

INCLUSIVENESS AND COMPETITIVENESS PERFORMANCE OF DIGITAL FINANCIAL INCLUSION: FROM THE PERSPECTIVE OF REGIONAL INEQUITY

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Abstract

With China's rapid economic development, disparities within provinces have increased, leading to significant regional inequality. The goal of financial inclusion is to provide financial services to lag-behind regions and disadvantaged groups to promote economic growth and enhance competitiveness. Further investigation is needed to determine whether digital financial inclusion has contributed to greater inclusion or aggravated regional inequality due to the digital divide. The main aim of this study is to examine the inclusive effects and competitiveness gains of digital financial inclusion from the perspective of regional inequality. By analyzing 23 Chinese provinces from 2011 to 2019 through the panel fixed effects model, the results support the existence of a digital divide, which creates regional inequality. Further analysis of the moderating effects reveals that the elimination of the digital divide by digital competitiveness reduces the effect of regional inequality's impact on digital financial inclusion. The advantages of digital financial inclusion to improve competitiveness are already beginning to emerge. This paper reveals that digital financial inclusion has a non-linear threshold effect. At a time of rapid growth in digital financial inclusion, it is crucial to be aware of the inequalities brought on by the digital divide and, more importantly, to capture the beneficial effects of digital competitiveness to enhance regional competitiveness.

Keywords: *digital financial inclusion; regional inequality; digital divide; regional competitiveness*

JEL Classification: G21, O11, R11

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1 INTRODUCTION

At the G20 Hangzhou Summit in 2016, the idea of digital financial inclusion was formally launched, and its crucial contribution to the growth of financial inclusion in emerging economies was acknowledged. Based on numerous similarities between shadow banking, internet finance and financial inclusion, some scholars questioned the rise of digital financial inclusion as a political move by the Chinese government to shape the global financial regulatory discourse (Knaack & Gruin, 2021). The truth is that China's initiatives to promote digital financial inclusion have boosted financial innovation to encourage internet platforms to comply with the law to provide innovative financial products and services to better meet the investment and financing needs of small and medium-sized enterprises (SMEs), innovative enterprises and individuals. Leaving politics aside, digitalization has become an important tool for China to improve its competitiveness. However, it is still unknown whether internet platforms, which are Non-Bank Credit Intermediations (NBCIs) performing digital financial inclusion functions in China, will exacerbate existing economic issues, much like shadow banking.

Now that we have returned to the reality of China's financial development, China is a financial system dominated by state-owned banks. It is important to note that China's rapid economic growth has resulted in several development concerns, such as environmental issues, social equality, and structural unbalance. Nevertheless, the important role of uneven development policies in China's regional development theory cannot be overstated (Fan, 1997). China's geopolitical and key strategic decisions have been significantly influenced by regional inequalities (Knapp et al., 1992). China's efforts to broaden financial inclusion also aim to solve the issue of regional inequality by enhancing the accessibility and equality of financial services (Zhang & Liu, 2021). From the policy level of financial reform, it is easy to find that the development of financial inclusion in China is strongly associated with innovative digital finance. By providing financial services to individuals and SMEs that are not covered by traditional banking institutions, internet platforms make up for the absence of basic financial services that are brought on by a lack of user data or geographic constraints. Digital forms thus improve the quality of financial services and enhance regional competitiveness.

However, information barriers, such as a dearth of digital essential services, pose a challenge to digital financial inclusion. According to the 45th China Statistical Report on Internet Development, 255 million internet users were found in rural China, with a penetration rate of only 46.2%. In addition, 72.4% of Chinese internet users had monthly incomes of less than 5,000 yuan, placing them in the low-middle economic class. Economic growth is largely influenced by factors such as competitiveness, and the performance of the degree of competitiveness is what determines long-term, sustainable growth (Skare et al., 2021). To enhance inclusiveness and competitiveness, we can make up for the lack of financial services caused by geographical problems through digitalization. The role of new, inclusive financial models backed by digital finance has recently come under the scrutiny of academics. Most academics have concluded that digital financial inclusion promotes economic growth, particularly for underdeveloped nations, lag-behind regions, and disadvantaged groups (Fernandes et al., 2021; Kulkarni & Ghosh, 2021). However, some academics think the actual economic impact has not yet been proven (Aziz & Naima, 2021; Vucinic, 2020). The positive influence of digital financial inclusion in China is well discussed (Ahmad et al., 2021; Liu et al., 2021), by encouraging innovation among SMEs (Han & Gu, 2021; Xie & Liu, 2022). In summary, the existing studies have ignored the equity issues posed by digital financial inclusion, especially the impact of digital competitiveness.

Whether digital financial inclusion has contributed more to the aim of inclusion or has aggravated the disparity owing to the digital divide requires further investigation. Due to data availability, it is challenging to assess the inclusive and competitive performance of underdeveloped regions and disadvantaged groups. Regional inequality is a concrete manifestation of the competitiveness gap. Thus, this paper reviews the inclusiveness and competitiveness performance of digital financial inclusion from the perspective of the impact of digital financial inclusion on regional imbalances. This study briefly examines the impact of digital financial inclusion on regional inequality at the provincial level in China and uses empirical analysis to confirm the impact. Huge regional economic inequalities are a natural consequence of China's enormous size and the diversity of its natural environment and resources (Guo, 2012), and these factor allocations are the primary factors influencing economic growth and regional inequalities in China (Liu et al., 2018). Thus, we chose the provincial level as the object of study, which is the first-class administrative division in China, but we excluded municipalities due to their apparent difference from other first-class administrative divisions. Different from the existing studies that focus on the impact of digital financial inclusion on inter-regional inequality, this paper offers one of the first investigations

from the perspective of intra-regional inequality. The results not only make a significant contribution in investigating how the latest technological revolution of financial inclusion influences intra-regional inequality at the provincial level of China, but also prove the important role of digital competitiveness in reducing economic inequality.

2 THEORETICAL BACKGROUND

The role of new, inclusive financial models backed by digital finance in the economy and society has recently come under the scrutiny of academics, specifically, in terms of how they influence lag-behind regions and disadvantaged groups. There are many different opinions about digital financial inclusion. Most academics believe that digital financial inclusion can enhance competitiveness and contribute to economic growth, particularly for developing nations, lag-behind regions, and disadvantaged groups. Digital financial inclusion has a considerable beneficial impact on economic growth and spatial spillover effects on surrounding countries (Shen et al., 2021). Digital financial inclusion improves access to financial services for Indian women to become more financially and socially independent (Kulkarni & Ghosh, 2021), and those who are financially underfunded in Mozambique (Fernandes et al., 2021). In terms of digital finance, China is currently one of the most developed countries (Gruin & Knaack, 2020). Over a decade passed between the early commercialization of China's digital financial inclusion and its formal development with rules and laws. Numerous scholars have also examined the benefits of digital inclusion in improving the competitiveness of China's rural areas and thus reducing poverty. In their survey of 1,900 rural Chinese families, 35.63% of farmers use digital financial services, lessening the vulnerability of rural poverty (Wang & He, 2020). Digital financial inclusion significantly increases the income of rural residents and reduces poverty in China. Furthermore, the positive impact on rural families' income is bigger than urban households' (Li et al., 2021). As China's experience of poverty reduction tells us, digital financial inclusion can be attained through easing information and credit restrictions, growing social networks, and encouraging entrepreneurship (Chen & Zhao, 2021). On the one hand, digital financial inclusion reduces the barriers to entrepreneurship caused by a lack of education and consequently alters farmers' entrepreneurial behavior choices (Liu et al., 2021). On the other hand, digital finance enhances the competitiveness of SMEs through improving innovative performance (Han & Gu, 2021; Ko et al., 2022). This improvement in competitiveness is particularly evident for Chinese SMEs, especially in China's central and western regions, non-heavy polluting industries, and non-state enterprises (Xie & Liu, 2022).

However, several academics who investigated lag-behind regions and disadvantaged groups discovered that while digital financial inclusion has aided the growth of financial inclusion, the actual effect of improving competitiveness and its impact on the economy has not yet been empirically tested. The experience of digital financial inclusion in Bangladesh shows that while it can help underserved individuals access financial services and indeed narrow the access gap from an inclusion perspective, in practice, these financial services are underutilized and do little to spur economic growth because of inadequate infrastructure development, financial literacy, and social awareness (Aziz & Naima, 2021). Thus, there is an urgent need for action to combat the digital divide and ensure that digital financial inclusion is inclusive (Khera et al., 2022; Wang et al., 2022). While digital fintech offers more opportunities for the development of financial services, it also poses additional risks to the financial system at both the macro and micro levels. For example, marginalized people in India who are already excluded from traditional financial services may also be excluded from digital financial services (Vucinic, 2020). Even though financial inclusion is promoted by the increasing usage of digital finance,

the effects on low-income and poor populations could be non-linear or negative (Ozili, 2018). It is also hindered by digital inequality, leading to inconsistent effects and new contradictions (Gopane & Ieee, 2019). Although digital financial inclusion in China is well developed, many farmers in China are still significantly impacted by digital financial exclusion (Su et al., 2021).

Despite many advantages of digital financial inclusion, a significant portion of society has not yet completely accessed digital financial services because of inequalities in their availability, accessibility, and use (Kangwa et al., 2021). Disadvantaged groups who are excluded by traditional financial institutions can benefit from digital financial inclusion, but there are still constraints, because digital and financial literacy are significant determinants of digital financial inclusion (Kass-Hanna et al., 2022). The digital divide, at the individual, organization or national level, has far-reaching implications for citizens, management, and the economy (Riggins & Dewan, 2005). Skills gaps widen income gaps, further entrenching poverty (Gorski & Clark, 2002). With greater risks and uncertainties than traditional finance, digital financial inclusion is a creative and innovative financial practice of NBCIs. In the digital age, competitiveness gaps are amplified by the uneven spread of information technology, and thus digital financial inclusion is likely to exacerbate regional inequalities. As a result, we propose the following hypothesis.

Hypothesis 1: Digital financial inclusion exacerbates regional inequality.

In the midst of fast technological development, it is vital to define the newly emerging set of factors required for productivity in the Fourth Industrial Revolution (4IR). Digitization is becoming a way to make processes more efficient and contribute to the economy, allowing for greater competitiveness and facilitating important transformations in all areas (Ahmadi et al., 2020). The adoption and utilization of information and communications technology (ICT) represent fundamentals of economic growth and competitiveness for businesses, organizations, and even nations that can utilize them. Adopting ICT benefits social capital, commercial success, and even lessens the digital divide that exists in rural areas (Steinfeld et al., 2012). Disparities in ICT adoption are a critical component in the digital divide (Billon et al., 2009), and regional development (Samara et al., 2022). Firms are typically advised to use ICT to help them achieve their existing business goals (Pires & Aisbett, 2003). Thus, e-commerce is also an expression of digital competitiveness. Earlier studies have shown that digital financial inclusion could enhance SME competitiveness, particularly in their innovation and development, as well as stimulate economic growth by driving e-commerce development. In summary, digital competitiveness is theoretically the core factor in reducing the digital divide. It is therefore also an important means of addressing regional inequities resulting from the digital divide. As a result, we propose the following hypothesis.

Hypothesis 2: The influence of digital financial inclusion on regional inequality is mitigated by digital competitiveness.

Digital technology is used to promote personalized, scenario-based, and intelligent digital financial inclusion services. Despite early exploration and quick development of digital financial inclusion in China, it was not until the G20 Summit in 2013 that a precise definition and regulatory regulation were established (Ozili, 2018). Consequently, it has taken about ten years for China's digital financial inclusion, a new type of financial service that depends on data precipitation and algorithmic upgrades, to grow formally. When fintech development is low, it has a dampening effect and hinders economic growth; after breaking through the inflection point, its contribution to economic growth becomes increasingly prominent (Bu et al., 2022). The theoretical basis for network economic effects is known as Metcalfe's Law (Spulber & Yoo, 2009). The internet sector is generally characterized by high fixed costs and

network externalities (Economides & Himmelberg, 1994). Digital financial inclusion naturally fits these characteristics. Also, there is a “Kuznets”-curve in financial inclusion (Aslan et al., 2017). Digital financial inclusion realizes the circulation of financial elements, reduces information asymmetry, and enhances the competitiveness of lag-behind regions and disadvantaged groups. The reasonable redistribution of excess capital to support balanced and high-quality economic development, the long-term accumulation of data and knowledge, and the upgrading of algorithms all take time to convert. As a result, many models of digital finance can achieve rapid growth to gain a competitive advantage as long as they go beyond a certain critical mass (Varian et al., 2004). This leads to the following hypothesis:

Hypothesis 3: The relationship between digital financial inclusion and regional inequality is nonlinear.

3 RESEARCH METHODOLOGY AND DATA

3.1 Data Description

This study is based on panel data from 23 Chinese provinces from 2011 to 2019. Because the outbreak of the epidemic in late 2019 had a significant macroeconomic impact on China, the sample period chosen for this paper is from 2011 to 2019. Since 2016, The Peking University Digital Finance Research Center and Ant Group Research Institute have collaborated to develop the index series “The Peking University Digital Financial Inclusion Index of China (PKU-DFIIC).” Based on massive data of the Ant Group on digital financial inclusion, the latest report released is from 2011 to 2020. The use of population weights reflects the regional inequality experienced by an “ordinary person,” i.e., regional disparities that may be due to a small number of sparsely populated areas growing very fast or very slowly, and which are irrelevant to the actual perception of inequality experienced by the population. Rather than the use of population weights that lack controls for the impact of labor mobility, the measured inequality is likely to be larger than it actually is (Milanovic, 2005). Thus, this paper uses Williamson (1965) method to quantify regional inequality within provinces.

We chose the provincial level as the object of study because provincial governments are first-level local state administrative organs in China. Due to different statistical systems, the samples are the provinces of mainland China, excluding Taiwan, Hong Kong, and Macao. Shanghai, Beijing, Tianjin, and Chongqing are also excluded because these four municipalities are directly under the central government and different from provinces without prefecture-level cities.¹

This paper draws on the weighted coefficient of variation (WCV) of regional GDP per capita of Williamson (1965) and Lessmann (2014) to quantify the regional inequality within provinces. To calculate the provincial regional inequality, the dispersion degree of each province’s prefecture-level cities in relation to the average economic development level of the province is chosen and weighted by the population percentage. The higher the coefficient of regional inequality within provinces (V_w), the greater the gap in economic development across prefectures and cities within the province. Gross domestic product per capita serves as a proxy for economic development level in this study, and the average population is used to derive the

¹ To ensure the quality of the study, the data from four provinces, Qinghai, Xinjiang, Tibet, and Hainan, which have more missing variables, are excluded from this paper.

population-weighted value.² This paper takes the representative index PKU-DFIIC³ divided by 100 as independent variables.

According to the IMD World Competitiveness Center, digital competitiveness is defined as the ability of an economy to adopt and explore digital technologies, leading to the transformation of government practices, business models and society. With reference to the data selection of ICT Adoption in the Global Competitiveness Index, this paper chooses mobile-cellular telephone subscriptions (*mobile*) and broadband subscribers of Internet (*bbs*) as the two indicators for measuring the region’s digital competitiveness. According to the research hypothesis of this paper, e-commerce is also an expression of digital competitiveness. Thus, the development of e-commerce circulation (*perexpress*) is also chosen as a moderator variable.

Eight control variables that have impacts on regional inequality are chosen. According to Williamson’s regional inequality hypothesis, regional disparities theoretically converge logically with economic development in an inverted U-shape. Thus, a quadratic term for the level of economic development is included as a control variable (Aslan et al., 2017; Dreher & Gaston, 2008). Globalization has an inequality-increasing effect (Dreher & Gaston, 2008; Heimberger, 2020). Industrial upgrading and government expenditure are also crucial to regional inequality (Cheong & Wu, 2014; Sidek, 2021). Gradually narrowing the development gap between regions is achieved continuously by promoting the construction of marketization (Chen et al., 2021). Human capital is one of the main factors influencing inequality, measured by a worker’s level of education, to stand for human capital quality (Baker et al., 2020). Oppositely, according to (Kanbur & Zhuang, 2013), urbanization is negatively associated with regional inequality. All variables are described in further detail in Tables 1 & 2.

Tab. 1 – Variable types, names, symbols, and descriptions

Variable types	Variable names	Variable symbols	Variable descriptions
Dependent Variable	Regional inequality within provinces	Vw_{it}	referring to Williamson’s theoretical measure, higher Vw_{it} indicates more unbalanced economic development
Independent Variable	Index of digital financial inclusion	$index_{it}$	digital financial inclusion index /100
Moderator variables	Mobile-cellular telephone subscriptions	$mobile_{it}$	the number of mobile-cellular telephone subscriptions per 100 population
	Mobile-cellular telephone subscriptions	bbs_{it}	the number of active mobile-broadband subscriptions, fixed-broadband internet, and fiber-to-the-home/building internet subscriptions per 100 population
	Development of e-commerce circulation	$perexpress_{it}$	log (express business revenue/total population at year-end)
Controlling variables	Economic development	$lngdp_{it}$ $sqlngdp_{it}$	log (per GDP) sq log (per GDP)
	Foreign trade	$open_{it}$	total imports and exports as a share of GDP

² Note: To ensure the consistency of statistical caliber, the GDP per capita of each province is derived from the GDP per capita of the prefecture-level city to which it belongs. Data on the average population of each region in 2020 are missing and replaced by data on the resident population.

³Data source: Institute of Digital Finance, Peking University <https://idf.pku.edu.cn/yjcg/zsbg/index.htm>

Non-agricultural industries	<i>nonagri_{it}</i>	the ratio of the sum of value added of secondary and tertiary industries to GDP
Government intervention	<i>gov_{it}</i>	the share of local fiscal expenditure in GDP
Marketization	<i>market_{it}</i>	the ratio of market value of listed stocks outstanding to GDP
Human capital	<i>humancap_{it}</i>	the share of employed persons with higher education
Urbanization	<i>urban_{it}</i>	the share of urban population
Financial inclusion policy	<i>policy_{it}</i>	0 for 2011-2013 and 1 for 2014-2019

Tab. 2 – Variables descriptive statistics. Source: own research

Variable symbols	Obs	Mean	Standard deviation	Minimum values	Maximum value
<i>Vw_{it}</i>	207	0.465	0.153	0.157	1.440
<i>index_{it}</i>	207	1.997	0.898	0.185	3.875
<i>mobile_{it}</i>	207	92.829	20.628	52.040	149.340
<i>bbs_{it}</i>	207	20.212	9.844	5.478	55.357
<i>perexpress_{it}</i>	207	4.463	1.123	2.431	7.600
<i>lngdp_{it}</i>	207	1.559	0.387	0.578	2.518
<i>sqlngdp_{it}</i>	207	2.579	1.230	0.334	6.340
<i>open_{it}</i>	207	0.204	0.208	0.010	1.109
<i>nonagri_{it}</i>	207	0.899	0.037	0.766	0.966
<i>gov_{it}</i>	207	0.231	0.085	0.075	0.490
<i>market_{it}</i>	207	0.297	0.182	0.000	1.135
<i>humancap_{it}</i>	207	0.183	0.062	0.080	0.338
<i>urban_{it}</i>	207	0.554	0.088	0.350	0.727
<i>policy_{it}</i>	207	0.667	0.473	0	1

3.2 Benchmark regression model

To test Hypothesis 1, the individual fixed effects regression model is used as the benchmark regression, as shown below.⁴

$$Vw_{it} = \alpha_1 + c_1 index_{it} + \gamma_1 Controls_{it} + \varepsilon_{it} \quad \dots\dots(1)$$

i and *t* in the subscripts of each variable represent the province and year, respectively, *Vw_{it}* denotes regional inequality within each province, *index_{it}* represents the index of digital financial inclusion, *Controls_{it}* are all the control variables selected above, α_1 and ε_{it} are the constant and residual terms respectively.

3.3 Moderation effect model

To gain insight into the equity issues posed by digital financial inclusion, and how digital competitiveness weakens the impact, we refer to Fairchild and MacKinnon (2009) moderation effect analysis for statistical analysis. To verify research Hypothesis 2, we chose three variables

⁴ Note: Because of the biased random effects estimation of the panel model, the paper uses the fixed effects model as the baseline regression after being tested by the Hausman test, and the test steps are omitted due to space limitations.

(*mobile*, *bbs* and *perexpress*) to represent digital competitiveness as moderate variables. This paper adds an interaction variable and constructs the following moderation effect models.

$$Vw_{it} = \alpha_{11} + c_{11}index_{it} + c_{12}Mo_{it} + c_{13}index_{it} \times Mo_{it} + \gamma_{11}Controls_{it} + \varepsilon_{it} \dots\dots(2)$$

In model (2), *i* and *t* in the subscripts of each variable represent the province and year, *Mo_{it}* denotes the digital competitiveness, including *mobile_{it}*, *bbs_{it}*, and *perexpress_{it}*, *Controls_{it}* are all the control variables selected above, α_{11} and ε_{it} are the constant and residual terms respectively.

4 RESULTS AND DISCUSSION

4.1 Digital financial inclusion and regional inequality

Table 3 shows the estimated results of the relationship between digital financial inclusion and regional inequality within provinces. As shown in model (1), $c_1 > 0$ and passes the statistical test at the 1% confidence level, which means the higher the level of digital financial inclusion development, the more it aggravates the inequality, confirming Hypothesis 1. Because inequality tends to change slowly over time, it is possible that the endogenous problem is caused by lagged dependent variables (Dreher & Gaston, 2008). This paper thus uses the lagged one period of the explanatory variables as instrumental variables. Referring to Forbes (2000), we apply the General Method of Moment (GMM) to test the robustness of benchmark regression. The placebo test also confirms the robustness of our result.

Tab. 3 – Results of benchmark regression estimation

	(1)	(2)
	OLS	GMM
	Vw	Vw
<i>index</i>	0.120*** (0.042)	0.190** (0.0904)
Control variables	Yes	Yes
Province fixed effects	Yes	Yes
obs	207	161
R-square	0.330	-
AR(1) (p-value)	-	0.021
AR(2) (p-value)	-	0.947
Hansen test (p-value)	-	0.861

Note: *, **, *** represent 10%, 5% and 1% confidence level respectively, the standard error of regression coefficient is in the parentheses, the following table is the same.

4.2 Digital financial inclusion, digital competitiveness, and regional inequality

Table 4 shows the estimated results of the moderation effect of digital competitiveness. As shown in model (2), the coefficient of the interaction variable *index*mobile* is -0.001, which is significant at the 1% level, whereas the coefficient of the interaction variable is opposite to *index*. The coefficient of the interaction variable *index*bbs* is -0.003, which is significant at the 10% level, whereas the coefficient of the interaction variable is also opposite to *index*. The coefficient of the interaction variable *index*perexpress* is -0.097, which is significant at the 1% level, whereas the coefficient of the interaction variable is also opposite to *index*.

Tab. 4 – Results of moderation effect

	(1)	(2)	(3)
	Vw	Vw	Vw
<i>index</i>	0.157*** (0.046)	0.177*** (0.038)	0.245*** (0.030)
<i>mobile</i>	0.004 (0.003)		
<i>index*mobile</i>	-0.001*** (0.000)		
<i>bbs</i>		0.004 (0.007)	
<i>index*bbs</i>		-0.003* (0.002)	
<i>perexpress</i>			0.162 (0.102)
<i>index*perexpress</i>			-0.097*** (0.030)
Control variables	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
obs	207	207	207
R-square	0.342	0.357	0.344

The considerable multicollinearity is introduced into a regression equation when interaction variables are not centered (Robinson & Schumacker, 2009). Consequently, the interaction variables are further centered in this paper, and the results obtained in Table 5 are consistent with the uncentred ones.

Tab. 5 – Results of moderation effect: centered interaction variables

	(1)	(2)	(3)
	Vw	Vw	Vw
<i>index</i>	0.088*** (0.025)	0.103** (0.0417)	0.103** (0.0386)
<i>mobile</i>	0.002 (0.003)		
<i>index*mobile</i>	-0.001*** (0.000)		
<i>bbs</i>		-0.001 (0.004)	
<i>index*bbs</i>		-0.003* (0.002)	
<i>perexpress</i>			-0.032 (0.128)
<i>index*perexpress</i>			-0.097*** (0.030)

Control variables	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
obs	207	207	207
R-square	0.344	0.342	0.357

The digital divide in digital financial inclusion results in desperate effects and a new contradiction (Gopane & Ieee, 2019). By acquiring digital and financial literacy through routine use, lag-behind regions can obtain greater socioeconomic capacity (Joshi et al., 2019). By enhancing digital competitiveness, the digital divide can be gradually reduced. In summary, digital competitiveness weakens the exacerbating effect of digital financial inclusion on regional inequality, confirming Hypothesis 2.

4.3 Nonlinear influence of digital financial inclusion

Metcalf's Law applies to digital financial inclusion, which means that as it develops, the value it creates multiplies, increasing with it. It is conceivable to produce a positive impact on balanced economic development once the growth of digital financial inclusion reaches a certain level. The effect of digital financial inclusion on regional inequality within provinces might not be linear. As a result, to test Hypothesis 3, this study uses a threshold regression model (Hansen, 1999; Ochi et al., 2022; Wang & Gong, 2020) to investigate the nonlinear effects.

Firstly, the individual fixed effect threshold regression test is conducted on independent variable $index_{it}$, and the test results are shown in Table 6.

Tab. 6 – Threshold estimation of digital financial inclusion

		<i>index</i> threshold estimation		95%confidence interval		
A. Threshold estimation	Single threshold	Th-1	1.271	[1.232,1.284]		
	Double threshold	Th-21	1.464	[1.441,1.475]		
		Th-22	2.548	[2.396,2.556]		
B. Threshold effect test		F-value	P-value	Number of Bootstrap	Thresholds	
	Single threshold	24.42	0.083	300	10%	5%
	Double threshold	25.69	0.017	300	10%	5%
					1%	

As shown in B, the threshold effect test of Table 6, the impact of $index_{it}$ on regional inequality has a double threshold effect. According to A, threshold estimation of Table 6, threshold values of 1.464 and 2.548 divide the index into three intervals, which may be defined as the initial stage, development stage and maturity stage of digital financial inclusion respectively. The estimated results of the staged regression are shown in Table 7. As digital financial inclusion gradually matures, its impact on regional inequality gradually decreases.

Tab. 7 – Impact of digital financial inclusion at different stages

	Initial stage : $index \leq 1.464$	Development stage : $1.464 < index \leq 2.548$	Maturity stage : $index \geq 2.548$
Coef	0.068** (0.029)	0.017*** (0.027)	0.013*** (0.027)
95%confidence interval	[0.009,0.125]	[0.113,0.218]	[0.077,0.182]

The impact of digital financial inclusion on exacerbated regional inequality is nonlinear, and the exacerbating effect steadily decreases over time as data accumulation and algorithm improvement take place, which supports Hypothesis 3.

5 CONCLUSION

In summary, the empirical analysis's findings indicate that there is a threshold effect on the effect of digital financial inclusion. With the gradual expansion of digital financial inclusion, NBCIs could circulate more user data and upgrade the algorithm to reduce information asymmetry. Moreover, underdeveloped areas and disadvantaged groups could get more guidance to use digital financial services wisely and correctly to understand financial risks.

Financial inclusion is proposed to address the current dilemma of unbalanced development, and digital financial inclusion is a key tool for advancing financial inclusion. We aim to reduce disparities by compensating for geographic gaps in financial services and enhancing the competitiveness of lag-behind regions and disadvantaged groups using digital financial technology. The digital divide is a feature of digital finance, and the question is whether it is more exclusionary or more inclusive when combined with inclusion finance. This paper examines the impact of digital financial inclusion on regional inequality in 23 provinces of China from 2011 to 2019, mainly arriving at the following conclusions. First, because of the digital divide brought about by new technology, digital financial inclusion has exacerbated the regional inequality within provinces. Second, the influence of digital financial inclusion on regional inequality is mitigated by digital competitiveness. Third, there is a non-linear influence of digital financial inclusion on regional inequality. With the development of digital financial inclusion, its exacerbating effect on regional inequality reduced greatly.

Initially viewed by regulators in advanced Western nations as shadow banking that threatened economic stability, China redefined NBCIs at the G20 summit in the interest of promoting digital financial inclusion (Knaack & Gruin, 2021). It is apparent that 78% of access to financial services in developing countries comes from digital financial technologies (Boshkov & Drakulevski, 2017). However, there is a chance that a small group of mathematically and technologically astute elites control the algorithms to change decisions and policies, leading to increased inequality (Edward, 2020). In China, fintech has not resulted in the devolution of financial power; instead, it has led to a form of digitalization of finance that is prompted by the government and driven by internet platforms. The Chinese government is integrating non-professional actors such as internet finance into the formal financial system (Wang, 2018). Reviewing the growth of digital financial inclusion in China, fintech is said to have drastically altered the country's economic and financial environment. Digital financial inclusion accelerates the process of financial inclusion and enhances SMEs' and low-income households' competitiveness by supplying financial services (Hua & Huang, 2021). However, the macroeconomic effects of digital financial inclusion are not currently being studied in China. The outstanding contribution of this paper is that it not only analyses the negative macroeconomic effects of digital financial inclusion from the perspective of regional inequality but also points out that it could level-up regional inequality through enhancing the competitiveness of lag-behind regions and disadvantaged groups. This paper offers China and other developing nations a fresh viewpoint, to alert them of the new inequalities caused by digital financial inclusion. Also, by accelerating the region's digital competitiveness, inclusive growth with extremely balanced economic development can be achieved.

Despite the fact that the influence of digital financial inclusion on regional inequality is clearly justified on both theoretical and empirical levels in this study, due to data availability constraints on digital financial inclusion, the study is representative but not comprehensive. The disparities revealed for other developing countries merit additional investigation for future contributions to digital financial inclusion in leveling-up regional inequality through enhancing competitiveness.

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Appendix

Tab. 1 - Hausmann test of benchmark regression

	(b)	(B)	(b-B)	$\sqrt{\text{diag}(V_b - V_B)}$
	fixed	random	Difference	Std. err.
index	0.1201	0.0900	0.0301	0.0182

$$\chi^2(10) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 20.86$$

$$\text{Prob} > \chi^2 = 0.0221$$

The highlighted p value is < 0.05 , thus use a fixed effects model.

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