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Research on the Impact of Digital Inclusive Financial Development on the Urban-Rural Income Gap in China

Wenjing Liang[1,a]

[1]*Shenzhen Finance Institute, Chinese University of Hongkong (Shenzhen), Shenzhen, China*
[a]*13669381808@163.com*

Abstract: *In recent years, digital inclusive finance, as a new financial model, is rapidly gaining popularity globally, providing a new development path for traditional financial services, while the urban-rural income gap is not only related to social equity and stability, but also directly affects the country's overall level of economic development. As an innovative financial service model, digital inclusive finance has the potential to narrow the urban-rural income gap and promote coordinated urban-rural development. In view of this, this paper takes China's macroeconomic data of the past ten years as the research object in order to deeply study the impact of the development of digital inclusive finance on China's urban-rural income gap. By collecting panel data from 31 provinces, cities and autonomous regions in China from 2011 to 2022 and conducting empirical analyses, the following conclusions can be drawn: (1) the development of digital inclusive finance can effectively reduce the urban-rural income gap; (2) the impact of digital inclusive finance on the urban-rural income gap varies in different dimensions that constitute the digital inclusive financial system; (3) the impact of digital inclusive finance on the urban-rural income gap varies in different regions.*

Keywords: *digital financial inclusion; urban-rural income gap; regional heterogeneity; dimensional heterogeneity*

1. Introduction

For a long time, the distribution of financial resources between urban and rural areas has not been balanced, and rural areas and low-income groups often face the problem of inadequate financial services. In order to address this difficulty, the concept of inclusive finance has emerged. Inclusive finance aims to popularize financial services to micro and small enterprises, low-income groups and residents in remote areas, etc., using relevant technologies and through the innovation of financial products and services to ensure that these services are both convenient and low-cost[1]. With the combination of inclusive finance and digital technology, digital inclusive finance has been developed rapidly in recent years and has had a far-reaching impact on the urban-rural income gap.

This study is committed to systematically exploring the impact mechanism of digital inclusive finance on the urban-rural income gap, clarifying the core concepts and their theoretical backgrounds, and adopting empirical analyses based on a wide range of panel data collection to explore the impact mechanism in depth, with a view to revealing its intrinsic correlations and paths of action, as well as analyzing the multidimensional and regional heterogeneity behind it.

2. Theoretical Analysis and Research Hypothesis

2.1. Related Definitions

2.1.1. Digital Financial Inclusion

In 2005, the United Nations first proposed the concept of financial inclusion[2]. Inclusive finance aims to provide reasonable and efficient financial services at affordable costs to all segments of society [3].In 2016, the Global Partnership for Financial Inclusion (GPFI) first proposed the concept of digital inclusive finance at the G20 Summit in Hangzhou [4]. That is, to achieve a Pareto allocation of financial resources by effectively covering marginalized rural groups and ensuring their equal access to a wide range of financial services. Globally, evaluating the degree of progress of emerging market countries in the field

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of digital financial inclusion often involves a comprehensive analysis of multidimensional indicators, such as Internet penetration, the penetration of electronic facilities, and the proportion of the agricultural population [5]. In China, scholars have created the 'China Digital Financial Inclusion Index' system using a large database of fintech transactions. At the same time, the Digital Finance Research Centre of Peking University has simultaneously compiled sub-indices for payment, insurance, credit and other businesses [6].

2.1.2. Urban-Rural Income Gap

The urban-rural income gap reflects the imbalance between urban and rural economic development. There is a considerable difference between urban and rural incomes in China; according to the data, the average income of urban residents in China is 2.53 times the average income of rural residents, a difference of 15.1%[7].

2.2. Theoretical Foundation

2.2.1. Dualist Theory of Economic Structure

The dual economic structure refers to the fact that in developing countries, the economy exhibits a dual structure in which a modern industrial sector coexists with a traditional agricultural sector, with a clear hierarchy of technological levels and significant differences. In China, the dual economic structure is particularly marked.

2.2.2. Financial Exclusion Theory

The theory of financial exclusion analyses in depth the inability of certain groups or individuals in the financial system to access adequate financial services and products due to multiple factors, thereby limiting their ability to use financial resources to promote their own development. It not only exacerbates the gap between the rich and the poor, leading to a more pronounced Matthew effect, but also triggers unbalanced regional economic development.

2.2.3. Inclusive Growth Theory

The theory of inclusive growth seeks to emphasize that in the process of economic growth, it should be ensured that the fruits of economic growth are shared equitably by all members of society and that equality of opportunity is achieved. Inclusive growth emphasizes the importance of pursuing economic growth while paying attention to the living conditions of the poor to ensure that they share in the fruits of economic growth.

2.3. Research Mechanisms and Hypotheses

2.3.1. Direct Impact Mechanisms

The direct impact is mainly reflected in the threshold effect and the exclusion effect [8].

Threshold effect refers to the high cost and complex process, low-income groups are difficult to reach the financial services, forming a 'threshold', digital financial inclusion using digital means, greatly reducing the threshold of use. While the traditional financial service system excludes rural and low-income groups, digital financial inclusion effectively alleviates financial exclusion through online channels and mobile devices. As a result, the development of digital inclusive finance has a direct impact on the urban-rural income gap.

2.3.2. Indirect Impact Mechanisms

The indirect impact is mainly reflected in the two aspects of promoting consumption and increasing employment opportunities [9].

The rise of digital inclusive finance has made it easier for low-income groups to access financial services, such as mobile payment and online shopping, which has stimulated the consumption demand of rural residents and low-income groups. With the rapid development of digital inclusive finance, related industries such as financial technology and big data analysis have risen rapidly, creating a large number of new employment opportunities in urban and rural areas. As a result, digital inclusive finance indirectly reduces the urban-rural income gap.

Based on the analysis of the impact mechanism, this paper puts forward the following hypotheses:

Hypothesis 1: The development of digital inclusive finance can effectively reduce the urban-rural

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income gap.

2.3.3. Heterogeneity Analysis

In this paper, we will analyze the heterogeneity of digital financial inclusion on the urban-rural income gap from the perspective of the different dimensions that make up the digital financial inclusion system and different regions [10].

Digital financial inclusion is a complex system, and its impact may show variability due to the different dimensions. In terms of breadth of coverage and depth of use, digital inclusive finance has a positive impact on narrowing the urban-rural income gap through the use of digital information technology, which makes the coverage of financial services broader and more relevant to the financial needs of rural residents. While the convenience brought about by digitalization has helped to narrow the urban-rural income gap, its overly rapid process may exacerbate the digital divide between urban and rural areas, widening the urban-rural income gap instead.

The regional heterogeneity of its impact is mainly manifested in the fact that regions with a higher level of economic development usually have a more complete financial infrastructure and a higher penetration rate of financial services, and the resulting effect is more pronounced; on the contrary, in regions with a lower level of economic development, the impact may be relatively small due to the weak financial infrastructure and the lack of financial knowledge of the residents, among other reasons.

Based on the heterogeneity analysis, this paper proposes the following hypothesis:

Hypothesis 2: The impact of digital inclusive finance on the urban-rural income gap varies across the dimensions that make up the digital inclusive financial system.

Hypothesis 3: The impact of digital inclusive finance on the urban-rural income gap varies across regions.

3. Variables and Model

3.1. Main Variables

3.1.1. Dependent Variables

The dependent variable chosen in this paper is the Theil index (theil). Existing studies usually use the disposable income ratio of urban and rural residents, Atkinson's index, Theil's index, coefficient of variation, generalized entropy index, Gini coefficient and so on[11]. The ratio of income disparity between urban and rural residents is prone to make the accuracy of the study affected by factors such as biased estimates [12]. The Gini coefficient does not adequately respond to changes in the incomes of low-income groups, and in China, where such groups account for a large proportion of the population, the use of this coefficient to measure may overlook important realities [13]. In contrast, the Thiel index measures the urban-rural income gap with full consideration of the dynamics of urban-rural population mobility and avoids the shortcomings of the Gini coefficient [14]. Therefore, this paper believes that the Tel index is a more scientific and comprehensive indicator for measuring income disparity. The specific formula for calculating the Tyrell index is as follows:

$$\text{theilit}=\sum_{j=1}^{2}\left(\frac{\text{Iij,t}}{\text{Ii,t}}\right)Ln\left[\left(\frac{\text{Iij,t}}{\text{Pij,t}}\right)/\left(\frac{\text{Ii,t}}{\text{Pi,t}}\right)\right] \quad (1)$$

Where j=1 represents urban, j=2 represents rural, t represents year, and i represents province. Iij,t denotes the disposable income of urban or rural residents of province i in year t, Ii,t denotes the disposable income of residents of province i in year t, Pij,t denotes the total population of urban or rural areas in province i in year t, and Pi,t denotes the total population of province i in year t.

3.1.2. Independent Variables

The core independent variable selected for this paper is the Digital Financial Inclusion Index (index), which is compiled and publicly released by the Peking University Digital Finance Centre. The index not only provides an overall indicator, but also provides a comprehensive portrayal of the degree of development of the digital economy through three dimensions: breadth of coverage (index1), depth of use (index2), and degree of digitization (index3). The higher the value, the more advanced the level of digital financial inclusion development in the region. Since the index is larger than other variables, which will affect the accuracy of correlation and regression analysis, its value is reduced by 100 times as the

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core explanatory variable in this paper.

3.1.3. Control Variables

In this paper, in order to analyze the influencing factors of the urban-rural income gap more comprehensively and accurately, several important control variables are introduced in addition to the core explanatory variables. These control variables include the level of economic development (gdp), industrial structure (is), level of fiscal expenditure (gov) and level of urbanization (urban). These variables play a key role in economic development and social progress and have a direct or indirect impact on the urban-rural income gap.

3.1.4. Variables Summary

In summary, the explained variables, explanatory variables and control variables of this paper are shown in Table 1.

Table 1: Main Variables

type	name	symbol	description
dependent variables	Theil index	theil	calculated using the Theil Index
independent variables	Digital Financial Inclusion Index	index	Digital Financial Inclusion Index
	breadth of coverage	index1	Digital Financial Inclusion Index Sub-Index
	depth of use	index2	
	degree of digitization	index3	
control variables	economic development	gdp	regional GDP per capita
	industrial structure	is	added value of secondary and tertiary industries/gross production
	level of fiscal expenditure	gov	general budget expenditure/gross regional product
	level of urbanization	urban	urban population/regional population

3.2. Model

Based on the above analysis, this paper will construct an individual time double fixed effects regression model using the explanatory variables, core explanatory variables, and control variables:

$$theilit=\beta0+\beta1indexit+\beta2gdpit+\beta3isit+\beta4govit+\beta5urbanit+\varepsilon it+\delta i+\varphi t \quad (2)$$

where theil, index, gdp, is, gov and urban stand for theil index, digital financial inclusion index, economic development level, industrial structure, fiscal expenditure level and urbanization level, respectively, β0 is the intercept term, β1 to β5 are the regression coefficients, i stands for the different provinces while t stands for the time, ε is the random disturbance term, δ is the individual effect and φ is the time effect.

4. Empirical Analysis

4.1. Data Test

4.1.1. Stationarity Test

The results of the stationarity test are shown in Table 2. The P values of all variables are less than 0.05, which indicates that all variables selected in this study are stable.

Table 2: Stationarity Test

variables	t	P	conclusion
theil	-26.2166	0.0000	pass
index	-14.6466	0.0000	pass
index1	-2.8667	0.0021	pass
index2	-11.6900	0.0000	pass
index3	-13.0513	0.0000	pass
gdp	-1.8776	0.0302	pass
is	-3.0324	0.0012	pass
gov	-4.0469	0.0000	pass
urban	-4.4888	0.0000	pass

ISSN 2706-6827 Vol. 6, Issue 10: 53-60, DOI: 10.25236/IJFS.2024.061008

4.1.2. Multicollinearity Test

According to Table 3, the variance inflation factors of all variables are less than 10, which means that there is no significant multicollinearity problem among the variables.

Table 3: Multicollinearity Test

variables	VIF	1/VIF
index	1.790	0.559
gdp	4.610	0.217
is	1.600	0.625
gov	1.420	0.702
urban	3.380	0.296
Mean VIF	2.560	

4.2. Correlation Analysis

As shown in Table 4, the correlation coefficient between the core explanatory variable digital financial inclusion index and Theil index is -0.538 ($p<0.01$), showing a moderately strong negative correlation, which indicates that the development of digital financial inclusion can effectively alleviate urban and rural income gap, consistent with assumptions. In addition, there are also varying degrees of correlation between control variables and core explanatory variables, as well as between different control variables. Based on the correlation analysis results, further regression analysis can be performed.

Table 4: Correlation Analysis

	theil	index	gdp	is	gov	urban
theil	1					
index	-0.538	1				
gdp	-0.670	0.612	1			
is	-0.214	0.115	0.527	1		
gov	0.410	-0.118	-0.357	-0.257	1	
urban	-0.844	0.487	0.794	0.337	-0.513	1

4.3. Regression Analysis

4.3.1. Baseline Regression

In order to explore further, this article conducted regression analysis on the data. First, this study will conduct baseline regression using an individual and time double-fixed model.

The benchmark regression results are shown in Table 5. According to the regression coefficient of the core variable, for every unit increase, the Theil index decreases by 0.018. It can be concluded that the development of digital inclusive finance can effectively reduce the urban-rural income gap, so hypothesis 1 is true.

Table 5: Baseline Regression

	(1)	(2)
	theil	theil
index	-0.043*	-0.018*
	(0.016)	(0.007)
gdp		-0.001
		(0.001)
is		0.004
		(0.009)
gov		0.008
		(0.019)
urban		-0.450***
		(0.064)
constant	0.103***	0.345***
	(0.007)	(0.040)
N	372.000	372.000
F	57.519	109.027
r2	0.690	0.785
individual fixed effects	Yes	Yes
individual fixed effects	Yes	Yes

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

ISSN 2706-6827 Vol. 6, Issue 10: 53-60, DOI: 10.25236/IJFS.2024.061008

4.3.2. Robustness Test

According to the results of replacing the model with a random effects model, the regression coefficient of the core explanatory variable is -0.006, still statistically significant negative. According to the results of introducing lagged three-stage regression analysis, the regression coefficient of the core explanatory variable is -0.017, which is similar to the previous -0.018, and is also statistically significantly negative. Hypothesis 1 has been verified under various models and methods.

Table 6: Robustness Test

	(1)	(2)
	random effects model	lagged three-stage regression
index	-0.006***	-0.017**
	(0.001)	(0.006)
gdp	0.002**	0.004*
	(0.001)	(0.002)
is	0.011	-0.022**
	(0.011)	(0.007)
gov	0.009	-0.000
	(0.011)	(0.028)
urban	-0.335***	-0.195
	(0.024)	(0.095)
constant	0.277***	0.259***
	(0.017)	(0.056)
N	372.000	279.000
R-squared		0.549

*** p<0.01, ** p<0.05, * p<0.1

4.4. Heterogeneity Analysis

4.4.1. Dimensional Heterogeneity Analysis

This article analyzes heterogeneity from different dimensions of digital inclusive finance. The results are shown in Table 7. The regression coefficients of coverage breadth, usage depth, and digitalization degree are -0.007, -0.001, and -0.004, indicating that coverage breadth and digitalization degree are negatively related to the urban-rural income gap, while the impact of usage depth is not significant. This may be due to the fact that usage depth involves complex applications modes and users cannot take full advantage of them. Based on the above analysis, hypothesis 2 can be established, the impact of digital inclusive finance on the urban-rural income gap differs in different dimensions that constitute the digital inclusive financial system.

Table 7: Dimensional Heterogeneity Analysis

	(1)	(2)	(3)
	theil	theil	theil
index1	-0.007***		
	(0.002)		
index2		-0.001	
		(0.001)	
index3			-0.004***
			(0.001)
gdp	0.002***	0.001	0.002**
	(0.001)	(0.001)	(0.001)
is	0.011	0.010	0.011
	(0.011)	(0.011)	(0.011)
gov	0.010	-0.007	0.012
	(0.011)	(0.011)	(0.011)
urban	-0.314***	-0.383***	-0.361***
	(0.025)	(0.022)	(0.020)
constant	0.265***	0.309***	0.293***
	(0.018)	(0.017)	(0.015)
N	372.000	372.000	372.000

*** p<0.01, ** p<0.05, * p<0.1

ISSN 2706-6827 Vol. 6, Issue 10: 53-60, DOI: 10.25236/IJFS.2024.061008

4.4.2. Regional Heterogeneity Analysis

This study divides different provinces and cities in China into three regions: eastern, central and western regions to represent regions with different economic development levels, social customs, science and technology and culture, and performs regression analysis respectively. The specific division is shown in Table 8.

Table 8: Regional Division

regions	provinces
eastern region	Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan
central region	Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi
western region	Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang

The heterogeneity analysis of different regions is shown in Table 9. Among them, the regression coefficients of the east, central and west are -0.006, -0.008 and -0.011 respectively. The regression results of the three regions are all significant. Furthermore, the regression results show that the degree of impact differs significantly in different regions. From this we can conclude that Hypothesis 3 is established, the impact of digital inclusive finance on the urban-rural income gap differs in different regions.

Table 9: Regional Heterogeneity Analysis

	(1)	(2)	(3)
	theil	theil	theil
index	-0.006***	-0.008*	-0.011**
	(0.001)	(0.004)	(0.003)
gdp	0.002***	0.002	-0.005
	(0.000)	(0.002)	(0.003)
is	-0.024	-0.000	0.443***
	(0.052)	(0.011)	(0.106)
gov	0.013	-0.001	-0.021
	(0.022)	(0.017)	(0.017)
urban	-0.244***	-0.284**	-0.176**
	(0.023)	(0.087)	(0.062)
constant	0.249***	0.255***	-0.120
	(0.040)	(0.040)	(0.103)
N	132.000	96.000	108.000

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

The development of digital inclusive finance can effectively alleviate the urban-rural income gap. First of all, digital inclusive finance has significantly lowered the entry threshold and operating costs of financial services, allowing rural areas and low-income groups to easily obtain efficient and convenient financial services. Secondly, digital inclusive finance promotes economic development and industrial upgrading in rural areas. Finally, the development of digital inclusive finance can help narrow the urban-rural information gap and uneven resource distribution.

The impact of digital inclusive finance on the urban-rural income gap is diverse and complex in different aspects. Regarding the different dimensions of digital inclusive finance, specifically, in terms of breadth of coverage and degree of digitalization, the development of digital inclusive finance has a positive effect on improving the financial literacy and economic capabilities of rural residents. In terms of the depth of use, its impact on narrowing the urban-rural income gap is restricted by a variety of factors. In different regions, in economically developed areas, its role may be relatively limited. In areas with relatively lagging economies, it has played a particularly prominent role. This heterogeneity may be jointly affected by multiple factors such as regional economic development level, financial infrastructure perfection, and policy environment.

ISSN 2706-6827 Vol. 6, Issue 10: 53-60, DOI: 10.25236/IJFS.2024.061008

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