

Digital Inclusive Finance and Financing Constraints - A Study Based on Manufacturing Industry

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Abstract. As an important part of China's economy, manufacturing firms have a fundamental impact on promoting high-quality economic growth. Digital inclusive finance is developing rapidly with its characteristics of digitization and other features, which is expected to alleviate the financing constraints of manufacturing firms. This paper selects manufacturing enterprises from 2011 to 2022 as the research object, and empirically examines the role and influence mechanism of digital inclusive finance on the financing constraints of manufacturing enterprises. The findings from the study indicate that there exists a substantial inverse relationship between digital inclusive finance and the financial limitations faced by manufacturers. In particular, the digital inclusive finance index has a more important negative relationship with financing constraints for enterprises with a high average age of management and high digitization level. In addition, digital inclusive finance can also reduce firms' financing constraints by breaking information asymmetry and reducing firms' leverage.

Keywords: Manufacturing Firms, Digital Inclusive Finance, Financing Constraints, Information Asymmetry, Company Leverage Levels.

1. Introduction

Chinese President Xi Jinping emphasized the importance of strengthening China's manufacturing sector and real economy to fulfill the goals of the "Two Centenary Goals," highlighting that "the manufacturing industry is the backbone of the national economy." By 2022, China's manufacturing industry had contributed 27.7% to the Gross Domestic Product (GDP), maintaining its position as the world's top manufacturing industry for more than a decade, with a continuous streak of 13 years. The manufacturing sector, a crucial component of the real economy, plays a vital role in China's economic advancement. Sustaining the growth of China's manufacturing industry has become a key focus in the current economic context. A significant challenge for manufacturing firms is the complexity and inefficiency in obtaining funding. Digital inclusive finance, which utilizes internet technology to lower transaction costs and financial service barriers, has emerged as a potent catalyst for the growth of the manufacturing industry. Conventional financing approaches often lack risk management systems, involve intricate qualification procedures, and consume considerable time, imposing burdens on enterprises seeking funding. These funding constraints are frequently apparent in funding restrictions.

In the academic sphere, substantial scholarly research has been dedicated to studying the influence of digital inclusive finance and its interplay with funding limitations. Studies on digital inclusive finance can be broadly categorized into two groups. The first group explores the impact of digital inclusive finance on urban-rural disparities and poverty alleviation. Huang Qian et al. [1] argued that the overall advancement of digital inclusive finance benefits residents in poverty alleviation, with marginalized groups gaining more from the progress of digital inclusive finance. Li Muchen et al. [2] explained that in the current developmental phase, the alignment of digital technology usage coverage and the depth of digital financial services has reduced the income gap between rural and urban areas.

The second group investigates the influence of digital inclusive finance on enterprises and economic progress. Liang Bang, Zhang Jianhua [3] empirically proved that the expansion and promotion of digital inclusive finance stimulate technological innovation in urban areas and small to medium-sized enterprises. The breadth of coverage, intensity of application, and quality of digital support services each have a significantly positive effect on technological advancement and innovation. Du Jinmin et al. [4] demonstrated that digital inclusive finance plays a crucial role in optimizing China's industrial structure, making significant contributions to the rationalization, advancement, and internal evolution trends of the industrial framework. Research by Zhao Xiaoge et al. [5] indicated that the expansion of digital inclusive finance can alleviate the "financial mismatch" issue in traditional financial services, thereby encouraging enterprise innovation. Previous studies have established correlations between factors [6] such as financial development, enterprise life cycle, ESG ratings, and funding constraints. However, scholarly exploration of the impact of digital inclusive finance on easing funding constraints within the manufacturing sector is somewhat limited.

Therefore, this study's innovation lies in two aspects: firstly, it seeks to explore the underlying mechanisms by which digital inclusive finance affects the funding obstacles faced by manufacturing enterprises, assessing the potential of digital inclusive finance in facilitating corporate funding. Secondly, the research conducts a comprehensive analysis of the interplay between digital inclusive finance and funding constraints, along with various heterogeneity examinations. The focus is on how digital inclusive finance can help manufacturing enterprises more effectively address funding challenges during the digital transformation process, ultimately achieving sustainable development.

2. Theoretical analysis and research hypothesis

Financial constraints typically refer to situations where firms face higher financing costs or cannot meet financing needs promptly compared to internal financing due to information asymmetry and agency problems. Alleviating financial constraints can adeptly enhance the financing capability of manufacturing enterprises, reduce financing costs, and promote healthy development. In contemporary times, scholars have begun to investigate the association between digital inclusive finance and the financial restrictions faced by businesses. Bu et al. clearly pointed out in their research that digital inclusive finance significantly contributes to easing financial restrictions faced by businesses.[7]. There are two main transmission pathways through which digital inclusive finance alleviates firm financial constraints.

Firstly, from the perspective of information asymmetry, digital inclusive finance can alleviate financial constraints by reducing the degree of information asymmetry. Information asymmetry refers to the unequal distribution of information between transacting parties, leading to inefficiencies in resource allocation. In the process of corporate financing, due to the presence of information asymmetry, financial institutions such as banks find it difficult to assess the true operating conditions and risk levels of enterprises. Consequently, financial institutions may increase financing costs or limit loan amounts to avoid potential adverse selection and moral hazard [8]. This exacerbates the financial constraints faced by enterprises, especially those in asset-specific manufacturing sectors [9]. Digital inclusive finance, however, can utilize online trading platforms to shorten the path to corporate financing, reduce resource misallocation, and improve the efficiency of corporate financing pathways. Additionally, internet financial services, relying on modern information technology, decrease the frequency of information transmission errors and data loss while leveraging their risk identification capabilities, thereby mitigating the degree of information asymmetry. This effectively reduces financial institutions' execution costs, risk assessment costs, and default costs [10], thereby effectively alleviating corporate financial constraints.

Secondly, from the perspective of corporate leverage levels, digital inclusive finance can affect the micro-transmission pathways of corporate leverage levels to alleviate financial constraints. Manufacturing enterprises are significantly influenced by macroeconomic conditions, and during economic downturns, the actual debt risk of manufacturing enterprises becomes more pronounced,

highlighting leverage risk [11]. The level of corporate leverage affects investor decisions, with higher leverage indicating higher debt levels, potentially leading to enterprises being forced to reduce debt financing to lower bankruptcy risks, thus facing higher financial constraints. Amid the advancement of digital inclusive finance, enterprises with financing advantages can reduce their liabilities, lowering financing costs. This creates space for leveraging up for enterprises with financing disadvantages, facilitating the optimization of capital structure and achieving the goal of structural deleveraging [12]. Furthermore, as digital inclusive finance, with its third-party payment features, effectively protects manufacturers' interests, it enhances corporate sales revenue, increases internal cash flow, and reduces the need for external funds [13], thereby lowering corporate leverage ratios. The reduction in corporate leverage levels signals lower debt levels, perceived as lower risk by creditors and investors, thus reducing financing costs and alleviating financial constraints. Drawing on the preceding analysis, this article suggests the subsequent transmission pathways for the consequences of digital inclusive finance on corporate outcomes financial restrictions:

H1: Digital inclusive finance has the potential to reduce financial constraints for manufacturing enterprises.

3. Research design

3.1. Sample selection and data sources

This paper investigates the impact of developing digital inclusive finance on the financial constraints of manufacturing enterprises listed on the Shanghai and Shenzhen stock exchanges from 2011 to 2022. The data for this study are derived from the China Stock Market & Accounting Research (CMSAR) database, with the exception of Green Inclusive Finance, which originates from the Digital Finance Research Center at Peking University. Following established research practices, the sample underwent the following treatments: (1) the exclusion of ST and ST* classified companies, (2) the elimination of instances with absent data, (3) the application of a 1% Winsorization technique to mitigate the influence of outliers on continuous variables.

3.2. Description of variables

(1) Dependent Variable

The Financial Constraints Index (SA) referenced from Yinbo F and Mengmeng M (2023) [14] is constructed in this study. The specific financial indicators and their respective weights are delineated as depicted in Equation (1).

$$SA_{it} = -0.737 \times Size_{it} + 0.043 \times Size_{it}^2 - 0.04 \times Age_{it} \quad (1)$$

Within this framework, "Size" denotes the log-transformed total assets of the corporation, whereas "Age" signifies the company's age (determined by subtracting the year of listing from the observation year). The "SA Index" is characterized by negative values, with smaller magnitudes indicating more severe financial constraints experienced by the enterprise.

(2) Independent Variable

The Beijing University Digital Inclusive Finance Index is employed to gauge the developmental level of inclusive finance across different regions [15]. Additionally, the provincial-level panel index (DIF) is selected as the explanatory variable. This index system, prevalent in current Chinese digital finance research, is adept at providing a comprehensive reflection of the developmental status of digital inclusive finance across various regions.

(3) Control variable

The covariates in this research comprise enterprise size (Size), leverage ratio (Lev), net profit margin (NetProfit), annual individual stock return rate, quantity of shares held by the top three shareholders (TOP3), price-to-book ratio (PB), asset turnover ratio (ATO), and ownership nature (SOE). The specific variable summary table is shown in Table 1.

Table.1. Variable definition

Variable type	variable symbol	Variable Definition
Dependent Variable	SA	The specific definition is given as described above
Independent Variable	Index_aggregate	Peking University Digital Financial Inclusion Index
Control variable	Size	The logarithm of the closing net assets
	Lev	Total liabilities / total assets
	NetProfit	(Net profit / sales revenue) ×100%
	Annual stock return	[(Ending year share price-Beginning year share price + annual dividend) / Beginning year share price] ×100%
	TOP3	Shares owned by the top three shareholders/the total share count
	PB	Market price per share / net assets per share
	ATO	Total asset turnover / type I agent costs
	SOE	Assign a value of 1 for state-owned enterprises, and 0 otherwise
	Year	Year dummy variables
	Industry	Industry dummy variables

3.3. Model building

In exploring the influence of digital inclusive finance on the financial limitations of corporations, this research sets up the foundational model in the following manner:

$$SA_{it} = \alpha + \beta_1 Index_aggregate + \beta_2 Control_{it} + \sum Year + \sum Ind + \varepsilon_{it} \quad (2)$$

In this model, the dependent variable SA_{it} represents corporate financial constraints, the explanatory variable $Index_aggregate$ signifies the digital inclusive finance index, $Control_{it}$ denotes control variables, $Year$ represents year-fixed effects, Ind indicates industry-fixed effects, α denotes the intercept, β_1 represents the coefficient of the explanatory variable, and ε_{it} represents the random error term.

4. Empirical analysis

4.1. Descriptive statistics

Table 2 presents the descriptive statistics for the main variables. The financing constraint (SA) exhibits a wide range of values, with a maximum of -3.243, a minimum of -4.437, a mean of -3.846, and a standard deviation of 0.237. This indicates that a substantial number of enterprises are grappling with financing challenges, underscoring the pressing need for solutions in this area. On the other hand, the digital inclusive finance index ($index_aggregate$) displays notable diversity, ranging from a minimum of 164.1 to a maximum of 459.0, with a mean of 304.8 and a standard deviation of 80.95. These figures suggest significant disparities in the adoption of digital inclusive finance among enterprises in different locations.

Table. 2 Descriptive statistics

Variable	N	Mean	SD	Min	p50	Max
SA	11980	-3.846	0.237	-4.437	-3.838	-3.243
Index_aggregate	11980	304.8	80.95	164.1	296.2	459.0
Size	11980	22.55	1.240	20.20	22.37	26.15
Lev	11980	0.454	0.192	0.0720	0.451	0.875
NetProfit	11980	0.0570	0.162	-0.775	0.0640	0.428
ISAR	11980	0.215	0.551	-0.550	0.0880	2.305
Top3	11980	46.51	14.61	18.22	45.34	83.88
PB	11980	3.638	3.071	0.510	2.730	18.70
ATO	11980	0.632	0.417	0.0880	0.540	2.448
SOE	11980	0.328	0.470	0	0	1

4.2. Basic regression analysis:

The findings from the primary regression analysis are outlined in Table 3. The regression coefficient linking the digital inclusive finance index and the SA index is 0.0002, signifying statistical significance at the 1% level. This result implies a negative association between the digital inclusive finance index and financing constraints, supporting the notion that digital inclusive finance can mitigate such constraints as hypothesized.

Table. 3 Basic regression results

VARIABLES	SA
index_aggregate	0.0002***
	(3.06)
Size	0.0223***
	(15.20)
Lev	-0.0794***
	(-13.66)
NetProfit	-0.0084**
	(-2.32)
ISAR	-0.0125***
	(-10.76)
Top3	0.0013***
	(16.01)
PB	0.0075***
	(25.44)
ATO	-0.0120***
	(-4.70)
SOE	-0.0178***
	(-5.75)
Constant	-4.2758***
	(-100.18)
Observations	11,980
Number of stkcd	2,997
R ²	0.7964
Year FE	YES
Industry FE	YES

z-statistics in parentheses

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

4.3. Robustness Tests

4.3.1 Replacement Dependent Variables

This paper conducts robustness test by constructing WW to replace SA index. Column (1) of Table 4 presents the outcomes of the regression analysis. The findings indicate that the coefficient associated with the digital financial inclusion index and the WW index is negative, successfully passing the statistical significance test. This finding aligns with the results from the baseline regression, thereby reinforcing the robustness of the baseline findings. It is evident that digital financial inclusion exerts a substantial negative influence on financing constraints.

4.3.2 Adding control variables

Considering the variables that may be omitted in this paper, on the basis of the previous study, this paper controls the company-level equity ratio (DER), liquid ratio (Liquid), total asset growth (Asset Growth), fixed assets (Fixed), and regresses them again. Displayed in column (2) of Table 4, the regression outcomes demonstrate the robustness of the study's conclusions.

In addition, due to the differences in economic level, policy regulations, culture and other factors in different provinces, considering that these factors may have an impact on the regression results, a province dummy variable (Province) is added so as not to miss important macro factors.

Moreover, to better test the robustness of the model, the cross fixed effects of year and industry are further controlled. The regression results are presented in columns (3) and (4) of Table 4. This result shows that it can be seen that after adding the dummy variable of province as well as the cross terms, the digital inclusion index and the SA index are significant at the 1% significance level, and digital inclusion still shows a negative effect on financing constraints, which reaffirms and solidifies the reliability of the model's findings.

4.3.3 Variable lagged

Taking into account the potential delayed effect of digital financial inclusion on the financing limitations of manufacturing firms, this paper newly generates the variable $NSA=F2.SA$ to test the robustness of the model. The regression results are shown in column (5) of Table 4. The regression results are consistent with the benchmark regression and the model has good robustness.

Table 4. Robustness test results

	(1)	(2)	(3)	(4)	(5)
VARIABLES	WW	SA	SA	SA	SA
index_aggregate	-0.0032**	0.0004***	0.0004***	0.0003***	0.0003***
	(-2.03)	(5.46)	(4.18)	(4.46)	(3.83)
Constant	9.4841***	-4.1866***	-4.1191***	-5.6154***	-4.4264***
	(9.46)	(-107.23)	(-100.65)	(-111.48)	(-106.21)
Observations	10,334	11,462	11,462	11,454	8,251
Number of stkcd	1,562	1,581	1,581	0.325	1,258
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES

4.3.4 PSM

In this paper, the total digital financial inclusion index is greater than the median is set as the treatment group, generating a dummy variable value of 1. Otherwise, it is assigned a value of 0 for the control group, and uses the enterprise size (Size), the balance sheet ratio (Lev), the net profit margin of sales (NetProfit), the individual stock return (ISAR) considering cash dividends in investment, the total asset turnover (ATO), and the nature of the property right (SOE) as the matching variables. The matching variables were processed according to 1:3 nearest neighbour matching and local linear regression matching respectively, and the matching variables passed the balance test. Columns (1) and (2) of Table 5 display the outcomes from the regression analysis. The findings indicate that the

coefficient associated with the impact of digital financial inclusion on financing constraints is positive. This finding provides additional evidence supporting the stability of the initial regression model.

Table. 5 Results of propensity score matching

	(1)	(2)
VARIABLES	SA	SA
index_aggregate	0.0003***	0.0003***
	(4.33)	(3.05)
Constant	-4.1303***	-4.1605***
	(-100.15)	(-73.89)
Observations	9,813	5,397
Number of stkcd	1,548	1,415
Year FE	YES	YES
Industry FE	YES	YES

5. Further study

5.1. Heterogeneity analysis

In this study, we conducted heterogeneity analysis based on the average age of the top management team (TMTAge). Older members in top management teams typically possess extensive company operational experience, which can impact investment decisions and strategic planning. The dataset was split into two groups using the median average age of the top management team. The regression outcomes are displayed in columns (1) and (2) of Table 6. The results reveal a significant coefficient of 0.0003 between the digital inclusive finance index and SA when the average age of the top management team is higher, at the 1% significance level. However, this significance diminishes for teams with a lower average age.

Furthermore, the level of digitization within enterprises serves as a valuable indicator of their development and technological influence. Hence, this study categorizes enterprises based on their digitization level (digitization_level). The regression findings are detailed in columns (3) and (4) of Table 6. The results demonstrate a significant coefficient of 0.0002 between the digital inclusive finance index and SA for highly digitized enterprises, significant at the 5% level. Conversely, the relationship between the digital inclusive finance index and SA is not statistically significant for enterprises with a low degree of digitization.

Table. 6 Heterogeneity analysis of the regression results

	(1) Higher average age of the management team	(2) Lower average age of the management team	(3) High digitization_level	(4) Low digitization_level
VARIABLES	SA	SA	SA	SA
index_aggregate	0.0003***	0.0000	0.0002**	0.0002
	(3.47)	(0.48)	(2.06)	(1.64)
Constant	-4.8808***	-3.7274***	-3.47927***	-3.5798***
	(-77.62)	(-64.51)	(-58.47)	(-69.77)
Observations	5,994	5,986	5,750	5,712
Number of stkcd	1,895	1,988	1,498	1,111
Controls	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES

5.2. Mechanism analysis

This research utilizes the firm's leverage ratio (Lev) as a surrogate for the level of corporate leverage. An elevated Lev value signifies a greater degree of leverage within the company. The fundamental regression outcomes of Lev concerning the development index of digital inclusive finance are depicted below. Based on the results, it is observed that, at a 1% significance level, there is an inverse association between the progression of digital inclusive finance and the extent of corporate leverage. As digital inclusive finance develops, the corporate leverage level gradually decreases, thereby reducing corporate financial constraints.

Furthermore, This study selects the comprehensive index of information asymmetry (DA) calculated based on stock liquidity as the measure of the degree of information asymmetry. The fundamental regression outcomes for DA in relation to digital inclusive finance are shown below. According to the results, at a significance level of 1%, the degree of advancement in digital inclusive finance is inversely associated with respect to the magnitude of information asymmetry. With the advancement of digital inclusive finance, the extent of information asymmetry for enterprises gradually decreases, leading to a reduction in corporate financing costs and a decline in the level of corporate financial constraints.

Table. 7 Mechanistic analyses of the regression results

	(1)	(2)
VARIABLES	Lev	DA
index_aggregate	-0.0001***	-0.0015***
	(-1.36)	(-5.76)
Constant	0.4191***	0.0856*
	(21.31)	(1.66)
Observations	11,428	11428
Number of stkcd	1,558	1558
Year FE	YES	YES
Industry FE	YES	YES

6. Conclusions

As an emerging sector that merges financial services with technological advancements, digital inclusive finance offers novel opportunities to mitigate the financial constraints faced by entities within the manufacturing industry. This study investigates how the progression of digital financial inclusion influences the financial limitations encountered by manufacturing firms by taking the manufacturing companies listed in Shanghai and Shenzhen A-shares from 2011 to 2022 as the research object. The specific conclusions of the study are as follows: firstly, a significant negative correlation is observed between the digital financial inclusion index and the financial limitations encountered by manufacturing businesses, suggesting that an increase in the digital financial inclusion index is associated with a mitigation of these constraints. Second, in the heterogeneity analysis, it is found that the correlation between the digital financial inclusion index and the SA index is more significant in companies where the average age of the company management is older and high digitization level. It indicates that the average age of company management is larger, as well as in the non-loss-making status, the financing constraints of the enterprises will be reduced. Finally, in terms of the mechanism, digital financial inclusion reduces corporate financing costs by breaking information asymmetry as well as alleviates the pressures associated with corporate financing by lowering corporate leverage levels.

The conclusion of this study has important policy implications for the development of digital inclusive finance in the new era, thereby alleviating the financing constraints of manufacturing enterprises and facilitating the shift in the dynamics of economic energy.

First, strengthen the improvement of digital inclusive finance to serve manufacturing enterprises. The central government emphasizes financial services for the real economy and people's lives. Therefore, it is essential to advocate for structural changes within the financial supply framework, with a concentrated effort on fostering the advancement of digital inclusive finance, thereby aiding the growth of manufacturing businesses. Concurrently, the financial sector ought to enhance its infrastructure, offer a variety of financial services, enhance the delivery of financial services to the tangible economy, and reduce barriers. This will enable small and medium-sized enterprises to access financial services with greater ease and reduced expense, thereby maximizing the inclusive impact of digital finance.

Second, manufacturing corporate should treat digital inclusive finance with a positive attitude. In particular, enterprises with older and non-loss-making management should seize the opportunity to make up for the shortcomings of the traditional credit market. Additionally, they should continue to improve their internal management level to ensure long-term advancement and optimize the utilization of the strengths inherent in digital inclusive finance.

Third, establish and promote the long-term mechanism to support the development of digital inclusive finance. The organic integration of technology and finance should be accelerated, the threshold of financial services should be lowered, and service boundaries should be expanded. The government should play a strategic leading role in the advancement of digital inclusive finance, formulate special support plans and strategies, overcome institutional barriers, strengthen talent training, innovation of technologies and the construction of digital inclusive financial platforms, and promote digital inclusive finance in all aspects to exert a more substantial influence in easing the financial limitations faced by manufacturing enterprises.

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