Development Quality Evaluation from the Perspective of Coordinated Development: Based on the Empirical Analysis of Five Provinces' Panel Data

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Abstract:

A coordinated development quality evaluation indicator system of four systems: economy, society, culture and ecological civilization was constructed. Taking the five provinces of Central China as the evaluation object and the panel data of 41 specific evaluation indicators from 2000 to 2020 as the evaluation samples, the coupling relationship and coordination degree index of four systems were calculated from the perspective of coordinated development. The results show that the indicators that contribute more to the development quality of five provinces are basically the same. The comprehensive development quality keeps improving, and the pace is relatively consistent. But the improvement speed of ecological civilization system is relatively slow, and there is a certain degree of difference. The coupling coordination degree indexes of five provinces have been rising steadily, but it is a pity that they are still in the disorder stage. The five provinces of the Central China can accelerate the coordinated, balanced and high-quality development of various systems by firmly establishing the coordinated development concept, strengthening the construction of their weak areas, and taking the road of characteristic development with the help of advantageous factors.

Keywords: *Coordinated development, Development quality evaluation, Coupling coordination degree, Five provinces of Central China.*

I. INTRODUCTION

China's economy has shifted from a stage of rapid growth to a stage of high-quality development. The root of high-quality development is to enhance the vitality, innovation and competitiveness of the domestic economy, and all these indicators are closely inseparable to green development. The green development is an important symbol to China's economic transformation, so the economic development must be a comprehensive development model of coordinating economic, social, cultural, ecological system.

The concept of coordinated development is one of the new development concepts of China, which are to promote the high-quality, sustainable and healthy development of economy, and we must be adhered to.

It is easy to lead a region or city' development by taking its advantage industry, but it is very difficult to promote other industries, and realize the coordinated development of all the fields only by taking the advantage industry. However, the coordination equilibrium of all the fields often reflect the high-quality development of higher level of a region or city. Therefore, this paper holds that the coordinated development not only means regional coordination, but also means the coordination of various systems within a certain region. And the high-quality development also must be the coordinated development of various systems within the region.

The five provinces of the Central Plains have great potential for development. In 2016, The State Council approved the Development Plan for the Central Plains Urban Agglomeration. The plan aims to build the Central Plains urban agglomeration into a new growth pole of China's economic development, an important base for advanced manufacturing and modern services, a pioneer zone for innovation and entrepreneurship in central and western China, a new plateau for two-way opening-up in the inland region, and a demonstration zone for green and ecological development.

After several years of construction, how is the overall development quality of the Central Plains Urban Agglomeration? Have the economic, social, cultural and ecological systems of the five provinces in the Central China achieved coordinated development? In the future, in order to meet the requirements of high-quality development, what aspects and fields should the five provinces improve?

The key to evaluate the development quality of a city or region is to establish a scientific comprehensive evaluation indicator system. It can be divided into multiple research topics according to the core content: economic development and development mode [1-2], urban-rural integration development [3-4], industrial structure and industrial agglomeration development [5-6], environment protection and ecosystem evaluation [7-8] and so on. The common evaluation indicators can be roughly divided into four categories: one is based on the "urban modernization and urban-rural integration", which measures development quality from the aspects of urban development quality and regional development quality [9-10]; Second, the indicator system is based on material civilization, spiritual civilization and ecological civilization [11-12]; Third, the indicator system emphasizes the role of cities in meeting people's needs and realizing value [13-14]. Fourth, the indicator system is constructed from the perspective of multiple subsystems within the urban system [15-16]. Research methods basically adopt multi-objective decision-making methods including factor analysis [17], principal component analysis [18], entropy weight method [19-20], cluster analysis [21] and multi-objective linear weighting method [22].

This paper collected the economic, social, cultural and ecological civilization development quality data sets of Shanxi, Hebei, Henan, Shandong, Anhui province during the period of 2000-2020.[23-24] The multi-system coupling coordination degree evaluation indicator system was designed and the model was built to do empirical analysis, explain the questions and explore the reasons of formation using the provincial panel data, in order to strengthen the weak fields and sustain development advantages. It can also further evaluate the construction effects of Central Plains Economic Region and Central Plains Urban Agglomeration in recent years.

II. MODEL SETTING AND DATA DESCRIPTION

2.1 Model Setting

Based on the concept of coordinated development, this article designed and built a coordinated development quality evaluation indicator system at provincial level. It adopt entropy weight method, a relatively objective empowerment method, to determine the indicator weights. It calculated the weight values and the comprehensive evaluation values by using the 2000-2020 panel data of economic, social, cultural and ecological systems in five provinces of central China. Furthermore, the coupling coordination degrees and evolution process between systems are obtained, and the future development direction and specific reform measures of each province are mastered. The specific model is set as follows:

(1) Select indicator j in year i, then x_{ij} is the data of indicator j in year i (i=1,2... , n. j= 1, 2,... , m).

(2) Since the measurement units of various indicators are not unified, they should be standardized before they are used to calculate comprehensive evaluation values. That is, the absolute values of indicators should be converted into relative values. The specific method is as follows:

$$x_{ij}^{*} = (x_{ij} - x_{\min})/(x_{\max} - x_{\min}) \tag{1}$$

(3) Calculate p_{ij}, the proportion of x_{ij} under the indicator j:

$$p_{ij} = x_{ij}^{*} / \sum_{i=1}^{n} x_{ij} \tag{2}$$

(4) Calculate the entropy value of the j indicator:

$$e_{j} = -k \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \tag{3}$$

(5) Calculate the weights of each indicator of four evaluation systems:

$$\lambda_{j} = (1 - e_{j})/(m - \sum_{j=1}^{m} e_{j}) \tag{4}$$

(6) Calculate the development quality comprehensive evaluation values:

$$V_{i} = \sum_{j=1}^{m} \lambda_{j} x_{ij}^{*} \tag{5}$$

(7) Coupling degree model, calculate the coupling relationship and synergistic effect of the four evaluation systems in the current year:

$$C = 4*(V_1*V_2*V_3*V_4)^{1/4}/(V_1+V_2+V_3+V_4) \tag{6}$$

$C \subset [0, 1]$. The C is closer to 1, the better the coupling relationship and synergistic effect between the four evaluation systems. While the C approaches to 0, the less interaction exists between them.

(8) Coupling coordination degree model, calculate the coordinated development degree of the four evaluation systems, the degree to which they are in harmony with each other during development:

$$D = \sqrt{C*T} \tag{7}$$

$T = \alpha V_1 + \beta V_2 + \lambda V_3 + \sigma V_4$, and $\alpha = \beta = \lambda = \sigma = 0.25$

(9) The coupling coordination degree interval and grade division. The coupling coordination degree is divided into ten continuous and orderly intervals, and endowed with ten corresponding coordination levels (Table I).

TABLE I. The coupling coordination degree interval and grade division

COUPLING COORDINATION DEGREE INTERVAL	COORDINATION GRADE	COUPLING COORDINATION DEGREE INTERVAL	COORDINATION GRADE
0.000 0~0.099 9	Extreme disorder	0.500 0~0.599 9	Slight coordination
0.100 0~0.199 9	High disorder	0.600 0~0.699 9	Low coordination
0.200 0~0.299 9	Moderate disorder	0.700 0~0.799 9	Moderate coordination
0.300 0~0.399 9	Low disorder	0.800 0~0.899 9	High coordination
0.400 0~0.499 9	Slight disorder	0.900 0~1.000 0	Extreme coordination

2.2 Indicator Description and Data Source

The coordinated development quality evaluation indicator system in this paper (Table II) includes four evaluation subsystems: economic, social, cultural and ecological civilization development quality. They cover 13 (V11-V113), 12 (V21-V212), 9 (V31-V39) and 7 (V41-V47) specific evaluation indicators respectively. One part of them are from the measurement indicators of other scholars studying urban agglomeration and urban development quality issues, and another part are the statistical indicators of statistical yearbooks. The time range of data is from 2000 to 2020, and the content range includes data sets of economic development quality, social development quality, cultural development quality, and ecological

civilization development quality of Henan (P1), Shanxi (P2), Hebei (P3), Shandong (P4), and Anhui (P5). All are from the website of the National Bureau of Statistics, statistical yearbooks (2001-2020), statistical bulletins of national economic and social development (2000-2020) and other official statistical data.

TABLE II. The coordinated development quality evaluation indicator system

EVALUATION SYSTEM	EVALUATION INDICATOR	WEIGHT				
		Henan	Shanxi	Hebei	Shandong	Anhui
Economic Development Quality System V1	**V11** per capita GDP/yuan	0.0666	0.0633	0.0575	0.0656	0.0805
	V12 per capita disposal income of residents/yuan	0.0661	0.0738	0.0744	0.0749	0.0782
	V13 per capita fixed asset investment/yuan	0.0863	0.0823	0.0833	0.0755	0.0901
	V14 per capita retail sales of consumer goods/yuan	0.0778	0.078	0.0792	0.0797	0.105
	V15 contribution rate of the tertiary industry/%	0.0609	0.0671	0.1029	0.0993	0.0407
	V16 proportion of total imports and exports in GDP/%	0.0531	0.0736	0.0431	0.0454	0.0336
	V17 total volume of goods transportation/ten thousand ton	0.0636	0.0506	0.0772	0.0526	0.0779
	V18 year-end deposit balance of various financial institutions/ hundred million yuan	0.0828	0.0722	0.0812	0.0834	0.0893
	V19 civil car ownership at year-end/ten thousand	0.0902	0.0929	0.0767	0.0837	0.0315
	V110 total volume of post and telecommunications services/ hundred million yuan	0.1451	0.1452	0.1317	0.1392	0.1719
	V111 per capita fiscal income/yuan	0.0733	0.0733	0.0682	0.0777	0.0834
	V112 total social employment/ten thousand	0.0704	0.0577	0.0542	0.0459	0.05
	V113 average wage of worker/yuan	0.0638	0.07	0.0705	0.077	0.0678
Social Development Quality System V2	**V21** natural growth rate of population/‰	0.0414	0.0412	0.0468	0.091	0.067
	V22 registered urban unemployment rate/%	0.03	0.133	0.0238	0.0379	0.0493
	V23 urbanization rate/%	0.1559	0.0612	0.1009	0.1208	0.1465
	V24 number of people insured by basic endowment insurance/ten thousand	0.1715	0.1325	0.1724	0.1133	0.0774
	V25 number of people insured by basic medical insurance/ten thousand	0.0604	0.0345	0.0738	0.0551	0.0347
	V26 minimum subsistence allowance number/ten thousand	0.0595	0.0528	0.0645	0.0585	0.0776
	V27 length of urban road/km	0.101	0.0786	0.0825	0.0742	0.088
	V28 commercial housing sales area/ten thousand m^2	0.0643	0.0773	0.0816	0.0817	0.0873
	V29 per capita income gap between urban and rural residents /yuan	0.1144	0.1076	0.1291	0.1208	0.1118
	V210 number of health technicians/ten thousand	0.1139	0.1467	0.1077	0.099	0.1305
	V211 health facility beds per 10,000 people/piece	0.0567	0.0619	0.0483	0.0543	0.0593
	V212 number of criminal cases registered/piece	0.0309	0.0726	0.0688	0.0933	0.0708
Cultural Development Quality System V3	**V31** education expenditure per student/yuan	0.105	0.1317	0.098	0.133	0.1063
	V32 number of students enrolled in institutions of higher learning per 10,000 people/person	0.0487	0.0509	0.0406	0.0485	0.0504
	V33 number of full-time teachers in schools of all types and levels per 10,000 people/person	0.0777	0.0509	0.0765	0.1314	0.0649
	V34 total tourism revenue/hundred million yuan	0.1527	0.1921	0.2228	0.1539	0.1558
	V35 R&D expenditure/hundred million yuan	0.1211	0.1198	0.1396	0.1365	0.139
	V36 R&D personnel of full-time equivalent/person	0.1243	0.0934	0.0934	0.1243	0.1113
	V37 number of patent applications/piece	0.207	0.1633	0.2152	0.1497	0.1649
	V38 number of public library institutions/piece	0.1028	0.1006	0.0818	0.0431	0.1553
	V39 television broadcasting coverage rate/%	0.0608	0.0973	0.0321	0.0797	0.0521
Ecological Civilization Development Quality System V4	**V41** per capita park green area/m^2	0.1008	0.0959	0.153	0.1092	0.1266
	V42 proportion of investment in environmental pollution control in GDP/%	0.2091	0.2959	0.1331	0.2084	0.2369
	V43 energy consumption per 10,000 yuan of GDP/kg of standard coal	0.2089	0.1772	0.1868	0.2635	0.1805
	V44 treatment rate of domestic sewage/%	0.1428	0.1021	0.1277	0.1169	0.1119
	V45 household garbage harmless disposal rate/%	0.1063	0.161	0.1493	0.073	0.1135

V46 comprehensive utilization rate of general industrial solid waste/%	0.0725	0.0649	0.138	0.0892	0.0708
V47 industrial emission/hundred million m^3	0.1597	0.1031	0.1122	0.1399	0.1596

III. RESULTS

3.1 Evaluation Indicator Weight of Five Provinces in Central China

The weight values of 41 specific evaluation indicators of five provinces in central China are presented in Table II, indicating the contribution of each indicator to the development quality evaluation system. In the economic development quality system, the total volume of post and telecommunications services makes the greatest contribution among all the five provinces in central China, and plays an obvious role in driving the economy of each province. The average growth rate of the total volume of post and telecommunications services in Henan, Shanxi, Hebei, Shandong and Anhui was 29.63%, 26.42%, 25.48%, 24.26% and 27.58% during this period respectively. In the social development quality system, there are great differences in the indicator weight values of five provinces. But on the whole, the weight values of the indicators related to social security, medical and health system are bigger. Therefore, the perfect social security and advanced medical and health system is very important to improve the social development quality as a whole. In the cultural development quality system, the weight values of the indicators related to tourism and scientific and technological progress are relatively large, which plays an obvious driving role in scientific and technological innovation and cultural industry. In the ecological civilization development quality system, indicators such as investment in environmental pollution control and energy consumption per 10,000 yuan of GDP have a relatively large weight. It can obviously promote the process of ecological civilization construction of each province, and has positive significance for realizing "carbon peak" and "carbon neutrality".

The indicators that have larger contribution to the development quality of four systems are basically consistent, indicating that the development focus of various undertakings of five provinces in central China has stronger synchronicity, and the development effect also has the obvious consistency.

3.2 Comprehensive Evaluation Value of Five Provinces in Central China

On the whole, the comprehensive development quality of economy, society, culture and ecological civilization system of the five provinces in central China is constantly improving, and the pace is relatively consistent. However, the improvement speed of the development quality of ecological civilization system is relatively slow, and there is a difference among provinces. The broken lines of comprehensive evaluation values of economic development quality of the five provinces almost overlap. The improvement speed of development quality is obviously accelerated, and there is a difference after 2017. It has a lot to do with the development focus and characteristics of provinces in recent years, and also makes the contribution values produce differences of every indicator. The comprehensive evaluation values of social development quality of five provinces basically have more or less difference during the evaluation year, and the development quality difference has further expanded in recent years. The differences mainly reflect in the allocation of

labor resources, social security level, development of medical and health undertakings, and public security situation, etc. After 2016, Henan province developed rapidly in various undertakings of its social system, which benefited from the honor of being selected as a national central city and the strategic planning of Central Plains Urban Agglomeration construction. Shanxi province also made continuous efforts in the past two years. As for the cultural development quality, the development pathways of five provinces are not the same. The change trends of the comprehensive evaluation values of cultural development quality vary widely with the economic and social development system, especially in the past two years in Shanxi, Hebei, Shandong, Anhui, a drop in the evaluation values. This phenomenon is mainly affected by the outbreak of COVID-19 in the industries related to tourism such as catering, accommodation, and scenic spots. Zhengzhou was selected as a national central city, and the Central Plains Urban Agglomeration with Henan province as the main body has grown into the fourth growth pole of China's economy. Zhengzhou released the talent projects to introduce outstanding talents in various industries, and intends to build a talent gathering highland and a innovation and entrepreneurship center in the inland region, which has greatly improved the development quality of science and technology and cultural undertakings in recent years. In terms of ecological civilization construction, the comprehensive evaluation values of five provinces are all lower than that of the economic, social and cultural development system, and the construction pace and development quality are different. Based on the model set in this paper, Anhui has a good performance in ecological civilization development quality in recent years. The investment in environmental pollution control grew rapidly, and energy consumption per unit GDP was low. However, the development quality of ecological civilization in Shanxi is not good. The energy consumption per unit GDP is high, and industrial waste emissions have not been effectively controlled. From the evaluation results, the policy effect of the Central Plains Economic Zone Plan was relatively insignificant during 2012-2016, while the overlapping policy effect of the Central Plains Urban Agglomeration Development Plan gradually emerged in recent years. (In Figure 1)
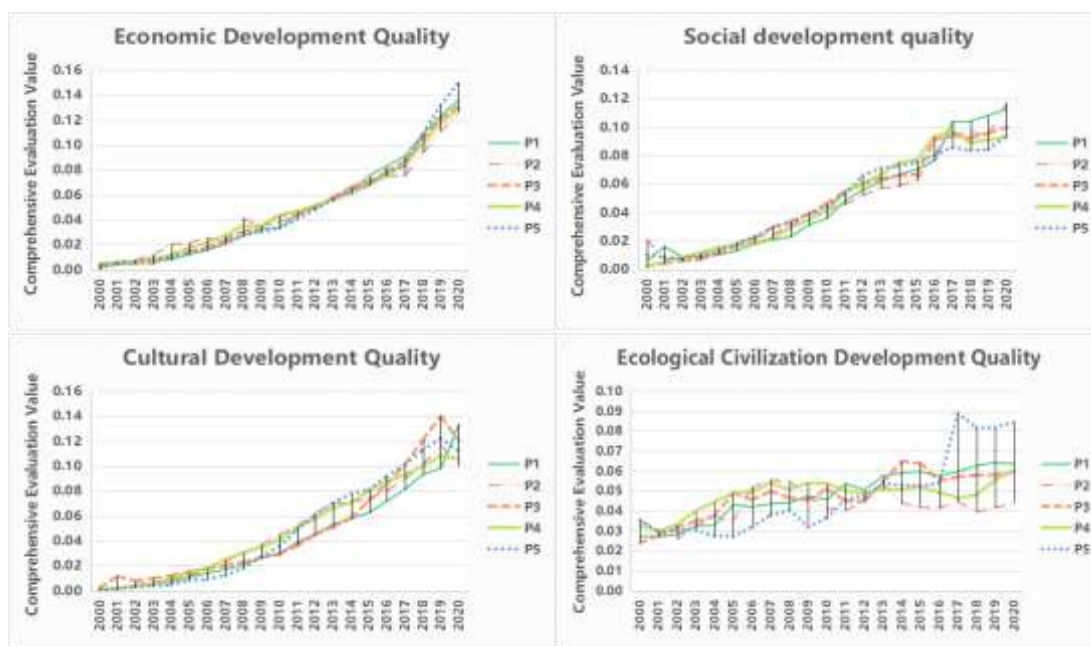
Fig 1: Development quality of four system of five provinces in central China from 2000 to 2020

As shown in Figure 2, the comprehensive development quality of the five provinces in central China shows a steady and orderly upward trend, which is measured by the sum of the comprehensive evaluation values of their economic, social, cultural and ecological civilization systems. Since the 21st century, the various undertakings in Central Plains have been vigorous, so that the inter-provincial comprehensive development quality has been continuously improved. There are obvious differences in comprehensive evaluation values after 2016, while the previous comprehensive evaluation values tend to overlap. The five provinces pay attention to characteristic development road in recent years. They increased investment and management in the advantageous fields on the basis of keeping the economic development quality ascend in the steady situation. These actions can make the advantageous fields become the strong contributors to comprehensive development quality. Furthermore, it can also show different development focus and characteristic development pattern.
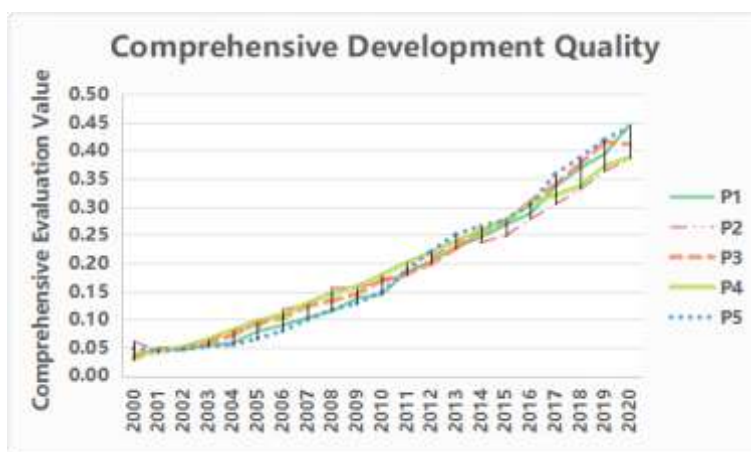

Fig 2: Comprehensive development quality of five provinces in central China from 2000 to 2020

3.3 Coordinated Development Degree of Four Systems of Five Provinces

The coupling degree indexes between the economic, social, cultural, and ecological civilization evaluation systems of the five provinces in central China have remained above 0.9 after 2006, even close to 1 in some years, and the change trend is highly unified. The coupling relationship and synergistic effect between four fields has been increasing, and the degree of interaction and mutual influence has been deepening. But have all systems achieved coordinated development on the whole? Based on the coupling degree model, this paper further defined and measured the coupling coordination degree index of four evaluation systems of the five provinces in central China, and divided the coordinated development grade. The results are shown in Figure 3 and Table III.
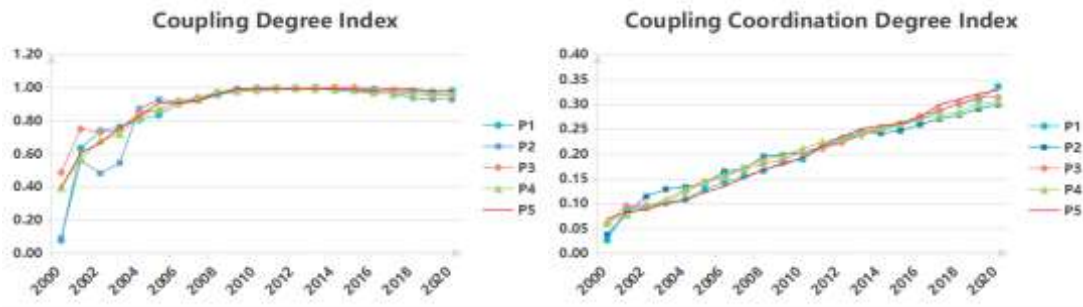
Fig 3: Coupling degree and coupling coordination degree index of four systems of five provinces from 2000 to 2020

TABLE III. The coordinated development stages of five provinces from 2000 to 2020

Coordination grade	Henan	Shanxi	Hebei	Shandong	Anhui
Extreme disorder	2000-2002	2000-2001	2000-2002	2000-2002	2000-2003
High disorder	2003-2010	2002-2009	2003-2009	2003-2009	2004-2010
Moderate disorder	2011-2017	2010-2020	2010-2017	2010-2019	2011-2017
Low disorder	2018-2020	—	2018-2020	2020	2018-2020

The coupling degree index and coupling coordination degree index of four evaluation systems of the five provinces changed significantly after the approval of Central Plains Urban Agglomeration Development Plan in 2016. Under the guidance of policies, all five provinces have taken measures to promote the development of various undertakings in various degrees. However, the development speed is not the same, and the development gap is increasingly apparent due to resource endowment, economic strength, development planning and other factors. The Central Plains Urban Agglomeration covers all cities in Henan province, so the development plan plays a more positive role in promoting its high-quality development in various fields.

The coupling coordination index of the four evaluation systems of five provinces in central China has been rising steadily during the evaluation period, which is consistent with the law of China's economic and social development. At the same time, it is also the requirement and development goal of China's new development concept in the new era and the new normal background. However, it is a pity that they are still in the disorder stage and cannot reach the goal of coordinated development in the new development concept at all. Especially, Shanxi is still in the moderate disorder state, while Shandong has just entered the low disorder stage. This shows that the various undertakings of five provinces are not balanced and harmonious, and the development concept and evaluation standard are still relatively backward. The five provinces attach great importance to the absolute development of their economic system, while other areas closely related to people's livelihood are relatively weak.

IV. CONCLUSION

When the coordinated development concept was first put forward, it was based on the overall plan for the cause of socialism with Chinese characteristics, and it called for proper handling of major relations in development, so as to promote coordinated and harmonious development in all economic and social fields. This paper builds a coordinated development quality evaluation indicator system to evaluate the development quality of the five provinces in central China, from the perspective of coordinated development of the provincial economic, social, cultural, ecological systems. The main research results are as follows: The various policies on the construction of Central Plains Urban Agglomeration have no obvious promoting effect in provincial in recent years. The indicators that contribute more to the development quality of each system are basically the same, indicating that the development focus of five provinces has a strong synchronization, the development effect also has obvious consistency, which can also explain the reason why the Central Plains Urban Agglomeration covers these five provinces. The comprehensive development quality of the four systems of five provinces is constantly improving, and the development pace is relatively consistent. However, the development quality of ecological civilization system is relatively slow, and there is a difference among provinces. The coupling coordination indexes of four systems of five provinces in central China have been rising steadily during the evaluation period, but it is a pity that they are still in the disorder stage and cannot reach the coordinated development goal. Therefore, there is still a long way to go for the coordinated development of various provinces.

When the five provinces in central China formulate their future high-quality development plans, they should not only make clear the development goals and standards in various fields, but also fully realize that the coordinated development of various systems will accelerate the process of high-quality development in the region. That is, while pursuing economic growth, social, cultural and ecological systems will be developed harmoniously and mutually, thus accelerating the process of high-quality development. Secondly, the five provinces should intensify reform and promotion of their own weak areas and weak indicators. Try to achieve balanced and coordinated development with the advantageous field, rather than blindly focusing on the advantageous field, and "one dominant" state is not conducive to the realization of high-quality development goals. Thirdly, the five provinces need to fully excavate their respective resource endowment, characteristic industries, current advantages and strengths, and take them into comprehensive consideration, balance and coordination, highlight their characteristics, and finally strive to find a road of characteristic development and help the construction of Central Plains Urban Agglomeration.

In the future, the author and the team will also further collect development quality evaluation indicators and panel data sets of economic, social, cultural, ecological civilization covering 30 cities of Central Plains Urban Agglomeration. We strive for establishing development quality database of Central Plains Urban Agglomeration, evaluate its development quality accurately and comprehensively, grasp the overall and important urban development bottlenecks. On this basis, we can promote the comprehensive and high-quality development of Central Plains Urban Agglomeration.

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