Research on the Evaluation of Coordinated Development Level of Industrialization, Informatization, Urbanization and Agricultural Modernization in China

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Abstract

The coordinated development of industrialization, informatization, urbanization and agricultural modernization is one of the important concerns in today's China. This paper constructs a set of 4 categories and 16 indicators of evaluation system to measure the development level of industrialization, informatization, urbanization and agricultural modernization of 31 provinces, municipalities and autonomous regions in China. Based on this, provincial coupling level and coordinated development level of four modernizations are calculated by the coupling degree model and the coordinated development degree model. It discovers that the coupling degree and the coordinated development degree of the whole nation and east, central and west China have a significant rise between 2003 and 2012. In general, the coordinated development level of east China is high and that of central and west China is low. By dividing coordination level of all provinces, it discovers that the number of uncoordinated development provinces is decreasing and that of coordinated development provinces is increasing. And eastern provinces are in a leading position.

Keywords: Industrialization, Informatization, Urbanization, Agricultural modernization, coordinated development level

1. Introduction

In recent years, China's industrialization, informatization, urbanization and agricultural modernization, referred to as four modernizations, are developing rapidly. But the development speed and developing stage of each modernization are different. The country faces with the problem that how to coordinate the development of four modernizations. Scholars have launched a heated discussion and done many researches on the coordinated development of four modernizations. Some have studied the interaction mechanism among four modernizations and have used unit root test, cointegration test, Granger causality test, and impulse response analysis and variance decomposition method to study the whole nation or some areas of China [1, 2]. Some have studied the influencing factors of the coordinated development of four modernizations and mainly used the multiple regression model [3] and spatial autoregressive model [4]. Based on these analyses, some scholars put forward a series of paths and measures to coordinate the development of four modernizations [5-8]. And the measurement of the coordinated development level has become the focus and hot spot of the research. Xiong *et al.* [9] and Gong *et al.* [10] have measured the coordinated development level of four modernizations of Hubei province and the Central Plains Economic Area respectively, analyzed the driving factors and gave some policy suggestions. But present research is mainly concentrated on comparison of many years in one region or many regions in one year. It is rarely to see measurement of 31 provinces in many years.

Therefore, this paper will measure the coordinated development level of four modernizations of 31 provinces of China between 2003 and 2012, analyze the change of the 10 years, judge the development stage of every province and put forward some policy suggestions.

2. Index System of Industrialization, Informatization, Urbanization and Agricultural Modernization

Following the comprehensive, objective, scientific and systematic principles and considering the data comparability and accessibility, the paper constructs an evaluation index system of industrialization, informatization, urbanization and agricultural modernization, which includes a set of 4 categories and 16 indicators, as shown in Table 1. The original data is obtained from *China Statistical Yearbook*, Support System for China Statistics Application and yearbooks of provinces, municipalities and autonomous regions.

Table 1. Evaluation Index System of Industrialization, Informatization, Urbanization and Agricultural Modernization

Category	Index	Weight
Industrialization	Proportion of non-agricultural industries	0.4533
	Second industry labor productivity	0.2365
	Proportion of non-agricultural employment	0.2230
	Industrial wastewater standard discharge rate	0.0872
Informatization	Per capita telecom business	0.3869
	Internet penetration rate	0.2836
	mobile phone penetration rate	0.2315
	fixed telephone penetration rate	0.0980
Urbanization	Urbanization rate	0.4550
	Third industry labor productivity	0.2627
	Per capita city road area	0.1411
	Per capita green area	0.1411
Agricultural modernization	First industry labor productivity	0.4194
	Land productivity	0.3424
	Total power of agricultural machinery per unit sown area	0.1662
	Effective rate of irrigation	0.0720

3. Measurement Model of the Coordinated Development Level of Four Modernizations

First, Analytic Hierarchy Process (AHP) will be used to determine the weight of index and each index in the evaluation system will be standardized. Second, the standardized index will be multiplied by weight and the obtained value will be added to get the development index of each subsystem. Finally, the comprehensive development index, the coupling degree and the coordinated development degree of four modernizations will be calculated.

3.1. Measurement of the Subsystem Development Level of Four Modernizations

As the dimension of each index is different and the numerical difference is big, it is difficult to directly compare. The original data need to be standardized. In this paper, the extremum method is used to standardize data, and the function is

$$x_i^{'} = \begin{cases} x_i / x_{\max} & x \text{ is a positive direction index} \\ x_{\min} / x_i & x \text{ is a negative direction index} \end{cases} \quad (1)$$

Where x_i is the original data and $x_i^{'}$ is the standardized data

This paper adopts AHP of multi expert decision to get the weight of each index, marked as w_i. The development level of each subsystem is

$$y_i = \sum_{j=1}^{m} w_{ij} x_{ij} \ (i = 1, 2, 3, 4) \tag{2}$$

Where y_1, y_2, y_3, y_4 represent industrialization, informatization, urbanization and agricultural modernization index respectively.

3.2. Measurement of the Comprehensive Development Level of Four Modernizations

The comprehensive development level is the reflection of the whole development situation of four modernizations. It measures the overall development level of four modernizations of a region, and the function is

$$T = \alpha y_1 + \beta y_2 + \gamma y_3 + \delta y_4 \tag{3}$$

Where T is the comprehensive development index of four modernizations α, β, γ, δ are the weight of industrialization, informatization, urbanization and agricultural modernization index respectively and they should meet $\alpha + \beta + \gamma + \delta = 1$. This paper holds that each modernization of the four is equal importance and let $\alpha = \beta = \gamma = \delta = 1/4$.

3.3. Measurement of the Coupling Degree of Four Modernizations

Coupling was originally a concept in physics and refers to a phenomenon that two or more than two systems interacting and influencing each other. Coupling degree is to reflect and measure the effect and influence [4, 11]. This paper uses capacity coupling coefficient model in physics for reference, extends the function proposed by Liao [12], and gets

$$C = \left\{ \frac{y_1 \cdot y_2 \cdot y_3 \cdot y_4}{\left[\left(y_1 + y_2 + y_3 + y_4 \right)/4 \right]^4} \right\}^k \tag{4}$$

Where C is the coupling degree and reflects the synchronization development status of four modernizations. And k is the adjustment coefficient, $k \geq 4$ and this paper take k=4.

3.4. Measurement of the Coordinated Development Degree of Four Modernizations

The coordinated development degree is the comprehensive measurement of comprehensive development level and the coupling degree. It not only reflects the overall development level of four modernizations, but also reflects mutual restriction and coordination among four modernizations. It embodies the degree of common development of four modernizations. The model is

$$D = \sqrt{C \cdot T} \tag{5}$$

Where D is the coordinated development degree of four modernizations, C is the coupling degree and T is the comprehensive development index.

Usually, the coordination development degree can be divided into 5 types, as shown in Table 2.

Table 2. Division Of The Coordinated Development Level

Coordinated development degree, D	[0,0.2)	[0.2,0.5)	[0.5,0.7)	[0.7,0.9)	[0.9,1]
Coordination level	Seriously uncoordinated	Uncoordinated	Intermediate coordinated	Upper-intermediate coordinated	Advanced coordinated

4. Empirical Study

4.1. Calculation and Analysis of Industrialization, Informatization, Urbanization and Agricultural Modernization Index

First, AHP method is used to get the weight of each index, as shown in Table 1. Second, all original data of 31 provinces, municipalities and autonomous regions from 2003 to 2012 is standardized by extremum method. Third, the standardized data is multiplied by weight and the obtained value is added to get the development index of industrialization, informatization, urbanization and agricultural modernization. Each modernization's average index of the whole nation and east, central and west China from 2003 to 2012 is chosen to draw Figure 1. The division of east, central and west China is shown in Table 3.

Table 3. Division Of East, Central And West China

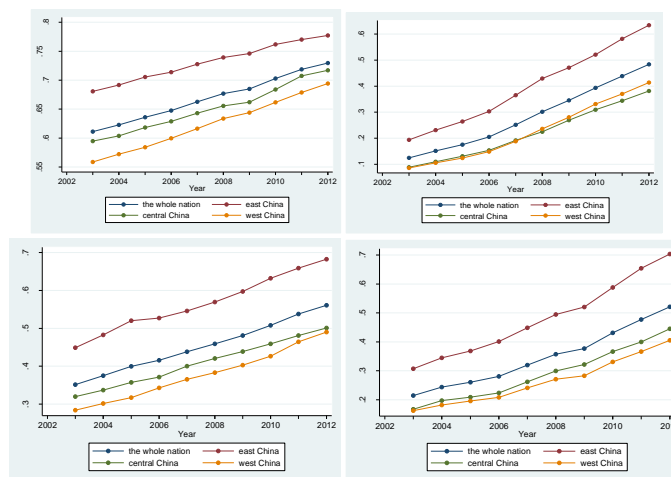| Area	Province, municipality and autonomous region
East China	Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan
Central China	Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan
West China	Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang

Figure 1. Industrialization, Informatization, Urbanization and Agricultural Modernization Average Index of the Whole Nation and East, Central and West China

As shown in Figure 1, average industrialization, informatization, urbanization and agricultural modernization indices of the whole nation and east, central and west China all have a significant upward trend from 2003 to 2012. The average indices of four modernizations of the whole nation have risen 19.33%, 287.78%, 59.53% and 142.59% respectively. Informatization's and agricultural modernization's rises are the largest in the four. This is mainly because the basis of informatization and agricultural modernization in China is weak and the starting point is low. Hence they are developing quickly and have a great increase in recent years. The comparison analysis of east, central and west China shows that the average indices of four modernizations of east China are the largest in the three areas. They are higher than the national average and far exceed indices of central and west China. The average indices of central China are the second. They are higher than west China, but lower than east China. West China is at the bottom, but its infomatization index had surpassed central China at 2008 and maintains the leading position in recent years. Meanwhile, the average indices of central and west China are lower than the

national average level and have a big disparity with east China. In terms of growth rate in the three areas, industrialization, informatization and urbanization of west China are the quickest, agricultural modernization of central China is the quickest and four modernizations of east China are the slowest. It reflects that central and west China show certain advantage of backwardness in the development of four modernizations and are catching up with east China fast.

4.2. Calculation and Analysis of the Coupling Degree, the Comprehensive Development Index and the Coordinated Development Degree

Industrialization, informatization, urbanization and agricultural modernization indices of 31 provinces, municipalities and autonomous regions from 2003 to 2012 are substituted into Eq. 3 to Eq. 5 to get the comprehensive development index, the coupling degree and the coordinated development degree of four modernizations. The coordinated development degree of 2003, 2005, 2008, 2010 and 2012 is presented in Table 4. The average coupling degree and the average coordinated development degree of the whole nation and east, central and west China from 2003 to 2012 are used to draw Figure 2.

Table 4. Coordinated Development Index Of Four Modernizations Of 31 Provinces, Municipalities And Autonomous Regions Of China

Province	2003	2005	2008	2010	2012
Beijing	0.5669	0.6456	0.7714	0.8289	0.9027
Tianjin	0.3235	0.4485	0.6530	0.7159	0.7764
Hebei	0.1213	0.2103	0.4246	0.5590	0.6531
Shanxi	0.0689	0.1318	0.2649	0.4331	0.5320
Inner Mongolia	0.0979	0.1754	0.3635	0.4965	0.6023
Liaoning	0.1821	0.2871	0.5289	0.6666	0.7603
Jilin	0.1466	0.2434	0.4207	0.5385	0.6381
Heilongjiang	0.0847	0.1619	0.3247	0.4413	0.5964
Shanghai	0.4056	0.4996	0.7349	0.8225	0.8540
Zhejiang	0.1730	0.2877	0.5376	0.7018	0.8065
Jiangsu	0.2828	0.4362	0.6815	0.7730	0.8434
Anhui	0.0525	0.1062	0.2427	0.4072	0.5222
Fujian	0.2462	0.3669	0.6411	0.7308	0.7989
Jiangxi	0.0646	0.1167	0.2744	0.3816	0.5053
Shandong	0.1309	0.2412	0.4535	0.5946	0.6712
Henan	0.0510	0.1311	0.2982	0.4329	0.5175
Hubei	0.0907	0.1729	0.3833	0.5457	0.6036
Hunan	0.0669	0.1284	0.3281	0.4605	0.5603
Guangdong	0.2571	0.4300	0.6510	0.7171	0.8112
Guangxi	0.0650	0.1520	0.3312	0.4553	0.5728
Hainan	0.1628	0.2946	0.5496	0.6502	0.7073
Chongqing	0.0779	0.1463	0.2980	0.4212	0.5519
Sichuan	0.0688	0.1345	0.2857	0.4263	0.5666
Guizhou	0.0210	0.0445	0.1625	0.2519	0.3857
Yunnan	0.0556	0.0994	0.2342	0.3180	0.4519
Tibet	0.0829	0.1442	0.3660	0.4694	0.5468
Shaanxi	0.0692	0.1484	0.3630	0.5257	0.6444
Gansu	0.0583	0.1024	0.2559	0.3949	0.4969
Qinghai	0.0779	0.1382	0.3689	0.4982	0.5980

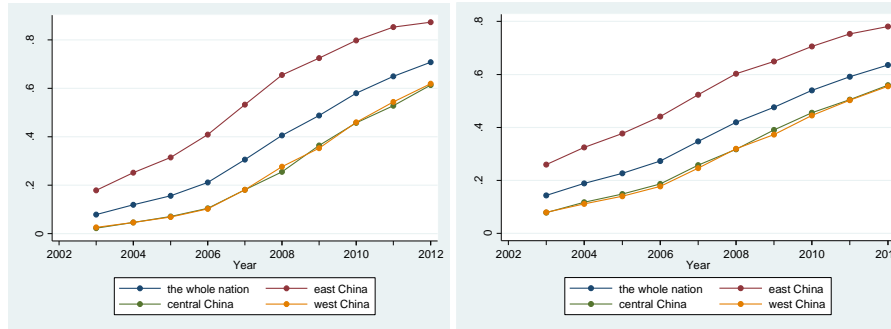| Ningxia | 0.0897 | 0.1516 | 0.3143 | 0.4677 | 0.5379 |
| Xinjiang | 0.1909 | 0.2525 | 0.4956 | 0.6192 | 0.7038 |

Figure 2. Average Coupling Degree and Average Coordinated Development Degree of Four Modernizations of the Whole Nation and East, Central And West China

As shown in Figure 2, the average coupling degree and the average coordinated development degree of the whole nation and east, central and west China are rising year by year. East China far exceeds central and west China and is higher than the national average. But central and west China are lower than the national average. It reflects that in terms of coordinated development of four modernizations, the level of east China is high and that of central and west China is low. Comparing central and west China shows that the coupling degree and the coordinated development degree of them are almost the same and the two curves almost coincide. In terms of the coupling degree, the two areas lead alternately. In terms of the coordinated development degree, central China slightly goes ahead and is just behind west China in 2008. Therefore, the coordinated development levels of central and west China are basically in the same horizontal line and keep a relatively same growth rate.

According to the classification standard of the coordinated development level, 31 provinces of China can be divided into different grades. Taking 2003, 2008 and 2012 as an example, it is shown in Table 5.

Table 5. Coordinated Development Grades Of 31 Provinces In China

Coordinated development grades	2003	2008	2012
Seriously uncoordinated [0,0.2)	Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Anhui, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangxi, Hainan, Chongqing, Sichuan, Guizhou,Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	Guizhou	
Uncoordinated [0.2,0.5)	Tianjin, Shanghai, Zhejiang, Fujian, Guangdong	Hebei, Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangxi, Chongqing, Sichuan, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	Guizhou, Yunnan, Gansu
Intermediate coordinated [0.5,0.7)	Beijing	Tianjin, Liaoning, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan	Hebei, Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangxi, Chongqing, Sichuan, Tibet, Shaanxi, Qinghai, Ningxia

| Upper-intermediate coordinated [0.7,0.9) | | Beijing, Shanghai | Tianjin, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan, Xinjiang |
| Advanced coordinated [0.9,1] | | | Beijing |

As shown in Table 5, in 2003, there are 25 provinces in the seriously uncoordinated state, 5 provinces in the uncoordinated state and only 1 province in the intermediate coordinated state. By 2008, the number of seriously uncoordinated province has reduced to only 1. There are 21 provinces in the uncoordinated state. The total of the two states is 22 and has decreased by 8 from 2003 to 2008. The number of intermediate coordinated province has increased to 7. Beijing and Shanghai have entered the upper-intermediate coordinated state. Until 2012, there is no province in the seriously uncoordinated state. Only Guizhou, Yunnan and Gansu are in the uncoordinated state. Other provinces are all in the coordinated state. There are 18 provinces in the intermediate coordinated state and 9 provinces in the upper-intermediate coordinated state. Beijing has entered the advanced coordinated state. Hence, most provinces have experienced transformation from uncoordinated state to coordinated state. The coordinated level continuously improves. They all show a good development momentum. Regional differences are still evident. Beijing has been in the leading position of the coordinated development of four modernizations all the time and the eastern provinces have been walking in the forefront as well. Taking 2012 as an example, in the upper-intermediate and advanced coordinated state, there are 10 provinces. 9 of them are located in east China, but only 1, Xinjiang, is located in west China. Most provinces in central and west China are in the intermediate coordinated state, and even Guizhou, Yunnan and Gansu are still in the uncoordinated state. It reflects the lag of the 3 provinces in the coordinated development of four modernizations. This maybe relates to their relatively low economic development level, inconvenient traffic conditions and other factors.

5. Conclusion

Following the comprehensive, objective, scientific, systematic principles, this paper constructs an evaluation index system of development level of industrialization, informatization, urbanization and agricultural modernization, including a set of 4 categories and 16 indicators. Subsystem's development level of four modernizations of 31 provinces between 2003 and 2012 is measured. It discovers that the subsystem's average indices of the whole nation and east, central and west China all show a significant upward trend in 2003 to 2012. Each index of east China is higher than the national average and that of central and west China are lower than the national average. Most indices of central China lead that of west China and only infomatization index of central China was surpassed by west China at 2008. By the coupling degree model and the coordinated development degree model, the two degrees of 31 provinces from 2003 to 2012 are calculated. It can be discovered that the change characteristics of the two degrees of the whole nation and east, central and west China are almost the same with the change of subsystems. Only the coupling degree curves and the coordinated development degree curves of central and west China are almost coincidence. They are on the same level line. Based on dividing the coordinated grades of 31 provinces, it can be discovered that the number of coordinated province is increasing and that of uncoordinated province is decreasing. Beijing has been in the leading position of the coordinated development of four modernizations all the time. Provinces of high coordinated development are mostly located in east China. Central and west China are relatively backward. Therefore, China should put more resources to central and west China to enhance their coordinated

development level of four modernizations and ultimately promotes the overall level of the whole nation.

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