How Digital Inclusive Finance Affects the Urban-Rural Residents Income Gap in China?

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Abstract. Based on provincial panel data from 2013 to 2022, the Theil index for 31 provinces in china is measured, and the impact of digital inclusive finance on the urban-rural residents income gap is empirically examined using the two-way fixed-effects model. This study found that: (1) Digital inclusive finance significantly narrows the urban-rural residents income gap; (2) Sub-sample regression results indicate that inhibitory effect is more pronounced in the eastern region; (3) The level of economic development plays a crucial role in moderating the effect of digital inclusive finance on the urban-rural residents income gap. This study concludes that digital inclusive finance should be vigorously promoted, but the government should emphasize coordinated regional development when introducing relevant policies, implement differentiated development strategies, and optimize the development environment for digital inclusive finance.

Keywords: Digital inclusive finance; Urban-rural income gap; Population income.

1 Introduction

The phenomenon of "preferring the poor to the rich" along with the moral hazard and adverse selection problems in the traditional financial market, has caused the financial system in a free-market economy to lose equilibrium, excluding some groups from services and preventing them from rationally utilizing financial resources[1]. Since the United Nations formally introduced the concept of inclusive finance in 2005, it has received positive responses and support from various countries. The rise of digital inclusive finance disrupts the 'Pareto principle' in traditional financial services, greatly enhancing service efficiency and boosting the income of both urban and rural residents by expanding coverage, deepening usage, and increasing digitalization. On the one hand, the digitalization of finance can introduce innovative technologies that enhance firms' access to financial resources and create new opportunities for investors[2]. On the other hand, it lowers the threshold for financial services, effectively alleviates financial exclusion, and benefits those excluded from traditional financial and credit services.

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This greatly expands the accessibility, convenience, and inclusiveness of traditional financial services.

China's long-standing financial construction program, differentiated between urban and rural areas, has caused the "siphoning effect" of urban financial resources in rural areas. The dichotomous urban-rural economic structure tilts financial capital toward urban areas, leaving rural and poor areas lacking financial resources and unable to meet the financial needs of vulnerable groups. According to the "trickle-down" theory, towns that develop and become rich first can drive the development of the relatively backward areas around them, thereby reducing the income gap[3]. In this context, it is essential to systematically examine the impact of digital inclusive finance on the urban-rural residents income gap. This paper offers new insights into the role of digital finance in narrowing this gap and addressing regional development imbalances in China.

2 Literature Review

Traditional financial development mainly refers to "financial deepening," which emphasizes the expansion of financial aggregates and the overall development of the financial system. However, this model of aggregate development is unable to meet a wide range of financial needs. Inclusive finance has advanced 'financial broadening,' aiming to deliver financial services to all social groups, especially disadvantaged ones like farmers, low-income urban and rural residents, small and micro-enterprises [4]. With the rapid advancement of network technology and the integration of digital tools into finance, technologies like big data, AI, cloud computing, blockchain, and 5G are enabling inclusive, precise, and personalized financial services that traditional methods cannot provide[5].

In terms of the economic effects of digital inclusive finance, at the macro level, digital finance has improved and strengthened the efficiency of resource allocation in capital accumulation, addressing the problem of balancing social supply and demand[6]. It fosters deeper financial inclusion, inclusive economic growth, technological innovation, and the rapid spread of new technologies. At the micro level, digital inclusive finance delivers substantial benefits to users, providers, and other stakeholders in the financial system[7]. Rajan et al. (2010) point out that financial innovation increases consumer choice, improves consumer participation in financial activities, and enhances household credit availability[8]. Digital finance facilitates the development of MSMEs by reducing borrowing and lending costs, increasing information transparency, and lowering business and intermediation costs [9].

Banerjee and Newman (1993) point out that improvements in financial markets can help alleviate the credit constraints of financially excluded groups, enabling these groups to access financial support for investment and entrepreneurial activities, thus narrowing the social income gap over time[10]. G Clarke et al. (2003), using panel data from 91 countries spanning 1960 to 1995, reconfirmed that financial development significantly converge urban and rural incomes. Arun et al. (2015) further found that financial inclusion is based on the principle of equitable distribution of financial well-being, and that accessibility is a core indicator of financial inclusion, determining

whether the urban-rural residents income gap can be reduced[11]. Lee et al. (2023) argue that digital inclusive finance has spillover effect and can make considerable contributions to China's poverty alleviation significantly [12].

3 Research Design

3.1 Data Sources

This article selected panel data from 31 regions in China from 2013 to 2022. Data on digital inclusive finance (DFI) are sourced from the 'Peking University Digital Inclusive Finance Index'. Additional data are obtained from the National Bureau of Statistics and the China Statistical Yearbook.

3.2 Regression Model

This paper constructs the following econometric model, see equation (1) for an example:

$$Theil_{it} = \alpha_0 + \alpha_1 lnDFI_{it} + \alpha_2 \mathrm{Ctrl}_{it} + \delta_i + \delta_t + \varepsilon_{it} \quad (1)$$

where i denotes region, t denotes year, α_0 is the intercept term; $Theil_{it}$ is the income difference between urban and rural residents; $lnDFI_{it}$ is the level of digital inclusive finance development. Ctrl_{it} is a series of control variables; δ_i denotes province fixed effects; δ_t denotes year fixed effects; ε_{it} denotes random error term.

3.3 Variable Measurement and Description

1. Dependent variable (Theil). In the existing literature, the urban and rural residents income gap is commonly measured using the Gini coefficient, the ratio of urban and rural residents disposable income, and the Theil index. Given that the Theil index accounts for population changes, as a positive indicator, the Theil index reflects larger income gaps with higher values, this study adopts it as the dependent varible. The specific calculation formula is as follows:

$$Theil_{it} = \sum_{i=1}^{2} \left(\frac{Y_{it}}{Y_t}\right) \times \ln \frac{Y_{it}/Y_t}{X_{it}/X_t} \quad (2)$$

where i=1 for urban and i=2 for rural; Y_{it} represents the disposable income of urban or rural residents; Y_t is the sum of disposable income of urban and rural residents; X_{it} is the total urban population or rural population; X_t is the total population.

2. Independent variable (DFI). The DFI index consists of 3 dimensions and 33 specific indicators: the breadth of digital financial coverage, the depth of digital financial use, and the degree of digitalization of financial inclusion. It also distinguishes between digital payment, digital credit, digital investment, digital fund, digital insurance, and digital credit.

3. Control variables. The control variables include Educational attainment(EDU), Government fiscal expenditure(GOV), Trade openness(OPEN), Industrial structure(IS), Level of technological innovation(TECH) with reference to scholars' practices.

4 Empirical Analysis

4.1 Benchmark Regressions Results

Prior to performing the regression analysis, this paper assesses potential multicollinearity using the variance inflation factor (VIF) to avoid issues such as 'pseudo-regression' and potential panel data selection biases. The results indicate that the maximum VIF value is 3.90, suggesting that multicollinearity is not a serious concern. Furthermore, the correlation between variables is highly significant. To mitigate the effect of multicollinearity, the DFI is logarithmically processed. To determine the most effective estimation model, this paper uses different estimation methods and models to cross-validate and conduct the Hausman test on the model. The test results show a P-value of 0, indicating that the fixed-effects model is more appropriate.

The regression analysis of model (1) is first performed. As seen in Table 1, the regression coefficients from the three models are significantly negative at the 1% level, which aligns with the theoretical expectations of this study. Specifically, in the fixed-effects model, the regression coefficient for digital inclusive finance on the urban-rural residents income gap is -0.044. This implies that a 1% increase in digital inclusive finance is associated with a 4.4% reduction in the urban-rural residents income gap.

Table 1. Benchmark regression results.

	(1)	(2)	(3)
	OLS	FE	RE
lnDFI	-0.167***	-0.044***	-0.047***
	(0.023)	(0.010)	(0.010)
EDU	-0.027***	-0.001	-0.006***
	(0.002)	(0.002)	(0.002)
GOV	-0.024***	0.038***	0.042***
	(0.009)	(0.010)	(0.009)
OPEN	0.001	-0.032***	-0.038***
	(0.010)	(0.006)	(0.006)
IS	0.008	0.140***	0.105***
	(0.027)	(0.034)	(0.033)
TECH	0.438***	0.256***	0.225***
	(0.053)	(0.031)	(0.031)
_cons	1.179***	0.202***	0.290***
	(0.119)	(0.059)	(0.060)
YEAR	YES	YES	YES
ID	NO	YES	YES
N	306	306	306
r2	0.760	0.908	

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. The standard errors in parentheses are the same below.

For the control variables, The negative coefficient of EDU in the regression model could be due to recent increases in national investment in rural education, have gradually reduced the disparity in educational resources across regions of China, including teaching staff, infrastructure, and other facilities. As a result, the level of human capital in rural areas has significantly improved, narrowing the income gap. The coefficient for OPEN shows a significantly negative effect. Higher levels of foreign trade in a region attract more foreign investment and bring advanced technology and resources, which further contribute to narrowing the urban and rural areas income gap. Notably, the regression coefficients of GOV, IS and TECH are all significantly positive at the 1% level. This can be attributed to the government's strategy of prioritizing capital-intensive sectors, which leads to a decline in urban employment demand. When rural residents find it difficult to move to the city, a large number of laborers remain in the countryside, causing the marginal and average output of the land to decline. Consequently, the average income level in rural areas falls, widening the urban-rural gap.

4.2 Robustness Test

1.Replacing the dependent variable. To account for potential time lags in the impact of digital inclusive finance, this study examines the DFI index with lags of 1 and 2 periods. The results presented in columns (1) and (2) of Table 2 show coefficients of -0.045 and -0.054, respectively. These findings indicate that digital inclusive finance from the past two years continues to have a significant effect in reducing the urban-rural residents income gap in the current year, thereby supporting the existing estimation results.

2.Change the sample range. To mitigate potential bias from extreme values in the regression results, this study adjusted the sample range using winsorizing at the 1% and 99% levels before conducting the regression analysis. The results, presented in column (3) of Table 2, confirm the robustness and reliability of the benchmark regression findings.

3.Endogeneity test. To address potential endogeneity issues, this study employs the two-stage least squares (2SLS) method. An ideal instrumental variable must meet two criteria: correlation and exogeneity. For this purpose, the study uses the DFI index with a lag of one period as the instrumental variable (IV) for 2SLS regression analysis.

Column (5) of Table 2 reports the regression results, with a coefficient of 0.483, and the model has an F-statistic of 169.74, verifying the significant and positive correlation between the DFI with a lag of one period and the DFI. Furthermore, to further validate that the instrumental variable used in this model is valid, a weak instrumental variable test is conducted. The Anderson test yields a p-value of 0, and the Cragg-Donald Wald F-test value is 169.74, which significantly exceeds the critical value of 16.38 at the 10% level, indicating no issues with under-identification or weak instrumental variables. The p-value for the over-identification test (Sargan test) is also 0. These results demonstrate that the chosen instrumental variable effectively explains digital inclusive finance, and confirm that digital inclusive finance maintains a significant inhibitory effect on the urban-rural residents income gap, thereby validating the robustness of the empirical analysis after addressing endogeneity concerns.

Table 2. Regression results of robustness tests[1].

	(1)	(2)	(3)	(4)	(5)
VARIABLES	THEIL	THEIL	THEIL	lnDFI	THEIL
L.lnDFI	-0.045***			0.483***	
	(0.010)			(13.03)	
L2.lnDFI		-0.054***			
		(0.009)			
lnDFI			-0.041***		-0.093***
			(0.011)		(-4.39)
Control variables	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
ID	Yes	Yes	Yes	Yes	Yes
Constant	0.227***	0.262***	0.232***		
	(0.057)	(0.051)	(0.060)		
Observations	276	246	306	276	276
R-squared	0.901	0.902	0.903		0.881

4.3 Further Analysis

1.Subregional heterogeneity analysis

The sample is segmented into three major regions: East, Central, and West to explore whether exist regional heterogeneity, with results presented in Table 3 below.

The regression results presented in columns (1), (2), and (3) of Table 3 indicate that digital inclusive finance significantly reduces the urban-rural residents income gap in the eastern and central regions but shows no significant effect in the western region. This lack of impact in the west may be attributed to its more remote geography, less developed technology, and limited financial resources, which contribute to outdated financial services, lower financial knowledge, and slower development of digital finance. The regression coefficient for the eastern region is -0.046, which is higher than central and western regions. This suggests a stronger reduction in the income gap in the eastern region, likely due to its more advanced economic development, higher Internet penetration, and better-developed industrial structure.

Table 3. Heterogeneity test and regulatory effects results.

	(1)	(2)	(3)	(4)
	East	Central	West	THEIL
lnDFI	-0.046***	-0.035**	-0.005	-0.274***
	(0.012)	(0.015)	(0.040)	(0.019)
lnGDP				-0.180***
				(0.013)
lnDFI*lnGDP				0.027***

[1]Due to space limitations, detailed results for the control variables are not presented in the subsequent text.

				(0.002)
Control variables	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
ID	Yes	Yes	Yes	Yes
Constant	0.219***	0.236***	0.124	1.901***
	(0.067)	(0.072)	(0.246)	(0.127)
Observations	110	80	40	306
R-squared	0.942	0.961	0.976	0.949

2.Regulatory effects analysis

In regions with advanced economic development, governments are typically more proactive in investing resources, which facilitates the enhancement of rural digital infrastructure and mitigates the urban-rural digital divide. To examine this interaction, the study incorporates the interaction term lnDFI×lnGDP, reflecting the interplay between economic development and digital inclusive finance, into regression model (3).

$$Theil_{it}=\alpha_0+\alpha_1 DFI_{it}+\alpha_2 \ln GDP_{it}+\alpha_3 \ln DFI_{it}\times \ln GDP_{it}+\alpha_4 Ctrl_{it}+\delta_i+\delta_t+\varepsilon_{it} \quad (3)$$

Where i denotes province, municipality directly under the central government or autonomous region, t denotes year. The GDP used is the per capita GDP of each area, and the empirical process to do the logarithmic treatment.

According to the column (4) of Table 3, the positive and statistically significant coefficient of the interaction term lnDFI×lnGDP suggests that the impact of digital inclusive finance on reducing the urban-rural income gap is strengthened by higher levels of economic development. This implies that regions with higher levels of economic development should use digital inclusive finance reasonably and judiciously to avoid excessively increasing the urban-rural residents income gap.

5 Conclusion

Digital inclusive finance has experienced rapid development in recent years. This paper offers a comprehensive analysis and empirical assessment of how the digital inclusive finance influences the urban-rural residents income gap. The conclusions of this paper mainly include: (1) Digital inclusive finance significantly narrows the urban-rural residents income gap; (2) Sub-sample regression results indicate that inhibitory effect is more pronounced in the eastern region; (3) The level of economic development plays a crucial role in moderating the effect of digital inclusive finance on the urban-rural residents income gap.

First, sustained promotion of digital inclusive finance is essential, with a focus on prioritizing and sequencing. The urban-rural digital divide widens the income gap, necessitating differentiated regional strategies, enhanced financial literacy in the west and rural areas, and improved digital infrastructure to bridge this divide. Second, encouraging innovative financial products is crucial. An integrated approach should leverage diverse financial providers, ensuring consumers and businesses access quality services at reasonable prices while controlling risks. Finally, optimizing the

development environment for digital inclusive finance is essential. The government should strengthen financial regulation, promote the social credit system, mitigate Internet-related systemic risks, and bolster financial stability guarantees. Additionally, the government should boost support and incentives for digital finance targeting disadvantaged groups, enhance rural financial services, and address the "last mile" issue.

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