The Impact of Digital Finance on Income Gap: An Empirical Investigation from the Perspective of Banking Digitalization

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Abstract—**This study investigates the heterogenous effect of digital finance on narrowing income gap. It is found that Internet digital finance and digital finance in banking both help narrow income gap and a U-shaped relation is found between digital finance development and income gap. Internet digital finance alleviates information constraints, while digital finance in banking alleviates credit constraints in narrowing income gap. The two forms of digital finance have stronger effects on the income gap in economically and digitally underdeveloped areas. This study provides suggestions for developing digital finance, breaking the dual urban-rural financial structure and promoting common prosperity.**

Index Terms—**Internet digital finance, digital finance in banking, income gap**

I. INTRODUCTION

Traditional financial institutions face many risks. They prefer to set up service outlets in cities and towns [1]). The scarcity of financial resources further hinders the income growth of rural residents. Rural residents' small-scale farming operation and lack of effective collateral [2]), together with the widespread information asymmetry in credit market expose traditional financial institutions in operational risks in rural areas [3, 4])

Digital finance could enhance banks' risk-management ability [5]), and promote the total factor productivity growth of commerci*al banks* [6]). The improvement of financial ecology drives the banking industry to produce economies of scale and scope [7]). Market forces effectively promote financial institutions to innovate financial products and services, and increase the supply of financial resources to rural households [8]). The inclusive financial system reduces the income inequality between urban and rural areas [9]). However, there still remains some problems with the development of digital finance. Big banks seize high-quality customers due to their advantage in capital cost, thus producing the crowding-out effect [10]). The uneven development of digital technology creates digital divide between regions and widens income gap [11]).

This paper investigates the heterogenous effect of Internet digital finance and digital finance in banking on income gap

by analyzing the da[1]ta from 30 Chinese provinces from 2011-2020.

II. THEORETICAL HYPOTHESIS AND ANALYSIS

Traditional financial institutions tend to set up offline physical outlets in cities and towns, reducing their financial service availability [12]). Digital finance expands the traditional business scope by using advanced technologies, overcoming space–time constraints, and increasing the financial availability of low-income rural residents. It further helps improve asset allocation for rural households, and raise rural incomes [13]).

With the development of digital finance, financial institutions by establishing a credit evaluation model and relaxing the adherence to asset guaranteeconditions [14]), improve the risk-management of financial suppliers and diversify risks in financial markets [15]), lower the barriers to service entry for financial service demanders and provide them with diversified services [5]). Financial deepening intensifies the competition in rural financial market market [16]), urges financial service providers to innovate products and services, increases capital supply to low-income rural residents, balances financial resources allocation, and improves the inclusiveness of rural digital *finance* [7, 17]).

In early development stage, financial institutions set an income threshold. Only when the total wealth held by families surpasses that threshold would financial institutions provide financial services for them. However, the per capita income of rural families is lower than the threshold, which intensifies financial exclusion. Digital finance makes it more likely for rural residents to obtain financial support, increasing the likelihood of their starting their own business and raising the possibility of their income growth [11]).

H1: Both Internet digital finance and digital finance in banking have a positive impact on narrowing urban-rural income gap.

Different modes of operation lead to different influencing mechanisms behind the impact of Internet digital finance and digital finance in banking on urban-rural income gap. Digital technologies help generate economies of scale and diminish marginal costs in information collection. Internet enables financial institutions to reduce information asymmetry, reduces the cost of information collecting and processing and

improves the coverage and availability of rural financial services. Therefore, the relief of information constraints reduces urban-rural income gap by financial service expansion.

Digitalization in banking narrows technical differences among financial institutions, intensifies the competition in credit market, further compresses the profit margins of customers, and expands the boundaries of credit services to long-tail customers. Digital technology improves the risk-taking ability of financial institutions, provides technical support for credit resources to flow to credit loans with larger market and higher technical requirements, thus relieving the credit constraints imposed on low-income residents.

H2: The relief of information and credit constraints exerts regulatory effect in digital finance's narrowing the urban-rural income gap. Internet digital finance alleviates the urban-rural income gap by relieving information constraints, while digital finance in banking narrows the income gap by relaxing credit constraints.

Unbalanced financial development leads to inequality in technology acquisition and business development [11]. Digital finance increases the inclusiveness of financial system and promotes common prosperity through digital technologies. Financial deepening facilitates technological innovation and circulation between urban and rural areas. The construction of digital villages continuously narrows urban-rural economic and digital gap, bridges the digital divide and achieves inclusive digital finance.

H3: Compared with economically and digitally developed areas, the impact of Internet digital finance and digital finance in banking on narrowing the urban-rural income gap is more obvious in less economically and digitally developed areas.

III. Research Design

A. Variable Selection

Explained variables. income gap which was measured by the ratio of per capita disposable income of urban residents to per capita net income of rural residents, the Gini coefficient and the Theil index Eq. (1).

$$TL_{it} = \sum_{j=1}^{2} \left(\frac{P_{ijt}}{p_{it}}\right) / \left(\frac{P_{ijt}}{P_{it}} / \frac{Z_{ijt}}{Z_{it}}\right) \tag{1}$$

B. Explanatory Variables

1) Internet digital finance index

This index was formulated with reference to the Peking University Digital Financial Inclusion Index of China (2011-2020) compiled by Institute of Digital Finance Peking University, which can better measure the development of Internet digital finance.

This paper aims to investigate the impact of different types of digital finance on the urban-rural income gap, and it emphasizes the empowerment of financial digitalization for the banking industry, therefore it is not appropriate to adopt this index only.

2) Banking digital finance index

This index was constructed by Sheng [7]) from the view of financial function, use Python to sort out Baidu search indices of keywords concerning bank digital finance in each province from 2011 to 2019, which were then summarized into bank digital finance indices.

The initial lexicon of digital finance was developed with reference to Li [9]) which includes eight aspects like Basic technological, Direct address Angle, Resource allocation, The risk management, The network channel, Technology path Information channel eight aspects. And then these 45 keywords were collected and sorted out according to the eight classifications and weighted by using the entropy method.

After synthesizing these key words into a composite index. These composite indices were divided by the population of each province, and the results obtained were used to indicate the banking digital finance development of these provinces.

C. Mediating Variables

1) Information constraints

An information availability index which incorporates two dimensions of the current information level and Internet development to measure information constraints.

2) Credit constraints

The credit availability index which incorporates two dimensions of the marketization of bank credit fund allocation and financial structure.

D. Control Variables

the real Gdp per capita and Gdp^2, industrial structure Is, the development of traditional finance Fd, government financial support for agriculture Afe, the education quality Edu, the openness of the province

E. Model Settings

To investigate the overall impact of Internet digital finance and digital finance in banking on the urban-rural income gap, the fixed-effects model was used to evaluate the impact of digital inclusive financing on farmers' vulnerability. The urban-rural income gap *TL* was treated as the explained variable, and Internet digital finance *Difi* and digital finance in banking Fintech as explanatory variables, and economic development Gdp and Gdp^2, urbanization level *Urban*, industrial structure *Is*, traditional financial development *Fd*, financial support for agriculture *Afe*, education quality *Edu* and openness *Open* as control variables. The fixed-effects benchmark model constructed in this study is as follows:

$$TL_{it} = a_0 + a_1 index_{it-1} + a_2 X_{it-1} + \mu_i + \varepsilon_{it} \tag{2}$$

where *i* represents province, *T* represents year, and *a* is the parameter to be estimated in the model. *X* is the control variable, and μ_i represents thee fixed effects of a certain province. If the estimated coefficient of $Index_{it}$ is significantly negative, it is considered that digital finance helps to narrow the urban-rural income gap.

IV. EMPIRICAL ANALYSIS AND RESULTS HYPOTHESES TESTING

A. Hypotheses Testing

As can be seen in Table I, with control variables being introduced into Eqs. (1−20, coefficients of the two digital finance indices significantly negative, which suggests that the development of Internet digital finance and digital finance in banking helps narrow the income gap.

TABLE I: HYPOTHESES TESTING

	Equation 1	Equation 2	Equation 3	Equation 4
	Explained Variable: TL			
Difi	-0.405***		-0.346***	
	(0.092)		(0.086)	
Fintech		-0.207**		-0.174**
		(0.086)		(0.080)
Difi*Income			0.534***	
			(0.052)	
Fintech*Income				0.451***
				(0.064)
Income*Income			0.034**	0.087***
			(0.014)	(0.011)
Income			-0.882***	-1.378***
			(0.201)	(0.171)
_cons	0.000	0.000	-0.108***	-0.126***
	(0.000)	(0.000)	(0.011)	(0.011)
Observations	270	270	270	270
R-squared	0.589	0.549	0.712	0.663

TABLE II: MECHANISM TESTING

	Equation 1	Equation 2	Equation 3	Equation 4
	Explained variable: TL			
Difi	-0.373***	-0.399***		
	(0.088)	(0.096)		
Fintech			-0.147*	-0.222***
			(0.073)	(0.078)
Difi*Information	0.076**			
	(0.031)			
Fintech*Information			0.181***	
			(0.042)	
Difi*Credit		0.059**		
		(0.026)		
Fintech*Credit				0.049**
				(0.022)
Information	-0.201*		-0.061	
	(0.111)		(0.094)	
Credit		-0.030		-0.096***
		(0.031)		(0.030)
_cons	-0.017**	-0.026**	-0.072***	-0.020**
	(0.007)	(0.011)	(0.017)	(0.009)
Observations	270	270	270	270
R-squared	0.608	0.600	0.585	0.567

Further testing shows that the first-order coefficient of the ratio of rural residents' income to urban residents' income is significantly negative while the quadratic coefficient is significantly positive, indicating that there is a U-shaped relationship between the development of digital finance and the income gap

B. Mechanism Testing

The interactive items between information constraint proxy variable and credit constraint proxy variable and digital financial development index were introduced to test Hypothesis 2, and the regression results are shown in Table II The coefficients of Difi*Information, Fintech*Information, Difi*Credit and Fintech*Credit in Equations 1 to 4 are significantly positive, indicating that the relief of credit constraints and information constraints exerts regulatory effect on digital finance's narrowing the income gap.

In addition, the coefficient of Information in Eq. (1) is significantly negative, but that in Eq. (2) does not reach the significance level; the coefficient of Credit in Eq. (4) is significantly negative, but that in Eq. (2) is not significant. These results suggest that, compared with the relief of credit constraints, Internet digital finance narrows the income gap by relieving information constraints. In contrast, credit constraints exert major mediating effect on digital finance in banking's alleviating the income gap. Thus, Hypothesis 2 is verified.

Information constraints and credit constraints play an important regulatory role in digital finance's narrowing the urban-rural income gap.

V. FURTHER ANALYSIS

The interactive terms between regional economic development proxy variable and digitalization degree proxy variable and digital financial development index were introduced into Eq. (2) to further investigate the regional heterogeneity of digital financial development on the income gap and the System GMM was used to conduct robustness testing.

Eqs. (1–2) in Table III consider the regulatory effect of economic development. The regression results show that compared with developed areas, financial digitalization has a stronger impact on narrowing income gap. Eqs. (3–4) indicates that the application of digital finance is constrained by the initial digitalization of the region and that compared with areas with low Internet penetration rate, the areas with high degree of digitalization are more inclusive, thus demonstrating the stronger impact of financial digitalization on narrowing income gap. Thus, Hypothesis 3 is verified.

The development of digital finance has a greater impact on economically and digitally underdeveloped rural areas, which further contributes to the inclusive economic development and the narrowing of urban-rural income gap.

TABLE III: FURTHER ANALYSIS

	Explained Variable: TL			
	Equation 1	Equation 2	Equation 3	Equation 4
L.TL	0.590***	0.329	0.584***	0.439
	(0.188)	(0.225)	(0.187)	(0.259)
Difi	-0.110*		-0.110*	
	(0.056)		(0.056)	
Fintech		-0.153*		-0.118*
		(0.086)		(0.066)
Difi*Backward	-0.044*			
	(0.024)			
Fintech*Backwar		-0.075*		

(Table II continued)

	Equation 1	Equation 2	Equation 3	Equation 4
d				
		(0.043)		
Difi*Internet			0.052*	
			(0.030)	
Fintech*Internet				0.092*
				(0.046)
_cons	-0.013	-0.038	-0.011	-0.018
	(0.040)	(0.072)	(0.042)	(0.060)
Observations	270	270	270	270

C. Endogenous Test

Due to limitations of the data, the econometric model in this study failed to include enough explanatory variables, which may incur endogenous problems. The average digital financial index of other provinces except this province was used as the instrumental variable of digital financial index of this province. After the instrumental variable was introduced, the significance of core explanatory variables remains basically unchanged, and the variation of regression coefficient is small, which proves the stability of the regression results.

D. Robustness Test

This paper used alternative indicators to test the robustness of the core explanatory variables. The coverage and depth of digital inclusive finance, two secondary indicators of the Peking University Digital Financial Inclusion Index of China (2011-2019), were used to measure the development of Internet digital finance. Then the development index of digital finance in banking was synthesized by simple arithmetic average method. The entropy method is highly objective since it determines the weight according to the degree of fluctuation of indicators and the information entropy. The index of digital finance in banking development in this paper mainly incorporates seven perspectives when doing keywords search and the weight of these keywords does not show large variations, so it is reasonable to use the simple arithmetic average method to derive the index of digital finance in banking. The above mentioned results support Hypotheses 1, 2 and 3.

VI. CONCLUSIONS

This paper drew the following conclusions.

- The development of Internet digital finance and digital finance in banking helps to break the urban-rural dual structure of traditional finance, and a U-shaped relationship is found between the income of rural and urban residents and the income gap.
- Both information constraints and credit constraints have mediating effect on narrowing income gap. There are differences in the mechanism behind the impact of Internet digital finance and digital finance in banking on narrowing income gap. Internet digital finance helps narrow income gap by relieving information constraints, while digital finance in banking achieves this by relieving credit constraints.
- Digital finance development exerts heterogeneous impact on regions with different economic

development and different digitalization degrees. Compared with economically developed regions, underdeveloped regions can benefit more from inclusive financial development, financial digitalization and the narrowing of economic development gap.

VII. POLICY-MAKING SUGGESTIONS

To better narrow the income gap and achieve common prosperity, this paper proposes the following suggestions.

- Digital infrastructure construction and financial service innovation should be prioritized in underdeveloped rural areas, and proper competition should be encouraged in the financial market so as to balance the financial resources distribution in urban and rural areas. Market information exchange should be promoted and the credit environment should be improved.

- The information availability of the supply and demand sides of financial services and the credit availability in the financial market are vital to digital finance's narrowing of income gap. Financial institutions should improve their services and increase the availability of financial services in rural areas. Governments should direct the flow of information, technology and human resources to rural finance industry, and encourage the digital transformation of traditional rural finance.

- Increasing the income of rural residents is the key to breaking the urban-rural dual structure and solving the Three Rural Issues. The financial industry development in economically and digitally underdeveloped areas should be encouraged to improve the microfinance environment and transform potential comparative advantages into real advantages.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Yuxin Shen conducted the research and wrote the paper; Zhiwei Wu analyzed the data, all authors had approved the final version.

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