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Digital Finance, E-Commerce Development and Income Gap between Urban and Rural Areas in China

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Abstract: Narrowing the income gap between urban and rural areas is an inevitable requirement for the stable and sustainable development of the national economy. Based on the panel data of 31 provinces in China from 2011 to 2019, this paper empirically tests the effect of digital finance and e-commerce development on the urban-rural income gap by using the adjustment model and the threshold regression model. The research found that: First, digital finance can significantly reduce the income gap between urban and rural areas, and the development of e-commerce plays a positive regulating role; Second, the marginal convergence effect of digital finance on the income gap between urban and rural residents will increase with the development level of e-commerce; Third, the depth of digital finance use and the degree of digitization are conducive to reducing the urban-rural income gap, but the breadth of digital finance coverage will widen the urban-rural income gap. The research results provide policy implications for China to use the synergistic relationship between digital finance and e-commerce to achieve a balance of income for urban and rural residents.

Keywords: digital finance; e-commerce; urban-rural income gap; threshold effect model

JEL Classification: R51; M21; D31

1. Introduction

The balanced income distribution of urban and rural residents is of great value to achieve the goal of high-quality economic development and common prosperity in China. However, China's current urban-rural development is still characterized by a "dual structure", and the problem of unbalanced income gap between urban and rural residents still exists. With the advancement of Internet technology, the rise of digital finance has provided rural residents with payment convenience and financing services, providing them with opportunities to generate income and increase efficiency. In recent years, the close integration of digital finance and e-commerce has promoted the interaction of urban and rural residents, increased the employment of rural population, and changed the industrial structure of rural areas, so that digital finance can directly affect the income of urban and rural residents, thereby affecting the income gap between the two groups. Therefore, this paper will focus on the impact of digital finance and e-commerce development on the income gap between urban and rural residents.

2. Literature Overview

With the continuous penetration of digital finance in various fields of society, scholars have conducted extensive research on the effect and mechanism of digital finance on the urban-rural income gap. Ozili and Peterson (2017) pointed out that digital finance itself has stronger inclusive features and can effectively reduce the income gap between urban and rural residents. Allen et al. (2016) argue that poor, low-income and illiterate individuals cannot fully benefit from the coverage of digital finance. Huang and Zhang (2020) found that the impact of the breadth of digital finance on the income gap between urban and rural residents is heterogeneous in different periods. In the short term, it will widen the urban and rural income gap, but only in the long run can it have a convergence effect on the urban and rural income gap. Agnello et al. (2012) pointed out that digital finance can effectively reduce financial exclusion and improve the uneven distribution of income between urban and rural areas. Dupas and Robinson (2013) found that when digital finance deepens to low-income groups, the income gap can be narrowed as the frequency of use of digital financial accounts continues to increase. In addition, some Chinese scholars have explored the mechanism by which digital finance affects the urban-rural income gap. Wang and Li (2021) explored the convergence effect of digital finance and new urbanization on the urban-rural income gap by constructing a spatial Durbin model. Zhang et al. (2021) analyzed the nonlinear characteristics of digital finance affecting the urban-rural income gap when the digital divide is used as a threshold variable. Ma and Zhang (2022) studied the impact of the breadth and depth of digital finance on the urban-rural development gap from the perspective of the synergistic effect of residents' education.

Both products of the Internet era, e-commerce and digital development have achieved deep integration. Yao (2017) proposed that in the process of e-commerce development, there will be a large number of payment transactions and financing needs, and digital finance can just provide mobile payment and lending convenience for the operation and popularization of e-commerce. Boateng et al. (2008) pointed out that the rise of e-commerce in developing countries has brought economic growth momentum to these countries and contributed to social development. Yang (2019) discussed the poverty alleviation mechanism and effect of e-commerce in rural China, and believed that e-commerce poverty alleviation can provide a historic opportunity for "overtaking on a curve" for traditionally poor areas. Kong and Wang (2022) pointed out that in the early stage of e-commerce development, e-commerce cannot reduce the urban-rural income gap, and only when e-commerce develops maturely can the convergence effect on the urban-rural income gap be manifested.

Existing literature explores the impact of digital finance on the urban-rural income gap from various dimensions, and also confirms that the development of e-commerce is conducive to improving the income of rural residents, but few articles discuss the synergistic effect of digital finance and e-commerce development on narrowing the urban-rural gap. Moreover, as the integration characteristics of digital finance and e-commerce have become more prominent in recent years, it is worth further exploring whether different stages of e-commerce development will affect the convergence effect of digital finance on the urban-

rural income gap. This paper attempts to expand in this area, and the main marginal contributions are as follows: First, it studies the impact of the interaction terms of digital finance, digital finance and e-commerce development on the urban-rural income gap, and analyzes the moderating role of e-commerce development in it. Second, it tests the threshold effect of e-commerce development, and examine the threshold characteristics of digital finance affecting the urban-rural income gap under different e-commerce development levels; Third, explore the heterogeneous impact of digital financial indicators of different sub-dimensions on the urban-rural income gap, in order to enrich existing research results and provide theoretical reference for achieving urban-rural income balance.

3. Methodology

3.1. Model Building

1. Benchmark regression model

In order to verify the impact of digital finance and e-commerce development on the urban-rural income gap, we first analyze the direct impact of digital finance on the urban-rural income gap by constructing model (1). Secondly, on the basis of model (1), the interaction term between digital finance and e-commerce development is introduced into the equation, and model (2) is constructed to further test the moderating effect of e-commerce development on the impact of digital finance on the urban-rural income gap.

$$Gap_{it} = \beta_0 + \beta_1 Index_{it} + \lambda_i Controls_{it} + u_i + v_t + \varepsilon_{it} \quad (1)$$

$$Gap_{it} = \beta_0 + \beta_1 Index_{it} + \beta_2 Index_{it} \times EC_{it} + \lambda_i Controls_{it} + u_i + v_t + \varepsilon_{it} \quad (2)$$

In formula (1) and (2), Gap_{it} is the urban-rural income gap of province i in year t, which is the explained variable of this paper; $Index_{it}$ is the digital financial development index of province i in year t, which is the core interpretation variable of this paper; EC is the e-commerce development index; $Controls$ are other control variables that may affect the urban-rural income gap, ui is the individual fixed effect, v_t is the time fixed effect, and ε_{it} is the random disturbance term. The coefficient β_1 and the coefficient β_2 are the focus of the model. If the coefficient β_1 is significantly less than 0, it means that digital finance can effectively reduce the urban-rural income gap. Similarly, if the coefficient β_2 is also significantly less than 0, it means that the development of e-commerce has played a positive role in regulating the impact of digital finance on the urban-rural income gap, that is to say, the synergistic effect between the two has a convergence effect on the urban-rural income gap.

2. Panel threshold model

When the development of e-commerce is in different stages, the impact of digital finance on the income of urban and rural residents may show a nonlinear relationship. Therefore, a panel threshold model (3) is constructed to explore the threshold characteristics of the impact of digital finance on the urban-rural income gap when e-commerce development is used as a threshold variable.

$$Gap_{it} = \alpha_0 + \alpha_1 Index_{it} \cdot I(EC_{it} \leq \gamma_1) + \alpha_2 Index_{it} \cdot I(EC_{it} > \gamma_1) + \cdots + \alpha_n Index_{it} \cdot I(EC_{it} \leq \gamma_n) + \alpha_{n+1} Index_{it} \cdot I(EC_{it} > \gamma_n) + \lambda_i Controls_{it} + \varepsilon_{it} \quad (3)$$

In formula (3), $I(\cdot)$ is an indicative function, which takes a value of 1 when the conditions in the parentheses are satisfied, and 0 otherwise; γ_n is the nth threshold value of e-commerce development, α_i is a parameter to be estimated, the interpretation of the remaining variables is the same as the previous one.

3.2. Indicator Selection

According to the research needs and the principle of data availability, this paper selects the following indicators:

- Explained variables. The urban-rural income gap (Gap) is measured by the Theil Index, which takes into account both the income of urban and rural residents and changes in population, and can better reflect the income gap of different groups. Its calculation formula is:

$$Gap_{it} = \sum_{j=1}^{2} \left(\frac{Y_{ij,t}}{Y_{i,t}}\right) ln\left(\frac{Y_{ij,t}}{Y_{i,t}} / \frac{P_{ij,t}}{P_{i,t}}\right) \quad (4)$$

  In formula (4), Gap_{it} is the Theil Index of province *i* in year *t*, that is the urban-rural income gap; $Y_{ij,t}$ is the total income of residents in urban areas (*j*=1) or the total income of residents in rural areas (*j*=2), $Y_{i,t}$ is the total resident income of province i in year t; $P_{ij,t}$ is the total population in urban areas (*j*=1) or the total population in rural areas (*j*=2), $P_{i,t}$ is province *i* in *t* the total population of the year.
- Core explanatory variables. The development level of digital finance (*Index*) is measured by the Digital Inclusive Finance Development Index, which is compiled by the Digital Finance Research Center of Peking University and covers mobile payment, online lending and internet finance in various regions. In addition, in this paper, the raw data of the digital financial index and its sub-dimension indicators are divided by 100, so as to make the model regression coefficient results more readable.
- Adjustment variables. E-commerce development (*EC*) is measured by the regional e-commerce development index, which mainly covers the breadth and depth of residents' use of e-commerce, and can effectively reflect the development trend of e-commerce in China.
- Control variables. In order to ensure the robustness of the estimation results, this paper selects the following control variables: first, the level of economic development (*Rgdp*), which is measured by the logarithm of the per capita GDP of each region; second, the industrial structure (*Str*), which is measured by the increase in the tertiary industry The third is the urbanization level (*Urban*), which is measured by the ratio of the urban population to the total population; the fourth is the education level (*Edu*), which is measured by the number of years of education per capita; the fifth is level of opening (*Open*), which is measured by the proportion of the total import and export trade of each

province in GDP; the sixth is the financial technology support (*Tech*), which is measured by the ratio of government financial science and technology expenditure to the general government budget expenditure.

3.3. Data Sources

The data used in the empirical research in this paper are mainly from the "China Statistical Yearbook" and the websites of local statistical bureaus over the years; the digital financial inclusion index is from the "Peking University Digital Financial Inclusion Index"; the e-commerce development index is from Ali Research Institute "China E-commerce Development Index Report" compiled. In addition, considering the difficulty of obtaining relevant data in Hong Kong, Macao and Taiwan, the data from 2011 to 2019 of 31 provinces (cities and regions) in mainland China was finally selected as the research sample.

4. Empirical Results

4.1. Benchmark Regression Results

By performing Hausman test on the previous benchmark regression model, the statistic result of the test shows that it is significant at the 1% level. Therefore, a fixed effect model is selected to estimate the regression coefficient. Table 1 shows the regression estimation results under the double fixed effects of individual and time.

Table 1. Benchmark regression results

	(1)	**(2)**	**(3)**	**(4)**
Index	-0.2477*** (-4.06)	-0.1067* (-1.72)	-0.2308*** (-3.75)	-0.1587** (-2.59)
Index×EC		-0.0017*** (-5.79)		-0.0013*** (-4.53)
Lnrgdp			0.1891*** (5.23)	0.1817*** (5.22)
Str			-0.0646 (-0.45)	-0.0264 (-0.19)
Urban			1.7911*** (8.25)	1.4947*** (6.84)
Edu			-0.0323* (-1.78)	-0.0324* (-1.86)
Open			-0.0084 (-0.28)	-0.0303 (-1.04)
Tech			-0.6000 (-0.68)	-0.4314 (-0.49)
_Cons	0.2382*** (8.96)	0.2078*** (8.16)	-0.6144*** (-2.96)	-0.4796** (-2.38)
Prov_fixed	YES	YES	YES	YES
Year_fixed	YES	YES	YES	YES
N	279	279	279	279
R2	0.0856	0.1985	0.4106	0.4585

Note: *, **, *** are significant at the level of 10%, 5% and 1% respectively, and the t statistic is in parentheses.

Columns (1) and (2) of Table 1 respectively show the impact of the intersection of digital finance (*Index*), digital finance and e-commerce development (*Index×EC*) on the urban-rural income gap without control variables. It can be seen that when no cross term is introduced,

the regression coefficient of digital finance is significantly negative at the 1% significant level, indicating that digital finance has a significant negative convergence effect on the urban-rural income gap. After adding the cross term, the regression coefficient of digital finance is still significantly negative, and the cross term of digital finance and e-commerce development is also negative, and it has passed the 1% significant level test. It shows that the development of digital finance and e-commerce has a positive synergistic effect on reducing the urban-rural income gap. Digital finance provides financing paths and payment convenience for the development of e-commerce, and the development of e-commerce provides more employment opportunities for residents, especially provides a sales platform for agricultural products in remote areas, and promotes the increase of farmers' income. Therefore, with the support of e-commerce, digital finance can better narrow the income gap between urban and rural residents.

Columns (3) and (4) of Table 1 are the regression results after adding a series of control variables. It can be seen that the coefficient of digital finance is still significantly negative, and the coefficient value does not change much. Similarly, the regression coefficient of the intersection of digital finance and e-commerce development is still negative at the significant level of 1%, indicating that the regression results of the benchmark model are relatively stable, and digital finance can effectively reduce the urban-rural income gap. And the development of e-commerce has a significant positive adjustment effect on digital finance to narrow the urban-rural income gap.

As far as the regression results of the control variables are concerned, the regression coefficients of industrial structure, education level, level of opening to the outside world, and financial and technological support are all negative, and the education level has passed the 10% significant level test. It shows that increasing the proportion of the tertiary industry in the industrial structure, strengthening the quality education of the population in various regions, encouraging international trade in various regions, and increasing the government's investment in scientific and technological innovation may narrow the urban-rural income gap to a certain extent. However, the level of economic development and urbanization has a significant positive impact on the urban-rural income gap, which shows that in the process of economic development and urbanization, it is necessary to take into account the income levels of different groups in urban and rural areas.

4.2. Analysis of Threshold Effect

Before analyzing the threshold effect, it is necessary to verify whether the threshold effect exists. This paper uses Stata15.0 to estimate and test the results of the threshold regression model.

Threshold effect test

Through the self-sampling test of the sample, it can be known whether the threshold effect exists, and the number of thresholds and the corresponding threshold value can be determined. When the development of e-commerce is in different stages, the impact of digital finance on the urban-rural income gap may be heterogeneous. Therefore, the development of e-commerce is used as a threshold variable to test the threshold effect. The test results are

shown in Table 2. It can be seen that under the condition that there is no threshold in the null hypothesis, the F statistic is 12.98, and the P value calculated by Bootstrap is 0.048 < 0.05, indicating that the null hypothesis can be rejected at the 5% significant level. In other words, there is a single threshold for the development of e-commerce However, in the double-threshold effect test, the P value is 0.16 2> 0.10, and the F statistic is not significant. Therefore, it is considered that when e-commerce development is used as a threshold variable, there is only a single threshold, and the threshold value is 30.71.

Table 2. The test results of the threshold effect of e-commerce development

Threshold variable	Threshold type	Threshold value	F statistic	P value	10% threshold	5% threshold	1% threshold
EC	Single	30.71	12.98**	0.048	9.6089	12.3157	19.0763
	Double	13.05；30.71	7.87	0.162	9.1648	13.501	18.9392

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, and the P value and critical value were obtained by repeatedly sampling 500 times using the threshold regression bootstrap sampling method.

Analysis of parameter results

Table 3 shows the difference in the impact of digital finance on the urban-rural income gap when e-commerce development is the threshold variable. When the development level of e-commerce is lower than the threshold value of 30.71, although the impact of digital finance on the urban-rural income gap is significantly negative, the estimated coefficient is small, only -0.0544. The main reason is that when the development level of e-commerce was low, e-commerce had not penetrated into the vast rural areas, and rural residents had limited understanding of e-commerce. It is difficult for digital finance to drive the development of rural industries and generate income for rural residents through e-commerce. In addition, in the early stage of e-commerce development, the network facilities, transportation facilities and residents' educational quality in many rural areas were relatively backward, and there were few e-commerce talents in rural areas, and the acceptance of digital finance was also lower than that of urban residents. Therefore, when the development level of e-commerce is low, the effect of digital finance in reducing the income gap between urban and rural areas is limited. When the development level of e-commerce crosses the threshold value of 30.71, the regression coefficient of digital finance on the urban-rural income gap is -0.0791, and it is significant at the 1% significant level. It shows that the better the development of e-commerce, the stronger the convergence effect of digital finance on the urban-rural income gap. It is not difficult to understand that with the continuous increase of e-commerce platforms, policies such as "e-commerce to the countryside" and "e-commerce poverty alleviation" have made rural areas begin to rapidly develop e-commerce business. Digital finance uses its convenient financing function to ease the capital needs of rural residents to operate e-commerce business. At the same time, the fast online payment function of digital finance also allows rural residents to sell goods and obtain income without leaving home. Therefore, the rapid development of e-commerce can promote digital finance to reduce the urban-rural income gap more effectively.

Table 3. The test results of the threshold effect of e-commerce development

Variable name	Coef.	Std.	t value	P value
Index(EC≤30.71）	-0.0544	0.0105	-5.16	0.0000
Index(EC>30.71）	-0.0791	0.0101	-7.80	0.0000
Lnrgdp	0.1266	0.0300	4.22	0.0000
Str	-0.2537	0.0975	-2.60	0.0100
Urban	1.5664	0.2150	7.28	0.0000
Edu	-0.0338	0.0171	-1.98	0.0490
Open	-0.0182	0.0273	-0.67	0.5050
Tech	-0.4466	0.8239	-0.54	0.5880
_Cons	-0.3838	0.1778	-2.16	0.0320

Heterogeneity analysis of digital finance sub-dimension

In order to further explore the structural characteristics of the impact of digital finance on the urban-rural income gap, the secondary indicators of the digital finance index were selected to estimate the benchmark regression model. The secondary indicators include: digital finance coverage breadth index (*Cover*), digital finance usage depth (*Depth*) and digitalization degree (*Digit*). Columns (1), (3) and (5) of Table 4 respectively show the estimated results of the impact of the three sub-dimension indicators of digital finance on the urban-rural income gap. The results show that the influence coefficients of digital finance coverage, depth of use and digitalization on the urban-rural income gap are all significantly negative. Among them, the regression coefficient of coverage breadth is significantly positive at the significant level of 5%, indicating that simply opening digital accounts for residents to increase the coverage breadth of digital finance not only fails to narrow the urban-rural income gap, but instead widens it to a certain extent income gap between the two groups. The possible reason is that although digital finance has effectively filled the service blind spots that traditional financial institutions cannot cover, it cannot play the true inclusive function of digital finance by only allowing residents to open digital accounts. The regression coefficients of the depth of use and the degree of digitization are significantly negative, indicating that the depth of use and digitization of digital finance can truly broaden borrowing channels for rural residents. By providing convenient services such as financing, wealth management and payment, digital finance has provided help for their employment and income growth. Column (2), column (3) and column (5) of Table 4 are the regression results after adding the interaction terms of each sub-dimension index of digital finance and e-commerce development. The results show that the estimated results of the regression coefficients of each interaction term are not significantly different from the coefficient values and significance of the previous benchmark regression model. It shows that after the dimensionality reduction and decomposition of the digital financial index, the previous research conclusions still hold, and the results of the benchmark regression model have good robustness.

Table 4. Regression results of digital finance sub-dimension

	(1)	(2)	(3)	(4)	(5)	(6)
Cover	0.1739** (2.06)	0.1757** (2.21)				
Cover×EC		-0.0015*** (-5.38)				
Depth			-0.1778*** (-5.98)	-0.1382*** (-4.45)		
Depth×EC				-0.0010*** (-3.60)		
Digit					-0.0395** (-2.14)	-0.0315* (-1.80)
Digit×EC						-0.0014*** (-5.17)
_Cons	-0.6606*** (-3.13)	-0.4799** (-2.37)	-0.6957*** (-3.51)	-0.5682*** (-2.89)	-0.5885*** (-2.73)	-0.4332** (-2.10)
Controls	YES	YES	YES	YES	YES	YES
Prov_fixed	YES	YES	YES	YES	YES	YES
Year_fixed	YES	YES	YES	YES	YES	YES
N	279	279	279	279	279	279
R^2	0.3863	0.4543	0.4581	0.4868	0.3871	0.4505

Note: *, **, *** are significant at the level of 10%, 5% and 1% respectively, and the t statistic is in parentheses.

Conclusions

This paper first empirically tests the effect of digital finance on the urban-rural income gap. Then, it analyzes the moderating effect and threshold effect of e-commerce development on the impact of digital finance on the urban-rural income gap. Finally, it explores the structural differences in the impact of digital finance on the urban-rural income gap from the three sub-dimensions of digital finance coverage, depth of use and degree of digitalization. The main research conclusions are as follows: First, digital finance can significantly reduce the urban-rural income gap, and the development of e-commerce has a significant positive moderating effect on the impact of digital finance on the urban-rural income gap; Second, the marginal convergence effect of digital finance on the urban-rural income gap will increase with the growth of e-commerce development level. In the stage of high e-commerce development level, the effect of digital finance in reducing the urban-rural income gap is stronger; Third, the heterogeneity analysis shows that the depth of the use of digital finance and the degree of digitization can significantly reduce the urban-rural income gap, but the breadth of coverage will widen the urban-rural income gap to a certain extent. The research conclusions suggest that in the promotion of digital finance, attention should be paid to the synergistic effect of e-commerce development on digital finance in reducing the income of urban and rural residents, and the use of digital financial products and services by rural residents should be strengthened to make digital accounts "live", so as to achieve the purpose of reducing the urban-rural income gap.

Conflict of interest: none

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