Measurement and Analysis of the Development Level of Digital Economy in Anhui Province

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Abstract

This paper uses the digital development level data of 16 prefecture-level cities in Anhui Province from 2013 to 2020 to measure the development level of digital economy in Anhui Province through the entropy weight method. This paper finds that from the perspective of time, the overall development level of digital economy in Anhui Province has shown the characteristics of increasing year by year. From a spatial point of view, the development of the digital economy among various local-level cities in Anhui Province is relatively uneven. According to the standard deviation of the digital economy development index over the years, the economic development types of various cities in Anhui Province are divided into stable development, rapid development and leapfrog development.

Keywords

Digital economy, Development evaluation, Entropy-weighting TOPSIS method.

1. Introduction

At present, the revolution in science and technology and the transformation of the industry are emerging a new round around the world. The construction of a new domestic development pattern is conducive to the ongoing changes in the world, so its construction is highly valued by the country. The era of digital economy is a new form of economic and social development after the agricultural economy and industrial economy. It is a new economic system for digitizing information and digitizing business activities. It belongs to and has an important role in promoting the construction of a new development pattern. Big data is the foundation of the digital economy, and the establishment of the big data center is undoubtedly to make China's digital economy grow faster and better. In order to accurately grasp the current real and objective situation of the digital economy, this paper takes Anhui Province as an example and uses the entropy weight method to construct a measurement model to evaluate the development level of its digital economy. This article will give Anhui Province to study the development of the digital economy, which is a good reference for the future development and strategic deployment of the digital economy. In addition, it can be compared with expected results to identify shortcomings and lessons learned in the implementation process; Grasp the accurate status situation in real time, which is convenient for timely adjustment of development strategies.

2. Literature Review

Research on the statistical measurement of digital economy has attracted the attention of many scholars and institutions at home and abroad. Compared with the international community,

domestic related research started late, but the popularity of the digital economy continues, many institutions and scholars have taken action, in recent years, the research scope has been expanding, and the research results have been deepening. China Academy of Information and Communications Technology, Tencent Research Institute and other institutions have released some research reports on the development of China's digital economy in recent years, defined different measurement scopes, and measured the overall level of China's digital economy by using methods such as value-added measurement and digital economy-related index compilation; Zhang Meihui (2017) systematically sorted out and summarized the development context and achievements of international research on the measurement of new economic forms such as digital economy, and summarized the experience that China can learn from; Fan Hejun and Wu Ting (2020) screened multiple digital index data for measurement, compared and evaluated the characteristics and trends of each indicator change, and provided a basis for the construction of a more comprehensive measurement system. Han Zhaoan, Zhao Jingfeng et al. (2021) estimated the scale of China's inter-provincial digital economy development, and described the characteristics and regional differences of the digital economy at the provincial level.

However, there are still few relevant studies on the measurement of digital economy in Anhui Province. Although Wang Tongyu (2020) discusses the current situation and related issues of the development of the digital economy in Anhui Province, it is not comprehensive and fails to clarify the regional differences and characteristics of the development of the digital economy in the province. Wu Wenjin and Xu Zhenwei (2021) evaluated the current situation and efficiency of the development of the digital economy in Anhui Province from the perspective of inter-provincial comparison, but did not compare the development of various cities in the province.

In summary, this paper selects the economic development data of various local-level cities in Anhui Province from 2013 to 2020 by screening the digital economy development indicators, and measures the level of digital economy development in Anhui Province through the entropy weight method. On the one hand, it supplements the research on related aspects, and on the other hand, it also has positive and important reference significance for the selection of the digital strategy direction of Anhui Province and the formulation of regional digital economy development strategy.

3. Construction of Digital Economy Development Index Measurement System in Anhui Province

3.1. Introduction to The Evaluation Method of The Digital Economy Development Index in Anhui Province

Based on the entropy weight method, this paper measures the development level of digital economy in Anhui Province, and obtains the digital economy development index of each prefecture-level city in Anhui Province by empowering each digital economy development index, and the weight of each index is determined by the degree of variation of each index value. Compared with the subjective empowerment method such as expert scoring method and analytic hierarchy method, the entropy weight method is more objective, and it is calculated through the corresponding formula, which overcomes the interference of people's subjective psychology, avoids the influence of subjective factors, and has higher accuracy of results. The steps to calculate the entropy weight method are as follows.

The first step is to normalize the data of each indicator so that each indicator is in the same order of magnitude. Its purpose is to homogenize indicators of different dimensions and eliminate the influence of different dimensions. The normalization steps of the positive indicator are as follows.

$$Y_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})}, \ i=1,2,3,...,n; j=1,2,3,...,m. \tag{1}$$

where i represents the sample and j represents the indicator; X_{ij} refers to the raw data for indicator jth in the ith region; $\min(X_{ij})$ is the minimum of the jth indicator in all years in the ith region in the raw data; $\max(X_{ij})$ is the maximum value of the jth indicator in all years in the ith region in the raw data; Y_{ij} represents the normalized metric values.

In the second step, calculate the proportion of the index value of the ith region under the jth indicator p_{ij}.

$$p_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}}, \ i=1,2,3,...n; j=1,2,3,...,m. \tag{2}$$

In the third step, calculate the information entropy value E_j of the jth indicator.

$$E_j = -k \sum_{i=1}^{n} (p_{ij} * \ln p_{ij}). \tag{3}$$

Where $k = -1/\ln(n)$, $0 \le E_j \le 1$.

The fourth step is to calculate the entropy redundancy D_j of the information of the jth indicator.

$$D_j = 1 - E_j, \ j=1,2,3,...,m. \tag{4}$$

Finally, the weights of each digital economy indicator are obtained, and the digital economy development index of each region is calculated.

$$W_j = \frac{D_j}{\sum_{j=1}^{m} D_j}, j=1,2,3,...,m. \tag{5}$$

$$M_i = \sum W_j \, p_{ij}. \tag{6}$$

3.2. Digital Economy Development Index System Construction and Data Selection

By querying the relevant literature of previous research on the level of digital economy development, this paper refers to the evaluation system of digital economy developed by referring to the article "Measurement and Analysis of the Level of Digital Economy Development in Henan Province", and constructs the measurement system from three dimensions: digital infrastructure construction, digital application level and digital innovation ability. Table 1 shows the evaluation system for the development level of the digital economy.

Table 1: Digital economy development level evaluation system

First level	Second level	Unit
Digital infrastructure	The total length of the postal route X1	Kilometer
	Mobile phone year-end users X2	Million households
	Fixed Internet broadband access users X3	Million households
Digital applications	Total telecommunications business X4	10,000 yuan
	The output value of the tertiary industr X5	100 million yuan
	Total digital business X6	10,000 yuan
Digital innovation capabilities	R&D Funding X7	10,000 yuan
	R&D Development Staff X8	Person
	Number of patent applications X9	Pieces

4. Evaluation results and analysis of the development of the digital economy

4.1. Evaluation of the Development Level of Digital Economy in Anhui Province

According to the steps of the entropy weight method, the second-level index data collected by the author from 2013 to 2020 in Anhui and various cities in Anhui Province are first brought into the corresponding formula for processing, and the weight of each index in different years of Anhui Province is obtained, as shown in Table 2.

Table 2: Entropy weights for each secondary index

Index	2013	2014	2015	2016	2017	2018	2019	2020
X1	0.0029	0.0049	0.0060	0.0000	0.0083	0.0084	0.0103	0.0084
X2	0.0035	0.0059	0.0004	0.0000	0.0131	0.0316	0.0394	0.0529
X3	0.0000	0.0026	0.0049	0.0095	0.0091	0.0123	0.0232	0.0238
X4	0.0000	0.0014	0.0045	0.0003	0.0069	0.0346	0.0685	0.0889
X5	0.0000	0.0020	0.0045	0.0076	0.0115	0.0168	0.0199	0.0212
X6	0.0000	0.0015	0.0044	0.0020	0.0084	0.0313	0.0600	0.0786
X7	0.0000	0.0023	0.0045	0.0075	0.0115	0.0152	0.0201	0.0239
X8	0.0000	0.0047	0.0054	0.0068	0.0089	0.0105	0.0194	0.0272
X9	0.0000	0.0009	0.0053	0.0121	0.0126	0.0174	0.0112	0.0167

As can be seen from Table 2, over time, the distribution of entropy weights of each secondary index is relatively stable, which reflects the stability of the information entropy of each indicator within the original data. Secondly, the values of each secondary indicator are increasing year by year.

From the perspective of time, from 2013 to 2020, the overall development level of the digital economy in Anhui Province showed the characteristics of increasing year by year. The Digital Economy Development Index was the smallest in 2013 and the largest in 2020. From 2013 to 2016, the growth rate of the digital economy development level in Anhui Province was

relatively slow, and from 2016 to 2020, the growth rate of the digital economy in Anhui Province was obvious, which was greatly related to the policies proposed by the state and Anhui Province. In 2015, China proposed the "National Big Data Strategy", and Anhui Province actively implemented national policies and issued the Digital Economy Policy to vigorously develop the digital economy. Since then, the construction of digital economy in Anhui Province has begun to accelerate.
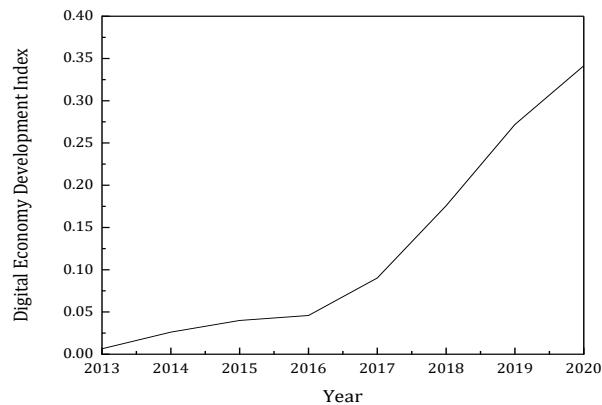

Figure 1: Time series characteristic values of digital economy development in Anhui Province

From a spatial point of view, the development of the digital economy among various local-level cities in Anhui Province is uneven. The highest score on the digital economy development index is Hefei, and the lowest score is Chizhou City, with an extreme difference of 0.1746. The rapid development of Hefei's digital economy is inseparable from the support of Hefei's scientific and technological innovation capabilities and the support of the local government. According to the digital economy development index of local-level cities, the 16 prefecture-level cities in Anhui Province can be roughly divided into four levels: the first level is only Hefei, whose digital economy development level is much higher than that of other prefecture-level cities, and has an absolute advantage. The second level includes Wuhu, Bengbu, Fuyang, Anqing and Chuzhou. The third level includes Ma'anshan, Lu'an, Suzhou, Bozhou, Xuancheng and Huainan. The fourth-level prefecture-level cities include Huaibei, Tongling, Huangshan and Chuzhou.
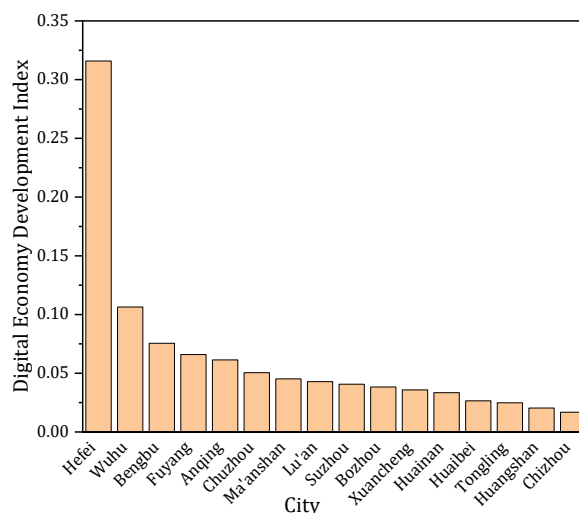

Figure 2: Digital economy development index of various cities in Anhui Province

Overall, it can be seen that from 2013 to 2020, the development level of digital economy in Anhui Province continued to grow steadily. However, from a spatial point of view, the level of digital economy development in various cities in Anhui Province is uneven.

Table 3: 2013-2020 Anhui Province digital economy development level

City	2013	2014	2015	2016	2017	2018	2019	2020
Hefei	0.0198	0.0212	0.0230	0.0292	0.0572	0.0440	0.0553	0.0662
Huaibei	0.0019	0.0021	0.0026	0.0023	0.0024	0.0037	0.0053	0.0062
Bozhou	0.0018	0.0020	0.0023	0.0028	0.0031	0.0057	0.0092	0.0114
Suzhou	0.0020	0.0022	0.0027	0.0032	0.0037	0.0060	0.0096	0.0113
Bengbu	0.0035	0.0039	0.0044	0.0055	0.0085	0.0145	0.0163	0.0189
Fuyang	0.0029	0.0032	0.0036	0.0045	0.0058	0.0103	0.0159	0.0197
Huainan	0.0026	0.0027	0.0029	0.0030	0.0038	0.0052	0.0061	0.0072
Chuzhou	0.0030	0.0034	0.0038	0.0043	0.0047	0.0080	0.0108	0.0125
Lu'an	0.0025	0.0028	0.0027	0.0035	0.0040	0.0059	0.0091	0.0124
Ma'anshan	0.0034	0.0039	0.0043	0.0047	0.0048	0.0063	0.0083	0.0095
Wuhu	0.0065	0.0075	0.0083	0.0093	0.0129	0.0177	0.0210	0.0232
Xuancheng	0.0024	0.0026	0.0030	0.0034	0.0037	0.0053	0.0070	0.0084
Tongling	0.0020	0.0021	0.0023	0.0028	0.0031	0.0035	0.0041	0.0049
Chizhou	0.0013	0.0013	0.0014	0.0016	0.0017	0.0024	0.0032	0.0039
Anqing	0.0032	0.0034	0.0036	0.0039	0.0048	0.0099	0.0158	0.0168
Huangshan	0.0015	0.0016	0.0018	0.0019	0.0021	0.0031	0.0039	0.0045

4.2. Subsystem evaluation of the level of digital economy development

Based on the constructed digital economy measurement system in Anhui Province, the average value of the digital economy development subsystem of various cities in Anhui Province from 2013 to 2020 is shown in Table 4.

Table 4: Average table of subsystems for the development level of digital economy

City	Digital infrastructure	Digital applications	Social innovation capabilities
Hefei	0.012151	0.012105	0.014533
Huaibei	0.000046	0.000179	0.000111
Bozhou	0.000998	0.003438	0.000494
Suzhou	0.000962	0.003821	0.000527
Bengbu	0.003995	0.002898	0.002445
Fuyang	0.002164	0.005386	0.000912
Huainan	0.000608	0.002357	0.001279
Chuzhou	0.000927	0.003262	0.002177
Lu'an	0.001607	0.003058	0.000816
Ma'anshan	0.000543	0.002303	0.002763
Wuhu	0.003515	0.004064	0.005513

Table 4(continued): Table of means of the subsystem for the development of the digital economy

City	Digital infrastructure	Digital applications	Social innovation capabilities
Xuancheng	0.000945	0.002125	0.001451
Tongling	0.000305	0.001179	0.001596
Chizhou	0.000482	0.001172	0.00048
Anqing	0.003326	0.003131	0.001253
Huangshan	0.000777	0.001263	0.000532

(1)Digital infrastructure. In the digital economy facility construction index, Hefei scored the highest and Huaibei scored the lowest. Hefei is the only city in Anhui Province with a digital economy construction index of more than 0.01 among the 16 prefecture-level cities. In Bengbu, Wuhu and Anqing, the digital economy facilities construction index is about equal, but there is a huge gap with Hefei. In general, the level of digital economy infrastructure construction in various local-level cities in northern Anhui is generally higher than that of cities in southern Anhui.

(2)Digital applications. The highest score on the Digital Application Index was in Hefei, while Chizhou scored the lowest. Other prefecture-level cities in Anhui Province have a big gap with Hefei in digital application. Secondly, compared with digital infrastructure, the development of digital applications in Bengbu City is not good.

(3)Digital innovation capabilities. The highest score on the digital innovation capability index was in Hefei and the lowest in Chizhou. Obviously, under the premise that the overall level of social and economic development is low, Chizhou's digital application and social innovation capabilities have a big gap compared with other cities.

4.3. Comparison of the development speed of digital economy in Anhui Province

From 2013 to 2020, it can be seen that the level of digital economy development of various cities in Anhui Province has been continuously improved in recent years. On this basis, the standard deviation of the digital economy development index of various cities in Anhui Province is calculated, and the development speed of digital economy of various cities in Anhui Province is compared. Here, the speed of digital economy development of various cities in Anhui Province is classified, and according to the standard deviation of the digital economy development index over the years, cities with standard deviations between 0 and 0.0045 are classified as stable development type, cities with standard deviations between 0.0046 and 0.01 are classified as rapid development types, and cities with standard deviations greater than 0.01 are classified as jump development types. The classification status of various local-level cities in Anhui Province is shown in Table 5.

Table 5: Anhui Province digital eonomy development index standard deviation and city classification table

City type	City
Steady development type	Chizhou(0.0009), Tongling(0.0009), Huangshan(0.0011), Huaibei(0.0015), Huainan(0.0017), Xuancheng(0.0021), Suzhou(0.0033), Lu'an(0.0034), Chuzhou(0.0034), Bozhou (0.0034), Ma'anshan(0.0021)
Fast-growing type Jump development type	Anqing(0.0054), Bengbu(0.0058), Fuyang(0.0060), Wuhu (0.0061) Hefei (0.0173)

As can be seen from Table 5, most prefecture-level cities in Anhui Province are stable development cities, including 11 cities such as Chizhou, Tongling, Huangshan and Huaibei. Fast-growing cities include Anqing, Bengbu, Fuyang, and Wuhu. There is only Hefei City that jumps and develops. As the capital of Anhui Province.

5. Conclusions

This paper measures the development level of digital economy in Anhui Province from three dimensions: digital infrastructure, digital application and digital innovation ability, and finds that the digital economy in Anhui Province has maintained an upward trend from 2013 to 2020 on the whole. From the perspective of spatial comparison, the level of digital development in various cities in Anhui Province is extremely uneven, and the digital economy development level index of Hefei is significantly higher than that of other cities. Secondly, the evaluation of the subsystem of the digital economy development level of various cities in Anhui Province found that Hefei City had the highest scores in the three indicators. and its scores were far higher than other cities.

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