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Calculation of the Development Level of Digital Economy in the Yangtze River Economic Belt

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Abstract

As an important strategic area to promote the high-quality development of China's economy, the Yangtze River Economic Belt has significant scale advantages and leading advantages in the development of the digital economy. Combined with existing research and based on the data from 2016 to 2020, from the four dimensions of potential development, infrastructure, industrial development and scientific and technological innovation, build a digital economy development level measurement index, and use the entropy weight method to establish the Yangtze River economic provinces and prefectures development level of the city. The study found that the development level of the digital economy in the Yangtze River Economic Belt has continued to rise, but there is still a problem of unbalanced regional development.

Keywords

Entropy Weight Method; Yangtze River Economic Belt; Digital Economy.

1. Introduction

In 1994, China officially entered the Internet era, and at the same time, the digital economy also entered the beginning of the development of a relatively single business model. After going through the budding period, the downturn period and the high-speed growth period, the attention of China's digital economy continued to increase, and in 2013, it officially entered the mature period, forming a new development pattern. General Secretary Xi Jinping emphasized the need to accelerate the development of the digital economy and digital transformation, and use the digital economy to promote social and economic development. In addition, the "14th Five-Year Plan" also clearly stated that it is necessary to increase the efforts to promote digital development and build a digital China. As an important strategic area to promote high-quality economic development in China, the Yangtze River Economic Belt has significant scale advantages and leading advantages in the development of the digital economy. In 2018, the development of the digital economy in the Yangtze River Economic Belt was very impressive, with a scale of more than 12 trillion yuan,accounting for almost half of the national total. In 2019, China's digital economy has grown substantially, reaching 35.8 trillion yuan. Among them, the added value of the digital economy in seven provinces and cities in the Yangtze River Economic Belt has exceeded 1 trillion yuan. The industrialization of the digital economy in the Yangtze River Economic Belt has also been further improved.

The digital economy is an emerging economic form in the new era, which plays a vital role in social development and industrial upgrading. This paper uses the entropy weight -TOPSIS model to measure the development of the digital economy in the 11 provinces and cities covered by the Yangtze River Economic Belt, so as to gain a deep understanding of the development of the digital economy in the Yangtze River Economic Belt.

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2. Literature Review

As a hot topic of the times, the digital economy has aroused heated discussions in the academic circles. At present, most scholars' research on the digital economy focuses on the connotation and definition of the digital economy and the powerful driving force provided by the development of the digital economy to related industries. For example, Li Changjiang (2017) compared the digital economy with other related concepts. [1]He believed that the digital economy essentially refers to social production in the form of digital technology. Zheng Jianzhuang and Li Qiang (2020) deeply analyze the concept of digital economy from different perspectives[2], define the scope of digital economy, and summarize its characteristics. Qian yiwen (2021) [3] found that the development of the digital economy can promote the transformation and upgrading of China's manufacturing industry, and at the same time, it will also greatly improve the modernization level of the manufacturing industry. Zhao Lei (2022) [4]discussed the enabling role of the digital economy in the high-quality development of the tourism industry, and studied the solution mechanism for the digital economy to reshape the tourism industry.

At the same time, due to the lack of research on the construction and measurement of digital economy indicators in the academic community, there is no unified statistical indicators and standards for measurement, resulting in the measurement of the development level of the digital economy becoming a shortcoming of digital economy-related research. Accurately discover the problems existing in the actual development of the digital economy and accurately implement policies. In the past two years, although the research on the measurement of the digital economy has gradually deepened, it has not been able to keep pace with the rapid development of the digital economy.

In terms of measuring the development level of digital economy, Jia Qi (2020) [5] conducted an empirical analysis on the development level of China's digital economy from three perspectives: penetration and application level, benefit and scale, and R&D innovation capability. Ji Xiaoyan (2020) [6]combined the statistical data of Zhejiang Province to study the comprehensive level of its digital economy development. Xu Xianchun and Zhang Meihui (2020) [7]measured China's digital economy development level from the perspective of national comparisons around the world. Wu Xiaoting and Zhang Keyu (2021) [8]studied the measurement of the integrated development of digital economy industry and manufacturing from the perspective of input and output. Wang Liying (2021) [9]pointed out the dilemma of the current measurement of industrial digitalization, and put forward suggestions for the measurement of the digital economy. Jiang Jianglin (2021) [10]conducted a comparative analysis of the development status of the digital economy in China, the United States, and Europe. Kwong Jinsong and Shi Xiaofei et al. (2022) [11]calculated the level of digital economy development based on the national and provincial statistical data from 2005 to 2017.

To sum up, although the current research on the digital economy has achieved certain results, there are still shortcomings. First, there is no unified and authoritative definition of the digital economy available; second, the calculation of the comprehensive index of the digital economy is mostly theoretical elaboration, and lacks empirical research and calculation; the third is to measure the development level of the digital economy. There is still a lot of room for improvement in the specific methods of the digital economy, including defining the statistical scope of the digital economy and dividing the statistical classification of the digital economy. Therefore, how to measure and compare the development of the digital economy is a key proposition for us to pursue high-quality economic development in the new era, which is conducive to the sustainable and healthy development of the Chinese economy.

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3. Design Research

3.1. Data Sources

In the calculation of the high-quality development of the digital economy in the Yangtze River Economic Belt, this paper selects the panel data of 11 provinces and municipalities in the Yangtze River Economic Belt from 2016 to 2020. The data for the indicators are all from the official website of the National Bureau of Statistics.

3.2. Selection of Principles and Indicators for the Construction of the Evaluation System

Table 1. Selection of evaluation indicators

	dimension layer	Indicator layer	Indicator positive and negative
The high-quality development of the digital economy in the Yangtze River Economic Belt is estimated	potential development	Number of students in colleges and universities	+
	infrastructure	Internet broadband penetration	+
		telephone penetration	
	Industrial Development	Software business revenue as a percentage of regional GDP	+
		Total telecom business	+
	Technological innovation	Number of patent applications of industrial enterprises above designated size	+
		Average R&D research expenditure of industrial enterprises above designated size	+
		The number of full-time R&D personnel in industrial enterprises above designated size	+
		Average number of new product projects of industrial enterprises above designated size	+

Note: Internet broadband penetration rate = number of Internet broadband access / number of permanent residents.

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In view of the development characteristics of the digital economy in the Yangtze River Delta Economic Belt, this paper focuses on the four dimensions of potential development, infrastructure, industrial development and technological innovation, and selects the number of college students, optical cable line density, Internet broadband penetration, telephone Proportion of software business revenue to regional GDP , total telecommunications business, number of patent applications of industrial enterprises above designated size, average R&D research expenditure of industrial enterprises above designated size, number of full-time R&D personnel equivalent to industrial enterprises above designated size, average number of new product projects of industrial enterprises above designated size , ten indicators, which comprehensively cover the development of the digital economy in the Yangtze River Economic Belt.

3.3. Entropy Weight -TOPSIS Model

3.3.1. Data Normalization

$$\lambda_{ij} = \frac{\lambda_{ij} - \min(\lambda_{ij})}{\max(\lambda_{ij}) - \min(\lambda_{ij})}$$

3.3.2. Variability of Indicators

$$p_{ij} = \frac{\lambda_{ij}}{\sum_{i=1}^{9} \lambda_{ij}}$$

3.3.3. Information Entropy and Information Utility Value of Each Index

$$e_j = -\frac{\sum_{i=1}^{9} p_{ij} \ln p_{ij}}{\ln 9}$$

The formula for calculating the information utility value is:

$$d = 1 - e_j$$

3.3.4. The Weight of Each Indicator

If the information entropy of each indicator is e_j , then the weight of each indicator is calculated by the information entropy:

$$w_{ij} = \frac{1 - e_i}{n - \sum e_i}$$

3.3.5. Calculate the Distance from the Ideal Value

The positive ideal solution is:

$$\lambda^+{}_j = \max_{1 \le i \le 5} \{\lambda_{ij}\}$$

The negative ideal solution is:

$$\lambda_j^- = \min_{1 \le i \le 5} \{\lambda_{ij}\}$$

Then the distance is:

$$D_i^+ = \sqrt{\sum_{j=1}^{3} \left[w_i (\lambda_j^+ - \lambda_{ij})^2 \right]}$$

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$$D_i^- = \sqrt{\sum_{j=1}^{3}\left[w_i(\lambda_j^- - \lambda_{ij})^2\right]}$$

3.3.6. Calculate the Relative Sticking Progress

$$S_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

3.3.7. Using MATLAB, The Information Entropy Redundancy of Digital Economy and the Weight of Each Index in 11 Provinces and Prefecture-level Cities are Shown in the Following Table

Table 2. Information entropy, information utility value and weight of each indicator

item	Information entropy	information utility value	Weights
Number of students in colleges and universities	0.9153	0.0847	0.0513
Internet broadband penetration	0.8582	0.1418	0.0858
telephone penetration	0.7517	0.2483	0.1503
Software business revenue as a percentage of regional GDP	0.8191	0.1809	0.1095
Total telecom business	0.8689	0.1311	0.0794
Number of patent applications of industrial enterprises above designated size	0.8168	0.1832	0.1109
Average R&D research expenditure of industrial enterprises above designated size	0.8098	0.1902	0.1152
The number of full-time R&D personnel in industrial enterprises above designated size	0.7540	0.2460	0.1489
Average number of new product projects of industrial enterprises above designated size	0.7545	0.2455	0.1486

Among them, the information entropy of the number of students in colleges and universities is the largest, indicating that the index has the smallest degree of variation, the smallest information utility value, and the smallest role in the comprehensive evaluation. The information entropy of telephone penetration rate is the smallest, indicating that the index has the largest degree of variation. Information has the largest utility value and plays the greatest role in comprehensive evaluation.

The weight calculated by the entropy weight method is brought into the TOPSIS algorithm to obtain the average score of each region from 2016 to 2020.

From the calculated results, it can be seen that the digital economy in Shanghai, Jiangsu, and Zhejiang has developed well and is more prominent in the Yangtze River Economic Belt, while the digital economy development rankings in Yunnan and Guizhou are at the bottom, the digital economy development of other cities is at a medium level. At the same time, there are still obvious gaps in the development of digital economy in various regions. If the digital economic development of the provinces and prefecture-level cities in the Yangtze River Economic Belt is evaluated from various dimensions, they are divided into "high level", "medium-high level", "medium level", "medium-low level" and "low level", as shown in the table below.

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Table 3. Schematic diagram of entropy weight -TOPSIS algorithm score

area	2016	2017	2018	2019	2020
Shanghai	0.8524	0.8410	0.8250	0.8574	0.8652
Jiangsu Province	0.8093	0.8358	0.8274	0.8440	0.8095
Zhejiang Province	0.7119	0.5634	0.6439	0.7204	0.7050
Anhui Province	0.2440	0.3452	0.2262	0.2294	0.2553
Jiangxi Province	0.1128	0.0960	0.1154	0.1302	0.1406
Hubei Province	0.1969	0.1557	0.1924	0.2112	0.2194
Hunan Province	0.1612	0.1594	0.1739	0.1904	0.2093
Chongqing	0.1881	0.1303	0.1638	0.1923	0.1919
Sichuan Province	0.2456	0.1804	0.2209	0.2518	0.2664
Guizhou Province	0.0341	0.0422	0.0516	0.0653	0.0657
Yunnan Province	0.0479	0.0668	0.0581	0.0698	0.0876

Table 4. Comprehensive score of manufacturing high-quality development level

The high-quality development level of the digital economy	area	ranking
high level	Shanghai	1
	Jiangsu Province	2
	Zhejiang Province	3
Intermediate to high level	Sichuan Province	4
	Anhui Province	5
medium level	Hubei Province	6
	Hunan Province	7
low to medium level	Chongqing	8
	Jiangxi Province	9
low level	Guizhou Province	10
	Yunnan Province	11

4. Development Suggestions

4.1. Improve Digital Infrastructure Construction

The new era of digital infrastructure is generated by Internet information technology is the basic system based on information network, combined with Internet information technology, and the formation of economic digital development. At the same time, digital infrastructure can provide power for economic digital transformation, innovation, and development to establish a new type of economic structure. As an important driving force for industrial development and innovation, the digital economy can promote the high-quality development of the Yangtze River economic band, so further accelerate the construction of digital information infrastructure,

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such as in the information infrastructure, speeding up 5G and fiber broadband network construction, and create intelligence Digital economic environment.

4.2. Coordinate Regional Digital Economic Imbalances

The overall digital development of the Yangtze River economy is good, but there is a significant gap between the development of each region. In order to create a sustained health development environment, the development gap should be reduced. Due to the trend of digital economy between the upper, medium and downstream regions into stepped increasing trends, and there are different local conditions and development characteristics due to local conditions and development. In the Yunnan Province, Guizhou Province, the Yunnan Province, Guizhou Province, such as the upstream of the Yangtze River, should promote the production of industrial digitalization to create a green industry system, and achieve effective use of resources; in Anhui Province, Sichuan, Hunan Province and Jiangxi Province and other areas are mainly manufacturing. Strengthen the application of digital production methods, improve production efficiency; downstream Shanghai, Zhejiang and Jiangsu Province are intensively of economic activities, and should promote digital technology and entity economy and establish digital economic industrial systems.

4.3. Strengthen the Guidance of Economic Digital Development

Combining the development characteristics of the Yangtze River Economic Belt, in order to further deepen the development of the digital economy, it is necessary to establish and improve the relevant governance system, formulate relevant policies, and provide policy guarantee for the development of the digital economy of the Yangtze River Economic Belt. At the same time, the government should also strengthen the encouragement and guidance of the digital transformation of the economy, and adopt different support policies for different economic development conditions. By establishing an effective evaluation incentive mechanism, evaluating and evaluating areas with relatively prominent digital economy development, and rewarding, thereby fully mobilizing the enthusiasm of the development of economic digitalization. In addition, the government can strengthen the supervision of digital economy - related industries, solve problems such as data security and privacy security, and optimize the environment for the development of the digital economy in the Yangtze River Economic Belt.

4.4. Strengthen the Training of Economic Digital Talents

Mastering advanced economic digital technology and excellent innovative people are an important part of economic development. At present, the high-end digital economic and technical personnel of the Yangtze River economy is lacking, and the high-tech talents in the upstream areas are scarcer, accelerate the innovation of the Yangtze River economy with digital economic mechanism, and cultivate and introduce excellent digital economic and technical personnel is imminent. Task for cultivating digital economic development can start from higher education talents, break the traditional standardized teaching mode, adopt innovative, personalized education, optimization of the professional structure, and cultivate comprehensive talents. At the same time, institutions and research institutions encourage colleges and scientific research institutions to study innovation, increase investment in scientific research, carry out regional innovation of various characteristics, and reward for national economic development. It is an important guarantee for the development of good economic digital talents.

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References

[1] Li Changjiang. A preliminary discussion on the connotation of digital economy. [J]. E-Government, 2017 (09): 84-92.

[2] Zheng Jianzhuang, Li Qiang. The basic connotation, measurement range and development path of the digital economy. [J]. Journal of Zhejiang Shuren University (Humanities and Social Sciences), 2020, 20(06): 33-39.

[3] Qian Yiwen, Huang Qinghua, etc. The connotation, logic and path of digital economy promoting the transformation and upgrading of traditional manufacturing industry [J]. Innovation and Technology, 2021, 21 (03): 10-17.

[4] Zhao Lei. The connotation and dimension of digital economy empowering the high-quality development of tourism [J]. Tourism Journal, 2022, 37(04): 5-6.

[5] Jia Qi. Statistical analysis of China's digital economy development level measurement and its influencing factors [D]. Liaoning, Liaoning University, 2020.

[6] Ji Xiaoyan. Comprehensive evaluation of Digital Economy Development in Zhejiang Province [D]. Zhejiang, Hangzhou University of Electronic Science and Technology, 2020.

[7] Xu Xianchun, Zhang Meihui. Research on the scale of value-added scale of the digital economy [J]. China Industrial Economy, 2020, (05): 23-41.

[8] Wu Xiaoting, Zhang Keyu. Measurement of the Integration of Digital Economy Industry and Manufacturing Industry --Based on Input-Output Perspective [J]. China Circulation Economy, 2021, 35 (11): 89-98.

[9] Wang Liying. Thoughts on Statistical Accounting and Contribution Measurement of Digital Economy [J]. Statistical Science and Practice, 2021, (07): 34-36.

[10] Jiang Jianglin. Analysis of the Status Quo and Policy Differential Analysis of Digital Economy in China [J]. Modern Business, 2021 (26): 51-53.

[11] Kuang Jinsong, Shi Xiaofei, etc. Research on the measurement of the development level and spatial evolution pattern of China's provincial digital economy [J]. Business Research, 2022, 29(01): 94-102.