

Evaluation of the Quality of Economic Development in Anhui Province Based on Entropy-TOPSIS Model

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Abstract: The quality of economic development is a key topic in economics research and an important measure of the merits of economic and social development. This paper takes the economic development quality of cities in Anhui Province as the research object, constructs the regional economic development evaluation index system, and uses the entropy-TOPSIS method to make a comprehensive evaluation of the economic development quality of cities in Anhui Province from 2011 to 2020. On this basis, this paper ranks the economic development quality of various cities in Anhui Province and develops spatial and temporal evolution analysis, and obtains the following conclusions: (1) The overall level of economic development quality in Anhui Province is low and has not yet been able to achieve high quality development, and there is much room for improving the economic development quality of local cities; (2) The imbalance of economic development quality among local cities in Anhui Province is serious, with the economic development quality in the east > west of the province, decreasing from the central region centered on Hefei to the north and south, and the difference of development level in the region is large and shows a trend of expansion. Therefore, in the new development stage, cities in Anhui province should propose development strategies according to local conditions, fully integrate into the Yangtze River Delta city cluster, and promote the inflow of production factors and industrial adjustment, so as to achieve high-quality economic development.

Keywords: Quality of economic development, Entropy method, TOPSIS, Economic quality evaluation.

1. Introduction and Literature Review

Anhui Province is located in East China, near the river and the sea, with 800 miles of cities along the river and the Wanjiang River Economic Zone, with the Yangtze River waterway inside and the coastal region economic radiation outside. The terrain consists of plains, hills and mountains; it spans three major water systems: the Huai River, the Yangtze River and the Xin'an River. Anhui, as a large Chinese province, is in a critical period of transformation and upgrading. The reason why it is necessary to continuously promote economic transformation and upgrading is that Anhui faces problems such as waste of resources, environmental pollution, unbalanced regional development and dualistic urban-rural economy in the process of economic growth, and it is imperative to promote high-quality regional economic development.

The quality of economic development has always been the focus of attention and research by experts and scholars at home and abroad, and is a key topic of economic theory research. Economic development includes multidimensional measurement of the efficiency, structure, stability and sustainability of the economy, so economic development is also more inclined to "good or bad", and the quality of regional economic development is also a comprehensive concept involving many, rich connotations. The research on evaluating the quality of regional economic development mainly starts from the selection of indicators and the application of research methods.

Regarding the selection of indicators: scholars have constructed different indicator systems to evaluate the provincial and urban economic quality development from the connotation of economic quality development respectively. Wen Yang et al. (2015) constructed indicators from five aspects such as economic development, infrastructure and social development and conducted a comprehensive

evaluation of the quality of urban development in China. In the work exploring the construction of indicators, some scholars also proposed to test the validity of indicators (Binxin Zhu, 2016). In further research, scholars have combined the subjective and objective methods to construct a theoretical indicator system of economic development quality from 221 specific observation indicators in four subsystems, including economic efficiency, innovation development, people's life, and sustainable development, at the stage of China's economic transition to high-quality development from the purpose and dynamics of economic development (Yunyun Zhang, et al, 2019). In addition, some scholars have also constructed a comprehensive evaluation index system based on the "five development concepts" by selecting indicators from five dimensions: innovation, coordination, green, openness, and development (Wang, Ximeng, 2020), and on the basis of summarizing the existing index systems and research methods, they proposed to construct a comprehensive index system consisting of economic fundamentals, ecological environment, education level, employment quality, etc, with seven dimensions. (Haijun Ren, et al, 2022). As for the application of research methods, Weilong Fang (2016) constructs an evaluation system of urbanization quality based on the entropy method, giving theoretical support for the specific application of the entropy method and model expansion. Zaiqi Chen et al. (2018) conducted a comprehensive evaluation and comparison of the quality of economic development in various cities and four major regions in Guangdong Province based on the entropy method evaluation model. Based on the connotation of high-quality development, Changdong Jin et al. (2021) used the entropy method and the coupling coordination degree model to study the level of high-quality economic development and its coupling degree coordination in various cities of Shandong Province. In addition, some scholars have also used a combination of entropy value method and hierarchical

clustering method to systematically evaluate the quality of economic development in China's coastal provinces (Zhonghui Wang et al, 2022).

To sum up, the issue of economic development quality has been the focus of attention and research by experts and scholars. Through the research of existing academic results, it is easy to find that the research on the quality of economic development mainly includes how to establish the indicator system and how to use the indicator system to conduct empirical research on countries or regions, while the single entropy method to evaluate the quality of economic development has shortcomings. Therefore, this paper takes the economic development quality of 16 cities in Anhui Province as the research object, constructs a regional economic development quality evaluation index system, uses the entropy weight TOPSIS method to compensate for the shortcomings of the single entropy value method, makes a comprehensive evaluation and ranking of the economic development quality of cities in Anhui Province from 2011 to 2020, and analyzes the spatial and temporal evolution of the results, in order to provide a scientific basis for the optimization path of high-quality economic development in Anhui Province.

2. Research Methodology and Indicator System

(i) Entropy-TOPSIS method

(1) Entropy value method to determine the weights

To eliminate the influence of different scales on the evaluation results, the indicators are standardized or normalized and the weight of the i th sample value under the j th indicator is calculated:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}}$$

Calculate the information entropy of each index:

$$e_j = -k \sum_{i=1}^n p_{ij} \ln(p_{ij}) \left(k > 0, k = \frac{1}{\ln n} \right)$$

Information utility value d :

$$d_j = 1 - e_j$$

Calculation of entropy weights:

$$W_j = \frac{d_j}{\sum_{j=1}^m d_j}$$

(2) Combined weighting with TOPSIS

Indicator forwarding and inverse processing:

$$\text{Positivization process: } x'_{ij} = \frac{x_{ij} - \min x_j}{\max x_j - \min x_j}$$

$$\text{Reversal of processing: } x'_{ij} = \frac{\max x_j - x_{ij}}{\max x_j - \min x_j}$$

Normalization matrix:

$$z_{ij} = x'_{ij} \times w_j$$

Optimal and inferior column values:

$$\text{Optimum: } z^+ = \left\{ \max_i(z_{i1}), \dots, \max_i(z_{im}) \right\} = (z_{ij}^+)$$

$$\text{worst: } z^- = \left\{ \min_i(z_{i1}), \dots, \min_i(z_{im}) \right\} = (z_{ij}^-)$$

Optimal and inferior distances:

$$\text{Optimal distance: } D_i^+ = \sqrt{\sum_{j=1}^m (z_{ij} - z_{ij}^+)^2}$$

$$\text{Worst distance: } D_i^- = \sqrt{\sum_{j=1}^m (z_{ij} - z_{ij}^-)^2}$$

Overall score:

$$C_i = \frac{D_i^-}{(D_i^+ + D_i^-)}$$

(C_i takes the value of (0,1), the closer to 1, the closer the evaluation object is to the optimal level, the higher the comprehensive score)

(II) Regional economic development quality evaluation index system

According to the connotation of regional economic quality development and the reality of Anhui Province's economic quality development, this paper constructs an index system with six dimensions of economic growth, economic structure and innovation development as the first-level indicators from the perspective of scientificity and rationality (Table 1).

Table 1. Regional economic quality development evaluation index system

Level 1 Indicators	Evaluation Indicators	Unit
Economic Growth	GDP growth rate	%
	Value added of tertiary industry	Billion
	Industry-wide electricity consumption	Billion kWh
	Industrial water withdrawal	million cubic meters
Economic Structure	Number of employed persons in the financial sector	person
	The proportion of added value of tertiary industry	%
	Total retail sales of social consumer goods	million yuan
Innovative Development	Science and technology expenditures	million yuan
	High-level talent	People per 10,000 people
	Number of patents granted	item
Coordination of development	Urban population share	%
	Urban Population Density	People per square kilometer
	Urban registered unemployment rate	%
	Urban-rural income ratio	%
People's Welfare	GDP per capita	million yuan
	Years of schooling per capita	year
	Public Library Book Collection	Thousands of copies, pieces
	Medical Resources	Beds per 10,000 people
	Road area per capita	Square meters
	Number of urban residents with minimum living standards	million people
Green Ecology	Green space per capita	Square meters
	Total municipal wastewater treatment	million cubic meters
	Amount of harmless disposal of domestic waste	million tons

(iii) Description of data sources

The data of 16 cities in Anhui Province from 2011 to 2020 used in this paper are mainly from the Statistical Yearbook of Anhui cities and the websites of cities and Anhui Provincial Bureau of Statistics. For a small amount of missing data, this paper mainly uses interpolation method to fill in the data.

3. Economic Development Quality Measurement Results and Spatial and Temporal Evolution Characteristics of Anhui Province

In this paper, the entropy-TOPSIS method is applied to measure the economic development quality of 16 cities in Anhui Province from 2011 to 2020 and rank them according to their relative proximity, and the results are shown in Table 2. where the higher the relative proximity C of each city, the better the quality of the city's economic development.

Table 2. Quality level of economic development in 16 cities in Anhui Province

prefecture-level city	2011		2013		2015		2018		2020	
	Relative proximity C	Ranking	Relative proximity C	Ranking	Relative proximity C	Ranking	Relative proximity C	Ranking	Relative proximity C	Ranking
Hefei	0.762	1	0.933	1	0.923	1	0.985	1	0.991	1
Huaipei	0.112	8	0.18	9	0.128	8	0.065	12	0.029	14
Bozhou	0.034	15	0.058	15	0.09	12	0.06	13	0.042	13
Suzhou	0.033	16	0.052	16	0.088	13	0.055	14	0.051	11
Bengbu	0.123	7	0.242	5	0.229	4	0.133	4	0.094	4
Fuyang	0.069	11	0.114	10	0.119	9	0.105	8	0.084	6
Huainan	0.171	4	0.202	7	0.173	5	0.1	9	0.051	12
Chuzhou	0.071	10	0.092	11	0.116	10	0.118	5	0.1	3
Lu'an	0.087	9	0.088	12	0.07	16	0.091	11	0.065	9
Ma'anshan	0.478	2	0.281	4	0.246	3	0.172	3	0.092	5
Wuhu	0.455	3	0.375	2	0.405	2	0.46	2	0.284	2
Xuancheng	0.063	12	0.08	13	0.094	11	0.105	7	0.069	8
Tongling	0.141	5	0.219	6	0.169	6	0.099	10	0.052	10
Chizhou	0.04	14	0.068	14	0.071	15	0.038	16	0.022	16
Anqing	0.136	6	0.188	8	0.145	7	0.116	6	0.076	7
Huangshan	0.045	13	0.312	3	0.083	14	0.055	15	0.025	15
Average value	0.176	-	0.218	-	0.197	-	0.172	-	0.133	-

The quality of economic development of cities in Anhui Province from 2011-2020 shows an overall trend of decreasing from the east to the west, and from the central region centered on Hefei to the north and south ends from a spatial perspective.

In terms of the quality of economic development in Anhui Province, the regional disparity in the level of economic development quality among cities in Anhui Province widens from 2011 to 2020. Relative to 2011, 62.5% of the cities in Anhui Province in 2020 experienced a decline in relative degree, and the relative proximity of the remaining 6 cities increased, which indicates that the gap of economic development quality level among cities widened. In 2011, the difference between Hefei and Suizhou, the city with the lowest relative proximity, is 0.729, while in 2020, the difference between Hefei and the city with the lowest relative proximity is 0.969, so the gap between regions is still expanding. Wuhu city, Bengbu city and Maanshan city are basically at the top of the ranking of the quality level of economic development of cities in Anhui province from 2011 to 2020, while Chuzhou city and Suzhou city are ranked third and eleventh in 2020, up seven and five places respectively compared with 2011. Wuhu and Bengbu cities are better developed in the province mainly due to their historically better economic development conditions, active economic development policies and the development-driven role of the provincial capital city Hefei, while Maanshan, Chuzhou and Suzhou cities are later on top mainly because they are mainly located at the border between Anhui Province and Jiangsu Province, adjacent to the developed city of Nanjing and subject to the radiation effect of Nanjing's economic

development, and because Anhui Province Since 2014, cities have been joining the Yangtze River Delta city cluster, and the convenience of geographical location makes the economy of these cities driven by the Yangtze River Delta more significant.

Looking at the optimal proximity of Anhui Province from 2011 to 2020, the optimal proximity of Anhui Province as a whole ranges from 0.133 to 0.218, which indicates that the overall economic development quality level of Anhui Province is low. The reason for this is that Anhui Province is located in the central region of China, and its economic development has poor location advantages and policy conditions, and it has joined the Yangtze River Delta city cluster for a short time, so its development ability and level are poor. From the optimal proximity of cities in 2011-2020, the optimal proximity of most cities in each year is between 0.022 and 0.478, except for Hefei, which is less than 0.5, indicating that there is still a lot of room for improving the quality of economic development of cities in Anhui Province. The quality of economic development in Hefei is absolutely dominant in the region.

4. Conclusions and Recommendations

This paper takes 16 cities in Anhui Province as the research objects, evaluates the economic development quality of each city in Anhui Province in six dimensions: economic growth, economic structure, innovation development, coordinated development, people's welfare and green ecology, and analyzes its spatial and temporal differentiation characteristics. Through the empirical analysis, the following conclusions are obtained: (1) The overall level of economic

development quality in Anhui Province is low, except for Hefei City, the economic development quality of all cities in the province is at a low level and has not yet been able to achieve high-quality development, and there is more room for improving the economic development quality in Anhui Province and all cities. (2) There is a large gap between the quality of economic development of cities and regions in Anhui Province, and the uneven economic development among cities and regions is serious. Spatially speaking, the quality of economic development in the province as a whole is east > west, with the central region centered on Hefei decreasing towards the north and south ends. The quality of economic development in Hefei is absolutely leading and far more than other cities in the province, in addition, cities located at the border of Anhui Province and Jiangsu Province and around Hefei are developing faster, and the gap of economic development quality among cities shows a widening trend.

Although the economic development of cities in Anhui Province from 2011 to 2020 has made certain achievements, the overall level of cities and Anhui Province is low, and there is still a big gap from realizing regional high-quality development, and the imbalance of economic development quality in the region is serious, in this regard, this paper proposes the following suggestions: (1) to realize the high-quality economic development of cities in Anhui Province, we should focus on the all-round development of economy and society. In addition to the regional economic growth, it is also necessary to promote the development of green ecology, people's welfare and economic structure, so as to get rid of the single economic development index and promote the improvement of economic development quality from multiple dimensions. In addition, Anhui Province should pay more attention to innovation development strategy, break the traditional constraints of resource and factor endowment through innovation economy development, and realize the rapid development of regional economy. In the process of developing innovative economy, we should promote diversified industrial innovation, drive the innovation development of industrial chain through the innovation of high-end industry, and link regional innovation with basic innovation. The innovation economy ecosystem should be built with high level, high standard and high openness. (2) The imbalance of regional development in Anhui Province is prominent, and it is necessary for each city to narrow the development gap according to local conditions, take into account the actual development situation of each city, give full play to the advantageous conditions, make up the shortcomings of development, propose suitable development strategies, and increase the tilting of resources to the less developed areas and indicators. In the new economic development, cities in Anhui Province should give full play to their comparative advantages, prioritize the development of leading industries that meet their own interests and match their regional characteristics, and promote the coordinated and efficient development of industries. Similarly, in order to better promote local economic development, cities can implement innovation-driven strategies, increase investment and support for science and technology and research and development, protect innovation, and continuously promote the introduction of talents, so as to better achieve steady progress in the economic development of each city. (3) In order to improve the quality of economic development, Anhui Province should give full play to the economic center of Hefei

City, the provincial capital, strengthen the construction of the provincial capital city and the "Hefei metropolitan area", cultivate new economic growth capacity in Anhui, and drive the development of more neighboring cities through the geographical center of Hefei City. We should take advantage of the development opportunities and policy benefits of the Yangtze River Delta city cluster and the geographical conditions of the neighboring Jiangsu province to learn and cooperate with the developed cities of the Yangtze River Delta in various aspects, so as to drive the scientific and technological innovation and technological progress of Anhui Province and promote the inflow of various production factors from the Yangtze River Delta to Anhui Province, thus making the welfare of reform and opening up benefit all cities in Anhui, promoting the development and quality of Anhui economy and realizing the high-quality development of regional economy.

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