

Analysis of Spatial Spillover Effects of Digital Inclusive Finance on Urban-Rural Income Gap

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ABSTRACT

This article mainly analyzes the changes in urban-rural disparities under digital inclusive finance, which can be divided into three levels of research objectives, gradually and layer by layer. Firstly, based on the theoretical foundation of accelerating the development of rural financial markets and reducing economic disparities between rural and urban areas through digital inclusive finance, a panel threshold model is constructed to quantitatively analyze the threshold effect of digital inclusive finance on the urban-rural income gap, and to study how to reduce the threshold effect and narrow the digital divide between rural and urban areas; Secondly, from the perspective of spatial spillover, this study examines the positive or negative spatial spillover effects of digital inclusive finance on regional urban-rural income disparities, in order to analyze the direction of the impact of digital inclusive finance on urban-rural income disparities. Using the Spatial Panel Lag Model (SAR) and Spatial Durbin Model (SDM) to empirically test their inherent correlation and impact; Thirdly, there are differences in policies and resource allocation among provinces and cities, as well as differences in urban-rural income disparities in different regions. Based on this, a quantitative analysis model is constructed to analyze the path and methods of digital inclusive finance promoting urban-rural income disparities.

KEYWORDS

Digital inclusive finance; Income gap between urban and rural areas; Spatial spillover effects

1. INTRODUCTION

Under the wave of reform and opening up, the Chinese economy has also ushered in a new spring. With the rapid development of the economy, the overall living standards of residents have been greatly improved. With the active construction of socialist modernization with Chinese characteristics, most residents have lifted themselves out of poverty and developed towards a better well-off life. At the same time, the rapid development of the economy has also brought certain impacts. The difference in resource allocation is becoming more and more obvious in rural and urban areas, such as in policy factors, social environment changes, and the resource conditions provided by the state. These differences have led to a serious polarization in the income of urban and rural residents, and the differentiation presents diverse and complex characteristics. As of 2017, the per capita disposable income of urban residents is still 2.7 times that of farmers, which does not include other factors such as education, healthcare, and social security. The 12th Five Year Plan emphasizes the shift of China's

economic growth goal from "national wealth" to "people's wealth", which indicates that China has begun to make significant changes to the urban-rural income distribution gap, achieve true people's wealth, make social development more fair, resource allocation more reasonable, and the gap between rich and poor is getting smaller. With the continuous combination of high-tech industries such as artificial intelligence, the Internet, blockchain, big data and cloud computing with the economic and financial industry in recent years, the cost of financial services has been greatly reduced, making residents closer to financial services, so that everyone can accept and enjoy services. At the same time, in September 2016, the G20 Hangzhou Summit officially adopted the G20 Advanced Principles for Digital Inclusive Finance, which were promoted and customized by China. The People's Bank of China, the China Banking and Insurance Regulatory Commission, the Ministry of Industry and Information Technology, and other departments have clearly confirmed their responsible areas to avoid gaps in regulatory oversight and the occurrence of no one taking responsibility; At the same time, various departments help and cooperate with each other, actively promoting the combination of digital inclusive finance and the development of the real economy, and achieving the rapid development of digital inclusive finance. According to data released by the Digital Finance Research Center of Peking University, China's Digital Inclusive Finance Index increased from 49.4 in 2011 to 229.9 in 2018. Digital inclusive finance encompasses a wider range of fields than traditional inclusive finance, with lower acquisition costs and stronger commercial sustainability. Therefore, from the current development in our country, one of the important means to significantly reduce urban-rural income inequality, reduce impoverished households, and promote innovation and entrepreneurship development is digital inclusive finance. From the current actual development situation in our country, the development of digital inclusive finance is relatively slow in areas with large urban-rural income disparities, while it is relatively smooth and has achieved certain results in areas with smaller urban-rural income disparities. This means that the government's policy goals are not precisely targeted, the supply and demand of financial resources are not consistent, and resource allocation is not reasonable. At the same time, it also indicates that digital inclusive finance has not made a significant impact on the urban-rural income gap. Therefore, in order to explore this issue, it is of great significance to evaluate the implementation effect of digital inclusive finance and clarify the development direction of digital inclusive finance during the 14th Five Year Plan period.

In order to analyze the impact of the implementation of digital inclusive finance on the spatial spillover effect of urban-rural income gap, this article focuses on analyzing the specific impact of empirical digital inclusive finance on urban-rural income gap from the perspective of spatial spillover, studying the implementation effect of policies, and the research perspective has a certain degree of innovation. In order to study the spatial spillover effects of inclusive finance on the urban-rural income gap, this study uses spatial econometric models, spatial Durbin models, and spatial panel lag models to analyze the specific effects of digital inclusive finance on the spatial spillover effects of urban-rural income gap. The research methods are innovative.

2. LITERATURE REVIEW

Analyze the domestic and international development status of three aspects based on the content of this article.

(1) Research on digital inclusive finance. With the advent of the Internet plus era, traditional finance has been unable to meet people's financial needs, and digital inclusive finance has taken advantage of the trend. It has brought challenges and opportunities to the inherent financial model and concepts, and brought new vitality to economic development. Digital inclusive finance can break geographical limitations and deliver financial services to thousands of households. Most studies have found a significant positive effect between the development of digital finance and economic growth. Qian Haizhang et al. conducted a quasi natural experiment using the double difference method for empirical analysis, and the results showed a significant positive correlation between the development

of digital finance and economic growth. XuM, ZhangX. analyzed the relationship between inclusive finance and urban-rural income gap through vector autoregression model, cointegration test, and Granger causality test. The research results showed that there is a long-term equilibrium relationship between inclusive finance and urban-rural income gap, and the improvement of inclusive finance level can narrow the urban-rural income gap.. Zhang Jiguo and Zhao Jimei used data from 31 provinces and cities in China from 2011 to 2017 as samples, and used the coefficient of variation method to measure the inclusive finance index. The study found that inclusive finance can narrow the urban-rural income gap in the central and western regions, but expand the urban-rural income gap in the eastern regions. The current situation in the past five years can also confirm the positive effect of digital inclusive finance on the economy. During the COVID-19, China's digital payment system provided a strong technical support for residents' daily survival activities, guaranteed people's basic life, and accelerated the resumption of work and production.

(2) Research on the income gap between urban and rural areas. China has been in a state of income inequality between urban and rural areas for a long time. According to data from the National Bureau of Statistics, the income gap between urban and rural areas in China has been increasing for the past 10 years, but the growth rate is slowing down. There are significant regional income disparities in China's economy, with some areas experiencing rapid rural economic development while others remain stagnant, which is closely related to the policy guidelines implemented by various provinces and cities. The country should coordinate the development of the eastern and western regions, strengthen the flow of resources to rural areas, and balance the economic development speed of each region. Gu Xiao'an et al. analyzed the relationship between inclusive finance and urban-rural income gap in 29 provinces and cities in China by constructing a threshold, indicating that inclusive finance first gradually expands the urban-rural income gap, then significantly expands, and finally narrows, presenting a dual threshold effect.

(3) A study on the spatial spillover effects of digital inclusive finance on the urban-rural income gap. Digital inclusive finance can effectively unleash the consumption potential of residents and has strong spatial spillover effects. But we should not only see its positive spillover effects. The development of digital inclusive finance can effectively promote local inclusive growth, but it has a negative spillover effect on inclusive growth in neighboring areas. China has a vast territory and regional differences, and there may be significant spatial dependence and heterogeneity between financial development and urban-rural income gap. Ignoring the spatial dependence and spillover effects of financial development on urban-rural income gap may lead to biased model setting and results. The research of He Yaping and Xu Kangning shows that the participation of the Internet is affected by "people" and "economy". Compared with urban areas, rural communication equipment and facilities are not perfect, the economy is relatively backward, and residents are less educated. The benefits of the Internet cannot be fully reflected, thus increasing the urban-rural income gap. Liang Shuanglu and Liu Peipei believe that with the help of digital technologies such as big data, digital inclusive finance significantly reduces the threshold effect of financial services, improves the accessibility of financial services, and thus helps to narrow the income gap between urban and rural areas.

Currently, China's economic development has entered a new normal, and the country is promoting coordinated and mutually beneficial integrated development among various regions. The spatial spillover effect of digital inclusive finance on the urban-rural income gap has also received widespread attention. Meanwhile, many mathematicians have conducted sufficient research on the spatial spillover effect, and this article will further explore it based on existing research.

Based on the current research results in the field of inclusive finance, most scholars hold the view that digital inclusive finance can reduce the cost of financial services for rural residents, expand the service areas of financial services, and promote the use of financial products in rural areas. Based on this argument, this project collects data based on theoretical content, constructs an econometric model for empirical analysis, analyzes countermeasures, and proposes suggestions.

3. THEORETICAL ANALYSIS

3.1. Theoretical Basis for the Impact of Digital Inclusive Finance on Urban-Rural Income Gap

In 1993, Leyshon and Thrift proposed the theory of financial exclusion, which refers to the situation in the era before the development of digital inclusive finance, where the target range of financial services was limited to mid to high end customers, and financial services could not be fully popularized. Some potential customers with financial service needs could not access financial services or financial products, and such customers were often small and medium-sized enterprises and low-income individuals. This is the situation in the pure traditional financial era. Under the phenomenon of financial exclusion, the theory of inclusive growth emerged in 2007. The concept originated from seeking legitimate benefits for low-income groups, aiming to expand the participation circle in the financial market. Its core is to emphasize that every individual should receive economic development and equal services. The background of this theory is that in the process of simple economic growth, the rich and poor begin to develop towards two poles, the social hierarchy is becoming increasingly severe, the service recipients are limited, and the internal development is extremely unbalanced. This theory corresponds to the theory of financial exclusion. In the above context, the inclusive theory emphasizes that economic development should benefit people from all walks of life, allowing low-income groups to participate in the financial market and achieve the popularization and prosperity of financial services.

3.2. Mechanism Analysis of the Impact of Digital Inclusive Finance on Urban-Rural Income Gap

(1) Digital inclusive finance can reduce threshold effects. In traditional finance, the threshold for purchasing financial services is high, and the operating and service costs of physical finance are also high. Low income groups cannot achieve this level of wealth accumulation and find it difficult to purchase financial products. Meanwhile, traditional finance has strict requirements for customer qualifications, requiring customers to have a certain degree of risk tolerance and wealth preservation, making it difficult for low-income groups to pass the screening. Financial institutions are more willing to choose clients with higher investment and greater risk tolerance, thereby forming investment thresholds. The emergence of digital inclusive finance has reduced the minimum purchase share of financial services, compressed the cost of services provided by financial institutions, reduced information asymmetry in financial information, and thus lowered the service threshold of traditional finance.

(2) Digital inclusive finance can mitigate non-equilibrium effects. In the traditional financial era, the flow of resources was single, and there were often situations where villages and towns lacked financial infrastructure and cities were clustered together. Financial resources were tilted towards developed regions, and there were significant differences in economic strength between the east, middle, and west regions. Resource distribution faults occurred between different provinces. This uneven economic development has widened the income gap between urban and rural areas. After the emergence of digital finance, it broke geographical restrictions and promoted the transfer of resources to a balanced state. Rural residents are more involved in financial activities, and financial institutions are also more distributed in rural areas.

(3) Digital inclusive finance can play a role in poverty reduction. In the era of digital finance, financial services are generally available, capital flows are accelerating, and income generation is significant. Digital inclusive finance has advantages such as wide coverage, low cost, high liquidity, and accessibility, which greatly promote the economic development of rural and underdeveloped areas and achieve a certain degree of poverty reduction.

4. DATA SOURCES AND VARIABLE SELECTION

4.1. Data Sources

The data selected in this article comes from the China Statistical Yearbook, the EPSDATA data platform's China Regional Database and China Macro Database, the Peking University Digital Inclusive Finance Index Report (2011-2021), and statistical yearbooks of various provinces and cities. The sample is panel data from 30 provinces, municipalities, and autonomous regions in China from 2011 to 2019.

4.2. Variable Description

4.2.1. The dependent variable

Income inequality between urban and rural areas: This article, by referring to other literature, understands that the Theil index contains relevant information on population changes. Compared to the situation of China's urban-rural population structure, the Theil index is closer to reality. The calculation formula is as follows:

$$\text{Income Theil}_{it} = \frac{y_{1,t}}{y_t} + \ln\left(\frac{\frac{y_{1,t}}{y_t}}{\frac{p_{1,t}}{p_t}}\right) + \frac{y_{2,t}}{y_t} \ln\left(\frac{\frac{y_{2,t}}{y_t}}{\frac{p_{2,t}}{p_t}}\right) \quad (1)$$

4.2.2. Core explanatory variables

Digital Inclusive Finance (Difi): Compared to traditional inclusive finance, digital inclusive finance has a wider coverage, lower costs, and stronger business sustainability. This article adopts the Peking University Digital Inclusive Finance Index (2011-2021), which includes three levels: county-level, municipal level, and provincial-level. This provides strong diversified data support for the research in this article.

4.2.3. Control variables

In order to make the estimation of the model more accurate and avoid bias in the calculated results, this article also studied other factors that may affect the urban-rural income gap, including regional urbanization level (Urban), education development level (Edu), opening up level (Open), industrial structure (Is), fiscal expenditure (Fe), fiscal support for agriculture (FeAg), and economic development level (Gdp).

5. EMPIRICAL AND RESULT ANALYSIS

5.1. Spatial Correlation Test

This article uses the Theil index to measure and analyze the urban-rural income gap, and the calculation formula is as follows (1). The smaller the value of the Theil index, the smaller the income gap between urban and rural areas. When the Theil index is 0, there is no income gap between urban and rural areas.

$$GAP_t = \sum_{j=1}^2 \left(\frac{y_{jt}}{y_t}\right) \ln\left(\frac{\frac{y_{jt}}{y_t}}{\frac{p_{jt}}{p_t}}\right) \quad (2)$$

Where, $j=1,2,1$ represents urban areas, and 2 represents rural areas. Represents the total income of urban ($j=1$) or rural ($j=2$) in the t -th year, represents the total disposable income of urban and rural areas in the t -th year, represents the total population of urban ($j=1$) or rural ($j=2$) in the t -th year, and represents the total population of urban and rural areas in the t -th year.

This article uses the Peking University Digital Inclusive Finance Index released by the Peking University Digital Finance Research Center to measure the development level of digital inclusive finance, which includes three levels: the breadth of digital finance coverage, the depth of use, and the degree of digitization, and has high scientific validity. This article selects 7 indicators as control variables, including: (1) Economic growth factors. Economic growth improves regional productivity and production relations, increases employment and investment opportunities, and affects the income of urban and rural residents. The degree of regional economic development is measured and controlled by industrial structure (IGDP of added value in the secondary and tertiary industries), urbanization level (urban population/total population in the region), economic development level (logarithm of per capita real GDP in the region), and level of openness to the outside world (GDP of total trade imports and exports). (2) Government actions. Regional construction and agricultural development cannot be separated from government support. Local fiscal investment affects household income. Therefore, fiscal expenditure (general fiscal budget expenditure/GDP) and fiscal support for agriculture (agricultural, forestry, and water affairs expenditure/GDP) are selected to measure government expenditure intensity. (3) Human capital. The improvement of human capital level is beneficial for increasing employment rate, expanding income channels for residents, and selecting the level of education development (average number of higher education students per 100000 population) to measure the level of regional human capital.

Table 1. Descriptive statistical results

Variable symbol	Mean	S.D.	Min	Max
Theil	0.127	0.063	0.012	0.263
Income_Ra	2.740	0.514	2.036	4.290
Difi	194.215	87.606	18.470	377.730
Breadth	169.972	84.500	3.060	346.330
Depth	201.855	87.253	27.510	400.400
Level	260.387	121.470	7.580	440.260
Is	0.905	0.045	0.838	0.997
Fe	0.230	0.073	0.119	0.402
Fe_Ag	0.025	0.012	0.008	0.053
Urb	56.246	13.401	34.960	89.600
Edu	7.796	0.227	7.134	8.176
Gdp_Per	10.748	0.480	9.706	11.814
Open	0.558	0.101	0.379	0.772

The overall index of digital inclusive finance in the Yangtze River Economic Belt has been increasing year by year, but there are differences in the three levels. In the early stage, the depth of use and construction is faster than the breadth of coverage, while in the later stage, the opposite is true. The degree of digitalization shows an N-shaped development characteristic; The Theil index showed an overall upward trend, but it significantly slowed down in 2016. In terms of digitalization level and usage depth, the downstream remains basically the strongest, while the level in the middle and upstream is comparable. Through data, it can be found that after the official introduction of digital inclusive finance in 2016, both the Theil Index of the Yangtze River Economic Belt and the development trend of digital inclusive finance have changed, which may be related to the service of digital inclusive finance in narrowing the urban-rural income gap.

5.2. Model Setting and Result Analysis

(1) Mixed effect model

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \quad (3)$$

α and β in the model are fixed values, and there is no individual effect in the model.

(2) Fixed effects model

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \quad (4)$$

In the model, α_i is influenced by individuals and varies with different interfaces, while β is a fixed value and is not affected by individuals.

(3) Random effects model

$$Y_{it} = \alpha_i + \beta_i X_{it} + \varepsilon_{it} \quad (5)$$

Both α_i and β_i in the model are influenced by individuals and vary with different interfaces.

5.3. Identification of Panel Models

The LR test is used to determine whether to choose a mixed effects model or a fixed effects model. The LR test assumes:

There is no fixed effect, α_i is equal, and a mixed effect model should be chosen.

There are fixed effects, α_i is not equal, and a fixed effects model should be chosen.

The Hausman test is used to determine whether to choose a random effects model or a fixed effects model. The Hausman test hypothesis is:

Individual effects are independent of the explanatory variable (X_i), β_i is not equal, and a random effects model should be chosen.

Individual effects are related to the explanatory variable (X_i), β_i is equal, and a fixed effects model should be chosen.

According to the results of LR and Hausman tests, fixed effects models should be selected for all samples, low-income regions, and high-income disparities.

According to the panel model regression results, the R^2 of the low-income and high-income gap sample regions both reached 0.9 or higher, indicating a good fitting effect of the model. From the regression results, it can be seen that the regression coefficients for both high-income and low-income areas have passed the 1% significance level test, and the coefficients are all negative. It can be concluded that inclusive finance has a significant promoting effect on narrowing the urban-rural income gap in the second category areas. The absolute value of the regression coefficient in high-income regions is greater than that in low-income regions. The development of inclusive finance has regional heterogeneity in narrowing the urban-rural income gap, and its impact is stronger in high-income regions than in low-income regions. From the regression results of various control variables, for low-income areas, UR passed the 1% significance level test with a regression coefficient of -0.1905, and PGDP passed the 5% significance level test with a regression coefficient of -0.0091. Urbanization and economic development have a significant effect on narrowing the urban-rural income gap in low-income areas; For high-income regions, PGDP and GOV passed a 1% significance level test, with regression coefficients of -0.028 and -0.0004, respectively. Economic development and government fiscal expenditure have a significant effect on narrowing the urban-rural income gap in high-income regions.

5.4. Analysis of Spatial Spillover Effects

Table 2. Analysis results of spatial spillover effects

LR_Direct	LR_Indirect	LR_Total
0.307	1.544*	1.851**
(0.391)	(0.824)	(0.923)
0.264	-0.960	-0.696
(0.339)	(0.739)	(0.758)
68.73***	-93.75	-25.02
(26.38)	(57.95)	(60.78)
0.0975**	-0.163***	-0.066***
(0.0451)	(0.0974)	(0.107)
3.009	-23.27***	-20.26***
(3.257)	(5.421)	(5.826)
10.67***	3.409*	14.08***
(0.912)	(2.027)	(2.333)
-3.431***	0.155	-3.277***
(0.288)	(0.593)	(0.617)
0.0246	2.746	2.770
(1.151)	(1.984)	(2.167)

The coefficient of influence of the total index of digital inclusive finance on the Theil index in the model is -0.0201, while the coefficient of -0.066 is significant at the 1% statistical level, indicating that the development of digital inclusive finance can indeed narrow the urban-rural income gap. However, the Hausman test rejects the null hypothesis at the 1% statistical level, indicating that using mixed OLS regression will exaggerate the convergence effect of digital inclusive finance on the urban-rural income gap. The significant positive impact of digitalization indicates that if digital inclusive finance only emphasizes digital technology and ignores regional development level and residents' digital cognitive literacy, it will lead to the phenomenon of "digital divide", making it difficult for the dividends of digital inclusive finance to be distributed more by the wealthy and to play its inclusive role.

The overall index of digital inclusive finance has a negative impact on the urban-rural income ratio at the 1% statistical level, with an impact coefficient of -0.1618. In the three levels, the coverage breadth has significantly decreased, but still passes hypothesis testing at the 5% statistical level; The negative impact coefficient of depth has been improved, and it is significant at the 10% statistical level; The degree of digitization still has a positive impact on the urban-rural income ratio at the 1% level. After replacing the Theil index with the urban-rural income ratio, the size and significance level of the coverage breadth and depth of use coefficients have changed.

6. CONCLUSION AND SUGGESTIONS

6.1. Conclusion

This project is based on empirical testing of panel data and spatial spillover perspectives from 30 provinces in China from 2011 to 2019. A spatial econometric model is constructed to study the spatial spillover effects of digital HP finance on the urban-rural income gap. Compared with traditional inclusive finance, digital inclusive finance can significantly improve the wealth of low-income rural populations and is beneficial for reducing the urban-rural income gap. Digital inclusive finance can

significantly improve the wealth of rural households and help reduce the income gap between urban and rural households in the region. By collecting panel data from 30 provinces in China from 2011 to 2019 and conducting empirical analysis from a spatial spillover perspective, it is concluded that the development level of digital HP finance has a significant positive impact on improving the income gap between urban and rural households, and even global spillover effects may occur, which can have a positive impact on narrowing the income gap between urban and rural areas in neighboring areas. After replacing the digital inclusive finance index with three primary indices, the conclusion remains robust. Based on the analysis and exposition of digital inclusive finance in narrowing the income gap between urban and rural residents in this article, the key and necessity of narrowing the income gap between urban and rural residents have been further clarified. We must fully support the popularization of digital inclusive finance and look forward to achieving a balance of income between urban and rural residents as soon as possible.

6.2. Suggestions

(1) Increase the configuration of digital infrastructure in rural areas. The government should increase financial support for underdeveloped areas with low levels of technology popularization, expand the coverage of digital inclusive finance, increase the frequency of rural low-income residents using financial services, in order to meet the needs of rural low-income groups for digital HP finance, and thus coordinate the allocation of facilities to a greater extent.

(2) Enhance the basic services of digital inclusive finance and reduce the difficulty of using rural financial services. At present, mobile payment is still the main business of digital inclusive finance services in China. Most urban and rural areas in China have basically achieved basic mobile payment coverage, but there are still some underdeveloped areas that have not been able to enjoy convenience, and mobile payment services still need to be continuously promoted. The planning of financial services business should focus on simplifying business processes, reducing the difficulty of use, so that digital inclusive financial services can be more easily used by low-income groups.

(3) Improve the supervision and management system for digital inclusive finance, and increase efforts to regulate financial system risks. Digital inclusive finance is flourishing, but the problems it reveals cannot be ignored. Due to the relatively relaxed regulatory environment of digital inclusive finance, on the one hand, it provides space for the development of digital finance, and on the other hand, it also accumulates a certain degree of financial risk in some functions of digital inclusive finance.

(4) To achieve digital inclusive finance in rural areas as soon as possible, it is necessary to strengthen the popularization of basic knowledge of digital HP finance, so that rural residents can act as consumers with financial awareness. It is necessary to strengthen the popularization of basic understanding of digital HP finance and the methods of identifying illegal financial behaviors, and strive to guide financial consumers to choose suitable financial services and products, improve their awareness of risk prevention, and stay away from illegal financial activities, thereby avoiding blind investment. To continuously implement the work arrangement of inclusive finance, it is necessary to take popularizing knowledge of digital HP finance as the starting point, effectively protect the legitimate rights and interests of digital HP finance consumers, and help create a harmonious financial ecosystem.

In general, it is necessary to strengthen the supervision of Internet monopoly giants and strengthen the regulation of the risks brought by the digitalization of inclusive finance. Continuously improving the regulatory system and development environment for digital inclusive finance, regulation and innovation should develop in both directions, only in this way can the development of digital inclusive finance flourish.

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