The Digital Inclusive Finance and Enterprise Innovation: Evidence from A-share Market

Bowen Liu[1], Xin Wen[2], Yufan Zhang[3(✉)], and Xiaomeng Zhong[4]

[1] High School, Zhangqiu Bilingual School, Jinan 250220, China
[2] Business School, Soochow University, Suzhou 215021, China
[3] College of Art, University of Minnesota, Minneapolis, MN 55455, US
zhan7884@umn.edu
[4] Business School, Durham University, Durham DH1 3LB, UK
xiaomeng.zhong@durham.ac.uk

Abstract. In China, the integration of digital technology and finance has gradually formed a digital supply mode of inclusive finance, which alleviates the financing limitations of small and medium-sized businesses to a certain extent and is significant for enterprise innovation activities that need financial support. Under the National Innovation-driven Development Strategy, it is particularly meaningful to evaluate whether digital inclusive finance can foster company innovation. This article empirically evaluates the impact of digital inclusive finance on firm innovation and development using data from all listed companies on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 2011 to 2018 together with the city level digital inclusive finance index. The result shows how digital inclusive financing may support businesses' innovative processes, and its role in promoting innovation differs among enterprises of different scales, but such heterogeneity effect can be absorbed by industry effect and time effect. The result of this paper sheds lights on the role of digital inclusive finance in improving enterprise performance by solving the financing dilemma of them, and according to the empirical results, this paper suggests that the support for digital inclusive finance should be further improved in order to promote the good and healthy development of the real economy, which refers to the part of a country's economy that produces goods and services, rather than the part that consists of financial services such as banks and stock markets.

Keywords: Digital inclusive finance · Enterprise innovation · Financing constraints

1 Introduction

1.1 Background Information

The term 'inclusive finance,' which is founded on the ideas of equal opportunity and corporate sustainability, refers to the general public having equal access to responsible and sustainable financial services. Its basic idea is to provide suitable and effective

financial services to all social classes and groups with financial service demands while assuming that all of them can afford such services. Inclusive finance mainly focuses on small and micro businesses, farmers, urban low-income individuals, and other disadvantaged groups as the key service targets, and focus on the balance to help relatively disadvantaged groups. With the rapid development of technology and related financial policy environment, 'Financial Technology' has become an important force in promoting financial inclusion.

The vigorous growth of inclusive finance is advantageous for promoting financial sector's sustainable and balanced development, encouraging mass entrepreneurship and innovation, facilitating the transformation and upgradation of economic development, and advancing social fairness and social harmony.

The target of inclusive finance is not to provide charity or relief; instead, it is to assist the groups enhancing the blood-making function while complying to the principle of commercial sustainability, sticking to combing market-oriented and policy support, and putting in place a sound incentive and constraint mechanism to ensure sustainable development. Principle of marketability is needed to be the foundation of inclusive finance, and it is essential to address the requirements of more groups as well as to reasonably benefiting the supply side in the process of developing inclusive finance. The topic of inclusive finance meets the current needs of international socio-economic and financial development, which includes both G20 and non-G20 countries, especially many developing countries.

The historical development of digital inclusive finance is roughly divided into four stages. The first stage is the theoretical presentation of the concept of digital inclusive finance, the second stage realized the simple application of the Internet, the stage to the Internet as a carrier to deliver information, to be able to provide less efficient offline financial services, are due to technical limitations but some remote areas basically cannot experience financial services.

In the third stage of development, which is currently in process, digital inclusive finance has been developed comprehensively and at a high speed, applying cloud computing, artificial intelligence, big data, and other financial technologies to establish a digital inclusive finance system, making financial services easier and more efficient than in the first two stages of development, changing the way of working and improving the standard of living of the public [1].

1.2 Financing Problems Faced by Chinese Enterprises

Enterprises have developed into a potent engine to support the high-quality development of China's economy as the primary driver of innovation. However, because of limitations imposed by China's traditional financial system, many businesses, those particularly small and medium-sized ones, frequently struggle because of a lack of adequate financial support, which limits their ability to grow.

On the one hand, small and medium-sized businesses tend to have higher credit risk and less available funding channels due to their small market scale, poor capital situation, and imperfect financial system. In addition, these enterprises tend to have insufficient fixed assets and other properties available for mortgage, so their mortgage capacity is often insufficient. Moreover, due to the high operational risk and low profitability

of these enterprises, guarantors who meet the banks' standards are often reluctant to guarantee them. On the other hand, when facing financing requests from these companies, traditional financial institutions are biased since they believe that the operation of these companies is lack stability, and they have to bear greater risks in providing loans. Thus, these institutions are more willing to provide financial support for large-scale enterprises in good financial condition [2].

Influenced by multiple factors, numerous companies of small and medium size in China are having trouble getting financed. The People's Bank of China estimates that bank loans account for 98.7% of the funding for these businesses. Although bank loans are these businesses' primary source of funding, their success rate with bank loans is only 77%, which is much lower than large ones (88%). Small and medium-sized businesses in China have major issues with a lack of access to capital and poor financing success rates.

Based on prior research, this paper will use A-share companies listed on the Shanghai and Shenzhen Stock Exchange from 2011 to 2018 as the research subject, empirically test how digital inclusive finance affects fostering enterprise innovation, and explain how the expansion of the financial market affects enterprise innovation from the perspective of digital finance. This paper's findings will serve as a guide for China's long-term development of digital inclusive finance.

This paper's remaining sections are organized as follows: The research design, which is the second component, introduces the data source, sample information, empirical model, and descriptive statistical findings; The third section contains the empirical findings and analysis, which talks about how enterprise innovation is affected by digital inclusive finance and its coverage as well as further examines the heterogeneity of the innovation incentive effect of digital inclusive finance. The robustness test's findings are presented in the fourth section, and the article's conclusion is presented in the fifth.

2   Literature Review

China is actively carrying out digital inclusive finance, which has played a positive role in improving China's financial market and promoting economic development. Dong Yufeng studied the theoretical logic of digital inclusive finance for poverty alleviation and found that digital inclusive finance can improve the financial availability in remote areas with the help of financial technology advantages [3]. By studying the impact of financial technology on high-quality development, Xue Ying et al. found that financial technology has an impact on resource allocation and innovation, which can promote the financial industry from virtual to reality and improve the ability of finance to serve the real economy [4].

Digital inclusive finance can help enterprises increase financial supply, which also encourages regular and prudent resource allocation and established certain restrictions on excessive business financial investment. In order to alleviate the 'crowding out effect' of enterprise financial investment on innovation output, Yang Yaping et al. Conducted a research on the account of the panel data of A-share market listed companies and new third board listed companies since 2011 until 2018. The paper studied the influence of the digital inclusive finance on the financial investment behaviour and innovation output

of Chinese real enterprises, and finds that the financial investment of real enterprises will inhibit enterprise innovation, and digital inclusive finance can alleviate the crowding out effect of financial investment behavior on enterprise innovation [5]. Using information from listed firms on the new third board from 2011 to 2018 along with the digital inclusive finance index at the prefecture level, Hui Xianbo conducted empirical research and found that the emergence of digital inclusive finance can aid businesses with their access to external capital while also enhancing the innovative impact of government tax declaration [6]. In addition, the role of digital inclusive finance in stimulating enterprise innovation is particularly obvious in the eastern region, regions with perfect market supervision and high-tech industries. Teng Lei and others believe that digital inclusive finance can further improve the value of information through data collection and mining, reduce information asymmetry in financial services, and reduce investment and financing risks of enterprises [7]. Wan Jiayu et al. discovered through empirical study that the promotion of digital finance will greatly ease businesses' financial restrictions, and that this can result in an improvement in corporate innovation [8].

To sum up, the higher the development level of digital inclusive finance, the more reasonable the allocation of financial resources. Digital inclusive finance avoids the unreasonable allocation of financial assets, further weakens the occupation of innovative resources by enterprises, and provides a stable and sustainable capital protection. To a certain extent, digital inclusive finance has played a positive role in the innovative outsource of corporate financial investment.

3   Research Design

3.1   Data Resources

This study's research object is Shanghai and Shenzhen A-share listed businesses from 2011 to 2018. The data selected are as follows: the enterprise technological innovation is taken from the China stock market and accounting research database, and the digital financial inclusion data is taken from the Peking University Digital Financial Inclusion Index published by the research team of Peking University Digital Finance Research Center. The sample data is processed as follows: excluding Special Treatment (ST), *Special Treatment (*ST), Penetrant Testing (PT), delisted companies, companies issuing B or H shares at the same time, financial enterprises with less than 8 employees, enterprises with the negative book value of main business income and owners' equity, and enterprises with key financial data for less than 5 years; shrinking all continuous variables at 1 and 99 places and deleting the missing samples. A total of 18,643 enterprise observations were obtained from 2011 to 2018.

3.2   Model Specification

The following empirical model is built up to assess the effects of digital inclusive finance on technical innovation on businesses.

$$R\&D = \alpha_0 + \alpha_1 \times \text{Coverage Breadth}_i + \mathbf{x'}_i\boldsymbol{\beta} + \varepsilon_i \qquad (1)$$

Table 1. Definition of variables (This figure was made by author.)

Variables	Variable types	Definition
Coverage Breadth	Core explanatory variables	For the breadth of digital financial coverage, see Peking University Digital Inclusive Financial Inclusion Index 2018
R&D	dependent variable	The logarithm of business research and development expenditure of digital finance
Asset, unit:10000 Yuan	Controlled variables	End-of-term total assets
Debt, unit:10000 Yuan	Controlled variables	Total debt at the end of the term
Age	Controlled variables	The length of time for companies to go public
top1	Controlled variables	The largest shareholder holds (%) shares
SOE = 1	Controlled variables	State-owned enterprise = 1, otherwise 0
Foreign = 1	Controlled variables	Foreign enterprise = 1, otherwise 0
Board Size	Controlled variables	Board size
No. of Independent Director	Controlled variables	Number of independent directors
Salary, unit:10000 Yuan	Controlled variables	Executive pay
ROA, %	Controlled variables	Return on assets

In Eq. (1), R&D is the dependent variable, which represents the technological innovation expenditure; Coverage Breadth is the explanatory variable, namely the digital financial coverage breadth; x'_i represents a series of control variables affecting the technological innovation of small and micro enterprises; and ε_i is a random error item.

This paper uses the digital financial inclusion index to measure the development of digital financial inclusion in various regions, and uses the sub dimension index of the index coverage width test.

Based on the research of Gan Li, the control variables selected in this paper include final total assets (Asset), final total liabilities (Debt), length of time for listing (Age), the largest shareholder shareholding ratio (%) (top1), state-owned enterprise = 1 (SOE), otherwise 0; foreign enterprise = 1 (Foreign), and otherwise 0. Size of the board (Board Size), number of independent directors (No. of Independent Director), executive compensation (Salary, unit: 10,000 Yuan), return on assets (ROA).

Table 2. Descriptive statistics of the main variables (This figure was made by author.)

Variable	Obs	Mean	Std. Dev.	Min	Max
Coverage Breadth	18643	193.1685	60.7928	−10.49	290.3175
R&D, unit:10000 Yuan	18643	10198.756	23028.672	0	148001.8
Asset, unit:10000 Yuan	18643	1319074.4	4190242.3	18657.975	45434239
Debt, unit:10000 Yuan	18643	807851.61	2976068.7	3627.572	33624640
Age	18643	9.6204	7.2536	0	25
top1	18643	34.9478	15.1419	.29	89.99
SOE = 1	18643	.3799	.4854	0	1
Foreign = 1	18643	.0477	.2132	0	1
Board Size	18643	8.6277	1.7213	5	15
No. of Independent Director	18643	3.1866	.5705	2	5
Salary, unit:10000 Yuan	18643	371.2091	358.3207	15.7712	2411.08
ROA, %	18643	4.3175	6.2884	−32.8121	23.4179

3.3 Summary Statistics

The descriptive statistical results of specific variables are reported in Table 2. The results in Table 2 show that the standard deviation of digital financial R&D expenditure (R & D) is 23028.672, the mean is 10198.756, and the maximum and minimum gap is relatively large, 148001.8 and 0 respectively, which indicates that the innovation output gap between the sample enterprises in this paper is large. The mean and standard deviation of digital financial coverage breadth (Coverage Breadth) are 193.1685 and 60.7926, respectively, and the gap between the highest and lowest values is relatively large, with 290.3175 and −10.49, respectively. The results show that there are great differences in the development level of digital inclusive finance in different regions. The standard deviation of the shareholding ratio (top1) is 15.1419, the mean value is 34.9478, and the gap between the maximum and minimum values is relatively large.

4 Empirical Results

4.1 Benchmark Regression

Table 1 displays the findings of the empirical investigation of digital inclusive financing on firm innovation incentives. The findings demonstrate that the coverage breadth coefficient is positive and is statistically significant at the 1% confidence level. Based on the estimated results in column (4), if the coverage breadth improves by 1 unit, the R&D investment of businesses would increase by 0.99 percent, showing that the creation and promotion of digital inclusive finance enhance business innovation. Teng Lei and Ye Rongsheng proved that this is due to the fact that digital inclusive finance may dramatically lower the cost of debt financing for firms of small and medium size and ease their financing limitations, so as to alleviate the financial difficulties in the innovation process of these enterprises [9].

In terms of control variables, the results show that the enterprise's every additional year of listing would bring about 21.54% decrease in the R&D expenditure. And if the year-end asset increases by 1%, the R&D expenditure would increase by 167.11%; if the year-end debt increases by 1%, this figure would decrease by 54.83%. Moreover, foreign companies' average R&D expenditure is 56.8% less than that of domestic companies. The R&D expenditure has a significant positive correlation with executive compensation (Table 3).

Table 3. Benchmark regression results (This figure was made by author.)

VARIABLES	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	OLS
	Ln R&D	Ln R&D	Ln R&D	Ln R&D
Coverage Breadth	0.0258***	0.0244***	0.0101***	0.0099***
	(0.0009)	(0.0009)	(0.0017)	(0.0016)
Age		−0.1588***		−0.2154***
		(0.0286)		(0.0223)
Age-sq		−0.0069***		0.0015
		(0.0013)		(0.0010)
Ln asset		1.7831***		1.6711***
		(0.1286)		(0.1059)
Ln debt		−1.1447***		−0.5483***
		(0.0939)		(0.0775)
top1		−0.0318***		−0.0042
		(0.0038)		(0.0030)
SOE = 1		−0.9479***		−0.1879*
		(0.1469)		(0.1142)
Foreign = 1		−0.6447***		−0.5680***
		(0.2011)		(0.1826)
Board Size		0.0270		0.0747**
		(0.0455)		(0.0375)
No. of Independent Director		0.0045		−0.1258
		(0.1419)		(0.1155)
Ln salary		0.5314***		0.6012***
		(0.0846)		(0.0659)
ROA, %		0.0012		0.0073
		(0.0085)		(0.0071)
Constant	8.8563***	−10.2438***	10.4299***	−20.9133***
	(0.1920)	(1.3204)	(0.3787)	(1.1376)
Observations	18,643	18,643	18,643	18,643
R-squared	0.0452	0.1730	0.4497	0.5050
Industry Dummy	No	No	Yes	Yes
Year Dummy	No	No	Yes	Yes

Note: in brackets are standard deviations; '*', '* * *', '* * *' means that the coefficients are significant at the significance level of 10%, 5% and 1% respectively.

The coefficient of Coverage Breadth is positive and statistically significant, which means that businesses' innovative process can be supported by digital inclusive finance.

4.2 Heterogeneity Analysis

Heterogeneity is also the existence of differences, each aggregate may be heterogeneous, mixed by a number of different sub-totals. For this reason, we try to relax the assumption of homogeneity in the model setting and selection as much as possible and conduct heterogeneity analysis in order to get a more reasonable understanding or to make an empirical test of more complex theoretical hypotheses.

It is assumed that Dummy is defined as the total asset size of the year above the 50th percentile is 1, otherwise, it is 0. That is, a large enterprise is considered when Dummy = 1 and 0 are considered as a small enterprise.

The coefficients of interaction terms in columns (1) and (2) in the Table 4 are significant but after the inclusion of time fixed effects and industry fixed effects in the estimated results in columns (3) and (4), the coefficients of interaction terms are not significant, indicating that the impact of digital finance development on corporate R&D expenditure is not scaled heterogeneous. Alternatively, the industry effect and time effect absorb these effects.

5 Robustness Test

An analytical procedure's robustness is an estimate of its capacity to remain unaffected by subtle but intentional modifications to method parameters and a sign of its dependability under typical conditions. A technique's robustness may be determined experimentally using a robustness testing device. The ability of an analytical process to be repeated in several laboratories or under various circumstances without causing unexpected variations in the obtained result is defined as robustness [10].

Based on the estimation results displayed in Table 5, the result for the test of coverage breadth age, and asset, are under the significance level of 1%, which means that the above empirical results are robust.

Additionally, since the robustness test uses the balanced panel data, the observations are different from the other analysis and it decreases to the same level of quantity, and in the test, the first two lines do not use the year dummy and the other two use the year dummy.

To sum up, as shown in the test result, the statistics selected could be estimated as robust, so the data used in the calculation is valid and the result of the test is reliable.

Table 4. Heterogeneity Analysis (This figure was made by author.)

VARIABLES	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	OLS
	Ln R&D	Ln R&D	Ln R&D	Ln R&D
Coverage Breadth	0.0256***	0.0234***	0.0105***	0.0102***
	(0.0010)	(0.0009)	(0.0018)	(0.0017)
Dummy	8.6084***	11.6346***	2.0392	1.3693
	(1.6288)	(1.6306)	(1.2886)	(1.2565)
Dummy × Coverage Breadth	−0.0316***	−0.0399***	0.0007	−0.0010
	(0.0064)	(0.0063)	(0.0050)	(0.0049)
Age		−0.1545***		−0.2143***
		(0.0285)		(0.0222)
Age-sq		−0.0074***		0.0013
		(0.0013)		(0.0010)
Ln asset		1.6950***		1.6083***
		(0.1295)		(0.1071)
Ln debt		−1.1306***		−0.5438***
		(0.0938)		(0.0774)
top1		−0.0308***		−0.0040
		(0.0038)		(0.0030)
SOE = 1		−0.9098***		−0.1748
		(0.1466)		(0.1141)
Foreign = 1		−0.6234***		−0.5619***
		(0.2001)		(0.1827)
Board Size		0.0230		0.0732*
		(0.0453)		(0.0374)
No. of Independent Director		0.0221		−0.1142
		(0.1415)		(0.1153)
Ln salary		0.5366***		0.6043***
		(0.0845)		(0.0659)
ROA, %		0.0014		0.0058
		(0.0084)		(0.0071)
Constant	8.8606***	−8.6235***	10.5129***	−19.7373***
	(0.1975)	(1.3708)	(0.3794)	(1.1801)
Observations	18,643	18,643	18,643	18,643
R-squared	0.0465	0.1768	0.4532	0.5058
Data	Unbalanced	Unbalanced	Unbalanced	Unbalanced
Industry Dummy	No	No	Yes	Yes
Year Dummy	No	No	Yes	Yes

Table 5. Robustness test (This figure was made by author.)

VARIABLES	(1)	(2)	(3)	(4)
	Panel FE	Panel FE	Panel FE	Panel FE
	Ln R&D	Ln R&D	Ln R&D	Ln R&D
Coverage Breadth	0.0293***	0.0441***	0.0045***	0.0039***
	(0.0010)	(0.0015)	(0.0006)	(0.0003)
Age		−0.7686***		−0.5746***
		(0.0530)		(0.0507)
Age-sq		0.0131***		0.0144***
		(0.0019)		(0.0018)
Ln asset		1.0378***		1.4269***
		(0.2416)		(0.2235)
Ln debt		−0.3835**		−0.3467**
		(0.1626)		(0.1527)
top1		−0.0223**		−0.0120
		(0.0091)		(0.0077)
SOE = 1		−0.5328		0.0387
		(0.3748)		(0.2855)
Foreign = 1		0.2801		0.3298
		(0.6147)		(0.5330)
Board Size		0.0736		0.0747
		(0.0621)		(0.0584)
No. of Independent Director		0.0695		−0.0647
		(0.1919)		(0.1769)
Ln salary		0.2000		0.2372**
		(0.1276)		(0.1172)
ROA, %		0.0155		0.0267***
		(0.0096)		(0.0092)
Constant	8.1306***	−6.1429**	12.1621***	−11.3835***
	(0.2429)	(2.9283)	(0.6179)	(2.5518)
Observations	13,200	13,200	13,200	13,200
Number of id	1,650	1,650	1,650	1,650
Data	Balanced	Balanced	Balanced	Balanced
Year Dummy	No	No	Yes	Yes

6   Conclusion

In conclusion, the coefficient of Coverage Breadth is positive and statistically significant, which means that digital inclusive finance might encourage the innovative process of enterprises. And as shown in the robustness test result, the statistics selected could be estimated as robust, so the data used in the calculation is valid and the result of the

test is reliable. As a result, digital finance can truly improve enterprise performance by solving the financing dilemma of enterprises, providing important impetus for economic structural transformation and high-quality growth, and promoting the good and healthy development of the real economy. The result of the research suggests that the government could support more deeply on the digital inclusive finance to help the development of enterprises and economy of the country.

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