Measurement Research of High-Quality Economic Development of East China Based on Critic Weight and Comprehensive Index Method

Ziyi Fan[1], Jinzhi Fan[2]

[1]School of Changzhi University, Changzhi, 046011, China
[2]School of Changsha University of Science & Technology, Changsha, 410114, China

Abstract: *It is of great practical significance to measure the level of high-quality economic development and make regional research on it for realizing the new pattern of development under the background of common prosperity. Based on this, First, this paper takes the data of East China from 2014 to 2019 as the research object, and considers the five development concepts of innovation, coordination, green, open and sharing to construct the index system of high-quality economic development of East China, then use the Critic and Comprehensive Index Law to measure the high -quality economic development level of East China. In addition, this paper uses the Theil index, coefficient of convergence and coefficient of variation have performed the level of time and space to analyze the level of high-quality economic development. The empirical results show that the quality of green development and the quality of open development have contributed the greatest increase in the level of high-quality development in East China. At the same time, the comprehensive index of high-quality development of the provinces in various provinces has shown an upward trend, the coordinated development between provinces and the pace is gradually consistent, but the differences in the same dimension in different provinces are large. Based on the conclusion of the appeal, relevant countermeasures and suggestions are put forward for realizing the high-quality economic development in East China under the new pattern.*

Keywords: *High-quality economic development, Critic method, Comprehensive index method, Convergence analysis, Cluster analysis*

1. Introduction

From 2012 to 2022, China's economy maintained rapid growth. To build a strong modern socialist country and avoid problems of uneven and inadequate economic development in various regions, our future economic growth must pay more attention to the improvement of economic quality, and make the economy open to a deeper and higher level of coordinated development. Among them, East China has become one of the regions with the fastest economic development by under its superior geographical location and innovative development ideas. Compared with most regions in central and western China, it has a higher degree of high-quality economic development. Therefore, its high-quality economic development level plays an important role in promoting the national economic development.

At present, many scholars have conducted researches on high-quality economic development in different directions, including the essence of high-quality development, the construction of the index evaluation system of high-quality development and the measurement of the level of high-quality development. Pei Jin[1] proposed that the essence of high-quality development is to meet people's ever-growing needs in various effective and sustainable ways, and that the criterion of high-quality development is whether it can meet people's ever-growing needs for a better life. Yongchang Wang[2] and others propose that high quality development is the objective request and inevitable trend of our economic development. Due to the different understanding of high -quality development, the index evaluation system established has large individual differences. Ru Ma and others[3] By analyzing the overall situation of high -quality development of China's regional economy through high-quality supply, high-quality demand, development efficiency, economic operation, and opening up to the outside world; the overall situation of China's regional economy; Min Wei and others[4] have established a high-quality development level measurement system covering 10 economic development levels such as economic structure optimization, innovation-driven development and economic achievements. For the study on the measurement method of high-quality economic development level, Menggen Chen and others[5]2 used the improved TOPSIS comprehensive evaluation model to conclude that the economic growth of central

and western provinces is fast, the economic growth of eastern regions slows down and enters the stage of improving the economic quality, and the development of central and western regions is slightly lagging. Jing Wang and others[6] , Xia Zhang and others[7] adopt linear weighted comprehensive evaluation models and entropy right to measure the high-quality development index of the provincial economy in China, Yu Hong and others[8] based on the gray system theory model, the high-quality development index of my country's economy is constructed.

To sum up, since "high-quality development" has been proposed for a short time, scholars' understanding of the essence of high-quality development system, the construction of high-quality development index system and the application of measurement methods are subjective and different. At present, most of the existing literature is mainly about the overall evaluation and analysis of China's high-quality economic development level. However, due to the different economic development environments and models in different regions of the country, it is more practical to study the measurement of regional high-quality economic development level.

Based on this, the main contribution of this paper is:

(1) Through the theoretical analysis of the high-quality development level of East China's economy, the measurement index system based on the five development concepts is constructed.

(2) For the first time, the combination measurement method and the comprehensive index method are combined, and the important conclusion is drawn that the level of high-quality economic development in each region is increasing year by year and the difference in high-quality economic development in each region is decreasing year by year.

2. Theories and Methods

2.1 The Construction of the indicator system

Table 1: East China Economic Economic High-quality indicator evaluation system

First -level indicator	Secondary indicators
Innovation	Regional GDP growth rate(+)
	Intensity of R&D investment(+)
	efficiency of investment (-)
	Technology trading activity rate(+)
	R&D activity personnel reduced to full time(+)
Coordination	Demand structure(+)
	Urban and rural structure(+)
	Industrial structure(+)
	Government debt burden(-)
	Theil index(-)
green	energy consumption elasticity coefficient(-)
	Waste water per unit of output(-)
	Exhaust gas per unit of output(-)
	forest coverage rate(+)
	Saving water consumption (10,000 cubic meters)(+)
	Comprehensive utilization rate of industrial solid waste(+)
Open	Proportion of workers' remuneration(+)
	Elasticity of personal income growth(+)
	Gap between urban and rural consumption(-)
	Share of private fiscal expenditure(+)
Share	Total import and export(+)
	Proportion of foreign investment(+)
	ratio of dependence on foreign trade(+)
	Degree of financial development(+)

Notes: In the second column, "+" means that the indicator is a positive indicator, and "-" means that the indicator is a reverse indicator.

During the "14th Five -Year Plan" period, my country will enter a new stage of development. Referring to Menggen Chen and others[5]4 this paper constructs a four-level evaluation index system, namely, the target level, The first-level index layer is set to take the development concept of "innovation,

coordination, green, open and sharing" as the theoretical basis for constructing the index system of high-quality economic development. In addition, with reference to Jinfeng Ou and others[9] and Changjiang Chen and others[10], corresponding second-level indicators are set up to construct a relatively complete evaluation index system. For each second -level indicator, this article further determines the indicator of each second -level indicator according to the connotation and essence of its high-quality development and the availability and effectiveness of the data. The comprehensive evaluation index system is based on the overall economic development index, including 5 first-level indicators and 24 secondary indicators. Indicators at all levels, specific indicators explain the documents of reference Hao Sun and others[11], such as Table. 1.

2.2 *CRITIC* method and comprehensive index method

(1) *CRITIC* method

CRITIC method is a better than the entropy weight method and the standard deviation method of objective method. It is based on the comparison strength of the evaluation indicators and the conflict between the indicators to comprehensively measure the objective weight of the indicator. After the index is not processed with infinite and variability, it is expressed in the form of standard deviation:

$$\begin{cases} \bar{X}_j = \dfrac{1}{n}\sum_{i=1}^{n} X_{ij} \\ S_j = \sqrt{\dfrac{\sum_{i=1}^{n}(X_{ij} - \bar{X}_j)^2}{n-1}} \end{cases} \tag{1}$$

Where S_j represents the standard deviation of the j indicator, and the larger the standard difference, the greater the value difference in the index.

$$R_j = \sum_{i=1}^{p}(1 - r_{ij}) \tag{2}$$

r_{ij} is the coefficient between the indicator i and the indicator j, and finally handle the amount of information of the weight. get:

$$C_j = S_j \sum_{i=1}^{p}(1 - r_{ij}) = S_j \times R_j \tag{3}$$

So the objective weight W_j of the j indicator is:

$$W_j = \frac{C_j}{\sum_{j=1}^{P} C_j} \tag{4}$$

(2) Comprehensive index method

On the basis of obtaining the weights of each indicator, the method of drawing on the UNDP to prepare the human development index method, that is, the IFI index method, and the calculation of high-quality economic development indexes.

$$IFI_i = 1 - \frac{\sqrt{(W_1 - E_{1i})^2 + (W_2 - E_{2i})^2 + \cdots + (W_k - E_{ki})^2}}{\sqrt{w_1{}^2 + w_2{}^2 + \cdots + w_k{}^2}} \tag{5}$$

IFI_i is the high-quality economic development index in the i -th area; E_k represents the calculation value of the first K -dimension; w_k means the weight of the first k. The high-quality economic development index, 0,1-, when IFI_i is 1, indicates that the level of high-quality economic development at this time is the highest. When it is 0, it means that the level of high-quality economic development at this time is the lowest.

The evaluation of high-quality development level in this paper is based on the above five dimensions, and the calculation formula is shown as follows: $E_{ki} = w_k * Y_{iK}$, Among them, Y_{iK} indicates that the value of the first K item indicator of the i province is valuable; the indicator weight wi uses Excel software, and the entropy value method is used to calculate. Y_{iK} is standardized processing data.

2.3 The Thiel index and Convergence index

(1) Thiel index

This paper first introduces Theil index to measure the difference level of high-quality economic development in East China. The model is as follows:

$$Tl = \frac{1}{n}\sum_{i=1}^{n}(\frac{D_{\theta i}}{\overline{D_{\theta \iota}}} \times ln\frac{D_{\theta i}}{\overline{D_{\theta \iota}}}) \tag{6}$$

The $D_{\theta i}$ said the first i provincial coupling coordination degree, $\overline{D_\theta} = \frac{1}{n}\sum_{i=1}^{n}D_{\theta i}$ for east China provincial coupling coordination degree average. The closer the Thiel index is to 0, the smaller the difference of coupling development between provinces. The closer you get to 1, the greater the coupling difference

(2) Coefficient of convergence and coefficient of variation

In this paper, coefficient of convergence and coefficient of variation are introduced to measure the convergence characteristics and deviation degree of coupling coordination degree. The model is as follows:

$$\tau_\theta = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(ln(D_{\theta i})) - \frac{1}{n}\sum_{i=1}^{n}ln(D_{\theta i}))^2} \quad V_\theta = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(D_{\theta i} - \overline{D_{\theta \iota}})^2}}{\overline{D_{\theta \iota}}} \tag{7}$$

Among them, τ_θ is the convergence coefficient, V_θ is the mutation coefficient, and the smaller the τ_θ and V_θ, the stronger the convergence.

3. Empirical results

3.1 Data source and Pre-processing

The statistical data of the relevant indicators in this paper comes from the "Chinese Statistics Yearbook", the provincial statistical yearbook, the "China Regional Economic Statistics Yearbook", the "China Financial Yearbook", "China Environment Statistics Yearbook", "China Trade Foreign Classics Statistics Yearbook" and *ifind* financial data terminal. In the process of correlation analysis, necessary statistical processing and adjustment have been carried out for each index data. Firstly, the missing value is processed by means of mean value and interpolation method. Secondly, the data of each index is normalized.

3.2 High quality economic development index measurement results

This paper uses $CRITIC$ method and comprehensive index method for east China region economic development level of high quality for the study of measure.

Table 2: Weights of high-quality economic development indicators in East China

Indicators	Weight
Share	0.16080618
Coordination	0.18649368
Innovation	0.19718309
Open	0.22595942
Green	0.26483363

The Weights of high-quality economic development indicators in East China of Table. 2 can be obtained. Green development accounts for the highest weight of 26.48%, followed by open development, accounting for 22.60%. The weight of shared development is 16.08%, which is the least, and the middle position of coordinated development and innovative development is 18.65% and 19.72%, respectively. Therefore, we need to maintain in -depth advancement, and should vigorously develop and share, coordinate and innovate the economy, thereby improving the level of high-quality economy.

It can be seen from the measurement results that the overall economic quality index of all provinces in East China showed an upward trend during 2014-2019. Therefore, the improvement of high-quality economic development level in East China is not the result of a single factor, but the overall influence of innovation strategy, coordinated development, green economy, opening to the outside world and mutual benefit and sharing. Under the background of regional economic integration in East China, the provinces begin to move towards the integration development stage of more agglomeration and close cooperation.

From the perspective of the development of the specific comprehensive index, Zhejiang Province is one of the provinces with the strongest comprehensive economic strength. Its economic index reaches 0.582. Its absolute gap with Shandong Province and Jiangxi Province has a widening trend. The highest index of Shanghai, Fujian Province, and Jiangsu Province maintains the median economic development of the region; From the perspective of the volatility of high-quality economic development, The economies of Anhui Province, Shanghai, and Zhejiang and Jiangxi provinces are growing steadily, Jiangsu, Shandong and Fujian provinces were more volatile. In summary, the high-quality development of the provinces in East China is booming, analyzing the following reasons:

(1).The deepening of the new round of scientific, technological and industrial revolution in the global environment has brought new opportunities for the transformation of growth momentum, structure and quality of China's economic development, as well as new directions for regional economic development.

(2).The major projects of the "Fourteenth Five-Year Plan" are implemented rapidly, the infrastructure of regional infrastructure has been continuously strengthened, and the active factors of effective investment have been fully mobilized. The development potential of China's economy has been continuously released, and government investment can be further used.

(3).Emerging economic development forms such as green finance and digital economy make regional economic development more diverse and flexible. At the same time, the implementation of rural revitalization and other strategies makes regional exchanges closer and the utilization of available resources has reached the maximum.

3.3 Convergence analysis results

The results of the convergence analysis of Figure. 1 in East China can be seen that the overall Coefficient of Variation, Theil index, Coefficient of dispersion of East China are less than 0.3. From 2014 to 2015, there was a rapidly decreasing trend, and the overall trend was stable, indicating that the gap between the regions with lower economic development levels and the regions with higher economic development levels was narrowing year by year.
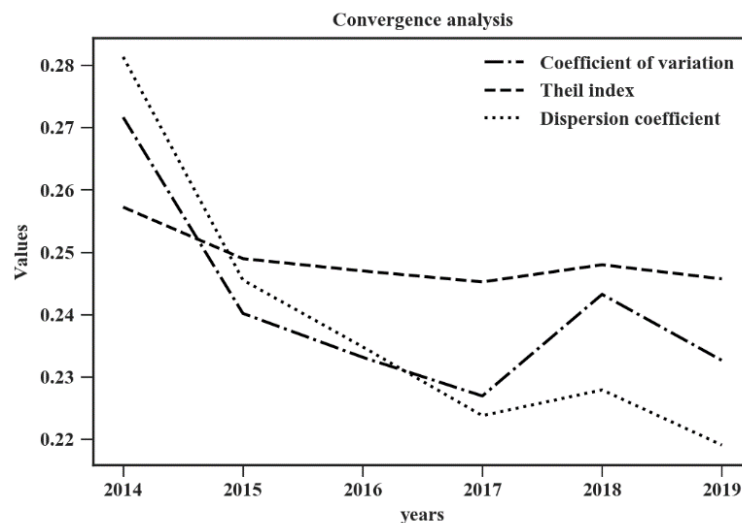

Figure 1: Analysis of convergence analysis in East China

The reason is that relevant economic support policies gradually spread from the initially economically developed provinces to the whole country, the development speed of provinces with a good economic foundation is delayed, and the development of provinces with a weak economic foundation is constantly accelerated, thus narrowing the gap between provinces, Since the reform and opening up, the regional economy has formed the pattern of implementing the strategy of "four sectors" and "three support belt". According to the relevant conclusions of Aimin Pan and others[12], the rise of new economic development channels such as digital economy has greatly enhanced the economic resilience of cities in East China, so East China shows obvious regional convergence on the whole.

Table. 3 shows the specific data results of Theil index, Coefficient of Variation and Coefficient of dispersion in East China during 2014-2019, From the results of data statistics, it can be seen that the overall economic level of East China is more coordinated, the indexes have developed steadily, and the overall

economic development trend is good in the future.

Table 3: Convergence index in East China

Year	Coefficient of Variation	Theil index	Coefficient of dispersion
2014	0.271683	0.257269	0.281363
2015	0.240230	0.249012	0.245589
2016	0.233203	0.247040	0.234868
2017	0.226990	0.245278	0.223831
2018	0.243285	0.248034	0.227962
2019	0.232689	0.245761	0.219125

3.4 Latest Clustering Results

The results of the comprehensive high-quality and economic evaluation of various provinces in East China are shown in Table. 4. According to the clustering summary of evaluation indexes of provinces in East China from 2014 to 2019, this paper divides seven provinces into three categories, and the evaluation results are successively high, medium and low. Zhejiang Province belongs to the first category, its economic growth rate is stable, and the overall economic quality is high; Fujian Province, Jiangsu Province and Shanghai belong to the second category. The development level of high-quality economy of the three provinces is in the middle, without great fluctuation, and the economic situation is good and steady. Anhui, Jiangxi and Shandong provinces are in the third tier, with a lower level of high-quality economic development. In terms of spatial dimension, Zhejiang Province has a high level of economic development, Fujian Province, Jiangsu Province and Shanghai are always at a medium level of economic development, and Anhui Province, Jiangxi Province and Shandong Province are at a low level of economic development. From the perspective of time dimension, the clustering results of most provinces did not change much during 2014-2019, and all provinces were able to maintain high economic quality.

Table 4: Evaluation results of comprehensive index of East China provinces

	2014	2015	2016	2017	2018	2019
Anhui	L	L	L	L	L	L
Fujian	M	M	M	M	M	M
Jiangsu	M	M	M	M	M	M
Jiangxi	L	L	L	L	L	L
Shandong	L	L	L	L	L	L
Shanghai	M	M	M	M	M	M
Zhejiang	H	H	H	H	H	H

Notes: The clustering results can be divided into three categories, "H" is the high level of economic development, "M" is the medium level, "L" is the low level.

4. Conclusions and Suggestions

This paper aims at the problem that the level of regional economic development in East China is not balanced and not comprehensive, by using the comprehensive index method, the paper probes into the economic quality development index of East China, and obtains the positive conclusion that the economic development level of each province in East China increases year by year, and the development level of each province is the same, and the regional economic quality index keeps rising as a whole. Based on these conclusions, the following suggestions are put forward:

(1).Strengthen the investment in innovative technology and the policy implementation of innovation choice. East China has a relatively low level of high-quality economic development in the three dimensions of innovation, coordination and sharing, but maintains a large lead in the two dimensions of green and open economy. We should further increase the utilization rate of environmental resources, open regional markets more intensively, and improve the mode of economic development. At the same time, it is one of the important ways to enhance the high-quality development level of East China's economy to increase the policy support of technology industry and technology innovation enterprises.

(2).In terms of promoting the transformation of economic development methods, East China should promote the construction of a high -level socialist market economic system and supply -side structural reform with greater efforts to accelerate the transformation of government functions, so that all industries can fully and effectively use government policy subsidies to create and create to create Harmony, mutual

benefit, and win -win market environment.

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