Evaluation of Digital Economy Development in 31 Chinese Provinces and Cities

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Abstract: The development of the digital economy is a strategic choice to build a new pattern of China's economic development and a necessary path to promote the high-quality development of China's economy. In addition, the digital economy has become a new driving force for China's economic growth and quality improvement. This paper constructs a comprehensive evaluation system for the digital economy (20 indicators in total) in four dimensions: digital infrastructure, digital industry revenue generation, digital service capacity, and digital innovation capacity. Based on regional sample data from 31 provinces and cities in China from 2014 to 2021, this paper uses an Entropy-based TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method to examine and assess the overall level of China's digital economy development, such as a weak industrial transformation, weak innovation capacity, lagging digital governance, an unbalanced internal structure of the digital economy, and unbalanced development within regions. The authors then make targeted recommendations based on specific issues. On the supply side, it is necessary to support infrastructure development, nurture market players, enhance innovation capabilities and strengthen the talent pool to form a strong support for the development of the digital economy. Meanwhile, on the demand side, a wide range of application scenarios and market areas should be built for the digital transformation of enterprises, residents, and government departments to form an effective driver for the development of the digital economy.

Keywords: Digital Economy, Chinese Digital Economy Development, Entropy-based TOPSIS Method, Digital Industrialization, Digital Governance
JEL: 011, 014, G18, R11, R50

1. Introduction

With the development of information technology, the digital economy has become a new engine to drive China's economic growth. The digital economy is based on digital technology, using new technologies such as the Internet, big data, artificial intelligence, and blockchain to upgrade and transform traditional industries, thus promoting rapid economic development. The development of the digital economy in China is at a stage of rapid growth and has become an important force in driving economic development.

Firstly, the development of the digital economy in China is characterized by rapid growth. With the popularity of the Internet and the spread of mobile devices, China's digital economy is showing explosive growth. By 2021, China's digital economy already accounted for over 36 percent of gross domestic product (GDP), the number of start-ups in the digital economy continues to grow, and the demand for digital transformation is increasing. China's digital economy has become a new engine for the country's economic development and provides a new impetus for the development of the global digital economy. Secondly, the development trend of China's digital economy is characterized by the following aspects: firstly, the continuous upgrading of digital technologies, including the widespread use of cloud computing, the Internet of Things, 5G, artificial intelligence, and other technologies, which provide strong support for the development of the digital economy; secondly, the diversified development of the digital economy, extending from traditional sectors such as e-commerce, finance and education to the new digital culture, digital healthcare, digital agriculture. Thirdly, the deep integration of the digital economy with the real economy has promoted the transformation and upgrading of traditional industries.

The promotion of the digital economy to China's economic development is mainly reflected in the following aspects. Firstly, it promotes innovation and entrepreneurship, stimulating enterprises' innovative vitality and competitiveness. Secondly, it enhances the competitiveness and creativity of the economy and promotes the rapid development of China's economy. Besides this, it also enables the upgrading of employment and consumption and drives up the living standard of the people. However, the development of the digital economy is also facing several challenges and problems. Firstly, there are still specific bottlenecks and difficulties in the integration of the digital economy with traditional industries, which require continuous promotion of innovation and upgrading; secondly, the security of the digital economy needs to be given high priority and strengthened

management; thirdly, the issues of equity and sustainability of the development of the digital economy also need to be given attention.

This paper adopts the entropy power TOPSIS research method to study the development status of China's digital economy from 2014 to the present and the development trend. In addition, the authors have used the literature review method to interpret the definition and characteristics of the digital economy in this paper. The authors also analyze the current situation and development trend of China's digital economy and discuss the promotion of the digital economy to China's economy and will also discuss the challenges and problems faced by the digital economy and propose corresponding solutions and suggestions, hoping to contribute to global digital economy governance and cooperation.

2. Literature Review

The digital economy is an economic form that uses digital technology to change economic and business models and create new economic growth points. With the continuous development of digital technology, the digital economy has become a significant trend in today's economic development (Lestantri et al., 2022). Governments and enterprises are using it as an essential tool to promote economic growth. This article will review the digital economy's definition, development history, impact, and future development trends (Carlsson, 2004).

Definition of the digital economy

The digital economy refers to using digital technology to promote economic development and economic activities supported by digital technology. The digital economy covers many areas, including the digital industry, manufacturing, business, trade, finance, and so on. A digital economy is a new form characterized by digitalization, networking, platform station, intelligence, innovation, etc. (Bukht and Heeks, 2017).

The development history of the digital economy

There are three stages for the development of the digital economy. The first stage is the information technology era. This stage is mainly based on information technology, represented by computers, and the traditional economy and business model are changed through information technology (Earl, 2000). The second

stage is the Internet era, dominated by Internet technology, represented by e-commerce and online marketing, and the use of the Internet to change the economy and business models (Lee et al., 2018). The third stage is the digital economy era. This stage is dominated by digital technologies such as artificial intelligence, big data, the Internet of Things, and cloud computing, which change the economy and business models through the use of digital technologies (Li et al., 2022; Li et al., 2019; Ulas, 2019).

Impact of the digital economy

The development of the digital economy has had an essential impact on the economy and society. The digital economy has provided new growth points for economic development. The digital economy has promoted the development of digital industries, which creates many jobs and injects fresh momentum into economic development (Sturgeon, 2021). The digital economy has changed the traditional economic and business model and promoted the transformation and upgrading of the economy and industry (Chauhan et al., 2022). The digital economy is changing how people produce and consume, promoting the coordinated development of productivity and production relations. The digital economy promotes the inclusive and sustainable development of society. The digital economy provides more convenient and efficient services for society while promoting sustainable development and future economic and social development opportunities (Viriyasitavat et al., 2019).

The development of the digital economy can make an essential contribution to a country's sustainable development. The digital economy is an information and communication technology-based economic activity that is efficient, innovative, and flexible and can contribute to economic growth, productivity, labor efficiency, a green economy, and sustainable social development (Rosário and Dias, 2022). Firstly, the digital economy can drive economic growth and increase productivity. The digital economy promotes the application of information and communication technologies to improve the productivity and competitiveness of enterprises and encourage economic growth. The digital economy can also promote industrial upgrading and transformation, drive the development of new economies and business models, and inject new momentum into economic development (Zhang et al., 2021). Secondly, the digital economy can promote a green economy and sustainable development. With its low-carbon, energy-saving and intelligent features, the digital economy can encourage the effective use of resources and environmental protection (Li et al., 2022). For example, digital production and service models

can reduce the waste of energy and materials, digital transport and logistics systems can reduce air pollution and traffic congestion, and digital energy systems can promote renewable energy, etc. The digital economy can also promote social equity and sustainable development, improve resource efficiency and environmental benefits, and create more opportunities and possibilities for sustainable development in the future (Zhang et al., 2022). Finally, the development of the digital economy also needs to focus on sustainable development. The development of the digital economy also faces a series of sustainability challenges, such as energy consumption and e-waste. The digital economy needs to strengthen environmental protection and resource management, promote the digital economy's green development, and reduce the digital economy's negative impact on the environment (Luo et al., 2022). The digital economy also needs to pay attention to social equity and sustainable development, promote the sound development of the digital economy and create more opportunities and conditions for sustainable economic and social development (Wang and Zhong, 2023).

The digital economy can therefore make an essential contribution to the sustainable development of a country. The growth of the digital economy needs to strengthen sustainability management, promote the sustainable development of the digital economy and achieve a win-win situation for both the digital economy and the economy and society (Guo et al., 2022). In addition, existing economic geography theories provide valuable insights into the spatial dynamics of digital economy adoption and its impact on regional development. Some scholars demonstrate that digital economy development significantly contributes to firm physical innovation and catalyzes strong substantive innovation more than strategic innovation (Feng and Nie, 2022). In addition, the urban development literature illuminates the role of the digital economy in shaping urban growth and sustainability. Several Chinese scholars have explored the urban planning and governance strategies needed to leverage digital technologies for smart city development (Li et al., 2011). By combining insights from this literature, our study aims to analyze the level of digital economy development in Chinese regions considered along four dimensions: digital infrastructure, digital industry revenue generation, digital service capacity, and digital innovation capacity, while considering the broader urban development context and the potential for creating sustainable and inclusive cities.

Furthermore, case studies related to cities where the digital economy has contributed to development can also illustrate the need for governments to focus on developing the digital economy. For example, the case of the city of Shanghai

highlights how strategic investment in digital infrastructure and cultivating a vibrant innovation ecosystem can facilitate its transformation into a thriving digital hub (Gu et al., 2022). What is more, in the case of Helsinki, through modern digital technologies, cities aim to optimize their performance and services. In addition, cities actively support modern digital technologies to facilitate digitization and the emergence of a data-based innovation and knowledge economy (Hämäläinen, 2020). This informs policy recommendations for other cities in China and can also provide lessons for development in other regions.

3. Methodology

3.1. Research Questions and Methods

The research questions of this paper are as follows.
1. How did China's digital economy develop from 2014 to 2021?
2. Are there any geographical differences in the development of the digital economy?
3. What was the focus of China's digital economy development during this period? and what is the future trend?

This paper uses the Entropy-based TOPSIS method to analyze 20 indicators to explore the development of China's digital economy from 2014 to 2021. The entropy-weighted based TOPSIS method is a multi-attribute decision analysis method, which combines the entropy-weighted method and TOPSIS method and can consider the correlation and importance of each indicator comprehensively and has strong applicability to multi-attribute decision problems.

3.2. Data Source

The accuracy of the evaluation of the development level of the digital economy depends on the understanding of the connotation of the digital economy. Based on existing research results, this paper considers that the digital economy is new and based on the traditional economic system. This new economic structure is rooted in the real economy. It has the characteristics of upgrading output models and promoting industrial innovation through advanced information technology such as the Internet and artificial intelligence.

Table 1. Digital Economy Evaluation Index System

Code	*Secondary indicators*	*Primary indicators*
X1	Length of optical fiber cables (km)	Digital infrastructure
X2	Number of broadband internet access ports	
X3	Penetration rate of mobile phones (number of users per hundred people)	
X4	Number of domain names (in ten thousands)	
X5	Capacity of mobile telephone exchanges (in ten thousands)	
X6	Revenue from software business (10,000 RMB)	Revenue from the digital industry
X7	Revenue from information technology services (10,000 RMB)	
X8	Telecom business volume (100 million RMB)	
X9	E-commerce procurement volume (100 million RMB)	
X10	E-commerce sales volume (100 million RMB)	
X11	The breadth of digital financial coverage	Digital service capability
X12	The depth of digital financial usage	
X13	Level of online and mobile payments	
X14	Level of digitalization of inclusive finance	
X15	Number of employed persons in urban units engaged in information transmission, software, and information technology services (in ten thousands)	
X16	Full-time equivalent (FTE) R&D personnel in industrial enterprises above designated size (person-years)	Digital innovation capability
X17	R&D expenses in industrial enterprises above designated size (10,000 RMB)	
X18	Number of R&D projects in industrial enterprises above designated size	
X19	Technology market turnover (100 million RMB)	
X20	Number of domestic patent applications and authorizations	

Source: Initial data were collected by authors from official websites of the National Bureau of Statistics of China (https://data.stats.gov.cn/english/).

From an economic point of view, the digital economy can meet the demand for digital consumption through digital products and services. In addition, the digital economy should be an ecosystem in which digital service producers, digital application consumers, digital output innovators, and the digital technology environment coexist harmoniously. Based on this and considering the principles of data availability, continuity, and operationalization, the authors cover the digital features of economic development as far as possible. Hence, this paper constructs a digital economy evaluation index system comprising 4 primary and 20 secondary indicators, including digital infrastructure, digital industry income generation,

digital service capacity, and digital innovation capacity, as shown in Table 1. All initial data was collected by authors from official websites of the National Bureau of Statistics of China (https://data.stats.gov.cn/english/). The four indicators—breadth of digital financial coverage, depth of digital financial usage, level of digitalization of inclusive finance and level of online mobile payments—are taken from the Peking University Digital Inclusive Finance Index, which was compiled by a joint research group formed by the Peking University Digital Finance Research Centre and Ant Financial Services Group (Guo et al., 2020).

3.3. Calculation Process

The main idea is to determine the weight of each indicator by the entropy method and then use the TOPSIS method to make a comprehensive evaluation. This method uses the objective weighting idea of the entropy method and the TOPSIS method to approximate the ideal solution, which can effectively eliminate the influence of human subjective factors. It is more effective than both the entropy method and the TOPSIS method. The primary process of the model shows below.

1. Building the original matrix. First, the data on the development of the digital economy in Chongqing is collated. Let a total of n years, and m indicators be selected for each year to build the original matrix.

$$X=\left(x_{ij}\right)nm(\,i=1,2,3,\ldots,n;\,j=1,2,3,\ldots,m) \tag{1}$$

2. The selected indicators were normalized to initially eliminate differences caused by the dimensions of the variables. As all the data and information selected in this study are positively oriented indicators, there is no need for either positive or reverse transformation. Therefore, this study adopts the "normalization by mean" method for data processing.

$$Y_{ij}=X/\,Mean \tag{2}$$

3. Determine the weights for the values of the j_{th} indicator of the i_{rh} object:

$$P_{ij}=\frac{x_{ij}}{\sum_{i=1}^{n}x_{ij}} \tag{3}$$

4. Determine the entropy value of the j_{th} indicator:

$$e_j = -\frac{1}{\ln(n)} * \sum_{i=1}^{n} P_{ij} \ln(P_{ij}) \ , \ (i = 1, \ldots, n; j = 1, \ldots, m) \tag{4}$$

5. Then, calculating the information utility value d:

$$d_j = 1 - e_j \tag{5}$$

6. Determine the entropy weight of the j_{th} indicator:

$$w_j = \frac{(1 - e_j)}{\sum_{j=1}^{m} (1 - e_j)} \ , \ 0 \le w_j \le 1, \sum_{i=1}^{m} w_j = 1 \tag{6}$$

7. Compute scores for individual indicators and overall performance level.

$$S_{ij} = w_i \times x_{ij}, \ S_i = \sum\nolimits_{j}^{n} S_{ij} \tag{7}$$

8. After the above steps, then use TOPSIS method for evaluation. Assuming there are m_{th} object, n_{th} indicators, then the matrix is $X = (x_{ij})_{mn}$, Normalize the decision matrix $Y = (y_{ij})_{mn}$. (8)

9. Next, to compute the weighted and normalized decision matrix *V*:

$$V = (v_{ij})_{m \times n} = (w_j y_{ij})_{m \times n} \tag{9}$$

10. Using the weighted and normalized decision matrix *V*, calculate the positive ideal solution and negative ideal solution. In the TOPSIS method, monotonicity is usually required. The formulas for positive and negative ideal solutions are as follows:

$$\text{positive ideal solution: } X^+ = (v_1^+, v_2^+, \ldots, v_n^+), \ v_j^+ = max_{1 \le i \le m} v_{ij} \tag{10}$$
$$\text{negative ideal solution: } X^- = (v_1^-, v_2^-, \ldots, v_n^-), \ v_j^- = min_{1 \le i \le m} v_{ij} \tag{11}$$

11. To calculate the distances between each object and its positive and negative ideal solutions, usually use the Euclidean distance:

$$S_i^+ = \sqrt{\sum\nolimits_{j=1}^{n} (v_{ij} - v_j^+)^2} \ , \ i = 1, 2, \ldots, m$$
$$S_i^- = \sqrt{\sum\nolimits_{j=1}^{n} (v_{ij} - v_j^-)^2} \ , \ i = 1, 2, \ldots, m \tag{12}$$

12. Computing the relative closeness of each object:

$$C_i^+ = S_i^- / \left(S_i^+ + S_i^- \right) \tag{13}$$

13. The relative closeness measure C_i^+ of each object is its comprehensive score index, with a higher C_i^+ indicating a better object.

4. Results

4.1. Empirical Analysis

Based on constructing the evaluation index system and measurement model for the development level of digital economy in China, the weight (w_j) of each evaluation index in each province and city is derived according to the above formula, as shown in Table 2 below.

Table 2. The weights of each evaluation index in 31 provinces and cities in China from 2014 to 2021.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
Shanghai	1.84	1.92	0.84	5.24	2.29	6.15	10.18	24.48	8.15	4.68	2.36	4	1.45	2.44	3.91	0.2	1.18	0.93	13.71	4.05
Beijing	2.46	1.65	0.04	3.19	4.65	13.1	16.32	24.77	3.59	8.92	1.99	3.94	1.67	2	1.4	0.55	0.49	0.4	3.93	4.95
Zhejiang	2.21	1.94	0.08	4.62	0.76	4.73	6.18	21.98	5.1	4.96	1.7	2.06	0.93	1.41	1.89	1.31	1.96	4.29	28.57	3.33
Jiangsu	2.15	2.5	0.35	3.61	6.11	1.71	5.44	28.97	2.5	6.22	2.78	3.04	1.53	1.43	0.34	0.7	2.29	4.01	16.06	8.27
Fujian	3.35	2.18	0.05	13.8	0.22	1.8	1.94	23.97	6.95	6.56	2.07	3.99	1.61	1.11	0.98	1.9	3.87	5.75	13.59	4.29
Guangdong	3.14	2.99	0.12	0.81	0.06	3.35	7.25	21.58	3.79	4.58	1.77	3.37	1.86	1.1	3.29	1.89	2.15	8	19.38	9.49
Tianjin	5.89	7.37	0.84	2.59	0.9	6.89	11.75	33.96	2.05	4.3	2.61	3.73	1.58	1.13	0.16	3.06	1.81	0.55	7.53	1.3
Hubei	4.25	3.07	0.42	8.49	0.02	3.54	7.9	25.82	6.34	4.52	2.5	3.2	1.61	0.89	1.47	1.26	1.89	4.47	5.95	12.39
Anhui	2.15	1.88	0.08	4.48	0.74	4.59	6	21.35	4.95	4.81	2.74	2.61	1.6	0.63	1.83	1.46	3.32	3.78	27.75	3.23
Shandong	3.56	2.87	0.22	2.71	0.17	3.05	3.13	25.55	4.31	5.61	2.59	3.13	1.78	0.88	0.2	1.02	0.4	4.83	23.39	10.56
Chongqing	3.6	3.32	0.55	6.09	0.62	6.32	5.27	29.12	9.27	4.8	2.29	3.26	1.16	0.74	0.35	1.88	3.28	5.3	8.9	3.92
hainan	2.45	3.88	0.11	5.08	0.7	11.54	13.2	15.99	0.59	2.97	1.5	1.74	0.78	0.55	1.01	1.4	0.81	1.67	20.15	13.88
Shaanxi	4.88	2.74	0.37	9.5	0	6.66	8.91	26.3	6.73	7	2.23	3.63	2.41	0.66	0.46	0.25	1.9	2.6	7.28	5.48
Henan	1.32	2.41	0.37	8.3	0.43	1.34	1.76	25.6	3.34	1.01	2.63	3.48	1.95	0.69	1.78	0.24	2.62	4.4	28.04	8.3
Jiangxi	6.31	1.74	0.66	11.6	1.46	4.12	1.5	19.03	5.45	2.84	2.1	1.95	1.02	0.38	0.27	5.65	3.57	9.93	12.4	8.05
Sichuan	3.9	3.74	0.58	4.17	0.04	2.83	3.19	24.75	11.87	8.22	2.11	2.71	1.18	0.88	0.64	1.09	2.9	6.52	14.49	4.2
Hunan	2.39	1.62	0.64	7.16	0.72	5.44	10.34	19.9	6.5	2.7	1.86	2.14	0.94	0.64	0.22	1.03	2.25	8.26	20.22	5.02
Liaoning	4.95	0.96	0.18	5.73	3.58	3.16	6.19	27.53	9.26	5.52	2.38	3.34	1.54	0.89	0.07	0.56	0.98	4.05	7.63	11.51
Shanxi	1.76	2.01	0.31	13.4	0.95	6.24	10.9	20.25	6.32	11.43	1.95	2.68	1.77	0.43	0.06	0.29	1.25	3.24	6.66	8.03
Guangxi	3.67	1.83	0.36	3.67	2.24	11.84	12.79	13.1	2.43	3.04	1.08	1.37	0.69	0.3	0.31	0.46	0.54	2.52	33.8	3.95
Hebei	3.5	1.62	0.43	3.88	0.42	3.84	4.62	22.43	4.3	3.73	2.1	3.01	1.83	0.65	0.69	0.13	2.04	3.51	27.28	9.99
Yunnan	6.94	3.44	0.46	15.3	0.69	3.48	4.33	26.57	6.05	2.73	2.45	2.64	1.18	0.62	0.04	2.47	5.09	4.3	2.79	8.39
Xizang	0.97	0.74	0.02	1	0.12			18.15	14.96	2.71	0.6	0.35	0.11	0.12	5.15	1.13	13.93	5.13	27.53	7.27
Ningxia	3.81	4.55	0.23	4.96	0.41	6.42	8.59	22.83	3.99	3.15	1.82	2.69	1.6	0.79	0.02	1.65	3.69	2	14.05	12.76
Neimenggu	3.2	0.85	0.15	3.15	0.01	25.32	35.28	11.01	4.61	3.18	0.87	1.41	0.65	0.2	0.01	1.14	0.24	0.72	2.66	5.35
Xinjiang	5.04	3.98	0.47	3.77	0.09	1.41	1.41	34.82	5.82	3.96	2.95	2.79	1.21	0.79	0.95	1.7	0.69	1.82	19.17	7.16
Jilin	6.06	2.38	0.43	12.7	0.81	1.33	0.67	26.11	0.77	0.12	2.26	3.09	1.64	0.83	0.86	3.75	0.7	0.55	25.72	9.22
Guizhou	2.15	2.76	0.34	21.4	0.48	5.5	8.74	21.31	1.37	1.03	1.99	2	0.91	0.31	0.36	1.09	2.87	4.52	15.27	5.6
Heilongjiang	5.17	2.12	0.55	9.32	0.3	11.29	13.07	20.62	7.67	5.11	2.29	2.65	1.36	0.6	0.53	6.07	0.68	1.02	5.91	3.67
Gansu	3.4	4.47	0.62	15.5	3.3	2.62	2.14	32.19	3.55	3.77	3.13	4.33	2.36	0.67	0.66	1.78	0.45	0.95	3.27	10.9
Qinghai	3.29	2.55	0.24	2.9	0.64	7.57	12.2	18.91	7.46	11.28	1.79	2.13	1.16	0.65	0.03	1.11	1.31	3.26	10.8	10.72

Source: Initial data were collected by authors from official websites of the National Bureau of Statistics of China (https://data.stats.gov.cn/english/).

To ease the discussion, the paper adopts the conventional geographical division method to divide the 31 provinces and cities into seven regions. It averages the digital economy development indices of the provinces and cities within the

regions to facilitate the examination of regional digital economy development trends. The results are shown in Table 3.

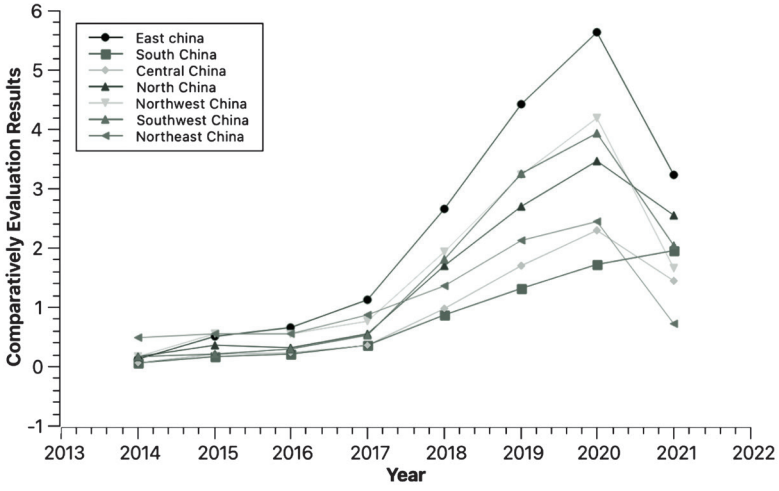
Table 3. Comprehensive evaluation of 31 Chinese provinces and cities from 2014 to 2021.

Region \ *Time*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*
East China	*0.14*	0.52	0.66	1.13	2.67	4.43	5.64	3.24
South China	*0.05*	0.16	0.22	0.37	0.87	1.31	1.72	1.96
Central China	*0.06*	0.21	0.23	0.36	0.98	1.71	2.29	1.45
North China	*0.17*	0.36	0.31	0.56	1.71	2.70	3.46	2.55
Northwest China	*0.17*	0.55	0.55	0.76	1.94	3.23	4.20	1.66
Southwest Region	*0.16*	0.22	0.30	0.53	1.81	3.26	3.93	2.03
Northeast Region	*0.50*	0.55	0.55	0.88	1.36	2.13	2.44	0.72

Source: Initial data were collected by authors from official websites of the National Bureau of Statistics of China (https://data.stats.gov.cn/english/).

In order to visualize the changes in the development of seven Chinese regions' digital economy between 2014 and 2021, the authors made a visual chart based on the above data, as shown in Figure 1 below.

Figure 1. Comprehensive Evaluation Results of Digital Economy Development in China from 2014 to 2021



Source: compiled by the authors.

At the national level, China's digital economy showed a year-on-year increase over the study period, with a 242 percent increase in 2020 compared to 2013, indicating that China's digital economy was at a rapid stage of development.

At the regional level, the seven regions also showed a significant growth trend. Still, there was an imbalance in the level of digital economy development among the regions, with East China having the highest level of digital economy. This is because Jiangsu, Zhejiang and Shanghai were ahead of the rest of the country in terms of infrastructure development, digital industrialization, and digitization of industries, reflecting their strong digital economy. Northern China was in the second echelon, with Beijing's digital economy being more developed after Guangdong and Jiangsu. It can give full play to its advantages in digital talent, IT industry and the digital transformation of mature industries. The digital economy in Tianjin, Hebei and Shanxi will be accelerated. From 2014 to 2017, the digital economy in the north-west, south-west and north-east regions lagged and grew slowly; after 2017, it grew faster. However, overall, China's digital economy development shows a large variation between regions, with a decreasing trend from the southeast to the northwest. It is also worth noting that the overall level of development has declined since 2020, due to the impact of the COVID-19 epidemic.

4.2. Policy Recommendations

Firstly, the government should increase its efforts to build digital economy infrastructure in the central and western regions and focus on rational planning of new digital infrastructure to give full play to the cluster synergy effect. Through financial transfers and other initiatives, the government should direct technology, capital, and talent toward less developed regions in the digital economy and vigorously promote the integration of advanced technologies, such as big data and the Internet of Things, with traditional industries to take advantage of the "latecomer advantage" and narrow the differences between regions. Secondly, the government should organize the removal of unfavorable factors, such as administrative regulations and policy rules that hinder the flow of factors across regions, and promote the in-depth development of digital infrastructure construction, digital economy resource sharing, and integrated development mechanisms in neighboring regions, to innovate a regional linkage model for digital economy development, and to give full play to the leading and driving role of developed digital economy regions in the neighboring regions, the "siphon effect" of resources and the harm of homogenous competition can be reduced. Finally, given the positive

impact of economic development, industrial structure, trade openness, foreign investment, and residents' purchasing power on the digital economy's development, the government should develop differentiated development strategies according to local conditions.

The southeastern coastal regions should strengthen the digital transformation of their industries and upgrade the quality of their industrial structure through the integration of digital technology with smart manufacturing, new energy, biomedicine, and software services while maintaining their openness to the outside world and their advantages in attracting foreign investment; the central and western inland regions should continue to improve their economic development and strengthen the construction of digital infrastructure to provide favorable conditions for the development of the digital economy. The government should focus on improving the investment environment to attract high-quality capital, and advanced technology, talent, and management experience are conducive to upgrading the industrial structure, which has a two-way effect on the development of the digital economy.

5. Conclusion

In conclusion, the development of the digital economy is essential for China to build a new economic pattern and achieve high-quality economic growth. This paper presents a comprehensive evaluation system for the digital economy and uses an Entropy-based TOPSIS method to examine and assess China's digital economy development. The results indicate that China's digital economy is rapidly developing but faces challenges, such as a weak industrial transformation, weak innovation capacity, lagging digital governance, and an unbalanced internal structure and regional development. To address these challenges, the government should take targeted measures on both the supply and demand sides, including supporting infrastructure development, nurturing market players, enhancing innovation capabilities, building application scenarios, and market areas for digital transformation.

The study also reveals an imbalance in the level of digital economy development among the regions, with East China having the highest level, followed by Northern China. In contrast, the northwest, southwest, and northeast regions show slow growth in the early years but have caught up in recent years. However, the overall level of development has declined since 2020 due to the impact of the

COVID-19 epidemic. To narrow the regional differences, the government should increase its efforts to build a digital economy infrastructure, promote resource sharing and integrated development mechanisms, and develop differentiated strategies according to local conditions. By doing so, China can fully tap into the potential of the digital economy and achieve sustainable and inclusive economic growth.

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