Original Research Article

Mechanism analysis of digital financial inclusion in narrowing the elderly digital divide

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Abstract: Using provincial panel data from 2012–2023, this paper examines whether digital inclusive finance mitigates the elderly digital divide. Empirical results show a significant narrowing effect. Urban-rural structure and educational expenditure serve as key mediating channels. Policy should promote age-adapted digital finance, improve resource allocation, and enhance elderly digital literacy.

Keywords: elderly digital divide; digital inclusive finance; urban-rural structure; educational expenditure level

1. Introduction

The rapid expansion of digital finance has lowered service thresholds and extended coverage to previously underserved groups. However, while digital financial inclusion has grown enormously in China, the elderly population faces a widening digital divide – many older adults lack digital skills, exhibit risk aversion, and encounter shrinking offline financial channels. This division is harmful to the rights of older people and obstructs the goals of inclusive finance and common prosperity. Most studies have not been systematic in connecting digital finance with the digital divide of older people. The deficiencies above will be addressed in the following ways: (i) Direct connection between digital inclusive finance and the digital divide of older people; (ii) Identification of two mediating channels: Urban-rural disparity and public education investment; and (iii) Provision of policy-relevant evidence based on provincial panel data.

2. Theoretical analysis and research hypotheses

2.1. Direct effect

The old model of inclusive finance is expensive and not widespread. New technology will be employed to reduce operating expenses and increase the scope of inclusive finance. Help older adults get online and learn to use the Internet by modifying the operation mode of banks. H1: Digital inclusive finance can help reduce the digital divide among older people.

2.2. Mechanism role of urban-rural structure

The first reason for the digital divide is that older people face it because the digital infrastructure in their communities is weak. A digitally inclusive financial system can send money to communities, improve the digital environment in areas, and help address issues of geographic inequality. H2a: A digitally inclusive financial system can help solve the problems that older people face in communities.

2.3. Mediating role of educational expenditure

Digital skills are essential for older adults in the digital age. Digital financial inclusion has increased the region's income and created a bigger demand for digital skills, so the government has boosted investments in teaching digital skills to older adults. Learning by doing is also a method. H2b: Digital financial inclusion can help cut the cost of education for older adults and reduce the digital divide.

3. Variable selection and model construction

3.1. Model specification

Using panel data for 31 Chinese provinces from 2012–2023, we employ a twoway fixedeffects model (individual and time fixed effects):

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \gamma Control_{it} + Id_i + Year_t + \varepsilon_{it}$$

where Y is the elderly digital divide index, X is the digital inclusive finance index, and Control Control includes several regional variables.

3.2. Variable and data

The dependent variable, the elderly digital divide index (Y), is constructed from three dimensions – access divide, usage divide, and knowledge divide – with specific indicators and equal weights as detailed in **Table 1**, and is subsequently logtransformed. The core explanatory variable (X) is the Peking University Digital Financial Inclusion Index, which captures coverage breadth, usage depth, and digitalisation level. To control for confounding influences, we introduce a set of control variables: Science and technology development level (STL), measured by the ratio of local fiscal expenditure on science and technology to total fiscal general budget expenditure; government selfsufficiency rate (GSSR), calculated as local fiscal revenue divided by total local fiscal expenditure; economic development level (EDL), represented by the logarithm of per capita regional GDP; industrial structure (IS), defined as the output value of the tertiary industry divided by regional GDP; marketisation level (ML), captured by the regional marketisation index; investment efficiency (IE), computed as the investment rate divided by the GDP growth rate; and digital infrastructure (DIG), measured by the word frequency of "new digital infrastructure" relative to the total word frequency in annual reports. For the mediation analysis, two mediating variables are selected: Urbanrural structure (M1), proxied by the ratio of urban to rural per capita disposable income, which reflects the urbanrural income gap; and educational expenditure level (M2), measured as the share of local fiscal education expenditure in total general budgetary expenditure, indicating regional humancapital investment. All variables are drawn from official sources including the China Statistical Yearbook, the Peking University Digital Financial Inclusion Index, the China Health and Retirement Longitudinal Study, and reports published by the China Internet Network Information Center, covering 31 provinciallevel regions over the period 2012–2023 with a total of 372 observations; all variables fall within reasonable value ranges without severe outliers.

Table 1. Indicator system for measuring the elderly digital divide index.

Dimension	Indicator	Weight
Access Divide	Internet penetration rate	1/6
	Mobile phone penetration rate	1/6
Usage Divide	Broadband internet subscribers	1/6
	Internet usage frequency	1/6
Knowledge Divide	Educational attainment	1/6
	Proportion of population with higher education	1/6

4. Empirical analysis

4.1. Benchmark regression analysis

Table 2 reports the results. Regardless of control variables, the coefficient of X is significantly negative ($p<0.01$), confirming H1. After adding all the controls, the coefficient is -0.004 (significant), and it can still decrease. Among the controls, STL is positive (maybe because technology mainly benefits the labor market), while IS and IE are negatively related to distribution. ML and DIG aren't statistically significant; so, market forces and hardware alone aren't enough without special policies.

Table 2. Benchmark regression results.

	(1)	(2)
X	-0.002***(0.002)	-0.004***(0.001)
Cons	1.244***(0.076)	-5.824**(2.132)
Controls	Yes	Yes
N	372	372
FE (id, year)	Yes	Yes
R^2	0.772	0.820

4.2. Robustness test

All will confirm that the reference results are correct. First, Principal Component Analysis is used to construct a composite index of digital inclusion finance; its coefficient is 0.213 and it is statistically significant at the 1% level, consistent with the results of the baseline. Second, after excluding the samples from the pandemic period (2020-2023), the main coefficients are still negative, so the base results have not been affected by external shocks. Third, omit the digital infrastructure variable from the control variables and add the financial support intensity variable. Most explanations have the same sign and importance. All tests show good stability for benchmark regression results.

Table 3. Robustness test results.

	(1)	(2)	(3)	(4)
X_{pca}	-0.213***(0.039)	—	—	—
FSI	—	—	—	0.184(0.400)
X	—	-0.004***(0.001)	-0.004*** (0.001)	-0.004*** (0.001)
Cons	-6.515***(1.331)	-5.722***(1.418)	-5.825*** (2.132)	-6.172***(2.125)
Controls	Yes	Yes	Yes	Yes
N	372	248	372	372
R^2	0.825	0.817	0.819	0.820

5. Further analysis: Mediating effect test

Based on the above empirical results, digital inclusive finance will have an immediate negative effect on the digital divide of older people. Most of the previous studies have only shown the general correlation, but not how it works internally. Therefore, this paper constructs a mediation model and, according to the dimensions of resource allocation and reduction in the capability gap, takes the urban-rural division structure (M1) and the level of educational expenditure (M2) as the two mediating variables. The three steps of mediation and a Sobel test will be used to determine whether there is mediation.

Inclusive Finance has been applied to solve the problem of urban-rural disparity. According to the regression results, digital inclusive finance has improved the urban-rural structure and reduced the elderly digital divide. The Sobel's Z statistic is 3.903 ($p < 0.01$), and the proportion of mediation in this path is 52.78%.

Educational expenditure will be relatively high at the level of digital inclusive finance, and thus the demand for digital skills will increase. Increase the proportion of high-education spending on older persons. The Sobel Z-value is 4.988 and the mediation proportion is 55.56%; therefore, Hypothesis H2b is supported.

Table 4. Mediating effect test of urban-rural structure.

Variable	(1)	(2)	(3)
X(M1)	-0.004***	-0.001***	-0.001*
X(M2)	-0.0036***	0.00004***	-0.0014*
M1	—	—	1.447***
M2	—	—	-53.768***
Controls		Yes	
FE (id, year)		Yes	
N		372	
R^2	0.951	0.988	0.954
Indirect Effect(1)	—	—	-0.0019***
Direct Effect(1)	—	—	-0.0017
Total Effect(1)	-0.0036***	—	—
Z1	—	—	-3.903***
Indirect Effect(2)	—	—	-0.002***
Direct Effect(2)	—	—	-0.0014
Total Effect(2)	-0.0036***	—	—
Z2	—	—	-4.988***

6. Recommendations and implications

Digital inclusive finance can reduce the digital divide among older people and promote the development

of urban-rural balanced development and education funds in all aspects. Policy Recommendations: (i) Financial institutions should develop age-friendly digital services with simple interfaces and low-risk products, and at the same time keep traditional offline service channels; (ii) Build a multi-stakeholder governance framework that includes the government, enterprises, communities, families, etc., to provide training and intergenerational assistance; (iii) Tailor regional strategies to improve service quality in coastal areas and strengthen infrastructure construction in central and western regions; (iv) Increase public education and practical digital skills training for older people to reduce technophobia and close the gaps in usage and knowledge.

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