Comprehensive Evaluation of Economic High-Quality Development in Hunan Province Based on Entropy Weight Method

Mingjun Zhu, Qi Zhu

School of Management, Hunan University of Technology and Business, No. 569 Yuelu Avenue, Changsha, China

Abstract: Based on the new development concept, this article constructs an evaluation index system for the high-quality development of Hunan Province's economy from the five dimensions of "innovative development, coordinated development, green development, open development, and shared development". Using the entropy weight method, the article evaluates and analyzes the level of high-quality economic development in Hunan Province from 2017 to 2021 based on the five primary indicators and fifteen secondary indicators in the evaluation index system. The results show that the high-quality economic development in Hunan Province is in good shape, but there are still areas for improvement.

Keywords: High-quality development, Entropy weight method, Evaluation index system, Hunan Province

1. Introduction

The report of the 19th National Congress of the Communist Party of China pointed out that China's economy has shifted from a phase of high-speed growth to high-quality development. China's economic development is at an important stage of transforming its economic development mode, optimizing its economic structure, and transforming its economic growth momentum. At the same time, Hunan Province adheres to the development strategy of "three highs and four news," vigorously builds three highlands, and promotes high-quality economic development. Improving the evaluation index system of high-quality development and scientifically and reasonably testing the level of high-quality development are key steps in promoting high-quality economic development. In recent years, Hunan Province has made significant progress in high-quality development.

Research on high-quality economic development mainly focuses on two aspects: the connotation and mechanism of high-quality economic development and the construction of an evaluation system for high-quality economic development. Scholars have explored the multi-dimensional and diverse aspects of high-quality economic development. Jin Bei believes that high-quality economic development is multidimensional and diverse, and clearly points out that high-quality economic development is to continuously adapt the development mode, structure, and dynamic state of the economy to the growing needs of the people[1]. Based on the optimization mechanism of demand and supply dynamics, Pu Xiaoye and Jarko Fidrmuc analyzed the mechanism of high-quality development, emphasizing the need to reshape demand dynamics and enhance supply dynamics[2]. He Qiang interpreted the quality of economic growth by measuring the efficiency of economic growth under the constraints of production factors, resource environment, economic structure, and income structure[3]. In the construction of the evaluation index system for high-quality economic development, Sun Hao, Gui Heqing, and Yang Dong constructed an index system for high-quality economic development based on the five new development concepts and measured the quality of China's provincial economic development in 2017, conducting an evaluation from multiple perspectives[4]. Su Limin and Ma Xiangwen used an unsupervised feature selection multi-subspace randomization cooperation model to optimize the initial set of six subsystems and thirty economic indicators, including the five new development concepts and the quality of economic growth, forming an evaluation index system for high-quality economic development[5]. Ma Ru, Luo Hui, Wang Hongwei, and Wang Tiecheng studied the high-quality development of China's regional economy from the five dimensions of high-quality supply, high-quality demand, development efficiency, economic operation, and opening up[6]. Su Yongwei and Chen Chibo constructed an evaluation indicator system for high-quality economic development

from six angles: quality and efficiency improvement, structural optimization, kinetic energy conversion, green and low-carbon, risk prevention and control, and improvement of people's livelihood[7].Based on previous studies, this article attempts to use the five aspects of the new development concepts as the first-level indicators and select fifteen second-level indicators to construct an evaluation indicator system to measure the level of high-quality economic development in Hunan Province from 2017 to 2021.

2. Construction of Evaluation Indicator System for High-quality Economic Development

2.1. Data Sources

According to research needs, the original data for all the indicators involved in this article are derived from the "Hunan Statistical Yearbook" from 2017 to 2021 and the "Hunan Province National Economic and Social Development Statistical Bulletin" from 2017 to 2021.

2.2. Indicator Selection

Based on the perspective of promoting high-quality economic development through Hunan Province's "Three Highs and Four News" strategy, this article selects indicators starting from the specific connotations of the five development concepts of "Innovation, Coordination, Green, Openness, and Sharing."

(1)Indicator selection under innovative development: Innovation is the endogenous driving force for promoting sustained and healthy economic development and is the key force for transforming China's economic development. This article selects the proportion of high-tech industry revenue to GDP [8], the activity of technology transactions, and the expenditure on the development of new products by industrial enterprises above designated size as secondary indicators, reflecting the level of innovative development from the perspectives of the innovative income,market,and R&D.

(2)Indicator selection under coordinated development: Coordinated development addresses the problem of development imbalance, and structural optimization is an important means to promote coordinated development. This article selects the proportion of the tertiary industry's value-added to GDP, the proportion of social consumer goods retail sales to GDP, and the Theil index [9] to reflect the degree of industrial, demand, and urban-rural structural optimization and reflect the level of coordinated development.

(3)Indicator selection under green development: Green development is a specific requirement for building an ecological civilization and is also the path for China's economic development to break away from its heavy reliance on resources and excessive environmental damage. This article selects forest coverage rate, energy consumption per 10,000 yuan of GDP, and the elasticity coefficient of energy consumption [10] to reflect the level of green development.

(4)Indicator selection under open development: Openness is the only way for high-quality development, and economic development not only needs to rely on the domestic market but also needs to have an international perspective and explore and develop international markets. This article selects the dependence on foreign trade, the proportion of foreign direct investment, and the proportion of high-tech product exports to total exports to reflect the level of open development.

(5)Indicator selection under shared development: Shared development focuses on social equity issues and the sharing of development results. This article selects the ratio of disposable income of urban and rural residents, the elasticity of income growth of residents, and the proportion of people's livelihood-oriented fiscal expenditures to reflect the level of shared development. Based on the above principles of indicator selection, the existing research results were summarized and organized, and relevant data were collected to finally establish the evaluation indicator system for high-quality economic development, as shown in Table 1.

Table 1: Evaluation index system for high-quality economic development

Target Level	Primary Indicator	Secondary Indicator		Unit
High-Quality Economic Development	A Innovative Development	A1	Proportion of high-tech income to GDP(+)	%
		A2	Activity of technology transactions(+)	%
		A3	Expenditure on new product development of industrial enterprises above designated size(+)	10000 yuan
	B Coordinated Development	B1	Proportion of value-added of tertiary industry to GDP(+)	%
		B2	Proportion of total retail sales of social consumer goods to GDP(+)	%
		B3	Theil index (-)	-
	C Green Development	C1	Forest coverage(+)	%
		C2	Energy consumption per 10,000 yuan of GDP(-)	TCE/10,000 yuan
		C3	Elasticity coefficient of energy consumption(-)	%
	D Open Development	D1	Dependence on foreign trade(+)	%
		D2	Proportion of foreign direct investment 比(+)	%
		D3	Proportion of high-tech product exports to total exports (+)	%
	E Shared Development	E1	Ratio of disposable income of urban and rural residents(-)	%
		E2	Elasticity of household income growth(+)	%
		E3	Proportion of fiscal expenditure on people's livelihood (+)	%

3. The determination of evaluation methods and indicator weights

3.1. Entropy Weight Method

Construct an initial matrix using the original data. The evaluation indicator system has n indicators in layer C, and there are m objects to be evaluated. Based on the initial matrix constructed by the objects to be evaluated and the indicator layer:

$$X= (x_{ij})_{m \times n} \quad (1 \le i \le m, 1 \le j \le n) \tag{1}$$

Standardize the data. Since there are differences in dimension, positive and negative signs, and other factors between the data of each indicator, it is necessary to standardize the data. This article uses the range standardization method to standardize the initial data, and the calculation formula is:

$$p_{ij} = (x_{ij}\text{-}\min_{xij})/(\max_{xij}\text{-}\min_{xij}) \tag{2}$$

If the indicator is a negative indicator, the opposite number is taken and then the formula is used to define the standardized matrix:

$$P= (p_{ij})_{m \times n}(0 \le p_{ij} \le 1 \tag{3}$$

Calculate the entropy value and the coefficient of variation for the indicators in the indicator layer:

$$ej = (\frac{-1}{\ln m})\sum_{i=1}^{m} p_{ij}\ln(p_{ij}) \tag{4}$$

$$k_j = 1\text{-}ej \tag{5}$$

Finally, the weight of the indicators in the indicator layer is obtained:

$$w_l = \frac{kj}{\sum_{i=1}^{m} kj} \tag{6}$$

3.2. Determination of Indicator Weights

Using the aforementioned evaluation method, based on the relevant data of Hunan Province from 2017 to 2021, the entropy weight method weight w1 is obtained after analysis and calculation, as shown in Table 2.

Table 2: The weight of high-quality economic development indicators

Target Level	Primary Indicator	Secondary Indicator		Weight
High-Quality Economic Development	A Innovative Development 0.2602	A1	Proportion of high-tech income to GDP(+)	0.0993
		A2	Activity of technology transactions(+)	0.0892
		A3	Expenditure on new product development of industrial enterprises above designated size(+)	0.0717
	B Coordinated Development 0.1565	B1	Proportion of value-added of tertiary industry to GDP(+)	0.0408
		B2	Proportion of total retail sales of social consumer goods to GDP(+)	0.0511
		B3	Theil index (-)	0.0646
	C Green Development 0.1663	C1	Forest coverage(+)	0.0437
		C2	Energy consumption per 10,000 yuan of GDP(-)	0.0661
		C3	Elasticity coefficient of energy consumption(-)	0.0565
	D Open Development 0.1568	D1	Dependence on foreign trade(+)	0.0546
		D2	Proportion of foreign direct investment 比(+)	0.0381
		D3	Proportion of high-tech product exports to total exports (+)	0.0641
	E Shared Development 0.2601	E1	Ratio of disposable income of urban and rural residents(-)	0.0832
		E2	Elasticity of household income growth(+)	0.1325
		E3	Proportion of fiscal expenditure on people's livelihood (+)	0.0444

3.3. Determination of Comprehensive Score

Based on the indicator evaluation system and the determined weights w1, the quantitative evaluation is carried out by calculating the comprehensive score. The calculation formula for the comprehensive score of the jth sample is:

$$R_j = \sum_{i=1}^{m} w_i \cdot x_{ij} \tag{7}$$

4. Empirical Analysis and Conclusion

4.1. Analysis and Evaluation of High-Quality Economic Development

From the perspective of weight structure. By studying the relevant data of Hunan Province from 2017 to 2021, the weights of each indicator were calculated. From the perspective of primary indicators, the weight of innovative development is the largest, followed by shared development. It can be seen that the importance of innovation and shared development to the construction of high-quality development in Hunan Province is slightly higher than the other three aspects. From the perspective of secondary indicators, among the fifteen secondary indicators, the weight of E2 household income growth elasticity and A1 high-tech income as a percentage of GDP is higher than the other indicators, which also shows that the evaluation of high-quality development in Hunan Province should focus on innovation and increasing household income.

From the perspective of overall score .As can be seen from Figure 1, from 2017 to 2021, the level of high-quality economic development in Hunan Province has been steadily improving, especially during the period from 2019 to 2020, when the growth rate increased by 150.5% compared to the previous year. Although the score in 2018 was lower than the previous year, the economic development was strong and progress was significant in all aspects, and the overall trend was good. At the same time, problems and shortcomings still exist, such as how to promote open development in the post-epidemic era, how to get rid of excessive reliance on resources, promote green development, and achieve the dual-carbon target, which are the problems that high-quality development will face in the future.
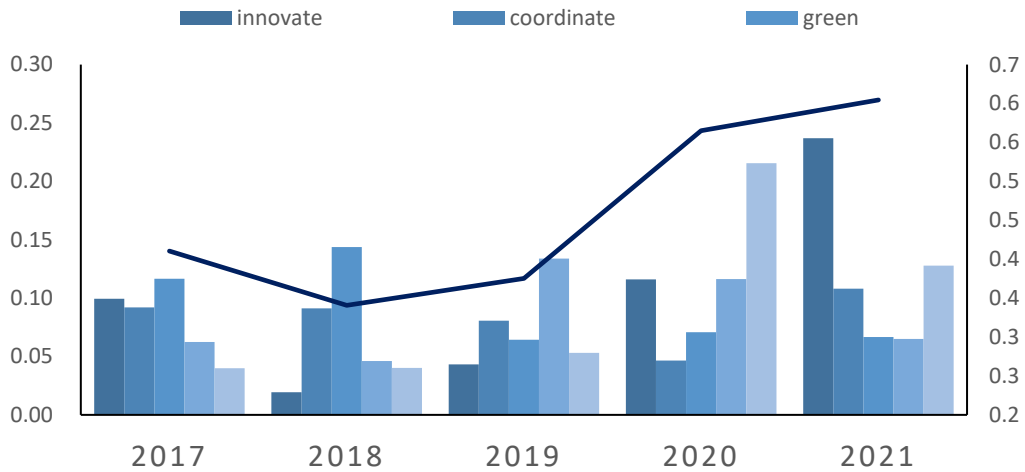
Figure 1: Comprehensive score of high-quality development level in Hunan Province from 2017 to 2021
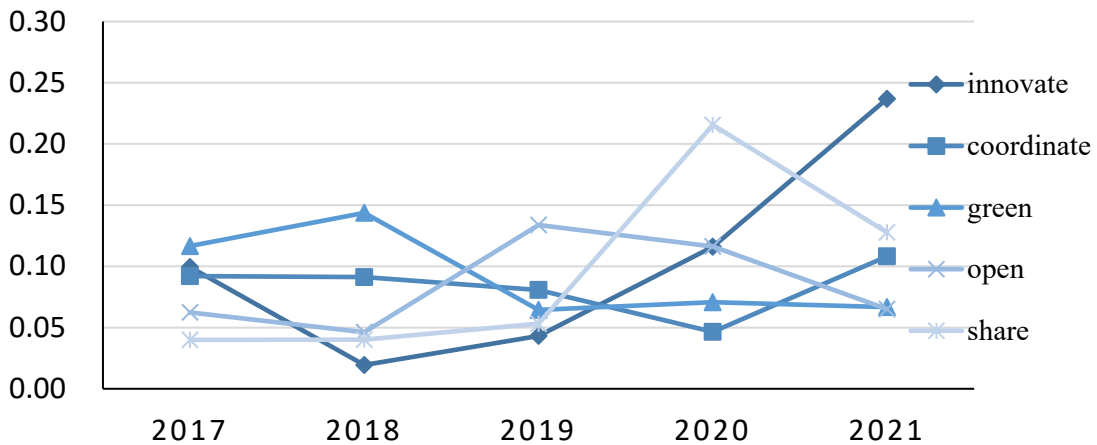

Figure 2: Five major development score trends in Hunan Province from 2017 to 2021

From Figure 2, it can be seen that from 2017 to 2021, innovative development has shown an overall upward trend. In terms of innovative development, the scores in 2018 and 2019 were lower than that in 2017, mainly due to the resistance encountered by high-tech industries in driving GDP growth. However, in the following two years, Hunan Province continued to make great progress in innovative development. Coordinated development showed a steady growth trend, with small fluctuations from 2017 to 2019 and a large drop of 42.3% in 2020 compared to the previous year. The main reason for this fluctuation was that the initial outbreak of the epidemic led to lower contribution of the tertiary industry to GDP growth and a decrease in the proportion of total retail sales of consumer goods to GDP. However, with the scientific and reasonable epidemic prevention and control in 2021, the score of coordinated development achieved a significant growth of 132.6%. The score of green development first increased and then decreased, with the highest score in 2018 and relatively stable fluctuation from 2019 to 2021. The main reason was that GDP growth still relied too much on energy consumption, and the elasticity coefficient of energy consumption and energy consumption per 10,000 yuan of GDP did not achieve effective reduction. The traditional model of relying on energy to drive economic growth is no longer suitable for the new development stage, and it is necessary to improve the traditional development model to promote green economy and achieve high-quality development. The score of open development showed a specific characteristic of first increasing and then decreasing, reaching the maximum value in 2019 and continuously decreasing in 2020-2021. The reason for this is that the outbreak of the COVID-19 epidemic caused a decrease in the proportion of import and export volume and attracted foreign investment, which hindered the development of open economy. The trend of shared development has been promising, with steady growth from 2017 to 2020. The ratio of disposable income between urban and rural residents has decreased, and the elasticity of income growth has also increased. This indicates that the overall prosperity and development of the economy

has led to a narrowing of the urban-rural gap, allowing the fruits of development to more fully benefit the general population.

4.2. Proposal and Strategies:

4.2.1. Developing high-tech industries to promote innovative development.

Policies to support the development of high-tech industries should be formulated, including relevant tax, subsidy, and investment policies. Special funds should be established to provide financial support to enterprises in emerging technological fields and to promote research and development in these areas. Financial support should also be provided to universities, research institutions, and enterprises to accelerate the development and marketization of new technologies. Science and technology innovation bases can be established to promote cooperation between research institutions and enterprises and to promote new technology. Technological talent development should be improved, and enterprises should be encouraged to cooperate with universities and research institutions to jointly cultivate talents in high-tech fields. An innovative system should be established to strengthen scientific and technological innovation and technological progress, enhance the endogenous driving force of economic development, and improve core competitiveness.

4.2.2. Optimizing the economic development structure to promote coordinated development.

The proportions of different industries in the economic structure should be reasonably adjusted. Strategic emerging and high-tech industries should be promoted, traditional industries should be transformed and upgraded, and the quality and efficiency of economic growth should be improved. Demand structure is an important component of economic development. Supply of consumer goods to residents should be strengthened, the scale of the service industry should be expanded, new consumption growth points should be cultivated, and the economy should be driven towards consumption. The urban-rural structure should be improved, and in the case of unbalanced development between urban and rural areas, attention should be paid to modernizing agriculture and building urban-rural integration. Balanced development of urban and rural infrastructure should be promoted, the modernization level of agricultural production should be improved, and urban planning should be optimized while enhancing linkage and coordination between urban and rural areas. Regional coordinated development planning and policy guidance should be strengthened to promote industrial synergy and resource complementarity between regions and improve regional economic linkage and competitiveness.

4.2.3. Improving the output efficiency of energy and achieving green development.

Clean energy development should be promoted, and the proportion of clean and renewable energy sources such as hydropower, wind power, and solar energy should be gradually increased to reduce dependence on fossil energy. Energy-saving technologies and devices should be promoted to improve energy utilization efficiency and reduce energy consumption costs. Publicity should be intensified for energy conservation, emissions reduction, and environmental protection, and a low-carbon lifestyle should be promoted to increase public awareness of environmental protection and foster a consensus for green development across society.

4.2.4. Rekindling economic vitality and accelerating opening up and development.

The scale of foreign trade should be expanded, and enterprises should be encouraged to actively participate in international trade, expand export channels, expand import markets, and actively participate in regional and international economic cooperation. Trade facilitation should be improved by building more efficient and convenient international trade channels, promoting the development of new types of trade models such as e-commerce and cross-border e-commerce, and accelerating the construction of a new pattern of domestic and international dual circulation. Domestic demand should be stimulated, the consumption potential of residents should be tapped, and the overall level of consumption should be increased. Policies to attract foreign investment should be implemented to increase the utilization efficiency of foreign capital and accelerate the development of new industries. Additionally, attention should be paid to the development of small and medium-sized enterprises, and policies to support their development should be formulated to create an environment conducive to their growth.

4.2.5. Assist in the construction of rural revitalization and promote shared development.

To support the development of rural areas and promote shared growth, it is essential to enhance the

construction of rural infrastructure by increasing investment in the development of basic infrastructure such as roads, electricity, communications, and water conservancy. Improving the convenience of transportation, energy, and information in rural areas can provide strong support for rural revitalization. Additionally, developing distinctive and advantageous industries through adjusting, optimizing, and upgrading rural industrial structures can create economic growth points for rural revitalization and advance agricultural modernization. To promote rural revitalization, it is necessary to introduce and cultivate a group of knowledgeable, skilled, and innovative talents. Strengthening talent introduction and cultivation, improving the quality and ability of rural talent, and cultivating a group of rural talent and industry skilled personnel is of utmost importance. Furthermore, encouraging enterprises and social capital to participate in rural industrial development and poverty alleviation is crucial. Promoting the construction of rural social governance and public service systems, strengthening the construction of rural social governance and public service capabilities, enhancing grassroots organization construction and social management, and improving the level of rural public services can drive rural revitalization, modernization, and achieve fair social development, accelerate urban-rural integration, and promote shared growth.

Acknowledgements

References

[1] Jin, B. (2018). Study on the "High-Quality Development" Economics. China Industrial Economics, 2018(04), 5-18. DOI: 10.19581/j.cnki.ciejournal.2018.04.001.

[2] Pu, X., & Fidrmuc, J. (2018). Study on Optimization of Power Structure in the New Normal Economic Development. Journal of Northwest University (Philosophy and Social Sciences Edition), 48(01), 113-118. DOI: 10.16152/j.cnki.xdxbsk.2018-01-014.

[3] He, Q. (2014). Endowments of Production Factors Internal Constraints and Quality of China's Economic Growth. Statistical Research, 31(01), 70-77. DOI: 10.19343/j.cnki.11-1302/c.2014.01.011.

[4] Sun, H., Gui, H., & Yang, D. (2020). Measurement and Evaluation of the High-quality of China's Provincial Economic Development. Zhejiang Social Sciences, 2020(08), 4-14+155. DOI: 10.14167/j.zjss.2020.08.001.

[5] Su, L., & Ma, X. (2022). Construction of Evaluation Index System for High-quality Economic Development. Statistics and Decision, 38(02), 36-40. DOI: 10.13546/j.cnki.tjyjc.2022.02.007.

[6] Ma, R., Luo, H., Wang, H., & Wang, T. (2019). Study of Evaluating High-quality Economic Development in Chinese Regions. Soft Science of China, 2019(07), 60-67.

[7] Su, Y., & Chen, C. (2019). Construction and Demonstration of Evaluation Index System for High Quality Economy Development. Statistics and Decision, 35(24), 38-41. DOI: 10.13546/j.cnki.tjyjc. 2019.24.008.

[8] Li, Q. (2021). Construction and measurement of evaluation index system for high-quality economic development. Statistics and Decision, 37(15), 109-113. DOI: 10.13546/j.cnki.tjyjc.2021.15.024.

[9] Ren, H., & Cui, J. (2022). Construction and Empirical Study of Evaluation Index System of High-quality Economic Development. Statistics and Decision, 38(13), 31-34. DOI: 10.13546/j.cnki.tjyjc.2022.13.006.

[10] Yang, M., Zhu, M., & Yin, T. (2021). High-quality Development Evaluation and the Measurement of Unbalanced of Provincial Economy in China, 2021(05), 5-21. DOI: 10.19313/ j.cnki. cn10-1223/f.2021.05.001.