The Impact of Digital Finance on Corporate Technological Innovation: Evidence from Chinese A-Share Listed Companies

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Abstract

Digital finance, leveraging advanced digital technologies such as big data and artificial intelligence, profoundly influences the process of corporate technological innovation and significantly impacts the quality of economic development. This paper examines the impact and mechanism of digital finance on corporate technological innovation by matching the Peking University Digital Inclusive Finance Index (2011–2022) provincial data with data from Chinese A-share listed companies. Using bidirectional fixed effects models and mediation effect models for empirical analysis, the study finds that digital finance significantly promotes corporate technological innovation, and this conclusion remains robust after robustness tests. Digital finance enhances technological innovation by alleviating financing constraints, with financing constraints mediating this process. The impact of digital finance on technological innovation varies by scale and industry, with its effect being more pronounced for small and medium-sized enterprises and high-tech firms. This research contributes to providing more efficient financial support for corporate technological innovation through digital finance. It offers new insights for optimizing the development of digital finance and formulating targeted policies for technological innovation.

Keywords: digital finance; technological innovation; financing constraints

Introduction

Since the launch of economic reforms in mainland China in 1978, the country has rapidly developed and become the world's second-largest economy. A key driver of this growth has been the prioritization of innovation as a national strategy. In the report of the 20th National Congress of the Communist Party of China (2022), it was emphasized that China must "improve the technology innovation system" and "uphold the core role of innovation in our modernization efforts." Innovation has been elevated to a national strategic priority, positioning it as a core driver of economic development. In line with these goals, China needs to accelerate the implementation of innovation-driven development strategies, achieve technological self-reliance, and enhance independent innovation capabilities. As the primary entities driving national technological innovation, enterprises play a critical role in advancing technological progress.

In recent years, technological advancements have significantly transformed the global economy, with the digital economy emerging as a new growth engine. The widespread application of big data, cloud computing, and artificial intelligence has spurred the development of financial markets, transforming the provision and structure of financial services. Digital finance—driven by the rise of digital technologies—has broadened the sources of funding available for business innovation, increased the speed of information processing, and strengthened support for the real economy. It extends the breadth and depth of financial services while addressing financing constraints caused by information asymmetry between businesses and financial institutions (Bi Huiling, 2023).

Despite the growing recognition of digital finance's impact, the specific mechanisms by which it influences corporate innovation remain unclear. Scholars have examined digital finance from both macro and micro perspectives. At the macro level, research has explored the role of digital finance in driving economic growth (Xu & Fan, 2022), its impact on regional technological innovation (Peng et al., 2023; Xie, 2021), and its contribution to industrial upgrading (Mou et al., 2022; Yang et al., 2022). At the micro level, studies have focused on how digital finance supports business resilience during the COVID-19 pandemic (Xia et al., 2022), affects resource allocation (Feng et al., 2023; Jin et al., 2023), and improves the performance of small and micro enterprises (Zhou, 2020). Researchers have also examined digital finance's role in promoting green technology innovation (Ma, 2023; Zhang, 2023) and innovating financing models for small businesses. Other studies have analyzed the impact of digital finance on business innovation concerning the business lifecycle

(Liu et al., 2022), market dynamics and government interventions (Li & Liu, 2022), risk–taking (Fan & Du, 2023), financial management (Wu, 2023), and stock price information content (Wang, 2023).

However, there is a significant gap in understanding the mechanisms through which digital finance influences corporate innovation. While existing research indicates that digital finance promotes technological innovation, the precise pathways through which this occurs remain underexplored. Specifically, few studies have integrated digital finance, financing constraints, and technological innovation into a unified analytical framework, leaving the mediating role of financing constraints ambiguous. As digital finance continues to evolve, its effects on corporate technological innovation, particularly within the context of Chinese capital markets, require further empirical validation.

Given the rapid development of digital finance in China and its growing influence in capital markets, this study aims to address these gaps by investigating the relationship between digital finance and corporate technological innovation. Focusing on Chinese A–share listed companies, this research employs bidirectional fixed effects and mediation effect models to analyze panel data spanning from 2011 to 2022. By examining the mediating role of financing constraints, this study offers valuable insights into the mechanisms by which digital finance influences corporate innovation. The findings will provide strategic guidance for businesses and inform policymakers on how digital finance can further support technological innovation in China's economy.

Research Objectives

1. To explore the impact of digital finance on technological innovation in listed companies and the extent of the impact.

2. To verify the impact mechanism of digital finance on the technological innovation of listed companies, taking financing constraints as a mediating variable.

3. To create differentiated technological innovation strategies by analyzing the heterogeneous impacts of digital finance on technological innovation among listed companies under varied conditions.

Scope of the Research

Content Scope

This study aims to examine "The impact of digital finance on corporate technological innovation: Evidence from Chinese A-share listed companies."

Population and sample scope

This study selects China's Shanghai and Shenzhen A-share listed companies as the research sample, covering the period from 2011 to 2022. The digital finance data is sourced from the "Peking University Digital Inclusive Finance Index (2011-2022)" compiled by the Digital Finance Research Center of Peking University. Firm-level data is obtained from the CSMAR (China et al.) Database and the Chinese Research Data Services platform (CNRDS). To ensure the continuity and reliability of the data, the original sample data was processed as follows:

1. Exclusion of listed companies in the financial and real estate industries. Companies in these sectors have unique operating methods, asset-liability structures, and profit models that differ significantly from those of other companies and could introduce substantial bias into the empirical results.

2. Exclude companies labeled as ST (Special Treatment), *ST, PT (Particular Transfer) by the stock exchange during the sample period, as well as those that conducted an IPO within the period. These companies exhibit performance volatility that could affect other variables and influence the research results.

3. To ensure data continuity, exclude companies with missing financial data for the variables in the sample.

4. To mitigate the effects of extreme values and outliers, continuous variables in the sample were winsorized at the 1st and 99th percentiles.

After applying these selection and processing steps, the data was grouped and consolidated using Excel software, resulting in a panel dataset of 4,502 listed companies and 32,886 observations.

Spatial scope: China's Shanghai and Shenzhen A-share listed companies

Times scope: May-December 2024

Literature Review

Analysis of the Impact of Digital Finance on Corporate Technological Innovation

The impact of digital finance on corporate technological innovation can be analyzed from the following two perspectives:

First, digital finance alleviates the financing difficulties faced by enterprises. Technological innovation is a high-risk, high-investment activity that requires substantial funding, which traditional financial institutions often struggle to provide. The development of digital finance has created a favorable financing environment, offering businesses more convenient and low-cost financing channels (Jia, 2022). By leveraging big data, digital finance builds multidimensional credit assessment systems that enhance information transparency. Digital finance platforms accurately assess company credit, reduce information asymmetry, enable quick and cost-effective capital matching, and minimize adverse selection and moral hazard. Additionally, digital finance overcomes temporal and spatial limitations, providing high-quality services to small and medium-sized enterprises and improving the efficiency of financial resource allocation (Nie, 2020).

Second, digital finance enhances the efficiency of corporate innovation. By utilizing big data analytics, digital finance accelerates credit matching, offers flexible pricing, and strengthens market autonomy, helping businesses better understand market demands and drive technological innovation (Wang, 2023). Additionally, digital finance provides intelligent research and development management tools such as cloud computing and artificial intelligence, which improve R&D efficiency and shorten development cycles. The transformation and upgrading of traditional finance have also facilitated business financing and sparked enthusiasm for technological innovation (Cheng, 2022). Furthermore, digital finance supports intellectual property management, protects innovation outcomes, and enhances core competitiveness.

Based on the above theoretical analysis, this paper proposes the first hypothesis:

H1: Digital finance can promote technological innovation in enterprises.

Analysis of the impact mechanism of digital finance on corporate technological innovation

When studying the relationship between digital finance and corporate technological innovation, financing constraints are a critical mediating variable. According to the theory of financing constraints, these constraints impede technological innovation. Digital finance alleviates financing constraints and promotes corporate technological innovation through the following mechanisms:

First, Expanding Financing Channels: Digital finance leverages big data platforms to mobilize idle resources, drive the transformation of traditional financial institutions, and offer innovative financial products that enhance the financing environment. By making financing more intelligent and platform–based, digital technology reduces information asymmetry, increases financing opportunities for businesses, and connects companies with investors, enabling quick matching and personalized services.

Second, Reducing Financing Costs: Digital finance uses internet technology to capture market dynamics, build third–party credit systems, track business activities, quantify risks, and reduce information asymmetry, offering low–interest services to companies. Compared to traditional financing methods, digital finance products are more liquid and have lower interest rates, saving businesses financial costs and encouraging technological innovation.

Third, Improving Financing Efficiency: Digital finance employs big data, blockchain, and cloud computing to quickly filter information, identify risks (Nie & Wu, 2021), and accurately price financial products, enabling information sharing. This streamlines the approval process, shortens financing times, and enhances efficiency. Investors can use digital finance platforms to monitor project progress and fund utilization, ensuring effective use of capital.

Based on the above theoretical analysis, this paper proposes the second hypothesis:

H2 : Digital finance promotes corporate technological innovation by alleviating financing constraints.

Analysis of Scale Heterogeneity

Digital finance promotes technological innovation in companies, but its impact varies with company size. According to Schumpeter's innovation theory, large enterprises with substantial funds, abundant talent, and strong risk–bearing capacity are more likely to receive bank loans supporting their innovation activities. In contrast, small and medium–sized enterprises (SMEs) often face funding shortages, limited resources, and low transparency, resulting in insufficient bank credit support and financing difficulties that hinder technological innovation (Wan et al., 2020). Large enterprises leverage digital finance to innovate by optimizing management processes, enhancing efficiency, and improving product quality. SMEs use digital finance technologies for information identification and intelligent analysis, obtaining targeted financial services to alleviate barriers to technological innovation. Digital finance allocates resources effectively, expands financing channels for SMEs

directly and indirectly, addresses financing challenges, and unleashes innovation potential, thus balancing the innovation development disparities between different–sized enterprises.

Based on the above theoretical analysis, this paper proposes the third hypothesis:

H3: Compared to large enterprises, digital finance has a more significant impact on promoting technological innovation in small and medium–sized enterprises.

Analysis of Industry Heterogeneity

Different industry types of companies result in varying levels of R&D investment and financing constraints. This study classifies the sample into high–tech and non–high–tech firms based on industry type. With the support of digital finance, the technological innovation characteristics of these two types of firms differ. High–tech firms, relying heavily on technology, have strong innovation momentum and align well with digital finance, receiving substantial financial support. The development of digital finance offers high–tech firms diverse and efficient financing channels to meet their funding needs (Zhang & Zhu, 2022), stimulates innovation, and accelerates the technological innovation process (Ren & Li, 2023). In non–high–tech industries, the impact of digital finance may be relatively weaker. These companies often operate with traditional production models and more straightforward technological requirements, rely on their resources for profit, have lower innovation demands, and exhibit less reliance on digital finance.

Based on the above theoretical analysis, this paper proposes the fourth hypothesis:

H4: Compared to non–high–tech firms, digital finance has a more significant impact on promoting technological innovation in high–tech firms.

Research Methodology

Sample Selection and Data Sources

This study uses data from Chinese A–share listed companies from the Shanghai and Shenzhen stock exchanges for 2011–2022. The digital finance data is sourced from the Peking University Digital Inclusive Finance Index (2011–2022), compiled by the Peking University Digital Finance Research Center. Company–level data is obtained from the China Stock Market & Accounting Research (CSMAR) database and the Chinese Research Data Services platform (CNRDS). The following data cleaning procedures were applied to ensure data continuity and reliability: (1) Exclude companies in the financial and real estate sectors. (2) Exclude ST, *ST, PT, and IPO companies. (3)

Exclude companies with missing financial data. (4) Apply Winsorizing to continuous variables below the 1st percentile and above the 99th percentile. The final dataset comprises panel data for 4,502 listed companies with 32,886 observations.

Data Analysis

The data used in this study are all secondary. The digital finance data are sourced from the Peking University Digital Financial Inclusion Index (2011–2022) compiled by the Peking University Digital Financial Research Center. Enterprise-level data are obtained from the China Stock Market & Accounting Research Database (CSMAR), while regional economic development level data are from the China Statistical Yearbook. Data on internet penetration rates by province are sourced from the "Statistical Report on Internet Development in China." The data on the number of inventions independently filed by enterprises in the year comes from the Chinese Research Data Services (CNRDS). This study employs quantitative analysis to achieve its research objectives, which include the following steps.

1. Descriptive Statistical Analysis

This study performs descriptive statistical analysis on the key variables, including their means, maximum values, minimum values, and standard deviations, to better understand each variable's basic characteristics.

2. Correlation Analysis

To anticipate the relationships between variables and address potential multicollinearity issues, this study employs Pearson correlation coefficients to identify the associations between digital finance, financing constraints, corporate technological innovation, and other variables. Additionally, the study calculates the Variance Inflation Factor (VIF) to assess multicollinearity further.

3. Benchmark Regression Analysis

This study uses the Hausman test to determine whether the fixed or random effects model should be used. Based on the chosen model, regression analysis examines the relationship between digital finance, its three dimensions, and enterprise technological innovation, thereby testing Hypothesis 1.

4. Mediation Effect Analysis

To investigate how digital finance affects enterprise technological innovation, this study performs regression analysis on digital finance, financing constraints, and corporate technological

innovation. The mediation effect model assesses whether financing constraints mediate the relationship between digital finance and technological innovation, testing Hypothesis 2.

5. Heterogeneity Analysis

(1) Due to differences in ownership structure between state–owned enterprises (SOEs) and non–state–owned enterprises, which result in distinct management models and social credit levels, there are significant variations in the extent of financing constraints these enterprises face in the market. This study categorizes the sample enterprises into two groups based on ownership structure: state–owned and non–state–owned. Group–based regressions are conducted to test Hypothesis 3.

(2) This study classifies the sample enterprises based on asset size to examine whether the scale of the enterprise influences the impact of digital finance on corporate technological innovation. Specifically, enterprises are ranked in ascending order of their total assets for the year. The top 75% are classified as small and medium–sized enterprises, while the bottom 25% are classified as large enterprises. Group–based regressions are conducted to test Hypothesis 4.

(3) This study categorizes the sample enterprises into high–tech and non–high–tech enterprises based on information disclosed in the CSMAR database on listed company qualifications. Group–based regressions are conducted to test Hypothesis 5.

(4) To investigate regional differences in the impact of digital finance on enterprise technological innovation, this study classifies the sample enterprises based on their registration locations into two groups: Eastern region and Central–Western region. Group–based regressions are conducted to test Hypothesis 6.

6. Endogeneity Test

Endogeneity issues primarily arise from two sources: First, reverse causality may occur because digital finance and corporate technological innovation might mutually reinforce each other, leading to potential endogeneity problems when assessing the impact of digital finance on enterprise technological innovation. Second, omitted variable bias can result from unobservable factors. This study employs two methods for testing endogeneity: First, the instrumental variable approach is used, with the provincial–level internet penetration rate (INTERNET) selected as an instrumental variable for the digital finance index to test for endogeneity. Second, lagged values of explanatory variables are introduced. Specifically, the total index of digital finance lagged by one period, while the dependent and control variables use current values to examine endogeneity issues further.

7. Robustness Test

To ensure the reliability of the research results, this study employs three methods for robustness testing. First, it substitutes the dependent variable, using the number of independently filed invention patents in a given year (INVENT) as an alternative measure of enterprise technological innovation and re-evaluates the regression results. Second, it excludes samples from municipalities directly under the central government by removing data from Beijing, Shanghai, Tianjin, and Chongqing and tests the remaining samples. Third, it revises the sample treatment method by replacing the previous 1% and 99% winsorization with a more precise 2.5% and 97.5% winsorization and then performs the robustness test.

Figure 3 depicts the data analysis process based on the research objectives and hypotheses. Hypothesis H1 is formulated to address Research Objective 1, while Hypothesis H2 is designed to meet Research Objective 2. Hypotheses H3, H4, H5, and H6 are proposed to explore Research Objective 3. Together, these three objectives and six hypotheses comprehensively analyze the study's research topic.

Results Analysis

1. Descriptive Statistics Analysis

This section provides a descriptive statistical analysis of the main variables, as shown in Table 1. There is substantial variation in the level of technological innovation among sample firms, with the minimum value being 0, indicating that some firms have no investment in innovation. The median level of technological innovation is relatively low, suggesting that the proportion of R&D expenditure relative to revenue is also low. The digital finance index shows significant variability, reflecting uneven development levels across provinces. The SA index for financing constraints varies noticeably, indicating firms' differing financing pressures. The values for the control variables are reasonable.

Table 1 Descriptive Statistics of Variables

Variables	N	mean	sd	min	median	max
ETI	32886	4.256	5.095	0.000	3.300	41.120
DFI	32886	2.929	1.098	0.185	3.109	4.607
BRE	32886	2.763	1.113	0.031	2.908	4.559
DEP	32886	2.962	1.135	0.128	3.176	5.107
DIG	32886	3.419	1.148	0.076	3.885	4.672
FC	32886	4.106	1.517	0.637	3.860	9.627
SIZE	32886	22.167	1.273	18.997	21.997	26.389
AGE	32886	18.820	5.851	3.000	19.000	38.000
LEV	32886	0.423	0.208	0.039	0.412	1.201
ME	32886	0.091	0.079	0.007	0.071	0.657
ROA	32886	0.033	0.079	−0.705	0.036	0.247
GROW	32886	0.303	0.818	−1.001	0.119	9.492
SUB	32886	16.206	2.684	0.000	16.488	20.764
TOP1	32886	33.671	14.790	7.860	31.225	75.100
DUAL	32886	1.707	0.455	1.000	2.000	2.000
RGDP	32886	11.246	0.462	9.866	11.301	12.156

2. Benchmark Regression Analysis

This study uses the Hausman test to select the fixed-effects model to analyze the impact of digital finance on corporate technological innovation. The model uses technological innovation as the dependent variable and the digital finance index as the independent variable, applying Model 3.1 for regression analysis. Table 2 presents the regression results from different models, progressively adding control variables, individual and time-fixed effects, and robust standard errors to improve model accuracy. Column (4) of Table 2 shows that the regression coefficient for digital finance on corporate technological innovation is 0.71, which is significant at the 5% level. This indicates that digital finance significantly promotes technological innovation in firms, validating Hypothesis H1.

Table 2 Benchmark regression results

Variables	(1) ETI	(2) ETI	(3) ETI	(4) ETI
DFI	0.62***	0.98***	0.71***	0.71**
	(47.53)	(21.68)	(3.69)	(2.25)
SIZE		0.11***	0.37***	0.37***
		(3.78)	(11.54)	(4.65)
AGE		−0.18***	−0.04	−0.04
		(−18.17)	(−0.28)	(−0.24)
LEV		−3.02***	−2.59***	−2.59***
		(−24.88)	(−21.02)	(−9.73)
ME		10.35***	9.88***	9.88***
		(40.00)	(37.15)	(11.58)
ROA		−5.28***	−5.14***	−5.14***
		(−25.11)	(−24.70)	(−11.69)
GROW		−0.03	−0.06***	−0.06**
		(−1.38)	(−3.09)	(−1.96)
SUB		0.06***	0.03***	0.03***
		(10.18)	(5.34)	(3.29)
TOP1		−0.02***	−0.01***	−0.01
		(−8.17)	(−3.44)	(−1.48)
DUAL		−0.13***	−0.02	−0.02
		(−3.15)	(−0.38)	(−0.22)
RGDP		0.87***	0.13	0.13
		(7.08)	(0.79)	(0.44)
_cons	3.14***	−6.65***	−6.73***	−6.73
	(34.34)	(−4.62)	(−2.68)	(−1.54)
Control	No	Yes	Yes	Yes
Indi_FE	No	No	Yes	Yes
Year_FE	No	No	Yes	Yes
Robust	No	No	No	Yes
N	32886	32886	32886	32886
r2			0.160	0.160
F			245.52***	52.49***

t statistics in parentheses

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

3. Mediation Effect Analysis

This section conducts regression analyses on Models 3.1, 3.2, and 3.3 to examine how digital finance affects corporate technological innovation. The empirical results are presented in Table 3.

Step 1: Assess the relationship between digital finance and corporate technological innovation. Column (1) of Table 3 shows that $\alpha 1 = 0.76$, which is significant. This indicates that digital finance significantly promotes technological innovation. This reflects the total effect of digital finance on corporate technological innovation.

Step 2: Evaluate the relationship between digital finance and corporate financing constraints. Column (2) of Table 3 shows that $\beta 1 = 0.18$, which is significant at the 5% level, suggesting that digital finance significantly alleviates financing constraints faced by firms.

Step 3: Investigate the mediating role of financing constraints. Column (3) of Table 3 shows that $\gamma 1 = 0.71$ and $\gamma 2 = 0.29$, both of which are significant. The absolute value of $\gamma 1$ is less than that of $\alpha 1$, indicating that financing constraints partially mediate digital finance's effect on technological innovation. The size of the mediation effect is $\beta 1 \gamma 2 = 0.0522$. This supports Hypothesis H2, demonstrating that digital finance promotes corporate technological innovation by alleviating financing constraints.

Table 3 Mediation Effect Regression Results

Variables	(1)	(2)	(3)
	ETI	FC	ETI
DFI	0.76**	0.18**	0.71**
	(2.42)	(2.01)	(2.25)
FC			0.29***
			(4.37)
SIZE	0.37***	1.17***	2.28***
	(4.65)	(306.91)	(4.00)
LEV	-2.26***	1.02***	-2.56***
	(-8.64)	(13.46)	(-9.62)
ME	9.25***	-1.89***	9.80***
	(11.34)	(-12.52)	(11.53)
ROA	-4.90***	0.80***	-5.13***
	(-10.95)	(10.30)	(-11.67)

Table 3 (Continue)

Variables	(1)	(2)	(3)
	ETI	FC	ETI
GROW	−0.05*	0.02***	−0.06*
	(−1.74)	(3.02)	(−1.93)
SUB	0.05***	0.05***	0.04***
	(4.55)	(13.51)	(3.42)
TOP1	−0.01	0.00	−0.01
	(−1.44)	(0.55)	(−1.51)
DUAL	−0.02	−0.01	−0.01
	(−0.23)	(−0.42)	(−0.20)
RGDP	0.14	0.05	0.13
	(0.49)	(0.49)	(0.44)
_cons	0.19	1.88*	−0.36
	(0.06)	(1.90)	(−0.11)
Control	Yes	Yes	Yes
Robust	Yes	Yes	Yes
Indi_FE	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes
N	32886	32886	32886
r2	0.156	0.366	0.159
F	56.66***	127.40***	54.78***

t statistics in parentheses

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

4. Heterogeneity Analysis

4.1 Scale Heterogeneity

This study divides the sample companies into small and medium-sized enterprises (SMEs) and large enterprises based on asset size. Companies in the bottom 75% by size are categorized as SMEs, while those in the top 25% are classified as large enterprises. The impact of digital finance on technological innovation is examined separately for these two groups. The SME group has 24,520 observations, while the large enterprise group includes 8,366 observations. Table 4 presents the empirical results. Column (1) shows the regression results for large enterprises, while Column (2) displays the results for SMEs. The analysis reveals that the coefficient for digital finance (DFI) is positive and significant (0.78) in the SME sample, whereas it is positive but not significant (0.33) in

the large enterprise sample. Thus, digital finance has a more pronounced effect on promoting technological innovation in SMEs, confirming Hypothesis H3.

Table 4 Regression Results by Scale Heterogeneity

Variables	(1) ETI	(2) ETI
DFI	0.33	0.78*
	(0.86)	(1.93)
SIZE	0.04	0.50***
	(0.34)	(5.63)
AGE	−0.03	−0.01
	(−0.14)	(−0.05)
LEV	−2.27***	−2.67***
	(−5.09)	(−8.66)
ME	8.57***	10.41***
	(3.51)	(11.77)
ROA	−5.05***	−4.95***
	(−5.70)	(−10.70)
GROW	0.04	−0.08**
	(1.03)	(−2.44)
SUB	0.00	0.04***
	(0.27)	(3.00)
TOP1	−0.01	0.00
	(−1.06)	(0.07)
DUAL	0.06	−0.06
	(0.49)	(−0.79)
RGDP	0.28	0.01
	(0.87)	(0.03)
_cons	−1.53	−8.55
	(−0.30)	(−1.62)
Control	Yes	Yes
Indi_FE	Yes	Yes
Year_FE	Yes	Yes
Robust	Yes	Yes
Group	Large Enterprises	Small and Medium−Sized Enterprises
N	8366	24520
r2	0.183	0.159
F	17.80***	39.80***

t statistics in parentheses

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

4.2 Industry Heterogeneity

To further investigate the varying effects of digital finance on innovation across different industries, this study divides the sample into high-tech and non-high-tech enterprises. The classification is based on information disclosed in the listed company qualification database, sourced from the CSMAR database. The results of the industry heterogeneity analysis are shown in Table 5. In the regression analysis for high-tech enterprises, the coefficient for digital finance (DFI) is positive (0.48) and significant at the 10% level. However, in the regression for non-high-tech enterprises, while the coefficient is also positive (0.51), it does not pass the 10% significance test. Compared to non-high-tech enterprises, digital finance has a more significant impact on promoting technological innovation in high-tech enterprises. This confirms Hypothesis H4.

Table 5 Regression Results by Industry Heterogeneity

Variables	(1) ETI	(2) ETI
DFI	0.48*	0.51
	(1.84)	(1.57)
SIZE	0.37***	0.33***
	(3.80)	(3.85)
AGE	0.04	0.12
	(0.17)	(0.53)
LEV	-3.32***	-2.17***
	(-8.65)	(-7.10)
ME	17.54***	6.90***
	(10.69)	(8.47)
ROA	-5.39***	-4.41***
	(-8.39)	(-8.02)
GROW	-0.04	-0.05
	(-0.91)	(-1.54)
SUB	0.03**	0.03**
	(2.16)	(2.42)
TOP1	-0.01	-0.01
	(-0.91)	(-1.16)
DUAL	-0.10	0.04
	(-1.07)	(0.39)
RGDP	0.45	-0.03

Table 5 (Continue)

Variables	(1) ETI	(2) ETI
	(1.15)	(–0.10)
_cons	–11.28**	–6.23
	(–2.03)	(–1.23)
Control	Yes	Yes
Indi_FE	Yes	Yes
Year_FE	Yes	Yes
Robust	Yes	Yes
Group	High–Tech Enterprises	Non–High–Tech Enterprises
N	15168	17718
r2	0.239	0.117
F	45.22***	20.06***

t statistics in parentheses

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

4.5 Robustness test

The previous analysis concluded that digital finance significantly promotes technological innovation in enterprises. This study employs an alternative, dependent variable approach to enhance the reliability of these results. Following the Li Chuntao et al. (2020) method, the number of independent patents filed by the enterprise in the current year (INVENT) is used as a proxy for technological innovation. The robustness test results are presented in Table 6. Even with this alternative measure of technological innovation, digital finance continues to promote technological innovation significantly at the 1% level.

Table 6 Robustness Test Results

Variables	(1) INVENT
DFI	25.50***
	(3.95)
SIZE	13.63***
	(8.26)
AGE	-4.02
	(-0.64)
LEV	-11.68***
	(-3.39)
ME	-1.18
	(-0.18)
ROA	3.37
	(0.97)
GROW	-0.11
	(-0.43)
SUB	-0.04
	(-0.26)
TOP1	-0.06
	(-0.68)
DUAL	-1.34
	(-1.35)
RGDP	4.48
	(0.67)
_cons	-291.56***
	(-2.63)
Control	Yes
Indi_FE	Yes
Year_FE	Yes
Robust	Yes
r_test	Replacing the Explained Variable
N	32467.000
r2	0.10
F	18.63***

t statistics in parentheses

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

Discussion

The research results are consistent with the research of Yanhong Mou (2024). A study was conducted on the impact of digital finance on technological innovation across enterprise life cycles in China. The research results found that: digital finance significantly improves the efficiency of technological innovation; more importantly, the Digital Finance Adoption Rate (DFAR) has a more significant influence than the Digital Finance Level (DFL). According to the Digital Transformation Maturity (DTM) scale, digital finance helps businesses transform digitally, increasing the effectiveness of technological innovation. State-owned businesses are more affected by the influence of digital finance on innovation efficiency than non-state-owned businesses. Other factors, including enterprise lifecycle, innovation investment, digital leadership, revenue strategies, and market rivalry, also shape the relationship between digital finance and technical innovation efficiency. To increase innovation efficiency, particularly in state-owned businesses, the study suggests expanding access to and adoption of digital finance. It also means leveraging elements such as enterprise lifecycle, innovation investment, digital leadership, revenue strategies, and market competition to spur more technological innovation. The impact of digital finance on technological innovation at different phases of organizational growth in China highlights the need for customized methods to harness its potential.

Conclusion

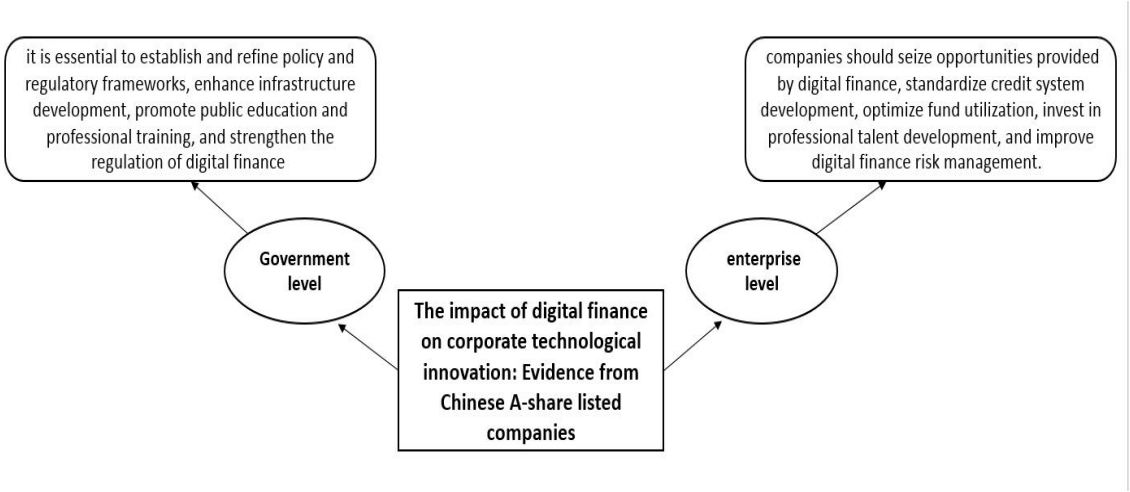
This study examines the impact of digital finance on corporate technological innovation in Chinese A-share listed companies from 2011 to 2022. The findings show that digital finance significantly promotes innovation, particularly by reducing financing constraints, which act as a mediator. The effects vary by company size and industry: digital finance has a strong positive influence on innovation in small and medium-sized enterprises (SMEs) and high-tech firms but little impact on large or non-high-tech companies.

Recommendation

In the era of digital finance, governments, financial institutions, and businesses all face the challenge of digital transformation and upgrading. To overcome financing constraints and stimulate technological innovation, it is crucial to integrate the policy-leading role of the government, the service-oriented role of financial institutions, and the innovation-driving role of businesses.

Governments should establish a comprehensive policy and regulatory framework, enhance infrastructure, promote public education and professional talent development, and strengthen digital finance regulation. Financial institutions should accelerate their digital transformation, provide precise digital financial services, and expand digital financial cooperation comprehensively. Businesses should seize the opportunities provided by the development of digital finance, standardize credit system construction, allocate and use funds efficiently, develop digital finance professionals, and strengthen risk prevention and control.

New knowledge



This study finds that Digital finance significantly promotes corporate technological innovation, and this conclusion remains robust after robustness tests. Digital finance enhances technological innovation by alleviating financing constraints, with financing constraints mediating this process. The impact of digital finance on technological innovation varies by scale and industry, with its effect being more pronounced for small and medium–sized.

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