

Spatial Agglomeration and Evolution of Digital Economy in Jiangsu Province

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Keywords: Digital economy; industrial agglomeration; location entropy

Abstract: With the second highest total GDP in China, Jiangsu Province has been at the forefront of developing digital economy in China. Based on the industrial output value and employment data from 2005 to 2019 for six digital economy sectors, the paper uses the location entropy index to measure the industrial agglomeration level, and makes a visual analysis with ArcGIS software. The results are as follows: (1) from the perspective of static distribution, the overall digital economy of Jiangsu Province has not achieved the scale agglomeration effect. (2) From the perspective of dynamic evolution, based on their respective advantages, cities vigorously develop their own competitive industries. Recommendations include the promotion of staggered layout planning of digital economic sectors, cultivation of industry leaders, and effective use of data industrial parks.

1. Introduction

Digital economy is an economic and social activity based on the new generation of information and communication technology and data is a key element in the digital economy. Digital economy includes five basic characteristics: high technology, high permeability, high integration, high growth and high security [1]. At present, digital economy has become an important engine to lead economic and social changes and promote high-quality economic development.

The rapid development of digital economy has improved the production efficiency of enterprises [2], promoted the level of China's industrial structure with marginal increase [3], and realized the adjustment, transformation and upgrading of industrial structure [4]. The digital economy has laid a solid foundation for China to build a new development model based on the "dual circulation" strategy which relies on domestic circulation and uses external circulation as a support [5]. In terms of regional development of digital economy, the spatial differentiation of China's digital economy development is evident, showing the geographical distribution characteristics of gradient decline from east to west [6].

With the second highest GDP in China, Jiangsu Province has been a leader in the development of digital economy. According to 2020 Digital Jiangsu Construction and Development Report, the size of Jiangsu's digital economy in 2019 has exceeded 4 trillion yuan, accounting for more than 40% of Jiangsu's GDP. However, the size of basic output is large, the overall property efficiency is not high, and the low efficiency of resource allocation is the main limiting factor [7]. This paper focuses on the industrial clusters of Jiangsu's digital economy, calculates and evaluates regional aggregation level in static state, the overall and sectoral aggregation levels in the dynamic state. Finally, the paper proposes policy suggestions on optimizing the industrial layout planning of Jiangsu digital economy.

2. Definition of digital economy

Digital economy, an organic combination of multiple industrial chains, is divided into digital industrialization and industrial digitization [8]. Digital industrialization refers to the production of specific physical products or digital products through data collection and processing. Industrial digitization refers to the use of digital technology to transform traditional industries in all dimensions to improve production efficiency [9]. The ultimate objective is to realize the digitization, networking and application of intelligence in traditional industries.

This paper divides the digital economy into four manufacturing industries and two service industries. The four major manufacturing industries are printing and recording media reproduction industry, special equipment industry, electrical machinery and equipment manufacturing industry, and computer, communication and other electronic equipment manufacturing industry. The two major service industries include information transmission, software and information technology service industry, and broadcasting, television, film and television recording and production industry.

3. Static characteristics

3.1 Measurement Index of Industrial Agglomeration

Location entropy index not only measures the spatial distribution of factors in a certain region, but also reflects the specialization level of an industrial sector [10]. Therefore, this paper uses location entropy to measure the agglomeration level of digital economy in Jiangsu Province. The calculation formula is as follows:

$$LQ_{ij}=(q_{ij}/q_j)/(q_i/q) \quad (1)$$

LQ_{ij} is the location entropy of digital economy industry i of region j in Jiangsu Province, q_{ij} is the output value of digital economy industry i in region j , q_j is the total output value of industry or service industry in region j , q_i is the output value of digital economy industry i in Jiangsu Province, and q is the total output value of industry or service industry in Jiangsu Province. This paper calculates the location entropy of each city, then it uses ArcGIS software and visually compares the levels of industrial agglomeration of the digital economy in 13 cities.

According to the calculation results of location entropy, the levels of industrial agglomeration of the digital economy in Jiangsu Province are divided into five levels: ① $LQ_{ij} > 2$, very high agglomeration area; ② $1.5 < LQ_{ij} < 2$, high agglomeration area; ③ $1 < LQ_{ij} < 1.5$, higher agglomeration area; ④ $0.5 < LQ_{ij} < 1$, lower agglomeration area; ⑤ $LQ_{ij} < 0.5$, low agglomeration area.

3.2 Static Analysis

Table 1 reports the overall agglomeration level of digital economy in Jiangsu Province in 2019. The location entropy is only 0.918. The metric indicates that Jiangsu's digital economy has not formed the scale agglomeration effect and remains at a low level. The main reason is that the digital economy is not balanced in terms of regional distribution.

Table 1. The Overall Agglomeration Level of Digital Economy in Jiangsu, 2019.

Region	Level	Region	Level
Jiangsu	0.918	Suqian	0.855
Southern Jiangsu	1.309	Yangzhou	0.727
Central Jiangsu	0.755	Nantong	0.688
Northern Jiangsu	0.689	Xuzhou	0.684
Suzhou	1.595	Huaian	0.603
Wuxi	1.348	Taizhou	0.469
Nanjing	1.232	Yancheng	0.425
Changzhou	1.114	Lianyungang	0.227
Zhenjiang	1.034		

Source: Calculated from data in Jiangsu statistical yearbook

From the regional level, Southern Jiangsu has become the core area in the development of digital economy in Jiangsu Province. The manufacturing industries in Southern Jiangsu have advantages of a strong foundation, a large talent pool and a high technological level. These advantages promote the convergence of data resources and industries. However, the location entropy index of Central and Northern Jiangsu is lower than 1. The difference between the regions is much related to geographical locations and regional disparities in terms of economic and social development.

4. Dynamic evolution

4.1 Overall Evolution

Fig.1. presents development trends from 2005 to 2019. The location entropy of Jiangsu digital economy shows a slow upward trend, but remain in a diffusion state and has not formed a certain industrial scale. Meanwhile, the agglomeration levels of digital economy in Southern Jiangsu, Central Jiangsu and Northern Jiangsu show a reverse change relationship. From 2005 to 2014, the gap of agglomeration levels between different regions has been narrowing, but the gap has been gradually expanding since 2014. The overall development level of digital economy in Southern Jiangsu is relatively high. Although the digital economy has experienced a period of decline, the location entropy has stayed above 1.0, higher than the average level in Jiangsu Province. This shows Southern Jiangsu has advantages in developing the digital economy. Since 2016, the growth of digital economy in Central and Northern Jiangsu has been sluggish. The level of industrial agglomeration has decreased, and the industrial factors have always been in a state of diffusion.

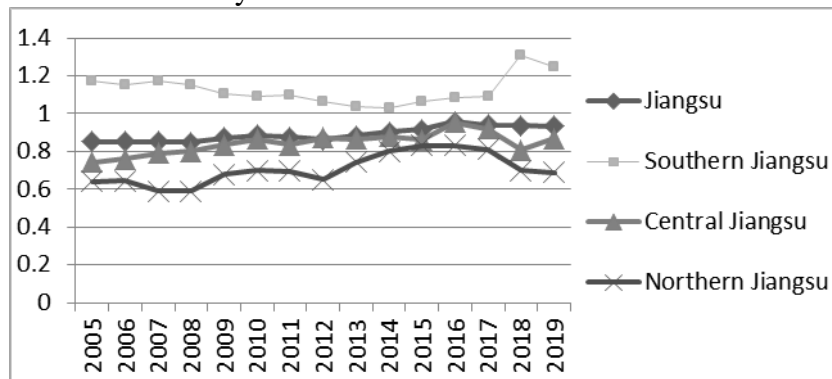


Fig 1. Industrial Agglomeration Level of Digital Economy in Jiangsu, 2005-2019.

Source: Calculated from data in Jiangsu statistical yearbooks

4.2 Evolution Status by Industry

This paper continues to discuss the evolution of the spatial structure from the perspective of six digital industries. ArcGIS software is used to analyse the level of digital industrial agglomeration of 13 cities between 2005 and 2019. In figures, the darker the colour is, the higher the level of industrial agglomeration is.

4.2.1 Printing and Recording Media Reproduction Industry

The overall development of printing and recording media reproduction industry in Northern Jiangsu is better than that in Southern and Central Jiangsu. The level of industrial agglomeration increases over time. In Northern Jiangsu, the extremely high concentration areas have changed. In 2005, Xuzhou and Huai'an were the agglomeration areas for the industry, but some businesses have relocated to Suqian. Possible explanations are that Xuzhou has relocated the printing industry with high energy consumption and high pollution out of environmental considerations. In Southern Jiangsu, the industrial advantages in Nanjing, Changzhou and Zhenjiang have had are gradually shifting to Wuxi and Suzhou. In Central Jiangsu, although the industry has been gradually developing in recent years, the industrial factors are still extremely scattered.

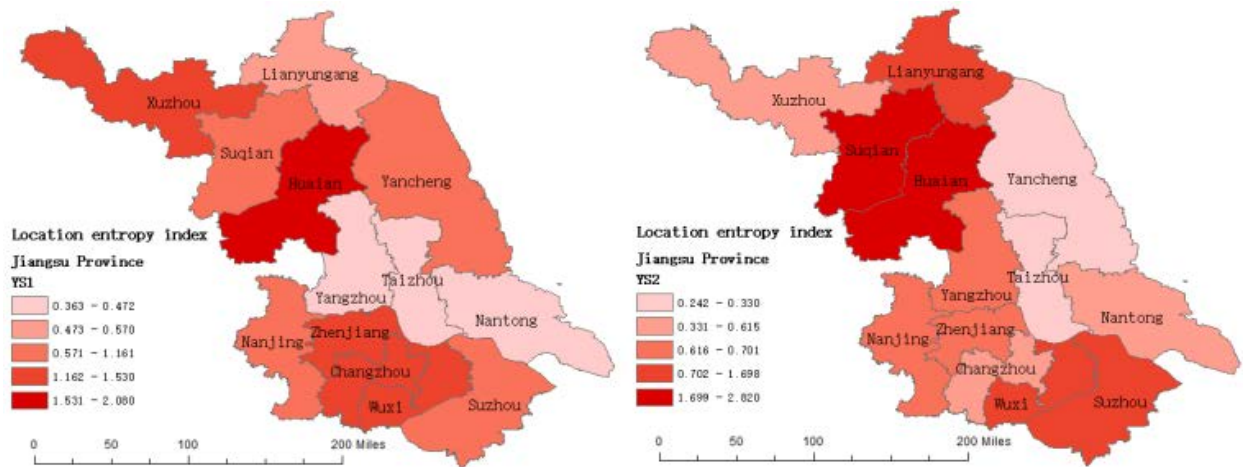


Fig 2. Agglomeration Level of Printing and Recording Media Reproduction Industry.

4.2.2 Special Equipment Industry

The spatial distribution of special equipment industry is stable and is mainly concentrated in Central and Southern Jiangsu. From 2005 to 2019, special equipment industries in Changzhou and Suzhou have been in a state of high concentration or extremely high concentration. Yangzhou and Taizhou in Central Jiangsu have always been the center for the development of special equipment industry, and their location entropy values have stayed in the range of [1,1.5] or [1.5,2] as shown in Fig.3. However, in 2019, the industrial output values of Yangzhou and Taizhou showed a sharp decline, resulting in the agglomeration index falling to 0.740 and 0.660 respectively. Possible explanations are the continuous adjustment of industrial structure and the emphasis on energy conservation and consumption reduction in the two cities. Although there are minor fluctuations in the industry in Central and Southern Jiangsu, the overall development is relatively stable. Central and Southern Jiangsu have always been two high concentration areas. Xuzhou in Northern Jiangsu has stood out. Xuzhou's location entropy value rises from 0.835 to 1.319 as shown in Figure 3, and industrial factors gradually evolve into a state of agglomeration. Xuzhou is expected to become the growth pole of special equipment industry in Northern Jiangsu.

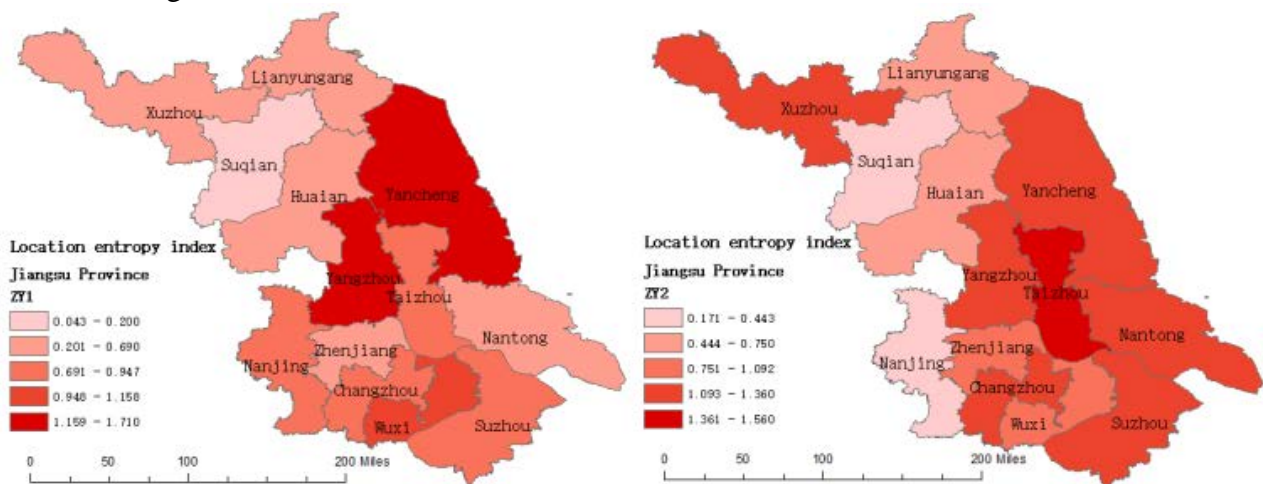


Fig 3. Agglomeration Level of Special Equipment Industry.

4.2.3 Electrical Machinery and Equipment Manufacturing Industry

Electrical machinery and equipment manufacturing industry is well developed in Southern Jiangsu and Central Jiangsu. From 2005 to 2019, as shown in Fig.4, Yangzhou has had a location entropy value of 1.821 and Changzhou has had a value of 1.515. The two cities are the high concentration areas of this industry. However, the development level of Northern Jiangsu is relatively low. The industrial development in Northern Jiangsu is in a discrete state. The average index of location entropy (0.518)

as shown in Figure 4 is only half of the overall provincial level. Southern Jiangsu and Central Jiangsu have long prioritized manufacturing industry. In particular, the two regions have strong industrial foundations in mechanical and electrical manufacturing, so they have competitive advantages in this industry. Industrial bases in Suqian and Lianyungang in Northern Jiangsu are relatively weak. As the growth pole of mechanical and electrical manufacturing industry, Central Jiangsu can relocate some manufacturing industries to Suqian and Lianyungang to promote industrial upgrading in Northern Jiangsu.

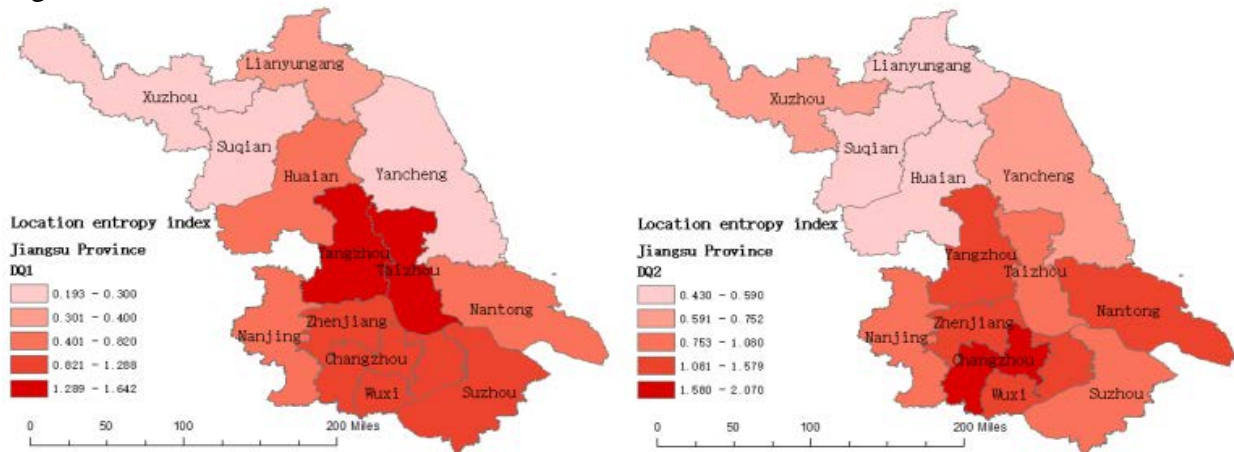


Fig 4. Agglomeration Level of Electrical Machinery and Equipment Manufacturing Industry.

4.2.4 Computer, Communication and Other Electronic Equipment Manufacturing Industry

Southern Jiangsu is the fast-growing area in computer, communication and other electronic equipment manufacturing industry. Nanjing and Suzhou, the representative cities, reach a high level in the development of the industry. With the average index of location entropy breaking through 2 as shown in Fig.5, Suzhou has an absolute advantage. Suzhou is a very high concentration area of this industry in Jiangsu Province. Except for Wuxi in Southern Jiangsu, the average index of location entropy in the other cities of Jiangsu Province is less than 0.5, and industrial factors are extremely scattered. This industry has high technology intensity. On the strengths of infrastructure, science and technology and talents, Southern Jiangsu has been developing this high-tech industry at a fast pace. But the average location entropy index of this industry in Jiangsu Province is only 0.605 as shown in Figure 5. Due to the lack of technical know-how and talents, Central and Northern Jiangsu have not been able to grow the industry very fast. The two regions should strengthen the exchange of technology and talents with Southern Jiangsu.

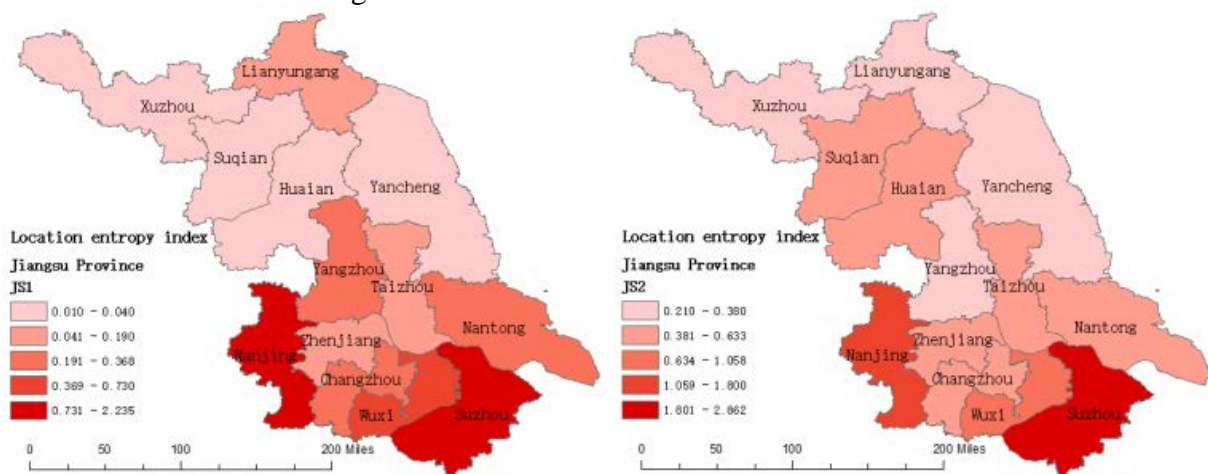


Fig 5. Agglomeration Level of Computer, Communication and Other Electronic Equipment Manufacturing Industry.

4.2.5 Information Transmission, Software and Information Technology Services

Information transmission, software and information technology services has consistently centred in Southern Jiangsu with Nanjing and Wuxi as the two representative cities. From 2005 to 2019, as is shown in Figure 6, the level of industrial agglomeration has increased year over year, up 24.59 and 58.36 percentage points respectively. As among the five communication hubs and eight Internet nodes in China, Nanjing has a solid foundation for the growth of digital economy thanks to its abundant information resources. The average index of location entropy reaches 1.955 as shown in Fig.6. In Northern Jiangsu, Suqian has a higher agglomeration level of industrial factors, and gradually spills over to Huai'an and Lianyungang in the east.

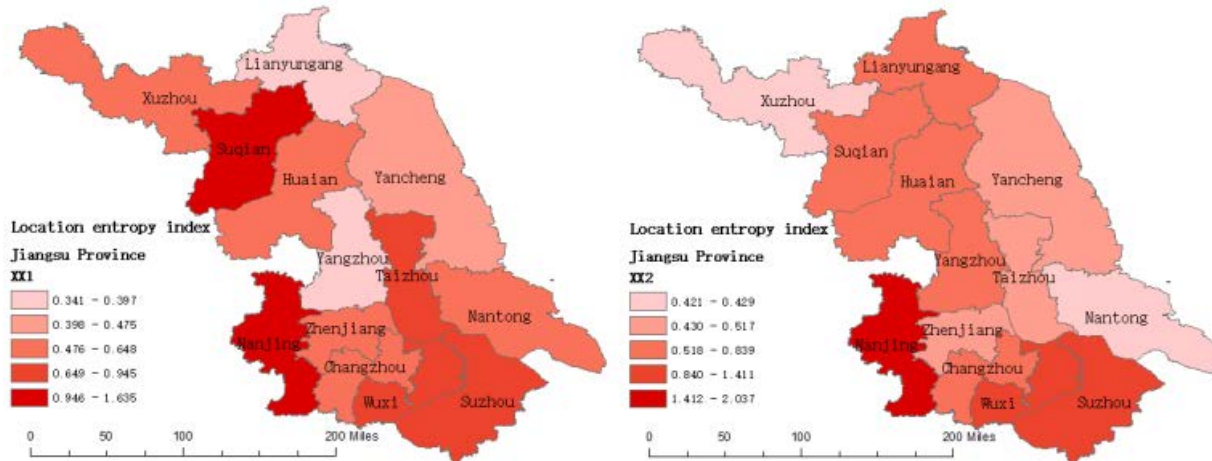


Fig 6. Agglomeration Level of information transmission, software and information service industry.

4.2.6 Radio, Television, Film and Television Recording Production

In view of the lack of data, table 2 only lists the industrial agglomeration levels of Nanjing, Suzhou, Zhenjiang and Suqian from 2014 to 2019. The average index of location entropy of Nanjing and Zhenjiang all exceed 2. The value indicates they are the extremely high concentration areas for the industry. Suqian performs less well than the other three cities. In recent years, cities in Southern Jiangsu have been grasping the opportunity that “Internet Plus” strategy brings, have been enhancing the scientific and technological strength in the cultural field. In Northern Jiangsu, the location entropy index of Suqian's industry increased to 0.975 in 2019. Although the index is nearly three times that of 2014, industrial factors are still in a state of diffusion. Cities in Central and Northern Jiangsu need to draw on the experiences that Southern Jiangsu cities have in developing this industry. They need to make attempts to integrate the film and television cultural industry with information technology and digital technology.

Table 2. The Agglomeration Level of Radio, Television, Film and Television Recording Production.

	2014	2015	2016	2017	2018	2019
Nanjing	2.102	2.434	2.786	2.713	2.617	2.631
Suzhou	1.517	1.710	1.786	1.444	2.074	-
Zhenjiang	2.245	2.357	2.398	2.829	-	2.749
Suqian	0.341	0.077	0.277	0.978	0.852	0.975

Source: Calculated from data in Jiangsu statistical yearbooks

5. Conclusion and policy suggestions

5.1 Conclusion

The results show that Southern Jiangsu outperforms Northern Jiangsu in the development level of digital economy in terms of spatial agglomeration level and evolution. For individual cities, the digital economy in Southern Jiangsu cities (Suzhou, Wuxi, Changzhou and Zhengjiang) present a high level

of agglomeration scale effect. Suqian, Yangzhou, Nantong, Xuzhou and Huai'an belong to the second tier and the remaining three cities, Taizhou, Yancheng and Lianyungang remain at a low level. However, in terms of the specific industries, each city employs its own advantages and develops its own competitive industries. They have achieved a certain scale agglomeration effect. In view of the above analysis of the spatial layout of digital economy in Jiangsu Province, this paper proposes policy suggestions in Section 5.2

5.2 Policy Suggestions

First, Jiangsu Province should promote staggered layout planning. Southern Jiangsu should speed up the integration of 5G and other new generation information technology with cultural and creative fields so that they may move up to the high-end cultural industry chain. Central Jiangsu should propel the development of special equipment industry. Northern Jiangsu should promote digitizing and automating in printing production process. Second, government should cultivate industry leaders. Industry policies should be formulated to guide the growth of digital economy. And government services should be guaranteed. Third, a provincial information resource sharing service platform and a regional data center would facilitate the growth of digital economy.

Acknowledgment

This paper is financially supported by Jiangsu Social Sciences Applied Research Project in 2020(Grant No. 20SYB-059): Research on the Development Strategy of Jiangsu Digital Economy Industrial Cluster and Jiangsu Social Science Fund Project (No. 17JYB001).

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