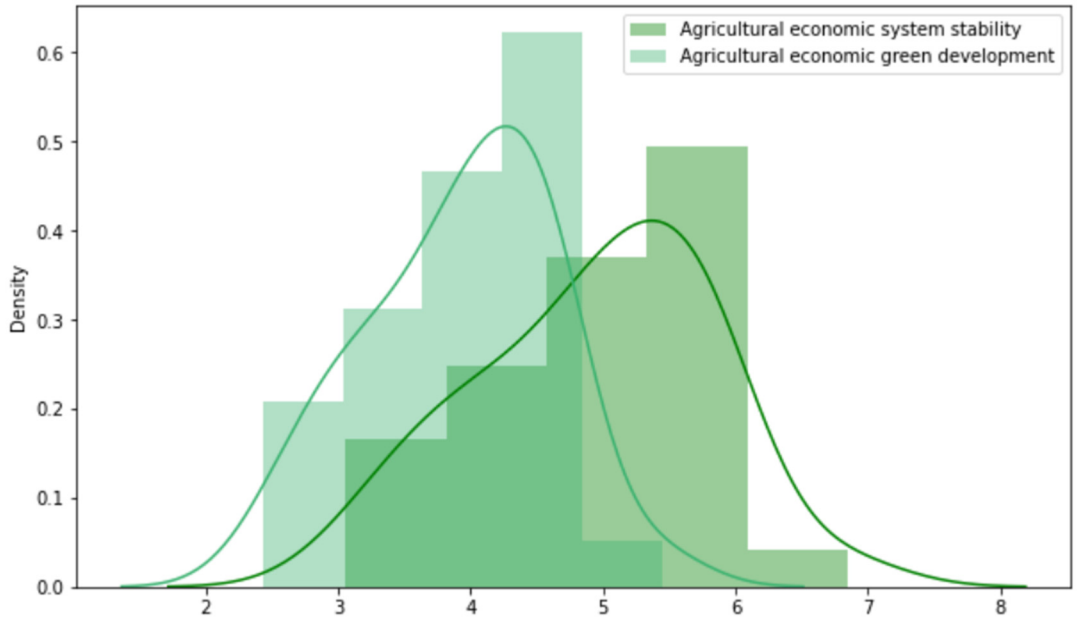

Figure 3. Kernel density distribution of stability and green development of agricultural economy system in China

3.3.4. Green Development of Agricultural Economy

From the kernel density estimation graph of green development of agricultural economy (Figure 3), the kernel density estimation curve of green development of agricultural economy in China shows a single-peaked trailing distribution with the center to the right, which indicates that the overall level of green development of agricultural economy in China is high, indicating that China has achieved good results in agricultural consumption, environmental protection and soil and water management, among which the rural toilet penetration rate performs the best, which also indicates that The "toilet revolution" has achieved remarkable results. There are still many shortcomings in the treatment of agricultural waste in Guizhou and Qinghai.

4. Conclusion and Recommendations

(1) With the goal of high-quality agricultural development, a system of high-quality agricultural economic development was constructed from five dimensions and 27 indicators: agricultural economic dynamics mechanism, agricultural economic structure optimization, agricultural economic system stability, agricultural economic green development, and agricultural economic welfare sharing. It was found that the weight size under the five dimensions was ranked as agricultural economic welfare (0.377) > agricultural economic dynamics mechanism (0.25) > agricultural economic structure optimization (0.195) > agricultural economic system stability (0.122) > agricultural economic green development (0.097).

(2) The Kernel density distribution plot of China's agricultural high quality development estimated using Gaussian kernel function shows that the peak of the distribution curve of China's inter-provincial agricultural high quality development is rising and the center is shifting to the right, indicating that the level of agricultural high quality development in most of China's provinces is improving.

In general, the level of agricultural development is low, and governments at all levels should check to find new ways of agricultural development in the region according to local conditions, establish a perfect evaluation mechanism for agricultural development, and improve the efficiency of resource use. In order to achieve high-quality agricultural development and meet the development requirements of agricultural modernization, the rigorous management of

ISSN: 2688-9323

environmental pollution problems should be increased and the use of chemical fertilizers, pesticides and agricultural plastic films should be continuously reduced.

Acknowledgments

Anhui University of Finance and Economics 2022 Research Fund Projects(XSKY22201).

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