

Research on the Evaluation System of High-Quality Economic Development Based on the Thoughts of Ecological Civilization

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Keywords: Thought of ecological civilization, ecological economy, high-quality economic development, Kaifeng

Abstract: There is no denying that people's demand for a better life is highly correlated with the ecological environment and economic growth. Consequently, based on the thought of ecological civilization, this study constructs an evaluation index system for high-quality development of ecological economics, which specifically contains five dimensions and 22 specific indicators. And the five dimensions consist of ecological environment, scientific and technological level, economic efficiency, people's welfare, and openness and cooperation. In addition, the index system was also applied to measure the level of eco-economic development in Kaifeng from 2006 to 2021, and the results showed that the index system has good general applicability.

1. Introduction

Over the past 40 years of reform and opening up, China's economy has made world-renowned achievements. However, from the viewpoint of economic development efficiency, it also mainly relies on the "high input, high energy consumption, high emissions" of the crude development model, at the cost of resources, energy waste, and environmental pollution, which is not sustainable development. For instance, in recent years, the continuously deteriorating ecological environment, frequent extreme climatic disasters, and resource depletion have seriously threatened people's lives and health and hindered economic development. To solve this problem, China has published a series of new concepts and assertions on the construction of ecological civilization. The new concepts and assertions are based on the main contradictions of current economic and social development, focusing on the current well-being of the people and the long-term development of the country, and finally forming the thought of ecological civilization in the new era, which is of great significance for China's high-quality economic development. Furthermore, it was found that ecological protection and economic development are complementary. Ecological protection is the basic premise, and high-quality development is the fundamental goal^[1]. And in the process of the development to high quality, the ecological environment is inevitably integrated with high-quality development, and the intersection of the two will produce mutual integration and promotion^[2]. Perkins^[3] stated that good environmental policies and regulatory approaches improve the efficiency

of a country's economic development; furthermore, improved eco-efficiency helps to reduce regional economic disparities ^[4]. It is because a green economy has positive results for increasing social wealth, improving economic output, increasing decent employment, and reducing poverty ^[5].

For the evaluation of high-quality economic development, the China Economic Exchange Center and other departments evaluate the overall status of China's economic development in five aspects: economic development, social and livelihood, resources and environment, consumption and emissions, and governance and protection ^[6]. Ren and Liu ^[7] combined the history and current situation of China's economic, ecological and social development to establish a high-quality green development evaluation system from three dimensions: economic development, ecological civilization, and social harmony. Hao and Zhu ^[8] constructed a regional green development evaluation index system in China, which mainly contains six primary indicators: resource utilization, environmental governance, environmental quality, ecological protection, growth quality, and green life, and 44 secondary indicators. Guo ^[9] evaluated the level of green development in Shandong Province from four primary indicators, including economic greenness, social greenness, environmental greenness, and government support, and 20 secondary indicators, including GDP per capita and energy consumption of 10,000 Yuan GDP. In summary, the relevant government departments have not issued a unified index system for evaluating high-quality economic development. And although there exist abundant achievements in academia, the research perspectives and focus are different, mainly focusing on the construction of evaluation indexes for high-quality economic development or the construction of a green economy evaluation index system. And it cannot fully reflect the characteristics and objectives of the integration of ecological and economic quality development. Therefore, based on the thought of ecological civilization in the new era and the requirement of high-quality economic development, this paper constructs a set of evaluation index systems integrating ecological and high-quality economic development based on the comprehensive consideration of existing research results, intending to provide a reference for the government, enterprises and relevant departments to scientifically evaluate the current situation of economic development and formulate relevant measures.

2. Establish an Evaluation Index System for High-Quality Development of the Ecological Economy

2.1 Selection of Indicators

Entering a new era, China's rapid economic development is accompanied by increasingly serious environmental problems. And the Chinese government has elaborated on the relationship between human beings and the ecological environment, the value of ecological protection, the institutional construction of ecological protection, the significance of the ecological environment to society, and how to protect the ecological environment, forming the thought of ecological civilization in the new era of China. The thought of ecological civilization mainly includes several aspects such as the ecological view of community, ecological view of value, ecological view of system, ecological livelihood view, and ecological system view ^[10]. Ecological view of community believes that human beings and nature are a community of life and interdependent, so human beings must follow the laws of nature and protect the natural environment on which they depend for survival. The ecological view of value points out that economic construction cannot be done at the cost of damaging the ecological environment, and with the improvement of people's material living standards, a good ecological environment has become the most universal welfare of people's livelihood. The ecological view of system emphasizes that the construction of ecological civilization is a systematic project, involving the integrated planning and coordinated development of various social and economic fields, so in the process of promoting ecological civilization, all

departments should cooperate and supervise each other, based on the whole, and promote comprehensively. The ecological livelihood view points out that a good ecological environment is fundamental to the happy life of the majority of people, and the ecological system view should be taken as a major matter that responds to the well-being of people's livelihood. The ecological system is a strong guarantee for the construction of ecological civilization. The thought of ecological civilization in the new era is a comprehensive view of development, which emphasizes a systematic and scientific perspective on economic development and environmental protection. According to China's new-era ecological civilization ideology, the evaluation of the level of high-quality economic development should focus on the ecological environment, economic efficiency, the level of scientific and technological development, people's well-being, and openness and cooperation. As shown in Table 1, this paper constructs 22 secondary indicators based on five dimensions: ecological environment, science and technology level, economic efficiency, people's welfare, and openness and cooperation, so as to evaluate the high-quality development of the ecological economy.

2.2 Index Weighting

For the assignment of indicators, hierarchical analysis, principal component analysis, entropy method, Delphi method, etc. have been used more often, and each method has its own advantages and disadvantages. Taking into account the characteristics of the indicators in this study, a combination of subjective and objective methods is used to assign the weighting, specifically the Delphi method is used for the assignment of primary indicators and the entropy method is used for the assignment of secondary indicators. Firstly, the first level of indicators is assigned, the specific process is the formation of an expert panel to anonymously assign weights to summarize and analyze the feedback anonymously assign weights to summarize and analyze to determine the weights. The expert panel is composed of five experts from universities, research institutions, and industry. After anonymously soliciting their opinions, the subject group aggregated and analyzed the opinions and sent them back to the experts, who then assigned the weights again, and so on for two rounds. Based on the second round of experts' opinions, the group determined the weights of the five primary indicators, as shown in Table 2. Next, the secondary indicators were assigned weights. As the units of measurement of each raw data vary, this paper adopts the extreme value method for dimensionless processing, the specific formula is as follows:

$$R_{ij} = \frac{A_{ij} - \min(A_{ij})}{\max(A_{ij}) - \min(A_{ij})}, \quad A_{ij} \text{ is a positive indicator} \quad (1)$$

$$R_{ij} = \frac{\max(A_{ij}) - A_{ij}}{\max(A_{ij}) - \min(A_{ij})}, \quad A_{ij} \text{ is a negative indicator} \quad (2)$$

Where A_{ij} denotes the initial value of the secondary indicator, R_{ij} denotes the index value after dimensionless quantification, $\min(A_{ij})$ denotes the minimum value of A_{ij} , and $\max(A_{ij})$ denotes the maximum value of A_{ij} .

After the standardization of processing, the entropy weighting method was then used to assign weights to each secondary indicator, the calculation formula is:

$$W_{ij} = (1 - X_{ij}) / \sum_{j=1}^m (1 - X_{ij}) \quad (3)$$

W_{ij} denotes the weight and X_{ij} denotes the information entropy. The weights of each indicator after calculation are shown in Table 2.

Table 1: Evaluation index system for high-quality development of the ecological economy

First-grade indexes	Second-grade indexes	Measurement method	Index attribute
A1 Ecological environment	A11 Unit GDP energy consumption than the last year rise and fall	%	-
	A12 Unit GDP electricity consumption than the last year rise and fall	%	-
	A13 Number of days with good air quality	Day	+
	A14 The afforestation area of the same year	Thousands of hectares	+
	A15 Energy saving and environmental protection input intensity	Ratio of environmental protection investment to GDP that year	+
A2 Economic efficiency	A21 Economic growth rate	%	+
	A22 Consumer Price Index	%	-
	A23 Producer Price Index	%	-
	A24 Capital productivity	GDP/Total social fixed asset investment	+
	A25 Labor productivity	GDP/number of employees	+
A3 Scientific and technological level	A31 Number of patents granted per 10,000 population	Pieces/per 10,000 people	+
	A32 R&D investment intensity	R&D expenditure / GDP	+
	A33 Technology Market Turnover	Billion	+
	A34 R&D Personnel ratio per 10,000 population	R&D population / resident population	+
A4 Well-being of the people	A41 Urbanization rate	%	+
	A42 Gross domestic product per capita	Yuan	+
	A43 Per capita disposable income of residents	Yuan	+
	A44 General public service expenditure	Billion	+
	A45 Level of investment in healthcare	Ratio of healthcare expenditures to the permanent resident population	+
A5 Openness and cooperation	A51 Foreign investment dependence	Foreign direct investment/GDP	+
	A52 Actual utilization of foreign capital	Million	+
	A53 Total imports and exports	Million	+

Table 2: Weighting of indicators for the evaluation of high-quality eco-economic development

First-grade indexes	Weights	Second-grade indexes	Weights
A1 Ecological environment	0.226	A11 Unit GDP energy consumption than the last year rise and fall	0.057
		A12 Unit GDP electricity consumption than the last year rise and fall	0.048
		A13 Number of days with good air quality	0.049
		A14 The afforestation area of the same year	0.019
		A15 Energy saving and environmental protection input intensity	0.053
A2 Economic efficiency	0.271	A21 Economic growth rate	0.063
		A22 Consumer Price Index	0.056
		A23 Producer Price Index	0.053
		A24 Capital productivity	0.051
		A25 Labor productivity	0.049
A3 Scientific and technological level	0.175	A31 Number of patents granted per 10,000 population	0.047
		A32 R&D investment intensity	0.050
		A33 Technology Market Turnover	0.042
		A34 R&D Personnel ratio per 10,000 population	0.038
A4 Well-being of the people	0.207	A41 Urbanization rate	0.052
		A42 Gross domestic product per capita	0.039
		A43 Per capita disposable income of residents	0.043
		A44 General public service expenditure	0.046
		A45 Level of investment in health care	0.029
A5 Openness and cooperation	0.121	A51 Foreign investment dependence	0.028
		A52 Actual utilization of foreign capital	0.036
		A53 Total imports and exports	0.056

2.3 Calculated Assessment

The current level of eco-economic development can be measured by assigning weights to the high-quality eco-economic development indicators, as calculated by the following formula:

$$Z = \sum_{i=1}^n A_i W_{ij} \quad (4)$$

Z denotes the level of high-quality eco-economic development and A_i denotes the value of the secondary indicator after dimensionless quantification. W_{ij} denotes the weight corresponding to the syndicator. The value of Z ranges from 0-1, with the closer to 1 the better the level of high-quality eco-economic development. According to the experts' opinions, the level of high-quality development of eco-economy is divided into four stages: 0 to 0.4 is the starting stage; 0.4 to 0.6 is the primary stage; 0.6 to 0.8 is the intermediate stage; 0.8 to 1 is the advanced stage. When the Z value is above 0.8 it means that the region has a good level of high-quality eco-economic development.

3. Empirical Test

3.1 Measurement of the Level of High-Quality Eco-Economic Development in Kaifeng

The economic development level of Kaifeng City during the 15-year period from 2006 to 2020 was measured according to the indicator system and weights for the high-quality development of the eco-economy established in Table 1 and Table 2. The data for each evaluation indicator was mainly obtained through the Kaifeng Statistical Yearbook, the Henan Provincial Statistical Yearbook, as well as the statistical bulletins and census reports released by the statistical departments, and the work reports of relevant departments, so as to ensure the authenticity and reliability of the data. Then the data was dimensionless processed by the extreme value method. Then calculate according to formula (4), and the results are shown in Table 3.

Table 3: Levels of high-quality eco-economic development in Kaifeng, 2006 to 2020

Year	Level of development (Z-value)	Stage	Ranking
2006	0.203	Start-up stage	15
2007	0.259	Start-up stage	14
2008	0.360	Start-up stage	10
2009	0.324	Start-up stage	12
2010	0.305	Start-up stage	13
2011	0.340	Start-up stage	11
2012	0.375	Start-up stage	9
2013	0.390	Start-up stage	8
2014	0.477	Primary stage	7
2015	0.511	Primary stage	6
2016	0.519	Primary stage	5
2017	0.577	Primary stage	4
2018	0.739	Intermediate stage	2
2019	0.767	Intermediate stage	1
2020	0.647	Intermediate stage	3

3.2 Analysis of Measurement Results

(1) The level of high-quality development of the ecological economy in Kaifeng is slowly rising. As shown in Table 3, the Z value was only 0.203 in 2006, and after 14 years of development, it had risen to 0.767 in 2019, which was close to the level of the high-quality development stage. In 2020, the ecological economy of Kaifeng was impacted by the COVID-19 pandemic, but it still

maintained a level of 0.647. Specifically, the Kaifeng economy has experienced three stages of development: starting, primary and intermediate. 2006 to 2013 was the starting stage of high-quality development of the ecological economy, among which there are obvious fluctuations due to the global financial crisis during 2008 to 2011. 2011, Kaifeng grasped the major opportunities such as the rise of Central Plains and the integration of ZhengBian and rode on the momentum, and the economy developed rapidly in 2014, Kaifeng economy entered the primary development stage. After that, after several years of rapid development, the ecological economy of Kaifeng improved from 0.577 in 2017 to 0.739 in 2018, leaping into the intermediate development stage. Overall, Kaifeng's ecological economy as a whole maintains a steady upward trend.

(2) The level of high-quality development of the ecological economy in Kaifeng is uneven. In terms of the ecological environment dimension, although the overall energy consumption and electricity consumption per unit of output value in Kaifeng has maintained a decreasing trend in the past 15 years, the total energy consumption has increased year by year. The investment in energy saving and environmental protection has increased from 160 million yuan in 2006 to 1.35 billion yuan in 2020, which was nearly 9 times higher, which still needs to be improved vigorously. From the science and technology level dimension, the technology market turnover, as well as the R&D funding investment intensity, are not high, the number of science and technology talents is insufficient, and there is a serious lack of high-tech talents. From the economic efficiency dimension, the structure of the three industries is not excellent, the primary industry accounts for a relatively large share, lacking advanced manufacturing support, while the tertiary industry is large but not strong, and labor productivity still has much room for improvement. In addition, from the dimension of open cooperation, the total import and export and foreign investment dependence were drastically reduced by the impact of the new crown epidemic in 2020, which especially needs to be paid attention to.

(3) The overall level of high-quality ecological economy development in Kaifeng needs to be improved. Kaifeng's ecological economy development level is still below 0.8 and has never stepped into the advanced development stage. Horizontally, Kaifeng's ecological economy is still far behind Zhengzhou and Luoyang in Henan Province. This indicates that there is still much room for improvement in the level of ecological economy development in Kaifeng.

3.3 Suggestions for High-Quality Ecological Economic Development in Kaifeng

According to the measurement results, the following suggestions are made for the high-quality development of the ecological economy in Kaifeng: (1) Strengthen the construction of ecological environmental protection. In response to the lack of investment in environmental protection in Kaifeng, financial support should be increased. At the same time, the high-quality development of the ecological economy must be escorted by a strict system. A responsibility system for ecological protection should be gradually formed, with the main person in charge of government departments taking the lead and setting up a leading group for ecological environmental protection with the participation of relevant departments. Strengthen the supervision, inspection, and guidance of enterprises within the jurisdiction to ensure that relevant environmental protection policies are put in place. (2) Develop green industries according to local conditions. Kaifeng has a deep cultural heritage and rich tourism resources. Kaifeng should focus on relying on the advantages of cultural resources, accelerate the construction of Kaifeng International Cultural Tourism City, and form a large tourism circle with Kaifeng as the core, so as to drive the development of related industries. (3) Actively seek inter-regional economic cooperation. From 2005 when ZhengBian integration was proposed to be adopted to now, ZhengBian cooperation has deepened gradually, but there are still structural bottlenecks in ZhengBian industrial cooperation, especially at the level of high-quality

industrial cooperation, which is still low. Kaifeng should actively make use of the location advantage and good investment environment to transform and upgrade the traditional pillar industries, guide the enterprises to accelerate the transformation of informatization, numerical control, and intelligence, transform and upgrade to high-tech industries, green industries, and high-growth industries, and promote the high-quality development of the ecological economy.

4. Conclusions

China's thought on ecological civilization in the new era starts from the relationship between human beings and the ecological environment, the value of ecological protection, and the relationship between ecology and economic development, specifying that the value interest and ultimate goal of the current ecological construction are to meet the people's growing demand for a better life. The thought of ecological civilization in the new era is highly compatible with the goal of high-quality economic development and is a scientific guide for China's current economic construction. Taking the thought of ecological civilization in China's new era as a guide, this paper constructs an evaluation index system for high-quality ecological economic development from five dimensions: ecological environment, scientific and technological level, economic efficiency, people's welfare, and openness and cooperation, and measures the economic development level of Kaifeng city during 2006 to 2020. It is found that the current level of ecological economic quality development in Kaifeng is slowly increasing, but the overall development level is not high, still in the intermediate stage of ecological economic quality development, and the level of ecological economic quality development is uneven. This result is consistent with the actual situation of Kaifeng's economy. The practical application of the index system proves that the constructed index system has good reliability and validity and can be used to evaluate the level of ecological economic high-quality development in other regions.

Acknowledgement

Kaifeng's soft science research programs in 2022 (Project Name: Leading the High Quality Development of Kaifeng Economy with Xi Jinping's Thought on Ecological Civilization; Project Leader: Yin Liping)

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