Research on the Coordinated Development of Agricultural Modernization, Industrialization and Urbanization in Central China

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Abstract: The realization of agricultural modernization, industrialization and urbanization has become one of the important ways to accelerate economic development in China. On the basis of existing research, this paper constructs the coordinated development index of regional agricultural modernization, industrialization and urbanization, selects the six provinces in the Central China as the sample, and uses the entropy method to determine the index weight, and then calculates the development level index of regional agricultural modernization, industrialization and urbanization and the comprehensive development index of regional "agricultural modernization, industrialization and urbanization". Finally, on the basis of empirical results, this paper analyzes the coordinated development situation of the "agricultural modernization, industrialization and urbanization" in the six provinces in Central China, and gets some relevant conclusions.

1. Introduction

For the research on the development level of regional agricultural modernization, industrialization and urbanization, both theorists and the practical departments tend to perform quantitative analysis by the indicators that reflect their characteristics. At present, many scholars have discussed the analysis indicators of development level of agricultural modernization, industrialization and urbanization from different angles, but because of the various understanding between different scholars, the use of the analysis and evaluation indicators is in equable. Some scholars tend to use the indicators which are agricultural labor productivity, the rate of industrialization and urbanization to describe the development level of agricultural modernization, industrialization and urbanization [1-3]. However, the description of this single indicator is too simple, and it cannot fully reflect the rich connotation of agricultural modernization, industrialization and urbanization [4, 5]. On the basis of the existing research, this paper constructs the evaluation index system of development level of regional agricultural modernization, industrialization and urbanization by the mean of multi-index description.

2. Evaluation Method

The development level of agriculture modernization, industrialization and urbanization is affected and restricted by multiple factors, so we must firstly establish the evaluation index which reflects the development level of "agricultural modernization, industrialization and urbanization" when we analyze it, and then establish the evaluation model to carry out quantitative analysis. Based on this, combining with the indicators of development level of regional agricultural modernization, industrialization and urbanization, using the entropy method to determine the index weight, and then calculating the development level index of regional agricultural modernization, industrialization and urbanization and the comprehensive development index of regional "agricultural modernization, industrialization and urbanization". Finally, completing the comparative analysis of development level of agricultural modernization, industrialization and

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urbanization. This paper uses entropy method to measure the comprehensive development level of regional “agricultural modernization, industrialization and urbanization”.

3. Entropy Method

Entropy is a uncertainty measure in information theory. When the larger the amount of information is, the smaller the uncertainty is, and the smaller the entropy is. On the contrary, when the smaller amount of information is, the greater the uncertainty is, and the greater the entropy is. In practice, according to the characteristics of entropy, it can use the entropy to determine the dispersion degree of the disorder of random event, and determine its impact on the comprehensive evaluation, that is , the greater the degree of dispersion is, the greater the impact is and the smaller the degree of dispersion is, the smaller the impact is. The advantage of the entropy method is that it determines the weight of the indicator in the final goal by judging the severity of the change in each indicator, and its conclusion is scientific and objective. Therefore, this paper uses the entropy method to determine the index weight and calculate the weighted value [6, 7]. There are three steps to use the entropy weight method to determine the weight:

Raw data matrix normalization. Supposing that the original data matrix of m evaluation index and n evaluation objects is $A=(a_{ij})_{m\times n}$, A is normalized to get $R=(r_{ij})_{m\times n}$. For the largest indicators, the normalized formula is:

$$r_{ij}=\frac{a_{ij}-\min\limits_{j}\{a_{ij}\}}{\max\limits_{j}\{a_{ij}\}-\min\limits_{j}\{a_{ij}\}} \tag{1}$$

For the smallest indicators, the normalized formula is:

$$r_{ij}=\frac{\max\limits_{j}\{a_{ij}\}-a_{ij}}{\max\limits_{j}\{a_{ij}\}-\min\limits_{j}\{a_{ij}\}} \tag{2}$$

Define the entropy. In the evaluation which has m indexes and n evaluated objects, the entropy of ith index is $h_i=-k\sum_{j=1}^{n}f_{ij}\ln f_{ij}$, in the formula, $f_{ij}=r_{ij}\Big/\sum_{j=1}^{n}r_{ij}$, $k=1/\ln n$. When $f_{ij}=0$ and $f_{ij}\ln f_{ij}=0$, finding the value of f_{ij} .

Define the weight of entropy. After defining the entropy of the ith index, the entropy weight of the ith index can be obtained:

$$w_i=\frac{1-h_i}{m-\sum_{i=1}^{m}h_i}\ \left(0\le w_i\le 1,\sum_{i=1}^{m}w_1=1\right) \tag{3}$$

4. Dimensionless Processing

In order to solve the problem that the different dimensions of each index are difficult to be aggregated, it is necessary to deal with the original data after the data collection work is completed. This paper chooses a simple and practical linear dimensionless method, which is based on the formula:

$$y_i=\frac{x_i}{\max x_i}\ \text{(When x is a positive indicator)} \tag{4}$$

$$y_i=\frac{\max x_i+\min x_i-x_i}{\max x_i}\ \text{(When x is a negative indicator)} \tag{5}$$

5. Linear Weighted Sum Method

It take a linear weighted sum method to deal with the dimensionless results and entropy. The formula is as follows:

$$X = \sum_{i=1}^{n} w_i x_i \tag{6}$$

In the formula, w_i is the weight of each index in the system, and x_i is the value after that each index is standardized in the system.

6. Evaluation of Coordinated Development Index of Regional Agricultural Modernization, Industrialization and Urbanization

Since the reform and opening up, Chinese regional development tend to rapidly promote economic development by industrialization and urbanization and tend to develop urban economy and non-agricultural industries, it ignored the development of rural and agricultural which resulted that the development of agricultural modernization, industrialization and urbanization was not synchronized. This phenomenon is also more obvious in Central China. As one of the four regional plate, the Central China belongs to the key development area in the strategy of national main functional area and has some conditions which can aggregate the population and industry on a large scale. At the same time, the strategic planning for the rise of Central China clearly stipulates that the Central China included three bases and one hub, respectively, grain production base, energy and raw materials base, modern equipment manufacturing and high-tech industry base, and comprehensive transportation hub. It is of great significance to promote the coordinated development of agricultural modernization, industrialization and urbanization and is the core task of the rise of Central China. Therefore, based on the fully understanding about the development level of agricultural modernization, industrialization and urbanization in Central China and the panel data which is the analysis of the six provinces and the whole country from 2005 to 2014, this paper evaluates the coordinated development level of agricultural modernization, industrialization and urbanization in these areas from 2005 to 2014. The weight of index and total weight were calculated by the entropy method, as shown in Table 1.

Table 1 Weight of evaluation index of development level.

First Grade Indexes	Second Grade Indexes	Wight	Total Wight
Agricultural Modernization (A)	A_1. General power of agricultural machinery (KW)	0.295	0.333
	A_2. Effective irrigation rate (%)	0.113	
	A_3. Amount of agricultural fertilizer applied per hectare (Million tons / ha)	0.288	
	A_4. Engel's coefficient of rural residents (%)	0.147	
	A_5. Proportion of agricultural science and technology personnel (%)	0.157	
Urbanization (U)	U_1. Proportion of urbanized population (%)	0.097	0.347
	U_2. Disposable income of urban residents (yuan)	0.266	
	U_3. Rate of urban employment (%)	0.214	
	U_4. Total retail sales of social consumer goods (yuan)	0.295	
	U_5. Per capita living space (square meter / person)	0.129	
Industrialization (I)	I_1. Added value proportion of the secondary industry (%)	0.132	0.320
	I_2. Employment proportion in the secondary industry (%)	0.119	
	I_3. Labor productivity in the secondary industry (%)	0.188	
	I_4. Margin of industrial output (%)	0.060	
	I_5. Industrial pollution control investment proportion (%)	0.501	

7. Analysis of Agricultural Modernization Development Level in Central China

Using the above-mentioned evaluation index system and evaluation model of agricultural modernization development level, collecting and calculating the corresponding evaluation data, it can calculate the evaluation value which is used to evaluate the development level of agricultural modernization in the six provinces and the whole country from 2005 to 2014, which called the development level index of agricultural modernization, as shown in Table 2.

Table 2 Agricultural modernization development level of six provinces in Central China.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Shanxi	0.100	0.139	0.163	0.185	0.228	0.243	0.288	0.324	0.267	0.290
Anhui	0.307	0.381	0.419	0.432	0.474	0.510	0.552	0.599	0.704	0.730
Jiangxi	0.115	0.222	0.223	0.228	0.287	0.315	0.349	0.402	0.473	0.505
Henan	0.331	0.363	0.286	0.356	0.417	0.465	0.545	0.611	0.641	0.685
Hubei	0.313	0.394	0.422	0.516	0.537	0.550	0.630	0.667	0.713	0.734
Hunan	0.159	0.259	0.282	0.299	0.294	0.320	0.370	0.398	0.439	0.454
China	0.291	0.348	0.380	0.423	0.454	0.482	0.524	0.565	0.578	0.607

From the data in Table 2, it can be found that the development level index of agricultural modernization in the six provinces from 2005 to 2014 is generally on the rise, indicating that the level of agricultural modernization in the six provinces in the central region has been increasing during this period. In 2005, the development level index of agricultural modernization in six provinces in Central China was ranked from high to low, respectively, Henan Province, Hubei Province, Anhui Province, Hunan Province, Jiangxi Province and Shanxi Province. In 2014, the index was ranked from high to low, respectively, Hubei Province, Anhui Province, Henan Province, Shanxi Province, Hunan Province and Jiangxi Province.

It can be seen from the changes of development level index of agricultural modernization in six provinces, there are some differences in the rate of change in different provinces. Among them, the growth of development level index of agricultural modernization in Anhui Province is the largest which is from 2005 to 2014, followed by Hubei Province which is 0.421, while the increasing rate in Shanxi Province is the smallest which is 0.224. It shows that there are some differences in the development speed of agricultural modernization in the six provinces in central China.

In 2005, the index of development level of agricultural modernization in Hubei province ranked second in Central China, and it has a certain advantage. Since 2006, Hubei province has become a leading province in the central region, because that Hubei province has insisted on the “three rural issues” is the focus of all work, and promoted the development of the “two-type agriculture” in Wuhan City Circle.

In 2005, the development level index of agricultural modernization in Henan province ranked first in Central China, but it was surpassed by Hubei province since 2006 and the gap was increasing. Henan Province as a large province of population, but less well-known colleges, and there are more migrant workers. These phenomena have a certain influence on the local agricultural development.

The development level of agricultural modernization in Shanxi province from 2005 to 2014 is obviously lagging behind the other five provinces and the whole country, which is closely related to the serious soil and water loss in Jiangxi province, the backwardness of soil and irrigation conditions, the serious environmental damage and the inconvenience of traffic.

The development level index of agricultural modernization in Anhui province ranked in the front position in six provinces from 2005 to 2014, and has been living in the second place after 2006. Hunan province and Jiangxi province is relatively later, respectively, occupy the fourth and fifth position from 2005 to 2011. After 2012, Jiangxi province beyond Hunan province and ranked fourth position.

In addition to Hunan province, Jiangxi province and Shanxi province that the development level

of agricultural modernization is lower than the whole country, the remaining provinces are higher than the whole country from 2005 to 2014. In 2005, the development level index of agricultural modernization in Henan province which is the highest was 0.040 higher than that of the whole country, and the development level index of Shanxi province which is the lowest was 0.191 lower than that of the whole country. In 2014, the development level index of agricultural modernization in Hubei province which is the highest was 0.127 higher than that of the whole country, and the development level index of Shanxi province which is the lowest was 0.317 lower than that of the whole country. The gap of development level between Shanxi province and the whole country is further enlarged. Generally speaking, the development level index of agricultural modernization in most provinces in central region is higher than that of the whole country. However, in 2014,comparing with the overall level of country, in addition to Hubei province and Anhui province which had some advantages, there are no obvious advantages in other provinces where the development level index of agricultural modernization is higher than the whole country. Therefore, it is still an important task for the central region to promote the development of agricultural modernization.

8. Analysis of Industrialized Development Level in Central China

Using the above-mentioned evaluation index system and evaluation model of industrialized development level, collecting and calculating the corresponding evaluation data, it can calculate the evaluation value which is used to evaluate the development level of industrialization in the six provinces and the whole country from 2005 to 2014, which called the industrialized development level index, as shown in Table 3.

Table 3 Industrialized development level of six provinces in Central China.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Shanxi	0.222	0.258	0.336	0.332	0.455	0.330	0.346	0.429	0.371	0.339
Anhui	0.350	0.347	0.365	0.421	0.489	0.439	0.405	0.505	0.521	0.509
Jiangxi	0.292	0.357	0.385	0.488	0.524	0.409	0.431	0.500	0.491	0.530
Henan	0.332	0.337	0.372	0.402	0.469	0.407	0.384	0.453	0.467	0.468
Hubei	0.434	0.527	0.611	0.518	0.557	0.593	0.604	0.621	0.638	0.650
Hunan	0.265	0.286	0.342	0.439	0.473	0.356	0.359	0.476	0.461	0.490
China	0.394	0.416	0.444	0.408	0.452	0.429	0.435	0.466	0.490	0.497

From the data in Table 3, it can be found that the development level index of industrialization in the six provinces from 2005 to 2014 is generally on the rise. It indicates that the development level of industrialization in the six provinces has been increasing during this period, and the region with the largest increase of the industrialized development level index is Jiangxi province, followed by Shanxi province, the smallest is Henan province. It shows that there are some difference in development rate of industrialization between different provinces.

In 2005, the development level index of industrialization in six provinces in Central China was ranked from high to low, respectively, Hubei province, Anhui province, Henan province, Jiangxi province, Hunan province and Shanxi province. In 2014, the index was ranked from high to low, respectively, Hubei Province, Jiangxi province, Anhui province, Hunan province, Henan province and Shanxi Province. It showed that there are some changes in the ranking but the overall change is not big.

In the industrialized development level of the six provinces in Central China, Hunan province and Shanxi province were relatively later than others, the difference between Hubei province which ranked in the first and Hunan province is 0.169, and Shanxi province is 0.212. However, in 2014, the gap between Hubei province and Henan province is 0.182, and Shanxi province is 0.311. It shows that the gap of industrialized development level between Shanxi province and the other advanced provinces in central region is further enlarged.

In 2005, the industrialized development level index of the six provinces in Central China was

lower than the national overall level except Hubei Province. However, in 2004, except that the industrialized development level in Shanxi Province was significantly lower than the whole country, Henan Province and Hunan Province were slightly lower than the overall level. Hubei Province, Jiangxi Province and Anhui Province were higher than the national overall level. It indicates that trend of industrialization development in Central China is generally on the rise.

9. Analysis of Urbanization Development Level in Central China

Using the above-mentioned evaluation index system and evaluation model of urbanization development level, collecting and calculating the corresponding evaluation data, it can calculate the evaluation value which is used to evaluate the development level of urbanization in the six provinces and the whole country from 2005 to 2014, which called the development level index of urbanization and was shown in Table 4.

Table 4 Urbanization development level of six provinces in Central China.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Shanxi	0.231	0.252	0.297	0.318	0.253	0.334	0.403	0.484	0.660	0.677
Anhui	0.024	0.084	0.151	0.217	0.248	0.335	0.395	0.458	0.551	0.637
Jiangxi	0.185	0.247	0.307	0.348	0.376	0.426	0.507	0.562	0.577	0.614
Henan	0.232	0.261	0.339	0.397	0.453	0.533	0.603	0.714	0.774	0.812
Hubei	0.113	0.164	0.201	0.255	0.327	0.383	0.469	0.586	0.709	0.835
Hunan	0.063	0.152	0.212	0.258	0.307	0.333	0.397	0.467	0.552	0.635
China	0.134	0.210	0.262	0.304	0.343	0.407	0.495	0.579	0.636	0.700

From the data in Table 4, it can be found that the development level index of urbanization in the six provinces from 2005 to 2014 is generally on the rise. It indicates that the development level of urbanization in the six provinces has been increasing during this period, and the region with the largest increase of the urbanization development level index is Hubei province, followed by Anhui province, the smallest is Jiangxi province. It shows that there are some differences in development rate of urbanization between different provinces.

In 2005, the development level index of urbanization in six provinces in Central China was ranked from high to low, respectively, Henan province, Shanxi province, Jiangxi province, Hubei province, Hunan province and Anhui province. In 2014, the index was ranked from high to low, respectively, Hubei Province, Henan province, Shanxi province, Anhui province, Hunan province and Jiangxi Province. The order of ranking of urbanization development level index in 2005 and 2014 has changed greatly. The order of Hubei Province rose from the fourth in 2005 to the first in 2014, Henan Province fell from the first in 2005 to the second in 2014, Anhui province rose from the end in 2005 to the fourth in 2014, and Jiangxi province fell from the third in 2005 to the end in 2014.

The development level of urbanization of Hubei province increased rapidly from 2005 to 2014 in six provinces, mainly because that Hubei province implemented the central city strategy to promote surrounding cities and vigorously promoted the new urbanization development initiatives. However, the development level of urbanization in Jiangxi Province is relatively backward, there are some important reasons that the central city is not strong, urban public service system has yet to be perfect, and the county economy is relatively weak and so on.

Comparing with the whole country, in 2005, development level indexes of urbanization in Henan province, Shanxi province and Jiangxi province are all higher than the whole country, among them, the difference between the level of Henan province which has the highest development level index of urbanization and the national overall level index is 0.098, and the difference between the level of Anhui province which has the lowest development level index of urbanization and the national overall level is 0.11. In 2014, the difference between the level of Hubei province which has the highest development level index of urbanization and the national overall level is 0.135, and the difference between the level of Jiangxi province which has the lowest development level index of urbanization and the national overall level is 0.086. It can be seen that the gap between the

development level of urbanization in the central region and the national average level has declined, but there is still a certain gap. Therefore, it is important for the coordinated development of agricultural modernization, industrialization and urbanization to vigorously promote the process of urbanization.

10. Analysis of Comprehensive Development Level in Central China

Using the above-mentioned development level index of agricultural modernization, industrialization and urbanization in six provinces in Central China and the whole country, and evaluation model which has been previously established, it can calculate the comprehensive development level index of agricultural modernization, industrialization and urbanization in six provinces in Central China and the whole country, as shown in Table 5.

Table 5 Comprehensive development index of six provinces in Central China.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Shanxi	0.248	0.308	0.349	0.361	0.321	0.403	0.461	0.471	0.540	0.510
Anhui	0.223	0.267	0.309	0.348	0.384	0.453	0.484	0.520	0.582	0.602
Jiangxi	0.196	0.246	0.284	0.320	0.337	0.386	0.442	0.463	0.457	0.466
Henan	0.330	0.380	0.408	0.450	0.486	0.544	0.599	0.610	0.634	0.663
Hubei	0.249	0.296	0.329	0.383	0.422	0.466	0.522	0.650	0.660	0.676
Hunan	0.159	0.231	0.277	0.304	0.318	0.369	0.418	0.447	0.489	0.512
China	0.269	0.322	0.359	0.386	0.407	0.459	0.505	0.538	0.558	0.576

From the data in Table 5, it can be found that comprehensive development level index of agricultural modernization, industrialization and urbanization in the six provinces from 2005 to 2014 is generally on the rise. It indicates that the comprehensive development level of agricultural modernization, industrialization and urbanization in the six provinces has been increasing during this period, and the region with the largest increase of the comprehensive development level index is Hubei province, followed by Anhui province, the smallest is Jiangxi province. It shows that there are some difference in comprehensive development rate of agricultural modernization, industrialization and urbanization between different provinces.

From comprehensive development level index in six provinces in Central China, Hubei province all ranked first from 2012 to 2014. Comprehensive development level index of Henan province all ranked first from 2005 to 2014apart from 2012 to 2014 in that Henan province ranked second, Anhui province ranked fourth from 2005 to 2008 and rose to third from 2010 to 2014, and Shanxi province fell from previous second or third to fifth. In 2005, the difference between Hubei province which has the highest comprehensive development level index of agricultural modernization, industrialization and urbanization and Jiangxi province is 0.134, and Hunan province is 0.171. In 2014, the difference between Henan province which has the highest comprehensive development level index of agricultural modernization, industrialization and urbanization and Shanxi province is 0.166, and Jiangxi province is 0.210. It shows that the gap has not narrowed, but has expanded.

Comparing with the whole country, in 2005, comprehensive development level index of agricultural modernization, industrialization and urbanization in Henan province is the only one higher than the national overall level index. In 2014, the comprehensive development level indexes of agricultural modernization, industrialization and urbanization in Hubei province, Henan province and Anhui province are all higher than the whole country. Among them, the difference of the comprehensive development level index of agricultural modernization, industrialization and urbanization between the whole country and Jiangxi province which comprehensive development level index is on the low side is 0.073, and Hunan province which comprehensive development level index is on the low side is 0.110 in 2005. In 2014, the difference between the whole country and Shanxi province is 0.066, and Jiangxi province is 0.110. On the whole, comprehensive development level of agricultural modernization, industrialization and urbanization in Central China is on the low side.

11. Conclusion

(1) Agricultural modernization, industrialization and urbanization in Central China from 2005 to 2014 is generally on the rise, but growth magnitude in different provinces is not completely consistent. On one hand, it shows that agricultural modernization, industrialization and urbanization is increasing continuously. On the other hand, growth speed of agricultural modernization, industrialization and urbanization in different provinces is not consistent.

(2) Comparing development level index of agricultural modernization, industrialization and urbanization, urbanization in six provinces is higher than agricultural modernization and industrialization in 2014. On the whole, agricultural modernization is lower than industrialization and urbanization. Therefore, it should be an important strategy for future development of the Central China to promote development of agricultural modernization.

(3) Comprehensive development level index of agricultural modernization, industrialization and urbanization in Central China is generally on the rise. It indicates that comprehensive development level in the six provinces has been increasing during this period. However, there are some differences between development speed and level in different provinces. In 2014, only three provinces are higher than the whole country, respectively, Hubei province, Henan province and Anhui province. Comparing with national overall level, comprehensive development level index of agricultural modernization in Hubei province was 0.100. Comprehensive development level of agricultural modernization, industrialization and urbanization in Central China is still backward, and it is also an important task to develop agricultural modernization, industrialization and urbanization in Central China.

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