

The Impact of Information Technology Innovation on the Financing Constraints of Small and Medium-Sized Enterprises: An Empirical Research Based on Panel Data

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Abstract—This paper is predicated on the assumption of China's fast growth of digital finance, which may aid the nation in better realizing financial service democratization and lowering the high cost of conventional financial services. The purpose of this article is to examine the link between the growth of digital finance and the financing restrictions of small and medium-sized enterprises, specifically whether the development of digital finance can effectively ease enterprise financing constraints. This study may contribute to a degree to the country's subsequent digital finance development strategy. Corporate data from 2011 to 2018 and the financial inclusion index from the same time were utilized in this article. Analyses using econometrics and big data models indicate that digital finance may significantly reduce SMEs' funding restrictions, however, the conclusions are not conclusive. It demonstrates that digital banking has a broader impact than merely assisting small and medium-sized enterprises in overcoming obstacles. It is suggested that China can also introduce relevant policies to further help small and medium-sized enterprises solve financing difficulties.

Keywords- Growth of digital finance, Funding of SMEs, Big data analysis, Econometrics, SA index.

1 INTRODUCTION

Financial transactions such as online payments are made possible by combining traditional financial institutions with modern internet-based digital technologies. In China, digital banking evolved over 30 years, starting with a shift in consumption. 2003 was noted as a landmark. Aside from banks and stock informatization, digital finance had limited influence on the financial industry until 2003. Since the launch of Alipay in 2003, China's internet finance has evolved. Although not created in China, this financial model is well suited to Chinese financial and commercial structures. Online buying platforms like Taobao have grown increasingly popular thanks to Alipay. It helps China's consumer business expand by improving transaction procedures and the transaction environment. In 2013, WeChat Pay made its public debut, forever changing the world of mobile payments. Paying using Alipay or WeChat is an entirely different experience. While Alipay distributes cash from customers to businesses through middlemen, WeChat transfers funds directly from consumers to merchants. China's two main transaction channels are now established. Few millennials have ventured out with cash in recent years [1].

The second difference is that as online third-party payments have grown in popularity, so has the market structure of China's transfer and clearing. Initially, transfer and settlement were required to permit inter-bank payments. The Central Bank Clearing Center founded Wanglian Clearing Co., Ltd. (Wanglian) in 2017 to build a shared transfer clearing platform for non-bank third-party payment organizations. Determining the appropriate network connectivity for each third-party payment institution is critical. There are two organizations for money transmission and clearing in China. UnionPay handles money settlements between traditional banks, whereas Netlink handles internet payments made by non-bank payment providers [2].

Third, the way data is used in digital banking is evolving. Banking is another data-intensive industry. Internet-based enterprises use a lot of data. Search engines and e-commerce companies acquire consumer data. They may run a modest lending company using their data resources. For example, Alibaba has established a financial small company loan based on e-commerce transactions. Traditional financial institutions gather data on people's assets and transactions, whereas internet businesses collect data on people's consumption habits and transaction quotas. Online transaction data gives e-commerce enterprises an advantage. Consumers are leaving a growing quantity of data assets online as a consequence of internet activity. As a result, big data systems at banks and internet companies may grow into a data transaction paradigm. Internet companies can improve the accuracy with which the financial industry analyses company, personal credit, and risk [3].

Because China oversees the digital financial system, citizens often use Alipay and WeChat to pay for consumption, utilities, and other living expenses, all of which build credit and produce credit histories. Chinese online finance aided by the rapid expansion of e-commerce and communication technology may reduce dependency on physical stores, expand geographical reach, reduce costs, and promote inclusive finance [1].

Small and medium-sized company finance has long been a Chinese economic concern. The main causes include the knowledge gap between banks and small and medium-sized firms (SMEs), and increased bank competition.

Historically, the Chinese state monopolized the banking industry. Since the mid-1980s, four giant banks have dominated Chinese banking: ICBC, Agricultural Bank of China, Bank of China, and China Construction Bank. Starting in 1987, when the government allowed the establishment of joint-stock banks like the Bank of Transportation and Commercial, through the late 1990s, when nation-owned banks were reformed and commercial banks were founded. The Chinese financial sector has progressively gained a reputation for fierce competitiveness. Because bank expansion affects the country's economic condition, the state is keenly interested in bank development. For example, Xi Jinping said in 2017 that "enhancing indirect finance structure, encouraging strategic reform of giant state-owned banks, and establishing small to medium-sized banks and private financial institutions" are important steps. While fast banking sector expansion is unquestionably advantageous to the country's overall economic condition, it will also result in financing limits such as loan availability. In the 2017 Government Work Report, Executive Council Premier Li Keqiang stated unequivocally that "large state-owned banks should lead the way in implementing differentiated assessment and evaluation methods and support policies to effectively ease the financing of small, medium, and micro-enterprises." High-risk, high-cost funding." [2]. The two main sources of SMEs financing are bank loans, private investment, and diluted shares. However, China's government's control of big publicly listed enterprises' information is strict. Small and

medium-sized businesses, however, are not as heavily regulated. Small and medium-sized enterprises face more operational risks and insolvency than large corporations. If we do not do a complete business evaluation and mortgage, the bank may deny the loan. A bank would certainly lose money if it competes blindly for consumers without complete corporate knowledge.

With insufficient research expenses, bank managers would seek to work with major corporations by lowering interest rates for large companies to borrow money from them. Large companies have larger loan amounts than ten small and medium-sized businesses, thus examining and approving them costs money. Large corporations regularly work with banks to prolong loan agreements for up to five to ten years, lowering loan interest and repayment time, thus saving banks a lot of evaluation expenses that SMEs cannot afford. A bank would certainly lose money if it competes blindly for consumers without complete corporate knowledge [2].

In this case, digital finance may help relieve some of the bank strain. First, the expansion of digital finance has increased the variety of financing sources and accessible funds. Digital finance is a growing financial business model that uses digital technologies to ease borrowing, payment, and investment. The financial market's long tail is made up of a vast number of scattered small-scale investors. The traditional financial market is hampered by cost, technology, and other considerations, making it inefficient to absorb this investor category. With digital banking, we can fix deficiencies in traditional financial services, cut entry barriers and costs, reach a larger audience, and provide more efficient and accessible services to more financial enterprises. Research shows that digital finance increases money accessible to enterprises and lowers credit distortion while promoting efficient resource allocation.

Digital finance also improves financial intermediation's data-gathering capacities. Credit and risk are crucial in financial borrowing. The daily credit evaluation of the enterprise's internal personnel can be used to assess the enterprise's structure and personnel structure, establishing a credible tripartite credit reporting agency that can provide a generally consistent judgment on whether SMEs satisfy loan goals and loan amounts. Investigate specific low-quality customers to guarantee banks may comfortably lend to SMBs.

Based on this, the major goal of this study is to examine the relationship between digital finance and easing financing limits for SMBs.

The paper is arranged as follows. Section 2 is the literature review. Section 3 is the research design. Section 4 shows the model's findings using existing data. Section 5 presents the model's empirical findings and the influence of data finance on SMEs funding; Section 6 concludes.

2 LITERATURE REVIEW

Numerous studies have been conducted in China on funding restrictions and digital finance, with a particular emphasis on the following areas. To begin, there is a wealth of literature on the evolution of digital finance. Zhang Xun stated that the development of digital finance is beneficial to achieving China's inclusive development and assisting low-income groups in their income distribution [4]. Huang Yiping demonstrated the existing and future development of China's digital finance industry and examined the link between digital finance and economic development, regulatory innovation, and monetary policy [3]. Wan Jiayu discovered that digital

finance contributes significantly to corporate innovation and gives theoretical support and innovation advice on topics such as inadequate corporate innovation [5]. Yang Weiming discovered that although digital finance has considerably increased the consumption level of urban residents in my nation in terms of coverage breadth, depth of usage, and degree of digitization, it has had little effect on rural inhabitants' consumption upgrades [6].

In terms of financing restrictions, Xie Jun demonstrated that corporate investment expenditures were highly dependent on internal cash flow and that macro-monetary policy may effectively ease corporate financing constraints [7]. State-owned businesses' compensation control systems may effectively reduce finance limitations and boost financing alternatives [8]. Zhang Zhaoqin discovered that developing SMEs significantly alleviates funding limitations [9]. Jiang Fuxiu investigated the effect of banking competition on financing limits, discovered that banks played a critical role in SMEs financing, and advocated that SMEs be actively guided to expand their financing options [2].

To summarize, although there are several studies on digital finance and financing restrictions, there is a dearth of research on the influence of digital finance on SMEs funding. This article performs an in-depth analysis of the evolution of digital finance and the difficulty index of corporate financing from this vantage point. This study examines the beneficial effect of digital finance on financing restrictions from a fresh perspective, doing an in-depth analysis using the econometrics model.

3 RESEARCH DESIGN

3.1 Sample screening and data sources

The data in this article are mostly drawn from listed companies in Shanghai and Shenzhen A-share markets between 2011 and 2018. According to a prior study conducted by researchers, the following precise screening steps are used: 1. Eliminate financial industry company samples. 2. Eliminate firms subject to ST and *ST from the sample. 3. Discard samples that have missing values for variables. 4. To account for the effect of extreme values, we used the winsorize technique to do a 1% double-sided winsorize of the major continuous variables. 5. Because this study is primarily concerned with the funding restrictions faced by small and medium-sized businesses, only firms with a stock code beginning with 002 are reserved.

The enterprise data relies on financial data from the Shenzhen Guotai'an CSMAR database. The CSMAR database is China's current large-scale, accurate, and comprehensive economic and financial research database. Cathay Pacific established it in response to academic research demands and accordance with the professional standards of globally famous databases such as the University of Chicago's CRSP and Standard & Poor's Compustat. It has the qualities of precision, authority, thoroughness, punctuality, and bilingualism in both Chinese and English. The CSMAR database series is the only one in Greater China to have been chosen by the Wharton Research Service System (WRDS) and has received great praise from Nobel Laureate Robert William Fogel.

Statistical and mathematical editing applications such as STATA16.0 and excel are used in the presentation, and the company's observation is 5096.

In order to quantify financial restrictions, we need to find a specific way of measurement. At the moment, there is no globally standardized technique of measuring. The most critical is the approach of variable index analysis. The KZ index, the WW index, and the SA index are three extensively used indicators. Lamont established the KZ index using a logistic regression analysis of corporate cash flow, dividend return, and cash holding rate data [10]. The precise formula is as follows:

$$KZ = -1.002 * \text{Cashflow} + 0.283 * Q + 3.139 * \text{Lev} + 39.367 * \text{Div} - 1.315 * \text{Cashholdings} \quad (1)$$

The WW index is a financing constraint index developed by Whited and Wu by estimating the Euler investment equation using a linear combination of cash flow, asset ratio, and other financial indicators [11]. The formula is as follows:

$$WW = -0.091 * CF - 0.062 * DIV + 0.021 * LDEBT0.044 * LNTA + 0.102 * ISG - 0.035 * SG \quad (2)$$

In comparison to the SA index, the aforementioned two indicators include a much greater number of endogenous factors, such as leverage and cash flow. Financing limitations are inextricably linked to these two factors, and the SA index is developed using two highly exogenous variables that are unlikely to be influenced by business changes [12]. The precise formulation is:

$$0.737 \times \text{Asset} + 0.043 \times \text{Asset2} - 0.040 \times \text{Age} \quad (3)$$

Among these, Asset is the natural logarithm of the firm's total assets (measured in millions of Yuan); and Age is the date the company became public. The SA index has a negative value, which is changed to a positive value in this article. The greater the value, the more severe the enterprise's funding limitations [13].

3.2 Variables introduction

The study utilizes Peking University's digital financial inclusion index from 2011 to 2018 as the primary explanatory variable and a vast amount of national financial data from Ant Financial, China's biggest digital financial enterprise. Payment, loans, investment, and other businesses in various fields are classified as indicators, and the financial inclusion index for each region is calculated using depth of use, breadth of coverage, and degree of digitization as indicators, and spatially includes all provinces, prefecture-level cities, and counties in mainland China, specifically 31 provinces/cities/districts, 337 There are 2,800 counties (county-level cities and municipal districts) in cities above the prefecture-level to ensure vertical consistency and comparability [14].

According to the analysis of previous articles, the control variables included in this paper are the following: total assets at the end of the period, total liabilities at the end of the period, time taken for the company to go public, the shareholding ratio of the largest shareholder (percent), state-owned enterprise (SOE) = 1, otherwise 0, foreign-funded enterprise = 1, otherwise 0, the board size, and the number of independent directors.

3.3 descriptive statistics

Table 1 summarizes the descriptive statistics for the study's major variables. As shown in Table 1, the mean value for the degree of digital finance development is 195.53, and the standard deviation is 81.24, indicating that China's degree of digital finance development is relatively high, but the degree of digital finance development faced by small and medium-sized enterprises is quite different. In terms of the SA index, the total mean of SMEs is 3.59, with a standard deviation of 0.16. When property and liability data are combined, a significant discrepancy across firms is seen, with standard deviations of 1,048,682.1 and 719,779.93, respectively. The similar issue arises in the business era. Enterprises have an average age of 5.15 years, but maybe as old as 14 years. We can see from the SOE that the percentage of Chinese nation-owned SMEs is quite low, with the SOE value of 0.1648 suggesting a relatively large share of private firms in China's SMEs. We may anticipate that SMEs in China would confront higher funding limitations as a result of the inescapable relationship between national firms and banks.

Similarly, we can see that the proportion of Chinese SMEs classified under the influence of foreign capital is only 0.055. There are also significant disparities in the number of stockholders among Chinese SMEs, ranging from 5 to 15. Similarly, with a standard deviation of 6.26, we can see that there is a large difference in enterprise ROAs.

Table 1 Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Digitization Level	195.5313	81.2395	3.64	437.9068
SA index	3.3097	.1564	2.8232	3.718
Asset, unit: 10000 Yuan	511747.62	1048682.1	18657.975	22776239
Debt, unit: 10000 Yuan	252928.61	719779.93	3627.572	19140186
Age	5.1517	3.2723	0	14
top1	34.2534	14.6142	4.15	88.92
SOE=1	.1648	.3711	0	1
Foreign=1	.0555	.229	0	1
Board Size	8.3958	1.461	5	15
No. of Independent Director	3.0983	.4637	2	5
Salary, unit: 10000 Yuan	345.8397	309.7526	15.7712	2411.08
ROA, %	4.708	6.2585	-32.8121	23.4179

4 EMPIRICAL RESULT

4.1 Benchmark regression results

In Table 2, four distinct strategies for controlling variables were employed to perform benchmark regression. The first column contains the regression result without controlling any variables; the second column contains all variables but does not include industry or time fixed effects; the third column contains all variables but does not include industry or time fixed effects, and the fourth column contains all variables but does not include industry or time fixed effects. The estimated findings from the four distinct methodologies indicate that regardless of the variables used, the development of digital finance has a considerable effect on the SA index. As can be observed, the development of digital finance has had a negative effect on the SA index, implying that the

development of digital finance has to alleviate financing constraints. If the fourth column is used as a criterion, the degree of digital financialization rises by one unit, but the SA index lowers by 0.0019. This implies that as digital finance develops, it will provide SMEs with more lending options or channels when confronted with funding challenges.

And it can be seen that the financing constraint grows with age, but when Age sq is used, it can be seen that the financing constraint continues to decrease with the growth of age, which suggests that the financing restriction increases with time in the early stage of the firm growth, however as the firm expands to a certain time, the finance limitations reduce with age, presenting a quadratic shape with an opening downward. It can also be shown that in terms of importance, the rise of assets, liabilities, and board size would lead to the increase of corporate finance limitations, which has extraordinary significance. Whether the number of independent directors is already a foreign-funded business is often important. The development in the number of independent directors will lessen funding limitations, whereas the arrival of foreign-funded firms will raise corporate finance constraints. At the same time, it can be seen that for several other variables: the shareholding ratio of the largest shareholder, SOE, and salary have no significant impact on financing constraints, which can be ignored when judging corporate financing constraints.

Table 2 Benchmark regression

VARIABLES	(1)	(2)	(3)	(4)
	OLS SA index	OLS SA index	OLS SA index	OLS SA index
Digitization Level	-0.0009*** (0.0000)	-0.0019*** (0.0000)	-0.0023*** (0.0001)	-0.0019*** (0.0001)
Age		0.0476*** (0.0011)		0.0473*** (0.0011)
Age-sq		-0.0006*** (0.0001)		-0.0006*** (0.0001)
Ln asset		0.0160*** (0.0039)		0.0149*** (0.0038)
Ln debt		0.0071*** (0.0015)		0.0088*** (0.0016)
top1		0.0000 (0.0001)		0.0001 (0.0001)
SOE=1		-0.0004 (0.0023)		-0.0015 (0.0024)
Foreign=1		0.0058** (0.0028)		0.0056** (0.0028)
Board Size		0.0038*** (0.0010)		0.0044*** (0.0010)
No. of Independent Director		-0.0058** (0.0025)		-0.0062** (0.0025)
Ln salary		-0.0012 (0.0016)		-0.0007 (0.0016)
ROA, %		0.0007*** (0.0002)		0.0007*** (0.0002)
Constant	3.1367*** (0.0043)	2.5828*** (0.0616)	3.1095*** (0.0698)	2.5385*** (0.0610)
Observations	5,096	5,096	5,096	5,096

R-squared	0.2113	0.8566	0.2754	0.8680
Data	Unbalanced	Unbalanced	Unbalanced	Unbalanced
Industry Dummy	No	No	Yes	Yes
Year Dummy	No	No	Yes	Yes

4.2 Heterogeneity Analysis

Table 2 still needs further analysis, i.e., if digital banking has a varied effect on enterprises of various sizes. This issue may be resolved successfully by the use of heterogeneity analysis. We assign a dummy variable to 1 when the company's total assets exceed the 50th percentile in the current year, and to 0 otherwise.

As shown in Table 3, the interaction term is highly positive when considering columns 1 and 2, showing that the development of digital finance has a stronger influence on large firms. After including the year dummy variable into columns (3) and (4), the interaction term ceases to be significant, showing that there is no scale heterogeneity in the influence of digital finance development on corporate funding limitations. This implies that regardless of the size of the firm, digital finance is very beneficial for funding. All small and medium-sized businesses can benefit equally from digital financial inclusion, which means that the existence of digital finance significantly aids small businesses in obtaining financing and loans, as small businesses' financing constraints are significantly smaller than those of medium-sized businesses, and they are even less known. They can achieve parity with medium-sized firms via the use of digital finance, indicating that the development of digital finance is worthwhile and can play a critical role in the development and innovation of small and medium-sized enterprises in the nation.

Table 3 Heterogeneity Analysis

VARIABLES	(1)	(2)	(3)	(4)
	OLS SA index	OLS SA index	OLS SA index	OLS SA index
Digitization Level	-0.0008*** (0.0000)	-0.0015*** (0.0000)	-0.0028*** (0.0001)	-0.0012*** (0.0001)
Dummy	0.4391*** (0.1495)	0.1398 (0.1232)	0.3252** (0.1512)	0.0593 (0.1211)
Dummy × Digitization Level	-0.0012** (0.0005)	-0.0005 (0.0004)	-0.0007 (0.0005)	-0.0003 (0.0004)
Constant	3.1473*** (0.0044)	2.5611*** (0.0640)	3.1234*** (0.0670)	2.5106*** (0.0638)
Observations	5,096	5,096	5,096	5,096
R-squared	0.2257	0.8571	0.2938	0.8684
Data	Unbalanced	Unbalanced	Unbalanced	Unbalanced
Industry Dummy	No	No	Yes	Yes
Controls	No	Yes	No	Yes
Year Dummy	No	No	Yes	Yes

5 ROBUSTNESS TEST

To confirm the validity of the results, a robustness test is required. A fixed-effects model is one in which the group means are fixed (non-random), in contrast to a random-effects model in which the group means are a random sampling from a population. Generally, data may be classified according to several observable variables. For each grouping, the group means might be described as fixed or random effects. Each group mean is a fixed quantity in a fixed-effects model.

Fixed effects are the subject-specific means in panel data with longitudinal observations for the same subject. The term fixed effects estimator (a.k.a. inside estimator) is used in panel data analysis to refer to an estimate for the coefficients in the regression model that include those fixed effects (one time-invariant intercept for each subject).

Not all corporate data included in the data selection spans the years 2011 to 2018. These are referred to as imbalanced data. Even after adjusting for 1,200 imbalanced data points, the expansion of digital finance continues to have a considerable effect on business funding limitations. As shown, the degree of digital financialization grew by one unit, while the SA index declined by 0.0037 units.

Table 4 Robustness Test

VARIABLES	(1)	(2)	(3)	(4)
	Panel FE SA index	Panel FE SA index	Panel FE SA index	Panel FE SA index
Digitization Level	-0.0023*** (0.0000)	-0.0035*** (0.0000)	-0.0047*** (0.0000)	-0.0037*** (0.0001)
Constant	3.1120*** (0.0054)	2.5997*** (0.1252)	3.2133 (0.0000)	2.5876*** (0.1216)
Observations	3,896	3,896	3,896	3,896
Number of id	487	487	487	487
Data	Balanced	Balanced	Balanced	Balanced
Controls	No	Yes	No	Yes
Year Dummy	No	No	Yes	Yes

6 CONCLUSION

This article explores digital finance as a starting point, explores the theoretical link between it and corporate funding limitations and, finds the macro and micro transmission mechanisms between the two: The primary data set is from Shanghai and Shenzhen A-share stock market that starts with 002 from 2011 to 2018. Using SMEs as a sample, this article empirically examines the link between digital finance and small and medium-sized enterprises' funding restrictions. The study findings indicate that, on a micro-level, the influence of digital finance on reducing funding limitations is more pronounced in non-state-owned firms and small-scale enterprises. From a macroeconomic perspective, the innovative development of digital finance benefits the

financing structure and market environment, thereby increasing the quality and efficiency of financial services for the real economy and significantly reducing the financing constraints of small and medium-sized enterprises. The development of digital finance streamlines the banking industry's access to reliable corporate data and considerably improves the channels for SMEs to acquire loans, therefore contributing to China's inclusive finance development. According to the heterogeneity research, digital finance has no discernible effect on the financing limitations of firms with a variety of assets.

Today, as the Internet continues to develop, digital money has established itself as the key means of transaction in the future society, and this is expected to continue in the future. The priority should be to reduce regional differences in digital inclusive finance development, especially in light of China's fast expansion of digital inclusive finance. This increases the number of financing choices accessible to small and medium-sized enterprises (SMEs). Secondly, the National Bank can provide financing benefits to small and medium-sized enterprises that adhere to national standards, such as interest rate reductions and other policies that encourage small and medium-sized enterprises to borrow money, encourage small and medium-sized enterprises to invest more in research and development, and encourage small and medium-sized enterprises to make greater contributions to national construction and development. Digital finance may be used to do financial research on qualified enterprises utilizing big data and other analytical tools when considering them for funding. The country can promote advanced technologies such as big data, artificial intelligence, and blockchain while also deepening the structural reform of the financial supply side through financial innovation, allowing it to better integrate the financial industry with virtual numbers and improve the quality of financial services in the Internet finance sector at the same time.

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