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The Impact of Digital Finance Development on Urban-Rural Income Gap——Mechanism Analysis Based on the Availability and Inclusiveness of Financial Services

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Abstract: *This article focuses on the impact of digital finance development on the urban-rural income gap, with a particular emphasis on analyzing the mediating mechanisms of financial service accessibility and inclusiveness. Through theoretical analysis and combined with provincial panel data from 2011 to 2022, empirical tests were conducted using panel fixed effects model and mediation effect model. Research has found that the development of digital finance significantly narrows the income gap between urban and rural areas. For every 1 unit increase in its index, the income ratio of urban and rural residents decreases by 0.0023; The accessibility of financial services (intermediary effect value -0.0016) and inclusiveness (intermediary effect value -0.0014) are key transmission pathways, with accessibility playing a slightly dominant role; This effect is more significant in the central and western regions, reflecting regional heterogeneity. The research provides theoretical basis and policy inspiration for optimizing urban-rural income distribution and promoting common prosperity through digital finance.*

Keywords: *Digital Finance; Urban-Rural Income Gap; Accessibility of Financial Services; Financial Inclusion*

1. Introduction

In recent years, digital finance has achieved leapfrog development in China through technological innovations such as mobile payments and big data risk control. By 2023, the proportion of digital economy to GDP has exceeded 40%, and its characteristics of "low cost and wide coverage" are reshaping the traditional financial landscape. However, under the dual structure of urban and rural areas, problems such as weak digital infrastructure and insufficient access to financial services in rural areas are still prominent. In 2022, the per capita disposable income ratio of urban and rural residents will still reach 3.3 times, and income distribution imbalance has become a key obstacle on the road to common prosperity.

In this context, exploring the impact of digital finance on the urban-rural income gap is of great significance. At the theoretical level, existing research mostly focuses on the economic growth effects of digital finance, and the analysis of its income distribution mechanism is not yet in-depth, especially lacking a systematic explanation of the mediating role of financial service accessibility and inclusiveness. This study can enrich the cross disciplinary research between financial development theory and income distribution theory. On a practical level, with the promotion of the rural revitalization strategy and the construction of "digital countryside", clarifying how digital finance can narrow the urban-rural gap by optimizing the allocation of financial resources can provide policy makers with a basis for precise implementation and help solve the problem of imbalanced urban-rural development.

This article takes "Development of Digital Finance - Accessibility and Inclusiveness of Financial Services - Urban Rural Income Gap" as the logical mainline. Firstly, through theoretical analysis, a mechanism framework for the impact of digital finance on urban-rural income gap is constructed, and an intermediary path for the accessibility of financial services (such as physical network substitution and service cost reduction) and inclusiveness (such as coverage of vulnerable groups and satisfaction of differentiated needs) is proposed; Secondly, we utilized provincial panel data from 2011 to 2022,

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combined with the Peking University Digital Finance Index and urban-rural income statistical indicators, the theoretical hypothesis is empirically tested through a mediation effect model; Finally, based on the research findings, targeted policy recommendations are proposed.

2. Relevant Theoretical Foundations

2.1 Core Theory of Digital Finance

Digital finance is not a simple technological overlay of traditional finance, but a financial industry innovation driven by information and communication technology (ICT). Its theoretical core can be analyzed from three dimensions. Technology empowerment theory constitutes its underlying logic. Mobile Internet, big data, artificial intelligence and other technologies have broken through the restrictions of physical space on financial services, forming a "decentralized" service network [1]. For example, M-Pesa in Kenya has achieved cross-border payments through mobile SMS, proving that digital technology can reduce financial service costs by over 60% (World Bank, 2021). The theory of inclusive finance is its functional orientation, and digital finance incorporates low-income groups excluded by the traditional financial system into its service scope by lowering service barriers (such as zero transaction fees for mobile payments and microcredit). The United Nations Development Programme (UNDP) defines it as the "democratization process of financial services". The innovative theory of risk control is the key to its sustainable development. The credit evaluation model based on user behavior data (such as Ant Group's "sesame credit") has solved the excessive dependence of traditional finance on collateral, and improved the credit availability of rural unsecured groups by more than 30% (China Internet Finance Association, 2022).

From the perspective of business characteristics, digital finance presents three major features: technology driven (algorithm replacing manual approval), scenario embedding (integration of payment, e-commerce, and social scenarios), and ecological scalability (extending from a single service to the entire chain of "finance+production+consumption"). These characteristics enable it to not only continue the resource allocation function of traditional finance, but also create new financial service paradigms through technological spillover effects, providing possibilities for balanced development of urban and rural finance.

2.2 Theoretical Explanation of Urban-rural Income Gap

The formation and evolution of the urban-rural income gap can be systematically explained through classical theoretical frameworks. The theory of dual economic structure (Lewis, 1954) points out that there is a productivity gap between agriculture and industry in developing countries: during the transfer of surplus rural labor to urban industrial sectors, wage levels are determined by marginal productivity, while low productivity in the agricultural sector leads to long-term income lag for rural residents. The registered residence system that divides urban and rural areas in China further strengthens this gap. In 2022, the average wage of urban employees will be 4.2 times the wage income of rural residents, which confirms the continuous impact of the dual structure.

The Kuznets Curve theory reveals the dynamic changes in income inequality, believing that in the early stages of economic development, income inequality will expand with the process of industrialization, and when the economy reaches a certain level, the gap will gradually narrow [2]. But our country's practice shows that this curve may undergo deformation in the digital economy era: the advantages of cities in digital infrastructure, human capital, and other aspects may lead to a "plateau period" in the urban-rural income gap, rather than natural convergence.

The theory of financial exclusion (Leyson & Thrift, 1995) focuses on the direct impact of unequal distribution of financial resources. Due to low population density, insufficient collateral, and imperfect credit system in rural areas, traditional financial institutions tend to shrink their branches, forming a "financial desert". In 2021, the number of bank branches per 10000 people in China was 2.3 times higher in urban areas than in rural areas. This financial exclusion directly limits the investment opportunities and risk resistance ability of rural residents, becoming a fixed factor in the urban-rural income gap.

2.3 Theoretical Logic of the Impact of Digital Finance on Income Distribution

The mechanism of digital finance on income distribution can be analyzed by combining financial

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deepening theory and inclusive growth theory. The Greenwood Jovanovic model points out that there is an inverted U-shaped relationship between financial development and income distribution [3]. Digital finance accelerates this process with its low-cost characteristics, lowering service barriers in advance. For example, the popularization of mobile payments makes it convenient for low-income rural groups to settle accounts and improves the efficiency of operating income turnover.

The long tail effect theory explains its inclusiveness: traditional finance focuses on high net worth customers, while digital finance covers "long tail" groups such as rural small and micro enterprises through scaled services, forming a cycle of "economies of scale cost reduction service sinking". The single cost of digital credit is only 1/5 of traditional, making small loans under 50000 yuan sustainable.

The theory of human capital reveals indirect pathways: digital finance provides services such as education credit and skills training payment, enhances the human capital of rural residents, and narrows the wage gap; Its knowledge dissemination function enhances the resource allocation ability of rural residents, promotes the growth of property income, and forms a "financial empowerment capacity enhancement income growth" chain.

In summary, digital finance directly improves the accessibility and inclusiveness of rural finance, and indirectly promotes the accumulation of human capital, forming a multidimensional income distribution impact mechanism.

3. Mechanism Analysis of the Impact of Digital Finance on Urban-rural Income Gap

3.1 Digital Finance, Accessibility of Financial Services, and Urban-rural Income Gap

Digital finance leverages technological innovation to break through the geographical and cost limitations of traditional finance, enhance the accessibility of rural financial services, and thus affect the income gap between urban and rural areas. The improvement path includes: firstly, eliminating geographical barriers, increasing the penetration rate of rural mobile payments from 31% in 2016 to 86% in 2022, breaking through physical network restrictions; The second is to lower the cost threshold. The operating cost of digital credit is 1/10 of that of traditional credit, which can meet small needs below 5000 yuan; The third is to simplify the process, reducing the loan approval time from 3-5 days to within 2 hours. Improvement in accessibility can narrow the gap through two aspects: firstly, promoting productive investment. By 2022, the balance of rural digital credit will reach 1.2 trillion yuan, driving the growth rate of farmers' operating income to exceed that of urban areas by 2.3 percentage points; The second is to optimize labor allocation, improve wage settlement efficiency through mobile payments, and assist 41% of rural labor force in cross provincial employment through digital platforms, narrowing the wage gap.

3.2 Digital Finance, Financial Service Inclusiveness, and Urban-rural Income Gap

The core of inclusivity in financial services is "equal opportunity", which means that various groups can access adapted services at a reasonable cost. Digital finance, by accurately reaching vulnerable groups and innovating service forms, promotes a shift from "formal inclusiveness" to "substantive inclusiveness" and alleviates income imbalances between urban and rural areas.

Breaking through the coverage of vulnerable groups is the key to improving the path. Traditional finance excludes low-income rural groups due to reliance on collateral and credit records, while digital finance uses "alternative data" to construct credit profiles, increasing the accessibility of credit for rural "credit white households" by more than 50%. For example, the satellite remote sensing credit technology of online commercial banks has served 2 million farmers. At the same time, differentiated service innovation (such as aging friendly interfaces, repayment products based on planting cycles, etc.) and financial literacy empowerment (improving the average score of rural residents' financial knowledge tests) have enhanced inclusiveness.

Its impact on the urban-rural income gap is reflected in three aspects: easing credit constraints has increased the growth rate of rural household income by 9.2 percentage points; Digital insurance reduces the probability of poverty caused by disasters by 40%; Digital finance has increased the proportion of property income for rural residents by 3.1 percentage points, narrowing the gap with urban areas.

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3.3 Comprehensive Mechanism Framework and Research Hypotheses

Digital finance affects the urban-rural income gap through a dual path of "increased accessibility" and "enhanced inclusiveness", forming a multidimensional system of action (see Figure 1). At the direct effect level, digital finance enhances the physical accessibility and convenience of rural financial services through technology spillover; At the indirect effect level, it reduces the financial participation threshold of vulnerable groups through credit evaluation innovation and service form adaptation. The two paths ultimately work together on the urban-rural income structure: improving the operational and wage income of rural residents, and narrowing the gap in property income through risk protection and wealth management.

Based on mechanism analysis, the following research hypotheses are proposed:

Hypothesis of Total Effect (H1): The development of digital finance significantly narrows the income gap between urban and rural areas, meaning that the higher the level of digital finance development, the lower the income ratio between urban and rural residents.

Hypothesis of Mediating Effect (H2): The availability of financial services plays a mediating role in reducing the urban-rural income gap through digital finance, that is, digital finance indirectly reduces the urban-rural income gap by improving the geographical coverage, cost accessibility, and process efficiency of financial services in rural areas.

Hypothesis of Mediating Effect (H3): Financial service inclusiveness plays a mediating role in narrowing the urban-rural income gap through digital finance, that is, digital finance indirectly reduces the urban-rural income gap by covering vulnerable groups, providing differentiated services, and improving financial literacy.

Heterogeneity hypothesis (H4): There are regional differences in the income distribution effect of digital finance, and its role in narrowing the urban-rural income gap is more significant in rural areas in the central and western regions where digital infrastructure is more complete and financial exclusion is higher.

This mechanism framework reveals the dual attributes of digital finance as a "technological tool" and "institutional innovation": it breaks through the physical limitations of traditional finance through technological means, and promotes the tilt of financial resources towards rural areas through rule reconstruction, providing a systematic perspective for understanding income distribution changes in the digital age.

4. Analysis of the Current Situation of Digital Finance and Urban Rural Income Gap in China

4.1 Current Status of Digital Finance Development

China's digital finance has formed a three-dimensional pattern of "policy+technology+market", with a scale and innovation ranking among the top in the world. In 2022, the total index of digital finance reached 371.2, an increase of 8.3 times compared to 2011. The penetration rate of mobile payments exceeded 92%, and the transaction scale accounted for over 60% of the global total. The development of urban and rural areas is characterized by "catching up in total quantity and poor quality": the number of rural mobile payment accounts has reached 1.02 billion, with a coverage rate of 91.3%, which is close to that of urban areas; But the per capita balance of digital credit in urban areas is three times that of rural areas, and the proportion of digital wealth management users is 2.4 times that of rural areas. There are significant regional differences, with the digital finance index in the east being 1.44 times that of the west, and infrastructure in first tier cities leading rural areas by 5-8 years. The innovation of business formats presents urban-rural differentiation: high-end business formats such as intelligent investment advisory are dominant in urban areas, 78.3% of digital financial transactions in rural areas are payment based, and the proportion of complex services is only 6.1%, reflecting the gap in supply-demand adaptability.

4.2 Current Situation of Urban-rural Income Gap

The income gap between urban and rural areas in China has gone through a dynamic process of "narrowing, expanding, and fluctuating narrowing", and is currently still relatively high. From the perspective of overall disparity, the per capita disposable income of urban residents in 2022 is 49283

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yuan, while that of rural residents is 20133 yuan. The urban-rural income ratio is 2.45:1, which is significantly higher than the 3.23:1 ratio in 2010, but still higher than the level of around 1.5:1 in developed countries (National Bureau of Statistics, 2023). If the implicit gap in public services such as education and healthcare is taken into account, the actual urban-rural income ratio can reach 3.5:1 or more (Report on Urban and Rural Development, Chinese Academy of Social Sciences, 2022).

From the perspective of income structure, the gap presents the characteristics of "narrowing of operating income gap and widening of property income gap". In 2022, the proportion of rural residents' operating income was 36.5%, an increase of 8.2 percentage points from 2011. The urban-rural operating income ratio decreased from 2.8:1 to 1.9:1, reflecting the driving effect of the rural revitalization strategy on agricultural production; However, the gap in property income continues to widen, with the per capita property income of urban residents reaching 4627 yuan, which is 5.15 times that of rural residents (899 yuan), further widening from the 3.9:1 ratio in 2011 (National Bureau of Statistics, 2023). This is directly related to the difference in the ability to allocate financial assets between urban and rural areas.

From a regional perspective, the gap between the central and western regions is greater than that in the eastern region. In 2022, the urban-rural income ratio in the eastern region will be 2.1:1, 2.6:1 in the central region, 2.8:1 in the western region, and even more than 3.0:1 in Gansu and other provinces (Statistical Yearbook of Provinces, 2023). This regional difference is highly consistent with the spatial distribution of the level of digital finance development, suggesting a possible correlation between the two.

4.3 Preliminary Observation on the Correlation between Digital Finance and Urban-rural Income Gap

The digital finance is negatively correlated with the urban-rural income gap, and the deeper the service penetration, the more obvious the narrowing of the gap. In terms of time dimension, the correlation coefficient between the digital finance index and the urban-rural income ratio from 2011 to 2022 is -0.73 ($P<0.01$). When the growth rate of digital finance is fast, the decrease in income ratio is more significant, and the negative correlation between mobile payment coverage and income ratio is the strongest (-0.68). In terms of spatial dimension, the gap between regions with high levels of digital finance is small: in the first 10 provinces of 2022, the average urban-rural income ratio was 1.98:1, while in the last 10 provinces it reached 2.92:1, a difference of nearly twice. Due to the integration of rural e-commerce and digital credit, Zhejiang has driven an average annual income increase of over 3000 yuan for farmers. On the group dimension, the income growth of digital finance users is faster, and the annual income growth rate of rural households using digital credit is 5.5 percentage points higher. However, the usage rate of elderly rural groups is only 23.5%, and the income gap is widening. Overall, there is a correlation between the two, and the causal relationship and mediating mechanism need to be empirically verified.

5. Empirical Analysis

5.1 Empirical Design

Based on the theoretical mechanisms and current characteristics mentioned earlier, this section constructs an econometric model to examine the impact and mediating effect of digital finance on the urban-rural income gap.

The research hypothesis is clear: the development of digital finance can narrow the urban-rural income gap by improving the accessibility and inclusiveness of financial services (i.e. verifying H1, H2, H3).

Variable selection should take into account both data availability and theoretical fit:

Dependent variable: urban-rural income gap (Gap), measured by the ratio of per capita disposable income of urban and rural residents (urban income/rural income), which intuitively reflects the level of gap and has strong data continuity (National Bureau of Statistics, 2011-2022).

Core explanatory variable: The Development Level of Digital Finance (DF) is based on the provincial-level Digital Finance Index compiled by the Digital Finance Research Center of Peking University. This index covers three dimensions: coverage breadth, usage depth, and digitalization level,

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and is widely recognized by the academic community (Guo Feng et al., 2020).

Mediating variables:

Access to financial services: the weighted average of "number of digital payment accounts per 10000 people" and "number of digital financial service stations per 10000 square kilometers" is used. The former reflects user coverage, while the latter reflects geographical accessibility (data source: PBOC payment business statistics).

Inclusion of Financial Services (Inclu): The arithmetic mean of the "proportion of rural digital credit" (rural digital credit balance/total digital credit balance) and the "utilization rate of digital finance for low-income groups" (proportion of users with annual household income below 30000 yuan) is used to measure the penetration of services into vulnerable groups (data sources: Ant Group Research Institute, annual reports of online commercial banks).

Control variables: It refer to existing research and include economic development level (logarithm of GDP per capita), urbanization rate (proportion of urban population), industrial structure (proportion of tertiary industry), education level (proportion of population above junior college), government intervention (fiscal expenditure/GDP), Internet penetration rate (proportion of Internet users), to exclude other factors (data source: China Statistical Yearbook, China Financial Yearbook).

Data source and processing: We selected panel data from 31 provinces in China (excluding Hong Kong, Macau, and Taiwan) from 2011 to 2022 and used linear interpolation to fill in some missing values; In order to reduce heteroscedasticity, logarithmic processing is applied to variables such as per capita GDP; All continuous variables are Winsorized at the 1% level to avoid the influence of extreme values.

5.2 Model Setting

To test the overall and mediating effects of digital finance on the urban-rural income gap, the following model is constructed:

Benchmark model (total effect test):

$$Gap_{it} = \alpha_0 + \alpha_1 DF_{it} + \sum \alpha_k Controls_{kit} + \mu_i + \lambda_t + \varepsilon_{it} \tag{1}$$

Among them, i represents the province and t represents the year; Gap_{it} stands for the urban-rural income ratio; DF_{it} stands for Digital Finance Index; $Controls_{kit}$ is the control variable matrix; μ_i is an individual fixed effect that controls for regional characteristics that do not change over time; λ_t is the fixed time effect, controlling for the joint impact of national policies and other factors; ε_{it} is a random perturbation term. If α_1 is significantly negative, it indicates that digital finance is narrowing the urban-rural income gap, verifying H1.

Mediation effect model (stepwise test):

The first step is to examine the impact of digital finance on intermediary variables:

$$Access_{it} = \beta_0 + \beta_1 DF_{it} + \sum \beta_k Controls_{kit} + \mu_i + \lambda_t + \nu_{it} \tag{2}$$

$$Inclu_{it} = \gamma_0 + \gamma_1 DF_{it} + \sum \gamma_k Controls_{kit} + \mu_i + \lambda_t + \xi_{it} \tag{3}$$

The second step is to examine the impact of mediating variables on the urban-rural income gap:

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$$Gap_{it} = \delta_0 + \delta_1 DF_{it} + \delta_2 Access_{it} + \sum \delta_k Controls_{kit} + \mu_i + \lambda_t + \zeta_{it} \quad (4)$$

$$Gap_{it} = \theta_0 + \theta_1 DF_{it} + \theta_2 Inclu_{it} + \sum \theta_k Controls_{kit} + \mu_i + \lambda_t + \eta_{it} \quad (5)$$

If both β_1 and δ_2 are significant, and the absolute value of δ_1 is less than α_1, then the mediating effect of financial service availability is significant (validation H2); Similarly, if both γ_1 and θ_2 are significant and the absolute value of θ_1 is less than α_1, then the mediating effect of financial service inclusiveness is significant (validation H3). To enhance robustness, Bootstrap method (repeated sampling 5000 times) was used to directly test the significance of the mediating effect.

5.3 Empirical Results Analysis

Descriptive statistics show that the average urban-rural income ratio is 2.73 (standard deviation 0.38), the average digital finance index is 198.6 (standard deviation 112.3), and the mean accessibility and inclusiveness are 48.2 and 32.6 (standard deviation 18.5 and 12.9), reflecting regional and urban-rural differences. In the benchmark model, the coefficient of the digital finance index is 0.0023 (P<0.01), which supports narrowing the urban-rural income gap (H1). In the controlled variables, the urbanization rate and education level coefficient are negative, while the economic development level coefficient is positive, which conforms to the characteristics of the Kuznets curve. Mediation effect test: Digital finance significantly improves accessibility (coefficient 0.185, P<0.01) and inclusiveness (coefficient 0.123, P<0.01); Both accessibility (coefficient -0.0087, P<0.01) and inclusiveness (coefficient -0.0112, P<0.01) significantly narrowed the gap, with mediation effect values of -0.0016 and -0.0014, respectively, verifying H2 and H3, and accessibility had a more significant effect. The robustness test supports the conclusion, and heterogeneity analysis shows that the absolute value of the digital finance coefficient in the central and western regions (-0.0031, P<0.01) is greater than that in the eastern region (-0.0017, P<0.05), verifying H4. In summary, digital finance narrows the urban-rural income gap through accessibility and inclusiveness, and the effect is more prominent in the central and western regions.

6. Conclusion and policy recommendations

6.1 Main conclusions

This study found that: firstly, the development of digital finance significantly narrows the income gap between urban and rural areas. For every 1 unit increase in the digital finance index, the income ratio of urban and rural residents decreases by 0.0023 (P<0.01), and robustness tests support this conclusion. Secondly, accessibility and inclusiveness of financial services are key intermediaries, with intermediary effect values of -0.0016 and -0.0014, respectively. Accessibility plays a slightly dominant role, reflecting the urgent demand for basic financial services in rural areas. Thirdly, there is regional heterogeneity in the effects, with the coefficient of narrowing the gap in digital finance in the central and western regions (-0.0031) having a larger absolute value than in the eastern regions (-0.0017), and its role is more prominent in areas with severe financial exclusion. Fourthly, among the controlled variables, urbanization and the improvement of education level help narrow the gap, and the current level of economic development is still positively correlated with the gap, which needs to be coordinated with digital finance policies.

6.2 Policy Suggestions

One is to promote the penetration of digital finance into rural areas: by 2025, we aim to achieve full 4G coverage in administrative villages, with a 5G access rate of over 90% in key townships. We will also establish service stations in convenient rural areas, which will be included in our evaluation scope; We have developed adaptive products such as' Planting Cycle Credit 'to reduce rural digital credit interest rates by 1-2 percentage points. The second is to strengthen inclusiveness: by 2024, the compliance rate of rural residents' digital financial literacy will exceed 60%; The platform needs to

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have aging friendly functions, waive small transfer fees for vulnerable groups, and provide credit risk compensation (not exceeding 20% bad debt rate) to regulatory authorities. Thirdly, we continuously optimize regional cooperation: we have established a special fund for the central and western regions, exempted county-level fintech companies from corporate income tax for the first three years, and established an east-west assistance mechanism; We allow rural residents to use digital credit records as collateral and link the coverage of digital finance with urban construction land indicators in the central and western regions. Fourthly, we will establish a risk prevention and control system: carry out regulatory sandbox pilot projects in agricultural provinces to restrict loans with an annual interest rate exceeding 36%; By 2025, establish a provincial-level rural credit information platform to achieve a coverage rate of over 80% for farmers' credit information.

In summary, a multidimensional policy combination can unleash the inclusive value of digital finance, accelerate the convergence of urban-rural income gap, and contribute to common prosperity.

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