

The Impact of Digital Financial Inclusion on Urban Entrepreneurial Activity

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Abstract. Propelled by the rapid expansion of digital economy and the national ‘Mass Entrepreneurship and Innovation’ strategy, effectively stimulating urban entrepreneurial vitality has become a cornerstone of high-quality regional economic development. This study investigates the impact of digital financial inclusion on urban entrepreneurial activity, alongside its underlying transmission mechanisms. Utilizing a balanced panel data from 238 prefecture-level cities in China covering the period from 2015 to 2023, this paper deploys a two-way fixed effects model, an instrumental variable approach, and a two-step mediation effect model to conduct systematic empirical analysis. The findings reveal that digital financial inclusion significantly catalyzes urban entrepreneurial activity, a conclusion that withstands a battery of endogeneity treatments and robustness checks. Mechanism analysis demonstrates that digital financial inclusion drives urban entrepreneurial activity by mitigating financing constraints. Furthermore, heterogeneity analysis uncovers a pronounced spatial asymmetry demarcated by the Hu Huanyong Line: the stimulative effect is highly significant in cities on the southeastern side, whereas it remains statistically insignificant for their northwestern counterparts. Accordingly, this study advocates for the continuous refinement of the digital financial inclusion framework to enhance financial accessibility for micro and small entrepreneurial entities, alongside the precise mitigation of financing constraints and the implementation of spatially differentiated digital finance policies. Additionally, optimizing the urban entrepreneurial ecosystem is paramount to fostering robust synergies among digital finance, public services, and industrial support.

Keywords: digital financial inclusion, urban entrepreneurial activity, financing constraints, Hu Huanyong Line.

1. Introduction

As a result of the digital economy and Mass Entrepreneurship and Innovation, the process of encouraging urban entrepreneurial spirit has become a key determinant of the overall economic growth in a given region, as well as the ability to absorb labor force in the region, and also the quality of the regional economy. In its turn, the concept of financial inclusion, which is based on the use of big data, cloud computing, and artificial intelligence technologies, is transforming the supply side of the financial services. The collateral used by traditional banks is often high, the cost of information screening is expensive, and they have a tendency to favor bigger businesses. Therefore, it becomes impossible to finance micro, small and medium-sized enterprises (MSMEs) or start-ups since they do not have any credit history, no fixed income statements, and no property to offer as a collateral. Conversely, the digital financial service can be able to assess the creditworthiness of the borrowers through the so-called digital footprint that would include online payment, mobile payment, consumer behaviour, network activity, etc., thus enhancing the processing of information and pricing of risk with less dependence on physical branches and hard collateral. This means that the money will now be available to the long tail group of people who were not served by the traditional financial institutions. In this way, the digital financial inclusion could be one of the main drivers of the development of the urban entrepreneurial spirit as it reduces the constraints on the availability of funds, reduces the barriers to the entry of the entrepreneurship, and facilitates access to the funds.

Based on this assumption, the present paper explores the question of whether digital financial inclusion has a significant impact on the level of entrepreneurial activity at the urban scale. Moreover, it analyzes the possibility that the mitigation of financing constraints is one of the main macro-level

transmission channels of this effect. To systematically respond to these research questions, this paper adopts balanced panel data of 238 prefecture-level cities in China between 2015 and 2023, and uses a two-way fixed effects model, an instrumental variable method, and a two-step mediation model. The results show that digital financial inclusion can greatly boost the level of urban entrepreneurial activities, which is still valid after strict endogeneity tests and robustness tests. Mechanism analysis shows that digital financial inclusion increases the urban entrepreneurial activities by easing the constraint of finance. In addition, heterogeneity analysis shows that this promoting effect has strong spatial variation across the Hu Huanyong Line with strong effects being observed in cities located on the southeastern side but weak effects being found in cities located on the northwestern side.

Even though the existing literature on the issue of financial development and digital finance, as well as the entrepreneurial behavior have been addressed in different angles, the literature on this topic has mostly been micro-based with a limited number of macro-level studies that deal with the urban entrepreneurial environment. Moreover, there is also much to do in terms of developing the indicators of financing constraints at the city level, the strategies of identifying mechanisms, and the heterogeneity analysis of the cities. This paper provides a slight contribution to four aspects compared to the current literature. First, it broadens the scope of research. The study will expand the perspective of the research because it will take the analysis up to the prefecture-city level and analyze the effect of the inclusion of digital financials in entrepreneurship based on the urban entrepreneurial ecosystem. Second, it enhances the measurement of variables. The paper is built on the basis of a Logit fitting model and offers a new method of measuring the transmission mechanism of the digital financial inclusion at the macro level which can be used to measure the effect of the macro-level of the digital financial inclusion on the vitality of entrepreneurs. Third, it improves identification of mechanisms. It is through the use of two steps that the author tests the mechanism of the transmission of the concept of digital financial inclusion - financing constraint - urban entrepreneurial activity, reduces the weakness of the traditional stepwise regression technique of interpretation of mechanisms and makes the results more reliable. Fourth, it shows differences in space. This article presents the Hu Huanyong Line theory that will help to explore the performance difference between the effects of digital financial inclusion on the entrepreneurial process in the different spaces, which will be useful in reducing the gap in the region and creating the differentiated policy of digital finance.

2. Literature Review and Hypotheses Development

2.1. Literature Review

The concept of digital financial inclusion is that the use of the Internet and other forms of digital technology will make the cost of a financial service cheaper, provide access to more people in terms of finance, and the identification of credit easier. The mobile payments and digital financial systems may be used to cut down on the transaction expenses, increase the capacity of risk-sharing, and extend the financial reach to the poor and the marginalized [1-2]. Digital footprints and machine learning are the two models of Fintech which rely on alternative data and algorithmic systems to maximize the process of creditworthiness analysis. This is a partial solution to the issue of the traditional financial system as it does not depend much on hard information, collateral, and physical branch networks [3]. In business, online payment systems such as mobile wallets can be employed to improve the efficiency of transactions made by micro and small business owners who then become entrepreneurs and grow their businesses [4]. Thus, the digital financial inclusion is not just an evolution of the financial technology, but it is rather a structural change, which has the potential to transform the nature of the entry into the entrepreneurial world and the distribution of resources.

The urban entrepreneurial activity is also a result of the combination of different factors, such as the economic structure of the city, its industry, population density, knowledge spillage and financial situation. The agglomeration of urban entrepreneurs has been generally linked with reduced costs to enter, higher levels of human capital and more frequent spillovers of knowledge [5]. In the case of job creation, it is worth noting that new business ventures and new market players are the main drivers

of the overall growth of the economy and the process of entering and exiting the firm is not only influenced by the presence of new entrants but also the absorption of labor force in the city and the sustainability of the economy [6]. Therefore, in order to understand the level of the entrepreneurial activities in the cities, it is important to control at the same time the macro-levels of the conditions like the degree of economic development, the number of inhabitants, the industrial composition, the level of financial development, and the provision of services.

Financing limitations is the major factor that relates to the financial aspect and the entrepreneurial actions. The initial capital, the conditions of external financing as well as the risk bearing capacity are all factors that determine the entry of a potential entrepreneur into the market. It is also clear that the liquidity constraints directly influence the decisions of individuals on whether to be entrepreneurs or not because it poses a significant hurdle in the process of entering the entrepreneurial market to the groups of people who do not have the means to accumulate wealth and collateral [7]. The entrepreneurship does not depend on the personal desire but rather the combination of the distribution of the wealth, availability of credit and the state of the capital markets [8]. The competition between banks and deregulation of finance may change the nature of firm entrance. Although improved external sources of funding would lead to an increase in the rate of new business start-ups, there will be a rise in rivalry and departure of the new businesses at the same time [9]. External debt financing is used by new ventures heavily and the bank credit is one of the main components of the capital structure during the first years of the existence of the enterprise [10].

Besides, the geographical endowments and imbalance in the economic growth of the regions have also been a factor that limits the digital financial inclusion on the Chinese economy since China is a very large country. The Hu Huanyong Line as one of the key demarcation lines of the population and the economic geographic distribution of the Chinese people can be seen to divide the country into two parts with significant differences in terms of agglomeration of factors, industrial supporting conditions, and information resources between the southeast and northwest part of the line. The cities in the southeastern region will have a more developed digital economy and market environment where there will be a well-developed ecosystem of the digital economy and entrepreneurial activities, which will result in the development of an effective network of cooperation between the digital finance and business activities. On the other hand, the northwestern cities are limited by the geography and economic resources and therefore face the problem of the lack of additional variables when it comes to unlocking the dividends of the digital finance. This inequality of the digital dividends based on the heterogeneity of the space geographically is a limiting condition to consider in assessing the macro impact of the digital financial inclusion.

To put it all together, the literature has given a lot of information that can be used in this study and the following points are still left to be explored. To begin with, although the idea of digital financial inclusion as an instrument to influence entrepreneurial activities through lowering the cost of transactions, credit identification, and enhancing the coverage of financial services is reasonable, the macro-level testing of the hypothesis is not enough. Second, since the result of urban entrepreneurial activity is a combination of the economic, demographic, industrial and institutional environment of the city, the process should be identified at the macro level. Third, there are also financing constraints that play a significant role in transmitting the effects of the digital financial inclusion on the urban entrepreneurial activity. The majority of previous research has been focused on the analysis of the digital finance and the behavior of entrepreneurs on the individual or household or firm level, which does not leave much room for empirical research on the overall scale of the urban entrepreneurial ecosystem. Furthermore, only a small amount of literature has studied the spatial limits of the dividends of the digital finance under the traditional geographical perspective of the Hu Huanyong Line. Following this logic, the paper will use the data of 238 prefecture-level cities of China over the period of 2015-2023 (balanced panel) to analyze the effect of the digital financial inclusion on the overall ecosystem of the urban entrepreneurship, and at the same time, the mechanism of the financing constraint will be tested.

2.2. Hypotheses Development

Grounded in long-tail theory and information asymmetry theory, digital financial inclusion can increase the financial accessibility of potential entrepreneurs by reducing transaction costs, transcending the spatial constraints of physical branches, and expanding the frontiers of financial services. Concurrently, digital footprints and big data-based risk management substantially improve credit identification efficiency, alleviating credit rationing issues exacerbated by information opacity and insufficient collateral [3][11]. Consequently, digital financial inclusion effectively lowers the entry barriers to entrepreneurship and stimulates urban entrepreneurial activity. Accordingly, this paper proposes the following hypothesis:

H1: Digital financial inclusion significantly promotes urban entrepreneurial activity.

The transmission channel of digital financial inclusion that influences urban entrepreneurial activity is the financing constraints. Startups in traditional financial system often have to deal with high barriers to funding because they lack collateral, credit history and unstable cash flows [6][12]. These micro-level financing challenges are mitigated by digital financial inclusion of entrepreneurial entities through diversification of fund supply sources, improving credit evaluation methods and lowering information search expenses thus facilitating urban entrepreneurial practice. Based on this, the following hypothesis will be suggested in this paper:

H2: Digital financial inclusion promotes urban entrepreneurial activity by alleviating financing constraints.

Additionally, the city and its digital financial inclusion can be considered as a heterogeneous factor in terms of the inclusive dividends of the digital financial inclusion in the urban entrepreneurial activities since it is dependent on the location of the city and the presence of additional resources. By dividing the Hu Huanyong Line into two parts, which are located in the south-eastern part with high population density, industrial concentration and development of digital technology, and the north-western part with low economic aggregate and migration effect, the cities that are separated by this line have the potential to establish powerful network effects and ecological relationships with the digital financial inclusion, whereby micro and small businesses can easily translate their financial assets to real production. On the other hand, the northwestern side is restricted by the lack of economic accumulation, the out-migration of talents, and lack of market depth. Although the access to funds offered by the digital financial inclusion will be minimal, the absence of the industrial collaboration, government services, and the demand of the markets might cause the idling of financial resources, and the inability to transform them into the micro-scale business practices. The following hypothesis is therefore suggested in the paper:

H3: The promoting effect of digital financial inclusion on urban entrepreneurial activity exhibits spatial heterogeneity along the Hu Huanyong Line, with a more pronounced effect in cities on the southeastern side.

3. Methodology and Data

3.1. Data

The research sample is the data of 238 prefecture-level cities in China over the years between 2015 and 2023. The Institute of Digital Finance, Peking University has provided a source of digital finance information that is the Peking University Digital Financial Inclusion Index of China. Data on financials at firm level are obtained through the database of the China Stock Market and Accounting Research (CSMAR). The macroeconomic statistics on the city level are based on the statistical bulletins of the China City Statistical Yearbook and provinces and municipalities year after year.

In terms of the sample selection and data pre-processing, the paper does not consider the firms in the financial and real estate sectors as well as those that are marked as ST, *ST or other forms of operations. The cities which were subject to administrative division change are also excluded to make the sample spatiotemporal consistent. Linear interpolation is used to fill in the missing values at the

macro level and continuous variables are winsorized at the 1st and 99th percentile to minimize the effect of extreme outliers. It has a total of 2, 142 city-year balanced panel observations.

3.2. Variable Selection

3.2.1. Dependent Variable

Consistent with prior work in the literature [5][7], this paper measures urban entrepreneurial activity as the number of new registered firms per 100 people, and then takes its natural logarithm to obtain the dependent variable ($\ln_Entrep$). There are two benefits from this transformation: first, the use of a per-capita density eliminates the confounding influence of the size of the urban population and facilitates comparisons across regions; second, the natural logarithm transformation alleviates the skewness and heteroscedasticity problems in the raw data, which helps improve the estimation of the model.

3.2.2. Explanatory Variable

The explanatory variable of this paper is the degree of urban digital financial inclusion development ($DIFI$), which is determined by the Peking University Digital Financial Inclusion Index of China, jointly created by the Institute of Digital Finance, Peking University and Ant Group. This index is built on the huge underlying data of Ant Group and includes three dimensions, coverage breadth, usage depth and level of digitization, which fully reflects the features of the development of digital financial inclusion and successfully avoids the biases in measurement that are usually related to single-indicator proxies. Furthermore, the index is specifically broken down to the city and county levels thus being very compatible with the prefecture-level city research scale of this paper. Since this dataset has been extensively used within the economics community, it significantly contributes to the comparability of the conclusions of this paper.

3.2.3. Control Variable

To exclude, to the greatest extent possible, the confounding effects of other city-level characteristics on entrepreneurial activity and to avoid omitted variable bias, this paper also selects the following control variables: (1) Economic development level ($\ln_GDP$), measured as the natural logarithm of per capita GDP . (2) Financial development (FD), measured as the ratio of the year-end loan balance of financial institutions to GDP . (3) Urbanization level ($Urban$), measured as the share of the urban resident population in the total population. (4) Government intervention (Gov), measured as the ratio of local general public budget expenditure to GDP . (5) Urban population size ($\ln_Pop$), measured as the natural logarithm of the total urban population.

3.2.4 Mediating Variable

The mediating variable selected in this paper is firm-level financing constraints (FC). Drawing on a approach [14], which identifies financing constraints based on firm characteristics and predicts the degree of financing constraints using a Logit model, this paper constructs a firm-level financing constraint index. The specific estimation formula is as follows:

$$P(QUFC = 1|Z_{i,t}) = \frac{e^{Z_{i,t}}}{1 + e^{Z_{i,t}}} \quad (1)$$

where $Z_{i,t}$ is the combination of characteristic variables that influence firm financing constraints, with the specific expression as follows:

$$Z_{i,t} = \alpha_0 + \alpha_1 size_{i,t} + \alpha_2 lev_{i,t} + \alpha_3 \left(\frac{CashDiv}{ta} \right)_{i,t} + \alpha_4 MB_{i,t} + \alpha_5 \left(\frac{NWC}{ta} \right)_{i,t} + \alpha_6 \left(\frac{EBIT}{ta} \right)_{i,t} \quad (2)$$

where $size$ denotes the natural logarithm of total assets, lev denotes the asset-liability ratio, $CashDiv$ denotes cash dividends, MB denotes the market-to-book ratio, NWC denotes net working capital, $EBIT$ denotes earnings before interest and taxes, and ta denotes total assets.

Operationally, this paper first standardizes variables such as firm size, firm age, and the cash dividend payout ratio by year with uniform direction, and then constructs a comprehensive firm financing constraint score. Smaller firm size, shorter firm age, and lower cash dividend payout ratios generally indicate a higher degree of financing constraints. Subsequently, the sample firms are ranked according to the comprehensive score, and the upper and lower tertile thresholds are utilized to construct a financing constraint dummy variable, *QUFC*: firms with higher degrees of financing constraints are assigned a value of 1, and firms with lower degrees of financing constraints are assigned a value of 0. A larger fitted probability value obtained from the above Logit model indicates a higher degree of financing constraints faced by the firm, and this is defined as the firm-level financing constraint index (*FC*). Finally, aggregating by the city of firm registration, the firm-level indices are averaged across the city-year dimension to obtain the macro city-level financing constraint index (*FC*), which serves as the mediating variable in the subsequent mechanism test. Variable definitions and descriptive statistics are shown in Table 1 and Table 2, respectively.

Table 1. Variable Definitions

Variable Type	Variable Name	Symbol	Measurement
Dependent Variable	Entrepreneurial Activity	<i>ln_Entrep</i>	Number of newly established firms per 100 people, logarithmized
Explanatory Variable	Digital Inclusive Finance Index	<i>DIFI</i>	Peking University Digital Financial Inclusion Index of China
Mediating Variable	Financing Constraints	<i>FC</i>	Fitted probability of financing constraint estimated by a Logit model based on firm-level characteristics
Control Variables	Financial Development	<i>FD</i>	Balance of loans from financial institutions / GDP
	Urbanization Level	<i>Urban</i>	Urban resident population / total population
	Government Intervention	<i>Gov</i>	Local general public budget expenditure / GDP
	Urban Population Size	<i>ln_Pop</i>	Natural logarithm of total year-end urban population
	Economic Development Level	<i>ln_GDP</i>	Natural logarithm of per capita GDP

Table 2. Descriptive Statistics

Variable Name	N	Mean	Median	SD	Min	Max
ln_Entrep	2142	4.934	4.889	0.470	3.566	8.533
DIFI	2142	245.118	244.737	47.073	136.300	373.221
Urban	2142	0.407	0.340	0.231	0.015	1.000
Gov	2142	0.212	0.181	0.107	0.059	0.916
FD	2142	2.869	2.560	1.294	0.910	21.301
ln_Pop	2142	5.876	5.865	0.723	3.302	8.075
ln_GDP	2142	10.916	10.878	0.530	9.304	12.237

3.3. Empirical Models

3.3.1. Baseline Regression Model

To investigate the direct impact of digital financial inclusion on urban entrepreneurial activity, this paper specifies the following two-way fixed effects model as the baseline regression model:

$$\ln_Entrep_{i,t} = \alpha_0 + \alpha_1 DIIFI_{it} + \sum_{k=1}^n \beta_k Control_{k,it} + \mu_i + \delta_t + \epsilon_{it} \quad (3)$$

where *i* and *t* index city and year, respectively; *ln_Entrep_{i,t}* represents urban entrepreneurial activity; *DIFI_{i,t}* denotes the level of digital financial inclusion development; *Control_{k,i,t}* represents control variables; *μ_i* denotes city fixed effects; *δ_t* denotes year fixed effects; and *ε_{i,t}* is the stochastic error term.

3.3.2. Mediation Effect Model

To verify the role of financing constraints in the logical chain of “digital financial inclusion - urban entrepreneurial activity,” this paper constructs the following mediation effect model:

$$FC_{i,t} = \gamma_0 + \gamma_1 DIFI_{i,t} + \sum_{k=1}^n \lambda_k Control_{k,i,t} + \mu_i + \delta_t + \epsilon_{i,t} \quad (4)$$

where $FC_{i,t}$ is the firm financing constraint index obtained through the Logit model. A significantly negative coefficient for γ_1 would substantiate the hypothesis that the proliferation of digital financial inclusion effectively alleviates financing constraints.

4. Empirical Results and Discussion

4.1. Baseline Regression Analysis

Table 3 presents the baseline regression results. The results show that the regression coefficient of digital financial inclusion (*DIFI*) on urban entrepreneurial activity (*ln_Entrep*) is 0.0052, and it is significantly positive at the 1% statistical level, indicating that for every one-unit increase in the *DIFI* index, urban entrepreneurial activity increases by an average of 0.52%. The underlying reason may be that digital financial inclusion, through technologies such as mobile payments, online lending, and big data-based risk control, lowers the barriers to entry for financial services, alleviates information asymmetry and credit rationing problems, and improves the financing accessibility of micro and small entities and startups. The alleviation of financing constraints reduces the entry costs of entrepreneurship, thereby invigorating urban entrepreneurial activity. Therefore, Hypothesis H1 is supported.

Table 3. Baseline Regression Results

	(1)	(2)
	ln_Entrep	ln_Entrep
DIFI	0.0058*** (5.27)	0.0052*** (4.34)
Urban		-0.2528* (-1.91)
Gov		0.1754 (0.77)
FD		-0.0265** (-2.52)
ln_Pop		0.0341 (0.19)
ln_GDP		0.1283** (2.09)
constant	3.5133*** (13.04)	2.1965 (1.60)
City FE	Yes	Yes
Year FE	Yes	Yes
N	2142	2142
R ²	0.7682	0.7707

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.2. Mechanism Analysis

To elucidate the internal mechanism through which digital financial inclusion affects urban entrepreneurial activity, this paper examines the mediating role of financing constraints using model (4). The regression results in Table 4 show that the coefficient of the core explanatory variable digital financial inclusion (*DIFI*) on financing constraints (*FC*) is -0.0023 and is significantly negative at the 1% level, indicating that digital financial inclusion significantly alleviates firm financing constraints, thereby verifying the logical pathway of “digital financial inclusion — alleviation of financing constraints — enhancement of urban entrepreneurial activity.” Through big data and algorithms, digital financial inclusion curtails information asymmetry, empowers micro and small entrepreneurial entities access funds at low cost, and lowers entrepreneurial barriers, demonstrating that alleviating financing constraints is an important lever through which digital financial inclusion drives the enhancement of urban entrepreneurial activity. This provides micro-level evidence for digital finance promoting the high-quality development of mass entrepreneurship and innovation. Hypothesis H2 is supported.

Table 4. Mediation Effect Test Results

	(1)	(2)
	FC	FC
DIFI	0.0021**	-0.0023***
	(2.28)	(-3.21)
Urban		0.0216
		(0.29)
Gov		-1.3136***
		(-9.09)
FD		0.3423***
		(40.41)
ln Pop		1.5269***
		(14.96)
ln GDP		0.5786***
		(15.72)
constant	0.2275	-14.7636***
	(1.00)	(-17.98)
City FE	Yes	Yes
Year FE	Yes	Yes
N	2142	2142
R ²	0.5699	0.7813

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3. Heterogeneity Analysis

The Hu Huanyong Line is a basic boundary of the spatial distribution of the population and economic development in China. The region to the west of this line has poor infrastructure, low population, and low resource endowments as compared to the region east of the line which has a comparatively developed economic base and productive capacity. Based on this, using the Hu Huanyong Line as the dividing line, this paper divides the research sample into two subsamples (cities on the southeastern side and cities on the northwestern side) and performs individual regressions with the findings presented in Table 5.

In column (2), it is revealed that in the case of cities located on the southeastern side of the Hu Huanyong Line, the coefficient of digital financial inclusion (*DIFI*) is 0.0047 and significantly positive at the 1% level which means that in densely populated and economically developed areas, digital financial inclusion can well release its benefits to reduce information asymmetry and relieve

financing pressure by extensive internet coverage and active market environments, thus greatly promoting entrepreneurial activity. Column (4) indicates that in the case of cities on the northwestern side, the coefficient is -0.0011 and not significant. These empirical findings are characterized by spatial imbalance, mainly because the northwestern side has a two-fold digital divide infrastructure-based and usage-based and an underdeveloped entrepreneurial ecosystem, which makes it hard to transform the dividends of digital financial inclusion into entrepreneurial momentum. Conversely, the southeast side has developed a robust digital finance environment where the conversion of financial resources into entrepreneurial momentum is more effective. Hypothesis H3 is supported.

Table 5. Heterogeneity Analysis Results

	(1)	(2)	(3)	(4)
	ln_Entrep	ln_Entrep	ln_Entrep	ln_Entrep
	Southeastern Side		Northwestern Side	
DIFI	0.0055***	0.0047***	-0.0006	-0.0011
	(4.85)	(3.74)	(-0.27)	(-0.48)
Urban		-0.2582*		-0.4541*
		(-1.88)		(-1.91)
Gov		0.0266		-0.1135
		(0.11)		(-0.36)
FD		-0.0445***		0.0149
		(-3.70)		(1.61)
ln_Pop		0.0132		0.0613
		(0.07)		(0.16)
ln_GDP		0.1123*		0.1895
		(1.75)		(1.62)
constant	3.5751***	2.7089*	4.9696***	2.9236
	(12.70)	(1.89)	(9.74)	(1.08)
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1998	1998	144	144
R ²	0.7732	0.7775	0.8862	0.8978

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.4. Endogeneity Check

To address the potential endogeneity concerns arising from reverse causality between digital financial inclusion and urban entrepreneurial activity, this paper uses the one-period lag of the digital financial inclusion index (*lag_DIFI*) as an instrumental variable and conducts 2SLS estimation. On the one hand, the development of digital finance exhibits clear path dependence and technological inertia; prior-period infrastructure construction and user habits directly determine the current period's service depth, so the lagged *DIFI* is strongly correlated with the current *DIFI*, satisfying the relevance condition. On the other hand, the lagged *DIFI* is a predetermined variable that temporally precedes the current period's entrepreneurial random shocks; it is unlikely to be reversely influenced by current unobservable factors, and the likelihood of being affected by random shocks to current entrepreneurial activity is low, satisfying the exogeneity condition.

The results in Table 6 show that in the first stage, the coefficient of *lag_DIFI* is 0.5588 and is significantly positive at the 1% level. The Kleibergen-Paap rk LM statistic and the Kleibergen-Paap rk Wald F statistic unequivocally reject the null hypotheses of under-identification and weak instruments, respectively. Meanwhile, the Hansen J statistic confirms that the instrumental variable selected in this paper satisfies the exclusion restriction, with no over-identification bias.

The second-stage results show that the coefficient of *DIFI* is 0.0090 and remains significantly positive at the 1% level, indicating that after controlling for potential endogeneity, the promoting effect of digital financial inclusion on urban entrepreneurial activity still holds, and the baseline conclusion exhibits satisfactory robustness.

Table 6. Endogeneity Test Results

	(1)	(2)
	DIFI	ln_Entrep
lag_DIFI	0.5588***	
	(29.64)	
DIFI		0.0090***
		(3.82)
Urban	-0.8395	-0.2333
	(-0.38)	(-1.52)
Gov	2.0539	0.3045
	(0.55)	(1.17)
FD	0.1821	-0.0345***
	(1.16)	(-3.13)
ln_Pop	17.4626***	-0.1700
	(5.69)	(-0.72)
ln_GDP	3.6200***	0.1215*
	(3.62)	(1.69)
City FE	Yes	Yes
Year FE	Yes	Yes
N	1904	1904
R ²	0.9939	0.0150
Kleibergen-Paap rk LM statistic		660.867
Kleibergen-Paap rk Wald F statistic		878.757
Hansen J statistic		0.000

t statistics in parentheses

$p < 0.1$, $p < 0.05$, $p < 0.01$

4.5. Robustness Check

To further validate the reliability of the baseline regression conclusions, this paper conducts robustness checks from two dimensions: replacing the core explanatory variable and adjusting the sample period. The results are shown in Table 7. First, the composite digital financial inclusion index is substituted with its sub-dimension metrics coverage breadth (*DF_Breadth*) and usage depth (*DF_Depth*) separately for regression. The results show that the regression coefficient of *DF_Breadth* is 0.0033 and that of *DF_Depth* is 0.0035, both significantly positive at the 1% level, indicating that the development of different dimensions of digital financial inclusion can significantly enhance urban entrepreneurial activity. Second, considering that the COVID-19 pandemic in 2020 may have introduced anomalous macroeconomic shocks to firm registrations and entrepreneurial activities, this paper further excludes the 2020 sample and re-estimates. The results show that the regression coefficient of *DIFI* is 0.0041 and remains significantly positive at the 1% level. The above results indicate that whether replacing the measurement indicators of digital financial inclusion or excluding the special-year sample, the promoting effect of digital financial inclusion on urban entrepreneurial activity remains significant, and the baseline conclusion exhibits satisfactory robustness.

Table 7. Robustness Checks

	(1)	(2)	(3)
	ln_Entrep	ln_Entrep	ln_Entrep
DF_Breadth	0.0033***		
	(3.32)		
DF_Depth		0.0035***	
		(3.86)	
DIFI			0.0041***
			(3.41)
Urban	-0.2339*	-0.2504*	-0.2571**
	(-1.76)	(-1.89)	(-2.00)
Gov	0.1618	0.1803	0.4466*
	(0.71)	(0.79)	(1.88)
FD	-0.0258**	-0.0240**	-0.0286***
	(-2.45)	(-2.29)	(-2.80)
ln_Pop	0.2058	0.1140	0.1916
	(1.23)	(0.66)	(1.10)
ln_GDP	0.1268**	0.1610***	0.1769***
	(2.04)	(2.66)	(2.82)
constant	1.6825	1.8287	0.9614
	(1.23)	(1.34)	(0.70)
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	2142	2142	1904
R ²	0.7698	0.7702	0.7892

t statistics in parentheses

$p < 0.1$, $p < 0.05$, $p < 0.01$

5. Research Conclusions and Policy Recommendations

5.1. Research Conclusions

This paper systematically examines the effect of digital financial inclusion on urban entrepreneurial activity, transmission mechanism and spatial heterogeneity based on balanced panel data of 238 prefecture-level cities in China between 2015 and 2023. The empirical results are as follows: First, digital financial inclusion has a significant positive impact on urban entrepreneurial activities. This conclusion is still valid after endogeneity problem is solved by instrumental variable method and robustness tests are conducted, which indicates that digital finance can exert a stable stimulating effect on urban entrepreneurship. Second, financing constraints are an important transmission channel for the impact of digital financial inclusion on entrepreneurial activities. Digital financial inclusion reduces the entry barriers to entrepreneurship by decreasing information asymmetry, increasing financial accessibility, and alleviating financing constraints, thus promoting urban entrepreneurial vitality. Third, the entrepreneurial promotion effect of digital financial inclusion has obvious spatial heterogeneity, which is demarcated by the Hu Huanyong Line. There are significant effects in cities on the southeastern side of the line, but not in those on the northwestern side, indicating that the entrepreneurial dividends of digital finance are unevenly distributed across geographic spaces, and that differences in digital infrastructure, industrial agglomeration levels, and the entrepreneurial ecosystem fundamentally constrain the actual efficacy of digital financial inclusion in empowering entrepreneurship.

5.2. Policy Recommendations

Based on the above results, this paper offers the following four specific policy suggestions to help regional policymakers leverage the entrepreneurial benefits of digital financial inclusion in light of local conditions.

To begin with, keep improving the digital financial inclusion framework and improve the financial reach of entrepreneurship. The policy framework on mass entrepreneurship and innovation should incorporate digital financial inclusion at all levels of government to promote commercial banks, internet banks, and other financial institutions to create low-threshold digital credit products that are specifically designed for startups and individual entrepreneurs. At the same time, facilitate the compliant incorporation of government data into financial institutions, minimize customer acquisition and risk control expenses, and direct financial resources towards micro and small entrepreneurial entities more accurately.

Second, specifically relieve the financing limitations and empower the credit empowerment of digital finance. Policy paradigms ought to shift beyond the simple enhancement of the supply of funds towards enhancing the ability to identify credits. The local governments can partner with fintech companies to create credit information platforms of micro and small businesses. These platforms can compile data across commerce, taxation, social security and judicial sectors to produce strong credit profiles of entrepreneurial entities hence enabling entrepreneurial groups without collateral, financial statements or loan records to access the formal financial system.

Third, use differentiated regional digital finance plans to close the digital divide that is cut by the Hu Huanyong Line. The cities in the southeastern part ought to encourage the combination of digital finance and industrial chains as well as innovation chains, which should create supply chain finance and sci-tech finance to trigger high-growth entrepreneurship. The northwestern side cities ought to concentrate on overcoming the shortcomings in digital infrastructure, enhancing network coverage in counties and rural regions, and institutionalizing digital financial literacy programs to provide entrepreneurial entities with the skills of how to use digital financial tools.

Fourth, improve the urban entrepreneurial ecosystem and increase the synergistic impacts of digital finance policies. The regional governments should align the digital financial inclusion with the industrial policies, talent policies and reforms in business environment. As an example, tax reductions or social insurance subsidies can be offered to micro and small enterprises that use digital credit for entrepreneurship, and digital financial services can be integrated into industrial parks and incubators, which would create an entrepreneurial support system based on the availability of finances, affordable costs and access to services.

References

- [1] JACK W, SURI T. Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution [J]. *American Economic Review*, 2014, 104 (1): 183-223.
- [2] SURI T, JACK W. The long-run poverty and gender impacts of mobile money [J]. *Science*, 2016, 354 (6317): 1288-1292.
- [3] BERG T, BURG V, GOMBOVIĆ A, PURI M. On the rise of FinTechs: Credit scoring using digital footprints [J]. *Review of Financial Studies*, 2020, 33 (7): 2845-2897.
- [4] AGARWAL S, QIAN W, YEUNG B Y, ZOU X. Mobile wallet and entrepreneurial growth [J]. *AEA Papers and Proceedings*, 2019, 109: 48-53.
- [5] GLAESER E L, KERR W R, PONZETTO G A M. Clusters of entrepreneurship [J]. *Journal of Urban Economics*, 2010, 67 (1): 150-168.
- [6] EVANS D S, JOVANOVIĆ B. An estimated model of entrepreneurial choice under liquidity constraints[J]. *Journal of Political Economy*, 1989, 97 (4): 808-827.
- [7] HALTIWANGER J, JARMIN R S, MIRANDA J. Who creates jobs? Small versus large versus young [J]. *Review of Economics and Statistics*, 2013, 95 (2): 347-361.

- [8] HURST E, LUSARDI A. Liquidity constraints, household wealth, and entrepreneurship [J]. *Journal of Political Economy*, 2004, 112 (2): 319-347.
- [9] KERR W R, NANDA R. Democratizing entry: Banking deregulations, financing constraints, and entrepreneurship[J]. *Journal of Financial Economics*, 2009, 94 (1): 124-149.
- [10] ROBB A M, ROBINSON D T. The capital structure decisions of new firms [J]. *Review of Financial Studies*, 2014, 27 (1): 153-179.
- [11] BRYNJOLFSSON E, HU Y J, SMITH M D. Research commentary—Long tails vs. superstars: The effect of information technology on product variety and sales concentration patterns [J]. *Information Systems Research*, 2010, 21 (4): 736-747.
- [12] STIGLITZ J E, WEISS A. Credit rationing in markets with imperfect information [J]. *American Economic Review*, 1981, 71 (3): 393-410.
- [13] STAIGER D, STOCK J H. Instrumental variables regression with weak instruments [J]. *Econometrica*, 1997, 65 (3): 557-586.
- [14] HADLOCK C J, PIERCE J R. New evidence on measuring financial constraints: Moving beyond the KZ index [J]. *Review of Financial Studies*, 2010, 23 (5): 1909-1940.