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Digital Inclusive Finance, Rural E-Commerce, and Urban-Rural Income Gap

Meidianzi Wu ^{1,*}

¹ Yanshan College Shandong University of Finance and Economics, Jinan, China

* Correspondence: Meidianzi Wu, Yanshan College Shandong University of Finance and Economics, Jinan, China

Abstract: This study explores the impact of digital inclusive finance and rural e-commerce on the income disparity between urban and rural areas in China. Using county-level panel data from 2014 to 2022, a fixed-effects model is employed to assess how these two factors contribute to reducing income inequality. The findings show that digital inclusive finance plays a vital role in narrowing the urban-rural income gap, with rural e-commerce acting as an intermediary. Specifically, digital inclusive finance promotes economic growth in rural areas, boosting residents' income through accessible and inclusive financial services. Rural e-commerce, by breaking down geographical barriers and connecting rural markets with domestic markets, enables rural residents to utilize local resources for entrepreneurship and increases their income levels. Therefore, the research emphasizes the importance of developing a standardized wealth growth system, optimizing the income distribution structure, and ensuring fair distribution processes to effectively reduce the income gap and promote social harmony and balanced development.

Keywords: rural e-commerce; urban-rural income gap; digital inclusive finance

1. Introduction

Over the last ten years, the digital economy has developed into the most inventive, rapidly expanding, and influential sector. By June 2022, China boasted 1.051 billion internet users, achieving an internet penetration rate of 74.4% (source: China Internet Network Information Center (CNNIC) "Statistical Report on the Development Status of the Chinese Internet"). Digital inclusive finance, as a crucial component of the digital economy, has addressed the limitations of traditional finance, such as limited coverage and high costs, by incorporating innovative technologies like blockchain and cloud computing. Its convenient and inclusive nature has promoted rural economic growth and increased residents' income.

Rural e-commerce serves as a prime illustration of the profound integration between digital technology and the actual economy, has been promoted through China's comprehensive demonstration policy since 2014. By breaking down geographical barriers and connecting rural markets with the domestic market, rural residents can utilize local resources for entrepreneurship, known as "e-commerce helping agriculture" to improve their income levels. As e-commerce expands and deepens its penetration in rural China, substantial transformations have taken place in the evolution of industries as well as production and operational frameworks. Nonetheless, e-commerce could also exacerbate the income disparity between urban and rural areas. On one side, it has the capacity to reduce

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information asymmetry, granting rural inhabitants access to the national marketplace for selling their products. Conversely, urban dwellers, who tend to have higher education levels and better economic circumstances, possess superior digital literacy and skills, allowing them to reap more advantages from e-commerce.

Given the accelerating pace of wealth accumulation, reducing the wealth gap is crucial for promoting social harmony and balanced development. Achieving this goal hinges on establishing a standardized wealth growth system, optimizing the income distribution structure, and ensuring the fairness of the distribution process to effectively narrow the income gap.

The positive impact of digital inclusive finance on rural areas depends on the specific application scenarios provided by e-commerce, further supporting agriculture and enriching farmers. This paper examines how digital inclusive finance can help reduce the urban-rural income gap through rural e-commerce. Using panel data on China's county-level digital inclusive finance index from 2014 to 2022, the study applies a fixed-effects model to evaluate the impact of digital inclusive finance in narrowing income disparities, particularly in the context of rural e-commerce demonstration policies, with the goal of further reducing the income gap between urban and rural populations.

2. Literature Review

2.1. Digital Inclusive Finance

Digital inclusive finance has the potential to increase non-farm income for farmers, with positive effects extending beyond provincial borders, thus enhancing non-farm income levels in adjacent provinces [1]. This contributes to the rural labor force's transition to non-farm employment [2]. Moreover, digital inclusive finance plays a role in narrowing the consumption disparity between urban and rural areas [3]. However, it is worth noting that the development of digital finance tends to exhibit a Matthew effect, which benefits wealthier households more than those in economically disadvantaged situations [4].

2.2. Rural E-Commerce

The growth of e-commerce in rural areas helps expand the exchange of agricultural products and boosts sales revenue [5]. In the context of agricultural production, rural e-commerce utilizes advanced digital technologies to support the development of family-owned farms [6], enabling them to scale up and contributing to the modernization of the agricultural sector [7].

3. Theoretical Mechanism Analysis and Research Hypothesis

3.1. Digital Inclusive Finance and Urban-Rural Income Gap

Digital inclusive financing leverages online assistance along with the application of big data and digital technologies, provides financial services to consumers without restrictions on location or time. This expands the scope of financial services, eases consumers' liquidity constraints, and promotes consumption while increasing the income level of producers. Traditional financial credit services have high thresholds, excluding many consumers who lack collateral. Digital inclusive finance guides funds to rural areas, mitigating the unbalanced phenomenon of urban-rural financial services and thus narrowing the income gap between urban and rural residents.

From this, the hypothesis put forward is:

H1: Digital inclusive finance can narrow the urban-rural income gap.

3.2. Rural E-Commerce and Urban-Rural Income Gap

The development of e-commerce in rural areas, by reducing the digital divide between urban and rural areas, promoting industrial development and factor inflow, driv-

ing farmers' employment, entrepreneurship, and income growth, helps farmers gain digital empowerment and thereby reduces the urban-rural income gap. Digital inclusive finance, characterized by its low cost, convenience, and focus on vulnerable groups, can reduce the financing constraints of small-scale farmers, improve the rural entrepreneurial environment, and promote the development of rural e-commerce. It also slows down the outflow of rural capital and guides capital and other factors to flow to rural areas, while promoting the transformation, innovation, and efficiency improvement of the traditional rural financial system, providing sufficient factor guarantees for the development of rural e-commerce.

From this, the hypothesis put forward is:

H2: E-commerce in rural areas has the potential to reduce the income disparity between urban and rural regions.

4. Research Design

4.1. Variable Selection and Descriptive Statistical Analysis

4.1.1. Dependent Variable: Urban-Rural Income Gap (inc)

To quantify the urban-rural income gap, the study compares the disposable income per capita of urban residents to that of rural residents within each county. This ratio provides a clear measure of the economic divide between urban and rural areas, emphasizing the inequality in income levels and access to economic opportunities. This analysis is crucial for understanding the implications of income disparities and their influence on policies designed to address them.

4.1.2. Explanatory Variables: Digital Inclusive Finance (index_ag), Rural E-Commerce (time)

The digital inclusive finance variable is represented by the Digital Inclusive Finance Index, which is compiled by the Digital Finance Research Center at Peking University. A value of 1 is assigned to counties recognized as rural e-commerce demonstration zones in the year of their designation and for the subsequent years. Counties that do not meet this designation are given a value of 0.

4.1.3. Control Variables

- 1) Economic Development Level (eco): Per capita GDP is used as the standard measure of economic strength, presented in logarithmic form.
- 2) Industrial Structure (indus): The proportion of the secondary industry's output value relative to GDP is used to assess industrial structure. It is thought that a higher share in this sector could help reduce the income gap between urban and rural areas.
- 3) Urbanization Level (urb): This is the percentage of the urban population within the total county population. The migration of people from rural areas to cities increases non-agricultural job opportunities, which can boost rural income levels and reduce the urban-rural income disparity.
- 4) Traditional Financial Development Level (fin): This is measured by comparing the total loan balances of financial institutions to the GDP. Increased access to loans can alleviate financial constraints for individuals and businesses, benefiting lower-income groups and potentially narrowing the income gap.
- 5) Regional Internet Penetration Rate (brban): This variable measures the proportion of households in the county that have internet access at the end of the year.
- 6) Mobile Phone Usage Rate (phn): This refers to the ratio of mobile phone users to the total number of households in the county at year-end.

- 7) Government Expenditure (gov): Government spending can vary in its distribution, potentially leading to unequal benefits. Excessive deviations in government expenditure might widen the income gap between urban and rural populations.

Table 1 provides a descriptive statistical analysis of the variables.

Table 1. Model variables and descriptive statistics.

Variable name	Variable symbol	Mean	Standard deviation	Min	Max
Urban-rural income gap	inc	2.257	0.676	-2.455	25.146
Digital inclusive finance	index_ag	0.943	0.243	0	1.366
Rural e-commerce	time	0.408	0.491	0	1
Economic development level	eco	10.546	0.619	6.057	13.189
Industrial structure	indus	0.384	0.149	0.011	0.887
Urbanization level	urb	0.35	5.412	-12.535	654.946
Traditional financial development level	fin	0.785	0.434	0.01	10.306
Regional internet penetration rate	brban	1.14	37.585	-31.848	2778.919
Mobile phone usage rate	phn	3.796	104.336	-191.042	8815.919
Government expenditur	gov	0.286	0.217	0.005	3.168

Urban-rural income gap: The average income gap is 2.257, meaning urban residents earn, on average, 2.257 times more than rural residents. The standard deviation of 0.676 shows a considerable spread in income disparities across counties, with the gap ranging from -2.455 to 25.146.

Digital inclusive finance: The mean value of 0.943 indicates a moderate level of digital inclusive finance development across the counties. The standard deviation of 0.243 suggests a relatively narrow distribution, with values ranging from 0 to 1.366.

Rural e-commerce: With a mean value of 0.408, around 40.8% of counties have implemented rural e-commerce demonstration policies. The standard deviation of 0.491 reflects considerable variation in policy adoption, with some counties fully participating while others do not.

Economic development level: The average per capita GDP of 10.546 indicates relatively high economic development in the counties. The standard deviation of 0.619 shows a moderate variation in values, with the range spanning from 6.057 to 13.189.

Industrial structure: The mean proportion of secondary industry output value in GDP is 38.4%, indicating a significant presence of secondary industries in the counties. The standard deviation of 0.149 suggests a relatively concentrated distribution of industrial structures, ranging from 1.1% to 88.7%.

Urbanization level: The mean urbanization rate of 0.35 suggests a relatively low level of urbanization across the counties. However, the standard deviation of 5.412 indicates a highly dispersed distribution, ranging from -12.535 to 654.946, which might be influenced by outliers.

Traditional financial development level: The mean financial development level, measured by the ratio of financial institution loan balances to GDP, is 0.785. The standard deviation of 0.434 suggests a moderate spread of values, ranging from 0.01 to 10.306.

Regional internet penetration rate: The mean internet penetration rate is 1.14, suggesting a relatively low level of internet access across the counties. However, the standard deviation of 37.585 indicates a highly dispersed distribution, ranging from -31.848 to 2778.919, which might be influenced by outliers.

Mobile phone usage rate: The mean mobile phone usage rate is 3.796, suggesting a relatively low level of mobile phone adoption across the counties. However, the standard

deviation of 104.336 indicates a highly dispersed distribution, ranging from -191.042 to 8815.919, which might be influenced by outliers.

Government expenditure: The mean government expenditure is 0.286, suggesting a relatively low level of government spending across the counties. The standard deviation of 0.217 indicates a relatively concentrated distribution of values, ranging from 0.005 to 3.168.

4.2. Model Setting

This research employs a nationwide county-level panel dataset covering the period from 2014 to 2022. Using a two-way fixed effects model, the study examines the relationship between digital inclusive finance and rural e-commerce, with particular emphasis on how they influence the income disparity between urban and rural regions.

To test Hypothesis 1 and analyze the effect of digital inclusive finance on the income gap between urban and rural populations, the following function is developed:

$$inc_{i,t} = \beta_0 + \beta_1 index_ag_{i,t} + \beta_2 contrals_{i,t} + \gamma_i + \mu_{i,t} \tag{1}$$

In equation (1), *inc* represents the income ratio between urban and rural residents, a key variable for analyzing economic inequalities. The variable *index_ag* corresponds to the digital inclusive finance index, which is essential for examining the influence of digital financial services on economic activities and consumption patterns. *contrals* includes various other factors that may affect rural consumption expenditure, offering a broader understanding of their economic behavior. The constant term is denoted as β_0 , and β_i represents the regression coefficients derived from the analysis. γ_i accounts for individual effects on the urban-rural income gap that remain constant over time, indicating these factors do not change with evolving conditions. Lastly, $\mu_{i,t}$ is the random disturbance term, capturing unobserved variations that may influence the model's results. This framework is vital for analyzing income distribution and consumption trends between urban and rural populations.

To examine Hypothesis 2 and investigate the influence of rural e-commerce on the income disparity between urban and rural areas, the model presented below has been developed:

$$inc_{i,t} = \beta_0 + \beta_1 time_{i,t} + \beta_3 contrals_{i,t} + \gamma_i + \mu_{i,t} \tag{2}$$

In equation (2), *time* represents the dummy variable for rural e-commerce demonstration villages, and the rest are the same as in equation (1).

4.3. Data Source

The dataset used in this study includes panel data from 27 provinces covering the period from 2014 to 2022, totaling 14,769 observations. E-commerce demonstration villages are identified based on information from the Ministry of Commerce's official website, while data on digital inclusive finance are derived from the "Peking University Digital Inclusive Finance Index" report [8]. Following the method outlined by Tang Long et al. [9], the digital inclusive finance index is normalized by dividing it by 100. Additional indicators, such as regional GDP, per capita GDP, secondary industry output, fiscal expenditure, urban population, total population, per capita disposable income of urban and rural residents, financial institution loan balances, internet and mobile phone usage, and the number of households, are sourced from the "China County-level Statistical Yearbook" (2015-2023).

5. Empirical Analysis

5.1. Baseline Results Analysis

The impact of digital inclusive finance on reducing the income gap between urban and rural areas was analyzed using a two-way fixed effects model, based on panel data from 1640 counties covering the period from 2014 to 2022. The results are shown in Table 2.

Table 2. Initial Regression Analysis of the Influence of Digital Inclusive Finance on the Income Disparity between Urban and Rural Areas.

	(1)	(2)	(3)	(4)	(5)
index_ag	-0.47356*** (0.00000)	-0.49134*** (0.00000)			-0.43222*** (0.00000)
time			-0.24993*** (0.00000)	-0.16484*** (0.00003)	-0.10500*** (0.00779)
eco		0.04893 (0.52928)		-0.08510 (0.21825)	0.06722 (0.36850)
indus		0.95519*** (0.00001)		1.25678*** (0.00000)	0.89098*** (0.00001)
urb		-0.08815** (0.01779)		-0.10683*** (0.00728)	-0.08285** (0.02542)
fin		-0.06415** (0.04044)		-0.08726** (0.01934)	-0.05463* (0.05104)
brban		-0.02789* (0.05679)		-0.03458** (0.03036)	-0.02522* (0.07143)
phn		-0.01327** (0.03556)		-0.01596** (0.01958)	-0.01252** (0.04712)
gov		1.73777*** (0.00000)		1.50857*** (0.00000)	1.73596*** (0.00000)
_cons	2.70770*** (0.00000)	1.39932* (0.06794)	2.35762*** (0.00000)	2.39410*** (0.00113)	1.19527 (0.10470)
adj. R ²	0.1128	0.1139	0.0806	0.0999	0.1181

p-values in parentheses: * *p* < 0.1, ** *p* < 0.05, *** *p* < 0.01.

Column (1) shows the impact of digital inclusive finance on the urban-rural income gap. It can be seen that at the 1% significance level, digital inclusive finance significantly narrows the urban-rural income gap. This result remains valid after further controlling variables are added, as shown in column (2), thus verifying Hypothesis 1. Columns (3) and (4) examine the rural e-commerce dummy variable, and at the 1% significance level, the development of rural e-commerce significantly narrows the urban-rural income gap, verifying Hypothesis 2. Column (5) fully considers the effects of both digital inclusive finance and rural e-commerce on the urban-rural income gap.

5.2. Robustness Tests

To ensure the credibility and stability of the research conclusions, this paper conducts regression tests by replacing the explanatory variables, shortening the research period, and eliminating extreme values. The estimation results are shown in Table 3.

Table 3. Robustness Test Results.

	(1)	(2)	(3)	(4)
index_ag	-1.09891*** (0.00000)	-0.50388*** (0.00004)	-0.21757*** (0.00000)	-0.43222*** (0.00000)
time	-0.17485 (0.18287)	-0.08232* (0.07855)	-0.08256*** (0.00001)	-0.10500*** (0.00779)
eco	0.20902 (0.34176)	0.06133 (0.41901)	-0.07445* (0.05445)	0.06722 (0.36850)
indus	2.09587*** (0.00084)	1.06938*** (0.00000)	0.23775** (0.01397)	0.89098*** (0.00001)
urb	-8.48504***	-0.10052**	-0.02875	-0.08285**

	(0.00000)	(0.02483)	(0.10486)	(0.02542)
fin	-0.26939**	-0.08134**	0.02745**	-0.05463*
	(0.01847)	(0.03881)	(0.02000)	(0.05104)
brban	-0.06454	-0.02641*	-0.01456	-0.02522*
	(0.16827)	(0.07473)	(0.21956)	(0.07143)
phn	-0.06173**	-0.01571**	-0.00321	-0.01252**
	(0.04881)	(0.04252)	(0.30085)	(0.04712)
gov	5.57977***	2.01045***	-0.17763	1.73596***
	(0.00000)	(0.00000)	(0.11339)	(0.00000)
_cons	2.69362	1.23738*	3.12459***	1.19527
	(0.22895)	(0.09733)	(0.00000)	(0.10470)
adj. R ²	0.1235	0.0875	0.2466	0.1181

p-values in parentheses: * *p* < 0.1, ** *p* < 0.05, *** *p* < 0.01.

5.2.1. Replacing Explanatory Variables

The Theil Index serves as a tool to assess the income disparity between residents of urban and rural areas. Unlike the straightforward disposable income ratio, the Theil Index incorporates considerations like shifts in population. An elevated value on this index signifies a greater income disparity between urban and rural populations. The formula for its calculation is presented below:

$$\text{index}_{i,t} = \sum_{i=1}^2 \left(\frac{y_{i,t}}{y_t} \right) \times \ln \left(\frac{y_{i,t}}{y_t} / \frac{x_{i,t}}{x_t} \right) \tag{3}$$

Where *i* = 1 denotes urban regions, *i* = 2 denotes rural regions; *t* indicates the year; *y* signifies disposable income; and *x* denotes the population. After modifying the explanatory variable, the findings in column (1) reveal that digital inclusive finance is significant at the 1% level, and the coefficient's sign aligns with the initial regression, suggesting that the outcomes of the initial regression analysis are trustworthy.

5.2.2. Shortening the Research Period

By reducing the research period to 2016-2022 and 2014-2020, the findings presented in columns (2) and (3) indicate that digital inclusive finance effectively diminishes the income disparity between urban and rural areas at a significance level of 1%.

5.2.3. Eliminating Extreme Values

This study utilizes a method that omits extreme values and applies a 1% trimming procedure at both the upper and lower ends for all variables. The findings presented in column (4) demonstrate that the direction and significance of digital inclusive finance largely align with earlier results, suggesting that the conclusion is reliable.

5.3. Heterogeneity and Mechanism Analysis

After decomposing the digital inclusive finance index into its three components — coverage breadth, usage depth, and digitalization degree — separate regression analyses were performed, as presented in Table 4. The results indicate that all three components are statistically significant at the 1% level. Furthermore, the signs of the coefficients align with those observed in the baseline regression, confirming the robustness of the original findings. In addition, the inclusion of an interaction term between digital inclusive finance and rural e-commerce as a mechanism variable shows, in column (4), a significantly negative coefficient. This suggests that rural e-commerce enhances the effects of digital inclusive finance, contributing to a significant reduction in the urban-rural income gap.

Table 4. Results of Heterogeneity and Mechanism Analysis.

	(1)	(2)	(3)	(4)
cb	-0.48686*** (0.00000)			
ud		-0.26655*** (0.00000)		
ia			-0.14807*** (0.00078)	
index_ag				-0.42906*** (0.00000)
i_t				-0.09222*** (0.00966)
time	-0.11821*** (0.00210)	-0.10979*** (0.00604)	-0.14180*** (0.00029)	
eco	0.01571 (0.81832)	0.05731 (0.45481)	-0.01078 (0.89115)	0.06752 (0.36720)
indus	1.02634*** (0.00000)	0.89325*** (0.00002)	1.08831*** (0.00000)	0.88993*** (0.00001)
urb	-0.09215** (0.01438)	-0.08403** (0.02520)	-0.09433** (0.01477)	-0.08262** (0.02606)
fin	-0.07507** (0.02012)	-0.04990* (0.07337)	-0.06882** (0.03192)	-0.05335* (0.05440)
brban	-0.03311** (0.02268)	-0.02261 (0.11137)	-0.02853* (0.05955)	-0.02524* (0.07262)
phn	-0.01309** (0.04359)	-0.01327** (0.03681)	-0.01435** (0.02932)	-0.01248** (0.04816)
gov	1.75878*** (0.00000)	1.64070*** (0.00000)	1.60061*** (0.00000)	1.71944*** (0.00000)
_cons	1.72909** (0.01256)	1.21247 (0.11054)	1.74154** (0.03005)	1.18930 (0.10690)
adj. R ²	0.1185	0.1144	0.1045	0.1177

p-values in parentheses: * *p* < 0.1, ** *p* < 0.05, *** *p* < 0.01.

6. Research Conclusions and Policy Recommendations

This study, utilizing national county-level panel data from 2014 to 2022, investigates the influence of digital inclusive finance and rural e-commerce on the income gap between urban and rural areas. The results demonstrate that digital inclusive finance significantly contributes to narrowing the urban-rural income disparity, with rural e-commerce acting as a key intermediary. Based on these findings, the study proposes several policy recommendations. Firstly, promoting the development of digital inclusive finance is crucial for bridging the income gap between urban and rural populations. Efforts should focus on expanding access to financial services and improving the inclusivity of digital finance, with particular attention to payment systems, credit access, and insurance products. Secondly, leveraging the synergy between digital inclusive finance and rural e-commerce can accelerate urbanization, enhance the quality of financial services in rural areas, and significantly raise the income levels of rural residents, contributing to rural revitalization.

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