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Can digital technology promote the equalization of regional basic public services?

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Abstract

Purpose – The purpose of this study is to explore the impact of digital technology on promoting the equalization of basic regional public services based on measuring the level of digital technology and the equalization level of regional basic public services.

Design/methodology/approach – Based on the inter-provincial panel data from 2013 to 2021, this article utilizes the method of replacing digital technology to verify the robustness of the conclusion, evaluating the impact of digital technology on promoting the equalization of basic regional public services, while carrying out an extended analysis of government intervention, population density and regional heterogeneity.

Findings – According to our findings, digital technology has significantly promoted the equalization of basic public services in the region. According to the result of the heterogeneity test, digital technology has a better effect on promoting the equalization of public services in regions with moderate government intervention and relatively low population density. Moreover, the development of digital technology can significantly promote the equalization of public services in China's eastern region.

Originality/value – This article elaborates on the impact of digital technology on the equalization of basic regional public services from three perspectives: reducing the cost of public services, increasing the degree of marketization of public services and realizing the sharing of public service resources. Thus, it enriches the empirical research literature on digital technology and the equalization of regional public services.

Keywords Digital technology, Equalization of public services, Inverse fiscal index

Paper type Research paper

1. Introduction

It was proposed in the "14th Five-Year" Digital Economy Development Plan to improve the level of digitalization of public services and share the benefits gained from such development. In the "14th Five-Year" Public Service Plan, it was proposed to promote the development of public services, as well as to improve the level of convenience and availability of public service sharing and to strengthen the security system for essential public service factors, continuously enhancing the service capabilities and efficiency of the public service system, while continuously promoting the equalization of basic public services. The report of the 20th National Congress of the Communist Party of China emphasized that it is necessary to strengthen the basic public service system, improve the level of public services, enhance balance and accessibility and firmly promote common prosperity. Promoting the equalization of basic public services is also an inherent requirement and an inevitable path to promote common prosperity in the new era (Li, 2021). In the past 10 years of the new era, the

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development of China's public services has made remarkable achievements, establishing the world's largest employment system, education system, social security system, medical and health system, housing security system and public cultural service system, yet still facing the contradiction between growing demands for services and the current state of public services, which is still not satisfactory enough in terms of balance and availability (Sun, 2023). At present, there is still a certain gap between the quality and quantity of public services in various provinces in China, which is unfavorable to the coordinated development of regions and is contrary to national policies. To enhance the balance and accessibility of public services and build a modern socialist public service system, we must further promote the equalization of basic public services. The rapid development of digital technology has provided a new technical foundation for the equalization of public services (Shen, 2022), and through the development of new forms and modes of business such as digital government, smart education, smart medical care and smart transportation, the gap between regional public services has been effectively made up, contributing to the achievement of equalization of regional public services. In short, digital technology provides the technological path to promote the equalization of regional public services. So, can digital technology achieve the equalization of regional basic public services, and what is the mechanism of digital technology to promote the equalization of regional public services?

With the development of the digital economy, the function of digital technology in improving the quality of public services and narrowing the regional gap has become increasingly prominent, but there is still no consistent conclusion on whether digital technology can narrow the regional public service gap. According to the existing literature, scholars have not reached a consensus on the equalization of basic public services empowered by digital technology, and there are two attitudes: affirmative and skeptical, with positive scholars believing that digital technology can achieve the equalization of basic public services in urban and rural areas from three aspects. First, digital technology improves the quality of rural public services (Thanh, 2022). On the one hand, digital technology can help reconstruct the digital village governance process, build a "demand-response" government work system (Li and Chen, 2020), explore the blind spots of rural public service coverage and fully protect the endogenous subject status of villagers (Yang and Zhou, 2023). On the other hand, it can improve the transparency level of public services (Turner *et al.*, 2020) and reduce the transaction cost of matching supply and demand of public services (Zhou, 2020a, b; Alina, 2016), improve the rural public service system, make public services more inclusive (Alina, 2016) and narrow the gap in public services. Second, digital technology promotes the flow of factors between urban and rural areas, which helps break down the barriers between urban and rural areas and the benign interaction between the digital economy and urban-rural relations, enhancing the balance of urban-rural development (Zhang and He, 2021) and helping to narrow the gap between urban and rural public services. Third, digital technology promotes the innovation of the supply side of public services (Man *et al.*, 2023), giving rise to new business forms and models, and the existence of digital platforms can realize the interaction between the subject and object of public service supply and the integration of resources (Shen, 2022); help improve the supply of public services such as education, culture and health (Yang *et al.*, 2019); promote more adequate and balanced public facilities (Chen, 2023); identify the differences in public services in different regions and fields (Gao, 2021a, b); make up for the shortcomings of public services (Xia and Liu, 2021) and promote the equalization of regional public services (Zhao and Jiao, 2023).

Skeptical scholars believe that there are still many problems in the process of digital technology to equalize basic public services, and it is difficult for digital technology to deeply integrate with rural social fields to activate the digital transformation of rural public services due to the limitations of knowledge distance, digital literacy and continuous operation and maintenance (Wang *et al.*, 2023). Although the "Broadband China" strategy has alleviated the

access gap to a certain extent, rural residents' digital awareness and ability to use and utilize digital information are poor (Chen and Feng, 2022), the willingness to use digital applications is low and even the phenomenon of "digital exclusion" has become increasingly prominent, and the phenomenon of "digital going to the countryside and not moving in the countryside" has become increasingly prominent. There is a large gap between the digital literacy and technical capabilities of urban and rural residents, and the application of digital technology has not been adapted to local conditions as much as possible in the vast rural areas, which is not conducive to the digital transformation of rural industries, and the rural budget for digital villages is limited (Yu, 2022), which in turn exacerbates the imbalance between urban and rural economic development (Wang and Wang, 2024).

The existing studies expound on the impact mechanism and development dilemma of digital technology to promote the equalization of regional basic public services, which provides an important reference for the research of this paper, but most of them are mainly focused on the theoretical level, and there are still disagreements and no consensus has been reached, and there are still shortcomings in the refinement of the mechanism of digital technology to promote the equalization of regional public services. Compared with previous studies, the possible marginal contributions of this paper are as follows: First, it combines digital technology with the equalization of regional basic public services at the theoretical level and discusses the relationship between digital technology and regional basic public service equalization from the perspectives of information integrity, cost saving and resource allocation, which broadens the research framework of digital technology. Second, this paper explores the impact mechanism of digital technology on the equalization of regional basic public services at the provincial level, enriches the quantitative research on the equalization of regional public services empowered by digital technology, affirms the importance of digital technology to regional coordinated development and provides empirical support and a decision-making basis for further optimizing policy guidelines and promoting the equalization of regional basic public services.

2. Theoretical analysis

Accelerating the equalization of basic public services is an important way to narrow the gap between urban and rural areas and realize a balanced development of basic public service supply and demand. It is also an objective requirement for realizing the transformation of government functions and building a service-oriented government, an actual need to realize basic civil rights and strengthen economic and social development focused on protecting people's welfare, as well as an important measure to maintain economic and social stability, balance and harmonious development (Shi *et al.*, 2023). Digital technology promotes the equalization of basic regional public services by reducing the cost of public services, improving the degree of marketization of public services and realizing the sharing of regional public service resources.

2.1 Digital technology reduces public service costs

Digital technology is becoming a new driving force for innovative governance, while "Big Data" provides scientific decision-making and accurate supply for government public services, reducing transaction costs of public services. Higher transaction costs could lead to a loosening of relationships between various administrative departments of the government. Meanwhile, digital technology can reduce transaction costs improve the degree of government integration, thus achieving economies of scale (Wang *et al.*, 2023). Digital technology connects people and services, yet faced with a diverse public service demands of urban residents, traditional public services tend to have a relatively high searching cost for

information. Before digital government gained popularity, license applications were subject to departmental approval, and different departments had very different requirements for the materials provided by applicants. Unless the applicant is well aware of this, the application has a high possibility of being rejected (Huang and Zhang, 2019). Hence, a rather high search cost is required for the applicants to gather this information. Relying on the Internet platform, the "One-stop Service Online" program promotes online dealing of administrative affairs, which resolves the critical difficulty of dealing with the government and saves time and effort that would otherwise be spent on journeys between various administrative departments for both residents and legal entities during the application process, greatly saving time and cost. What's more, this online business model also saves residents and legal entities the cost of searching for various application materials and also conserves human resources for administrative departments, improving the government's service efficiency. The "One Network Unified Administration" program covers citywide governance system such as public administration and public safety and provides early warning and decision support for the administrative departments, reducing management costs with integrated supervision, management and command. Apart from that, digital government can also make government service processes available to the public, improving government transparency while also reducing efficiency losses caused by information asymmetry (Zhou and Huang, 2022). Due to a lack of transparency, traditional public services are vastly different in terms of material transfer and processing efficiency. Yet with digital government, inquiries for tracing administrative processes can be met, citizens can check out the handling progress of related affairs in real time and supervise the efficiency of government departments, thereby improving government transparency. The government is bound to upgrade its organizational structure and optimize its efficiency with its transparency greatly improved.

2.2 Digital technology improves the degree of marketization of public services

At present, the public administration, as the provider of basic public services, cannot fully meet the diverse demands of the people. The rapid development of digital technology propels the development of digital enterprises and digital platforms. Digital enterprises and digital platforms can make up for the insufficient supply of public administrative subjects. Digital enterprises and digital platforms have expanded the field of application for digital technologies, providing better connections between government public administration and people's daily life while also improving the marketization of public services at the same time (Zhou, 2020a, b). Digital technology provides technical support for the marketization of public services, promotes innovations of public service models, transforms government operation models and promotes the formation of partnerships between public departments and enterprises. Digital technology has led to the establishment of various derivative public service platforms. After the initial construction work and resource introduction have been finished, the public service platforms can stimulate their inherent market genes and development advantages through effective cooperation with external enterprises, making up for the government's lack of capabilities in providing public service, make full use of market means to promote platform based operation and play the due role of the platform (Gao, 2021a, b). The services provided by the public service platform originally belonged to the range of business and duties of different administrative departments. By introducing a market-oriented business model to achieve innovative transformation, problems such as overlapping functions between departments, miscommunications of information and difficulties in sharing resources that have always existed in social and economic activities can be further resolved. The focus can then be shifted to promoting business collaboration and data sharing between relevant government departments that are conducive to platform-based operation and development. The People's Government of Heilongjiang Province and China Mobile

signed a strategic cooperation agreement in 2022 with regard to constructing a premium 5G network and empowering Longjiang with smart digital technology, helping Heilongjiang lead the country in establishing digital infrastructure, digital government and digital society. It took only two months for Heilongjiang to build a provincial digital government operation center and a provincial governmental service center. At present, the provincial government service center already has 35 departments with 1,547 items, gradually realizing "One-stop Service Online" for governmental services and "One Network Unified Administration" for governance. Compared to the government, platform enterprises are more professional in terms of operation and are more motivated to reduce service costs and bear market risks. Digital technology has made public services profitable, opened up channels for transforming public services into commodities and made the pricing and charging of certain public services feasible. The marketization of public services has not only reduced the financial burden of government agencies but also improved the economic benefits of public services.

2.3 Digital technology realizes sharing of public service resources

In cities with higher levels of economic development, the government has a comprehensive system for recruiting talents, and the efficiency of public services is relatively high. On the contrary, in cities with lower levels of economic development, the government's system for recruiting talents is defective; thus, its environment of development is unable to attract more competent administrative personnel, resulting in low efficiency of public services in these areas. The digital economy can improve the level of quality of government services while making up for their shortcomings. Digital governance can improve government service capabilities and realize cross-departmental digital resource sharing. In the era of the digital economy, a sound digital infrastructure is a solid foundation for common prosperity, as the development of the digital economy can promote the equalization of digital infrastructure, especially in backward and rural areas where they are enabled to fully enjoy modernized and digitalized infrastructure, realizing the equalization of digital infrastructure. In terms of medical healthcare, by relying on technologies such as remote sensing, telemetry and remote control lamps, the superior resources of larger cities and better equipped hospitals are taken advantage of through telemedicine, while remote consultation and diagnosis are carried out for residents of frontier areas and isolated islands with less than ideal medical conditions, realizing the sharing of medical resources. In terms of education, digital technology can free education from constraints of space and time (Song, 2019), with online education promoting the popularization and dissemination of knowledge, narrowing the educational gap between urban and rural areas as well as between regions. Digital technology can realize the sharing of public service resources, transcend geographical constraints and extend high-quality government services to economically underdeveloped areas by providing residents with high-quality public services (Shanggaun and Pan, 2021). Digital technology helps bring the transparency, intelligence and precision of basic public services into reality, effectively improving the quality of basic public services, while accelerating the equalization process of basic public services.

3. Research design

3.1 Calculation of public service equalization index

This paper refers to the reverse fiscal index method adopted by Liu *et al.* (2021), first using the entropy method to measure the supply level of public services in 31 provinces and then the reverse fiscal method to measure the equalization level of public services in each province. As is shown by Formula (1), $ABPS_{it}$ represents the actual basic public service investments received by certain regions, while $SBPS_{it}$ stands for the amount of basic public service

investments that certain regions should obtain based on the percentage of the total population they represent.

$$RBPSEI_{it} = (ABPS_{it} - SBPS_{it})/ABPS_{it} \quad (1)$$

A bigger value of $RBPSEI_{it}$ indicates a higher level of basic public services and a more significant difference with the national average of basic public services during period t. The specific evaluation indicator system is as shown in the chart. If $RBPSEI_{it} > 0$, it is indicated that province i is the "destination of import" for public services and that its level is higher than the national average level of basic public services. If $RBPSEI_{it} < 0$, it is indicated that province i is the "origin of export" for public services and that its level is lower than the national average level of basic public services. Referring to Peng and Wang, based on the availability of data, this paper established an evaluation indicator system for the level of public service supply, considering the following six aspects: education, medical healthcare, social security and employment, environmental protection, transportation and public safety, as shown in Table 1.

Table 2 shows the results of the public service equalization index in each province. The results show that there are significant differences in the equalization index of public services in different regions. Beijing, Tianjin, Shanxi, Inner Mongolia, Liaoning, Jilin, Shanghai, Fujian, Hainan, Chongqing, Guizhou, Gansu, Qinghai, Ningxia and Xinjiang's public service equalization indicators have always been positive, with the supply level of public services exceeding the national average, which makes them "pure importer" of public services. On the other hand, the equalization indicators of public services in Hebei, Jiangsu, Hubei, Hunan, Shandong, Henan, Sichuan, Yunnan, Anhui, Guangdong and Guangxi have always been negative, with the supply level of public services lower than the national average, which puts them in the "pure exporter" category of public services. The equalization indicators of public services in Heilongjiang and Jiangxi went from negative at first to positive at last, which

Level 1 indicators	Level 2 indicators	Property
Education	Teacher-student ratio of normal colleges and universities	Positive
	School of special education	Positive
	Teacher-student ratio of normal senior middle school (high school)	Positive
Medical and healthcare	Hospital beds per thousand people	Positive
	Hospital bed rate of utilization	Positive
	Number of medical staff and healthcare technicians per thousand people	Positive
Social security and employment	Number of residents insured by Urban and Rural Pension Insurance Program	Positive
	Number of residents insured by Basic Urban Medical Insurance Program	Positive
	Number of people benefiting from work-related injury benefits	Positive
Environmental protection	Percentage of domestic waste that received decontamination treatment	Positive
	Percentage of built-up area covered by green landscaping vegetation	Positive
	Amount of industrial SO_2 emission	Negative
Transportation	Passenger turnover	Positive
	Total freight/cargo turnover	Positive
Public safety	Death toll of traffic accidents	Negative
	Direct property damage caused by traffic accidents	Negative

Source(s): Arranged by authors

Table 1. Evaluation indicator system of public service supply level

Table 2. Provincial public service equalization index

Public service equalization index									
Province	2013	2014	2015	2016	2017	2018	2019	2020	2021
Beijing	0.351	0.265	0.243	0.232	0.208	0.209	0.218	0.170	0.178
Tianjin	0.457	0.397	0.369	0.365	0.336	0.325	0.339	0.428	0.449
Hebei	−0.111	−0.111	−0.131	−0.008	−0.052	−0.073	−0.073	−0.089	−0.093
Shanxi	0.103	0.121	0.093	0.108	0.056	0.056	0.053	0.080	0.204
Inner Mongolia	0.231	0.229	0.222	0.236	0.234	0.219	0.204	0.281	0.261
Liaoning	0.221	0.300	0.202	0.213	0.177	0.174	0.151	0.120	0.088
Jilin	0.202	0.169	0.125	0.174	0.127	0.174	0.190	0.329	0.338
Heilong jiang	0.003	−0.035	−0.023	−0.030	−0.024	−0.048	−0.04	0.122	0.141
Shanhai	0.417	0.417	0.430	0.423	0.443	0.448	0.456	0.471	0.473
Jiangsu	−0.277	−0.263	−0.283	−0.304	−0.254	−0.278	−0.252	−0.319	−0.319
Zhejiang	0.129	0.135	0.117	0.078	0.034	0.037	0.040	−0.153	−0.169
Anhui	−0.009	0.002	−0.070	−0.081	−0.117	−0.036	−0.091	−0.015	−0.033
Fujian	0.021	0.030	0.022	0.012	0.052	0.045	0.049	0.026	0.025
Jiangxi	0.015	0.020	0.001	−0.01	0.056	0.041	0.018	0.080	0.064
Shandong	−0.364	−0.368	−0.240	−0.255	−0.322	−0.342	−0.335	−0.354	−0.350
Henan	−0.352	−0.333	−0.351	−0.337	−0.182	−0.222	−0.241	−0.311	−0.290
Hubei	−0.147	−0.133	−0.135	−0.148	−0.110	−0.159	−0.183	−0.197	−0.176
Hunan	−0.136	−0.118	−0.116	−0.097	−0.038	−0.057	−0.075	−0.075	−0.067
Guang dong	−0.384	−0.278	−0.331	−0.349	−0.315	−0.349	−0.366	−0.548	−0.569
Guangxi	−0.205	−0.181	−0.157	−0.160	−0.064	−0.120	−0.118	−0.074	−0.065
Hainan	0.602	0.594	0.590	0.579	0.543	0.548	0.568	0.585	0.622
Chong qing	0.307	0.304	0.297	0.282	0.241	0.224	0.227	0.199	0.195
Sichaun	−0.412	−0.418	−0.430	−0.350	−0.331	−0.333	−0.330	−0.327	−0.344
Guizhou	0.046	0.080	0.127	0.077	0.006	0.147	0.149	0.103	0.083
Yunnan	−0.224	−0.261	−0.236	−0.249	−0.130	−0.131	−0.116	−0.032	−0.044
Gansu	0.193	0.194	0.189	0.195	0.222	0.225	0.241	0.285	0.284
Xizang	0.800	0.795	0.803	0.795	0.788	0.778	0.781	0.788	0.796
Shanxi	0.072	0.077	0.063	0.073	0.025	0.104	0.104	0.087	0.090
Qinghai	0.729	0.737	0.734	0.730	0.732	0.723	0.727	0.747	0.735
Ningxia	0.725	0.717	0.712	0.714	0.698	0.685	0.689	0.682	0.671
Xinjinag	0.265	0.248	0.238	0.228	0.183	0.219	0.210	0.159	0.181

Source(s): Arranged by authors

classifies them as "quasi-importers" of public services. Meanwhile, the public service equalization indicator of Zhejiang went from positive at first to negative at last, which identifies it as a "quasi-exporter" of public services.

3.2 Model construction

In order to verify the effect of influence and the strength of impact of digital economy on the equalization of public services, this paper constructs the following model:

$$RBPSEI_{it}^{ad} = \alpha_0 + \alpha_1 DT_{it} + \sum \alpha_j Z_{it} + \gamma_{it} + \delta_{it} + \varepsilon_{it} \quad (2)$$

Among which, $RBPSEI_{it}^{ad}$ is the adjusted public service equalization index, which is the dependent variable; DT_{it} is the level of digital technology, which is the core dependent variable; Z_{it} represents a controlled variable; γ_{it} stands for an individual controlled variable and δ_{it} is a time controlled variable, with δ_{it} being a random disturbance item. This paper focuses on coefficient α_1, which stands for the development level of the digital economy, as it can reflect the comprehensive effect of the development level of the digital economy in various regions on the equalization level of their respective local public services.

3.3 Variable selection and descriptive statistics

1. Dependent variable: The equalization of public services. The entropy method is adopted to measure the supply level of public services in 31 provinces, the specific evaluation indicator system is shown in Table 1. The reverse fiscal method is then utilized to measure the equalization level of public services in each province. The value range of the public service equalization index calculated according to Formula (1) is [-1, 1], and the smaller the value of $RBPSEI_{it}$, the higher the level of public service equalization. For the convenience of empirical analysis, we obtained the adjusted public service equalization index, as its shown in Formula (3).

$$RBPSEI_{it}^{ad} = 1 - \{(RBPSEI_{it}+1)/2\} \quad (3)$$

2. Core independent (dependent) variable: level of digital technology development. For the measurement of the level of digital technology, the existing research usually uses the Internet penetration rate to measure. Although it can reflect the level of digital technology application to a certain extent, it is relatively one-sided. Referring to Liu and Song, this paper selected 11 indicators mainly from the infrastructure, application and innovation aspects of digital technology development to measure the level of digital technology development in each region. The specific evaluation indicators are shown in Table 3. In this paper, the entropy weight Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is adopted to measure the level of digital technology development. First, new data are obtained by calculating the weight according to the entropy weight method, and then the TOPSIS method research is carried out based on the obtained data.

3. Control variables: Considering the impact of economic development, urbanization, government intervention and population density on the equalization level of public services, this paper selected economic development level, urbanization level, government intervention index and population density as control variables, the proxy variables being per capita GDP, urbanization rate, local government fiscal expenditure/gross domestic product (GDP) and resident population/total area.

Level 1 indicators	Level 2 indicators	Level 3 indicators
Level of digital technology development	Digital infrastructure	Capacity of mobile phone exchange
		Capacity of long-distance optical cable line
		Number of broadband Internet access port
	Digital technology application	Number of R&D projects of industrial enterprises above designated scale
		Number of patents applied by industrial enterprises above designated scale
		Number of domain name holdings
		Number of Internet holdings
		R&D expense spent by industrial enterprises above designated size
	Digital technology innovation	R&D internal expenditures of high-tech enterprises
		Number of patents applied by high-tech enterprises
		Number of R&D institutions of high-tech enterprises

Source(s): Arranged by authors

Table 3. Evaluation indicator system of digital technology development level

The data about various basic indicators selected in this paper come from the EPS database, while the missing data are supplemented by the annual average method. The descriptive statistics of each variable are shown in Table 4.

4. Empirical analysis

4.1 Benchmark regression and corresponding results

In this paper, the Hausman test was carried out before the benchmark regression, and the result Prob > chi2 = 0.0000 indicated that the null hypothesis was rejected. Therefore, a two-way fixed effect model was used, and the least squares method was adopted for the benchmark regression. The regression results are shown in Table 5. The core dependent variable coefficient in Model 1 is significantly positive, indicating that the level of digital technology development has a significant role in promoting the equalization of public services. Model 2 introduces the control variable of economic development level based on Model 1. The coefficient of the core dependent variable is still significantly positive and the coefficient of economic development level is significantly negative, indicating that the level of economic development has a negative impact on the equalization of public services, which may be due to improving the level of economic development widening the gap between different regions, which in turn reduces the level of equalization of public services. The above result shows that during the period of high-quality economic development, one should pay attention not only to the efficiency of economic

Variables	Symbol	Average	Variance	Min value	Max value	*N*
Level of digital Technology	DT	0.1103	0.1108	0.01846	0.8688	279
Equalization level of public services	Y	0.4475	0.1576	0.0985	0.7843	279
Level of economic development	Z1	1.5828	0.0607	1.4549	1.7549	279
Level of urbanization	Z2	0.5994	0.1245	0.2393	0.896	279
Government intervention	Z3	0.2845	0.2051	0.1066	1.3792	279
Population density	Z4	0.2901	0.1117	0.1059	0.5541	279

Source(s): Arranged by authors

Table 4. Descriptive statistics for each variable

Name of variables	Model (1) Coef	Model (2) Cofe	Model (3) Cofe	Model (4) Cofe	Model (5) Cofe
DT	0.2610***	0.2815***	0.2720***	0.2916***	0.2904*** (0.0419)
	(0.0419)	(0.0418)	(0.0422)	(0.0417)	
Z1		−0.3191***	−0.2654**	−0.5608***	−0.5562*** (0.1456)
		(0.1123)	(0.1174)	(0.1445)	
Z2			−0.1857	−0.1588	−0.1568 (0.1196)
			(0.1214)	(0.1191)	
Z3				−0.2058***	−0.2048*** (0.0612)
				(0.0610)	
Z4					0.0118 (0.0401)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Constant term	0.3506***	0.8806***	0.9438***	1.4549***	1.4442*** (0.2437)
	(0.0105)	(0.1868)	(0.1908)	(0.2405)	
Adj *R*-squared	0.9770	0.9776	0.9778	0.9787	0.9786
N	279	279	279	279	279

Table 5. Benchmark regression results

Note(s): The robust standard errors are shown in brackets, *, **, *** indicate that the null hypothesis is rejected at the significance level of 10%, 5% and 1%, respectively, the same applies to charts below
Source(s): Arranged by authors

development but also to the issue of fairness and equality. Model 3 added urbanization level as a control variable to Model 2 and found out that the coefficient of the core dependent variable is still significantly positive, but the urbanization level has no significant impact on the equalization of public services. Model 4 added government intervention as the control variable on the basis of Model 3. The coefficient of the core dependent variable is still significantly positive, and the coefficient of government intervention is significantly negative, indicating that government intervention has a significant negative effect on equalization of public services. This illustrates that in order to achieve the equalization of public services, it is necessary to increase the degree of marketization of public services and keep the government from intervening excessively. Model 5 added population density as the control variable to Model 4. The coefficient of the core dependent variable is still significantly positive, and the coefficient of population density is not significant.

4.2 Robustness test and results

4.2.1 Replacing the measurement method of digital technology development level. Replace the measurement method of digital technology development level by adopting the principal component analysis (PCA) method to measure the digital technology level and repeat the regression. The first step is to normalize the variable data, and the second step is to perform the Kaiser–Meyer–Olkin (KMO) and Bartlett's tests of sphericity for the variables. According to the calculation of Stata software, KMO = 0.817 and the corresponding *p*-value of Bartlett's tests of sphericity is 0, indicating that the null hypothesis is rejected. Therefore, the data selected in this study are suitable for PCA. The third step is mainly to determine and extract several factors, since there is only one nonnegative eigenvalue, but the cumulative variance contribution rate is greater than 80, so it is more reasonable to extract two common factors. Then, the variance contribution rate of the factors is weighted to calculate the composite index of the development level of digital technology. The results of the regression are shown in Table 6 model (1), and the results are still significant after replacing the explanatory variable calculation method, which is consistent with the benchmark regression results, which further proves the robustness of the results.

Name of variables	Model (1) Coef	Model (2) Coef	Model (3) Coef
DT	0.0143***	0.2712***	0.3122***
	(0.0022)	(0.044)	(0.0451)
Control variables	Yes	Yes	Yes
Add variables	No	Yes	No
Time fixed effects	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Constant term	1.4428***	0.9464***	1.6862***
	(0.2461)	(0.3752)	(0.2391)
Adj *R*-squared	0.9782	0.9793	0.9802
N	279	279	243

Source(s): Arranged by authors

Table 6. Robustness test

4.2.2 Account for missing variables. In order to alleviate the bias of the regression results caused by the omission of variables as much as possible, this paper adds variables such as industrial structure upgrading and government expenditure on general public services to the benchmark regression, which are expressed by the output value of the tertiary industry/the output value of the secondary industry and the budget expenditure of the government on general public services, respectively. The results of the robustness test are shown in Model 2 in Table 6, and the core explanatory variables are still significantly positive, which verifies the robustness of the conclusion.

4.2.3 Eliminate key cities. Considering that the social, economic and financial conditions of key cities are significantly different from those of ordinary cities, four municipalities directly under the central government were excluded. Model 3 in Table 6 shows the regression results after excluding key cities, and the core explanatory variables are still significantly positive, which is consistent with the regression results above.

4.2.4 Endogeneity test. Although measurement errors and missing variables are addressed in the robustness test, the regression results may still be biased and incongruent if there is a causal relationship between digital technologies and the equalization of basic public services. In this paper, the endogeneity problem is mainly dealt with in the following ways, and the specific results are shown in Table 7. First, the two-stage least squares method (2SLS) is adopted. First, this paper refers to the article by Bartik to construct a "Bartikin strument":

	IV Bartik		IV distance	
Name of variables	Model(1)	Model(2)	Model(3)	Model(4)
DT		0.826***		2.229***
		(0.096)		(0.733)
IV	0.073***		0.114**	
	(0.0027)		(0.043)	
Control variables	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Constant term	0.030***	0.361***	0.036***	0.213***
	(0.003)	(0.013)	(0.027)	(0.733)
Wald-F	741.732(16.38)		43.925(16.38)	
N	248	248	248	248

Note(s): The Wald-F column is a 10 cut-off in parentheses

Table 7. Endogenous test result

$DT_{i,t-1} \times \Delta DT_{t,t-1}$,where $DT_{i,t-1}$ is the first-order digital technology index with lagging behind and $\Delta DT_{t,t-1}$ is the first-order difference in time of the national digital technology index, and the interaction term between the two is taken as an instrumental variable. The national digital technology comes from the average value of the synthesis of 31 provinces. Its change trend will not be significantly affected by a single province, and the difference item can be regarded as exogenous relative to a single province. Moreover, the equalization of public services in the province may be affected by other unobserved shocks, but as long as such shocks are not important enough to affect the national digital technology index, then the instrumental variables are valid, which meets the basic conditions of correlation and exogeneity of instrumental variables. Second, referring to the research of Zhang *et al.*, the distance from the provincial capital city to Hangzhou and the digital technology interaction term of the previous period were used as instrumental variables because Hangzhou is a demonstration city for digital village construction; therefore, the closer it is to Hangzhou, the higher the level of digital technology, and the distance from Hangzhou will not have a significant difference in the equalization of basic public services, which meets the selection conditions of correlation and exogeneity of instrumental variables. The regression results for the two-SLS method are presented in Table 7. The estimation results of Models 1 and 3 show that the instrumental variables have a significant positive correlation with digital technology, and digital technology has a significant positive correlation with the equalization of basic public services. The Wald-F test proves that the selection of instrumental variables is reasonable. After the instrumental variables are adopted, the main conclusions of this paper remain robust.

4.3 Heterogeneity test

4.3.1 Heterogeneity of the degree of government intervention. Local government fiscal expenditure/GDP is used to represent the degree of government intervention, which is then divided into four equal intervals, namely 0–25%, 25–50%, 50–75% and 75–100%, and regression is then performed on the quartiles. Models 1 to 4 represent the results showing degrees of government intervention from slight to severe, with the results of the heterogeneity of government intervention shown in Table 8.

Name of variables	Model (1) Coef	Model (2) Cofe	Model (3) Cofe	Model (4) Cofe
DT	0.28816***	1.1049***	−2.1770**	−0.9223
	(0.0456)	(0.4433)	(0.8546)	(0.7711)
Z1	−0.7404***	−0.1976	−2.1784***	−0.4792
	(0.2299)	(0.4882)	(0.5285)	(0.3176)
Z2	−0.2893**	−3.5387**	0.1772	−0.4108
	(0.1380)	(1.008)	(0.4712)	(0.4628)
Z3	−0.3676**	−1.4796***	−0.9134***	−0.2264***
	(0.1806)	(0.3150)	(0.2426)	(0.0606)
Z4	−0.1058*	0.2204	−0.2198**	0.2264
	(0.0633)	(0.1556)	(0.0982)	(0.0606)
Time fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Constant term	1.9384***	3.0631***	4.0741***	−0.3385
	(0.3865)	(0.7959)	(0.9290)	(0.4687)
Adj *R*-squared	0.9658	0.9895	0.9859	0.9950
N	177	22	45	29

Source(s): Arranged by authors

Table 8.
Heterogeneity test of degree of government intervention

From the results in Table 8, it can be seen that when the degree of government intervention is between 1–25% and 25–50%, the coefficient of the core dependent variable is positively significant, and digital technology has a positive impact on the equalization of public services. Moreover, the coefficient of the core dependent variable is the highest and the effect of digital technology on promoting the equalization of public services is most significant when the degree of government intervention lies between 25 and 50%. However, digital technology has a negative impact on the equalization of public services when the degree of government intervention lies between 50 and 75% and has an insignificant impact on promoting the equalization of public services when the degree lies between 75% and 100%. The above results show that moderate government intervention is conducive to promoting the equalization of public services by adopting digital technology.

4.3.2 Heterogeneity of population density. The population density is represented by the resident population/total area, which is then divided into four intervals, namely 0–25%, 25–50%, 50–75% and 75–100%, and regression is then performed on the quartiles. Models 1 to 4 present the respective results showing the impacts of digital technology on public services, based on population density from small to large, with the results of population density heterogeneity shown in Table 9.

From the results in Table 8, it can be seen that when the population density lies between 1–25% and 25–50%, the coefficient of the core dependent variable is positively significant, and as the population density increases, the impact of digital technology on promoting the equalization of public services decreases. When the population density exceeds 50%, the core dependent variable coefficient is insignificant, and digital technology is shown to be less than significant in promoting the equalization of public services. The above results show that digital technology has a more significant impact on promoting the equalization of public services in areas with lower population density.

4.3.3 Regional heterogeneity test. Affected by factors such as history, geography and economy, the level of digital technology development in different regions of China has different effects on the efficiency of local government in providing public services. This paper divided the 31 provinces (including autonomous regions and municipalities) in Mainland China into eastern, central and western regions. In this study, we further compared the

Name of variables	Model (1) Coef	Model (2) Cofe	Model (3) Cofe	Model (4) Cofe
DT	0.3935***	0.3867***	0.0833	−0.0925
	(0.1127)	(0.0721)	(0.1142)	(0.4252)
Z1	−0.1025	−1.0771***	−0.8879**	−1.7643***
	(0.2235)	(0.2767)	(0.4334)	(0.6128)
Z2	−0.2270	0.6846	−0.4436	−0.4434
	(0.2196)	(0.1534)	(0.3117)	(0.9766)
Z3	−0.0462	−0.2941	−0.0446	−1.0943***
	(0.0789)	(0.2102)	(0.1987)	(0.2916)
Z4	−0.2043	−0.5344***	−0.1216	0.4157**
	(0.1963)	(0.4821)	(0.1440)	(0.1691)
Time fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Constant term	0.7126*	2.3361***	2.1490***	−0.3385***
	(0.3691)	(0.4821)	(0.7507)	(0.4687)
Adj *R*-squared	0.9849	0.9864	0.9836	0.9634
N	89	47	101	35

Source(s): Arranged by authors

Table 9. Heterogeneity test of population density

regional heterogeneity characteristics of the relationship between the level of digital technology and the equalization of public services provided by local governments. The results of regional heterogeneity are shown in Table 10.

From the results of the regional heterogeneity test, the coefficient of the core dependent variable is only significantly positive in the eastern region, while it's rather insignificant in the central and western regions. It's indicated that the level of digital technology in the eastern region can significantly promote the equalization of public services, while the level of digital technology in the central and western regions has no significant impact on the equalization of public services. This may be due to the reason that the eastern region has always been an area of priority for the development of digital economy in the past few years, while the digital economy in the central and western regions is experiencing rather sluggish development, so the impact of digital economy on the equalization of public services is limited.

5. Conclusion

Based on the panel data of 31 provinces in China from 2013 to 2021, this paper evaluated the impact of digital technology on the equalization of public services on the basis of measuring the level of digital technology and equalization of public services and performed a robustness test on the benchmark regression results while also carrying out an extended analysis of government intervention, population density and regional heterogeneity. The following conclusions are drawn. (1) Both the baseline results and regression results of the endogenous test show that digital technology can significantly promote the equalization of public services, and the results of the robustness tests carried out with the method of replacing dependent variables further confirm the significance of digital technology in promoting equalization of public services. (2) The results of the heterogeneity test show that the effect of digital technology on the equalization of public services is heterogeneous due to the influences of government intervention, population density and regional differences. Thus, digital technology can better promote the equalization of public services in areas with moderate government intervention and lower population density, so the level of digital technology can significantly promote the equalization of public services in the eastern region,

Name of variables	Eastern Coef	Central Coef	Western Coef
DLODE	0.3215***	−0.0324	0.0190
	(0.0586)	(0.1184)	(0.2267)
Z1	−0.3475	−0.7254**	−1.1515***
	(0.4739)	(0.2892)	(0.3138)
Z2	−0.1868	−0.6231	0.6436
	(0.2139)	(0.3885)	(0.4156)
Z3	−0.2070	−0.7571***	−0.1370*
	(0.2604)	(0.1628)	(0.0737)
Z4	−0.0046	0.0169	0.0003
	(0.1598)	(0.0714)	(0.0493)
Time fixed effects	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Constant term	1.1541	2.1667***	1.8815***
	(0.8284)	(0.4161)	(0.4938)
Adj *R*-squared	0.9756	0.9368	0.9884
N	90	99	90

Source(s): Arranged by authors

Table 10. Results of regional heterogeneity test

while the impact of digital technology on the equalization of public services in the central and western regions is not so significant.

Based on the above conclusions, the following suggestions are put forward: (1) make full use of digital technology as a tool to narrow the gap in basic public services and empower regional integrated development with digitalization and attach great importance to the application of digital technology in public services. However, it is also necessary to pay attention to the application of digital technology among vulnerable groups in rural areas to avoid the emergence of a new "digital divide." (2) Because digital technology is heterogeneous for the equalization of public services in different regions, differentiated development strategies should be adopted to form a regional coordinated development pattern and narrow the regional "digital divide." The eastern region should give full play to the roles of demonstration and leadership; carry out pilot projects in tackling key digital technologies; cultivating digital talents; governing the digital economy and regional cooperation in the digital industry and give full play to the role of leadership, breakthrough and demonstration. The central region will strive to build competitive and characteristic digital industrial clusters and promote the deep integration of digital technology and local advantageous industries. For the western region, we will continue to promote the construction of digital infrastructure, optimize the layout of cyberspace and promote the digital development of industries. At the same time, the government should give full consideration to factors such as regional economic level and population density and implement policies that meet the development needs of the region. If the application of digital technology does not achieve the expected goals, the funds used to build digital infrastructure may crowd out the finances for public services, resulting in the loss of social welfare.

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Further reading

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