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## Bridging the Digital Divide: Making the Digital Economy Benefit to the Entire Society

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# **Bridging the Digital Divide: Making the Digital Economy Benefit to the Entire Society**

Bin Zhang   Zhiye Jin   Zhidao Peng

## **ABSTRACT:**

With the development of information technology, the connotation of the Digital Divide has evolved constantly. At present, we have entered the new era of “Digital Economy” and newer information technologies such as Big Data, Artificial Intelligence, Internet of Things, and Cloud Computing have been widely developed and applied. New technologies should also be included in the measurement of the Digital Divide. At the same time, the physical gap in traditional information technology has been greatly reduced. Under the condition that physical access conditions are similar, the gap in digital technology skills and use is highlighted. Under such circumstances, the measurement of the Digital Divide should be more concerned with Digital Literacy and Digital Experience. Under the background of the Digital Economy, the existence of the Digital Divide means that there is a huge first-mover advantage for the party at a more advanced position. Countries, regions and communities with faster information development will be able to use information dividends promptly to promote their own economic development. However, the party that is far lagging behind will have fewer opportunities to participate in the information-based Digital Economy. At the same time that economic development is at a disadvantage, because under the new economy condition, more work and social activities are closely related to information technology, therefore, opportunities for the information poor to participate in online education, training, entertainment, shopping and communication have also become fewer, and these have exacerbated social inequalities. In this study, qualitative analysis and quantitative analysis were used to study the Digital Divide evaluation system in the era of Digital Economy. In the qualitative part of this article, we summarize the definition of Digital Economy, the definition of Digital Divide and the measurement theory of regional Digital Divide by studying the literature, laying a solid theoretical foundation for the research of this article. Starting from the six aspects of Digital Technology Infrastructure, ICT Readiness, Economy Development, Government Innovation Support, Education and Digital Literature, Digital Contents and Applications, we put forward research hypotheses and build the corresponding evaluation system model. In the quantitative research part of this paper, empirical research methods were used to verify the hypothesis and model. Among them, through a large amount of domestic research data collected from China Statistical Yearbook, with SPSS statistical analysis software to process the data, this paper proposes a complete index system of informatization and Digital Divide evaluation in the Digital Economy era and weights distribution for the system, using Factor Analysis, Analytic Hierarchy Process and Expert Interview Methods. On this basis, this article understands the current situation of informatization development and regional Digital Divide by the calculation of the index.

Through the Clustering Analysis and Average Deviation Analysis, we analyze the causes of the Digital Divide formation, understand the gap of regional informatization and digital development, and find the weakness in digital development. Then, we put forward some suggestions that can effectively improve bridging the Digital Divide to solve the “information gap”, “knowledge division” and “rich and poor division” between regions due to the development and application level gap. It provides reference for bridging the Digital Divide and promoting regional information, economic and cultural balanced development. This will enable digital technology to be more utilized in the process of promoting the development of the Digital Economy. Giving full play to the connectivity of the Internet will allow the Digital Economy to benefit more regions and enhance the well-being of the entire society.

**Keywords:**

Digital Divide, Digital Economy, Evaluation Index System, Policy Suggestion

## **1 Introduction**

### *1.1 Research Background*

The emergence of the Internet has promoted the world's connectivity and exchanges. It is precisely because of the world's interconnection that greatly reduces the barriers of technological exchange and sharing, which has led to the rapid development of information technology and brought about a huge Digital Divide. On this basis, high-tech industries and applications are constantly being integrated and innovated, forming a new situation in which “digital technology” drives economic development. The contemporary economy is more about a “Digital Economy” based on, pioneered by and driven by digital technology. On one hand, digital technology penetrates into the traditional production field, making the traditional production fields radiate new vitality under the catalysis of new technologies and gradually transform into a Digital Economy. On the other hand, digital technology has brought new economic forms. Rapid emergence and development of high-tech industries based on Big Data, Internet of Things, Cloud Computing, Artificial Intelligence and other high technologies, such as autonomous vehicles, smart homes, and wearable devices, have triggered a new wave of change and created a considerable economy value. China has made noticeable progress in the e-development since 1998; yet, progress varied in different dimensions (Becky P.Y. Loo & Bo Wang, 2017). The Digital Divide continues to exist between regions and communities. The Digital Divide has been a key issue faced by many developing countries (Liu, 2016; Loo & Ngan, 2012; Srinuan & Bohlin, 2012; Xia & Lu, 2008). It can be seen that, whether from a global perspective or from a regional perspective, when information technology becomes more advanced, the higher connectivity it brings, the stronger its role in promoting the development of the economy and even the entire society. The existence of the “Digital Divide” splits society into two camps of “information rich” and “information poor”. The benefits of the Digital Economy are more limited to the “information-rich”

side, which undoubtedly hinders the balanced development of society. Under such background, bridging the Digital Divide and giving full play to the connectivity of the Internet will enable the Digital Economy to benefit the entire society and will be the focus of research in the new era.

### *1.2 Research Significance*

Under the big background of the Digital Economy, the existence of the Digital Divide means that there is a huge first-mover advantage in the leading edge of the gap. Countries, regions, and communities with rapid information development will be able to quickly use the information dividend to promote their own economic development, while those who are far behind in the gap will have less opportunity to participate in the information-based Digital Economy. While economic development is at disadvantage, and because of the new economy, more jobs and social activities are closely related to information technology, so that the information-poor people are less likely to participate in online education, training, entertainment, shopping, and communication. All these have increased social inequality. The Digital Divide is a big concept. It is reflected in many aspects. For those who need to measure and compare the Digital Divide, the gap in all aspects of digital development is different. It may be that the traditional information technology gap has narrowed, and the gap in the field of emerging information technology has increased. For example, what areas are the major sources of the Digital Divide? This requires a comprehensive Digital Divide measurement in all areas. Dissecting all aspects of the Digital Divide in a comprehensive manner helps to understand the level gap between regional information technologies especially the digital technology development, and find the shortcomings of its digital development, so as to solve the issues of “information gap”, “knowledge division” and “rich and poor division” existing between regions due to development and application level gaps, to provide a reference for bridging the Digital Divide and promoting the balanced development of regional information, economy, and humanities.

### *1.3 Research Content and Method*

This study uses a combination of qualitative analysis and quantitative analysis to study the Digital Divide assessment system in the Digital Economy era. In the qualitative research section of this paper, the literature is used to summarize the definition of Digital Economy, the definition of Digital Divide, and the regional Digital Divide assessment theory, which lays a solid theoretical foundation for the study of this paper, and from the six latitudes of Digital Technology Infrastructure, ICT Readiness, Economic Development, Government Innovation Support, Education and Digital Literacy, Digital Content and Application , research hypotheses are put forward and a corresponding evaluation system model is built, using Analytic Hierarchy Process and Factor Analysis. In the quantitative research section of this article, empirical research methods are used to validate the research hypothesis and model. Among them, after the massive collection of domestic and foreign research data, SPSS statistical analysis software is used to process

the data. Based on the verification model and research hypothesis, this paper proposes a complete Digital Divide evaluation index system in the Digital Economy era, combines the status quo of the Digital Divide in the region, analyzes the measurement results of the Digital Divide through the use of Hierarchical Clustering Based on Distance and Correlation and Average Deviation, and proposes suggestions that can effectively improve the causes of the Digital Divide. This will enable digital technology to be more utilized in the process of promoting the development of the Digital Economy. Giving full play to the connectivity of the Internet will allow the Digital Economy to benefit more regions and enhance the well-being of the entire society.

## **2. Literature Review**

### *2.1 Digital Economy*

Nowadays, data has become a key production factor driving economic growth. The convergence of Big Data and Cloud Computing has promoted the rapid development of the Internet of Things and has realized the interconnection of people to people, people to things, and things to things, resulting in data volume showing explosive growth. Digital infrastructure becomes the new infrastructure (Si Xiao & Meng Zhaoli & Wang Hualei, 2017). The Digital Economy has gradually become the consensus of all governments in the world and the focus of global discussion (Tian Li, 2017).

In the virtual and rigorous digital space, the economic activities related to the application of digital technologies, trading of digital products, etc. are called digital economies and are a new form of economy (Zhao Xing, 2016). All products and services provided based on (digital) computer production belong to the category of Digital Economy activities (Zhou Hongren, 2017). Pang Jian and Zhu Xinmin of Sichuan University believe that the Digital Economy is based on information and communication technology, and through the Internet, mobile communication networks, and the Internet of Things, etc. the digitalization of transactions, exchanges, and cooperation will be realized, and economic and social development and progress will be promoted (Pang Jian & Zhu Xinmin, 2013). The modern information technology revolution represented by computers, networks, communications, etc. has spawned the Digital Economy, so sometimes the Digital Economy is also referred to as the network economy and information economy (Zhang Xinhong, 2016). All in all, scholars, government agencies, and organizations all agree that the Digital Economy is an economic form brought about by information technology and informatization, forming a Digital Economy, and the essential feature of this economic form is the production made by the way of digital technology (Li Changjiang, 2017). It is an advanced economic stage following the agricultural economy and industrial economy (China Information & Communication Institute, 2017).

The concept of Digital Economy in the first digital economic policy document, G20 Digital Economy Development and Cooperation Initiative, which was the first document signed by many countries, passed by the G20 Hangzhou Summit, is as follows: The

Digital Economy refers to a series of economic activities with the use of digital knowledge and information as key production factors, the use of modern information networks as an important carrier and the effective use of information and communication technologies as an important driving force for efficiency improvement and economic structure optimization. Regarding the outcome of this meeting, Tian Li believes that China's definition of the Digital Economy emphasizes that the Digital Economy is the integration of the main industries and industry fusion of information communication (Tian Li, 2017).

## *2.2 Digital Divide*

The "Digital Divide" (Heppell, 1989) has been widely studied by academia since its appearance in 1989. Its connotation has also evolved with the development of the times. The initial research on the Digital Divide refers it to the gap between access to information and communication technologies between information owners and information lackers. The US National Telecommunications and Information Administration (NTIA) defines it as: "The Digital Divide refers to the gap between those who own digital technology and those who have never owned it" (National Telecommunications and Information Administration, 1998). This definition focuses on the technical level, which is the difference of access and ownership of information technology hardware and software (Mack, 2001; Warf, 2001; Wilson & Wallin JS & Reiser C, 2003). Some scholars call this "access ditch" or the "First-Generation Digital Divide" (Yan Hui & Sun Lili, 2012). The connotation of the "Second-Generation Digital Divide" extends from "access technology" to the difference in the degree of use of information technology at the social and political level (Williams, 2001). Corresponding to the "access ditch", such a usage gap is called "use ditch" (Wei Lu & Xie Dian, 2015). With the concept of the second generation of Digital Divide, scholars' understanding of the Digital Divide also extends from the popularization of ICT and the Internet to more connotations such as application, skills training, etc. (Yan Hui, Sun Lili, 2012). The Organization for Economic Cooperation and Development defines the Digital Divide as: the gap between individuals, house-holds, business and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the Internet for a wide variety of activities (OECD, 2001), which is widely accepted by scholars (Pick & Azari, 2011; Cilan et al., 2009). Hu Angang et al. defined the Digital Divide as an "unbalanced phenomenon in the spread and application of emerging information and communications technologies represented by the worldwide web" (Hu Angang & Zhou Shaojie, 2002). Chen Hongxing believes that the Digital Divide based on information understanding is an endogenous gap in the information cycling process, namely, the gap between the proliferation of information and the poor ability to receive and understand information, and the gap between information production and information absorption (Chen Hongxing, 2008). Xie Yangqun deepened the Digital Divide concept from the apparent "gap in the possession and use of information technology" to the "gap in the capabilities of possession, acquisition and use of information" (Xie Yangqun &

Wang Chuanlei, 2001).

With the development of the Internet, the Digital Divide has given birth to some new connotations. It has expanded from the traditional information and communication technology level to the gap between information resources and knowledge in the digital age, resulting in the “Third-Generation Digital Divide” research. Xie Jungui described the connotation of the Digital Divide as: “the first is the gap between different information subjects in information contact and information ownership and this gap is often called the information gap, and it is the meaning of information differentiation as an existing state; the second is the generation and expansion of information gaps between different information subjects and this is a connotation of information differentiation as a changing process.” (Xie Jungui, 2003)

Wang Mei and others further proposed the concept of a “New Digital Divide” and paid more attention to the “skill gap” caused by differences in computer or online skills, and the “use gap” caused by differences in bandwidth, duration, and usage patterns of the Internet. He pointed out that in the traditional “Digital Divide” era, people worked hard to provide “digitally disadvantaged” groups with computers and other equipment and Internet access opportunities in order to bridge the “physical divide.” This has achieved results in narrowing the “physical gap,” but the existence of the “skill gap” and “use gap” have made it likely for the “digitally disadvantaged” group to remain at a disadvantage. (Wang Mei & Sui Xiaoyu, 2014)

A review of the research history of the Digital Divide by scholars reveals that the connotation of the Digital Divide has evolved and changed with the development of information technology. The scope covered has also expanded from the initial communication technology to the Internet. However, at present, we have evolved from the Internet era into the new “Digital Economy” era, newer information technologies such as Big Data, Artificial Intelligence, Internet of Things, and Cloud Computing have been widely developed and applied. New technologies such as “Big Data, Artificial Intelligence, Internet of Things, and Cloud Computing” should also be included in the range of Digital Divide measurement. At the same time, the physical gap in traditional information technology has been greatly reduced. Under the condition that physical access conditions are similar, the gap in digital technology skills and usage is highlighted. Under such circumstances, the measurement of the Digital Divide should be more focused on Digital Literacy and Digital Experience. The Digital Divide in the era of Digital Economy should have the following two connotations: First, the Digital Divide includes the gap between the quantity of possessions and the quality of possessions of information technology. Possession quantity include such as coverage rate, access status, etc., and possession quality include access price rate, access speed rate, and advanced degree of information technology. Second, the Digital Divide includes the gap in digital literacy. Digital literacy includes the ability to possess, acquire, and use information.

### *2.3 Measure and Bridge the Digital Divide*

The importance of detecting, measuring and understanding the DD comes as a result

because it can reveal the existing inequalities in the global society of information (Van Dijk, 2006). There is a broad consensus among academia, industry, and politics that public policies are needed to ensure that everyone has access to the potential benefits of ICT (Menou & Taylor, 2006). These technological inequalities and of access to the ICTs directly affect economic growth and the development of the different countries (Vu, 2011). There are a number of steps that would narrow the current divide between Internet users and non-users, and foster a robust and open Internet. When individuals go online, they need affordable services, diverse content, reasonable costs, reliable infrastructure, uncensored information, and local language translation (Darrell, 2015).

It was verified that the geographic area, among others, was an important factor in the definition of the DD (Ruiz-Rodríguez, F., et al., 2017). At present, the Digital Divide study focuses on measuring and explaining the DD based on the social and demographic factors and the economic characteristics of the users of the ICTs (Barzilai-Nahon, 2006; Mason & Hacker, 2003; Vehovar & Sicherl & Husing & Dolnicar, 2006). In order to bridge the Digital Divide, first it is necessary to measure the level of development in all aspects of digital development in order to understand the seriousness of the inter-regional digital gap in each specific area, thus making decision-making more targeted. Therefore, it is crucial to develop a holistic analytical framework for tracing and understanding the characteristics and different stages of e-development, which allows researchers and policy-makers to evaluate the readiness of a community towards a more mature stage of an e-society and to make the best decisions of promoting the e-development. (Loo, 2012; Menou & Taylor, 2006).

Since 2009, ITU has released the “Measuring Information Society” annual report, which uses the “ICT Development Index (IDI)” to measure the overall level of informatization development, which is calculated from weighted sum of the three dimensions of ICT access, ICT use and ICT skills (ITU, 2009). Published by the World Economic Forum and Harvard University, the Network Readiness Index (NRI) is based on the informatization environment, informatization readiness, informatization application, and informatization impact. Weighted calculations are used to measure the development level of informatization. (Johnson Cornell University, INSEAD, World Economic Forum, 2016).

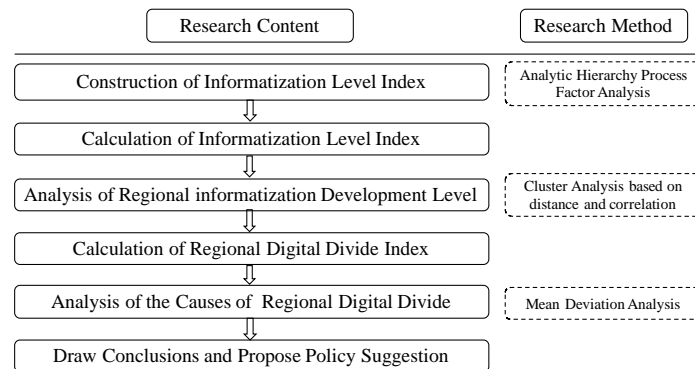
With the further development of informatization, society has entered the stage of Digital Economy, and measurements of high-tech information technology, digital literacy, and digital skills have entered people’s vision, instilling new connotations to the development of informatization in the era of Digital Economy. The OECD's digital economic index is mainly measured from a number of dimensions including the digital transformation framework conditions, digital infrastructure, commercial applications of digital technologies, and the proportion of Internet users using digital technologies, digital skills personnel, ICT-related innovations, digital security and trust. (OECD, 2017). Zero-rating plans include methods to reduce telecommunication access costs, increase network efficiency, expand digital infrastructure, enhance digital literacy, provide multiple content, encourage multiple languages, promote free expression, realize affordable services, and



increase digital competition. By integrating the poor into a diversified and highly competitive digital world and promoting the demand for local content and services, we can expand the effective channels of access (Darrell, 2015).

China's informatization assessment has a certain degree of specialness. Although the media has become increasingly interested in the development of China's information and communication technologies, tracking and understanding of the development of China's informatization is not yet systematic enough (Atsmon & Magni, 2010; Chu, 2008; Loo, 2003). In addition, it has been widely recognized that the ICT development in China has been heavily shaped by the government policy (Harwit, 2005; Loo, 2003; Loo & Ngan, 2012; Ward & Zheng, 2016; Wu, 1996; Zhen, Wang, & Wei, 2015; Zheng & Ward, 2011). It is necessary to formulate an index system that conforms to China's national conditions.

In conclusion, to evaluate the regional Digital Divide in China, a comprehensive informatization evaluation system needs to be constructed to measure the level of regional informatization development. The level index usually applies AHP and factor analysis. Then, analyze the level of regional informationization development, such as cluster analysis. Finally, the regional Digital Divide index is calculated to compare the Digital Divide (Francisca Ruiz-Rodríguez & Angel Luis Lucendo-Monedero\* & Reyes González-Relan˜o, 2017; Wei L & Xie D, 2015). The research framework of this paper is shown in figure 2-1.



**Figure 2-1 Research Framework**

### 3. Construction and Analysis of Informatization Level Index

The first step of the measurement of Digital Divide is to construction of the whole informatization evaluation system. In terms of the establishment of an informatization evaluation system, first of all, the selection of indicators needs to take into account the various elements of ICT development. And it should reflect the connotation of the Digital Divide in the era of Digital Economy. Second, the data should be easily accessible and can be measured by region. Finally, this article uses the Analytic Hierarchy Process to determine the weights of the third-level indexes. SPSS statistics software is used to classify the data with the method of Factor Analysis to get the weights of the second-level and first-level indexes and construct the whole informatization level index system.

#### 3.1 Selection of Indicators

Informatization Level Index (ILI) (Zhang Bin, 2017) continuously researches the level of domestic informatization from the five dimensions of technology, economy, government, education and society. In the past index system, it is measured by three-level index system, including 5 first-level indicators, 10-12 second-level indicators and several third-level indicators. Considering that Digital Economy has become the main theme of the information era, and high-technology is developing rapidly, so in the new era of informatization, Digital Divide has a new definition and connotation. Therefore, the ILI for measuring the Digital Divide should be reformed and improved with the times.

The original informatization evaluation system focuses more on ICT access capabilities and possession quantity, etc. This article makes appropriate adjustments and adds the indicators related to possession quality and digital literacy, such as Percentage of Employed Persons in Scientific Research and Technical Services, Investment in Fixed Assets of Scientific Research and Technical Services /capita, Broadband Download Rate, Popularization Rate of 4G Mobile Phone, Sales of E-commerce/capita. The final ILI is shown in Table 3-1. Among them, the indicators related to infrastructure and popularity reflect the capabilities of ICT access and possession, and Broadband Download Rate can reflect the quality of possession of information technology. Popularization Rate of 4G Mobile Phone reflects the advanced level of information technology. E-commerce Sales reflect the level of application of the Digital Economy. The indicators related to talents in ILI represent the digital literacy of the people in the region to a certain extent.

The final ILI consists of 6 first-level indicators, 15 second-level indicators and 28 third-level indicators on the six major factors of Digital Divide (Digital Technology Infrastructure, ICT Readiness, Economic Development, Government Innovation Support, Education and Digital Literacy, Digital Content and Applications.).

The Digital Technology Infrastructure mainly examines infrastructure construction and access, reflecting the level of regional informatization infrastructure construction. ICT Readiness measures the readiness of the region to make full use of ICT infrastructure and digital content, and represents information popularization and information access. Economic Development mainly reflects the economic payment ability to acquire and use information. Government Innovation Support reflects government investment in innovation of science and education and ICT, highlighting the government level and behavior in the information construction and the ability to guide the country and the region to comprehensively improve the level of informatization. Education and Digital Literacy are focused on literacy, basic education, and labor technology skills to measure the regional digital literacy. It is a prerequisite for the effective use of ICT such as Internet. Digital Content and Applications represent the richness of digital content resources and the level of ICT applications.

### *3.2 Weight Determination of Indexes*

This paper adopts the Analytic Hierarchy Process (AHP) to determine the weights.

The weight of each level is calculated by the expert questionnaire and the judgment matrix. The weight of each third-level index relative to the total index = the weight of the

third-level index \* The sub-weight of the second-level index which the third-level index belongs to\* The sub-weight of the first-level index which the third-level index belongs to. The final weights of ILI are shown in Table 3-1.

**Table 3-1 Composition and weights of ILI**

First-level Index	Weight	Second-level Index	Weight	Third-level Index	Weight	The weight of relative to the total index
<b>Digital Technology Infrastructure</b>	0.149	Communication Network Infrastructure	0.3157	Length of Optical Cable Lines /capita. square kilometers	1	0.0471
		Broadband Facilities Construction	0.5315	Percentage of Administrative Village with Access to the Internet by Broadband	0.514	0.0407
				Broadband Subscribers Port of Internet/capita	0.267	0.0212
				Broadband Download Rate	0.219	0.0174
		Network Facility Access	0.1528	IPv4 Addresses/capita	0.545	0.0124
				Number of Domain Names/capita	0.455	0.0104
<b>ICT Readiness</b>	0.113	Information Popularization Application	0.6915	Popularization Rate of Fixed Line Telephone	0.091	0.0071
				Popularization Rate of Mobile Telephone	0.342	0.0267
				Popularization Rate of Internet	0.239	0.0186
				Popularization Rate of Broadband Connection	0.328	0.0256
		Information Terminal Access	0.3085	Digital television subscriptions per 100 households	0.377	0.0131
				Computer subscriptions per 100 households	0.623	0.0217
<b>Economic Development</b>	0.232	Consumption Capacity	0.761	Per Capita Disposable Income	1	0.1764
		Economic Development Level	0.239	GDP per capita	1	0.0554
<b>Government Innovation Support</b>	0.156	Innovation Ability	0.3312	Patents Applications Granted/capita	1	0.0518
		Government Investment	0.6688	Expenditure on R&D/capita	0.263	0.0275
				Input of Information Infrastructure /capita. square kilometers	0.406	0.0425
				Investment in Fixed Assets of Scientific Research and Technical Services /capita	0.331	0.0346
<b>Education and Digital Literacy</b>	0.2	Education Budget	0.2405	Public Expenditure on Education/capita	1	0.048
		Human Resources	0.3266	Percentage of Information Industry Employee	0.487	0.0317
				Percentage of Employed Persons in Scientific Research and Technical Services	0.513	0.0335
		Resident Culture Quality	0.4329	Literacy Rate over 15	0.617	0.0533
				Percentage of College Students	0.383	0.0331
<b>Digital Content and</b>	0.15	Internet Application	0.1831	Popularization Rate of 4G Mobile Phone	1	0.0275

Applications	Internet Content	Local	0.237	Number of Websites/capita	0.463	0.0165
				Number of Webpages/capita	0.537	0.0191
	Internet Business		0.5799	Software Income/capita	0.35	0.0305
				Sales of E-commerce/capita	0.65	0.0566

### 3.3 Calculation of ILI

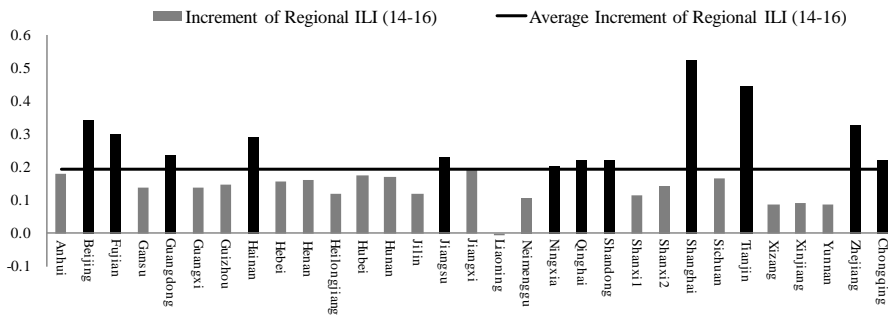
The Linear Weighting Method is adopted to calculate the indexes. First, the data of the third-level indicators are standardized. Then, the second-level and first-level indicators are calculated from the weighted sum of the third-level indicators and second-level indicators. At last, the total index is calculated by similar weighted sum of the first level indicators. The formula for calculating ILI can be simply expressed as follows using the weights of the third-level index relative to the total index.

$$ILI = \sum_{k=1}^{28} I_k^3 w_k$$

$I_k^3$  represents the standardized Kth three-level indicator.  $w_k$  represents the weight of Kth three-level indicator relative to ILI.  $k=1, 2, \dots, 28$ .

The data sources are China Statistical Yearbook and China Broadband Rate Report.

On such basis, the paper uses the national ILI in 2014 as a benchmark, setting the ILI in 2014 as 1. According to the calculation, we get the ILI value of 31 regions in 2014-2016. For three years, the overall level of informatization in China has been greatly improved. The ILI has increased from 1(2014) to 1.0986(2015) and 1.2167(2016). And cumulative total growth rate is 21.67%.



**Figure 3-1 Growth of Regional ILI in 2014-2016**

Figure 3-1 describes the growth of regional ILI from 2014 to 2016. The figure compares the average increment and regional increment from 2014 to 2016. The horizontal line represents the average while the vertical bar represents increment of each region.

From the comparison, the increase of ILI in most regions is less than the average. It shows that the growth rate of informatization in most regions is lower than the national average. The reason is that the informatization in Shanghai, Tianjin, Beijing, Zhejiang, Fujian, Hainan and other regions has grown by a large margin, bringing the average increment to a higher level. We can see that there are large imbalances in the growth of

informatization in 31 regions. In particular, the increase of Liaoning from 2014 to 2016 is negative.

### 3.4 Cluster Analysis on the Level of Regional Informatization Development

After measuring ILI, it is necessary to further analyze the level of regional informatization development. This article uses Hierarchical Clustering Method to compare the regional informatization. Hierarchical Clustering (Hou Jingxin & Yin Weihong, 2004), also referred to as System Clustering Method, is a commonly used clustering method. According to the different methods of similarity measurement in cluster analysis, it can be divided into hierarchical clustering based on distance and hierarchical clustering based on correlation. Clustering based on distance measures the distance between the samples while clustering based on correlation measures the structural similarity between the samples.

Therefore, when the research is concerned with the overall aspect, classification based on the degree of comprehensive distance between the samples is needed. This article uses Hierarchical Clustering Based on Distance to analyze the level of regional informatization development per year. When the research is concerned with the structural aspect, classification based on the degree of structural similarity is needed. This article uses Hierarchical Clustering Based on Correlation to analyze the promotion and hindering factors of regional informatization.

#### 3.4.1 Clustering of regional informatization yearly

There are differences in the level of informatization development in various regions. In order to intuitively reflect the level of informatization development in each region, this section uses Hierarchical Clustering Based on Distance to classify the informatization of 31 regions per year. The regions are divided into 4 big categories and 12 small categories and ranked according to the ranking of ILI. The classification is as follows.

- I - the highest level of informatization
- II - the higher level of informatization
- III - middle level of informatization
- IV - low level of informatization

Meanwhile, each category is divided into three subcategories, representing three level of informatization in each category – high, middle, and low.

According to the ILI from 2014 to 2016, we can get a yearly classification result, as shown in Table 3-2.

**Table 3-2 Level of Informatization Development in 2014-2016**

Category	Subcategory	2014	2015	2016
I	High	Beijing	Beijing	Beijing
	Middle	Shanghai	Shanghai	Shanghai
	Low	Tianjin	Tianjin	Tianjin
II	High	Zhejiang, Jiangsu	Zhejiang	Zhejiang
	Middle	Guangdong	Jiangsu	Jiangsu
	Low	Fujian, Liaoning	Guangdong	Guangdong

Category	Subcategory	2014	2015	2016
III	High	Shandong	Fujian	Fujian
	Middle	Shanxi, Chongqing, Hainan	Liaoning, Shandong	Shandong, Hainan, Chongqing
	Low	Jilin, Hubei, Neimenggu	Hainan, Chongqing, Shanxi2	Liaoning, Shanxi2
IV	High	Ningxia, Anhui, Hunan, Hebei, Sichuan, Heilongjiang, Shanxi1, Jiangxi, Henan	Hubei	Hubei, Ningxia, Jilin, Anhui
	Middle	Guangxi, Qinghai, Xinjiang, Yunnan	Jilin, Neimenggu, Anhui, Ningxia, Sichuan, Hunan, Heilongjiang, Qinghai, Hebei, Jiangxi, Henan, Shanxi1	Neimenggu, Hunan, Sichuan, Hebei, Qinghai, Jiangxi, Henan, Heilongjiang, Shanxi1
	Low	Guizhou, Gansu, Xizang	Guangxi, Xinjiang, Yunnan, Guizhou, Xizang, Gansu	Guangxi, Xinjiang, Guizhou, Xizang, Gansu, Yunnan

As can be seen from Table 3-2, Beijing, Shanghai and Tianjin have been in the first-class for a long period, as the leading regions. The regions that remain at a high level are relatively stable in three years. Beijing is the first, Shanghai second and Tianjin third. Meanwhile, Zhejiang, Jiangsu, Guangdong are all in the second-class in 2014-2016.

From the result of clustering we can see that the level of informatization in China is clearly high in coastal areas while low in inland areas. Whereas, the proportion of regions in the first and second classes is low. Areas with better level of informatization development are basically concentrated in the eastern coastal provinces, while areas with poor informatization development are mostly distributed in the western and central regions. Meanwhile, all the central and western regions are in the third and fourth categories.

### 3.4.2 Cluster Analysis of Impetus and Hindering Factors of Regional Informatization

#### *Development*

The reasons for the differences in the level of informatization development in various regions are different. In order to deeply explore the promoting and hindering factors of regional informatization development, this paper uses clustering analysis based on correlation to analyze. According to ILI, the most direct influencing factors of informatization are Digital Technology Infrastructure, ICT Readiness, Economic Development, Government Innovation Support, Education and Digital Literacy, Digital Content and Applications. Through the correlation clustering analysis of these six factors, we can find out the impetus and hindering factors to informatization in different regions. In order to more clearly show the causes of the past and present ILI in various regions, this paper studies on the outstanding and weak aspects of each factor related to the growth of region's informatization. We use clustering based on correlation to analyze the regional ranking of the first-level indicators. According to the clustering data from 2014 to 2016, 22 categories of clustering results were obtained, which were divided into 3 categories: balanced, promoting, and hindering. Meanwhile, we named the categories based on differences of impetus and hindering factors.

According to the rankings of the first-level indicators from 2014 to 2016, the

clustering results are shown in Table 3-3, Table 3-4, and Table 3-5. "Technology" means Digital Technology Infrastructure, "Readiness" indicates ICT Readiness, "Economy" indicates Economic Development, "Government" indicates Government Innovation Support, "Education" indicates Education and Digital Literacy, and "Application" represents Digital Content and Applications. Among them, "balanced type" is divided into two categories. The balanced-leading type indicates that ranking of each index is always among the top, while the balanced-lagging up behind type indicates that ranking of each index is at the middle and lower. The "promoting type" indicates the ranking of promotion-corresponding indexes (1-2 indicators) is relatively prominent, compared with other indicators. The "hindering type" indicates that the ranking of hindering-corresponding indexes (1-2 indicators) is weak, compared with other indicators.

**Table 3-3 Clustering based on correlation of regional ILI - Balanced**

Type	Region
<b>Balanced-leading up</b>	Beijing14, Beijing15, Beijing16, Shanghai14, Shanghai15, Shanghai16, Liaoning14, Liaoning15
<b>Balanced-lagging behind</b>	Guizhou14, Guizhou15, Guizhou16, Guangxi14, Guangxi15, Guangxi16, Jiangxi 14, Jiangxi15, Jiangxi16, Hubei14, Hubei15, Hubei16, Yunan16

As shown in Table 3-3, it can be seen that Beijing and Shanghai are balanced-leading up types from 2014 to 2016, indicating that these two cities have always been at a high level in the development of China's informatization, and the indicators are relatively balanced. Although indicators in Hubei, Guizhou and Guangxi are balanced, they are all in the middle and lower rankings of the informatization level. Therefore, these provinces need to be strengthened in all aspects.

**Table 3-4 Clustering based on correlation of regional ILI - Promoting**

Type	Region
<b>Technology Promoted</b>	Hunan14, Hainan15, Hainan16, Ningxia14, Ningxia15, Ningxia16
<b>Readiness Promoted</b>	Hebei16, Shanxi115, Xinjiang15
<b>Economic Promoted</b>	Hunan15
<b>Government Promoted</b>	Anhui14
<b>Education Promoted</b>	Gansu15, Gansu16, Jilin14, Jilin16, Shanxi2 16, Xizang14, Xizang15, Xizang16, Qinghai14, Qinghai15, Qinghai16, Shanxi2 14, Shanxi2 15
<b>Application Promoted</b>	Yunnan14, Yunnan15
<b>Technology-Readiness Promoted</b>	Shanxi1 14, Shanxi1 16
<b>Technology-Government Promoted</b>	Anhui 15, Anhui16
<b>Readiness-Education Promoted</b>	Jilin15, Xinjiang14, Xinjiang16

Type	Region
<b>Economic-Government Promoted</b>	Hunan14
<b>Government-Education Promoted</b>	Gansu14
<b>Education-Application Promoted</b>	Sichuan14, Sichuan15, Sichuan16

Table 3-4 shows that some indicators are outstanding (resulting in a higher ranking), indicating that the indicators have become major promoting factors in the development of the informatization level in a certain region. Therefore, in addition to maintaining the promoting index, we can intensify the efforts to develop relatively weaker aspects to promote the balanced development of regional informatization level.

**Table 3-5 Clustering based on correlation of regional ILI - Hindering**

Type	Region
<b>Technology Hindering</b>	Neimenggu15, Neimenggu16
<b>Readiness Hindering</b>	Tianjin14, Tianjin15, Tianjin16
<b>Education Hindering</b>	Fujian14, Fujian15, Fujian16, Guangdong14, Guangdong15, Guangdong16, Hebei14, Hebei15, Henan14, Henan15, Henan16, Jiangsu14, Jiangsu15, Jiangsu16, Shandong14, Shandong15, Zhejiang14, Zhejiang15, Zhejiang16, Chongqing14, Chongqing 15, Chongqing16
<b>Government Hindering</b>	Liaoning16
<b>Application Hindering</b>	Heilongjiang14
<b>Technology-Education Hindering</b>	Shandong16
<b>Technology-Application Hindering</b>	Heilongjiang15, Heilongjiang16, Neimenggu14
<b>Readiness-Education Hindering</b>	Hunan16

Table 3-5 shows that informatization development is weaker in some indicators than others. For example, Liaoning in 2016 was government-hindering (Liaoning was strong-balanced in 2014 and 2015), indicating that Liaoning should strengthen government innovation support to balance the development speed of other indicators. Fujian, Guangdong and Hebei, which are education-hindering, will require these regions to increase education and digital literacy so that all aspects of the regions can develop together.

We can see clearly that Anhui changed from government-promoting (2014) to technology-government-promoting (2015, 2016), indicating that Anhui strengthened the construction of digital technology infrastructure in 2015 and 2016 and led to the enhancement of informatization. Gansu changed from government-education-promoting (2014) to education-promoting (2015, 2016), indicating that Gansu's government innovation support in 2015 and 2016 was weak and is no longer the promotion aspect of the region, so continued effort in strengthening the construction from the government is needed to balance the regional informatization.



According to the different types of "balanced", "promoting" and "hindering" in different regions yearly, the main promoting and hindering factors of the regional informatization level can be concluded from the six factors: technology, readiness, economy, government, education and application. Comparative studies have found that the impetus and hindering factors of informatization development in all regions are different, and it is found that most regions are balanced-lagging behind, education-promoting and education-hindering. It helps different regions to find the breach to promote the informatization development and provide decision support for policymaking. Therefore, different regions need to take corresponding policies in various aspects (digital technology infrastructure, ICT readiness, economic development, government innovation support, education and digital literacy, digital content and applications) to comprehensively improve the level of informatization and reduce regional Digital Divide.

## 4. Measure and Analysis of Regional Digital Divide

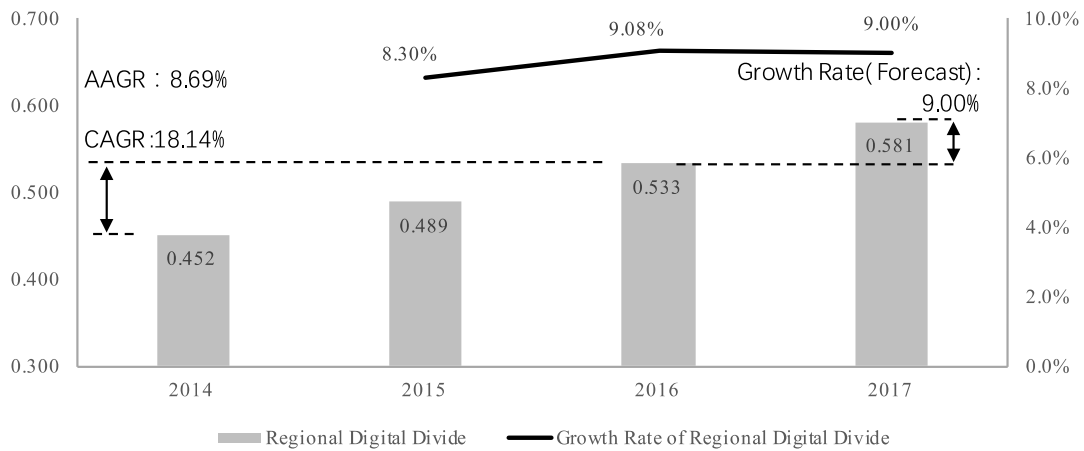
### 4.1 Calculation of Regional Digital Divide

After constructing and measuring ILI, we can get the measurement results of the Digital Divide. The calculation method of regional Digital Divide (RDD) (Zhang Bin & Li Xiao & Richard D. Taylor, 2009) is as follows: first, standardize the data of third-level indicators. Then, calculate the average deviation of these indicators yearly. Final, RDD is obtained by weighted summing the average deviation of each indicator. The formula for calculating RDD can be simply expressed as follows:

$$RDD = \sum_{i=1}^{28} (\frac{w_i}{31} \sum_{n=1}^{31} |I_i^n - \frac{1}{31} \sum_{n=1}^{31} I_i^n|)$$

$I_i^n$ , the standardized index of Ith third-level indicator in the Nth region;  $w_i$ , the weight of the Ith third-level indicator relative to ILI.  $i=1, 2, \dots, 28$ ;  $n=1, 2, \dots, 31$ .

According to the above method, RDD of 31 regions in China was calculated. The results are shown in Figure 4-1.



**Figure 4-1 Development of RDD in 2014-2017 (including forecast)**

In the past three years (2014-2016), RDD has increased from 0.4516 to 0.5335, with a cumulative growth rate of 18.14%. RDD in China has always presented a trend of continuous expansion, with an average annual growth rate of 8.69%. Among them, the growth rate of China's RDD in 2016 was 9.08%, which was a significant increase from the 8.3% growth rate in 2015.

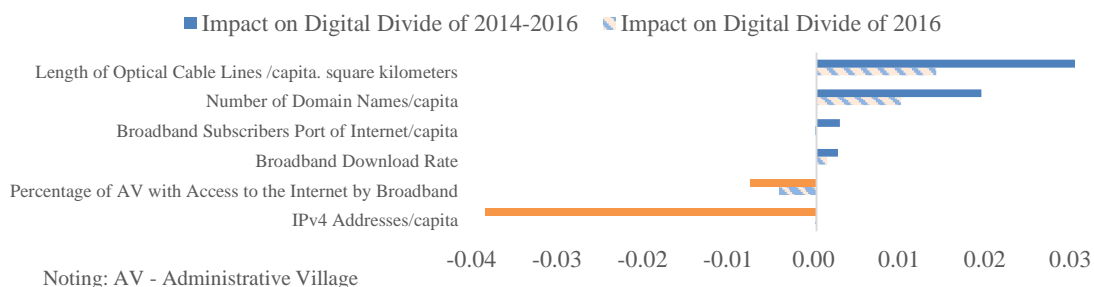
According to China's RDD from 2014 to 2016, the grey forecasting model (grey forecasting model mainly focuses on predictions of small samples, poor information, uncertain problems) is used to predict and the forecasted value of China's RDD in 2017 is approximately 0.5815. The growth rate is about 9.00% compared with 2016, which is higher than the average growth rate of 8.69% over the past few years. The regional difference in informatization is still at a relatively high level and shows an increasing trend. However, through analysis we believe that the Digital Divide will continue to rise, but the growth rate will gradually decrease.

#### 4.2 Analysis of the Formative Factors of the Digital Divide in China

The existence of the Digital Divide stems from the gap between the number and quality of possession of ICT among regions and the difference between digital literacy. To compare the formative factors of the Digital Divide between the regions, this section will calculate the impact of each indicator on the Digital Divide between 2014 and 2016, and the impact on the Digital Divide in 2016, analyzing the three-level indicators under the first-level indicators of the informatization evaluation system and the formative factors of the regional Digital Divide.

##### 4.2.1 Digital Technology Infrastructure

The digital technology infrastructure represents the construction and access of ICT infrastructure and broadband facilities. Infrastructure construction is affected by factors such as the level of ICT innovation, economic level, and government-related policies, affecting the number of hardware devices and the richness of information resources. It can reflect the level of regional information infrastructure construction. Thus, the first step in narrowing the regional Digital Divide is to solve the problem of digital technology infrastructure construction.



**Figure 4-2 Impact of digital technology infrastructure on Digital Divide**

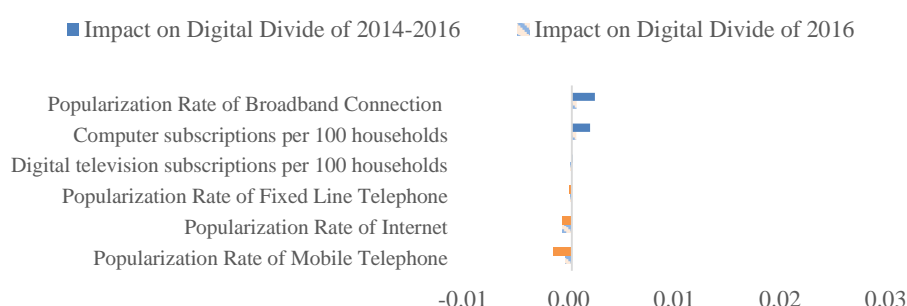
Figure 4-2 shows the impact of digital technology infrastructure indicators on the

Digital Divide. The impact of Length of Optical Cable Lines (/capita. square kilometers) and Number of Domain Names (/capita) on the expansion of the Digital Divide is more obvious, indicating that the imbalance in the regional development of these indicators is slightly larger. Broadband Subscribers Port of Internet (/capita) and Broadband Download Rate have contributed to a slight increase in the RDD. However, with the advancement of basic broadband access, the broadband download rate has gradually narrowed the expansion of the divide, and broadband subscribers port of Internet (/capita) has shown the trend for bridging in 2016.

From 2014 to 2016, Percentage of Administrative Village with Access to the Internet by Broadband and IPv4 Addresses (/capita) have inhibiting effects on the growth of regional Digital Divide. In particular, IPv4 Addresses (/capita) play an extremely important role, indicating that the gap in the information coverage and IPv4 network access between the developed regions and underdeveloped regions has gradually narrowed, and the development has become more balanced.

#### 4.2.2 ICT Readiness

ICT readiness mainly measures the readiness of the region to make full use of ICT infrastructure and digital content, representing the information infrastructure business access coverage and information access. The prevalence of ICT is also a fundamental issue for narrowing the regional Digital Divide.



**Figure 4-3 Impact of ICT Readiness on Digital Divide**

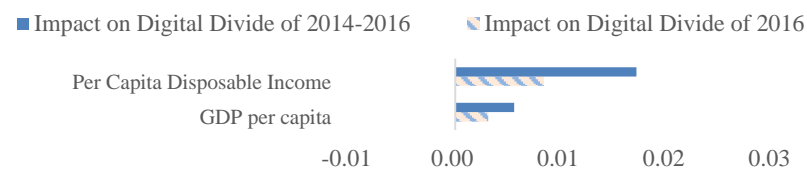
Figure 4-3 shows the impact of ICT readiness indicators on the Digital Divide. Under the information popularization application index, Popularization Rate of Fixed Line Telephone, Popularization Rate of Internet and Popularization Rate of Mobile Telephone have played a role in narrowing the expansion of the Digital Divide from 2014 to 2016. It shows that the level of popularization of information applications in various regions is relatively balanced, and in particular, popularization rate of mobile telephone played a relative greater role in bridging the Digital Divide.

However, Popularization Rate of Broadband Connection, Digital television subscriptions per 100 households and Computer subscriptions per 100 households have led to a slight expansion of the Digital Divide from 2014 to 2016. Under the rapid

development of digital technology, there is a gap in the quality of broadband access between developed and underdeveloped regions. In 2016, the impact of popularization rate of broadband connection and computer subscriptions per 100 households on the growth of the Digital Divide has decreased from the last two years. Digital television subscriptions per 100 households has started to gradually narrow the regional Digital Divide. It shows that in recent years, the input and development of these indicators have gradually become more balanced and coordinated in various regions.

### 4.2.3 Economic Development

In terms of the national economy development, it mainly represents the ability of the regional economy to invest in digital technology infrastructure and residents' ability to afford digital services. The establishment of ICT infrastructure and the introduction of emerging digital technologies in the regions are all affected by economic factors. Under the background of the Digital Economy, the highly applied digital technology will strongly promote regional economic development. The high economic level will promote the popularization of digital services and digital education, and then affect the employment of local information industry and the digital literacy of residents.



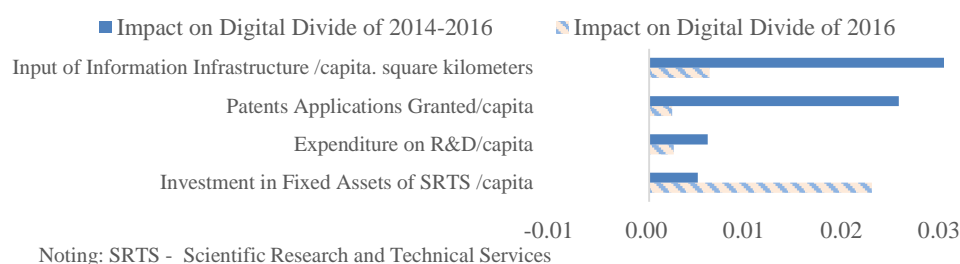
**Figure 4-4 Impact of Economic Development on Digital Divide**

From figure 4-4, we can see that the impact of the national economic development indicators on the Digital Divide. Per Capita GDP (Economic development level) and Per Capita Disposable Income (Consumption capacity) have an expanding effect on the Digital Divide. The influence of consumption capacity on the Digital Divide is greater than the level of economic development, indicating that people in different regions have a large gap in the cost-bearing capacity of acquiring digital services.

### 4.2.4 Government Innovation Support

In terms of government innovation support, it mainly focuses on the level of support and involvement of relevant government agencies in enhancing innovation capabilities, promoting informatization development and technological development in all regions, including incentive policies and government-related investment. The government encourages healthy competition and universal service by releasing relevant policies in ICT field. These policies and services have a direct impact on the construction of informatization infrastructure in various regions and the level of informatization services provided by residents. They have an important influence on the richness of information resources and the popularity of information applications.

The government's increased investment of technology will help improve the innovation drive of the information industry, and it will help foster innovative talents and develop innovative projects in the new digital economic fields such as Big Data, Cloud Computing, the Internet of Things, and Artificial Intelligence, thus strengthening the popularity and application of "Internet+".



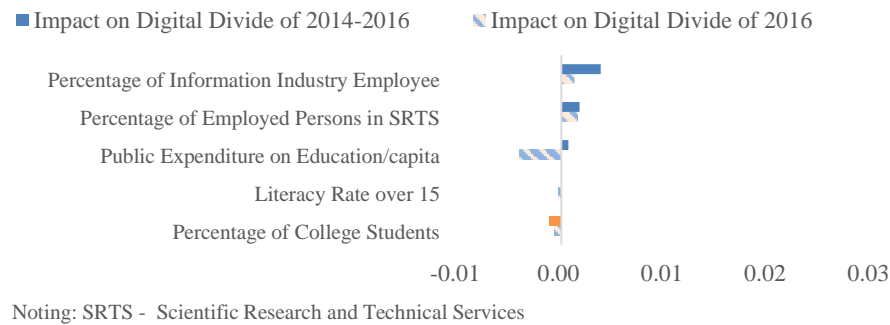
**Figure 4-5 Impact of Government Innovation Support on Digital Divide**

Figure 4-5 shows the impact of the relevant indicators of government innovation support on the regional Digital Divide. Between 2014 and 2016, Input of Information Infrastructure (/capita. square kilometers) and Patents Applications Granted (/capita) have a greater impact on the growth of the Digital Divide. However, in 2016, the impact has sharply decreased, indicating that the expansion of the Digital Divide caused by these two factors has slowly eased. Expenditure on R&D (/capita) and Investment in Fixed Assets of Scientific Research and Technical Services (/capita) have relatively little impact on the expansion of the Digital Divide in three years. Nevertheless, Investment in Fixed Assets of Scientific Research and Technical Services /capita has a greater impact on the Digital Divide in 2016. It shows that, from 2016, the input gap in the scientific research and technology service industries in various regions has begun to widen, expanding the Digital Divide.

The above shows that there is still a certain gap between the level of informatization development in developed regions and underdeveloped regions in government investment and innovation capabilities. The government should pay attention to the balanced development between developed regions and underdeveloped regions.

#### 4.2.5 Education and Digital Literacy

Education mainly examines the government's investment in education budget, while digital literacy represents the level of social information skills and the cultural quality of residents. On the one hand, the level of education and digital literacy influences whether residents can effectively obtain information, identify information, understand information, and accept information and determines whether ICT can be fully utilized. On the other hand, the improvement of education level and digital literacy can help the country develop more innovative talents in the field of science and technology. These talents can better promote the development of national economic and social informatization.



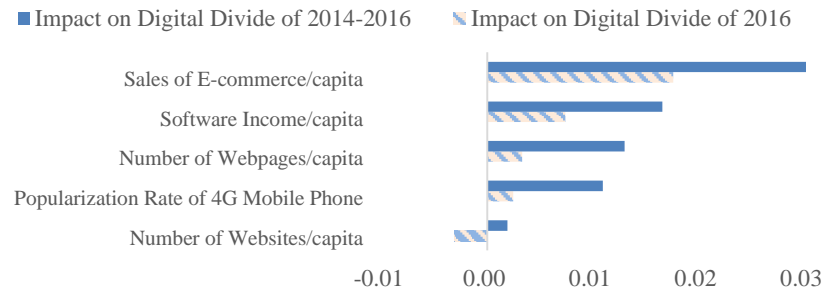
**Figure 4-6 Impact of Education and Digital Literacy on Digital Divide**

Figure 4-6 shows the impact of indicators related to education and digital literacy on the regional Digital Divide. Among the third-level indicators of education and digital literacy, Percentage of College Students has a negative effect on the growth of the Digital Divide from 2014 to 2016, indicating that the indicator has played a role in narrowing the Digital Divide. The value of Literacy Rate over 15 is close to 0, indicating that the indicator has little effect on the growth of the Digital Divide in three years. The other three levels of indicators, Public Expenditure on Education (/capita) and Percentage of Employed Persons in Scientific Research and Technical Services, led to a slight increase of the Digital Divide from 2014 to 2016. Impact of Percentage of Information Industry Employee is relatively large in education and digital literacy.

In 2016, the impact of all third-level indicators of education and digital literacy on the growth of the Digital Divide has become even smaller. Even three indicators are negative, that is, narrowing the Digital Divide between regions. It shows that, from 2014 to 2016, the development of education and digital literacy in the developed and underdeveloped regions has been more balanced, and the regional gap has continuously narrowed. The investment in education and digital literacy by the government and society slows the growth of the Digital Divide, and even getting results of narrowing the Digital Divide.

#### 4.2.6 Digital Content and Applications

The level of digital content and applications is affected by gender, age, ethnicity, geographic location, and consumer attitudes, resulting in the need to obtain different information devices and content resources for use in all aspects of society. Digital content and applications refer to the degree of application of the Internet's local content and related industry development brought about by digital technology, and is related to the frequency, time, scope, skills, and convenience level.



**Figure 4-7 Impact of Digital Content and Applications on Digital Divide**

Figure 4-7 shows the impact of digital content and applications indicators on the regional Digital Divide. Sales of E-commerce (/capita) has a significant impact on the Digital Divide from 2014 to 2016. For the remaining third-level indicators, Software Income (/capita), Number of Webpages (/capita), Popularization Rate of 4G Mobile Phone and Number of Websites (/capita) also have a greater impact on the expansion of the Digital Divide in the past three years. Nevertheless, with the popularization of the mobile Internet, the speed of the expansion of the gaps has slowed down in all regions. However, it has still accelerated the expansion of the regional Digital Divide, indicating that the imbalance phenomenon of emerging digital technologies in various regions is more serious. Compared with the influence in 2016, especially Number of Websites (/capita), has gradually narrowed the Digital Divide between regions.

## 5. Conclusions and Suggestions

Through the measurement of the informatization index and the regional Digital Divide index in China, we can see that nowadays, by the deep integration of emerging information technologies with the Digital Economy, the overall China informatization level is constantly rising, but it is accompanied by the continuous expansion of the regional Digital Divide. The rapid development of first- and second-tier cities and regions has driven the overall level of development. However, the development of third- and fourth-tier cities and regions has been slow, and the gap between the developed and underdeveloped regions has grown. This requires China to promote the deep integration of the Internet, big data, artificial intelligence, and the real economy, to further increase the investment in underdeveloped regions, to vigorously develop the Digital Economy, and pay attention to the areas that lag behind in the economic development level and structure.

"Digital China" is the major development strategy that General Secretary Xi Jinping put forward for the first time in the report of the Nineteenth Congress. Digital technology applications represented by Cloud Computing, Big Data, and Mobile Internet are no longer confined to the economic field, but are widely penetrated into all aspects of public services, social development, and people's lives, which require macro-coordination, overall control, and integrated development (Tencent Research Institute, 2018).

The development of the economy and informatization are mutually complementary. The balanced development of the economy is beneficial to bridging the Digital Divide and promoting the balanced development of information technology. In return, information technology can exert a certain pulling effect on economic development. Promoting the deep integration of information technology with the economy and promoting the development of the Digital Economy will undoubtedly have a profound and positive impact on China's both economy and informatization. Therefore, China should focus on creating more favorable conditions to develop Digital Economy and bridge the Digital Divide. Based on the above analysis of China's informatization development status and the regional Digital Divide in chapter 3 and 4, this paper will make policy recommendations for narrowing the Digital Divide in China as follows by focusing on six factors: Digital Technology Infrastructure, ICT Readiness, National Economic Development, Government Innovation Support, Education and Digital Literacy, Digital Content and Applications.

*(I) Accelerate the construction of digital technology infrastructure and reduce the cost of information use*

China should speed up the construction of information and communication infrastructure in underdeveloped regions, continue to implement the national broadband strategy, and steadily promote the deployment of the information poverty alleviation strategy in rural and western regions; China should accelerate the equalizing process of basic digital public services, and incorporate digital technology infrastructure construction into the overall plan of urban and rural development. Strengthening the construction of information and communication infrastructure in underdeveloped regions and promoting the popularization of high-quality digital resources will help improve the connectivity of information technology and promote the balanced development of the entire society. In terms of fixed broadband, operators should comprehensively upgrade their existing optical fiber networks so as to achieve a truly universal service. While intensively implementing fiber-to-the-home strong standards, China also must focus on the construction of high-speed broadband networks, speed up the expansion of backbone broadband, and implement the "speed increase and fee reduction" policy. By improving the quality of communication network services, reducing network tariffs, and innovating services and business, the gap in the development of communication services between regions can be reduced.

*(II) Fully realize internet information access and achieve triple play*

In order to reduce the impact of the information access level on the Digital Divide, all types of Internet resources should be fully and efficiently used in all regions. In particular, attention should be given to the development of advanced digital technologies because the gaps in traditional information technologies have narrowed while the gaps in emerging areas are expanding. The chasm of emerging technologies between developed



and underdeveloped regions is the focus of the Digital Divide in the future. Therefore, we should speed up the construction of fiber-optic broadband networks in underdeveloped areas, improve the enthusiasm of telecom companies, upgrade and improve the communication networks in remote mountain areas, increase the speed of network access, and guide and support them through government policies. China should comprehensively promote the reform and transformation of digital television in underdeveloped areas, increase the coverage of radio and television public services, integrate various types of network resources, and gradually realize the integration of the Internet, radio and television networks, and telecommunications networks.

### *(III) Accelerating ICT Economic Integration and Improving Economic Development and Consumption Levels*

In terms of the development of the national economy, it is suggested to continue to implement in depth the overall strategy for regional development, strengthen inter-regional economic ties, promote the coordinated development of regional economies, encourage cooperation between enterprises, society and governments at all levels. In the less-developed regions, actions should be taken to adapt to local conditions, vigorously develop related industries with abundant resources, and strive to raise the level of economic development and narrow the gap between these regions and developed regions. Governments at all levels should speed up the construction of regional industrial Internet, coordinate the healthy development of the information industry and other industries, and create a favorable market environment to promote the deep integration of emerging digital technologies with the real economy. They should also formulate encouraging fiscal policies to attract new digital companies to enter the region to increase regional competitiveness, and thus increase the level of people's consumption, expand the market for digital service products, and narrow the gap in the popularization and application of regional digital products. It is necessary for China to promote the establishment of the information industry circle for the second and third-tier cities so as to promote the development from one point to the surrounding areas. On the one hand, it can gradually narrow the development gap in China's regional information industry, and on the other hand it can provide more employment opportunities in the information industry. It can also promote the development of regional economies and help bridge the Digital Divide at multiple levels.

### *(IV) Increase government support and promote innovation to drive transformation*

In terms of government support for innovation, China should focus on the balanced development of information infrastructure and technological innovation capabilities in various regions. The comprehensive construction and improvement of information infrastructure is not only a key factor in narrowing the Digital Divide in the region, but also an important step in China's strategy to build a strong nation on the Internet. To build a high-quality information infrastructure environment requires an efficient government.

The government should break the bottleneck and increase the support for investment in information infrastructure in underdeveloped regions. In addition, the government should improve the laws and regulations related to information infrastructure, establish a more in-depth and comprehensive standard for the construction of information infrastructure, and fully link up with the development strategy, outline, and planning of the national informatization. At the same time, the integration of information infrastructure into the overall planning of urban-rural integration in all regions will establish a solid foundation for the balanced development of information infrastructure. Data analysis shows that the advantage of technological innovation in the eastern region is gradually expanding, and the central and western regions are still weak overall. Therefore, the government should also increase support for technological innovation in underdeveloped regions. First of all, the government must provide support in policies and funding for technological innovation in universities, research institutes, and enterprises in underdeveloped areas. Secondly, through the introduction of policies for attracting investment enterprises and the settlements of talents to speed up the introduction of IT talents and resources, the innovation and entrepreneurship environment in underdeveloped regions can be improved. Third, the government should strive to create conditions to actively encourage more enterprises in underdeveloped regions to enhance their innovation capabilities, so that the market can play an increasingly important role in promoting innovation-driven transformation.

*(V) Balance education resources and increase talent training strength*

In the future development of informatization, in terms of education and digital literacy, China should continue to increase the balanced investment in education in all regions so as to significantly reduce the Digital Divide between regions. First of all, it is suggested that the government should increase investment in education funds in areas with lower level of education and digital literacy, especially in poor areas in the central and western regions, and promote the balanced development of compulsory education. Due to the high population density and the large number of school-age children, there is still a large insufficiency in basic education resources in the central region. The western region is still the least development region in China's basic education, whether it is the possession of the basic education resources, the quality level or the enrollment rate, there is a certain gap with other regions. We should actively promote the standardized development of middle school education and the innovative development of high school education in underdeveloped areas, improve the running conditions for schools with weak educational resources, and establish effective mechanisms for attracting and retaining outstanding young teachers. However, it is not only necessary to pay attention to infrastructure construction and capital investment, but also need to allow education in underdeveloped regions to advance with the times, integrate education and the Internet, make full use of Internet platforms and applications, and obtain more extensive educational resources. In addition, the training and construction of information

technology talents and innovative talents in underdeveloped areas should be strengthened. It is needed to build an open information technology and high-tech education system. All localities are encouraged to actively carry out pilot projects for the promotion of vocational education. It is also desirable to formulate guidance on the construction of the talent team, to make clear regulations on the cultivation, selection, evaluation, use, motivation, exchange, and guarantee of the talent team, so that all work in the talent team building can be implemented according to law. China should also increase the flow of talented people, introduce the talent house-purchasing subsidy system, implement the material and spiritual treatment of high-skilled personnel, and increase the degree of social security.

*(VI) Enrich Internet content resources and strengthen Internet business applications*

In terms of digital content and applications, the gap in digital content and applications between developed regions and underdeveloped regions should be reduced. In underdeveloped regions, Internet information access and information application facilities should be further developed, Internet content resources should be enriched, and Internet applications should be strengthened. In terms of mobile Internet, the current 4G network construction has achieved remarkable results, but regional differences are still evident. China should continue to improve the coverage of 4G networks, and accelerate the research and development of 5G technologies to promote the application of the next generation of mobile Internet as soon as possible. In terms of digital technology development, China should increase investment in emerging technologies such as the Internet of Things, Cloud Computing, Artificial Intelligence, Big Data, and IPV6, and accelerate the application of new technologies in many fields such as agriculture, medical care, and education. It is necessary to use the new forms of traditional industries to promote balanced development of digital technology infrastructure resources in all regions. At the same time, traditional enterprises must adapt to the general trend of the Internet, combine their own development models, persist in innovation, and realize enterprise transformation relying on the “Internet+”. In addition, China should actively promote the construction of e-government in underdeveloped areas, promote e-government information applications. China also needs to encourage internet companies to actively participate in rural e-commerce projects, vigorously develop e-commerce in rural areas, and enable e-commerce services to reach villages and towns. At the same time, China could develop internet financial services and promote the development of characteristic industries in poor areas.

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